2) AIR (PREVENTION AND CONTROL OF POLLUTION) ACT, 1981

3) ENVIRONMENT POLLUTION (PREVENTION AND CONTROL) AUTHORITY (EPCA) [1998 - 2020]

- **About EPCA**
  - » EPCA was a **Supreme Court mandated body** tasked with taking various measures to tackle air pollution in National Capital Region (NCR).
  - » MoEF&CC notified this body in 1998 under the EPA, 1986.
  - » **Mandate**
    - ▫ Protect and improve the **quality of environment** and prevent and control **environmental pollution** in the **NCR**.
    - ▫ It is also mandated to implement the **Graded Response Action Plan (GRAP)** in NCR as per the pollution level.
  - » The Authority can take complaints **suo motu** or on the basis of a **filed complaint**.
- **Key contributions of EPCA** in 22 years of its existence
  - » Notification of Graded Response Action Plan
  - » Early adoption of BS-VI fuels standards
  - » Suggestions for Construction of the regional rapid transport system
- **Note:** The 22-year-old Environment Pollution (Prevention and Control) has been dissolved. (Oct 2020)

4) THE COMMISSION FOR AIR QUALITY MANAGEMENT IN NATIONAL CAPITAL REGION AND ADJOINING AREAS

- **Need**
  - ▫ A major reason behind high pollution levels in NCR has been the inability of CPCB, EPCA etc. to impose rules on the ground.

- The new permanent Commission envisages a multi-sectoral, participatory, multi-state dynamic body with a statutory status.

- **Details**

- The commission has been set up to monitor and check **air pollution levels** in the NCR and adjoining region.
  - » It **supersedes all existing bodies**. The commission shall have exclusive jurisdiction in respect of matters covered by the law.
  - » **Powers of CPCB/SPCB continue:** The CPCB and its state branches have the power to implement provisions of the Environment Protection Act for air, water and land pollution.
    - However, in case of **dispute** or clash of jurisdictions, the Commission's writ will prevail specific to matters concerning air pollution.
- **The commission** will look at:
  - » Coordination between states
  - » Planning and execution of policy and interventions
  - » Operations of industry
  - » Inspections
  - » Research into the cause of pollution etc.
- The powers to l**evy fines - ranging up to Rs 1 crore or five years of prison** also lies with the commission.
- The commission will be empowered to constitute special investigative groups for stricter implementation of air pollution norms on the ground.
- **Structure**
  - » There will be at least **six permanent members** and it will be headed by a former or incumbent secretary to the GoI, or chief secretary to a state government.
  - » Overall, there would be **18 members** which would include **five ex-officio members representing the five states;** technical members from CPCB and ISRO; three representatives from NGOs with experience in combating air pollution; one representative from NITI Aayog.
- **NGT:** Only the NGT, and not civil courts, is authorized to hear cases where the commission is involved.
- **Area covered:** Delhi, Punjab, Rajasthan, Haryana and Uttar Pradesh

- **How is it different from EPCA?**
  - **EPCA** was a Supreme Court mandated body, whereas the commission will be a **statutory body**.
  - **Area coverage:** EPCA - NCR, Commission -> NCR and adjoining areas.
    - » The pollution in Delhi is also caused by adjoining areas and therefore it has been given powers accordingly.
  - **State representation** was absent in EPCA but is present in the commission.
    - » The new 18-member commission brings together the Centre, states, and other stakeholders on one collaborative platform.
  - **Improved coordination:** the body has the mandate/powers to coordinate among states, which was absent in case of EPCA.

5) GRADED RESPONSE ACTION PLAN (GRAP)

- **GRAP** is the Delhi's **five-step escalating plan** to counter air pollution.
    - It was formulated in 2016 by Environmental Pollution Control Authority (EPCA) and approved by SC in the same year.

- **MoEF&CC had notified GRAP** for Delhi and NCR in 2017 and it draws its authority from this notification.
    - It institutionalized measures to be taken when air quality deteriorates.
    - The plan is **incremental in nature**. The **nature scope and rigor of measures** to be taken is linked to levels of pollution viz. Severe+ or Emergency, Severe, Very Poor, Moderate to Poor and Moderate.
    - **Note:** GRAP works only as an emergency measure and doesn't include actions by various state governments to be taken throughout the year to tackle industrial, vehicular and combustion emission.
    - Various directives of GRAP kick in based on the recommendations of a committee of experts;

- **Note:**
    - Since the formation of "the Commission for Air Quality Management in National Capital Region and Adjoining Areas", it is the designated agency for the implementation of the plan.

- **Significance**
    - GRAP has been successful in doing two things that had not been done before:
        - Creating a step-by-step for the entire Delhi-NCR region.
        - Getting on board several agencies: All pollution control boards, industrial area authorities, municipal corporations etc.
        - Fixed accountability and deadlines. For each action to be taken under a particular air quality category, executing agencies are clearly marked. In a city like Delhi which has multiplicity of authority, this has had a crucial difference.
        - EPCA along with GRAP has contributed in **three major policy decisions:**
            - Closure of thermal power plant at Badarpur, brining BS-VI fuel to Delhi before the deadline set initially, and the ban on Pet Coke as a fuel in Delhi-NCR.
- **Limitations of GRAP**
    - **Focus on Delhi -** other states have managed to delay several measures, citing lack of resources;

- **How was GRAP implementation different in 2022**:
    - On 5th Aug 2022, the CAQM issued statutory direction, for the implementation of revised schedule of the GRAP.
    - **Key Changes in the revised action plan**:
        a. Restriction on polluting activities will be dependent on Air Quality Index (AQI) rather than PM2.5 and PM10 concentration.
        b. Measures could be taken up to three days in advance based on forecasts, the revised plan states.
            - **Earlier**, measures were implemented only after the PM2.5 and PM10 concentrations (micrograms per cubic meter) reached a certain threshold.
    - The **GRAP** for Delhi-NCR is divided into four stages. As per the plan, actions under stages 2-4 are invoked at least three days in advance of the AQI reaching the projected levels.

Stage	Key steps in each stage:

Stage-1: "Poor" AQI: 201-300	Ban on construction and demolition activities at specific sites. Agencies must ensure that all solid waste is lifted from dedicated dump sites, and none is dumped on the open land. Heavy fines are to be imposed for openly burning municipal solid waste and biomass. Roads will be mechanically cleaned and water will be sprinkled from time to time. Authorities will ensure that thermal power plants comply with emission norms and that industries use approved fuel. The ban on firecrackers should be followed as per the directions of respective courts Social Media is to be used to update people about pollution levels and control room contact details so that violations can be reported to the authorities.
Stage-2: Very Poor AQI: 301-400	**Daily Mechanized sweeping** of roads; Water sprinkling with dust suppressants at least on alternate days; Use of Coal and firewood in eateries would be banned. Use of Diesel Generators might be allowed only in certain cases. Parking fees may be raised to discourage private transport. Resident Welfare Associations would be required to provide electric heaters to security staff during winter to prevent the burning of solid waste or biomass.
Stage-3: Severe AQI: 401-450	The frequency of cleaning roads intensifies in this stage. Water would be sprinkled daily before traffic hours. Strict ban on all construction activities except ongoing work on roadways, railways, metro, hospital etc. Authorities will levy different rates on public transport services to encourage off-peak travels. The state government will be empowered to impose restrictions on BS-III petrol and BS-IV diesel light motor vehicles (4-wheelers)
Stage-4: Severe Plus AQI > 450	Entry of **all trucks** except those carrying essential commodities, or providing essential services is to be stopped into Delhi. This will be followed by a ban on plying of diesel-operated medium goods and heavy goods vehicles in Delhi, except those carrying essential items. **All construction** and **demolition** activities would have to be stopped.

	The respective government could meanwhile, take a call on allowing public, municipal and private offices to work at 50% strength. If required, the Centre can allow work from home for central government employees. Additional emergency measures like closing schools and other educational institutes, non-emergency commercial activities and plying of vehicles on an odd-even basis may also be enforced.

- **Revised GRAP to deal with adverse air quality scenario (Nov 2022)**
    - In a move to mitigate dust arising out of C&D activities sites and intensify actions to further ameliorate the overall air quality of the NCR, the CAQM has mandated all C&D projects in NCR to deploy adequate number of anti-smog guns, in proportion of the total area of construction for the project.
        - Different number of guns have been recommended based on different size of the project. (1-> 5,000 - 10000 sqm; 2 for 10001-15,000 sqm; 3 for 15,001 - 20,000 sqm; 4 for 20,000 sqm)

- **Role of Citizens:**
    - GRAP also includes a graded advisory for public:
        - **Under Stage-1**, the measures include properly tuning the engines of their vehicles, ensuring accurate air pressure in tyres, and updating PUC (pollution under control) certificates. Turn off engines at red lights; don't dispose of waste or garbage in open space. Report air pollution activities through apps 311, Green Delhi, SAMEER"
        - **For Stages-2, 3 and 4**, the commission advises the public to opt for public transport, or work from home if required.
        - **Under stage-4**: the elderly and those with respiratory, cardiovascular, cerebrovascular or other chronic diseases are advised to avoid outdoor activities and stay indoors once stage-4 is implemented.

6) NATIONAL CLEAN AIR PROGRAM

- It is a pollution control initiative that was launched by the **Ministry of Environment** in Jan 2019 with the intention to cut the concentration of coarse particulate matter**(PM10)** and fine particles or **PM2.5** by at least **20%** (20-30%)in the **next five years** (i.e. by 2024), with **2017 as the base year** for comparison.

- It is a long term time bound national level strategy to tackle air pollution across Indian in a comprehensive manner.

- **Which are the cities covered?**
    - **132 Non-attainment Cities** identified on the basis of Ambient Air Quality Data for the period 2011-2015 and WHO report 2014/18.
- **Objectives**
    - Ensure implementation of **prevention, control and abatement** measures for air pollution
    - Improve the **monitoring network**.

- Enhance **public awareness** regarding air pollution and capacity building measures.

- **Who all are participating?**
  - Apart from **experts from industry** and academia, **various ministries** like Ministry of Road Transport and Highways, Ministry of Petroleum and Natural Gas, Ministry of New and Renewable Energy, Ministry of Heavy Industries, Ministry of Housing and Urban Affairs, Ministry of Agriculture, Ministry of Health, **NITI Aayog**, and **CBCB** are participating.

- **Key Steps being Taken**
  - **i. Pollution Reduction measures**
    - Plantation drives, promotion of better technology, sectoral interventions like electric vehicle promotion, promoting renewable energy, waste management etc.
    - City specific Plan - A separate emergency action plan will be created for each of the 132 cities. It will include measures for strengthening the monitoring network, reducing vehicular/industrial emissions, increasing public awareness etc.
  - **ii. Enhancing R&D and Data collection**
    - Studies related to air pollution and its impact will be taken on
    - Monitoring infrastructure will be expanded and will start covering rural areas as well.
    - A National Emission inventory will be established to provide proper inputs for future policy making.
  - **iii. Strengthening various pollution related institutions**
    - A National Apex Committee under MoEF&CC, a steering committee under Secretary (environment) and a monitoring committee (under joint secretary) will be established.
    - There will be project monitoring committees at the state-level with scientists and trained personnel.
    - In Addition sectoral working groups, National level project monitoring units, State level project monitoring units, city level review committee under Municipal Commissioner and DM level committee in the districts are to be constituted under NCAP for effective implementation and success of the program.
  - **iv. Increased focus on awareness generation and people's participation**.

7) BHARAT STAGE EMISSION STANDARDS (BS NORMS)

- **Intro:**
  - **Bharat stage emission standards** (first introduced in 2000) have been instituted by the GoI to **regulate the output of certain air pollutant** (NO_x, CO, HC, PM, SO_x) by vehicles and other equipment using internal combustion engine. As stage goes up, the control on emissions become stricter.
  - The standards and timeline for implementation are set up by the Central Pollution Control Board under the Ministry of Environment, Forest and Climate Change.

- **Dates of Application**
  - **BS-4:** BS-IV norms are applicable throughout the country from 1st April 2017.
  - **BS-V:** GoI has **decided to skip** the standards and directly move to BS-VI standards by 2020.

» **BS-VI:** Introduced in Delhi from 1st of April 2018, it is applicable **throughout the country from April 2020** for all vehicles.

- **Differences in BS-IV and BS-VI standards**
  - » The main difference between BS-IV and BS-VI norms is the **amount of Sulphur** in the fuel.
    - Reduction in Sulphur will make it possible to equip vehicles with better catalytic converters that capture pollutants.
  - » Similarly, **NO_x emission** from diesel is expected to come down by 70% and by 25% in petrol vehicles. Further, the **restrictions on PM** has been increased in both diesel and petrol vehicles.
  - » There are also lower limit for **HC and NO_x in** diesel engine**.**

	g/km	g/km	g/km	g/km	g/km	Sulphur
Petrol Emission Norms	**CO**	**HC**	**NO_x**	**HC + NO_x**	**PM**	
BS-III	2.3	0.2	0.15	---	--	
BS-IV	1.00	0.1	0.08	---	--	50 ppm
BS-VI	1.00	0.1	0.06	---	0.005	**10 ppm** (10 mg/kg)
Diesel Emission Norms	**CO**	**HC**	**NO_x**	**HC + NO_x**	**PM**	
BS-III	0.64	--	0.50	0.56	0.05	
BS-IV	0.50		0.25	0.30	0.025	50 ppm
BS-VI	0.50	--	**0.06**	**0.17**	**0.005**	**10 ppm**

- **Other Key Changes being brought:**
  - **Diesel Particulate Filter (DPF) and Selective Catalytic Reduction (SCR)** are being introduced with the roll-out of Bharat Stage VI norms, which were not a part of Bharat Stage IV.
  - **Real Driving Emissions** (RDE) will be introduced in India for the first time with the implementation of Bharat Stage VI emission norms. It will measure a vehicle's emission in real-time conditions against laboratory conditions.
  - **Onboard diagnostics** has been made mandatory for all vehicles.
  - BS VI would require usage of **Fuel Injection Technology** for two wheelers. This will the first such norm in India. This will filter out some PMs, some NO_x etc.

8) PETROL VS DIESEL COMPARISON

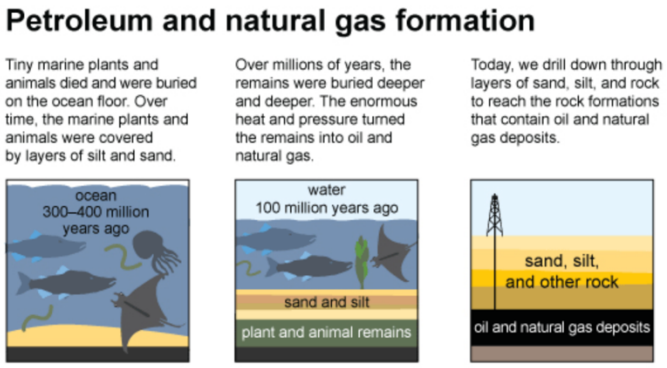
- **Conversion to CNG**
  - » Converting petrol car to CNG only costs around 30,000 rupees, whereas in case of diesel car it costs around 1,50,000 rupees, as it requires fundamental changes in the engine of the car and is an expensive time-consuming process.

- **Is Diesel worse than petrol?**
  - » **More SPMs:** A diesel car emits 22 times more Suspended Particulate Matters (SPM) - the tiny particles which easily penetrate your lungs, hearts and even brains.

» **More Nitrogen di oxide:** Diesel emits four times more nitrogen di oxide.
» **Less CO_2 and better fuel economy:** However, a diesel car emits 15% less CO_2 than petrol and since it is more efficient fuel (it burns more than petrol), it also gives a higher fuel economy.

9) NATURAL GAS

- Natural gas is a fossil fuel containing different organic compounds. It primarily consists of **methane**. Some other compounds in it includes ethane, propane etc. It is a colorless, tasteless and odorless gas.
- **How is natural gas formed?**
  - It is a fossil fuel which is formed due to extreme pressure and heat for millions of years on remains of plants and animals buried under the surface of the earth.



- **Advantages of Natural Gas**
  - **Environmentally more clean than other fossil fuels**: It releases very less byproducts into the atmosphere as pollutants.
  - **Economical** - it is cheaper than other fossil fuels.
  - **Safer to use**: Unlike LPG cylinders which has the risk of leakage and accident, natural gas is lighter than air. In case of leakage, it dissipates quickly into air avoiding fire.
  - **Abundance**
  - **Easy to deliver** - **Piped transportation** make it easy to transport.

- **Limitations**
  - **Non-Renewable Fossil Fuel -** Emits CO2 - Global Warming, Climate change.
  - **Easily inflammable**

- **Natural Gas comes in four basic forms:**
  - **Liquified Natural Gas** (liquified at -160 degree celsius). This facilitate transportation in large volumes in cryogenic tankers across seas/ land.
  - **Regasified LNG** (RLNG): LNG re-gasified at import terminals before transporting it to consumers through pipelines.
  - **Compressed Natural Gas (CNG)**: Compressed to a pressure of 200-250 kg/ cm3 - used for fuel transportation.
  - **Piped Natural Gas**: Natural gas distributed through a pipeline network that has safety valves to maintain the pressure, assure safe, uninterrupted supply to the domestic sector for cooking and heating/ cooling applications.

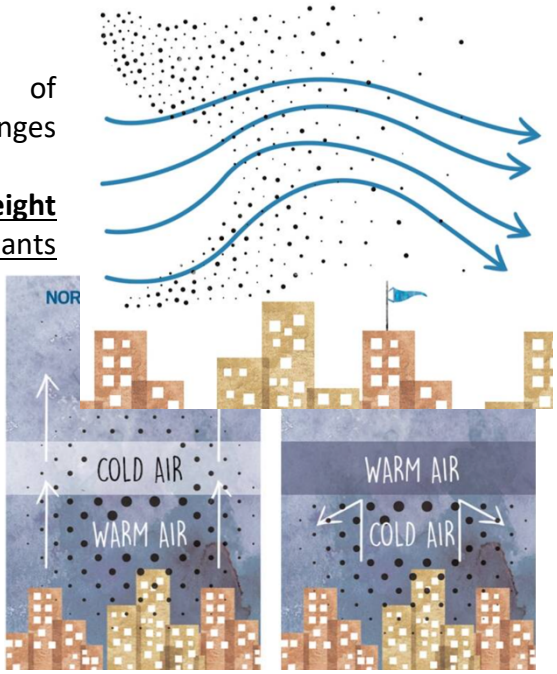
5. RECENT AIR POLLUTION ISSUES

1) DELHI'S AIR POLLUTION PROBLEM

- **Introduction**
  - » Delhi's air quality dips drastically every year with the arrival of harvest season during October-November. Though, government generally blames the stubble burning in the neighboring states as the key cause, but the air pollution in Delhi is a complex phenomenon that is dependent on a variety of factors.

- **Key Factors include:**
  - **i. Input Pollutants**
    - Dust is the biggest cause of pollution during winters. Dry cold weather leads to dust being easily available in the entire region.
    - Vehicular Pollution is the second biggest cause of pollution in winters.
      - According to a study by IIT Kanpur, around 20% of PM2.5 in winters comes from vehicular pollution.
    - Stubble burning
      - At the time of Rabi harvesting around 25% of PM content in Delhi is due to stubble burning.
    - Industries, thermal power plants, burning of waste during winters
    - Diwali Pollution

  - **ii. Meteorological Factors**
    - **Wind Direction:** With the departure of Monsoon, the wind direction in Delhi changes from easterlies to westerlies.
    - **Dip In Temperature brings the inversion height to lower levels.** The concentration of pollutants in the air increases when his happens.
      - Note: Inversion Height is the layer beyond which pollutants cannot disperse into the upper layer of the atmosphere.



  - iii. **Low Wind speed in winters:** High wind speeds are effective in dispersing pollutants, but with arrival of winters, the average wind speed decreases.

  - **iii. Other factors**
    - When compared to other metropolitan (i.e. Kolkata, Mumbai and Chennai) - Delhi is surrounded by high density region on all the sides. The other three cities are located near the coast, thus leaving the breathing space for the cities.

- **Steps taken in Delhi in the past to fight Air Pollution:**
    - In 1996, the Supreme Court took a note of the extremely poor air quality of Delhi and ordered the closure and relocation of over 1,300 highly polluting industries from Delhi's residential areas beyond the NCR in a phased manner. Multiple brick kilns were also directed to be relocated outside the city limit.
    - In 1998, the Supreme Court ordered the MoEF&CC to establish an authority for Delhi, which led to the creation of **Environment Pollution Control Authority (EPCA)** in 1998.
    - Supreme Court subsequently ordered conversion of the whole fleet of DTC buses, taxis and autos to CNG.
    - During this time centre also took several steps:
        - It revamped its Air Quality Monitoring Program and established a network of monitoring stations, under the National Air Quality Program.
    - In 2009, National Ambient Air Quality Standards were revised to include the 12 categories of pollutants including PM 2.5 - a noxious pollutant which can penetrate deep into the lungs and even enter the blood stream.
- **Steps taken in recent years to deal with pollution in Delhi**
    - **The Commission for Air Quality Management in National Capital Region and Adjoining Areas**
        - Formed in Oct 2020 through an ordinance to strengthen the air pollution control system in NCR and adjoining region
        - Replaces the EPCA
    - **Ban on Coal and other unapproved fuels from 1st Jan 2023**
    - Introduction of **BS-VI** norms for Vehicles
    - **Graded Response Action Plan (GRAP)**
    - **Push for Electric Vehicles - Delhi's Electric Vehicle Policy, 2019** subsidizes buying of electric vehicle and encourage people to move to electrical
    - **Various steps for controlling stubble burning**
    - **Prohibition on polluting crackers and promotion of green crackers**
    - **Odd-Even rule for vehicles** as emergency measures
    - **Construction of Eastern and Western Peripheral Expressways**
        - To provided fast alternative routes to vehicles not destined for Delhi.

2) BAN ON COAL AND OTHER UNAPPROVED FUEL IN DELHI (JAN 2023)

- CAQM has imposed a ban on coal and other unapproved fuels from 1st of Jan 2023. Industries using them would be closed and heavy fines would be imposed on them.
    - **Exceptions:**
        - Use of low sulphur coal in thermal power plants in Delhi NCR is allowed. It can be used wherever the primary purpose is **power generation**.
        - Firewood and biomass briquettes can be used for religious purposes and cremation.
        - Wood or bamboo charcoal can be used for tandoors and grills of hotels, restaurants, banquet halls (with emission control systems), and open eateries and Dhaba.
        - Use of wood charcoal for cloth ironing is allowed.
- The ban was notified by CAQM in June 2022

3) STUBBLE BURNING – CLASS DISCUSSION

A) PUSA DECOMPOSER

- a technology developed by IARI to manage paddy stubble in fields. It can rapidly degrade paddy straws in the field and convert them into compost, which then doesn't pose any issues for sowing of wheat crops, as per IARI scientists.
  - » It contains seven strains of fungi, which is to be mixed with water, 150 gms of jaggery and 50 gms of besan, to prepare a 25-litre solution that can be sprayed on 1 hectare of field.
  - » **Results:** Farmers of north Delhi found in 2020 that PUSA decomposer took about 20-22 days for stubble to decompose. This has helped in increasing soil fertility (less fertilizer use) and reduced the need of extensive ploughing to mix stubble with soil.

4) FIRE CRACKERS

- **Introduction**
  - » Firecrackers are among the most poisonous air pollutants. The **chemical footprint left by them have a devastating impact on human health and especially affects children**.
  - » **CPCB** in a study in Delhi in 2016 found that the levels of Aluminium, Barium, Potassium, Sulphur, Iron and Strotium rose sharply in Diwali night, from low to extremely high.

- **Science behind Firecrackers**
  - » Firecrackers use fuel and oxidizers to produce a combustion reaction, and the resulting explosion spreads the material in a superheated form. The metal salts in the explosive mix get 'excited' and emit light. Metals in the mix, which have varying arrangement of electrons in shells outside their nucleus, produce different wavelength of light in this reaction, generating spectacular colors.
    - For e.g. **Barium compounds** produce green light, Strontium and lithium salts produce red colors.

- **But firecrackers are big health hazards.**
  - » Chemicals such as barium nitrate and cadmium compounds cause respiratory irritation and gastrointestinal problems.
  - » Aluminium sulphide is known to cause Alzheimer's.
  - » Lithium and copper compounds cause hormonal imbalance and so on.

- In order to tackle the air and noise pollution during the festival season, the Supreme Court in a judgment (**Arjun Gopal & others Vs Union of India & others**), in Oct 2018 have mandated a series of steps to reduce the pollution from firecrackers. The key highlights of the Supreme Court Judgment includes:
  - **i. Improving the quality of crackers to reduce Air pollution**
    - a. Use of reduced emission firecrackers (**improved crackers**) only.
      - Avoiding use of ash as filler material -> Reduce particulate matter by 15-20%.
      - Use of charcoal meeting the PESO specifications.
    - b. Use of Reduced emission firecrackers (**green crackers**)
      - To reduce emission of PM, NO_x, and SO_2 due to in-situ water generation as dust suppressant.

c. **Firecrackers only with permitted chemicals** to be allowed -> PESO shall test and check for the presence of banned chemicals like lithium/arsenic/antimony/lead & mercury.
d. **Banning of Barium salts in Firecrackers**
    - Barium emits poisonous gas causing respiratory problems and may have health complications due to long-term exposure.
    - **Why Barium so common in firecrackers**: emits green light, low cost, readily available.
e. **Enough facilities should be created to ensure use of quality raw material** in gun/flash powder as per the Petroleum and Explosives Safety Organization (PESO) specifications. This will address the issue of high content of unburnt/partially combusted material.
f. **PESO to ensure firecrackers satisfy decibel levels**

ii. **Time Limit**
a. Firecrackers are only allowed from **8-10 pm** in Diwali and **11.55 pm - 12.30 pm** in Christmas and New year.

iii. **Blanket ban on online sale**

iv. **Ban on series cracker** ('*laris*').

v. **Stations house officer** will be held liable for contempt of court in case of violation of any judgment.

5) NGT BANS FIRE CRAKERS (NOV 2020)

- In Nov 2020, NGT has prohibited the sale and use of firecrackers during Deepavali in the NCR and in urban centres that recorded poor or worse air quality in Nov 2019.
- Sale of green crackers are allowed in cities and towns where air quality is moderate or below. But bursting of firecrackers are restricted to two hours during Diwali, Chatth, Christmas, and New Year.
- **Significance:**
    - A response to deteriorating air quality in various parts of the country. Primacy to precautionary principle in sustainable development over employment and revenue losses.
- **In July 2021, the SC upheld the NGT judgement**.

6) PETROLEUM AND EXPLOSIVE SAFETY ORGANIZATION (PESO)

- PESO is an statutory authority entrusted with the responsibility under the Explosives Act, 1884; Petroleum Act, 1934; Inflammable Substances Act, 1952, Environment (Protection Act), 1986 and rules made under those acts.
- It is a subordinate office under Department of Industrial Policy & Promotion.
- It is the nodal organization to look after the safety requirements in manufacture, storage, transport and use of explosives and petroleum.
- The organization is headed by Chief Controller of Explosives with its headquarter at Nagpur (MHA).
- **Other Recent Developments**
    - » In May 2018, Union Cabinet approved formation of Group 'A' service of the technical cadre of PESO in the name of Indian Petroleum & Explosives Safety Services (IPESS).
    - » The measure will enhance the capacity and efficiency of the organization and it will also enhance the career progression of its Group 'A' Officer.

- **Barium Nitrate** is used to produce green light and can produce more colors in combination with other chemicals.
  - » It is used in all light emitting fireworks.
  - » **Health Hazards**: Barium salts, as per the SC, can lead to health complications.
  - » **A replacement** of the salt is yet to be explored

7) GREEN CRACKERS

- **What are Green Crackers?**
  - » **Green Cracker**s are firecrackers produced using less harmful raw materials and additives to reduce emissions.
    - CSIR-NEERI has defined Green crackers as those which will reduce emission by 30% and can limit sound to 125 decibels (at a distance of 5 meters).
    - Since the Supreme Court had banned barium nitrate, the green chemicals contain Potassium nitrate and zeolite in green crackers instead.
    - They newly developed crackers also include Safe Water Releaser, Safe Minimal Aluminum Cracker and Safe Thermite Crackers.
      - The additives in Safe Water Releaser give out water, air and dust suppressants.
      - The Safe Minimal Aluminium minimizes the use of aluminium, potassium nitrate and sulfur.
      - The Safe Thermite Cracker is based on a combination of metals, including aluminium, and metal oxides like iron oxides to produce heat.
  - » The **packaging** of these crackers contains a **QR code** and **a green logo** that states that they have been certified by CSIR and NEERI.
- **Supreme Court** in Nov 2019 has said that it wants every consignment of the material used in manufacturing green fire crackers to be tested for quality control.
  - » Quality control mechanism should be set up in each manufacturing unit of green fire crackers within 15 days and such units be monitored by officials from the Petroleum and Explosive Safety Organization (PESO).

- **Are Green Crackers completely Green?**
  - » **No**
  - » They produce 30% less PM2.5 and 50% less SO2 emissions. But they still produce PM2.5 and SO2.

8) SMELTING INDUSTRY AND POLLUTION

- Smelting is a metallurgical process that involves heating raw ore or metal in order to extract or refine a desired metal.
  - » The process involves use of high temperatures and chemicals to break down the ore, allowing the desired metal to be separated from the other materials in the ore or metal.
  - » Generally, the raw material is usually heated to a high temperature in a furnace, along with a **reducing agent such as coke or charcoal**, which helps to reduce the metal oxide in the ore or metal to a pure metal.

- Smelting is used in the extraction of metals like iron, copper, lead and zinc as well as in the production of alloys such as steel.

- **Smelting is also a major source of Pollution**:
  - » It releases large amounts of pollutants such as sulfur dioxide and heavy metals into the air, water, and soil. The industry also causes noise pollution.

9) ODOUR POLLUTION

- **Introduction**
  - World Health Organization recognizes Odour (unpleasant smell) as a pollution and says it affects the quality of life and social well-being of individuals. The unpleasantness is created by presence of compounds such as Ammonia, Hydrogen Sulphide, butyric acid, ethyl and methyl mercaptan and dimethyl sulphide.
  - **Impact**
    - Effect of odour varies from person to person but at sufficiently high concentrations, odour compounds may have direct effect on human health.
    - It may lead to vomiting, headaches, nausea, stress, anxiety, frustration, restriction in outdoor activities, children unable to sleep and discomfort for elderly and others.
- **Main Sources of Odour Pollution**
  - MSW dumpyards, oil refineries, fish markets, slaughter houses, distilleries, pharmaceuticals, biomedical and hazardous waste disposal sites and pesticide plants.

- **Steps Taken**
  - i. **Central Pollution Control Board (CPCB) issues detailed guidelines for proper Monitoring and Management of Odour at Urban Municipal Solid Waste Landfills** (Sep 2017)
    - **The guidelines were based on the 'scientific pilot study' of East Delhi's Ghazipur landfill site.**
    - **Buffer zones: Green Belt around land fill** sites and suggested selection of appropriate plant species for vegetation cover to assist in reducing odour.
    - **Trapping LFG gases:** MSW landfill sites should be designed to tap landfill gases (LFG) efficiently to mitigate fugitive odorous emissions.
    - **Legislative norms on baseline data:** The guidelines also suggested for initiating legislative norms for creating baseline data on odour.
    - Need for **gradual shift for installation of Continuous Odour Measurement Systems** (Sensor based) similar to Continuous Air Quality Monitoring Stations (CAAQMS).
      - This is needed as manual measurement is time consuming
    - **Various Considerations before choosing landfill sites**
      - Present population and projected growth for the next 20 years
      - Whether the selected site is free from the impact of other odorous sources and the topography of the site (slope, proximity to water sources like river and natural springs)
      - Selection should be integrated with the urban development plan of the city so that even expansions of the city in next two or three decades are not encompassing the selected MSW site

6. VARIOUS AIR QUALITY MEASURING INITIATIVES IN INDIA

1) NATIONAL AIR QUALITY MONITORING PROGRAMMES (NAMP)

- **CPCB** is executing a nation-wide program of ambient air quality monitoring known as National Air Quality Monitoring Program (NAMP).
- **Objective** of NAMP is:
  i. To Determine status and trends of ambient air quality
  ii. To Ascertain whether the prescribed air quality standards are violated
  iii. To obtain the knowledge and understanding necessary for developing preventive and corrective measures
  iv. To understand the natural cleansing process undergoing in the environment through pollution, dilution, dispersion, wind-based movement, dry deposition, etc.

- **Pollutants covered:**
  i. Under NAMP, **four air pollutants** viz., Sulphur dioxide (SO2), Oxides of Nitrogen (NO2), Respirable Suspended Particulate Matter (RSPM/ PM10), and Fine Particulate Matter (PM 2.5) have been identified for regular monitoring at all the locations.
  ii. The monitoring of meteorological parameters such as wind and wind direction, relative humidity (RH) and temperature were also integrated with the monitoring of air quality.

2) NAAQS (NATIONAL AMBIENT AIR QUALITY STANDARDS) BY CPCB

- Ambient Air Quality refers to the condition or quality of air surrounding us in the outdoors.
- NAAQS are the standards for ambient air quality set up by CPCB and are applicable nationwide.
  - The CPCB has been conferred this power by the Air (Prevention and Control of Pollution) Act, 1981.
- The current standards were set up in 2009 and were an improvement over previous standard. It covers **12 pollutants**:
  - CO, SO_2, NO_x, PM10, PM2.5, Ozone, NH_3, lead, Arsenic, Benzene, Benzopyrene, Nickel.

3) AIR QUALITY INDEX (AQI)

- Air Quality Index is a number used by government agencies **to communicate to the public how polluted the air quality** is or how polluted it is forecasted to become.
- In India, National Air Quality Index, was launched in Sep 2014 as part of Swachh Bharat Abhiyan by MoEF&CC.
- The **CPCB**, the nodal agency for air pollution data in India, has developed a color coded air-quality index to mark hazardous levels for the public benefit.
- There are six AQI categories, namely Good, Satisfactory, Moderately polluted, Poor, Very Poor, and severe.
- It considers 8 pollutants (PM_{10}, $PM_{2.5}$, NO_2, SO_2, CO, **O_3**, NH_3, and Pb.)
- Initially it was launched in 10 cities and today it covers 24 cities in 10 states.

Color	AQI	Remark
	Good 0-50	Minimal Impact
	Satisfactory 51-100	May cause minor breathing discomfort in sensitive people.
	Moderate 101-200	May make breathing difficult for people with lung diseases and cause discomfort in children, older adults and heart patients.
	Poor 201-300	May make breathing difficult after prolonged exposure, and cause discomfort to people with heart diseases.
	Very Poor 301-400	May cause respiratory illnesses in people on prolonged exposure. Effect may be more pronounced in those with lung and heart diseases.
	Severe 400	May cause respiratory problems even in healthy people, and seriously impact those with lung/heart diseases. Even increased breathing during light physical activity can impact health.

- **Need of AQI**
  - Traditionally air pollution data has been reported in very voluminous way. It was important that information of air quality is put up in public domain in simple linguistic term that is easily understood by common person.

TARGET PRELIMS 2024
BOOKLET-13; EB&CC-3
WATER – RIVER, GROUND WATER AND OCEANS

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2. INTERNATIONAL EFFORTS – CONVENTIONS, REPORTS, MEETS ETC.

1) WATER CONVENTION

- Negotiated under: United Nation Economic Commission for Europe.
- **Convention on the Protection and Use of Transboundary Watercourses and International Lakes** (Water Convention) was adopted in Helsinki in 1992 and entered into force in 1996.
  - » It is a legally binding instrument and **aims** to protect and ensure the quantity, quality and sustainable use of **transboundary water resources** by facilitating cooperation.
  - » It provides inter-governmental platform for day-to-day development and advancement of transboundary cooperation.
  - » It was initially negotiated as a regional (Pan-European) instrument. Later, it turned into a universally available legal framework for transboundary water cooperation, following the entry into force of amendments in Feb 2013, opening it to all UN Member States.
- It has emerged as a powerful tool to achieve the objective of **SDG 6** (clean water and sanitation)
- **Is India a member?**
  - » No
- **Report:** "The Water Convention: 30 Years of Impact and Achievements on the Ground"

2) WORLD WATER DAY: 22ND MARCH

- **About World Water Day**
  - » WWD is an annual UN Observance Day which highlights the importance of fresh water. The day is used to promote awareness related to water conservation and advocate sustainable management of the freshwater resources.
  - » **UN-Water** is the convener for World Water Day and selects the theme for each year in consultation with UN organizations that share an interest in that year's focus.
  - » The day was first formally proposed in the 1992 UN Conference on Environment and Development in Rio de Janeiro. UNGA adopted the resolution regarding this in Dec 1992.
  - » The **first WWD** was observed on 22nd March 1993.
- **World Water Day, 2023**
  - » The theme for the year 2023 is "Accelerating Change."
    - It focuses on accelerating change to solve water and sanitation issues.

3) THE UN WORLD WATER DEVELOPMENT REPORT, 2023

- **Who Publishes the report.**
  - The UN World Water Development Report (WWDR) is an **UN-Water's flagship report** on water and sanitation issues, focusing on a different theme each year.
  - The report is published by UNESCO, on behalf of UN-Water and its production is coordinated by the UNESCO World Water Assessment Program.

- **Key Highlights of the 2023 Report:**
  - It assesses the role of partnerships and cooperation among the stakeholders in water resources management and development and their role in accelerating progress towards water goals and targets.

3. INITIATIVES IN INDIA

1) REPORT: COMPOSITE WATER MANAGEMENT INDEX (CWMI)

- **Introduction**
  - The CWMI is a first of its kind, **comprehensive scorecard** for **identifying, targeting and solving problems in water sector across the country**. It was first published in 2018.
  - **It is expected** to:
    - » Promote data-based decision making and thus scientific management of water.
    - » Encourage competitive and cooperative federalism.
    - » Establish a clear baseline and benchmark for state-level performance on key water indicators.
    - » Uncover and explain how states have progressed on water issues over time, including identifying high-performers and under-performers, thereby inculcating a culture of constructive competition among states.
    - » Identify areas of deeper engagement and investment on the part of the states.
    - » Eventually, the NITI Aayog plans to develop the index into a composite national-level data management platform for all water resources in India.

- **The indicators in the Water Index have been grouped into nine major broad themes.**
  i. Source Augmentation and Restoration of water bodies
  ii. Source Augmentation (ground water)
  iii. Major and medium irrigation (supply side management)
  iv. Watershed development - supply side management
  v. Participatory Irrigation Practices - Demand side management
  vi. Sustainable on-farm water use practices - Demand side management
  vii. Rural Drinking water
  viii. Urban water supply and sanitation
  ix. Policy and Governance

- **Note:** CWMI 3.0 is worked in progress; CWMI 2.0 was published in Aug 2019
- **Note**: NITI Aayog now plans to combine CWMI 3.0, 4.0, 5.0 and 6.0 to cover the years 2021-22, and 2022-23. It is also contemplating data coverage to **district level.**

2) GOVERNMENT INITIATIVES

A) MINISTRY OF JAL SHAKTI

- A Unified Ministry of Jal Shakti was **launched in May 2019** as an immediate response to the escalating water crisis in the country.

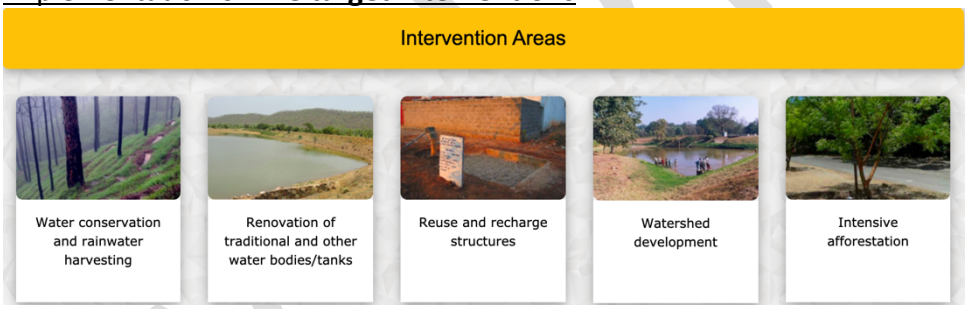
- The ministry was formed by **merging of two ministries:** Ministry of Water Resources, River Development & Ganga Rejuvenation and Ministry of Drinking Water and Sanitation.
- **Functions** of the new ministry ranges from providing clean drinking water, international and inter-state water disputes, cleaning Ganga river, its tributaries and sub tributaries.
- **Why?**
  - All water related initiatives are complementary to each other and therefore it's better to have one ministry for better coordination and integrated data management system.

B) JAL SHAKTI ABHIYAN

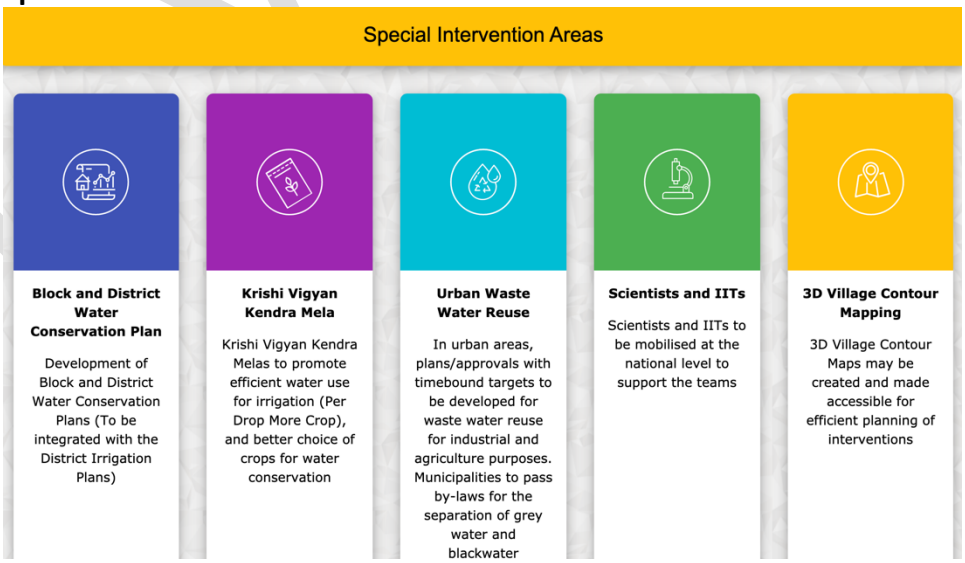
- **What is Jal Shakti Abhiyan?**
  - » It is Jal Shakti Ministry's flagship **water-conservation campaign**.

- **Need of the program:**
  - » In 1951, per-capita water availability in India: 5,000 cu m per year
  - » In 2011 -> 1,545 cu m per year

- **Jal Shakti Abhiyan-1**
  - » **Campaign was first launched in 2019** which was focused on water-stressed districts and blocks (256 districts and 1592 blocks). It was run through citizen participation during Monsoon season. (July - Sep and Oct - Nov (for states receiving north-east retreating Monsoon))
  - Under this, GoI worked with state and district officials in this water stressed districts to promote water conservation and water resource management by focusing on accelerated implementation of **five target interventions**:



  - **Special Intervention Areas**



- It was aimed at **making water conservation a Jan Andolan** through asset creation and extensive communication.
- **No separate funds** were allocated for JSA-1 and funds from convergence of different central and state government schemes were utilized.

- **Jal Shakti Abhiyan 2.0** couldn't be undertaken due to **COVID-19 restrictions**.

- However, Ministry of Jal Shakti has taken up the "***Jal Shakti Abhiyan: Catch the Rain" (JSA: CTR)*** with the theme "*Catch the rain, where it falls when it falls*" covering both rural as well as urban areas of **all districts in the country**, during the pre-monsoon and monsoon period - i.e., upto 30th Nov 2021.

- "Jal Shakti Abhiyan: Catch the Rain" (JSA: CTR) -2022, **the third in the series of JSAs**, has been launched on 29.3.2022.
  - » It covers all blocks of all districts (rural as well as urban areas) **across the country** during 29th March 2022 to 30th Nov 2022 - the pre-monsoon period.
  - » The targeted interventions of the campaign in the current year are (1) water conservation and rainwater harvesting (2) enumerating, geo-tagging & making inventory of all water bodies; preparation of scientific plans for water conservation based on it (3) Setting up of Jal Shakti Kendras in all districts (4) intensive afforestation and (5) awareness generation.
  - » In this campaign, **additional activities/ sub-interventions** have been incorporated under the intervention 'water conservation & rainwater harvesting' which include spring shed management, protection of water catchment areas and creation/ renovation of 'amrit sarovars'

C) JAL JEEVAN MISSION (JJM) (WATER FOR LIFE) (HAR GHAR NAL SE JAL)

- **JJM** was launched in 2019 to provide **functional household tap connection (FHTC)** to every household **by the end of 2024**

- **Need:**
  - » **Water inequality is a major concern in India. 81% of households** in India were without tap connection (14.6 cr /17.87 cr)
  - » Safe drinking water together with a comprehensive sanitation program is important for reducing the disease burden of the poor.

- **Details**
  - » **JJM** restructures and subsumes the National Rural Drinking Water Program (running since 2009). The scheme is also known as **Har Ghar Nal Se Jal (HGNSJ)**.

- **The Broader Objectives of JJM are:**
  - » To provide **Functional Household Tap Connections (FHTC) to every rural household by 2024** with a service level of 55 litres per capita per day (lpcd).
  - » To **prioritize provision of FHTCs in quality affected areas**, desert areas, drought prone areas and Sansad Adarsh Gram Yojna villages.
  - » To provide functional tap connection to **Schools, Anganwadi centres, GP buildings**, Health centres, wellness centres and community buildings

» To **monitor functionality** of tap connections.
» To **promote and ensure voluntary ownership a**mong local community by way of contribution in cash, kind and/ or labour and voluntary labour (shramdaan)
» To **assist in ensuring sustainability of water supply system**, i.e. water source, water supply infrastructure, and funds for regular O&M
» To **empower and develop human resource** in the sector such that the demands of construction, plumbing, electrical, water quality management, water treatment, catchment protection, O&M, etc. are taken care of in short and long term.
» To **bring awareness** on various aspects and significance of safe drinking water and involvement of stakeholders in manner that make water everyone's business.
» A **dedicated fund** called '***Rashtriya Jal Jeevan Kosh***' has been set up by Ministry of Jal Shakti to **mobilse and accept contributions** received from other sources such as Corporate Social Responsibility to fund JJM.

- **Cost:** The total project is estimated to cost **Rs 3.60 lakh crore**.
  » **Center: State:** 50: 50 (90:10 for NE and Himalayan States and 100% for UTs)

- **Implementations**
  » JJM is implemented by the Department of Drinking Water and Sanitation (DDWS) under the recently formed MJS.

- **Steps which are planned:**
  » augment local water sources.
  » recharge existing sources and.
  » promote water harvesting and de-salination wherever required.
  » Reuse grey water or discharged water.

D) MISSION AMRIT SAROVAR

- **Ministry:** Ministry of Rural Development (MoRD)
- Mission Amrit Sarovar was launched on National Panchayati Raj Day on 24 April 2022 with the objective to **conserve water for the future**.
- The Mission is aimed at **developing and rejuvenating 75 water bodies in each district** of the country during this Amrit Varsh, 75th Years of Independence.

- **The impact of this initiative has been.**
  » About 32 crore cubic meters of water holding capacity has been enhanced.
  » Water Users' groups have been associated with each Amrit Sarovar inter-alia improving the livelihoods base of the local community.
  » Participation of freedom fighters, Martyr's families, Padma Awardees, and other eldest citizens of the local areas helped in **community participation at a large scale**, promoting social harmony and patriotism, and making this mission a mass movement.
  » People's participation has been seen in this mission in a form of "**Shram -Daan**".
  » This will result in the creation of a total carbon sequestration potential of 1,04,818 tonnes of carbon per year.

3) JALDOOT APP

- **Ministry: MoRD**
- MoRD has developed 'JALDOOT App' which will be used across the country to capture water levels of selected well.
  - » It will enable Gram Rojgar Sahayak (GRS) to measure the water level of selected wells twice a year (pre-Monsoon post-Monsoon).
  - » In every village adequate number of measurement locations (2-3) have to be taken

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A) NATIONAL WATER AWARDS

- **Why in news?**
  - 5th National Water Awards Launched on Rashtriya Puraskar Portal (www.awards.gov.in) (Oct 2023)
    - Application for awards could be filed here. Last date for submitting applications is 15th Dec 2023.
- **Department and Ministry**: The Department of Water Resources, River Development and Ganga Rejuvenation (DoWR, RD, & GR), Ministry of Jal Shakti .

- **Details**
  - NWA were instituted to recognize and encourage exemplary work and efforts made by states, districts, individuals, organizations, Panchayats, ULB, School, Industry, Society, Water User Association, Individual etc. across the country in attaining the government's vision of a '*Jal Samridh Bharat*'.
  - It also strives to create awareness among the people about the importance of water and motivate them to adopt the best water usage practices.
  - SO far, it has provided a good opportunity to start-ups as well as leading organizations to engage and deliberate with senior policymakers on how to adopt the best water resources management practices in India.
  - The **first National Water Award** was launched by the Jal Shakti Ministry in 2018.

4. WATER POLLUTION RELATED ISSUES

1) RIVER POLLUTION

- **Why in news?**
  - » The number of polluted stretches in India's rivers has fallen from 351 in 2018 to 311 in 2022, though the number of most polluted stretches is practically unchanged: Report by CPCB (made public in Dec 2022)

- **Current River Pollution Situation in India** (Dec 2022)
  - » CPCB in association with pollution control boards/committees in different states/Uts monitors water quality of rivers and water bodies across the country through a network of monitoring

stations under the **National Water Quality Monitoring Program**. Total 4,484 locations in 28 states and 7 UTs including rivers, lakes, creeks, drains and canals are observed.

» **Standards of measurement by CPCB**:
- CPCB measures pollution level on the basis of **Biological Oxygen Demand**. If BOD is less than 3mg/L, it means the river stretch is fit for 'outdoor bathing'. If BOD of a point is **> 3.0 mg/L**, it is identified as **polluted locations**.
  - Two or more polluted locations on a river in a continuous stretch are considered as a "**polluted river stretch**".
- **Polluted stretches** are classified between **Priority1** (BOD of 20-30 mg/L) **to Priority-5** (BOD of 3-6 mg/L).
- The success of river cleaning program is measured on the basis of how the river stretches are moving from Priority-1 to Priority 5 and if the priority-5 stretches are getting reduced.

» **Situation in 2018 report**: Number of stretches under various priorities:
- **P1** (45**);** P2 (16); P3 (43); P4 (72); P5 (175);

» **Situation in 2022 report**
- **P1** (46); P2(16); P3 (39); P4 (65); P5 (145);

» **Thus**, there are **no changes or slight changes** in **Priority 1 and 2**. This indicates that number of worst polluted regions remain the same.
- **Gujarat** and **Uttar Pradesh** have the maximum number (6) of Priority 1 river stretches.
- **Maharashtra** has the maximum number of polluted river stretches.

- **Factors:**
  - **Discharge of untreated or partially treated sewage and Industrial effluents** from cities/towns in their respective catchments is the main cause of river pollution in states.
  - **Illegal dumping of solid waste** on the banks of the rivers
  - **Shortage of STP/ETP Capacity**
    - As per CPCB report (March 2021), the sewage generation in urban areas is at **72,368 million liters**/ day whereas total operational treatment capacity was **only 26,869 MLD**.
  - **Poor operations and maintenance** of **Sewage and Effluent Treatment plants**
  - **Non-points sources** of pollution
  - **Rapid Industrialization and Urbanization** is further compounding the issue.
  - **Min-Ecological flow** is not being ensured in many rivers.

- **Key steps being taken.**
  » It is the responsibility of states/Uts/local bodies to ensure treatment of sewage and industrial effluents before it being discharged into water bodies.
  » **MoEF&CC** is contributing in conservation of rivers by **providing financial and technical assistance** for abatement of pollution in identified stretches of rivers in the country through the Central Sector Scheme of Namami Gange for rivers in Ganga Basin and the Centrally Sponsored Scheme of National River Conservation Plan (NRCP) for other rivers.
  » Further, under MGNREGA, rejuvenation of small rivers is being prioritized.

» In Addition, sewerage infrastructure is created under the AMRUT and Smart Cities Mission of MoHUA.

» **Law and Regulations**:

- As per the Environmental (Protection) Act, 1986 and the Water (Prevention and Control of Pollution), Act 1974, the industrial units are required to install effluent treatment plants (ETPs) and treat their effluents to comply with stipulated environmental standards before discharging into river and water bodies.
- CPCBs, SPCBs and Pollution Control Committees (PCCs) monitor the industries with respect to treatment of effluent discharge standards and act for non-compliance under the provision of various acts.

2) NAMAMI GANGE

- **Introduction**
  - There have been several initiatives to clean Ganga so far. **National Ganga Action Plan 1** was started in 1986, **NGA-2** in 1993 and later extended to other states. Till 2014, more than 4,000 crores had been spent. But the river had remained dirty.
  - So, when government launched the Namami Gange in mid-May 2015, there was a new hope.

- **Namami Gange Program** was launched from June 2014 to 31st March 2021 to rejuvenate River Ganga and its tributaries with a budget of Rs 20,000 crores.
  - A total of Rs 14,084 crores has been released by GoI to NMCG, from FY15 to 31st Jan 2023, out of which Rs, 13,607 crores have been released by NMCG to state governments, state mission for clean ganga, and other agencies for the implementation of projects related to Ganga Rejuvenation.

  - In 2023, Government approved **Namami Gange Mission-II** with a budgetary outlay of Rs 22,500 crores till 2026. It includes projects of existing liabilities (Rs 11,225 crores) and new projects/interventions (Rs 11,275 crores)

  - **Eight Mains Pillars of Namami Gange Scheme**
    - Sewage Treatment Infrastructure
    - River Surface Cleaning
    - Industrial Effluent Monitoring
    - Ganga Gram
    - Afforestation
    - River Front Development
    - Biodiversity Protection
    - Public Awareness

- **Improved Governance Structure under Namami Gange:**
  - **Implementation by** NMCG and its state counterparts - State Program Management Groups (SPMGs).
  - **National Ganga Council** (replaced NGRBA) which is headed by PM and has chief ministers of five ganga basin states - UK, UP, Bihar, Jharkhand and West Bengal.

- It has the overall responsibility for the superintendence of pollution prevention and rejuvenation of River Ganga Basin, including Ganga and its tributaries.

- **For Monitoring**
  - High level task force chaired by Cabinet secretary and assisted by NMCG.
  - State level committee chaired by Chief Secretary and assisted by SPMG.
  - District level committee chaired by the District Magistrate.

- An **empowered task force**, headed by Union Water Resource Minister, was created and it has on board the chief secretaries of the five Ganga basin states. It is supposed to meet every three months.

- **State Ganga Committee** have been formed. These committees would be the **nodal agency to implement the Program in states**. Further, they would also conduct safety audits of the river and river remedial measures.

- **Synergy between different ministries** - Ministry of Jal Shakti have signed MoUs with 10 other ministries to synergize the activities under Namami Ganga.

- **Focus on involvement of more stakeholders** including states, ULBs and PRIs, People and private sector (through PPP projects)

- **4 Battalion of Ganga Eco-Task force** has also been envisaged to spread awareness and for protecting the river.

- **Mains Focus** on Namami Gange is on **pollution abatement interventions** which include
  - **Interception, diversion and treatment of waste wate**r through bio-remediation, in-situ treatment, innovation technologies, STPs, Effluent Treatment Plants etc.
  - **Rehabilitation** of existing STPs
  - Immediate short-term measures for **arresting pollution at exit points on river front** to prevent inflow of sewage etc.

- **Other Steps under the Namami Gange Program**
  - **i. Hariyali** is a plantation project along the stretch of Ganga in all five states through which it flows.
  - **ii. Ganga Gram Yojana**
    - To develop STP, toilets etc. in all villages along the river ganga. Based on Sichewal model (a Punjab village) which I based on cooperation of villagers for water management and waste disposal.
    - Government will spend Rs 1 crore per village in this plan.
  - **iii. Smart Ganga Cities**
    - **Program for infra development along cities on Ganga river.**
  - **iv. Promotion of organic farming** in villages along the Ganga.

A) NATIONAL GANGA COUNCIL (NGC)

- **About National Ganga Council**
  - » National Ganga Council (NGC) chaired by the Prime Minister is an authority created in Oct 2016 under the River Ganga (Rejuvenation, Protection and Management) Authorities Order, 2016, dissolving the National Ganga River Basin Authority.
  - » It has been given the overall responsibility for the superintendence of pollution prevention and rejuvenation of River Ganga Basin, including Ganga and its tributaries.

- **Composition**
  - » **PM** is the ex-officio chairperson.
  - » **Union Minister of Jal Shakti** is the ex-officio Vice Chairperson.
  - » The **other ex-officio members** of the council are from various ministries and CMs of the corresponding states among other stakeholders.

- **Jurisdiction**
  - » The Jurisdiction of NCG extends to states through which Ganga, its tributaries and sub-tributaries flow - Himachal, Uttarakhand, Uttar Pradesh, Haryana, NCR of Delhi, Rajasthan, Madhya Pradesh, Bihar, Chhattisgarh, Jharkhand, West Bengal etc.

3) ECOLOGICAL FLOW OF RIVERS

- **What is ecological flow (e-flow) of a river?**
  - Ecological flow (or environmental flow) is the acceptable flow regimes that are required to maintain a river in the desired state. It is the quantity and timing of water essential for the river to fulfil its ecological, social and economic functions.

- **In Oct 2018**, the central government **notified the minimum e-flow for River Ganga** with an aim to maintain the natural pattern of the river flow (*Aviral Dhara*)
  - **NMCG** has laid down these norms. It's applicable to the upper Ganga River Basin - starting from the Originating Glacier to **Haridwar** - and the main stem of Ganga upto Unnao district in Uttar Pradesh.
    - The e-flow notification specifies that the upper stretches of the Ganga — from its **origins in the glaciers and until Haridwa**r — would have to maintain:
      - **20% of the monthly average flow of the preceding 10-days between November and March**, which is the dry season.
      - **25% of the average during** the 'lean season' of October, April and May; and
      - **30% of monthly average** during the monsoon months of June-September.

4) GROUND WATER ISSUES

Introduction: Global Situation

- As per World Water Development Report, 2022, Ground water accounts for 99% of the liquid freshwater on earth. It has continued to serve humankind for many millennia and currently around 50% of water used in domestic purpose and 25% of water used for irrigation globally comes from groundwater.

India's Situation:

Annual extractable groundwater availability in India (2017) is **393 BCM**.

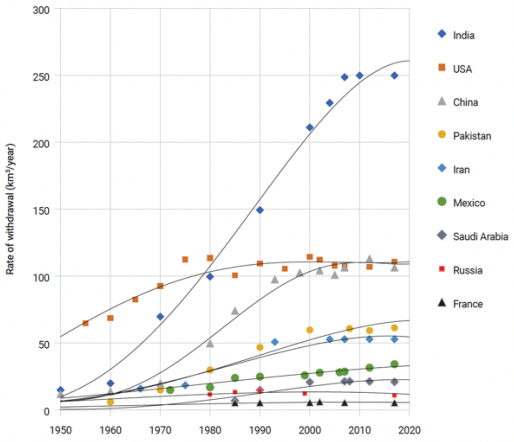
- India is the largest user of ground water in the world, extracting **253 BCM** per year, which is 25% of the global ground water extraction. It extracts more groundwater than USA and China combined together.

Most of the ground water extracted in India is for **Irrigation** (228 billion Cubic Meter (BCM)) which accounts for **90%** of the total extraction.

- In India, 60% of irrigation requirement is fulfilled by groundwater.

The remaining **10%** (225 BCM) is for drinking, domestic as well as industrial uses.

- **Industrial use** accounts for **only 5%** of the total extraction



EVOLUTION OF GROUNDWATER EXTRACTION IN VARIOUS COUNTRIES

- **Satellite Gravimetry** has provided convincing evidence in support of the alarming rates of groundwater depletion.

- The data is supported by local level water table measurements in wells, where in 61% decline has been seen by CGWB.

- As per the 2022 assessment by the CGWB, 14% of assessments units in the country (1006/7089) have been categorized as 'Over-exploited' where the annual groundwater extraction is more than annual available Ground Water Resource. 4 States/Uts viz. Haryana, Punjab, Rajasthan, Dadra & Nagar Haveli and Daman & Diu have stage of Ground Water Extraction greater than 100%.

- **Key Challenges:**
  - **Depletion due to Over-extraction:**
    - Over the years, groundwater has become **the dominant source of irrigation** as well as for domestic purpose. This is primarily due to unavailability of surface irrigation in regions such as Rajasthan.
    - Installation of tube-wells have increased in north-western plains. Since the 1980s, 77% of the total addition to irrigation has come from tubewells. This has allowed farmers in the region to grow water intensive crops like Wheat and Rice. It has also allowed increase in cropping intensity by allowing for sowing of crops during dry winters.
    - **Electricity Subsidy for agriculture and increased rural electrification** has also been a factor behind over-exploitation of ground water.

    - » **Expansion of solar powered irrigation systems** which have led to very affordable cost of ground water extraction.
    - » **Weak law and regulations** to prevent or limit diffuse groundwater pollution.
    - » **Industry that withdraws groundwater** include manufacturing, mining, oil, and gas, power generation, engineering, and construction.
        - **Bottled water industry** is emerging as a major extractor.
  - **Destruction of wetlands, acquifers etc.** which used to act as water sinks and contributed to ground water recharge.
  - **Pollution**: (Both from Agriculture and Industry)
  - **Irreversibility**: Once polluted, the acquifers tend to remain with polluted water.
  - **Climate Change:** CC impacts groundwater through impacting precipitation, leakage from surface water, sea water intrusion into coastal acquifers

- **Key Efforts for Groundwater**:
  - **Recent Schemes:**
    - » **Jal Shakti Abhiyan:** First launched in the year 2019, it focuses primarily upon effectively harvesting the monsoon rainfall through creation of artificial recharge structures, watershed management, intensive afforestation, awareness generation etc. JSA for the year 2023 was launched on 4th March 2023 with the theme "Source Sustainability for Drinking Water".

    - » **Amrit Sarovar Mission** - launched in April 2022 - focuses on developing and rejuvenating 75 water bodies in each district of the country as part of celebration of Azadi ka Amrit Mahotsava.

    - » **Atal Bhujal Yojana** is being implemented by central government in collaboration with states. It has an outlay of Rs 6,000 crores and is being implemented in certain water stressed areas of Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan and Uttar Pradesh. The Primary aim of the scheme is demand side management through scientific means based on **water budgeting** of the area involving local communities at village levels leading to sustainable groundwater management in targeted areas.

  - **Institutions:**
    - » **Central Ground Water Authority** (CGWA) has been **constituted under Section 3(3) of the "Environment (Protection) Act, 1986"** for the purpose of regulating and control of ground water by industries, mining projects, infrastructure, projects etc. in the country.
        - The latest guidelines in this regard with Pan- India applicability was notified by Minsitry in 2020. CGWA and State issues No Objection Certificate (NOC) for extraction of groundwater to various industries/project proponents as per their jurisdiction and as per the extant guidelines.

    - » **CGWA** is also implementing National Acquifer Mapping Program (NAQUIM) in the country. These reports along with management plans are shared with States/Uts for suitable intervention.

- **MoHUA** has formulated Model Building by Laws (MBBL), 2016 for the states/ Uts, wherein adequate focus has been given on requirement of rainwater harvesting and water conservation measures. 35 states/Uts have adopted the features of the Model Bye Laws.
- **Major** and **Medium projects** under Accelerated Irrigation Benefit Program are also reducing dependency on ground water extraction.

A) INSTITUTIONS FOR GROUND WATER

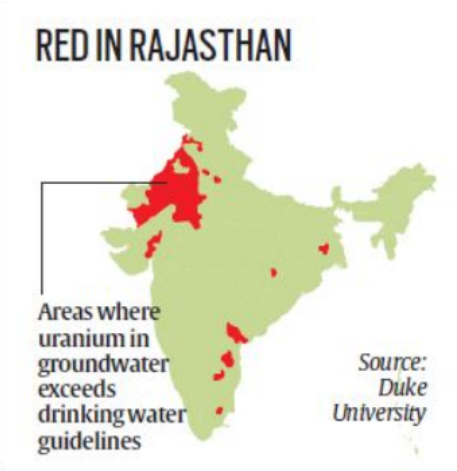
- **Central Ground Water Authority, Ministry of Jal Shakti** has the mandate of regulating ground water development and management in the country.
  - It has been doing it through measures such as issue of advisories, public notice, grant on NOC for ground water withdrawal etc.
  - It has been constituted under section 3(3) of the Environment (Protection) Act, 1986 to regulate and control development and management of ground water resources in the country.

- **Central Ground Water Board (**under ministry of Jalshakti**)** monitors water levels and quality through a **network of 23,916** "National Hydrograph Monitoring Stations" - 6,503 dug wells and 16,693 piezometers.
  - **Note: Piezometer** is a device placed in a bare hole to monitor the pressure of groundwater.

5) URANIUM CONTAMINATION OF GROUND WATER

- **How much of Uranium in Water is acceptable?**
  - » **WHO** has set a provisional safe drinking water standard of **30 micrograms of Uranium per liter** for India. This standard is also consistent with the US Environment Protection Agency Standards.
  - » **In India,** the **Indian Standard IS 10500:** 2012 for Drinking Water specification has specified the maximum acceptable limits for radioactive residues as alpha and beta emitters, values in excess of which render the water not suitable.
    - **But** Individual radioactive elements have not been specifically identified.
    - As per Information provided by Bureau of Indian Standards (BIS), they are **working to incorporate** maximum permissible limit of Uranium as 30 micrograms/liter.

- **Situation in India:**
  - » According to a study published in *Environmental Science and Technology* **- there is high Uranium Contamination in Ground Water of 16 Indian States**.
  - » **A report by Duke University, USA** in association with Central Ground Water Board and State Ground Water Departments states that Andhra Pradesh, Chhattisgarh, Gujarat, Haryana, Himachal Pradesh, Jharkhand, Karnataka, MHA, Odisha, Punjab, Rajasthan, Tamil Nadu, Telangana, UP, WB and J&K have localized occurrence of Uranium concentration.



» **WHO** has also said that there is prevalence of concentration above 30 mg/lt of Uranium in some localized pockets of few states/UTs in the country.

» **Why the contamination?**
  - Ground Water Depletion and Nitrate Pollution may be aggravating the already present natural uranium contamination to dangerous levels.
  - **Process:**
    - Many of India's aquifers are composed of clay, silt and gravel carried down from Himalayan weathering by streams or uranium-rich granitic rocks. When over-pumping of these aquifers' groundwater occurs and their **water levels decline, it induces oxidation conditions** that, in turn, enhance uranium enrichment in the shallow groundwater that remains.
    - Though the **primary source is geogenic**, anthropogenic factors such as ground water table decline and nitrate pollution may further enhance uranium mobilization.

» **Impact**
  - Uranium contamination of drinking water may be responsible for chronic kidney diseases. Radioactivity is not an issue here, but the **toxicity** is.

6) DETERGENT AND WATER POLLUTION

- Water pollution caused by detergents is emerging as a big concern all over the world.
- **How much of detergent in consumed in different countries?**

Country	Per capita detergent consumption per year
India	2.7 kg
Phillipines and Malaysia	3.7 kg
USA	10 kg

- **Pollution due to detergents**
  - **Nonylphenol**, a hazardous chemical present in detergents, is known to enter water bodies and food chain. It also bio-accumulates and can cause severe environmental and health risks.
    » It has been detected from human breast milk, urine and blood.
    » The Bureau of Indian Standards (BIS) has set the standard of phenolic compounds in drinking water at 0.5 mg/L and surface water at 5.0 mg/L.
  - The detergents are also suspected to contain carcinogenic compounds.
  - Many laundry detergents contain 35 - 75% of **phosphate salt**. This can cause many water pollution problems.
    » It can inhibit biodegradation of organic substances.
    » **Eutrophication** can also be caused by phosphate salts.
      - This may choke water bodies with algae and other plants. It can also deprive water of available oxygen, causing the death of other organisms.
    » In **Belgium**, phosphate has been restricted since 2003 in detergents.
  - **Detergents can also harm biodiversity**

» They are capable of destroying the external mucus layers that protect the fish from bacteria and parasites, causing severe damage to the gills.
  - Fish can die at detergent concentration near 15 ppm. Even at a concentration of 5 ppm, fish eggs would be killed.

- **Detergents may also cause** the water to grow murky. This blocks out light and disrupts the growth of plant. Turbidity also clogs the respiratory system of some fish species.

- **Way forward**
  - Finding **sustainable substitutes for harmful components** (for e.g. for Nonylphenol)
  - Efficient Use - Reduce
  - **Nanotech** - to develop newer varieties of fiber -> don't need harmful chemical detergent to wash.
  - **Improved Regulation** for chemical sector -> identify harmful chemicals; phase out these chemicals.

7) FRESH WATER SALINATION SYNDROME (FSS)

- **Introduction**
  - » Approx. 70% of the earth is covered by water; only 2.5% of that is fresh water.

- **How is FSS caused?**
  - » Road salts
  - » Human accelerated weathering of infrastructure, rocks and soils
  - » Sea-level rise and saltwater intrusion
  - » Evaporative concentration of salt ions from hydrologic modifications and climate
  - » Disturbance in vegetation and local groundwater hydrology.

- **Impacts**
  - » Increased water toxicity
  - » Reduction in freshwater resources
  - » FSS also increases chances of heavy metal pollution of water.
    - For e.g. saltwater can mobilize elevated levels of arsenic in water.
  - » Salination may degrade fertile land and make agriculture unviable.

8) HEAVY METAL POLLUTION

- **Heavy Metals and their Health Impacts**
  - » Heavy Metals are metals with relatively high densities, atomic weights, and atomic numbers.
    - Some heavy metals are either **essential nutrients** (Iron, Cobalt, Zinc etc.) **or relatively harmless** (such as ruthenium, silver, indium etc.), but can be toxic in large amounts.
    - Other heavy metals like (**Lead, Cadmium, Mercury, Chromium, Arsenic etc.)** are **highly poisonous**.
      - **Lead** was the most common cause of heavy metal poisoning. But with phasing out of leaded petrol all across the world, this would go down.

        - Lead poisoning may lead to damage to brain, nervous system, Kidney etc. It may also interfere with the development of RBCs
    - **Mercury** - covered separately in details.
    - **Cadmium** - Industrial waste, batteries etc. are the most important source of cadmium poisoning. It negatively hampers the heart condition. It may also cause cancer and organ system toxicity such as skeletal, urinary, reproductive, cardiovascular etc.

» Long term exposure to heavy metals may result in slowly progressing physical, muscular, and neurological degenerative process.

» Once dispersed in the biosphere, these metals **cannot be recovered or degraded**. Hence, environmental effects of metal pollution tend to be permanent.

- **Sources of Heavy Metal Poisoning:**
    - **Mining**
        - For e.g. mining releases chromium, cadmium, lead and mercury - all toxic heavy metals.
        - Raniganj in West Bengal, Jharia in Bihar and Singrauli in Madhya Pradesh are considered some of the "hot spots" of metal pollution.
    - **Tailings**
    - **Industrial Waste**
    - **Agricultural runoffs**
    - **Occupational exposures**
    - **Paints**
    - **Treated Timber**

A) LEAD POISONING

- **Lead:**

» It is a naturally occurring toxic metal found in the Earth's crust. Its widespread use has resulted in extensive environmental contamination, human exposure and significant public health problems in many parts of the world.

» There is no safe level of lead in the body.
    - Mental impairment can occur due to the presence of five micrograms of lead per deciliter (mcg/dL) of blood. Levels in excess of 100 mCg/dL can be fatal.

» **Where is lead used?**
    - More than 3/4th of the global lead consumption happens in manufacture of lead acid batteries for motor vehicles.
    - It is also used in products like pigments, paints, solder, stained glass, lead crystal glassware, ammunition, ceramic glazes, jewellery, toys and some cosmetics and traditional medicines.

» **Important sources of environmental contamination**:
    - **Mining**
    - **Smelting**

        - **Manufacturing**
        - **Recycling activities**
        - **Use of leaded paint and leaded aviation fuel**
        - **Drinking water** - delivered through lead pipes or pipes joined with lead solder may contain lead.
    - » Much of the global use of lead is now obtained through recycling.
- **Health Issues**:
    - » **Young children** are particularly vulnerable to the toxic effects of lead. It also causes long-term harm in adult, including increased risk of high blood pressure and kidney damage.
    - » **Pregnant women,** if exposed to high level of lead, may suffer from miscarriage, stillbirth, premature birth or low birth weight.
- **Sources and routes of exposure**:
    - » **Inhalation** of lead particles **generated by burning materials containing lead** for e.g. during smelting, recycling, stripping etc.
    - » **Ingestion of lead contaminated dust**, **water** (from leaded pipes) and **food** (from lead-glazed or lead soldered containers).
    - » **Some traditional medicines** (in India, Mexico and Vietnam), also had presence of lead.

- **World Freed from toxic leaded Petrol: UNEP (Aug 2021)**
    - » **Details**
        - A global campaign led by the UNEP and its Partnership for Clean Fuels and Vehicles (PCFV) have successfully led to freeing world from the toxic leaded petrol.
    - » **India and leaded Petrol**
        - India was among the early countries to take steps against lead. The process of phase down started in 1994 and got completed in 2000.

B) MERCURY POLLUTION

- **Introduction**
    - » Mercury occurs **naturally** in the earth's crust, but **human activities**, such as mining and fossil fuel combustion, have led to widespread global mercury pollution.
    - » Mercury **emitted into the air** eventually settles into water or onto land where it can be **washed into water**. Once deposited, certain microorganisms can change it into **methylmercury**, a highly toxic form that builds up in fish, shellfish and animals that eat fish.

- **Prescribed standards by Indian government and WHO**
    - » Drinking water: 0.001 mg/l
    - » Industrial waste: 0.01 mg/l

- **Sources of Mercury Pollution**
    - » An element in the earth's crust.
    - » **Other Natural sources** include volcanic eruptions and emissions from the ocean.
    - » **Anthropogenic Sources include:**
        - **Coal burning power plants** are the largest human caused source of mercury.
        - Use of Mercury to **separate gold from ore** bearing rock (another major source of mercury pollution)

- **Other sources** of mercury pollution includes.
    - Burning hazardous waste
    - Producing chlorine
    - Breaking mercury products and spilling mercury
    - Improper treatment and disposal of or wastes containing mercury (Kodaikanal Mercury Poisoning by Hindustan lever)

- **Exposure**
    - **Most human exposure to mercury is from eating fish** and shellfish contaminated with methylmercury
    - **Breathing mercury vapor:** When products that contain elemental mercury break and release mercury to the air, particularly in warm poorly ventilated indoor spaces.

- **Harmful effects:** Mercury is **poisonous in all forms** - inorganic, organic or elemental. It is a neurotoxin; it is particularly harmful in the early stages of development, it can impair motor skills and can adversely affect immune system

- **Airborne Mercury**
    - » Until recently species that do not eat fish were thought to be safe from the harmful effects of Mercury. However recently researchers have documented mercury in **Bicknell's thrushes,** terrestrial birds that inhabit mountain top in northeast Illinois, where habitat lie downwind of the coal burning epicenter of the Ohio.

- **Mercury Pollution in India**
    - Mercury contamination in India is reaching alarming levels largely due to the discharge of **mercury-bearing industrial effluents** ranging from 0.058 to 0.268 mg/liter.
    - **Centre for Science and Environment** have compiled data from various sources to identify critically polluted mercury regions in India:
        - High level of mercury in **fish stocks** have been found, mainly in coastal areas.
            - Mumbai, Kolkata, Karwar and North Koel (in Bihar) are some of the severely affected areas.
                - Koel river showed mercury concentration almost 600-700 times above the limits.
        - Mercury in **ground water** and **Surface water** was detected throughout the country
        - Further, near **industrial units** such as chlor-alkali, cement, chemical units and thermal powerplants, levels higher than the permissible limits were found.

- **Minamata Convention on Mercury**
    - It is an international treaty designed to **protect human health** and **the environment** from anthropogenic emissions and release of mercury and mercury compounds.
        - Convention was ratified by delegates from 140 countries in January 2013.

    - **Why is global response needed?**

- **Mercury pollution is global problem** that requires global action because it moves with air and water, transcends political boundaries, and can be transported thousands of miles in the atmosphere.

- **Major Highlights**
  - **Bans new mercury mines**; **phase out existing mines.**
  - **Control measures on air emissions** from power plants.
  - Regulate informal sectors like small scale gold mining.
  - Phase out or reduce mercury use in products like batteries switches etc.;
  - Addresses supply and trade, safer storage and disposal and strategies to address contaminated sites.
  - Technical assistance, information exchange, public awareness and research and monitoring
  - Parties to **report** on measures taken to implement certain provisions.

- **India ratified** the convention in 2018.
  - This allows India to get technological and financial assistance in the fight against mercury pollution.
  - The convention has given five year time to India to control and reduce emissions from new power plants and 10 years' time for already existing power plants.

- **Minamata COP-5 (Nov 2023)**
  - Held in Geneva
  - Parties decided new dates to phase out mercury-added products including cosmetics,
  - Strengthened ties with indigenous people.
  - Advanced the first effectiveness evaluation of the convention.
  - Reached an agreement on a threshold for mercury waste.

C) ARSENIC POLLUTION

- **Introduction**
  - » **Arsenic** is an odorless and tasteless metalloid which is widely distributed in the earth's crust.

Periodic Table	Elemental arsenic is a member of Group VA of the periodic table, with nitrogen, phosphorus, antimony and bismuth. It has an atomic number of 33 and an atomic mass of 74.91

  - » **Arsenic contamination of the ground water is one of the most serious drinking water issue** being faced in India.
  - » **BIS** stimulates a permissible limit of 0.01 mg/L of arsenic in water. But, as per the latest CGWB study, **21 states** across the country have pockets of arsenic levels higher than this limit.

- **Key Areas impacted by Arsenic Pollution in India**
  - » The states in **Ganga-Brahmaputra-Meghna** river basin are the most affected. They include - UP, Bihar, Jharkhand, WB, and Assam.
  - » Other arsenic affected areas include Punjab, Haryana, Manipur, Chhattisgarh and Karnataka.

- **Sources of Arsenic Pollution**

» Arsenic is introduced in soil and groundwater through **weathering of rocks and minerals followed by subsequent leaching and runoff**.

» **Anthropogenic sources -** coal fired power plants, burning vegetation, and Volcanism.

» **Ground water contaminated with Arsenic** is also entering food chain.

- The chemical has found its way into rice, wheat and potato. A unique observation was that in several samples, arsenic content in food items was higher than that in drinking water.

- **Impact**
  - Long-term intake of arsenic polluted water leads to **arsenic poisoning** or arsenicosis, with **cancer of skin**, bladder, kidney or lung or diseases of skin, blood vessels of legs and feet.

- **Key Recent steps:**
  - Under Jal Jivan Mission (Har Ghar Nal se Jal), since, planning, implementation, and commissioning of piped water supply scheme based on a safe water source may take time, purely as an interim measure, state and Uts have been advised to install **community water purification plants (CWPP)** especially in Arsenic and Fluoride affected habitations to provide potable water to every household at the rate **of 8-10 litres per capita per day** to meet their drinking and cooking requirements.

D) RADIOACTIVE POLLUTION IN WATER

- **Details**
  - » Radioactive pollution of water is a newly emerging, but grave concern of water pollution and human health.
  - » Radioactive elements are naturally found in earth's crust. Percolation of naturally occurring radioactive materials (NORM) from the soil sediments to the aquifer causes groundwater contamination.
  - » **Anthropogenic sources include:**
    - **Nuclear weapon investigation.**
    - **nuclear calamities.**
    - **nuclear powerhouse;**
    - **dumping of radioactive waste are the major sources.**
    - **Use of radioisotopes in industries and scientific laboratories are the minor sources.**
  - » This pollution is **more prevalent in groundwater** as compared to surface water since it is much exposed to radioactive elements found in rocks. Sometimes magma also releases radioactive gases in environment.

» **A number of radionuclides** are found in surface and sub-surface waters, among which 3H, 14C, 40K, 210Pb, 210Po, 222Rn, 226Ra, 228Ra, 232Th, and 234,235, 238 U are common.
  - **Uranium**, **thorium,** and **actinium** are three NORM series that contaminate water resources.
  - **Radium**, a descendent of NORM series, is one of the decidedly radiotoxic elements found in aquatic systems and can be penetrated into groundwater via (i) acquifer rock dissolution (ii) decaying of 238U and 232Th, or (iii) desorption process

- **How is radioactivity measured?**
  » It is measured in **Becquerel** (SI unit) or in curies.
    - Energy absorbed per unit mass is measured by Gray, while the unit Sievert measures the quantity of radiation absorbed by human tissues.

- **A small amount** of radiation is found in all types of water, but the extended amount of radiation is harmful to human health.

- **Harmful Impacts of nuclear radiation:**
  » Immediate: recoverable consequences distressing skin, lungs, genitals, and causing of hair fall.
  » Long standing: permanent outcomes such as various infections like radiation damage, bone marrow fatality, cataract initiation, cancer stimulation, cholera, etc.
  » Genetic effects: ionizing radiation induces mutations in germ cells

- **WHO guidelines:**
  » Guidelines for drinking water quality and a permissible limit of reference dose level of 0.1 micro-sieverts per year.

E) THERMAL POLLUTION: WATER POLLUTION FROM THERMAL POWER PLANTS

- **Thermal Pollution** is the degradation of water quality by any process that changes ambient water temperature.
- **Heat** is considered a **water pollutant** if it is caused by human activities.
- **Major causes of thermal pollution include:**
  - **Coolant from thermal power plants**
  - **Industry effluents**
  - **Alteration of vegetation cover** - increases the heating of water.

- **Negative impact of Thermal Pollution**
  - **Oxygen** deficiency (reduced solubility and high metabolism)
  - **Temperature** sensitive aquatic organisms die.
  - **Decrease in decomposition of organic matter** (oxygen deficiency leads to aerobic decomposers not functioning effectively)
  - **Primary productivity and diversity** of aquatic plant species decline

- **Note:** Even unnatural lowering of temperature of a water body is harmful.
  - Aquatic biodiversity is very sensitive to temperature change.

9) MARINE POLLUTION

A) LISBON DECLARATION

- **Why in news?**
  - **All 198 members** of the UN have unanimously adopted the **Lisbon Declaration on Ocean Conservation** in July 2022 on the last day of the UN Ocean Conference 2022.

- **Details**
  - Participants agreed to work on preventing, reducing and controlling **marine pollution**. It includes:
    - Nutrient Pollution
    - Untreated Wastewater
    - Solid Waste Discharges
    - Hazardous Substances
    - Emissions from the marine sector, including shipping, shipwrecks
    - Anthropogenic underwater noise
  - The nations committed to follow science based and innovative action on an urgent basis.
  - They also agreed that developing countries (particularly small island developing states) and LDCs need assistance with capacity building.
  - Developing and promoting **innovative financing solutions** to help create **sustainable ocean-based economie**s as well as expanding nature-based solutions to help conserve and preserve coastal communities.
  - Member nations also committed to empowering women and girls, recognizing their participation is crucial to building a sustainable ocean-based economy and achieving the UN-mandated SDG14.

- The conference has set the stage for the **fifth session of the intergovernmental conference** on an international legally binding instrument for the conservation and sustainable se of marine biological diversity of areas beyond national jurisdiction.

B) HIGH SEAS TREATY

- **Why in news?**
  - Negotiators from almost every country in the world finalized a new global treaty meant for conservation of sustainable use of biological resources in the high seas (March 2023)

- **Background:**
  - The High seas are open ocean areas that are outside the jurisdiction of any country. It consists of around 64% of the ocean surface and around 43% of earth. These are home to millions of marine species and trillions of micro-organisms.
  - **Existing Legal Framework for High Seas:**
    - **UNCLOS**
    - **Antarctic Treaty System**

  - Limitations:

- **UNCLOS** is **not primarily focused on sustainability** and environment protection. Though, it asks countries to protect the ocean ecology and conserve its resources, it doesn't provide the specific mechanisms or processes to do so.

- **Technical Name of the Treaty**: the '**Agreement under the UNCLOS on Conservation and Sustainable use of marine biodiversity in areas beyond national jurisdiction (BBNJ))**

- **Key Highlights of the Treaty:**
  - The nations of the world have agreed to a **Framework for the Conservation and Sustainable Use of Resources** in the open oceans.
  - The **High Seas Treaty** will work as an implementation agreement under UNCLOS, much like Paris Agreement under UNCLOS.
  - **Key Provisions:**
    - The treaty has **Four Main Objectives**:
      - Demarcation of **Marine Protected Areas** (MPAs), rather like there are protected forest and wildlife areas.
        - Under this, a state or group of states can submit a proposal for MPA along with relevant information. It also provides guidelines for implementation, monitoring, and review of MPAs established.
        - **Note:** As of now, only 1.44% of high seas are protected according to IUCN.
      - **Sustainable use** of marine genetic resources and **equitable sharing of benefits** arising from them.
      - Initiation of the process of **Environmental Impact Assessments** for all major activities in the oceans
        - The agreement includes an obligation to conduct EIAs for activities with potential impacts on the high seas that will apply to new activities such as geo-engineering.
        - It also includes a new impact threshold to trigger a screening process, which means more activities will now be subject to at least some assessment.
      - **Capacity building** and **Technology transfer**.
    -

Marine Protected Areas	MPAs are where ocean systems, including biodiversity, are under stress, either due to human activities or climate change. These can be called the national parks or wildlife reserves of the oceans. Activities in these areas will be highly regulated, and conservation efforts similar to what happens in forest or wildlife zones, will be undertaken
Marine Genetic Resources	Oceans host very diverse life forms, many of which can be useful for human beings in areas like drug development. Genetic information from these organisms is already being extracted, and their benefits are being investigated. The treaty seeks to ensure that any benefits arising out of such efforts, including

	monetary gains, are free from strong intellectual property rights controls, and are equitably shared amongst all. The knowledge generated from such expeditions are also supposed to remain openly accessible to all
Environmental Impact Assessment	The high seas are international waters that are open for use by all countries. Under the provisions of the new treaty, commercial or other activities that can have significant impact on the marine ecosystem, or can cause large-scale pollution in the oceans, would require an environmental impact assessment to be done, and the results of this exercise have to be shared with the international community
Capacity Building and Technology Transfer	The treaty lays a lot of emphasis on this, mainly because a large number of countries, especially small island states and landlocked nations, do not have the resources or the expertise to meaningfully participate in the conservation efforts, or to take benefits from the useful exploitation of marine resources. At the same time, the obligations put on them by the Treaty, to carry out environmental impact assessments for example, can be an additional burden

- **COP,** which acts as the decision making body of the treaty, will take the work forward and will also act as a platform to work with existing authorities that regulate fishing, shipping and mining.

- **Difficult road ahead:**
  - The treaty is a result of 20 years of protracted negotiation. The **details of all the major contentious provisions**, including EIA, sharing of benefits from genetic resources, and mobilization of funds for conservation activities, are still to be worked upon. Many issues remain unaddressed, including mechanisms for policing the protected areas, the fare of the projects that are addressed to be heavily polluting, and resolution of disputes.
  - Process of ratification is also not going to be easy. (UNCLOS took 12 years to become international law and Kyoto Protocol took 8 years - because necessary number of ratifications were not achieved)
    - Treaty must be ratified by a minimum 60 countries for it to come into force

C) MARINE LITTER / MARINE PLASTIC POLLUTION

- **Introduction:**
  - **What is marine litter?**
    - It's any man-made, long standing solid material that humans have incorrectly disposed of and that has ended up on the beach, in estuaries, rivers, seas and ocean.
    - **Plastic** is the most common type of litter found at sea. Around 8 million tonnes of plastics end up in the world's ocean every year. It is estimated that more than 1 lakh of turtles and marine mammals die every year due to these plastic marine litter. It is estimated that around 18,000 plastic pieces are floating on every square kms of the world's ocean.

  - **Reasons for Increasing Marine Litter:**

- Very slow rate of degradation of litter items, mainly plastic
- Continuously growing quantity of the litter and debris disposed in oceans due to increased population, industrialization, single use plastics etc.

- **Harmful impacts**
  - Affects public health (plastics have now been found in human blood).
  - Threatens marine ecosystem
    - Animals get trapped in this litter. They also sometimes confuse marine litter with food.
    - Ghost Fishing: Nets, Fish Aggregation Devices (FAD) and other gears continue to fish for decades after getting discarded.
  - Impacts fishery and tourism sector

- **Key steps taken by India:**
  - **Marine Plastics Survey Program of NCCR (National Centre for Coastal Research)**
    - This program studied the distribution of microplastics in coastal locations in the Bay of Bengal and Arabian Sea in particular along the International Shipping Routes.
    - It found that 50% composition of marine litter was by single use plastics from 2018 - 2021 at various beaches of India.
  - 2021 Amendment to Plastic Waste Management Rules, 2016
    - Ban on several single use plastic from July 2022;
    - Increase in thickness of plastic bags.
  - EPR guidelines related to Plastic packaging materials.
  - **Swatch Sagar Surakshit Sagar:**
    - Commemorating the 75th year of India's independence, a coastal cleanup drive was carried out at 75 beaches across the country across 75 days over 7500 km long coastline. This unique first ever national campaign culminated on "**International Coastal Clean-Up Day"** on 17th Sep 2022.
    - This drive was aimed at removing 1,500 tonnes of garbage from the sea coast which will be a huge relief to marine life and the people staying in coastal regions.

  - At UN Ocean Conference in Lisbon, India has assured the world community that under PM Modi, it is committed to **protecting at least 30% of our lands, waters and oceans**, and thus adhere to its commitment of **30X30 by 2030** in a mission mode.
    - **Note:** India is part of the **High Ambition Coalition for Nature and People**, which was initiated at the "One Planet Summit" in Paris in January 2021, to promote an international agreement **to protect at least 30 per cent of the world's land and ocean by 2030**

  - **International Cooperation:** Under the **Commonwealth Litter Program (CLiP)**, the UK's Centre for Environmental Fisheries and Aquaculture Sciences (CEFAS) and India's National Centre for Coastal Research (NCCR) launched a pilot project to understand deteriorating sea water quality due to marine litter.

- **Key International Initiatives:**

- **London Dumping Regime** (of International Maritime Organization): it regulates deliberate dumping of plastic waste at sea from vessels and platforms.
- **International Convention for the Prevention of Pollution from Ships** (MARPOL): It regulates both deliberate and accidental discharge of plastics from vessels.
- But, the **problem with both these rules is lack of enforcement**. It is hard to monitor and enforce the prohibition on plastic pollution from vessels on the high seas. Flag states often lack incentives to do so.

D) OCEAN DEOXYGENATION

- **Ocean Deoxygenation**
  - » It is the phenomenon of oxygen loss in ocean caused by excessive growth of algae due to nutrient pollution. The nutrient pollution may be caused by fertilizers, sewage, animal or aquaculture waste.

- **The IUCN Report '<u>Ocean deoxygenation: Everyone's problem</u>'** is the largest peer reviewed study to date of the causes, impacts, and potential solutions to ocean deoxygenation.
- **Key Findings**
  - » **Ocean regions with low oxygen concentration** have expanded to all depths of the Ocean
  - » The **volume of area depleted with oxygen**, known as "**anoxic waters / dead zones**" have **quadrupled**.
  - » **What if the present situation continues?**
    - Under a business-as-usual scenario, the ocean is predicted to lose 3-4% of its global oxygen by 2100.
      - **Local changes** will be more severe.
    - Further, **most of the oxygen loss** will take place in the upper 1,000 meters, which is the richest part of the Ocean for biodiversity.

- **Reasons for Ocean Deoxygenation**
  - » **Climate Change** and **Nutrient Pollution** are the main drivers of the ocean oxygen loss.
  - » Ocean oxygen loss is also closely related to **Ocean Warming and Acidification** caused by anthropogenic carbon di oxide emissions and biogeochemical consequences related to anthropogenic fertilization of the ocean.

- **Adverse impact of low oxygen levels**
  - » **Balance of Marine Life**: The IUCN report has started impacting the balance of marine life, favoring species tolerant of low-oxygen conditions, like jellyfish, some squid and microbes, at the expense of species sensitive to low-oxygen, including most fish and many marine species.
  - » Negatively hamper **cycles of nitrogen and phosphorus**

E) SARGASSO SEA WEED

- **About Sargasso Seaweed**
  - » **Between 2000-2010** there was little sea weed in the central Atlantic: most was found in the Gulf of Mexico and Saragossa Sea.

» **Explosion** in Sargassum seaweed first materialized in 2011. It developed in subsequent years into a vast band - in 2018 this stretched for 5,500 miles.
  - The bloom peaks in the middle of the year and develop larger from small populations of the seaweed in the central Atlantic, with some contributions from west Africa.
  - A number of natural and man-made factors align together to make this happen.

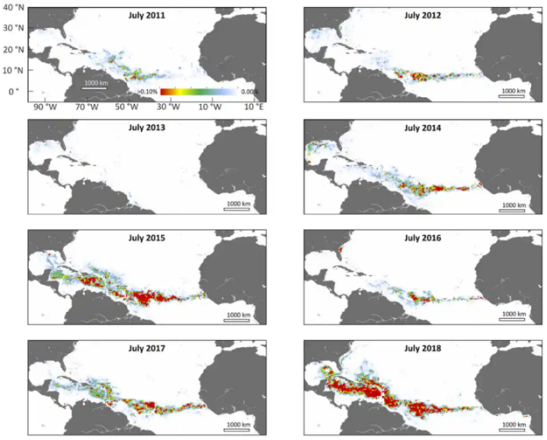
» **Problems caused by this explosion.**
  - Thick mats can block sunlight
  - Sometimes, when they die and sink, they may be deadly for fish and Corals.
  - They are also proving disastrous for humans. Increasingly huge quantities are washing up in tourist destination, creating stinking masses that threaten the tourism industry and pose a threat to health.

» **Reasons:**
  - Alignment of circumstances like conducive sea-surface temperature and salinity combining with an increase in nutrients - in part from the upward movement of cool, nutrient rich water in the eastern Atlantic and an increase in discharge from the Amazon in the preceding years.

- **About Sargasso Sea**

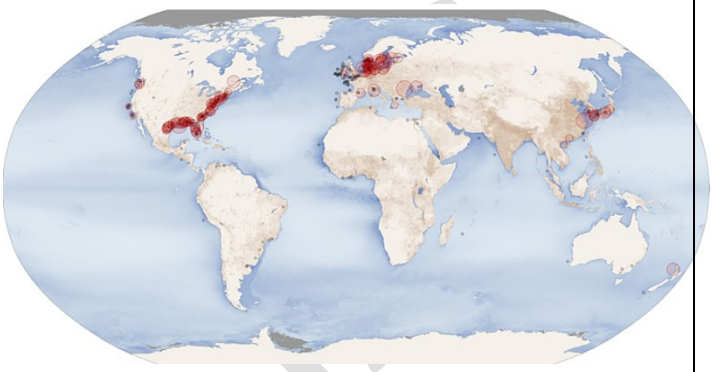
» Located entirely within the Atlantic Ocean, it is the **only sea without a land boundary**. While **all other seas in the world are defined at least in part by land boundaries,** the **Sargasso Sea is defined only by ocean currents.** It lies within the Northern Atlantic Subtropical Gyre. The Gulf Stream establishes the Sargasso Sea's western boundary, while the Sea is further defined to the north by the North Atlantic Current, to the east by the Canary Current, and to the south by the North Atlantic Equatorial Current. Since this area is defined by boundary currents, **its borders are dynamic**, correlating roughly with the Azores High Pressure Center for any particular season.

» It has been named after **genus of a free floating seaweed called Sargassum.**
  - While there are many different types of algae found floating in the ocean all around world, the Sargasso Sea is unique in that it harbors species of sargassum that are **'holopelagi'** - this means that the algae not only freely floats around the ocean, but it reproduces vegetatively on the high seas. Other seaweeds reproduce and begin life on the floor of the ocean.
  - Sargassum provides a home to an amazing variety of marine species.
    - Turtles use sargassum mats as nurseries where hatchlings have food and shelter. It also provides essential habitat for shrimp, crab, fish and other marine species.



F) DEAD ZONES

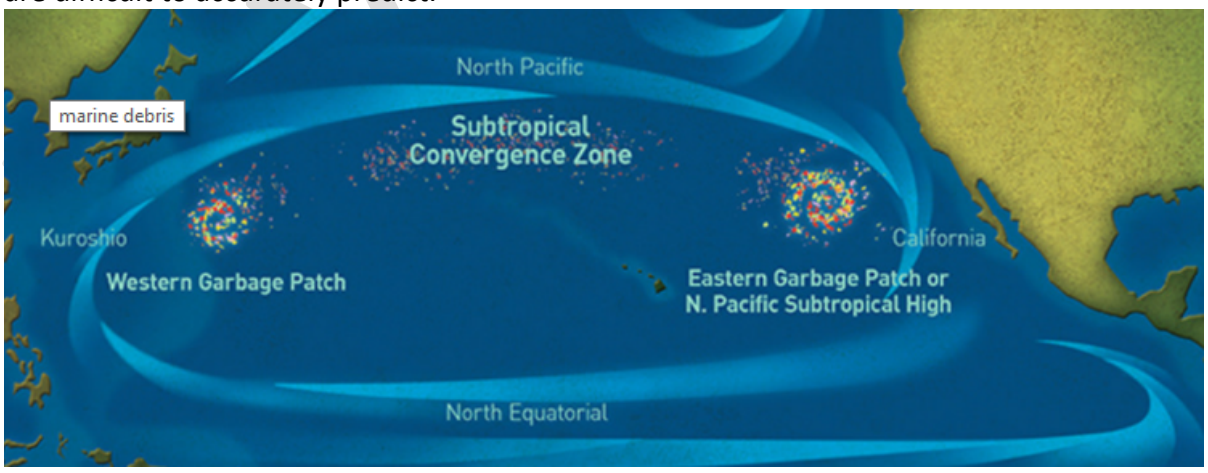
- **Introduction**
  - » Excess nutrient pollution in oceans/lakes create a situation of **hypoxia** i.e. reduction in availability of oxygen in the water. This situation is often referred as **Dead zone** as most marine life either dies, or if they are mobile, leave the area. Because of creation of dead zones, habitats which are normally teeming with life become essentially **biological deserts**.
- **Can Dead zone occur naturally?**
  - » Yes, dead zones may occur naturally. But, environmentalists are concerned about those which are created or enhanced by human activities.



- **Key factors responsible for creation of dead zones?**
  - » There are many physical, chemical and biological factors that combine together to create dead zones, but **nutrient pollution is the primary cause** of those zones created by human activities.
  - » **Nutrients -> Algae -> Decomposition -> Oxygen Depletion**.
  - » **Climate Change** -> Rising temperatures -> reduce the dissolved oxygen, increase metabolism rate and oxygen demand.

G) THE GREAT PACIFIC GARBAGE PATCH (GPGP)

- The Great Pacific Garbage patch is located about halfway between Hawaii and California. It is the **largest accumulation zone of ocean plastic on earth**.
- It consists of higher concentration of waste item, but much of the debris is actually small pieces of floating plastic that are not immediately evident to naked eyes.
- While great pacific patch is a term regularly used in the media, it doesn't paint the correct picture of the marine pollution problem in the North Pacific Ocean. Marine debris concentrates in various regions of the North-Pacific, not just in one area. The exact size, content, and location of the **"garbage patches"** are difficult to accurately predict.



- **Why is it difficult to clean up the patches?**
  - i. Very large and shifting area
  - ii. Uneven distribution of debris

iii. Small pieces of plastic forms the largest chunk
iv. Marine life doesn't allow simple skimming of these debris

10) PROTECTION OF COASTAL REGION

- **Introduction**
  - » Coastal zones are places of enormous ecological, cultural, social and economic significance. They contain unique and sensitive ecosystem of great natural and economic value and is home to numerous endangered species. The region also serves as home to 50% of the world's population and generated 40% of the global economic activities.

- **Key Problems Faced by Coastal Regions:** Recent decades have seen drastic increase in population, rapid industrialization, increased pollution and climate change. All these factors have negatively hampered the coastal region.
  - Along much of the earth's coast **a warming climate and sea level rise** are already negatively affecting natural ecosystems and human communities
  - **Coastal Erosion** has started hampering a number of coastal regions. E.g. Vishakhapatnam
  - **Rapid Industrialization and Deforestation**
  - **Pollution** due to mining, municipal waste disposal and industrial waste disposal are also leading to environmental problems in coastal regions.
  - **Invasive Species** -> Biodiversity loss

- **Efforts by India to Protect Coastal Regions**

A) COASTAL REGULATION ZONE

» CRZ notification is issued under the **Environmental Protection Act, 1986** for regulation of activities in the coastal area by the MoEF&CC. The first CRZ was issued, in 1991 which was replaced by the 2003 and then by 2011 notification.

» It classifies the **coastal land upto 500 m from the HTL and a stage of 100 m along the banks of creeks**, estuaries, backwater and river subject to tidal fluctuations as the Coastal Regulation Zone (CRZ). The **CRZ** are further classified in **four categories:**

- **CRZ-1** are ecologically sensitive areas.
  - **CRZ 1-**A constitute the ecologically sensitive area and the geomorphological features which play a role in maintaining the integrity of the coast viz: Mangroves, corals, sand dunes, salt marshes, national parks, WLS, Reserved forests, nesting grounds for turtles, birds etc.
  - **CRZ 1-B** consist of inter-tidal zones (between HTL and LTL)
- **CRZ-2** are areas that have been developed upto or close to the shoreline. Unauthorized structures are not allowed in this zone.
- **CRZ-3** are areas that are relatively undisturbed (both urban and rural)
- **CRZ-4** are areas covered between Low Tide Line and 12 nautical miles seaward

» **CRZ Notification, 2018: Easing of Norms for CRZ** approved by Cabinet (Dec 2018)
  - The comprehensive review was necessitated because of **demands of various stakeholders** to review the CRZ notification, 2011 as it was hindering developmental activities.
  - **Aimed** at streamlining of CRZ clearances and promoting economic growth while keeping in mind conservation principles of coastal regions.
  - The notification is based on the recommendations of the **Shailesh Nayak** (former secretary, Ministry of Earth Science) headed committee.

» **Key Changes**
  - **Delegation of Project Clearance Power to State Governments.**
    - **Only Projects in CRZ-1 and CRZ-IV will require permission from Union Ministry.** The Powers to clear projects in **CRZ-2 and CRZ-3 have been delegated to State Governments**
  - **Defreezing of Floor Area Ratio (FAR**) in construction norms
    - Earlier, for CRZ-2, it was frozen to 1991 Development Control Regulation (DCR) levels, Now, it will be based on laws which are in vogue.
  - **Relaxation of No Development Zone (NDZ) criteria**
    - Densely populated (density > 2,161 per sq km) rural areas (under CRZ-III) referred as CRZ-III-A, now have a NDZ of 50 m from the High Tide Line (HTL) as against earlier 200 meters.
    - Further, for island close to the mainland coast and for all backwater islands the new NDZ is 20 m.
  - To **fight pollution**, treatment facilities have been made permissible activity in CRZ-I B area, subject to necessary safeguards.
  - **Steps to Facilitate Tourism**:
    - Permission of temporary tourism facilities such as shacks, toilet blocks, change rooms, drinking water facilities etc, in beaches even in the NDZ of the CRZ-III.

11) BLUE FLAG BEACHES

- **Why in news?**
  » Two more Indian Beaches enter the coveted list of Blue Beaches (Oct 2022)

- The iconic blue flag is one of the world's most recognized **voluntary eco-labels** awarded to beaches, marinas, and sustainable boating tourism operators.
  » The Blue flag program was started in France in 1985 and in areas out of Europe in 2001.
  » The certification is provided by the **Foundation for Environmental Education (FEE)**.
  » To get blue flag certification **33 stringent criteria** under **four major heads** should be met and mantained.
    - Environment Education and Information
    - Bathing Water Quality
    - Environment Management and Conservation
    - Safety and Services

- **Spain** with 620+ blue flag beaches have highest number of blue flag beaches in the world.

- **Blue Flag Beaches in India**
  - » As of Jan 2024, **12 Indian beaches** have blue flag certifications.
  - » **Two Beaches** - **Minicoy Thundi Beach** and **Kadmat Beach** - both in Lakshadweep were awarded the certification in Oct 2022.
    - The Thundi Beach is one of the most pristine and picturesque beaches in Lakshadweep archipelago where white sand is lined with turquoise blue water of the lagoon. It is a paradise for swimmers and tourists alike
    - The Kadmat beach is specially popular with cruise tourists.
    - Both these beaches comply **with all 33 criteria** mandated by the Foundation for Environment and Education.
  - » **Two beaches** - the **Eden Beach in Puducherry** and **Kovalam Beach in Tamil Nadu** were awarded Blue Flag certification in Sep 2021.
  - » **Eight Beaches** under blue flag certification earlier were: Kappad (Kerala), Shivrajpur (Gujarat), Ghoghla (Diu), Kasakod and Padubidri (Karnataka), Rushikonda (Andhra Pradesh), Golden (Odisha) and Radhanagar (Andaman and Nicobar Islands)

12) COASTAL EROSION

- **Introduction:**
  - Coastal erosion refers to **wearing a way of land and the removal of beach and dune sediments by wave action, tidal currents, drainage or high winds.**
  - **Wave action** is the main cause of coastal erosion. Wave energy is a result of three factors: the speed of the wind blowing over the surface of the sea; the length of fetch; and the length of time the wind has been blowing.

- **Causes of Coastal Erosion** can be divided into two broad categories: **Natural** or **Manmade:**
  1. **Natural Causes:**
     - i. These include waves, winds, tides, near shore currents, sea level rise etc.
     - ii. Another major natural factor is **phenomenon of subsidence**. It is a regional phenomenon that lowers the surface area in a specific region.
     - iii. Catastrophic events like severe storms, tidal surges, and cyclones can cause severe erosion.
  2. **Manmade Factors:**
     - i. **Infrastructure creation in coastal regions**: For e.g., building houses via land reclamation or within sand dune areas.
     - ii. **Sand removal** above replenishable quantities from the coast upsets the longshore sand transport budget and can result in erosion.
     - iii. **Coral Mining and other means of damaging protective corals** may cause beach degradation.
     - iv. **Structures like seawalls, breakwaters** also have a side effect as it increases erosion of adjacent areas.
     - v. **Deforestation**: Damaging of mangroves and other coastal vegetation is a major factor.
     - vi. **Climate Change** which is mostly human induced is leading to sea level rise which is eroding more and more coastal regions.

vii. **Unscientific Coastal Management**

- **Factors that influence Erosion Rates**
  - » The ability of waves to cause erosion of the cliff face depends on many factors.
    - **Primary Factors**
      - **Erodibility of sea facing rock** is controlled by rock strength and the presence of fissures, fractures, and beds of non-cohesive materials such as silt and fine sand.
      - Power of the waves
      - Beaches (they dissipate wave energy on the foreshore and provide a measure of protection to adjoining land)
      - The **Adjacent bathymetry,** or configuration of the sea floor, controls the way energy arriving at the coast, and can have an important influence on the rate of cliff erosion.

    - **Secondary Factors**
      - Weathering and transport slope processes.
      - Slope Hydrology
      - Vegetation
      - Human Activity
      - Resistance of cliff foot sediment to attrition and transport.

- **Impact of Coastal Erosion**
  - Floods including worsening impact of high tide flooding.
    - Saltwater penetration into rivers, coastal agriculture plains

- **Coastal Erosion Control Strategies:** There are **three coastal erosion control methods.**
  - **Soft Erosion Controls/ Non-Structural Methods**
    - These methods are **temporary options of slowing the effects of erosion.**
      - **Artificial nourishment** of beaches
      - **Coastal Vegetation** such as mangrove and palm plantation
      - **Dune Reconstruction/rehabilitation**
      - Other options are **beach scraping** and **beach bulldozing** which allows for the creation of artificial dunes in front of building or as means of preserving building foundation.

  - Most common method is the **Beach nourishment** projects.
    - It involves placing **additional sand on a beach t**o serve as a buffer against erosion or to enhance the recreational value of the beach.
    - Because nourishment doesn't stop erosion, it has to be repeated to maintain the beach.
    - **Advantages**
      - Restores and widens recreational beach
      - Beach nourishment doesn't leave hazards on the beach or on the surf zone.

    - **Disadvantages**
      - Erodes faster than natural sand so **continuous refurbishing** required.

- Number of Storms affecting the beach makes the life time of the nourishment vary.
- Expensive, and must be repeated periodically.
- Process of nourishment may damage, destroy or otherwise hurt marines and beach life by burying it, squishing it under bulldozers, changing the shape of the beach, or making the water near the beach too muddy.
- Difference in "grain size" of the added sand affect the way waves interact with beach. This will affect surf conditions and bars on the submerged part of the beach.

- **Hard Erosion Controls/ Structural Measures**
  - More permanent solution than soft erosion methods.
  - **Seawalls and groynes (or groin)/breakwaters** serve as permanent infrastructure; Tetrapod-based seawall are also included in the category.
  - **Limitations**
    - Not immune from normal wear and tear and will need **refurbishment or rebuilt.**
    - Further, as the understanding of natural shoreline function improves, there is a growing acceptance that structural solution can cause more problems than they solve. It interferes with natural water currents, and prevent sand from shifting along coastline.
    - They also cause erosion to adjacent beaches and dunes and lead to unintended diversion of stormwater and waves onto other properties.

- **Combination of the Structural and Non-Structural Methods** (i.e. combination of hard erosion control and soft erosion control)
  - This hybrid method reduces limitations of both the methods and provides better efficacy and efficiency.
  - Some of the common approaches of combination are:
    a. **Combining Beach nourishment** with artificial headlands/groynes.
    b. **Revegetation with temporary offshore breakwaters/ Artificial reefs** is commonly used.
  - Using a combination of beach nourishment and groynes/artificial headlands promotes the trapping of the downdrift movement of the sediments, thus reducing downdrift erosion. This also reduces the frequency of re-nourishment.

- **Relocation**

- **Situation of Coastal Erosion in India: Ministry of Earth Sciences** has informed the Lok Sabha that about 34% of coastal region in India is under varying degree of erosion.
  - Of the rest, 40% is stable and 26% is accreting in nature.

13) BIOLUMINESCENCE

- **Why in news?**

- Vishakhapatnam Beaches are glowing due to a phenomenon called **bioluminescence** (April 2023)

- **Details**
  - Bioluminescence, the glow of the waves, is caused by tiny marine organisms called **Phytoplankton**, which emit light on the ocean surface at night.
  - It is best experienced during a moonless night.

- **Bioluminescent** is widespread among deep sea animals in general. Many marine creatures like sponges, jellyfish, worms, species of fish, arthropods, echinoderms, and unicellular algae exhibit bioluminescence to either evade predators, attract prey or during mating.
- **Why did it happen in Vishakhapatnam?**
  - In Vishakhapatnam this phenomenon is most likely the result of algal bloom (Significant accumulation) of the **dinoflagellate species of noctiluca and ceratium**. These emit light when disturbed by breaking waters. This occurs when the luciferase enzyme reacts with luciferin compound in the presence of oxygen to produce a cold light.

- Some other beaches in India where this phenomenon is visible are - Havelock Island in the Andamans, Thiruvanmiyur beach in Chennai, Mattu beach in Karnataka and Bangaram Island in Lakshadweep.

TARGET PRELIMS 2024
BOOKLET-14; ENVIRONMENT-4
ENVIRONMENTAL POLLUTION-3

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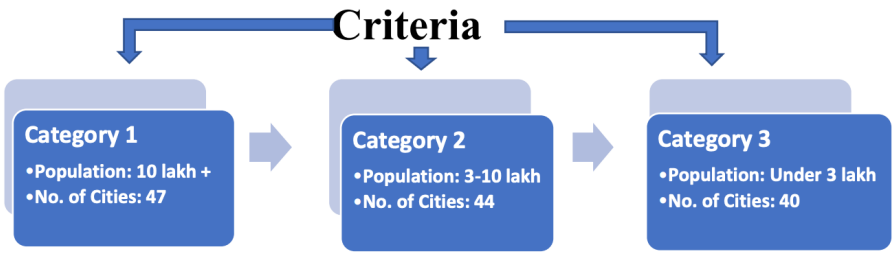
2. AIR RELATED CURRENT UPDATES

1) WORLD AIR QUALITY REPORT, 2023

- Published by a Swiss Air Purifier Company **IQAIR**.
- **Key Highlights** (March 2023)
  - » Delhi ranked 4th out of 50 of the world's most polluted cities in terms of PM 2.5 in 2022.
  - » India ranked 8th with a population weighted average of PM2.5 level of 53.3 micrograms/m3 in 2022.
  - » Chad, Iraq, Pakistan, Bahrain and Bangladesh are the most polluted countries in 2022.
- **Situation after Diwali 2023**
  - » The Day after Diwali (13h Nov 2023), Delhi was the most polluted city in the world with an AQI of 287.
- **Live Situation**: https://www.iqair.com/in-en/world-air-quality-ranking

2) SWATCH VAYU SURVEKSHAN, 2023

- "Swatch Vayu Survekshan" is an initiative by MoEF&CC to **rank cities on the basis of implementation of activities approved under city action plan** and air quality in 131 NCAP cities.
- **Objectives**:
  - **Create Awareness**; **Inform citizens** about the health impacts related due to exposure; comparing air quality conditions at different locations/cities; to achieve the goal of NCAP "Clean Air for All".



- All 131 cities covered under NCAP are assessed based on ranking framework submitted by cities/ULBs on **PRANA** portal (Dashboard to capture progress of NCAP program).
- **Air Quality** is improving on the basis of **PM10** data.

AIR QUALITY	2019-20	2020-21	2021-22	2022-23	2023-24
Reduction in annual PM10 levels vis a vis base year 2017	Improvement in 85 cities	Improvement in 102 cities	Improvement in 95 cities	Improvement in 90 cities	Calculated on Financial Year basis so the data is awaited

3) CLOUD SEEDING

- **Understanding Cloud Seeding**:
  - » **How clouds are formed naturally?**

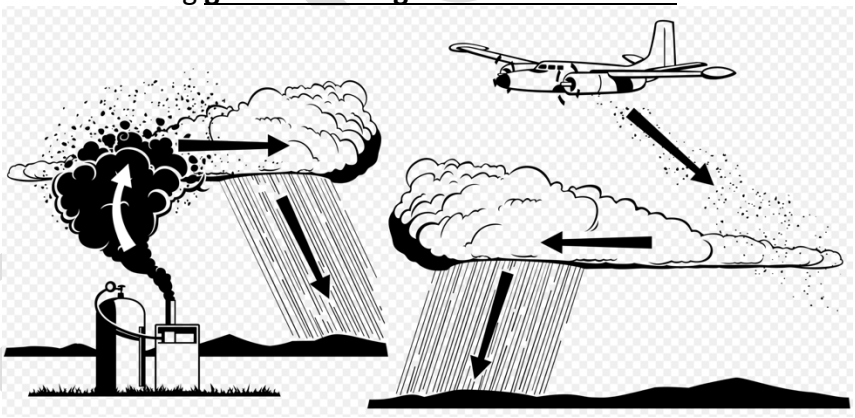
- Clouds are made up of tiny water droplets or ice crystals that form when water vapor in the atmosphere cools and condenses around a tiny particle of dust or salt floating in the atmosphere. Without these tiny particles raindrops or snow flakes can't form and precipitation will not occur.

» **What is cloud seeding**?
- It is a weather modification technique aimed at **enhancing precipitation from clouds**. The idea of cloud seeding was first conceived during WW-II and has since then become a much practiced activity in different dry regions of the world.

» **How does it work?**
- In cloud seeding, clouds are injected with salts like silver iodide, potassium iodide, or sodium chloride which act as seed. These salts provide additional nuclei around which more cloud droplets would form.

» There are **two principal cloud seeding techniques**:
i. **Hygroscopic Cloud Seeding**: It aims at speeding up droplet coalescence in liquid clouds, leading to production of large droplets that start to precipitate. Here seeding material is generally large salt particles.
ii. **Glaciogenic Cloud Seeding**: In this method the idea is to trigger ice production in supercooled clouds, leading to precipitation. It is usually done by dispersing efficient ice nuclei, such as **silver iodide** particles or **dry ice** (solid carbondioxide) into the cloud, causing heterogeneous ice nucleation.

» **How is cloud seeding done?**
- It is done using **ground based generators** or **aircraft**.



» **What are the conditions required for cloud seeding to be done?**
- **Moisture laden clouds:** Cloud seeding can only happen if there is sufficient cloud and sufficient depth of cloud.
- **Wind speed below a certain level**
- **Temperature** - cloud should be cold enough to contain supercooled liquid water

- **Application/advantages**
» **Fighting water** scarcity: Rainfall in drought prone areas.
» **Increasing winter snowfall** - which can supplement the natural water supply for communities in the surrounding area.

» It can also be done to **prevent hailstorm**, dissipate fog etc.
» **Increasing hydro power generation** (for e.g. in Tasmania, Australia)
» **Fighting air pollution** and **Water pollution**
  - Rainfall can wash off pollution from air
  - More rainfall can also ensure ecological flow in rivers leading to reduced scope of pollution.
» **Controlling forest fires**
» **Atmospheric studies** - Studying cloud seeding can help scientists understand how normal cloud formation would occur.

- **Could cloud seeding be used to fight air pollution in Delhi**?
  » In India, **cloud seeding hasn't been tried for fighting pollution**.
    - **China** has tried this option.
  » In winters, cloud from over Delhi due to Western Disturbances and thus some experts suggested cloud seeding for rainfall to occur.

- **Has Cloud seeding been done before in India, and has it been successful?**
  » It has been attempted in Monsoon, in places such as Karnataka, Maharashtra, and Tamil Nadu.
  » A recent experiment, the fourth phase of the **Cloud Aerosol Interaction and Precipitation Enhancement Experiment (CAIPEEX-IV)** that took place in monsoon seasons of 2018 and 2019. It was conducted in drought-prone Solapur in Maharashtra. It pointed to **relative enhancement of 18% in rainfall**.
    - The approx. cost of producing water through this method was 18 paisa per litre, the cost will drop by more than 50% if we use indigenous seeding aircraft.

4) COAL FIRED POWER PLANTS

- **Why in news?**
  » Only 5% of India's coal-based thermal power capacity meets SO2 emission norms: CSE report (June 2023)

- **Introduction:**
  » Coal is the most important and abundant fossil fuel in India. It accounts for 55% of India's energy needs. Infact, India's industrial heritage was built upon Indigenous coal.

- **Environmental Impacts of Coal Based Thermal Power Plants**:
  » **Air Pollution**: Burning of coal produces air pollutants like NO_2, SO_2, CO, PM, Mercury etc. which are primary air pollutants in the world.
  » **Acid Rain**: Pollutants like **NO2, SO2 etc.** are primary contributor of Acid rain. It can harm forests, aquatic ecosystems, and buildings and it can also lead to soil and water acidification.
  » **Climate Change due to global warming**
  » **Excessive water Extraction**: Coal based thermal power plants require huge quantities of water which is often drawn from nearly rivers, lakes, or groundwater sources.
  » **Water Pollution**: Leakage of **heavy metals and acids** from the exposed coal seams may cause water pollution. They can leach into the groundwater and nearby waterbodies, posing risks to

drinking water source and health of aquatic ecosystem. In addition, the release of warm water from the thermal power plant also causes **thermal pollution**.

» **Other issues created by mining of coals**

- **Emission Norms:**
  - » The MoEF&CC had notified the emission norms for coal-based power plants in Dec 2015.
  - » In 2021, **MoEF&CC divided the power plants on the basis of distance from polluted cities** to enforce deadlines and extended the **deadlines**.
    - i. **Category A** - coal based power plants within 10 kms radius of NCR and of cities with million+ population. (deadline changed from 31st Dec 2022 to 31st Dec 2024)
    - ii. **Category B** - power plants within 10 kms radius of critically polluted areas or non-attainment cities. (deadline changed from 31st Dec 2023 to 31st Dec 2025)
    - iii. **Category C** - remaining plants throughout the country. (deadline changed from 31st Dec 2024 to 31st Dec 2026)
      - This has the longest deadline and most of the country's coal based power plants fall in this category.
  - » Even after **multiple extension**, only 5% of the coal fired power plants have installed FGD (Flu Gas Desulfurization) systems, which are air pollution control devices for SO2 emissions (June 2023 : CSE Analysis)
  - » Similarly, another analysis by the Centre for Research on Energy and Clean Air (CREA) has found less than 8% of India's coal based power plants have installed the SO2 emission reduction technology recommended by MoEF&CC (Dec 2023)

- **Problems caused by Coal Based power plants**
  - » **Older technology** -> Larger emissions of CO, NOx, SOx, Ozone etc.
  - » **Lesser Fly ash Utilization** due to weak fly ash guidelines and poor implementations.
  - » **Difficulty** in achieving the **Paris Agreement Targets**.

- **Why moving away from coal based power plants may be difficult?**
  - » Very large dependency -> 75% of India's annual power output.
  - » **Phasing in renewable energy sources and phasing out conventional sources rapidly** may lead to instability in the electricity grid which may potentially cause blackout.
  - » **Political Economy Risk:** Aggressive early retirement of coal based capacity, without detailed analyses, could result in real or perceived electricity shortage in some states.

A) FLUE GAS DESULFURIZATION (FGD)

- FGD is a set of technologies that remove SO2 from exhaust flu gases of fossil fuel power plants, and from the emissions of other sulfur dioxide emitting processes such as waste incineration, petroleum refineries, cement and lime kilns.
- FGD systems use a scrubbing solution to absorb SO2.
  - » The most common type of FGD is wet scrubber which uses a limestone slurry or seawater to absorb SO2.
    - The SO2 reacts with the scrubbing solution to from sulfate particles which can then be removed.
    - The removal efficiency is upto 99%.

» **Drug scrubbers** can also be used. It uses sorbent such as **sodium bicarbonate or calcium oxide to absorb SO2,**
» **Regenerative scrubbers**, use a chemical solvent to absorb SO2 and then regenerate the solvent for reuse.

B) CIRCULATING FLUIDIZED BED COMBUSTION (CFBC)

- **CFBC** is a type of combustion technology used in thermal power plants to increase the efficiency of combustion and reduce emissions.
- It works by suspending a bed of inert particles (like sand or limestone) in a stream of air, creating a fluid like state. Fuel is injected in the bed and burned, with the heat transferred to the particles and then to a heat exchanger to produce steam or hot water.

C) CENTRE FOR RESEARCH ON ENERGY AND CLEAN AIR

- It is an independent organization focused on revealing trends, causes, and health impacts as well as the solutions to air pollution.
- It uses scientific data, research and evidence to support the efforts of government, companies and campaigning organizations worldwide in their efforts to move towards clean energy.
- It is **registered in Finland** with staff across Asia and Europe.
- It is funded by philanthropic grants and revenue from commissioned research

3. NITROGEN POLLUTION

- **Introduction**
  » While nitrogen is the dominant gas in the atmosphere, it is inert and doesn't react. However, when it is released as part of compounds from agriculture, sewage and biological waste, nitrogen is considered 'reactive' and may be polluting and causing greenhouse effect.
  » The release of these reactive nitrogen compounds in the atmosphere have increased over the years because of increased use of **fertilizers for agriculture** and increased **industrial pollution**. NO_x emissions grew at 52% from 1991 to 2001 and 69% from 2001-2011.
  » In fact, a study in 2017 showed that we have **breached the planetary boundary of N (Nitrogen)**. This planetary boundary is set at 44 Tg (Tera-grams) per year globally. But currently we use 150 Tg N per year, primarily through fertilizer usage.

  » **Key Forms of Nitrogen**

N_2 - Un-reactive di-nitrogen; forms 78% of the air we breathe

N_R - Reactive nitrogen; fixed in soil by microbes; reacts to form different compounds with various impacts

NH_3 - Ammonia; used for making fertilisers; can escape into the air as a pollutant

NH_4NO_3 - Ammonium nitrate, acts as fertiliser; when synthesised in the atmosphere, contributes to particulate matter, water pollution and results in eutrophication

N_2O - Nitrous oxide, a greenhouse gas; depletes ozone layer

NO_x - Mixture of NO and NO_2; a major air pollutant

NO_3 - Nitrate; the form in which nitrogen gets fixed in soil; can pollute water sources; forms ozone, which adds to particulate matter load

  » **More Details about N_2O:** It is a greenhouse gas 300 times more potent that CO_2. It has the third highest concentration - after CO2 and methane - in our atmosphere among greenhouse gases. It can live in our atmosphere for upto 125 years.

- **2020 Study about N2O published in Nature:**
  - » **Human emission** of N2O increased 30% in 36 years.
  - » 43% of the total emissions came from human sources.
  - » The increase means that climate burden from non-carbon sources is also increasing.
  - » Dichotomy between Climate Crisis and Food Security - Major proportion of the N2O emissions in the last four decades came from the agricultural sector, mainly because of the use of nitrogen-based fertilizers.
  - » **Most of the emission** have come from **developing countries** like China, India and Brazil.

- **Key causes of Nitrogen Pollution**
  - » **Emission from chemical fertilizer** –
    - ▫ About 50% of the nitrogen used in global agri sector is released in environment (atmosphere, water bodies etc.).
    - ▫ Most important source.
    - ▫ Difficult to control (non-point source, food security concerns etc.)
  - » **Sewage and organic solid wastes** (second largest source):
  - » **Burning of fossil fuel**s: Vehicular pollution, mostly from road transport is another major NOx producer.
  - » **Industries**

- **Key threats due to nitrogen pollution**
  - ▪ **Air Pollution:** Emissions of Ammonia, nitrogen oxide and nitrous oxide contribute to **particulate matter and acid rain**. These cause respiratory problems and cancers for people and damage to forests and buildings.
  - ▪ **Water Pollution - Eutrophication**
  - ▪ **Negatively hampers soil health** -> brings down the yield of agri-land.
  - ▪ **Climate Change:** Nitrous Oxide (N_2O) -> GWP: 300 times of CO2; Also contributes to Ozone depletion.
  - ▪ **Negative impact on Health, economy and livelihood**
    - Deteriorating soil quality impacts Agri output and livelihood. Further, particulate matter and acid rains have adverse impact on health.

A) UNEP'S COLOMBO DECLARATION ON SUSTAINABLE NITROGEN MANAGEMENT (OCT 2019)

- Sri Lanka, with support from the UNEP, convened an event at which member states came together to adopt what is called the "**Colombo Declaration**".
- **Key Highlights**
  - ▫ Halve nitrogen waste by 2030.
  - ▫ The member countries also endorsed UN's plan for a sustainable nitrogen management called "**Nitrogen for Life**", which stems from the Sustainable Nitrogen Management Resolution which was adopted during the fourth session of the UN environment Assembly held from 11-15th March 2019, at the UNEP headquarter in Nairobi.
- **Analysis**

- This is the first-time governments have agreed to work together on a major quantitative global goal for improved nitrogen management.

4. SOLID WASTE

- **Introduction**
  - » Solid waste is the **unwanted or useless solid materials generated from human activities** in residential, industrial or commercial areas.

- Solid waste may be **categorized in three ways**:
  - » **Origin** (domestic, industrial, commercial, construction or institutional)
  - » **Contents** (organic material, glass, metal, plastic, paper, hazardous chemical)
  - » **Hazard Potential** (toxic, non-toxin, flammable, radioactive, infectious)

- As per **Indiawaterportal.org** the total MSW generated in urban India has been estimated at **68.8 million tons per year** (TPY).
  - » This is expected to go to 165 million tonnes by 2030.

- But the Solid **waste collection efficiency in India is around 70%** at present, while it is 100% in many developed countries.

- Therefore, around 30% of MSW is not collected and thus lies littered around in Indian cities. Even the waste which is collected is not treated and thus is highly hazardous.

- **Problems of unscientific MSW disposal ->** Untreated, unprocessed and indiscriminately dumped waste causes air, water and soil pollution which have adverse impact on health situation. Further, this type of dumping goes against the **4Rs** principle of environment Protection.

- **Factors for increasing Solid Waste in India**
  - **Population, Urbanization, Increasing Per-Capita Income**
  - Increased Consumerism, Use and throw culture.
  - **Plastic waste** -> non availability of good alternative
  - **Technology change** -> Increasing electronic waste.
  - **COVID-19** also led to shooting up of domestic hazardous waste.

- **Proper Solid waste management**
  - SWM reduces or eliminates the adverse impact on the environment & human health. It includes a number of processes including **segregation, collection and treatment and disposal** in an environmentally sound manner.
  - The local authorities are responsible for the development of infrastructure for collection, storage, segregation, transportation, processing and disposal of MSW

5) TREATMENT AND DISPOSAL OF SOLID WASTE

A) OPEN DUMPING, LANDFILLS AND SANITARY LANDFILLS

- **Advantage**: Waste limited to well defined area; Reduces contact between waste and environment.
- **Disadvantages** - Open dumps get exposed to natural elements, stray animals and birds and may cause air pollution, water pollution and soil pollution.

B) THERMAL TREATMENT

- **Incineration plants (Waste to Energy Method)**
  - Incineration is combustion of waste in the presence of oxygen. Waste gets converted in CO_2, Water Vapor and Ash along with **heat**.
  - **Advantages** - reduction in volume; kills many diseases causing germs.
  - **Limitations -** Air pollution -> Health issues; Climate Change

- **Pyrolysis**
  - Here material is exposed to **very high temperatures** in an **inert (oxygen less) environment.** The material decomposes due to the limited thermal stability of chemical bonds of material, which disintegrates.
  - Pyrolysis is thus a **thermo-chemical** treatment, which can be applied to any organic (carbon-based) product. It produces volatile products and leaves a solid residue enriched in carbon, char.

- **Plasma Arc Gasification (PAG)** process
  - It is a waste treatment technology that uses a **combination of electricity and high temperature** to turn municipal waste (garbage or trash) into **usable by-products without combustion**.
    - » It **shouldn't be confused with incineration**. This technology doesn't combust the waste as happens in incinerators. It converts the organic waste into gas that contains all its chemical and heat energy and converts the inorganic waste into an inert vitrified glass called **slag**.
    - » This process reduces the volume of waste reaching the landfills and also generate electricity.

C) BIOLOGICAL TREATMENT METHODS - USE OF MICROORGANISMS

- **Bio-Gasification**
  - » It is a waste-to-Energy technique where biological decomposition of organic matter of biological origin under un-aerobic condition is done to produce **methane** and other secondary gases.

- **Composting**
  - » In this process, the o**rganic waste is converted into compost through decomposition**. Compost is rich in nutrients and can be used as soil conditioner, a fertilizer, addition of vital humus and humic acids and as a natural pesticide in soil.
  - » It can also be used for erosion control, land and sea reclamation, wetland construction, and as landfill cover.

- **Vermiculture/Vermicomposting**: It is the process of making compost through decomposition process. But here, decomposition is done by using various species of worms, usually red wigglers, white worms, and other earthworms.

- **Bioremediation**
  - » It involves use of bio-culture or microorganisms to degrade organic waste and contaminants that pose environmental and human risks. Here the environment is altered to stimulate the growth of micro-organisms and degrade pollutants. The organic waste is eventually converted into soil.
  - » **Various approaches** - Biostimulation; Bioaugmentation; a combination of both etc.

D) BIOMINING

- Biomining involves use of separator machines or large sieves to separate waste material of different sizes, thereby obtaining soil, plastic, wood and metal components in isolation for appropriate processing.

6) LANDFILLS IN DELHI AND KEY CONCERNS

- **Why in news?**
  - » Our target is to clear all three landfill sites in Delhi by December 2024: CM Kejriwal (March 2023)

- Chronic negligence of sustainable and scientific treatment has resulted in an ever-growing mass of municipal solid waste (MSW) making its way into dumpsites in India.

- There are **three main landfills** in Delhi - **Bhalswa** in north, **Ghazipur** in east and **Okhla** in south with total estimated waste of **20 million tonnes (as of Oct 2022)**
  - » Note: In 2019, the total legacy waste at these three sites totaled to 28 million tonnes.

- **Present Situation of Landfills:**
  - » **Bhalswa** (36 acres): **8 million tonnes**.
  - » **Gazipur** (70 acres): **14 million tonnes**
  - » **Okhla** (46 acres): Currently the site contains around **4 million tonnes** of legacy waste. In last few years, around 2.5 lakh tonnes have been removed from it. (at its peak it contained around 6.5 million tonnes of waste)

- **Harmful Impacts of landfills:**
  - » **Ground Water and River Water** Pollution: Leachate from these landfills are not only contaminating ground water but are also reaching Yamuna River.
  - » **Other concerns due to landfills** -> Air Pollution (methane); Odour Pollution; Wastage of Resources; breeding ground for diseases.
  - » **Prolonged exposure** to compounds such as **dioxins** which are carcinogenic.

Dioxin:

Dioxins are a group of chemically-related compounds that are persistent environmental pollutants. They are found throughout the world in environment and they accumulate in the food chain, mainly in the fatty tissue of animals.

More than 90% of human exposure is through food, mainly meat and dairy products, fish, and shellfish. Many national authorities have programs in place to monitor the food supply.

They are highly toxic and can cause reproductive and developmental problems, damage the immune system, interfere with hormones and also cause cancer.

Due to omnipresence of dioxins, all people have background exposure, which is not expected to affect human health. However, due to the highly toxic potential, efforts need to be undertaken to reduce current background exposure.

Prevention or reduction of human exposure is best done via source-directed measures, i.e., strict control of industrial processes to reduce the formation of dioxins.

- **Ecological Loss**: A study conducted by experts from the NEERI, CPCB and IIT Delhi assessed that ecological damage due to these three landfill sites is **450 crore rupees per annum**.

7) LANDFILL FIRE – CAUSES

Methane Gas; Sabotage; collection of scrap metals; difficult to extinguish.

8) SOLID WASTE MANAGEMENT RULES, 2016

- In 2016, The Environment ministry had revised the solid waste management rules after 16 years.

- **Salient Features**
  - » **Extended Beyond Municipal Areas** - Covers urban agglomerations, census towns, notified townships, areas under control of railways, airports, airbases, port and harbour, SEZ etc.
  - » **Source Segregation** of waste has been mandated to channelize the waste to wealth by recovery, reuse, and recycle.
    - Waste generators have to segregate the waste in **three streams** - Wet (biodegradable; Dry (plastic, paper, glass, metal etc.) and Domestic Hazard wastes (diapers, napkins, empty containers etc.)
      - They should handover the waste to authorized rag pickers or waste collector or local bodies.
    - **Street vendors** to keep **separate containers** for separate wastes.
    - **Sanitary napkins and diapers** manufacturers or brand owners explore the possibility of using **recyclable material** in the product and shall provide a **pouch or wrappe**r for disposal of each napkin or diapers along with packet of their sanitary products.
      - Educate masses in wrapping and disposal of their products.

- The rules emphasized on **integration of waste pickers/ rag pickers and waste dealers** in the formal system by state governments, SHGs or any other group to be formed.

- **Ban on open throwing burning or burying**; **Provisions for User Fee** for waste collectors and 'Spot Fine' for Littering and non-segregation.
- **Provisions for Bulk and institutional generators** -> directly responsible for segregation and sorting the waste and manage in partnership with local bodies.
- **The developers of SEZs, Industrial estate, industrial parks etc.** to earmark 5% of the total area of the plot or minimum 5 plots/sheds for recovery and recycling facility.

- **All manufacturers of disposable products such as tin, glass, plastics packaging etc. or brand owners who introduce such products** in the market should provide **necessary financial assistance to local authorities** for the establishment of waste management system.

- **The Biodegradable waste** -> processed through composting, bio-methanation etc.

- **Promoting Waste to Energy**
  - Industrial units within 100 km of Solid waste RDF plants should get at least 5% of their fuel from them.
  - Non-recyclable waste with high calorific value (1500 K/cal/kg or more) should not be disposed of and should only be utilized for refuse-derived fuel or by giving away the feedstock for preparing refused derived fuel.
  - **High calorific wastes** shall be used for co-processing in cement or thermal power plants.

5. DOMESTIC HAZARDOUS WASTE

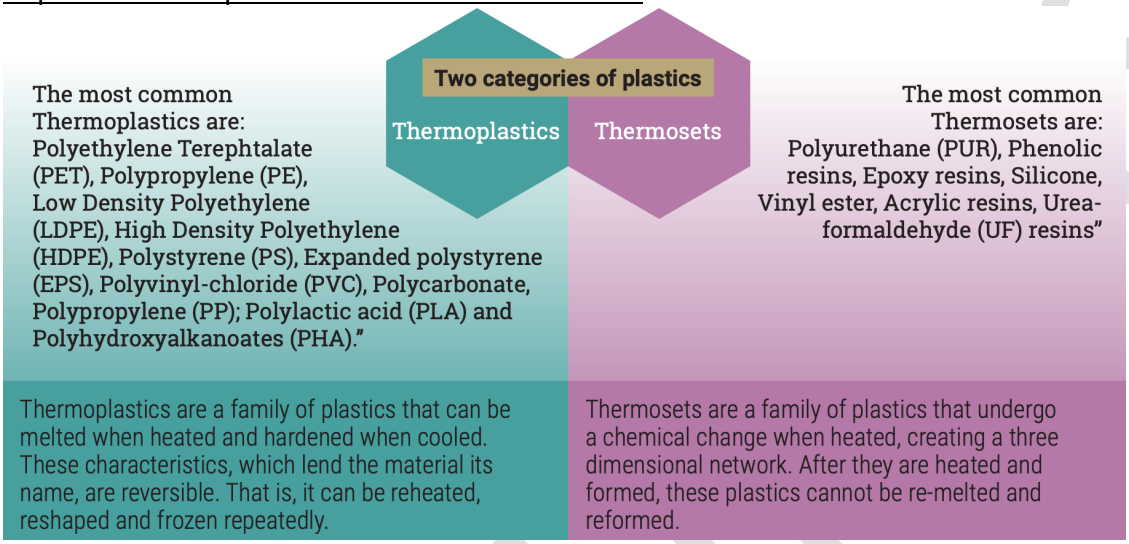
- **Details**
  - **A lot of harmful chemicals are used for domestic purposes**
    - Chemicals to sanitize houses.
    - Power bulbs, CFLs, Tube lights
    - Medicines, ointments etc.
  - Caution is not applied while they are thrown in garbage.
  - **Current Concerns:**
    - India hasn't estimated how much domestic hazardous waste do we generate.
    - Traces of toxic waste can be found in most landfills.
    - Absence of robust framework and infrastructure
    - Segregation of domestic hazardous waste remains a distant dream for most cities.

- **Indore Municipal Corporation has shown the way:**
  - It has introduced a 3-way source segregation in 2018-19: **Wet, Dry and Domestic Hazardous**. Later, it has asked its residents to follow a **five-way source segregation** (wet, dry, hazardous, e-waste, and sanitary) to improve the purity levels of waste that can be recycled.
  - In Jan 2021, they added plastic waste as the **sixth category**.
  - The municipal corporation has taken an authorization of sending 1,000 tonnes of domestic hazardous waste to a treatment facility every year.

- **Bhopal has brought similar initiatives** and is making citizens segregate wastes into 4 categories (wet, dry, hazardous and sanitary)

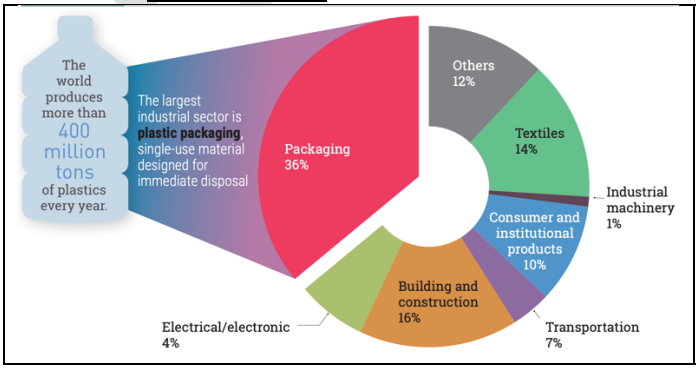
6. PLASTIC POLLUTION

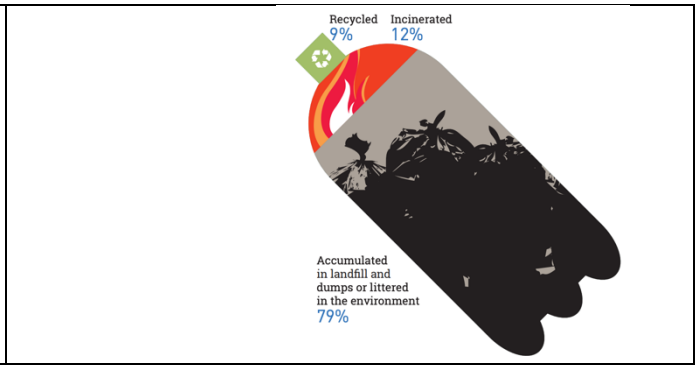
- Plastic is a lightweight, hygienic and resistant material which can be molded in wide range of applications and is cheaply manufactured. Because of these reasons, since the 1950s, the production of plastic has outpaced almost all other materials.



- **Negative Impact on Humans:** A study published by **World Wildlife Foundation** in 2019 estimates that an **average human may be ingesting as much as 5 gram of plastic every week**. This is because almost 1/3rd of the plastic waste that is getting generated ends up in nature, especially water, which is the largest source of plastic ingestion.

- **Extent of Plastic Pollution**:
  - » Globally, plastic production stands at about **400 million tonnes**, and could double by 2040.
  - » **Global Plastic Production by Industrial Sector, 2015**
- **How is plastic disposed off?**
  - According to the UNEP, as of 2015, of **the 9 billion tonnes of** Plastic that the world has ever produced, **only 9**% has been recycled and **12%** has been incinerated, the balance **79% has accumulated in landfills** or in the natural environment. About 11 million tonnes of plastic is dumped into the ocean each year, and this figure is projected to double by 2030 and nearly triple by 2040.





» **India** produces around **10 million tonnes of plastic** per year of which **around 5 million tonnes** is rendered waste every year. Therefore, its crucial that this waste is properly managed.

A) GLOBAL PLASTIC OUTLOOK: POLICY SCENARIO TO 2060

- Recently released by OECD
- It is 2nd of the two reports, and provides a set of coherent projections on plastics to 2060, including plastic use and waste as well as the environmental impacts.
- **Key Projections:**
  - Tripling of the use of plastic and plastic waste by 2060
  - Largest increase will come from emerging economies in Africa and Asia
  - This is expected to double GHG emission, ozone depletion, acidification and human toxicity.

1) MICROPLASTICS

- Plastic never truly biodegrade, but simply breaks up into **smaller** and **smaller pieces**. These tiny fragments are called **micro** (1 micro meter - 5 micro meter) and **nano** (less than 1 micro meter) plastics.

- The world sea floor is littered with an estimated **14 million tonnes of microplastics**. They contribute to about 80% of the ocean debris. As per the UNEP, in the last four decades, the concentration of microplastics is supposed to have increased drastically in the sea surface water.

- **Microplastics** are divided into **two categories**:
  i. **Primary Microplastics**: They enter the environment directly as tiny particles. They may be tiny particles designed for industrial use or microfibers shed from clothing and other textiles like fishing nets. Example of microplastics include micro beads found in personal care products, plastic pellets used in industrial manufacturing, and plastic fibers used in synthetic textiles.
  ii. **Secondary Microplastics** form from the breakdown of larger plastics such as water bottles. This happens when larger plastics undergo weathering through exposure to sea waves, UV rays of sun, wind abrasion etc.

- **Impact of Microplastics**
  - **Introduction in food chain**
  - They can also alter the functioning of important habitats, impact hatching, growth rates and food consumption of multiple different animals and cause mass death in coral species.
  - A study in March 2022, found micro-plastics in **nearly 80% of the individual blood samples**.
  - In **June 2022**, for the first time microplastics have been found in freshly fallen snow in **Antarctica**. Samples from 19 sites showed that all of them contained micro-plastics.
  - **Nano plastics** can cross over cellular membranes into the brain, where it can cause Behavioural and neurological problems.

2) SINGLE USE PLASTICS

- **What is Single use plastic?**

» Single use plastics (SUP) are disposable plastics intended to be used only once before they are thrown away or recycled.
    - They include grocery bags, food packaging, bottles, straws, containers, cups and cutlery.
    - These are the waste products of a **throwaway culture** that treats plastic as disposable material rather than a valuable resource to be harnessed.

- Plastic Waste Management Amendment Rules 2021 defined SUP as "a plastic commodity intended to be used once for the same purpose before being disposed of or recycled".
    » The rules also provides for phasing out of single use plastics.

- **Ban on several forms of Single Use Plastics from July 1, 2022**:
    » As per the Plastic Waste Management Rules, 2016, there is a complete ban on sachets using plastic material used for storing, packing, or selling **Gutkha, tobacco and Pan Masala**.
    » As per the PWM (Amended) Rules, 2021:
        ▫ Carry bags made up of virgin or recycled materials and of less than 75 microns is banned wef 30th Sep 2021.
        ▫ Import, stocking, manufacture, distribution, sale **and** use of the following identified SUP items, which have low utility and high littering potential is banned **from 1st July 2022**.
            - ear buds with plastic sticks, plastic sticks for balloons, plastic flags, candy sticks, ice- cream sticks, polystyrene [Thermocol] for decoration.
            - plates, cups, glasses, cutlery such as forks, spoons, knives, straw, trays, wrapping or packing films around sweet boxes, invitation cards, and cigarette packets, plastic or PVC banners less than 100 microns, stirrers.
    » **Why ban these items?**
        ▫ "difficulty of collection and therefore recycling".

3) HARMFUL IMPACT OF PLASTIC POLLUTION

- **Physical Pollution:** Pieces of plastics, the polymers themselves, interact with bodies and ecosystems.
- **Chemical Pollution:** Added chemicals escape plastics and interact with bodies and ecosystems;
    - A number of chemicals used in the plastic are toxic and problematic. These chemicals, in lab settings, have been shown to be associated with infertility, recurrent miscarriages, feminization of male foetuses, early onset of puberty, **cancer** etc.
- **Environmental Impacts:** Plastics take upto thousands of year to decompose and thus contaminate soil and water.
- **Plastisphere**: Sometimes called the 'Plastisphere', **bacteria, viruses and other life colonize the surface of plastic waste**, creating distinct communities and population structure.
    - They may also contribute in growth of **invasive species**. For e.g., more than 80% of invasive species in the Mediterranean may have arrived on floating plastic waste.
- **Health and Social Impact:** Health losses, welfare losses -> unusable parks, Sewage Blocking -> Malaria, Dengue etc.
- **Economic Impact**
    - **Visual pollution** negatively impacts the tourism sector.
    - Further, **future cost** of removing these plastics from nature is higher than the cost of preventing the littering today.
- **Exacerbate disasters like floods** - an important cause of urban floods.

- **Even the biodegradable plastics** have many **unintended consequences.**
- **Exacerbates Climate Change:** Plastics are 80% carbon and more than 99% of plastics use crude oil, fossil gas or coal as feedstock. Manufacturing also involves burning of large quantities of fossil fuels to provide high energy demands of the industrial processes.
    - By 2015, the total estimated lifecycle emissions from plastics were **1.78 billion tonnes** of CO2 equivalent (GtCO2e). For context, if the whole plastics lifecycle were a country, it would be fifth largest emitter of greenhouse gases in the world.

4) PLASTIC WASTE MANAGEMENT RULES 2016 (AND 2021 AMENDMENTS)

- **Key Provisions of the 2016 Rules**
    - **Min thickness** of plastic carry bags has been increased to 75 microns by 30th Sep 2021 and **120 microns by 31st Dec 2022** (after the 2021 amendment to the rules)
    - **Expand the coverage to rural areas**. The earlier regulations only covered urban municipal areas.
    - **Phasing out of non-reusable Multi-layered Plastic**.
    - **Introduces Extended Producer Responsibility** for producers and generators of Plastic Waste
        - **Note:** India first introduced EPR to manage electronic-waste in 2012.
            - EPR was extended to Plastic manufacturers after the notification PWMR, 2016.
    - **Shopkeepers and Vendors** can only use plastic carry bags which have been properly labelled and marked for use or else there will be imposition of fines.
    - **ULB and Panchayats** have been provided with the responsibility of establishing and operating waste management systems.
    - The **Land Department** (or any department with business allocation of land allotment with state governments) should allocate land for establishing waste management facilities.
    - **Gainful usage of Plastic waste** has also been promoted in road construction, waste to oil conversion etc

5) PLASTIC WASTE MANAGEMENT RULES, 2021 AND OTHER CHANGES

- **Key provisions of 2021 amendment rules:**
    - The **min thickness of plastic carry bags** has been increased from 50 micros **to 75 microns from 30th Sep 2021** and **to 120 microns** with effect from the 31st Dec 2022.
        - **Note:** Advantage of increased thickness - Higher cost -> more resuse; less mobile -> less pollution; less chances of being consumed by stray animals.
    - The manufacture, import stocking, distribution, sale and use of following **single-use plastic**, including polystyrene and expanded polystyrene, commodities shall be prohibited with effect from **1st July 2022**.
        1. Ear buds with plastic sticks, plastic sticks for balloons, plastic flags, candy sticks, ice-cream sticks, polystyrene [Thermocol] for decoration;
        2. Plates, cups, glasses, cutlery such as forks, spoons, knives, straw, trays, wrapping or packing films around sweet boxes, invitation cards, and cigarette packets, plastic or PVC banners less than 100 micron, stirrers.

      Note: It doesn't cover compostable plastic.

      Note: The CPCB and the SPCBs have issued notification asking manufacturers, suppliers and consumers of single use plastic items to scrap and phase them out and switch to greener and sustainable alternatives.

- **Plastic Packaging Waste**, which is not covered under the phase out of identified single use plastic items, shall be collected and managed in an environmentally sustainable way through the **EPR** of producer, importer and Brand Owner (PIBO), as per the Plastic Waste Management Rules, 2016.
    - For effective implementation of EPR, the Guidelines for EPR being brought out have been given legal force through the Plastic Waste Management Rules, 2021.

A) THE MOEF&CC HAS NOTIFIED THE GUIDELINES ON EPR FOR PLASTIC PACKAGING UNDER PLASTIC WASTE MANAGEMENT RULES, 2016, IN THE GAZETTE OF INDIA ON 16TH FEB 2022.

- **Key Highlights of the guidelines:**
    - It **promotes development of new alternatives** to plastics and provide further next steps for moving towards sustainable plastic packaging by businesses.

- **Obligated entities that fall under the category of EPR** (**Producer** of Plastic Packaging; **Importer** of all imported packaging, **Brand Owners** including online platforms, **Plastic Waste Processors**) have to get registered in the **centralized portal developed by CPCB**.

- **The amendment categorizes SUPs in 4 categories**:
    i. **Category 1**: Rigid plastic packaging.
    ii. **Category 2: Flexible plastic packaging with single layer or multilayer** (more than 1 layer of plastic), plastic sheets, covers made of plastic sheets, carry bags, plastic sachets, or pouches.
    iii. **Category 3**: Multi-layered plastic packaging where at least one layer is non-plastic, such as tetra pack cartons etc.
    iv. **Category 4**: Plastic Sheet or like used for packaging as well as carry bags made of Compostable Plastics

- The **targets for minimum level of recycling** (excluding end of life disposal) as per Guidelines, are given below:

Plastic Packaging Category	2024-25	2025-26	2026-27	2027-28 onwards
Category I	50	60	70	80
Category II	30	40	50	60
Category III	30	40	50	60
Category IV	50	60	70	80

- **Environmental Compensation** shall be levied based upon polluter pay principle, with respect to non-fulfilment of EPR targets by Producers, Importers & Brand Owners, for the purpose of protecting and improving the quality of the environment and preventing, controlling, and abating environmental pollution.

- **Implementation of EPR** will be done through a **Customized Online Platform** which would act as the Digital backbone of the system.
    - It will allow tracking and monitoring of EPR obligations and will reduce the compliance burden for companies through online registration and filing of annual returns.

- Producers, Importers and brand-owners shall have to provide the **details of recycling certificates only from registered recyclers** along with detailed quantity sent for end-of-life disposal, by June 30, 2022 of next financial year while filing annual return on online portal.
- **Sale and Purchase of surplus EPR certificates are allowed** -> this has thus set up **market mechanisms** for plastic waste management.

- Levy **of environmental compensation** based upon polluter pay principle, with respect to non-fulfilment of EPR targets by the producers, importers & brand owners. The funds collected shall be utilized for collection, recycling, and end of life disposal of uncollected plastic waste in an environmentally sound manner.
  - **CPCB** shall charge compensation on default producers, importers & brand-owners that operate in more than two states.
  - **SPCB** shall levy compensation on the default producers operating within their jurisdiction.

- Producers, importers, & brand owners, may operate **schemes such as deposit refund system** or **buy back** or **any other model**.
- CPCB shall **constitute a committee under chairpersonship of Chairman, CPCB** that shall be responsible for recommending measures to MoEF&CC for the effective implementation of EPR that shall included amendments to the EPR guidelines.

6) OTHER STEPS BEING TAKEN

- Strengthening of waste management infrastructure through the **Swatch Bharat Mission**.

- **Promotion of Alternatives:**
  - CPCB has already issued one-time certificate to around 200 manufacturers of **compostable plastics**.
  - India Plastic Challenge - Hackathon 2021 is launched to develop innovative alternatives to SUP.
    - It calls upon start ups/ entrepreneurs and students of HEIs to develop innovative solutions to mitigate plastic pollution and develop alternative to single use plastic.

- **Strengthening of Institutional Framework at State/National level** to better implement 2016 rules:
  - States/Uts have been asked to develop a comprehensive action plan for elimination of SUP.
  - States have been requested to form a Special Task Force for elimination of SUP and effective implementation of 2016 rules.
  - A National Level Task force has been constituted by the ministry to take coordinated efforts to ban SUP and to implement 2016 rules.

- **Awareness Generation:**
  - **Mascot 'Prakriti'** has been launched to spread mass awareness about how adoption of small changes in our lifestyle can play a big role in environmental sustainability. It also teaches about various efforts and initiatives that the MoEF&CC and CPCB have taken in order to ensure effective Plastic Waste Management in the country (2022)

- **Promoting Alternative uses of plastic waste:**
  - For e.g. in 2021, MoRT&H issued guidelines for use of plastic waste in road construction.
    - Indian oil is also using technology to convert plastic waste into bitumen.

- **Promoting Reduce, Reuse and Recycling:**
    - World-Wide Fund for Nature - India (WWF India) and the Confederation of Indian Industry (CII) have **joined hands to develop a platform to promote a circular system for plastics**. The new platform is called, the '**India Plastic Pact**'

A) INTERNATIONAL EFFORTS

a. **Steps towards Plastic Pollution Treaty**: In 2022, the UN member states agreed to start negotiating new global treaty to end plastic pollution. Now its is crucial that the treaty that is finalized is ambitious and effective enough to truly address the plastic crisis.
    - As of July 2023, 2 negotiation meetings, for the new treaty has taken place.

b. **Awareness and Education:**
    - The theme of **World Environment Day, 2018** was "**Beat Plastic Pollution**" and it focused on increasing awareness related to plastic pollution across the world.

c. **EU Parliament bans 10 single use Plastics** with effect form 3rd July 2021

B) GLOBAL PLASTIC TREATY NEGOTIATIONS:

- **Why in news?**
    - 2nd Session of Intergovernmental negotiation Committee (INC) on plastic pollution was held in Paris in June 2023.

- **Background:** In 2022, the UN member states agreed to start negotiating new global treaty to end plastic pollution. Now it is crucial that the treaty that is finalized is ambitious and effective enough to truly address the plastic crisis.
    - The Intergovernmental Negotiation Committee (INC) on Plastic Pollution is in the process of developing "an international legally binding instrument on plastic pollution, including in the marine environment"
    - As of July 2023, 2 negotiation meetings, for the new treaty has taken place.

- **Why is a global Treaty on Plastic Pollution required?**
    i. **Plastic Pollution is a global problem** which requires global solution. Most of the plastic is being dumped into oceans. This is eventually converting into micro-plastics, entering food chain and affecting everyone.
    ii. Plastic pollution is harmful to wildlife and biodiversity which is impacting everyone.
    iii. **Increased International Cooperation** will be feasible through a global treaty.
    iv. The treaty may **set global target for reduction**
    v. A global treaty may make the fight against plastic pollution more fair -> by giving higher responsibility to developed economies and giving more time to under developed countries.

7) PROMOTING ALTERNATE USE OF PLASTICS

A) USE OF PLASTIC WASTE IN STEEL MANUFACTURING (DEC 2022: SOURCE: PIB)

- Waste Plastic can be used as replacement of coking coal (by upto 1%) in coke making.
- Waste plastic can also be added in marginal quantities in Electric Arc Furnace (EAF) as replacement of pet coke.
- As per Plastic Waste Management Rules (PWM-2016) and subsequent amendment vide gazette notification G.S.R. 522(E) dated 06th July 2022, issued by the MOEF&CC, o**nly "End-of-Life Disposal" plastic is allowed for co-processing in the steel industry** and other waste plastic which can be recycled has been mandated for recycling only.
    - Presently, availability of "End-of-Life Disposal" waste plastic is a major constraint.
- Under the aforesaid Plastic Waste Management Rules, the municipalities/ local bodies are responsible for the creation and establishment of the plastic waste segregation, collection, storage, transportation, processing, and disposal system either on their own or by engaging agencies or manufacturers.

B) ROADS MADE UP OF PLASTIC WASTE

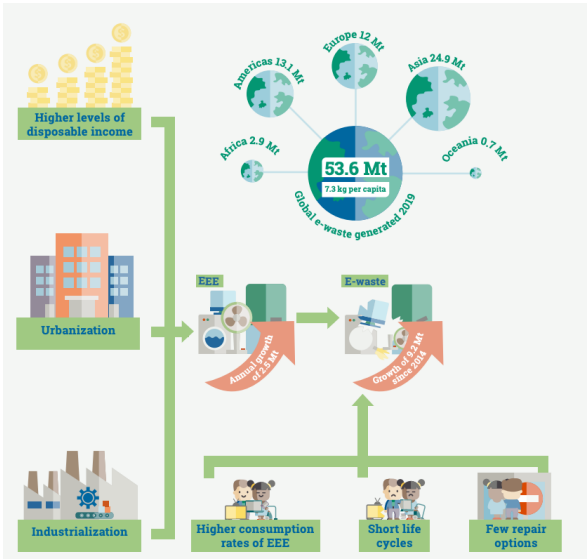
- **Why in news?**
    - MoRT&H has issued guidelines for use of plastic waste in Road construction (July 2021)
- **Details**
    - Mandatory use of waste plastic in periodic renewal coat of pavement on National Highways and also in wearing course of service road within 50 km periphery of urban areas having population of 5 lakhs or more.
    - Indian Roads Congress (IRC) has formulated guidelines for the use of waste plastic in hot bituminous mixes for wearing courses.

7. E-WASTE

- E-waste is a popular name for electrical and electronic equipment (EEE) discarded after their end of life'. Discarded laptops, desktops, cellphones, and their batteries, air conditioners and television sets, cables, and wires, tube-lights and CFLs which contain mercury, are some examples of e-waste.
- It is one of the fastest growing waste stream in the world.

- **Annual waste Output**
    - Global E-waste monitor (published by UN University) estimates that **53.6 million tonnes (7.3 kg per capita)** of e-waste was generated world over in 2019.
        - This is an increase of 21% in just five years.
        - This is expected to go to **74.7 Mt** by 2030.

- **E-waste generation in India is expected to grow rapidly in the coming future** (income, urbanization, changing technology, import (legal or illegal), poor quality equipment, power surge issues etc.)
- **India** is already the third largest e-waste generator.



- **Harmful effects of e-waste:** -
    - Hazardous and toxic heavy metals - mercury, cadmium etc;
    - Ozone Depleting Substances;
    - High Global Warming Potential gases;
    - Unscientific extraction - Air Pollution, Water Pollution and Soil Pollution;
    - Severe negative health impacts - hampers central and peripheral nervous system, bran development, kidney, reproductive system etc.

1) E-WASTE MANAGEMENT RULES, 2022 NOTIFIED BY MOEF&CC IN NOV 2022

- It will replace E-Waste (Management) Rules, 2016 and will be effective from 1st April 2023. These rules will have new EPR regime for e-waste recycling.

    - **Key Features:**
        - Applicable to every manufacturer, producer, refurbisher, dismantler and recycler.
        - All the manufacturer, producer, refurbisher and recycler are **required to register on portal developed by CPC**B.
            - No entity shall carry out any business without registration and also not deal with any unregistered entity.
            - **Authorization has now been replaced by Registration through online porta**l and only manufacturer, producer, refurbisher and recycler require Registration.
        - **Schedule I expande**d and now **106 EEE (**Electrical and Electronic Equipment**) has been include under EPR regime**.
        - Producers of notified EEE, have been given annual **E-Waste Recycling targets** based on the generation from the previously sold EEE or based on sales of EEE as the case may be.
            - Target may be made stable for 2 years and starting from 60% for the year 2023-2024 and 2024-25; 70% for the year 2025-26 and 2026-27 and 80% for the year 2027-28 and 2028-29 and onwards.
        - **Management of solar PV modules /panels/ cells added in new rules**.
        - The quantity recycled will be computed on the basis of end products, so as to avoid any false claim.
        - Provision for g**eneration and transaction of EPR Certificate** has been introduced.
        - Provisions for **environment compensation and verification & audit h**as been introduced.
        - Provision for c**onstitution of Steering Committee** to oversee the overall implementation of these rules.
        - Provision for **reduction of hazardous substances** in manufacturing of Electrical and Electronic Equipment (EEE) has been provided.
            - It mandates that every producer of EEE and their components shall ensure that their products do not contain lead, mercury and other hazardous substances beyond the maximum prescribed concentration.
        - The E-Waste (Management) Rules also provide for recognition and registration, skill development, monitoring and ensuring safety and health, of workers involved in dismantling and recycling of e-waste.

A) MANAGEMENT OF SOLAR PV MODULES/CELLS HAS BEEN ADDED IN CHAPTER V OF THE SAID RULES.

- As per these rules, every manufacturer and producer of solar photo-voltaic modules or panels or cells shall:
  i. Ensure registration on the portal;
  ii. store solar photo-voltaic modules or panels or cells waste generated up to the year 2034-2035 as per the guidelines laid down by the Central Pollution Control Board in this regard.
  iii. file annual returns in the laid down form on the portal on or before the end of the year to which the return relates up to year 2034-2035.
  iv. ensure that the processing of the waste other than solar photo-voltaic modules or panels or cells shall be done as per the applicable rules or guidelines for the time being in force;
  v. ensure that the inventory of solar photo-voltaic modules or panels or cells shall be put in place distinctly on portal; and
  vi. comply with standard operating procedure and guidelines laid down by the Central Pollution Control Board in this regard.

8. BATTERY WASTE MANAGEMENT RULES, 2022

- MoEF&CC, Government of India published the Battery Waste Management Rules, 2022 on 24th August, 2022 to ensure environmentally sound management of waste batteries.

- New rules will replace Batteries (Management and Handling) Rules, 2001.

- The rules cover **all types of batteries**, viz. Electric Vehicle batteries, portable batteries, automotive batteries and industrial batteries.

- The rules function based on the concept of **Extended Producer Responsibility (EPR)** where the producers (including importers) of batteries are responsible for collection and recycling/refurbishment of waste batteries and use of recovered materials from wastes into new batteries
  - EPR mandates that all waste batteries to be collected and sent for recycling/refurbishment, and its prohibits disposal in landfills and incineration. To meet the EPR obligations, producers may engage themselves or authorize any other entity for collection, recycling or refurbishment of waste batteries
  - The rules will enable setting up a mechanism and centralized online portal for exchange of **EPR certificates** between producers and recyclers/refurbishers to fulfil the obligations of producers.

- The rules promote **setting up of new industries and entrepreneurship in collection and recycling/refurbishment** of waste batteries.
- **Mandating the minimum percentage of recovery of materials from waste batteries** under the rules will bring new technologies and investment in recycling and refurbishment industry and create new business opportunities.
- Prescribing the **use of certain amount of recycled materials in making of new batteries** will reduce the dependency on new raw materials and save natural resources.

9. RADIOACTIVE WASTE IN SCRAP

- **Radioactive materials or contaminated devices are entering into the booming scarps recycling chain,** posing a grave health hazard, according to the **annual data on illicit trafficking of nuclear and other radioactive material** released by IAEA

- **Details**
  - » The latest data has been extracted from the IAEA ***Incident and Trafficking Database (ITDB)***, where some 143 member states and international agencies report incidents of illicit trafficking of nuclear and other radioactive material under or out of regulatory control. This is part of IAEA's nuclear security plan.

10. CONSTRUCTION AND DEMOLITION WASTE

- In **2016,** government for the first time came up with **Construction and Demolition Waste Management Rules**, 2016. These rules are aimed at promoting recovering, recycling and reuse of the waste generated through C&D.
  - **Mandatory segregation** of C&D waste into four types - concrete, soil, steel and wood, plastics, bricks and mortars.
  - Deposit it at **collection centers** or hand it over to **processing facilities**.
  - It makes all stakeholders responsible for waste **disposal** (be it small scale generators, the municipal body or the government)
  - It makes debris **recycling mandatory**
  - **Illegalizes the dumping** of waste outside designated areas.
  - **Waste processing** authorities -> should have authorization from SPCB and should be located far away from habitation.
  - For **effective monitoring** of the rules, specific roles have been allocated to **CPCB**, the **Bureau of Indian Standards** (BIS), the **Indian Road Congress** (IRC) and Central Ministries.
  - **Land Department** - Provide land for storage processing and recycling of C&D waste

11. BIOMEDICAL WASTE MANAGEMENT RULES, 2016

- The rules are applicable for wastes from vaccination camps, blood donation camps, surgical camps or other healthcare activity.
- **Main Provisions**
  - **Pretreatment** of laboratory waste, microbiological waste, blood samples and blood bags through disinfection or sterilization **on site** should be carried out as prescribed by WHO or NACO (National Aids Control Organization).
  - **Waste classification in four categories instead of 10** to improve the segregation of waste sources.
    - The BMW have to be collected by the health care facilities in colored bags - yellow, red, blue/white and black according to the category of biomedical waste.

Red Bin	Yellow Bin	Blue Bin	Black Bin

Plastic Waste such as syringes bottles etc	Infectious waste - Bandages, Cotton, Placenta etc	Glass bottles, discarded medicines etc	Needles without syringes, metal articles etc.

- **Phased discontinuation of chlorinated plastic bags**, gloves and blood bags
- **Bar-code system to classify disposal of bags of containers having BMW**
  - It can be used to track and identify bags better.
- **More Stringent standards** have been prescribed for incinerators to reduce the pollution to environment.
- **States to provide land** for setting up common biomedical waste treatment and disposal facility.

- **2018 Amendment** to the rules provided for:
  - **Extension of dates to** phase out chlorinated bags to March 27, 2019.
  - **Establishing** of barcode system by both generators and operators by March 27, 2019
  - **Institute GPS** in vehicles of CBMWTF

1) SEQUENTIAL PRODUCTION OF BIO-DIESEL, BIO-ETHANOL, BIO-HYDROGN, AND METHANE FROM LEATHER SOLID WASTES, AND EFFLUENT TREATMENT SLUDGES

- MoEF&CC had approved the lab-cum-demonstration project titled *Sequential production of Bio-Diesel, Bio-Ethanol, Bio-Hydrogen and Methane from leather solid wastes and effluent treatment sludges* in 2015.
  - The project was approved for Central Leather Research Institute, Chennai with the total project outlay of Rs 77.11 lakh.

- The Project envisaged delivery of environmental benefits like:
  a. Effective solid waste management techniques for tanneries
  b. Better pollution abatement techniques
  c. Avoidance of groundwater contamination
  d. Efficient greenhouse emission control techniques

- **CAG Report** for financial year 2020-21 (released in Dec 2022)
  - » Only one unit of a biodiesel recovery had been established in March 2018 against the expected physical output of four distinct fuel recovery units.
    - The unit produced 80 litres of bio-diesel and none of the other three units achieved fruition by May 2022.
  - » The deliverables of 10 international publications in high-impact factored journals and three PhD degrees had also not been achieved.
  - » Key deficiencies observed by CAG Report:
    - **Inaction in processing the request** of Central Leather Research Institute, Chennai (CLRI) to revise the number of project fellowships. Due to this, CLRI was unable to retain the project fellows who were engaged in the project.
    - **Failure to obtain formal commitment from the industry partners**, which resulted in limited participation by the industry partner;
    - A lack of regular monitoring of the progress of the project, which affected the timely implementation of the project.

12. SOME OTHER TECHNOLOGIES

1) HYDROTHERMAL CARBONIZATION

- The Hydrothermal Carbonization (HTC) is a (pre)treatment of lignocellulosic biomass in hot (180 degree - 280 degree) water at saturated pressure of 2-10 MPa and residence time varying from minutes to hours. It is carried out mainly to produce solid product similar to coal. The energy density is much higher for this solid product. They can be either combusted to produce energy or disposed for soil nourishment as fertilizer (also sequestration of carbon)

13. NOISE POLLUTION

- **Intro**
  - » Noise pollution refers the presence of such levels of noise or sound in the environment that are disturbing, irritating and annoying to living beings. It causes discomfort and harm to living being's mental and physical health. It is one of the major causes of deafness and other health hazards. Even animals suffer from excessive environmental noise.

- **Causes of Noise Pollution -** Vehicles, factories, industries, construction sites, fire crackers, loud speakers, domestic appliances; TV/Radio etc.
- **Effects of Noise Pollution**
  - Loud and prolonged noise can cause physiological and psychological damage.
    a. **Loss of hearing and deafness :** Noise above the tolerable threshold is the leading cause for loss of hearing and deafness.
    b. **Cardiac Disturbance :** Noise increase the risk of cardiac disturbance including coronary artery disease or ischemic heart disease
    c. **Sleeplessness :** Noise may make people restless. It may keep people away from sound sleep
    d. **Headache :** Human mind can tolerate sound only to a limited extent. Excess noise cause headache.
    e. **Stress, tension and aggressiveness**
    f. **Mental Imbalance and nervous debility**
    g. **Psychological imbalance**
    h. **Difficulty in talking**
    i. **Diabetes and Hypertension**:
       - Two 15 year long studies for long-term resident of Toronto, Canada found that exposure to road traffic noise elevated risks of acute myocardial infarction and congestive heart failure, and increased incident of Type 2 diabetes by 8% and hypertension by 2%.
    j. **Affects biodiversity:** For instance a recent study published in the Conservation Biology journal noted that chicks of the birds which were exposed to noise were smaller than the ones in quiet nests.

- **How sound is measured?**
  - » The faintest sound that our ears can detect is known as the Threshold of Hearing (TOH). The most intense sound that our ears can detect without suffering any physical damage is one billion times more intense than TOH. This large hearing range makes a linear scale of sound measurement inappropriate.
  - » Hence, we use **logarithmic scale** to measure the sound. The unit is a **decibel (dB)** and TOH is assigned zero dB.
    - So 10 dB means a sound that is 10 times more intense than TOH. 20 dB refers to an intensity of sound that is 100 times more than a TOH sound, 30 dB means an intensity that is 1000 times more than TOH, and so on.
      - $10*Log_{10} (P_1/P_0)$
  - » **What is dbA?**
    - Frequency and pitch of the noise also determines whether it is harmful or not. A **modified scale called decibel-A (dbA)** takes pitch into account.
    - **A-weighted decibels**, abbreviated dBA, or dba or dB(a), are an expression of the relative loudness of sounds in air as perceived by the human ear. In the A-weighted system, the decibel values of sounds at low frequencies are reduced, compared with the unweighted decibels, in which no correction is made for audio frequency.

- **What is the safe limit for noise?**
  - » The latest 2018 WHO guidelines established a health-protective recommendation for road traffic noise levels of **53 dB**.
  - » Hearing loss begins if a person is exposed more than 8 hours a day to a noise level of 80-90 dbA.
  - » A level of 140 dbA is painful and 180 dbA could even kill a person.
    - Examples of noise levels

Source	dbA	Source	dbA
Threshold of hearing	0	Food Blender	90
Rustling of leaves	20	Diesel Truck (1m)	100
Quiet whisper (1 m)	30	Power Mower (1m)	107
Quiet Home	40	Jet Plane (30 m)	130
Normal Conversation	60	Rocket Launch	180
Loud Singing (1 m)	75		
Alarm clock	80		

- **What is being done to curb the noise pollution?**
  - » The **CPCB** is mandated to track noise levels, set standards as well as ensure, via their State Units, that sources of excessive noise are controlled.
  - » In 1980s and 1990s there were several court judgements in India restricting the generation of noise by industries, fire crackers, electric horns etc.
  - » Finally in 2000, Indian government notified the **Noise Regulation Rules**, which were amended in 2010.
    - Noise Regulation Rules were notified under the Environment (Protection) Act of 1986.

- **Two types** of noise level standards are Prescribed
  - Ambient noise level standards
  - Noise levels for designated types of machinery, appliances, and fire crackers.
- **Ambient Noise Levels have been defined as follows**:

Category of Area/Zone	Limits in dB(A) (Day) (6 am - 10 PM)	Limits in dB(A) (Night
Industrial Area	75 dbA	70 dbA
Commercial Area	65 dbA	55 dbA
Residential Area	55 dbA	45 dbA
Silence zone	50 dbA	40 dbA

  - **Silence zone** - zones of silence (100 meters) near schools, courts, hospitals etc.
- The rules specify that no permission could be granted by any authority for use of public address (PA) system in the open after 10. 00 pm and before 6 am. Even after permission has been procured, the sound level must fall within the limits prescribed in the Noise rules.

- **National Ambient Noise Monitoring Network (NANMN)** was launched in 2011
  - Central government set up a National Ambient Noise Monitoring Network (NANMN) through **CPCB** and **the state pollution control boards (SPCBs)** to monitor noise on a 24X7 basis in **India's seven largest city**.
  - Under NANMN, during Phase 1 and Phase 2, **70 monitoring stations** have been set up in seven cities - each in Delhi, Bengaluru, Kolkata, Chennai, Hyderabad, Lucknow, and Mumbai. - which are operated by SPCBs.
  - Phase 3 plan was to launch 90 stations in 80 other cities.

- **2015 Supreme Court Judgements:** In 2015, the Supreme Court, acting on a petition filed by four infants (all aged between six months and 14 months) seeking curbs on air and sound pollution, banned the bursting of sound-emitting crackers between 10 pm and 6 am during Diwali.

- **In June 2020**, the CPCB has proposed a new set of fines between **Rs 1,000 to Rs 1,00,000** for those who violate norms restricting noise pollution under the **Noise Pollution** (Regulation and Control) Rules, 2000.
  - This was submitted in a report filed with National Green Tribunal in response to a set of ongoing cases over noise pollution.
  - **Under the new norms:**
    - **Violations related to norms over**:

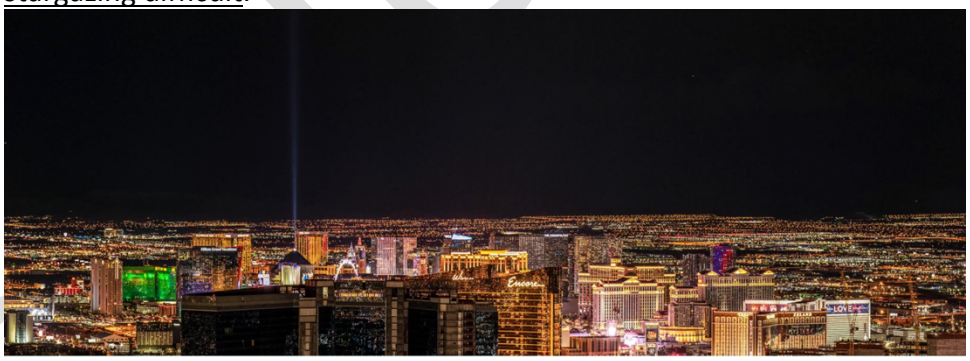
Use of loudspeakers/PA systems etc.	Confiscation of system and a fine of upto Rs 10,000
Diesel generator sets	Sealing of the sets and a fine between Rs 10,000 to 1 lakh.
Sound Emitting Construction Equipment	Seizures, sealings and a fine of Rs 50,000

14. LIGHT POLLUTION

- **Why in news?**

» International Dark Sky Week is an annual event hosted by International Dark Sky Association (IDA).
  - Astronomers and Sky enthusiasts marked the 2022 International Dark Sky Week from April 22-30. Hundreds of events were conducted across the globe where participants came together to learn astrophotography, take night walks, and observe he night sky without light pollution and learn how it negatively impacts our ecosystem.

- **Introduction**
  » Light pollution, also known as photo-pollution or luminous pollution, is the **excessive, misdirected or invasive use of artificial outdoor lighting**.
  » **Harmful Impact**
    - **Disturbs circadian rhythm** (the 24 hour cycle of many organisms) including humans and induces sleep disorder, and other health risks like obesity, depression, and diabetes.
    - **Unhealthy:**
      - Light pollution may cause damage to the retina in the eyes.
      - Some lights such as blue LED lights may be harmful for health.
    - **Impacts biodiversity:** It affects insects as they are drawn towards these lights. This affects their food chain and reduces pollinating activities. Other animals such as turtle are also affected as they get attracted towards these lights and thus are snapped by predators.
    - **Wastage of light** is also a reason for overuse of fuel and thus a factor behind climate change.
    - **Impacts astronomy:** Mismanaged lighting alters the color and contrast of the nighttime sky and eclipses natural starlight. It hinders study of the universe as proper study becomes difficult from areas where these artificial lights hinder celestial light. It makes stargazing difficult.



The city of Las Vegas dumps an enormous amount of light into its environment, turning the night sky above into a seemingly blank canvas.

- **Light Pollution and Satellites**
  » A new study published in *Monthly Notices of the Royal Astronomical Society*: *Letters* shows that satellites that orbit the Earth can increase the overall brightness of the night sky by 10% above natural levels.
    - This additional light pollution has an impact over a larger part of the globe than ground-based sources

15. ENVIRONMENTAL IMPACT ASSESSMENT – EIA RULES AMENDED

- **Environmental Impact Assessment**
  - EIA can be defined as the study to predict the **environmental, socio-economic, cultural and human-health impacts** of proposed project/activity. The global environmental law for the EIA

is the "**precautionary principle**". Environmental harm is often irreparable so there should be a focus on prevention.

- It is a **decision making tool** which **compares various alternatives** for a project and chooses the one which ensures best combination of economic and environmental costs and benefits.

- **Advantages of EIA**: By considering the environmental effects of the project and their mitigation early in the project planning cycle, environmental assessment has many benefits:
  - Promotes environmentally safe and sustainable development.
  - Optimum utilization of resources
  - Saving of time and cost of the project
  - Properly conducted EIA also **lessens conflict** by promoting community participation, informing decision makers, and helping lay the base for environmentally sound project.

- **History of EIA in India**
  - » The Indian experience of EIA started in 1976-77 when the Planning Commission asked the Department of Science and Technology to examine the river valley project from an environmental angle.
  - » Till 1994, EIA was an administrative decision and lacked statutory backing.
  - » In 1994, the Ministry of Environment and Forest, under the EPA, 1986, promulgated an **EIA notification making environmental clearance mandatory** for expansion or modernization of any activity or for setting up new projects listed in Schedule 1 of the notification.

- **EIA Notification, 2006**
  - » Notified by MoEF&CC under the Environmental (Protection) Act, 1986.
  - » It makes it **mandatory for various projects** such as mining, thermal power plants, river valley, infrastructure (road, highway, ports, harbors and airports) and industries including very small electroplating or foundry units to **get environmental clearance**. This clearance is given only after the environmental requirements are fulfilled.

  - Unlike, the 1994 notification, it has put the **responsibility of clearing certain projects on the state government**:
    - **Category A** (National Level Appraisal): This category project mandatory require clearance and thus they don't undergo the screening process.
    - **Category B** (State level Appraisal) undergo screening process.
      - **Category B1** (mandatorily requires EIA)
      - **Category B2** (Don't require EIA)

- **Process of EIA**
  - » After 2006, EIA in India involves **four steps:**
    - Screening
    - Scoping
    - Public Hearing
    - Appraisal

  - » However, EIA process is cyclical with considerable interaction between various steps.

- The **assessment** is carried out by an **Expert Appraisal Committee (EAC)**, which consists of scientists and project management experts.
    - The EAC frames the scope of EIA study and a preliminary report is prepared.
    - The report is published and a **public consultation** process takes place, where objections can be heard including from project-affected people.
    - The EAC then makes a final appraisal of the project and forward it to MoEF&CC. The Ministry is ordinarily obliged to accept the decision of the EAC.

- **Amendment to EIA Rules notified** (July 2022)
    - » It has exempted highway projects of strategic and defence importance, which are 100 km from the LoC, among other locations, from an environmental clearance before construction.
    - » Thermal power plants upto 15 MW based on biomass or non-hazardous municipal waste using auxiliary fuel such as coal, lignite or petroleum products up to 15% have also been exempted - as long as the fuel mix is eco-friendly.
    - » Increasing the threshold of ports which exclusively deal in fish handling and caters to small fisherman, which are exempted from environment clearance.
        - This is taking into account issues of livelihood security of fishermen involved at fish handling ports and harbors, and less pollution potential of these ports and harbors.
    - » **Toll plazas** that need more width for installation of toll collection booths to cater to a large number of vehicles, and **expansion activities in existing airport related to terminal building expansion** without increase in airports existing area, rather than expansion of runways, etc., are two other exempted projects.

TARGET PRELIMS 2024
BOOKLET-15; ENVIRONMENT-5
CA UPDATES ON POLLUTION

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2. AIR UPDATES

1) DUST SUPPRESSANTS AND AIR POLLUTION MITIGATION

- **What are Dust Suppressants?**
  - » These are salts of calcium or magnesium that can absorb moisture.
  - » **Delhi government used** Dust suppressants on roads to control pollution. Environment Minister Gopal Rai had said "the Dust Suppressant powder would be mixed with water and sprayed on roads to keep the dust down for longer."

- **In 2019**, the CPCB told the NCR states that they may consider using dust suppressants on excavated earth surfaces, piles of construction and demolition waste, and access roads in construction areas.
  - » **One of the CPCB study** had found that dust suppressants along with water is relatively more effective in control of pollution than conventional methods of dust control i.e. **water spraying**.

- **In 2019**, the Delhi Pollution Control Committee had also issued directions that all construction agencies will use dust suppressants to control dust emissions and road-owning agencies with use it in dusty patches.

3. WATER UPDATES

1) 'WATER TRADING MECHANISM TO PROMOTE THE REUSE OF TREATED WATER': NITI AAYOG REPORT

- **What is water trading?**
  - » This is a water market mechanism that considers water as a commodity that can be traded among users according to their needs. Under this, water rights are allocated to each sector, and they use it according to their needs – Buy when they need mor water and sell when they need less.
  - » In many countries water trading has promoted water use efficiency.
- **NITI Aayog Report**:
  - » Though it may not be advisable to introduce a full-fledged water trading in India for various socio-economic reasons, **trading of treated wastewater among industrial users could be tried**.

- **Advantages of trading:**
  - » Increased treatment (currently only 40% of India's wastewater is treated).

2) GROUNDWATER EXTRACTION HAS SHIFTED THE EARTH'S AXIS: A NEW STUDY (JUNE 2023: IE)

- **Background: Earth's Axis Keep Shifting**:
  - » Earths spins around an imaginary axis which passes through the north pole, its centre of mass and the south pole – just like a top spin around its spindle.
  - » The poles and axis keep shifting naturally as the mass distribution in and on the planet changes. The phenomenon is known as "Polar Motion".
  - » For e.g., rocks slowly circulating inside Earth's mantle causes the Planet's mass to shift, leading to a change in the position of the rotational axis.

- The study – "**Drift of Earth's Pole Confirms Groundwater Depletion as a Significant contributor to Global Sea Level Rise 1993-2010",** was published in the journal **Geophysical Research Letters**.

- The study noted that humans pumped out around 2150 gigatons of ground water between 1993 and 2010. This has led to planet's axis drifting at a rate of **4.36** cm per year towards the east. Although the shift isn't significant enough to have real-life consequences, but the study shows shift in planet's axis and **rise in global sea level**.

-

3) NIT WARANGAL FACULTY MEMBERS DEVELOP INNOVATIVE WASTEWATER TREATMENT SYSTEM FOR TEXTILE INDUSTRY EFFLUENTS

- **Textile Effluents:**
- A team of faculty members at **NIT-Warangal** has developed an environment friendly **hybrid wastewater treatment system** for textile industry effluents.
  - » **Traditional methods** use a lot of chemicals**.**
  - » However, in the new method, in order to reduce pollution levels to permissible limits of discharge, the team put forward a combination of coagulation, hydrodynamic cavitation (HC) – based oxidation system and ceramic membrane (CM) – based filtration process.
  - » In the coagulation process – turbidity of the effluents is removed.
  - » HC, a process involving generation and collapse of microbubbles in a liquid, is employed afterwards to initiate the breakdown/mineralization of complex organic compounds.
  - » In place of polymeric membrane, the novel methodology uses ceramic membranes. After two years, polymeric membranes need to be discarded. It becomes a solid waste.
    - The surface modified ceramic membrane further improves filtration efficiency, ensuring the removal of even finer particles and impurities.
  - » This integrated method achieved an 80% reduction in **organic pollutants**.

4) COASTAL AQUACULTURE AUTHORITY

- Why in news?
  - » Coastal Aquaculture Authority (Amendment) Act, 2023 passed by both houses of the Parliament.

- **Background**:
  - » The Coastal Aquaculture Authority Act 2005 was enacted with an aim to protect coastal environment, while promoting orderly growth of coastal aquaculture farming in coastal areas.
  - » The act has established **Coastal Aquaculture Authority** which regulates activities connected with coastal aquaculture in the coastal areas.
  - » The act has also **defined coastal aquaculture** to include culturing under controlled conditions in ponds, pens, enclosures or otherwise, in coastal areas of shrimp, prawns, fish or any other aquatic life in saline or brackish water, but **doesn't include freshwater aquaculture**.
  - » The act also ensures **continued operation of coastal aquaculture** within **CRZ area** subject to restrictions imposed by the Authority.
  - » It also penalizes unregistered farms in prohibited areas.

- **Impact**:

» **Facilitated millions of jobs, self employment opportunities, businesss** and environment protection.
» **Increased production of fishery sector**.

- **Need of Amendment**:
  » Some ambiguities related to the provisions of CRZ notifications - like that of "**No Development Zone**" has been misinterpreted to be applicable in the hatcheries as well. Hence, aquaculture farmers and stakeholders have been requesting to remove the ambiguities and amend some of the provision of the act to make this legislation progressive and decrease the regulatory burden.

- **2023 Amendment**:
  » **Broadens the definition** of Coastal aquaculture to include things like cage culture, sea-weed culture, bivalve culture, marine ornamental fish culture etc.
  » **Registration given** under the Coastal Aquaculture Authority Act will be considered a valid permission under CRZ notification. This will enable lakhs of small marginal aquaculture farmers to avoid the possible need for obtaining CRZ clearances from multiple agencies.
  » **Some Aquaculture activities** like hatcheries, nucleus breeding centres, and broodstock multiplication centres can be established in NDZ [200 m from HTL] of seas and buffer zones of creeks/rivers/backwaters.
  » **Decriminalization** of cases of illegal coastal aquaculture and fixed penalties.
    ▪ The original act provided for imprisonment for a period of 3 years for carrying out coastal aquaculture without registration. This was a very harsh punishment for an offence of purely civil nature.
  » **Increase in role of the Authority**:
    ▪ Fix standards of input and discharge of effluents from aquaculture units.
    ▪ Prohibition of certain harmful inputs
    ▪ Monitor and regulate various aquaculture units, inputs and outputs.
  » The act also **prohibits the use of insecticides** and other pharmacologically active substances that can harm human health in coastal aquaculture.

4. PLASTIC UPDATES

1) PLASTIC OVERSHOOT DAY: BY EARTH ACTION (EA) (JULY 2023)

- On July 28, 2023, the Earth saw its first Plastic Overshoot Day: The point at which the amount of plastics exceed the global waste management capacity - As per Swiss based research consultancy **Earth Action** (EA).
  » **Nearly** 68 million tonnes of additional plastic waste will end up in nature in 2023.
  » **India** is among the 12 countries of the world including China, Brazil, Indonesia, Thailand, Russia, Mexico, USA, Saudi Arabia, the DRC, Iran and Kazakhstan, which are responsible for 52% of the world's mismanaged plastics.
  » Under current scenario, despite pledges and increased waste management capacity, increased production of plastics will lead to global plastic pollution tripling by 2040.

- Plastic Overshoot Day is determined on the basis of country's **Mismanaged Waste Index** (MWI).

» The imbalance between the volumes of plastic that are produced and used, as well as the world's ability to manage those volumes when they become waste, is the root cause of plastic pollution. The gap in waste management capacity and plastic consumption is called MWI.
» India ranks fourth (after Mozambique, Nigeria, and Kenya) in terms of highest mismanaged waste with 98.55% of generated waste being mismanaged.

2) US STUDY FINDS HUNDREDS OF THOUSANDS OF NANOPLASTIC PARTICLES IN BOTTLED DRINKING WATER (JAN 2024)

- **About the Study**:
  » The research was published in journal - *Proceedings of the National Academy of Sciences.*
  » The study analysed micro and nanoplastics in three popular brands and daily consumed bottles of water using a technique called stimulated Raman scattering microscopy. The technique passes two lasers through the sample. It is particularly suitable for the identification of microplastics due to its ability to distinguish different types of plastics based on their molecular fingerprints.
    ▪ The team looked for **seven common types of plastics**: Polyamide, polypropylene, polyethylene, polymethyl methacrylate, polyvinyl chloride, polystyrene, and polyethylene terephthalate.

- **Key Findings**:
  » **Each litre of bottled water** contains **110,000 to 370,000 plastic particles** — and about 90 per cent of them are nanosized (less than 1 micrometer in size), a new study has found.
  » These nanoplastics are even smaller than microplastics and **pose a greater risk to human health**. Unlike microplastics, nanoplastics can move from the intestine and lungs directly into bloodstream before reaching the heart and brain.

3) PET46: NEWLY DISCOVERED DEEP-SEA ENZYME BREAKS DOWN PET PLASTIC (SEP 2023)

- A new study involving scientists from Professor Ruth Schmitz-Streit's research group at Kiel University has shown for the first time, **using microorganisms from the deep sea, that polymers such as PET are continuously degraded by an enzyme called PET46**.
  » The results fundamentally expand the knowledge of PET degrading enzymes, the underlying mechanisms and the evolutionary understanding of the diversity of putative PET-degrading enzymes throughout the global ocean.

TARGET PRELIMS 2024
BOOKLET-16; EB&CC-6
CLIMATE CHANGE, OZONE LAYER, DESERTIFICATION

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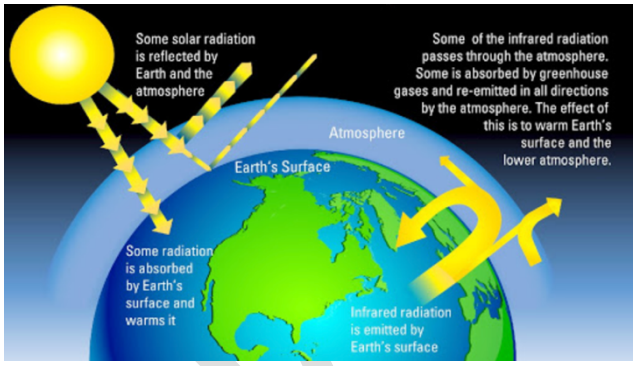
2. CLIMATE CHANGE AND GREEN HOUSE GASES

- **Climate:** Long term pattern of weather in a particular area.

- **Climate Change:**
  - The increasing temperature of earth due to greenhouse effect is known as climate change. It is leading to extreme weather events, melting of Polar ice, rising of sea levels etc.



- **Green House Effect:** Class discussion

- **Greenhouse Gases:** Gases in the earth's atmosphere that trap heat are known as Greenhouse gases. They let sunlight pass through the atmosphere, but they prevent the heat that the sunlight brings from leaving the atmosphere. Greenhouse gases are crucial for survival of life on earth. In the absence of Greenhouse gases, the average temperature on earth would have been -18 degree Celsius instead of the present 15 degree Celsius.

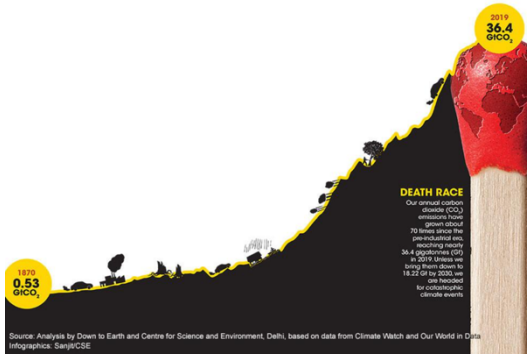
1) WATER VAPOR:

It is the most important Greenhouse gas and plays an important role in controlling earth's temperature.

- Water Vapors account for about 60% of the warming effect. The amount water in atmosphere rises with rising temperature and decreases with the fall in temperature. So, in a way it can be said that water vapors in atmosphere is controlled by the temperature.
- But it is the non-condensable gases (mainly CO_2 which is bringing the increase in the temperature after the first industrial revolution) which are really responsible for recent rise in global warming.

2) CARBON DIOXIDE (CO_2)

- It is produced by **burning of carbon containing substances,** mostly fuels (Coal, natural gas, oil), Solid waste, trees, other biological materials etc.
- CO_2 is removed from atmosphere when it is absorbed (sequestered) by plants during photosynthesis.
- **Concentration of CO_2 in atmosphere:**
  - For the first time in history, the atmospheric CO2 level reached **419 parts per million (PPM)**, as measured by the United States' National Oceanic and Atmospheric Administration's Mauna Loa Atmospheric Baseline Observatory in Hawaii.
    - This is nearly 45% above the pre-industrial baseline of **278 PPM** in 1750 accepted by IPCC.
  - Our **annual CO2 emission** have grown about 70 times since the pre-industrial era reaching nearly **36.4 Gt** in 2019.



3) METHANE

- As per UNEP, **Methane is a** GHG which is responsible for 30% of the warming since pre-industrial times. Its contribution is 2nd only to carbondioxide.
  - » Although the warming effect of methane **is 30 times greater than CO2**, it is a shorter lived and lasts in the atmosphere for about 12 years. (CO2 lingers for centuries)

- **Why special focus on methane is needed in our fight against climate change?**
  - » IPCC had said that the methane mitigation has the **greatest potential to slow warming** over the next 20 years.
    - A 0.3% reduction per year in methane is equivalent to net-zero for CO2 - there would be no additional warming if this level of reduction is achieved.

- **Methane Emission: Biggest Source:**
  - **Natural Sources**: Wetlands, termites etc.
    - **Wetlands** are the largest source of methane.
  - **Agriculture** - Rice cultivation, animal husbandry etc. generate substantial amount of methane.
  - **Energy Production** (fossil fuel) - Among anthropogenic factors, after Agriculture, it is this sector which contributes to the highest methane production. It is released during the extraction, processing, and transport of fossil fuels, including coal, oil, and natural gas.
  - **Leakage**: For e.g. the ruptures in the underwater Nord stream in Sep 2022 caused the single largest such release of the greenhouse gas.
  - **Landfills** in recent times are also becoming a big source of methane emissions.
  - **Thawing of permafrost** in polar region is also releasing methane. In future, it may become a big source of methane emissions.

- **Current Emission levels:**
  - As per US NOAA, the atmospheric level of methane has jumped to **17 parts per billion** in 2021, beating the previous record set in 2020.

A) INTERNATIONAL EFFORTS TO FIGHT METHANE POLLUTION

IMPROVING DETECTION:

- UNEP has launched International Methane Emissions observatory - the Methane Alert and Response System (MARS) at COP27. It is focused on scaling up global efforts to detect and act on major emissions sources in a transparent manner and accelerate implementation of the global methane pledge.

GLOBAL METHANE PLEDGE ANNOUNCED AT COP26

- By COP27, 150 countries have joined the initiative lead by USA and EU. They have promised to **cut their methane emission by at least 30%** from 2020 levels by 2030.
- **Significance:**
  - » Global warming would be **reduced by at least 0.2 degree Celsius by 2050**, if countries deliver according to the pledge.

» **Health benefits**: Oxidation of methane is responsible for formation of ground-level ozone (smog), which is a harmful air pollutant.

- **Why has India not joined the pledge**?
  - » India's methane emissions are '**survival emissions**' and not 'luxury' emissions.
    - The two prominent source of methane in India are enteric fermentation and 'paddy cultivation' and any restriction on them would harm small and marginal farmers.
  - » Other than harming farmers, it may also reduce agri production. Currently, India is one of the largest producers and exporters of rice.
  - » India also argues that 6th IPCC report has highlighted that CO2 is the major global warming gas and this pledge is shifting focus to methane which has a lifetime of only 12 years, whereas CO2 can survive for more than 100 years.

- **India has not joined the global methane pledge**, but it doesn't mean the India is not worried about methane emissions. There are several fronts on which India is working.
  - » **National Innovation in Climate Resilient Agriculture (NICRA)** project of ICAR has developed several technologies with the potential to mitigate methane emissions.
    - For instance, the 'System of Rice Intensification' has the potential to enhance rice yield from 36-49% with 22-35% less water than conventional transplanted rice. It also uses less seed, fertilizers, and pesticides.
      - » Key steps involve:
        1. Planting young seedlings (less than 15 days old) with only one or two leaves
        2. Planting them singly, spaced widely apart
        3. Maintaining soil moisture at a level that promotes aerobic soil conditions
        4. Controlling weeds by mechanical means, such as hand weeding or using a rotary hoe
        5. Using organic matter to improve soil fertility.
        6. Applying small amounts of fertilizer at specific stages of plant growth
    - Another technology, 'Direct Seeded Rice' reduces methane emissions as it does not involve raising nurseries, puddling, and transplanting. Unlike transplanted paddy cultivation, standing water is not mantained in this system.
    - **Harit Dhara**: It is an anti-methanogenic feed supplement developed by ICAR. It can cut down cattle methane emissions by 17-20% and can also result in higher milk production.
    - Under Crop Diversification Program, methane emission is being avoided due to diversion of paddy to alternate crops like pulses, oilseeds, maize, cotton, and agro-forestry.

B) REPORT: METHANE GLOBAL TRACKER REPORT BY IEA (FEB 2023)

- **Summary:**
  - » **Emissions from Energy Sector:** The **energy sector accounts for around 40% of the total average methane emissions from human activity**, as oil and natural gas companies are known to release methane into the atmosphere when natural gas is flared or vented. The greenhouse gas is also released through leaks from valves and other equipment during drilling, extraction and transportation process.
- **How can methane emission be reduced:** Although, it's impossible to completely eliminate all the emissions, **75% of the methane emissions from the energy sector** can be reduced with the help of cheap and readily available technology. However, **fossil fuel companies have failed to take any substantial action regarding the issue**.
- The effort will cost less than 3% of the net income received by the oil and gas industry in 2022.
- **Details:**
  - » Fossil fuel companies emitted 120 million metric tonnes of methane into the atmosphere in 2022, only slightly below the record high seen in 2019.
  - » The cheap and readily available technology can reduce 75% of the methane emissions from the energy sector.

C) BURP CONTROL: HOW CAN METHANE RELEASED IN LIVESTOCK BELCHED BE REDUCED? (DEC 2022: SOURCE - DTE)

- **Feed Supplements** - which can reduce a potent greenhouse gas belched out by stock animals like cattle, goat and sheep. A food supplement is considered ideal if it can **lower methane emissions by at least 20%**.
- In 2021, **EU approved a food supplement**, **Bovaer**, developed by Dutch bioscience company Royal DSM, saying it consistently reduces methane emissions from dairy cows by 30-80%.
  - **Bovaer**, is a fine granular powder containing **3-nitrooxypropanol**, which inhibits an essential enzyme responsible for the methane production.

D) TERMITES EMIT METHANE: BUT THE EXTENT OF THEIR RISK TO GLOBAL WARMING IS UNCERTAIN (SOURCE: DTE)

- As per the Global Carbon Project, in 2008-17, the world emitted **576 Tg** of methane per year, of which termites contributed 9 Tg.
- **However**, scientists say that the real emissions may be greater or lesser than this. To establish certainty, there is a need to understand the relationship between termite colonies and methane.
- **How is methane produced by Termites?**
  - In natural ecosystems, they feed on and recycle the nutrients present in dead and decaying plant and animal matter.
  - It is this cellulose-rich diet that causes their emissions.
  - **Methanogenic microorganisms that live in the gut of termite**s break down the cellulose entering the body and release methane.

4) NITROUS OXIDE (N_2O)

- It is the third most important GHG. It is long lived (average > 100 years), and also has ozone depleting properties.

- It is a natural part of the nitrogen cycle. Bacteria in soil and the ocean make it. It is also produced during agricultural and industrial activities, combustion of fossil fuels and solid waste, as well as during treatment of wastewater.

- **Reports: Global Nitrous Oxide Budget**
  - N_2O is accumulating in the atmosphere at an increasing rate, with **global emissions of 17 Tg N in 2016**, 10% greater than in the 1980s. **Net emission** (thus net addition) is **4.3 Tg.**
  - **Main Anthropogenic factors** is the agriculture.
    - Other factors include - fossil fuels, industry, waste and wastewater, and biomass burning.

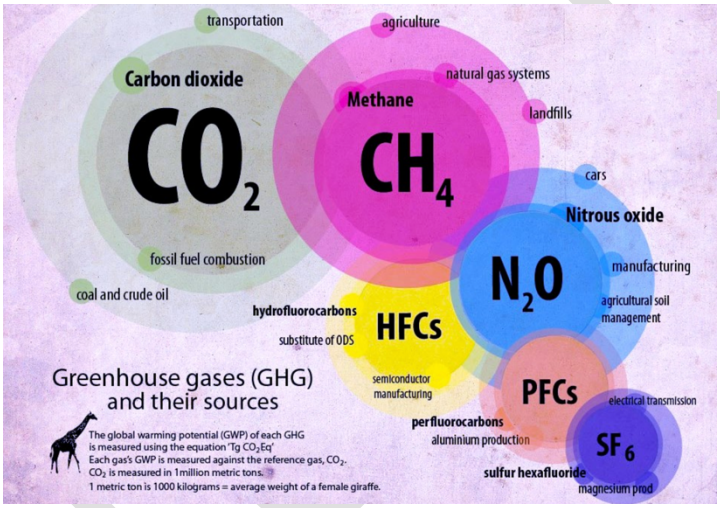
5) OZONE (O_3) -> ALREADY COVERED WITH AIR POLLUTION

6) FLUORINATED GASES (HFCS, PFCS, SF_6, NITROGEN TRIFLUORIDE (NF3) ETC.)

- Not naturally found in atmosphere and are manmade.

- Fluorinated gases are used as substitute for ozone depleting substances like CFCs, HCFCs, and Halons.

- Though they are released in small quantities, but their global warming potential is very high.



7) BLACK CARBON

- **What is black carbon?**
  - » It is the **sooty black material** emitted from gas and diesel engines, coal-fired power plants, and other sources that burn fossil fuel. It comprises a significant portion of particulate matter or PM, which is an air pollutant. It consists of pure carbon in several linked forms.

- **Environment Pollutant -** It is a **short-lived** pollutant which is the key component of PM2.5. It has negative implications for our health and may cause respiratory and cardio-vascular diseases, cancer, birth defects and premature mortality.

- **Climate Change:** It is also responsible for **climate change.**
  - » BC deposits can **accelerate the pace of glacier and snow melt** in the Himalayan region.
    - How?
  - » It is also responsible for affecting the **cloud formation and thus affects rainfall**.
  - » A recent study has shown that it may also be **depleting ozone layer**.

- **Main Sources: Incomplete burning of fuel** (i.e., inefficient burning environment) produces black carbon.
  - » **Solid Fuel burning** [coal, biomass etc.]
    - Industry (primary brick kilns) and residential burning of solid fuel together account for about 45-66% of anthropogenic BC deposition in Himalayan region.
  - » **Diesel exhausts** etc. contributes to 7-18% of BC deposits in the Himalayan region.
  - » Since, India has a large population depending on **bio-mass and solid fuel**, it contributes to around 25% of the world's Black Carbon emission.
    - According to a study published in the journal *Atmospheric Research* in April 2019, India is the 2nd largest contributor to Black carbon in the world.

- **Steps taken by Government to reduce black carbon:**
  - Enhancing **fuel efficiency standard of Vehicles**, phasing out diesel vehicles and promoting electric vehicles
  - Promotion of the use of **LPG** for cooking **(PM Ujjawala Yojana**)
  - Clean Cookstoves program
  - Upgrading brick kiln technologies
  - **Real time monitoring of black carbon aerosols in the Glaciated valley of northwestern Indian Himalayas**.

- **However**, with all existing measures, water from glacier melt is still projected to increase in **absolute volume by 2040**, with impact on downstream activities and communities.

8) BROWN CARBON

- **Brown carbon** is emitted mainly by **biomass combustion**. It is a **light absorbing** part of the **organic aerosol** (note: soot is also light absorbing in nature). In recent years it has come under a lot of research.
  - It absorbs strongly in the ultraviolet wavelength (high frequency) and less significantly into the visible (low frequency).

- **Sources of Brown Carbon**
  - » **Tar Material** from smoldering fires or coal combustion.
  - » **Breakdown products** from biomass burning, stubble burning.
  - » **A mixture of organic compounds** emitted from soil, and volatile organic compounds given off by vegetation.

- **TAJ: The Pollutants causing discoloration identified**
  - » **Particulate carbon and fine dust particles** that are deposited on the marble are responsible for its browning.
  - » **Brown Carbon:** The group of carbon which absorbs light in the blue region of spectrum, and this is called brown carbon. Discoloration is because of what is happening to reflectance, reflectance in turn is influenced by these particles.
  - » **Presence of hematite in the dust** that is responsible for the **brown hue**. If hematite is not present in the dust then the dust would be only scattering in nature. Hematite is the ingredient that absorbs the blue wavelength of the spectrum**.**

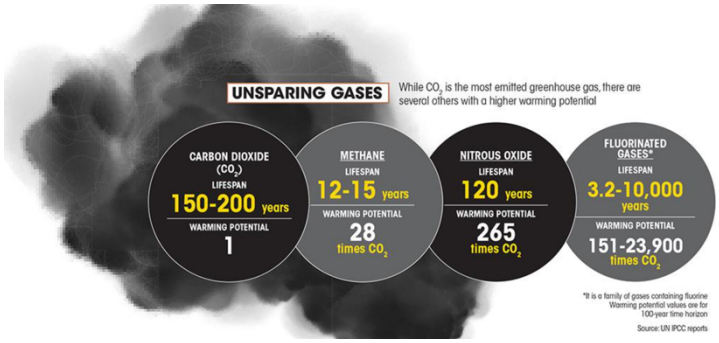
- **Note: Brown Carbon vs Black Carbon**
  - » Black carbon is primarily produced by high temperature combustion and brown carbon is emitted mainly by biomass combustion.
  - » Of the total atmospheric absorption by aerosol, brown carbon contributes about 19%, while 72% is contributed by Black carbon. The remaining 9% is due to the coating effect of sulfate and organic aerosols on black carbon.
  - » Both of these are two most important light absorbing substances in the atmosphere.

- **Tarballs and its implications**
  - » Tarballs are formed from brown carbon. They are small light absorbing, carbonaceous particles formed due to burning of fossil fuels that deposit on snow and ice.
  - » Recent research has shown that tarballs from long-range transport can be an important factor in the climatic effect of glacier melting in Himalayas.
    - Nearly, 28% of particles collected from the air samples from a research station in Himalayan-Tibetan Plateau were tarballs.

Extra for Pre
Blue Carbon: It is the carbon that is stored and sequestered in the coastal ecosystem such as Mangroves, seagrass meadows and intertidal saltmarshes.

9) EFFECT OF A GAS ON CLIMATE CHANGE DEPENDS ON THREE MAIN FACTORS:

1. **Quantity** i.e., how much of the gas is present in the atmosphere.
2. **Life** i.e., for what duration can the gas survive in atmosphere
3. **Strength** i.e., how strongly they trap the heat



- **For** each gas a **Global Warming Potential** (GWP) is calculated by considering its duration of existence (i.e., life) and strength of its impact.

10) SDG AND CLIMATE CHANGE

- **Goal 13: Climate Action**
- **Targets**
    - Strengthen **resilience and adaptive capacity to climate-related hazards and natural disasters** in all countries
    - Integrate climate change **measures** into national policies, strategies and planning.
    - Improve **education, awareness-raising and human and institutional capacity** on climate change mitigation, adaptation, impact reduction and early warning
    - Implement the commitment undertaken by developed-country parties to the United Nations Framework Convention on Climate Change to a goal of mobilizing jointly $100 billion annually by 2020 from all sources to address the needs of developing countries in the context of meaningful mitigation actions and transparency on implementation and **fully operationalize the Green Climate Fund** through its capitalization as soon as possible
    - Promote mechanisms for raising capacity for effective climate change-related planning and management in least developed countries and small island developing States, including focusing on women, youth and local and marginalized communities.

3. IPCC AND ASSESSMENT REPORT 6 (AR-6)

- **Recent News**:
    - Scotsman **James Skea** elected new IPCC chair in Nairobi. He is a professor of sustainable development at Imperial College London and will lead IPCC through its seventh assessment report (July 2023: Source: DTE)
        - » The election was held at 59th session of IPCC which was held at UNEP headquarter in Nairobi, Kenya.
- The Intergovernmental Panel on Climate Change (IPCC) is the **UN body** for assessing the science related to climate change. Its job is **to assess already published scientific literature** to update our knowledge of climate change science.
    - IPCC's Assessment Reports (ARs), which are produced every few years, are the most **comprehensive and widely accepted** scientific evaluations of the state of Earth's climate.
    - They form the basis for government policies against climate change and provide scientific foundation for the global Climate Change negotiations.
    - So far, **Six Assessment Reports** have been produced.
- **IPCC** was **set up in 1988** by World Meteorological organization (WMO) and United Nations Environment Program (UNEP) to provide policy makers with regular assessment of the scientific basis of climate change, its impacts and future risks, and options for adaptation and mitigations.
- Currently it has 195 members and relies on thousands of scientists who volunteer their time to support its work.
    - **India** is a member of IPCC

A) WHAT HAVE PREVIOUS REPORTS (AR-1 TO AR-5) SAID?

- The **first Assessment Report** (1990) noted **that anthropogenic emissions are increasing atmospheric GHGs**. In the business-as-usual scenario, temperature was likely to increase by 2 degree C compared to pre-industrial levels by 2025, and 4 degree C by 2100.
    - » The report formed the **basis for the negotiation of the UNFCCC in 1992**, known as the Rio Earth Summit.

- The **Second Assessment Report** (1995) revised the projected rise in global temperature to 3 degree C above pre-industrial level by 2100. It was the scientific underpinning for the Kyoto Protocol of 1997.

- The **third Assessment Report** (2001) projected the rise in global temperature to 1.4 to 5.8 degree C by 2100 compared to 1990.

- The **fourth Assessment Report** (2007) said that the GHG emissions increased by 40% between 1970 and 2004 and the atmospheric CO2 was the most in 650,000 years. In the worst-case scenario, the global temperature could rise by 4.5 degrees.
    - » The report won the 2007 Nobel Peace Prize for IPCC. It was also the scientific input for the 2009 Copenhagen Climate meeting.

- The **fifth Assessment Report** (2014) said that more than 50% of the temperature rise since 1950 is due to human activities. The rise in global temperature by 2100 could be as high as 4.8 degree C from pre-industrial times, and more frequent longer heatwaves were "virtually certain". It formed the scientific basis of the Paris Agreement in 2015.

1) IPCC SYNTHESIS REPORT

- **Why in news?**
    - » The IPCC has released its Synthesis report for the sixth assessment Cycle on 20th March in **Interlaken, Switzerland**
        - The report was signed by country representatives - an unusual step taken to ensure governments accept its findings (March 2023)

- **What is the report?**
    - » It is a compilation of the main findings of the IPCC's sixth assessment report, based on the results from three Working Groups (WGs).
        - **WG, I** evaluated the physical science basis of the climate change.
        - **WG II evaluated the impacts, adaptation, and vulnerability**,
        - **WG III evaluated the mitigation**.
        - The synthesis report also drew from **Special Report based on Global Warming of 1.5 degree C** (Oct 2018), Climate Chane and Land (August 2019), and the Ocean and Cryosphere in a Changing Climate (Sep 2019)

    - » The report was finally approved by nations after major economies like China, Brazil, Saudi Arabia, the US, and EU raised concerns about the working of the text.

    - » **Key Highlights:**

- The report highlights the urgency of drastically reducing the emission of greenhouse gases and so limit rising global temperature by 1.5 degree C from pre-industrial levels, set by the Paris Agreement.

2) AR-6

- The sixth report was published in **three parts**: - the first in Aug 2021, the second in Feb 2022, and the third in April 2022. These three parts were by three working groups of scientists:
    - **Working Group-1**: Deals with **scientific basis of climate change**
    - **Working Group-2**: Looks at **likely impacts, vulnerabilities, and adaptation issues.**
    - **Working Group-3**: Deals with a**ction that can be taken to combat climate change.**

- The first report "***Climate Change 2021: The Physical Science Basis"*** highlighted the following:
    1. Climate was changing more rapidly than originally anticipated by climate scientists.
    2. Rise in **global temperature was direct result of human activities** and there is 'unequivocal evidence' about it.
    3. Temperature has already rise by 1.1 degrees from the pre-industrial 19th century.
    4. **Greenhouse gas Emissions:**
        - Emissions of Carbon dioxide, methane and nitrous oxide breached records in 2020.
        - CO2 Concentration in the atmosphere - at around 416 parts per million - are the highest they have been in 2 million years.
    5. **Impact:**
        - A more intense and frequent heatwaves; increased incident of extreme rainfall; a dangerous rise in sea-levels; prolonged droughts; Melting of glaciers.

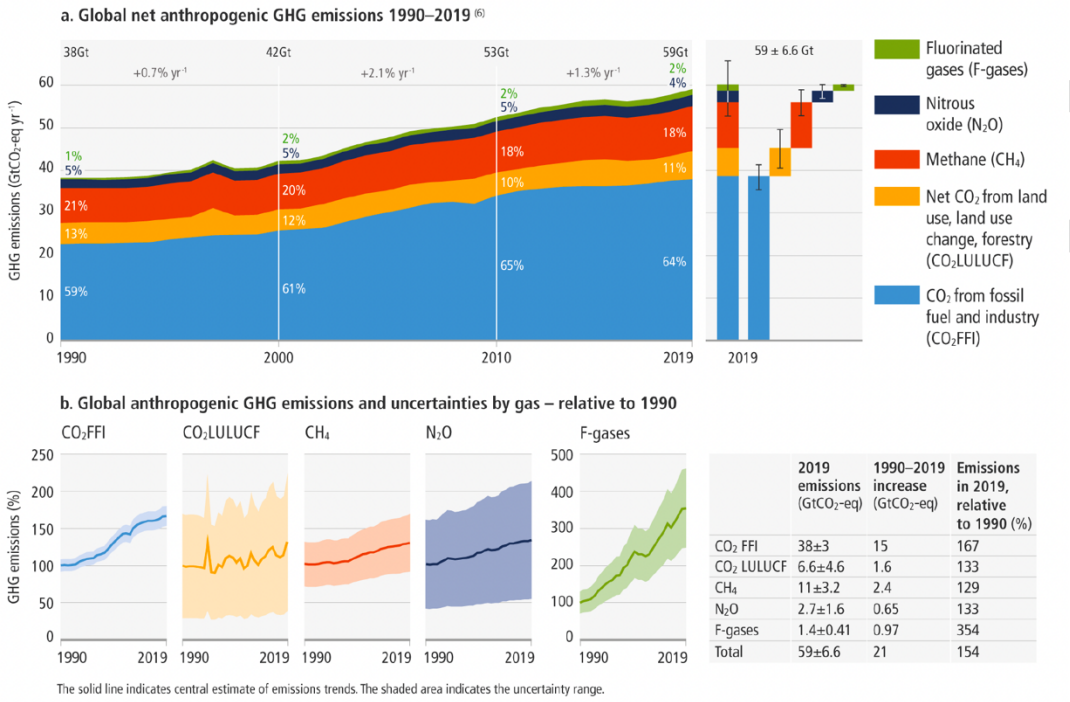
- The second report: **Climate Change 2022: Impacts, Adaptation and Vulnerability**
    - The report recognizes the interdependence of climate, ecosystem, and biodiversity, and human societies and integrates knowledge more strongly across the natural, ecological, social and economic sciences than earlier IPCC reports.

A) THE THIRD REPORT: CLIMATE CHANGE 2022: MITIGATION OF CLIMATE CHANGE

- The report lays out actions that the world can take to stop global temperatures rising beyond certain levels by the end of the century.
- If countries stick to current NDC commitments, it will lead to breach of 1.5 degree C temperature rise.
    - Even the 2-degree Celsius target, in that case, would rely on "rapid acceleration" of climate actions after 2030.
    - **What should be the reduction to prevent temperature rise beyond 1.5 degree C?**
        - Global GHG emissions to peak before 2025 at the latest and be reduced by 43% by 2030; at the same time methane also needs to be reduced by 43% by 2030. Global use of coal, oil and gas in 2050 must decline by about 95%, 60% and 45% respectively, relative to 2019.
        - Even if all this happens, it is almost inevitable that this ceiling would be temporarily breached but, with appropriate action, it could again dip by the end of century.

- **Global warming would stabilize if emissions reach net zero**.
  - For 1.5 degree C target, this meant achieving **net zero emissions globally in the early 2050s**; for 2 degree C, it is in early 2070s.
  - Even limiting warming to 2 degree C would require greenhouse gas emissions to peak before 2025 at the latest and be reduced by a quarter by 2030.

Global net anthropogenic emissions have continued to rise across all major groups of greenhouse gases.



	2019 emissions ($GtCO_2$-eq)	1990–2019 increase ($GtCO_2$-eq)	Emissions in 2019, relative to 1990 (%)
CO_2 FFI	38±3	15	167
CO_2 LULUCF	6.6±4.6	1.6	133
CH_4	11±3.2	2.4	129
N_2O	2.7±1.6	0.65	133
F-gases	1.4±0.41	0.97	354
Total	59±6.6	21	154

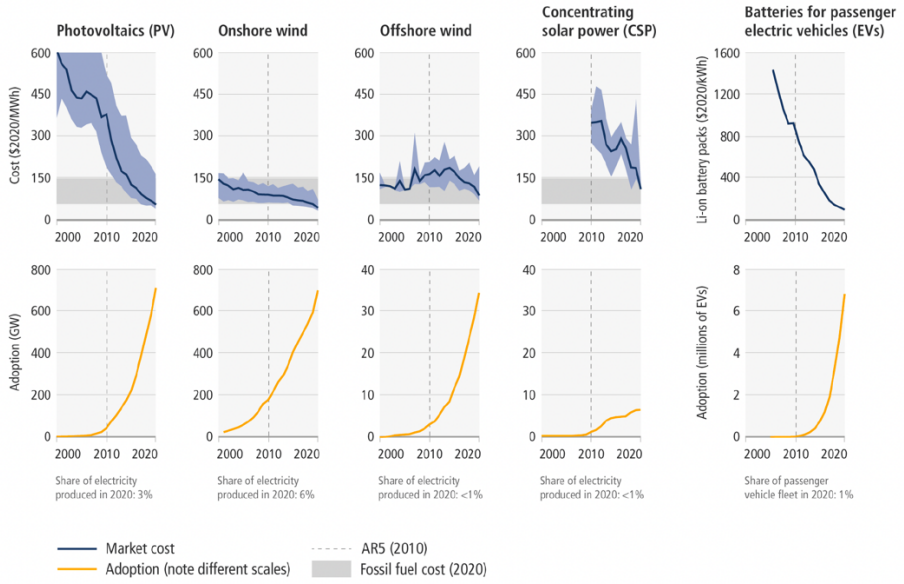
- **Carbon Inequality remains pervasive** as ever with LDCs emitting only 3.3% of global emissions in 2019.
  - Their average per capita emissions in the period 1990-2019 were only 1.7 tonnes CO2e, compared to global average of 6.9 tCO2e.

- The **Least Developed Countries (LDCs)** emitted only 3.3% of global emissions in 2019.

- **Abundant and Affordable Solutions exist across sectors including energy, buildings, and transport**, as well as **individual Behavioural changes**.
  - The report has detailed **60 different options and pathways** that can lead to 40-70% reduction in global emissions.
  - It states with high confidence that "**several mitigation options**, notably solar energy, wind energy, electrification of urban systems, urban green infrastructure, energy efficiency, **demand side management**, improved forests - and crop/grassland management and reduced food wastage and loss, are **technically viable**, are becoming increasingly cost effective and are generally supported by the public".

- The per-unit costs of several low emissions technologies have fallen continuously since 2010, however **innovation has lagged in developing countries due to weak enabling conditions**.
    - On a unit costs basis, solar energy has **dropped 85%**, **wind by 55%**, and lithium-ion by 85%.
        - Their deployment and usage has increased multifold since 2010 - 10 times for solar and 100 times for electric vehicles.
    - **Factors**: Higher public spending in R&D; Funding for demonstration and pilot projects; and demand pull instruments such as deployment subsidies to attain scale.

The unit costs of some forms of renewable energy and of batteries for passenger EVs have fallen, and their use continues to rise.

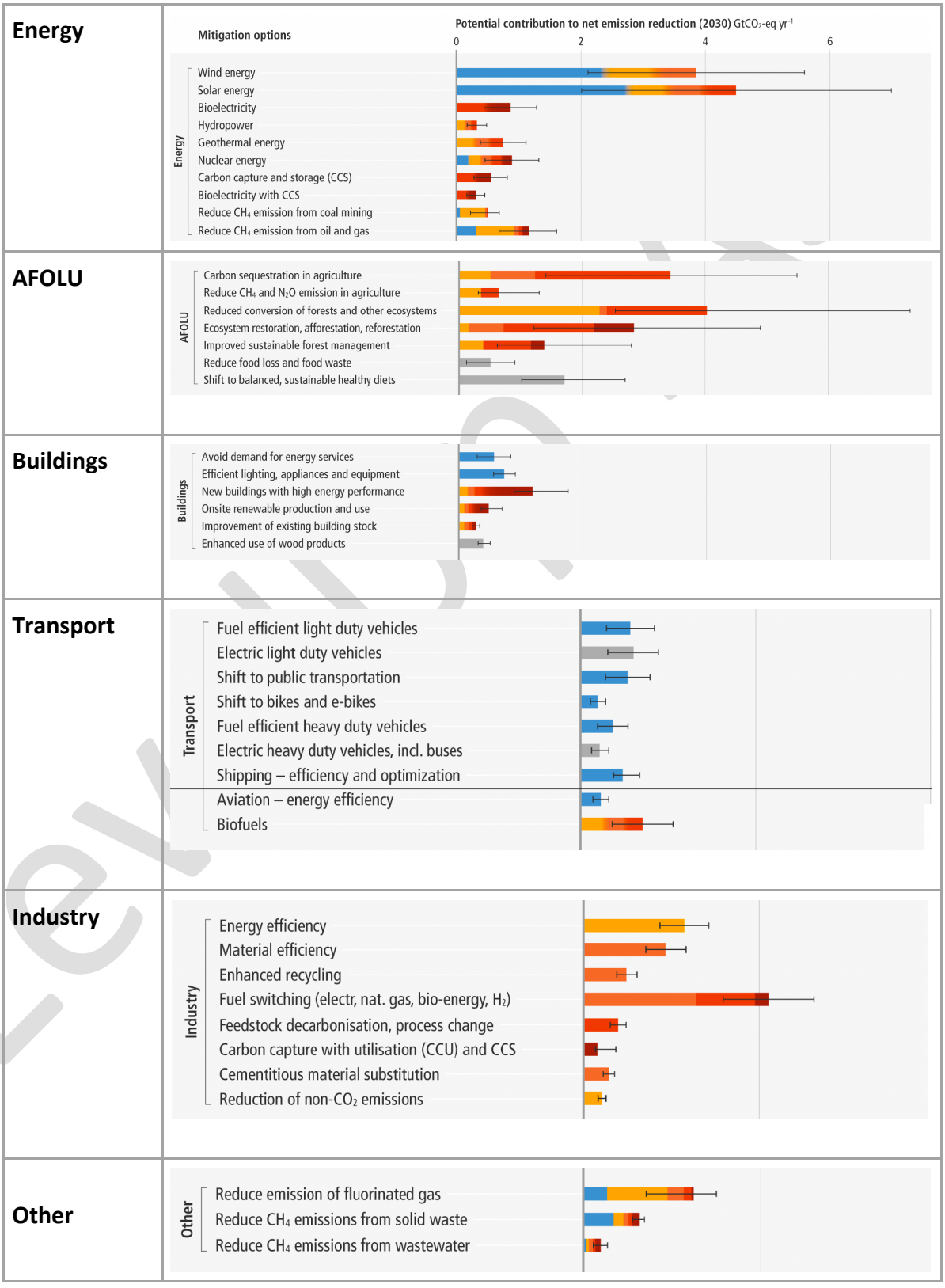


- The report covers **demand side mitigation** and states that it can help reduce emissions by 40-70% by 2050.
    - Demand Side Mitigation can be achieved through changes in socio-cultural factors, infrastructure design and use, and end-use technology adoption by 2050.

Food	Industry	Land transport

- **Individuals can also contribute in other ways:**
  - Putting political pressure on leaders.

- **Many options available now in all sectors are estimated to offer substantial potential to reduce net emissions by 2030**. Relative potential and cost will vary across countries in the longer term compared to 2030.



- **Implementing these mitigation strategies** would come at a substantial cost. The report estimates that taking the actions to keep temperature below 2 degree C could **reduce global GDP by 1.3% to 2.7% by 2050**, but not doing so has its own costs.

- **Climate Finance**:
    - Tracked financial flows were still **falling short** of the levels needed to achieve mitigation goals across all sectors and regions.
    - The **gaps are the widest** for the agriculture, forestry, and other land use (**AFOLU**) sector and for **developing countries**.
    - But the **global financial system is large enough** and "sufficient global capital and liquidity" exist to close these gaps.

- **Implications of the report for India**
    - The report warns against opening new coal plants.
        - The report says that Coal-fired power plants, without the technology to capture and store carbon (CCS), would need to be shuttered by 2050 if the world aspired to limit global temperature rise to 1.5-degree C.

B) OTHER IPCC REPORT

IPCC Report, 2018: The Special Report on Global Warming (1.5C Report)

IPCC Report: Special Report on Climate Change and Land

IPCC Special Report on the Ocean and Cryosphere (SROCC)

4. REPORTS ABOUT CLIMATE CHANGE

A) REPORT BY WORLD METEOROLOGICAL ORGANIZATION (WMO)

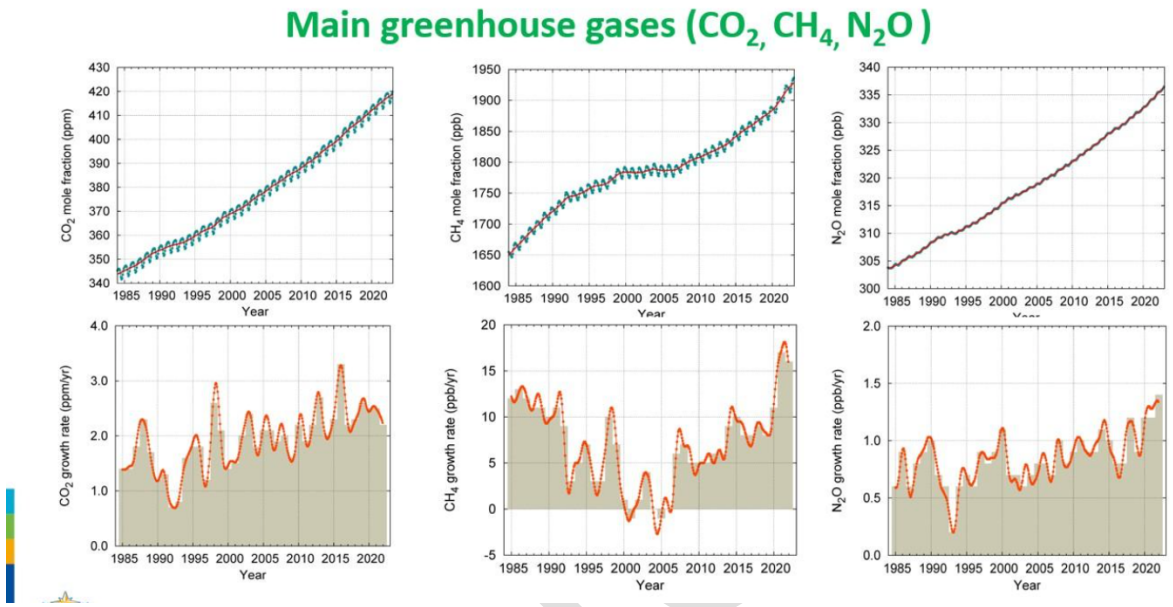
- **About WMO**
    - **WMO** is a specialized body of UN which is an authoritative voice on behaviour of earth's atmosphere, its interaction with the oceans, the **climate** it produces and the resulting distribution of water resources.
    - **Headquarter:** Geneva
    - It originated from the International Meteorological Organization, which was founded in 1873. It was established in 1950, and became the specialized agency of UN in 1951 for Meteorology (weather and climate), operational hydrology and related geophysical sciences.

B) STATE OF GLOBAL CLIMATE REPORT, 2023

- Provisional data shows that 2023 is set to be the warmest year on record. Data until the end of Oct 2023 shows that the year was about 1.4 degree C (with a margin of uncertainty of +-0.12 degree C) above the pre-industrial levels.

C) GREENHOUSE GAS BULLETIN, 2023 BY WMO

The abundance of heat-trapping greenhouse gases in the atmosphere once again reached a new record last year (i.e. in 2022) and there **is no end in sight to the rising trend**, according to a new report from the World Meteorological Organization (WMO).



D) GLOBAL OCEAN OBSERVING SYSTEM (GOOS) REPORT CARD, 2022

It was prepared in collaboration with WMO, the Intergovernmental Oceanographic Commission of UNESCO (IOC-UNESCO) and other GOOS partners and experts, and produced by its operational centre OceanOP.

E) OTHER REPORTS BY WMO

- State of Climate in Asia, 2021
- State of Climate Service Report

3) REPORTS BY UNEP

F) THE EMISSION GAP REPORT, 2023

- **About the Report**
  - The report provides the latest assessment of scientific studies on current and estimated future Green House Gases (GHG) emissions and compares these with the emission levels permissible for the world to progress on a least-cost pathway to achieve the goals of **Paris agreement**. The

difference between "where we are likely to be and where we need to be" has become known as the "**emission gap**".

- **Key Highlights of the 2023 Report:**
  - There has been progress since the Paris Agreement was signed in 2015.
  - GHG emissions in 2030, based on policies in place, were projected to increase by 16 per cent at the time of the agreement's adoption.
  - **Today,** the projected increase is 3 per cent.
  - However, **predicted 2030 greenhouse gas emissions still must fall by 28 per cent** for the Paris Agreement 2°C pathway and 42 per cent for the 1.5°C pathway.

G) THE ADAPTATION GAP REPORT

- **Introduction:**
  - The report by UNEP looks at the **progress in** planning for, financing and implementing **adaptation** - with a focus on nature-based adaptation.
  - **Adaptation** action is critical to enable both public and private sectors to prepare for and respond to the impacts of climate change.

- **Adaptation Gap Report 2023:** ***Underfinanced. Underprepared – Inadequate investment and planning on climate adaptation leaves world exposed***
  - The report finds that progress on climate adaptation is slowing when it should be accelerating to catch up with these rising climate change impacts.

H) OTHER REPORTS BY UNEP

- Global Environment outlook report

4) REPORTS BY GLOBAL CARBON PROJECT

- Global Carbon Budget 2022 Report
- Global Methane Budget (GMB)
- Global Nitrous (N_2O) Budget

I) ABOUT GLOBAL CARBON PROJECT (GCP)

- GCP is a global research project of **Future Earth** and a research partner of the **World Climate Research Program**.
- It was formed to work with international science community to **establish a common and mutually agreed knowledge base** to help fight climate change.
- It was established in 2001 by a shared partnership between the International Geo-Sphere-Biosphere Program (IGBP), the International Human Dimension Program on Global Environmental Change (IHDP), the World Climate Research Program (WCRP) and Diversitas. This partnership constituted the **Earth Systems Science Partnership** which subsequently evolved into **future Earth**.

- **Goals**

» Develop complete picture of the global carbon cycle, including both in biophysical and human dimensions together with the interactions and feedbacks between them.

5) OTHER REPORTS

J) CLIMATE CHANGE PERFORMANCE INDEX (CCPI)

- Published since 2005, CCPI is an **independent monitoring tool** of countries' climate protection performance. It aims to enhance transparency in international climate politics and enables the comparability of climate protection efforts and progress made by individual countries.
- The CCPI assesses each country's performance in **four categories:**
  - **GHG emissions** (40% of the overall ranking)
  - **Renewable Energy** (20%)
  - **Energy Use** (20%)
  - **Climate Policy** (20%)
- **59 countries** (which together are responsible for 92% of the global emissions) are assessed under the ranking.
- The report **is jointly presented** by: **GermanWatch**, NewClimate Institute and Climate Action Network (CAN).

K) GLOBAL CLIMATE RISK INDEX – BY GERMANWATCH

L) OTHER REPORTS

- Climate and Development: An Agenda for Action: By the World Bank
- NDC Synthesis Report, 2022: UNFCCC
  - It is the annual summary of climate commitments made by countries and their impact on GHG emissions.
- Investing in Carbon Neutrality: Utopia or the new green wave
- State of Climate Action Report 2022 – By Climate action tracker (an independent analytic group comprising Climate Analytics and New Climate Institute), the United Nations High Level Climate Change Champions, World Resource Institute and Others
- The World Heritage Glaciers Report – Jointly released by UNESCO and IUCN
  - 1/3rd of the World Heritage Glaciers will disappear by 2050.
  - Note: So far, around 50 UNESCO Heritage sites have glaciers in them.

5. OTHER MISCELLANEOUS TOPICS

A) WET BULB TEMPERATURE

- **What is wet bulb temperature?**
  - Wet bulb temperature is the lowest temperature to which air can be cooled by the evaporation of water into the air at a constant pressure.

        - It is therefore measured by **wrapping a wet wick around the bulb of a thermometer** and the measured temperature corresponds to the wet bulb temperature.
        - In simpler terms, **wet bulb temperature** is the lowest temperatures that our bodies can reach when we are in hotter environments, by sweating. It tells us at what level our bodies will not be able to cool themselves down by sweating. In this case the threat of heat stroke rises dramatically.
    - The **dry bulb temperature** is the ambient temperature.
    - **The difference between** the two temperatures (dry bulb and wet bulb) is a measure of humidity of the air. The higher the difference in these temperatures, lower the humidity of the air.

- **Why is wet bulb temperature important?**
    - Dry temperature, or the temperature that we see in daily weather forecast - doesn't tell us the full story. Wet bulb temperature, especially in times of heat waves, tells us how habitable a place is for human body.
    - **A wet bulb temperature of 32 degree C** is the maximum that a human can endure and carryout normal outdoor activities. This is equivalent to dry temperature of 55-degree C. The **theoretical maximum wet bulb temperature** is 35 degree C - most humans, even with unlimited water supply, are likely to suffer heat strokes at this level, likely leading to death.

- **Climate Change and Wet Bulb temperature:**
    - IPCC study shows that with climate change, the wet bulb temperature in India is going up.
        - If emissions continue to increase Lucknow and Patna would be the cities which would reach wet bulb temperature of 35 degree C. Parts of Central India, including Vidarbha are at risk of exceeding wet bulb temperature of 32-34 degree C

6. IMPACT OF GLOBAL WARMING

GWG emissions is breaching all the records: As per the AR6, **Emissions of Carbon dioxide, methane and nitrous oxide breached records in 2020.** CO2 Concentration in the atmosphere - at around 419 parts per million - are the highest they have been in 2 million years.

- **Three factors** make carbon budgeting complex:
    1. **The pollutants** - primarily GHGs like CO2 and methane - have an extraordinary long life. Thus, historic emissions continue to warm up the planet just like current emissions.
    2. GHG emissions are linked to **economic growth**.
    3. **Sharing of burden** becomes difficult as the emissions are associated with economic growth.

1. **Rising Temperatures**
    - As per the AR6 of IPCC, the global temperature has already risen by 1.1 degree C since preindustrial 19th century. This could increase upto 1.5 degree Celsius in less than 20 years (before 2040).
        - **Further,** the **2 degree C warming** is likely to get exceeded by the end of this century unless immediate and deep reductions in greenhouse gas emissions are initiated immediately.
        - **In business-as-usual approach**, or in **worst case scenario**, the temperature rise by the end of this century would exceed **even 4 degree Celsius'**

        - The report is also '**unequivocal**' (i.e. there is almost no doubt) that most of the observed warming of the planet since the late 1800s is caused by human activities.
    - » As per the WMO, the **decade 2010-20 and the five years (2015-20)** were the hottest in the earth's history

2. **Melting of Glaciers and Sea Level Rise -> Submergence of coastal region**
    - » AR6: Sea level rise has tripled compared with 1901-1971. The Antarctic sea ice is the lowest in last 1,00 years.
    - » The temperature of Antarctica rose above 20 degree Celsius for the first time on record.

3. **Heating up of Oceans -> marine heat waves, intense cyclones etc**.

4. **Increasing variability in weather patterns**
    - » **Heat waves and floods** which used to be once-in-a century event are becoming more regular occurrence.
    - » **Weather Disasters** have displaced millions of people this year and **affected rainfall patterns** from India to northern Russia and the Central United states.
    - » **For instance: India saw 13 Deficit Monsoons in 18 years between 2001-18**.

5. **Compounding extremes** (several climate change drivers operating together) are maximizing disaster in India and elsewhere.
    - » E.g., heavy rainfall, landslides, snow avalanches, and flooding occurring together is an example of compounding event.

6. **Thawing of Permafrost and Arctic Lakes Bubbling Methane**
    - » **Reasons: Permafrost Thawing producing methane gas**
        - Organic matter in Artic generally remain frozen. But, with climate change thawing is taking place. This thawing is leading to organic matter decaying into carbon di oxide and methane which is leading to methane getting emitted in atmosphere.
    - » **Warmer temperature increases the thawing of permafrost and release methane to the atmosphere**
        - But this also means that growing season increases, more plant growth takes place and thus more CO_2 getting absorbed. But overall, the increase in release of GHGs would be much higher.
    - » **Presently Arctic is a net carbon sink**
        - **But** soon arctic could become a carbon source, if the earth continues to warm, and a lot of permafrost thaws out. This would start a cycle of releasing more carbon from permafrost thawing and less absorption where the extra carbon in the atmosphere results in increasing warming.

7. **Sea Water** is **26% more acidic** than at the start of the industrial era. This is leading to degradation of marine ecosystem.

8. **Biodiversity Loss**
    - » At least **1 million species were at risk** because of the rising CO_2 concentration in the atmosphere and global warming.

- For instance, a recent study shows that seal pups (IUCN: LC) are finding it tough to survive in the Baltics in the absence of ice. 100s of grey seal pups are dying on the shores of the Baltic Sea in Estonia and Latvia as the Nordic coastline faced winter without ice in decades.

9. **Negative Impact on Food Security, Agriculture and Economy**
   - » Variability in rainfall
   - » Increased temperature and evaporation of water sources
   - » Increased chances of Locust attacks
   - » Extreme weather events triggered by climate change costs India $87 billion annually : State of Climate in Asia, 2020 (report by WMO)

10. **Climate Change has adversely affected both physical and mental health of people.**
    - » Impacts on health is mediated by both through natural and human systems, including economic and social conditions and disruptions.
    - » Extreme heat events -> Mortality and morbidity
    - » Climate related food borne and water borne diseases has increased. The incidence of vector borne diseases have also increased due to range expansion and/or increased reproduction of disease vectors.
    - » Some **mental health challenges** are associated with increasing temperatures, trauma from weather and climate extreme events, and loss of livelihood and culture. Exposure to wildfire smoke, atmospheric dust, and aeroallergens have been associated with climate sensitive cardiovascular and respiratory distress.

11. Achievements of SDG targets have been negatively hindered.

12. **Shrinking of Stratosphere:**
    According to a study published by NASA, the earth's energy imbalance doubled over the 14 year period between 2005 - 2019, doubling the pace at which the Earth retains heat from 2005. As a result of this **we are already on the brink of losing stratosphere**

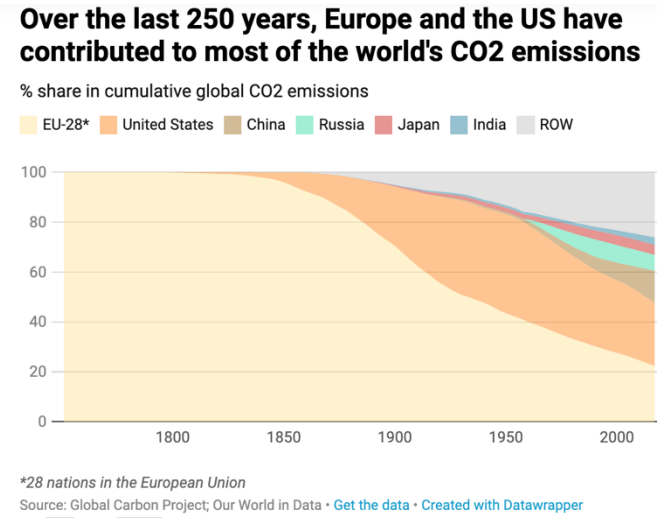
7. UNFCCC – PARIS AGREEMENT TO COP27

1) UNFCCC

- It is one of the three conventions adopted at the Rio Earth Summit (UN summit Conference on Environment and Development (UNCED)) in 1992. Its sister Rio Conventions are the UN Convention on Biological Diversity and the Convention to Combat Desertification.
- This was the first multilateral legal instrument on climate change and **came into force in 1994** after a sufficient number of countries had ratified it.
- **Ultimate Aim** of UNFCC
  - Prevent dangerous human interference with the climate system by stabilizing greenhouse gas concentration in atmosphere.

- It sets on **non-binding limits** on greenhouse gas emission for individual countries and contain **no enforcement mechanism**.

- **Parties to Convention**
  - **197 parties**
    - All UN member states, Palestine (observer state), Niue and Cook Island (non-member states) and the European Union.
  - **Annex 1 Parties** -> Industrialized OECD countries, Economies in Transition (EIT), EU
  - **Annex 2 Parties** -> OECD members of Annex-1, NO EIT.
    - Provide financial and technical support to EITs and developing countries for mitigating Climate change.
  - **Non-Annex 1 Parties** -> Mostly developing
  - **Least Developed Countries** (LDCs)



Key Significance of UNFCCC - 1) Recognition of the problem 2) Setting target of stabilizing GHGs 3) Onus on Developed countries 4) Funds and technology transfer to developing countries 5) Regular Reporting -> Keep a tap on the problem.

A) KYOTO PROTOCOL

- It was an international agreement to reduce greenhouse gas emissions. It was negotiated under the UNFCCC during a meeting held in Kyoto, Japan, in 1997 and came into force in 2005 (due to complex ratification process)
  - **The first commitment period** was 2008-2012
  - **The second commitment period** beginning **1 Jan 2013 to 2020**.
    - Launched by Doha Amendment (2012)
- The **objectives of KP** included reducing greenhouse gas emissions through enforcement of compliance; promote sustainable development through tech-transfer and investment; and encourage developing countries and private sector to contribute to emission reduction.

- **Parties to Kyoto Protocol**
  - **Annex B:** Nearly identical to Annex - I of the UNFCCC; Agreed for emission reduction.
  - **Non-Annex B Parties:** Countries which are not listed in Annex B of KP.

- **Key Features**
  - The protocol 'operationalized' the UNFCCC. It commits industrialized countries to stabilize greenhouse gas emissions based on the principles of the Convention.
  - **Binding Emission targets for 38 industrialized countries and the European Community (Annex 1 Parties)** in its first commitment period.

- **Only bound developed countries - Common but Differentiated Responsibility**

- **Flexible Architecture of KP Regime to meet target**
  - **National Measures** and **Market Based Mechanisms**
    - This market based mechanism allows GHG abatement to start where it is most cost-effective - for e.g. in the developing world.
  - **3 Components - Carbon Trading, Clean Development Mechanisms and Joint Implementation**

- **Penalties for not meeting the targets**

- **What is the status of the Kyoto Protocol?**
  - The Protocol was ratified by 191 countries and EU. **Canada** withdrew from the Protocol in 2012.
  - The **US** was the only country that signed the protocol and never ratified it.
    - Internal country politics.
  - **Were targets met?**
    - Most countries didn't meet the targets for emission reduction assigned for the first period of commitment (2008-2012).
    - So protocols impact was very small.

- **Kyoto Beyond 2012**
  - **At Doha in 2012, the amendments to Kyoto Protocol for the 2nd commitment period** (the Doha Amendment) were successfully adopted for the period 2012-2020.
    - It entered into force on **31st Dec**, following an acceptance by the mandated minimum of at least 144 states, although the second commitment period ended on the same day.
    - **It entered into force in 2020** as the required number of countries didn't deposit their instrument of accession earlier.
    - But some developed countries started implementing their commitments under the '**opt-in**' **provisions** of the Doha Round.

  - **Note: India ratified** the second commitment period of Kyoto Protocol in Jan 2017

B) PARIS AGREEMENT

- The Paris **Agreement** and the accompanying COP decisions are focused on enhancing **efforts to mitigate and adapt to climate change beyond 2020**.
  a. **Long Term Goal:**
     » Reaffirm the goal of limiting global temperature increase well below 2 degree Celsius, while urging efforts to limit the increase to 1.5 degrees.
     » **Two long term emission goals**
       - Peaking of emissions as soon as possible (with a recognition that it will take longer for developing countries)
       - A goal of Net Green House Gas Neutrality (expressed as "a balance between anthropogenic emissions by sources and removals by sinks") in the second half of this century.
  b. **Ends the Strict Differentiation between developed and developing countries:** Provides for a **framework that commits all countries** to put forward their best efforts against climate change and keep strengthening these efforts.

c. **Mitigation - Binding Procedural Commitments ->** Preparing, communicating and maintaining NDC; Communicate new progressive NDC every five years;
   - » The agreement commits parties to "pursue domestic measures with the aim of achieving the objectives" of its NDC.
   - » Doesn't make implementation or achievement of NDCs a binding obligation**.**

d. **Carbon Markets –** the agreement recognized that the parties may use internationally transferred mitigation outcomes to implement its NDCs.

e. **STOCKTAKE/SUCCESSIVE NDCs**
   - » To ensure successive improvement in efforts, the agreement provides for **two linked processes**, each on a five-year cycle.
     - ▫ **Global Stocktake** to assess collective progress towards the agreement's goals. The first global stocktake took place in 2023.
     - ▫ **New NDCs** every five years informed by the outcomes of the global stocktake. Signatories should ensure that the new NDCs are more ambitious than the previous ones.

g. **Finance**
   - **Provisions for Support to poor developing countries by Developed countries.**
   - **Finance Mobilization goal.**
     - The COP decided to extend the $100 billion-a-year goal through 2025, and beyond that, by 2025 COP will set a "new collective quantified goal from a floor of "$100 billion a year".

h. **Adaptation**

A major priority for many developing countries was strengthening adaptation efforts under the UNFCCC. The agreement does that by:
   - Establishing a global goal of "enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change"
   - Committing enhanced adaptation support for developing countries
   - Including a review of adaptation progress, and of the adequacy and effectiveness of adaptation support, in the global stocktake to be undertaken every five years.

i. **Loss and Damage**
   - In a victory to small island countries and other countries highly vulnerable to climate impacts, the agreement includes a **free-standing provisions** extending the Warsaw International Mechanism for Loss and Damage
     - The mechanism, established at COP-19 is charged with developing approaches to help vulnerable countries cope with unavoidable impacts, including extreme weather events such as sea-level rise.
     - Potential approaches include **early warning systems** and **Risk insurance**.
   - Loss and Damage provision "did not involve or provide a basis for any liability or compensation.

C) WHEN DID PARIS AGREEMENT ENTER INTO FORCE?

- It required approval of atleast **55 countries accounting for atleast 55 percent of greenhouse gas emission.**
- It came into force on **Nov 4, 2016** (a month after required number of ratification)

D) INDIA'S UPDATED FIRST NDC UNDER PARIS AGREEMENT (AUG 2022)

- India submitted its INDC on 2nd Oct 2015.

- The NDC submitted in Aug 2022 is India's first NDC under the Paris Agreement. The Article 4, paragraph 9 of the Paris Agreement provides that each Party shall communicate **a nationally determined contribution every five years** in accordance with the decision of COP21.

- So, in Aug 2022, India communicated an update to its first NDC submitted earlier on Oct 2, 2015 for the period upto 2030, as under:
    - To put forward and further propagate a healthy and sustainable way of living based on traditions and values of conservation and moderation, including through a mass movement for **'LIFE'– 'Lifestyle for Environment'** as a key to combating climate change [UPDATED].
    - To adopt a climate friendly and a cleaner path than the one followed hitherto by others at corresponding level of economic development.
    - To **reduce Emissions Intensity of its GDP by 45 percent by 2030**, from 2005 level [UPDATED].
    - To achieve about **50 percent cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030,** with the help of transfer of technology and low-cost international finance including from Green Climate Fund (GCF) [UPDATED].
    - To create an **additional carbon sink of 2.5 to 3 billion tonnes of CO2 equivalen**t through additional forest and tree cover by 2030.
    - To better **adapt to climate change by enhancing investments in development programmes i**n sectors vulnerable to climate change, particularly agriculture, water resources, Himalayan region, coastal regions, health and disaster management.
    - To **mobilize domestic and new & additional funds from developed countries to implement the above mitigation and adaptation actions** in view of the resource required and the resource gap.
    - To **build capacities, create domestic framework and international architecture for quick diffusion of cutting edge climate technology** in India and for joint collaborative R&D for such future technologies.

This update to India's existing NDC is a step towards our long term goal of reaching net-zero by 2070.

E) INDIA'S LONG TERM LOW EMISSION DEVELOPMENT STRATEGY (LT-LED STRATEGY) (NOV 2022)

- **Details**
    - LT-LED is a requirement emanating from the 2015 Paris Agreement whereby countries must explain how they will transition their economies beyond achieving near-term NDC targets, and work towards the larger climate objective of cutting emissions by 45% by 2030 and achieve net zero around 2050. This is what scientists say, offers the best chance of keeping temperature rise below 1.5 degree C. So far, no country is on track towards such a pathway.

- Very few countries (including India) have submitted their Long-Term Strategy. So far.

- **Highlight of India's Long-Term Strategy:**
  i. **Nuclear Power Capacity** - It will be increased at least 3-fold in the next decade.
  ii. India will focus on **increasing the proportion of ethanol in petrol** - with ethanol blending to reach 20% by 2025 and a strong shift to **public transport** for passenger and freight traffic.
  iii. India would also become an **international hub of producing green hydrogen**.
  iv. India will also focus on **energy efficiency** by the Perform, Achieve and Trade (PAT) scheme; increasing electrification; enhancing material efficiency; and recycling and ways to reduce emissions.
  v. The country is also on track to achieve the NDC commitment of **2.5 to 3 billion** tonnes of additional carbon sequestration in forest and tree cover by 2030.
  vi. The emphasis is on ensuring energy security, energy access and employment, while keeping focus on our vision of Atmanirbhar Bharat.

2) THE CONTINUING UNFCCC NEGOTIATION

- **The Continuing UNFCC Negotiations:**
  - After the COP-21 - Paris Agreement, the negotiations have continued. COP-22 (Marrakech Summit, 2016), COP-23 (Bonn Summit, 2017), COP-24 (Katowice Summit, 2018), COP-25 (Madrid Summit, 2019), COP-26 (Glasgow, 2021);

B) COP 26 (GLASGOW PACT) - KEY OUTCOMES: 2021

- **Mitigation:**
  - » It asked countries to strengthen their 2030 climate action plan or NDCs by 2022.
  - » First clear recognition of the need to move away from fossil fuels -> it called for "phase down of coal" and "phase out of inefficient fossil fuel subsidies".

- **Adaptation:**
  - » Asked developed countries to atleast double the money being provided for adaption by 2025 from the 2019 levels.
  - » It created a **two year work program** to define a goal on adaptation.

- **Paris Rule Book has been finalized.**
  - » 'Transparency Framework' was completed - it included reporting rules and formats for emissions, progress on pledges and financial contributions.
  - » Carbon Market provisions have been finalized [a major achievement of COP26].
    - **Credit generated from earlier periods**, including through Clean Development Mechanism were transferred to the Paris Agreement but only since 2013. This will allow developing countries to meet its first NDC targets.
    - On the **issue of double counting**, it has been decided that a country that generates a credit will decide whether to authorize it for sale to other nations or

to count towards their climate targets. The emission cuts will be **counted only once**.

- **Various Positive "Parallel Outcomes"** (not part of the official COP26 negotiations)
  - » **India's announcement of a Panchamitra**
  - » **Plurilateral Agreement on Methane Reduction** among 100 countries is crucial. (Note: India is not a member)
  - » **Plurilateral Agreement to reverse deforestation** among another group of 100 countries. (Note: India didn't join the group due to concerns over a clause on possible trade measures related to forest products).
  - » **COP26 Transport Declaration** -> 100% transition to emission less (electric vehicles) cars by 2040.
    - This has also been signed by over 30 countries.
  - » **Glasgow Financial Alliance for Net Zero (Gfanz):** 450 of the world's banks and other financial institutions have pledged to report annually on the carbon emissions linked to the projects they lend to.
    - They also plan to lend trillions of dollars in green finance - while committing to net zero emission across the board by 2050.

- **Problems that remained:**
  - » Funding
  - » L&D
  - » Didn't specifically raise emission reduction targets.

C) COP-27 (SHARM EL SHEIKH, EGYPT)

- **Quotes:**
  - » The **UN Secretary General had declared at the start of the conference,** "*We are on a highway to climate hell with foot still on the accelerator*".

- **Key Highlights**:
  - » Nod for establishment of **Loss and Damage Fund**.
  - » **Estimates of Financial Requirements -> COP27 agreement** for the first time, quantified the financial needs for climate action. It said about US$ 4 trillion had to be invested in the renewable energy sector every year till 2030 if the 2050 target of net zero was to be achieved.

D) COP28: DUBAI, UAE (30TH NOV 2023 – 12TH DEC 2023)

- The meeting reviewed the Progress of commitment made by 197 countries under the Paris Agreement to mitigate the razing global warming.

- **Outcome**: **Dubai Consensus**:
  - Negotiators adopt resolution **titled "Dubai Consensus"**; the text reflects a compromise between developed and developing countries on emissions.

- **Highlights of Global Stocktake (GST)**:

- The GST text echoed the GST input findings that **1.5 degree target would require** "**deep, rapid and sustained" reduction in global emissions of 43% by 2030 and 60% by 2035** from the 2019 levels and **eventually reaching net zero by 2050**.

- **Fossil Fuel Phase-out**:
  - Fossil fuels was the most hotly contested issued of the COP28; It was first time that fossil fuel was at the centre of discussion at UNFCCC COP.

  - **Outcome**:
    - COP28 agreement has called upon countries to **contribute towards "transitioning away"** from fossil fuels and **phase down of unabated coal power** so as to **achieve net zero by 2050**.

  - **Criticisms:**
    - No timelines
    - Not using the phrase "fossil fuel phase-out" and instead the use of "transitioning away".
    - While calling for phase down of "unabated coal power, the door was left open for "low-carbon fuels", "low emission" technologies, "low-carbon hydrogen" - all terms with very loose definitions.

- **Tripling global renewable energy capacity by 2030** (from 3400 GW today to 11000 GW) and **doubling of global average rate of energy efficiency improvements by 2030**.
  - COP28 calls the member countries to achieve these two targets which have the potential to avoid emissions of about 7 billion tonnes of carbondioxide equivalent between now and 2030.
  - **Tripling is a global** target for renewables is not incumbent on every country individually. It is not thus clear how this tripling will be achieved.
  - This is the only outcome that contribute to additional emission reduction between now and 2030.

- **Accelerating and substantially reducing non-carbon-dioxide emissions globally**, including in particular methane emissions by 2030.
  - **Criticisms**: No target mentioned
  - **Note**: A group of about 100 countries at Glasgow (in 2021) had made a voluntary commitment to reduce methane emissions by 30% by 2030.
- **Reduction of emission from road transport** on a range of pathways, including through development of infrastructure and rapid deployment of zero-and low-emission vehicles;

- **Phase down of inefficient fuel subsidies** that don't address energy poverty or just transition, as soon as possible.

- **Operationalization of L&D Fund**:
  - **Background**: A decision to set up a Loss and Damage Fund had been taken last year in Sharm el-Shaikh (COP27) but it had not been created, and no money had been promised.

- **COP28 operationalized the fund** and several countries have already made commitments worth around $800 million by the end of the conference.
  - COP28 decided that the fund will be serviced by new, dedicated and independent **secretariat**. It will be supervised and governed by the Board.
  - The fund is accountable to and functions under the guidance of the CoP serving as the meeting of the Parties to Paris Agreement (CMA).

- **This is the most significant outcome for vulnerable countries** as L&D fund is meant to provide financial help to countries trying to recover from climate-induced disasters.

- **Santiago network** has also decided to avert, minimize, and address loss and damage to catalyze the technical assistance of relevant organizations, bodies, networks and experts for the implementation of relevant approaches associated with climate change impacts.

> **Santiago Network**: At COP25, the parties to UNFCCC decided to set up a Santiago network as part of Warsaw International Mechanism (WIM) for loss and damages. It is aimed to organize the technical assistance of relevant organizations for the implementation of relevant approaches in developing countries that are particularly vulnerable to adverse impacts of climate change.

- **Global Goal on Adaptation (GGA)**:
  - **Background**: COP26 at Glasgow had decided to set up a two-year work program to define the contours of adaptation framework.
    - Adaptation hasn't received enough attention and the entire focus of various agreements have been on mitigation. But, developing countries have been arguing for a global framework for adaptation.
    - The two year work program resulted in identification of some common adaptation goals like reduction in climate-induced water scarcity, attaining climate-resilience in food and agricultural production, supplies and distribution and resilience against climate induced health impacts.
  - The COP28 retains calls for a doubling in adaptation finance and plans for assessment and monitoring of adaptation needs in the coming year.
    - An explicit 2030 date has been integrated into the text for targets on water security, ecosystem restoration, health.

- **Issue of Climate Finance Target**s will be reviewed in next COP:
  - Currently, the $100 billion goal hasn't yet been met (although it appears on track this year) and is far short of what is needed.
  - **COP28 saw an agreement to draft a post 2025 finance target ahead of COP29**. This is a step forward, but details will only be hammered next year.

- **COP28 Declaration on Climate Change and Health**
  - This is the first ever move to commit action and finance to combat the health impact of climate change.
  - The COP28 Presidency and the WHO together issued the 'COP28 UAE Declaration on Climate and Health'.

- It's signatories aim to accelerate action to protect public health and communities from negative and growing climate impacts and strengthen healthcare systems to cope with the effects of extreme heat, air pollution, infectious and zoonotic diseases and environmental risk factors.

- **Other Related Outcomes**:
  - A group of **22 countries** signed a **declaration to triple nuclear energy capacity** between 2020 and 2050, in order to reduce dependence on oil, gas, and coal.
  - **G7 countries** have announced to phase out coal by 2030 and have urged G20 countries to also agree on it.
  - India and Sweden co-launched Phase II of the Leadership Group for Industry Transition (LeadIT 2.0) for the period 2024-26 at COP-28. They also launched the Industry Transition Platform, which will connect the governments, industries, technology providers, researchers, and think tanks of the two countries.
  - **Green Industrialization Initiative**: African leaders came together on the third day of COP28 to launch the initiative. The GII is set to accelerate green growth of industries in Africa and attract finances and investment opportunities.

- **Limitations/Criticisms**:
  - **Countries failed to adopt rules to set up global carbon market**: Civil society has hailed the move as parties didn't agree to adopt weak rules for carbon markets.
  - **Climate Finance** issue is still pending and would be taken up in COP25.
  - **No timelines for fossil fuel transitioning**: The text related to fossil fuel transitioning is weak, in-adequate and with loopholes.
  - **NDCs** remain far away from achieving Net Zero by 2050.
  - **Net Zero by 2050** target is expected to bring pressure on China and India whose net zero targets are for 2060 and 2070 respectively.
  - **Major Decisions** have not been integrated with agendas like '**Common but differentiated responsibilities**'.

3) NET ZERO

- **Details**
  - Achieving a global balance between emissions and removal of greenhouse gases to and from the atmosphere is called **net zero** (or no net emissions). The Paris agreement targets this to be achieved somewhere in the second half of this century, but the earlier this happens, the greater the chances of keeping global warming below 2-degree C.
  - Electricity and heat are responsible for 25% of global GHGs. The **International Energy Agency** envisages that in a net-zero world, almost 90% of electricity could come from renewable sources, mostly solar and wind, with nuclear power making up most of the rest.

- **Achieving Net Zero:**
  - **Focus on 2030 goal first**:

    - IPCC's AR6 emphasized that to keep temperature rise within 1.5 degree C, global emissions should be reduced by 45% from 2010 levels by 2030, on the way to net zero by 2050.
    - But the UN NDC report says that as per the current NDCs, the global emission is expected to increase by 16.3% in 2030 (compared to 2010 levels).
- **Energy Conservation and Efficiency:** Global emissions show that energy is the biggest emitter (73.2%) including its use in transport, industry, and building. Therefore, energy efficiency can play a crucial role in achieving net zero.
    - Targeted consumer education and behavioral change would also be important here.
- **Renewable Energy:** Gradually phasing out thermal energy (coal, petrol, gas etc.) and increase the capacity of renewables with improved grid infrastructure, smart grids, etc.
    - **Insure against Renewable Droughts** through other sources like **Nuclear Energy**.
- **Transport Sector:** Accelerated transition to e-mobility and non-motorized transport is required.
- **Create Offset:** Inspite of all the efforts, humans would still produce some billions of tonnes of emissions by mid-century. This will have to be balanced by removals to achieve net zero. Offset can be in the form of afforestation, increasing soil organic carbon, and **advanced carbon sequestration techniques**.
- **Enhancement in Funding:** The Promised funding from developed to developing countries need to be delivered.
- **More R&D in advanced technology** like low and zero emission technologies across all sectors. There is also a need of innovation for renewable integration, power to x-storage, and conversion and reconversion pathways. Moreover, carbon-removal technologies need to be focused upon.
- **CBDR should not be ignored**: Developed countries should achieve net zero earlier and few extra decades should be available to developing countries.

4) INDIA'S DECISION TO ACHIEVE NET ZERO BY 2070: CRITICAL ANALYSIS

- At COP26, PM Modi has proposed a **fivefold strategy** for India to play its part in helping the world get closer to 1.5 degrees Celsius. India's '**Panchamrita'** promises include:
    - India will get its **non-fossil energy capacity** to **500 GW** by 2030.
        - This is a 50 GW increase from its existing target.
    - India will meet 50% of its energy requirements till 2030 with renewable energy.
    - India will reduce its projected carbon emission by one billion tonnes by 2030.
    - India will reduce the carbon intensity of its economy by 45% by 2030.
    - India will achieve net zero by 2070.

- **India's demand from developed countries:**
    - In the spirit of **climate justice**, the developed countries should be providing **at least $1 trillion** in climate finance to assist the developing countries and those most vulnerable.

- **Analysis:**
    - This is a **very positive move** as India had resisted any net zero target in the run up to the COP26. This announcement is expected to put India on a **firm path towards decarbonization**.
    - This announcement also keeps in mind the **Common but Differentiated Responsibilities and Respective Capabilities (CBDR-RC).**

        - India's net zero comes in 2070 and NDC is subject to funding from developed countries
    - **India is contributing more than its share**: Despite a 2070 net zero year for India, India's cumulative emissions between 1900-2100 would be lower than the US, China or EU.
    - **India continues to show international leadership** - It has launched the Infrastructure for Resilient Island States - an initiative under the coalition for Disaster Resilient Infrastructure to support vulnerable island countries. India has also launched Green Grids Initiative in partnership with UK to tap into renewable energy resources everywhere.

- **Critics of shifting to a Net Zero target**
    - **Over-appropriation of global carbon budget** by a few.
        - Countries which have higher emissions presently are taking more advantages of the environment.
        - The campaign to achieve net zero by 2050 is designed to achieve Paris goals by the "lowest cost" methods, **foregoing equity and climate justice**.
    - **Wasn't mandated by Paris Agreement**.
    - **India is anyways a small contributor** - Our emissions are 4.37% of the world's share (with 18% population).

Critics of Sustainability of India's Net Zero Strategy

- India's plan to increase dependence on **hydro projects and nuclear energy** will create displacement, deforestation, hazardous radiation etc.
- Solar and Wind Energy is also focused on **Mega energy parks** which may cause displacements.

5) MECHANISMS AND ISSUES WITH CLIMATE FUNDING

- **Introduction**
    - » Money has been central to many a fight at the Climate Change negotiations. UNFCCC as part of its CBDR principle requires developed countries to provide financial assistance to developing nations in their fight against the climate change.
    - » **Globally**, there are two funding mechanisms - **The Green Climate Fund** and the **Global Environment Facility.**

- **Green Climate Fund (GCF)**
    - » Established at COP-16 in 2010, it is the financial mechanism for UNFCCC under article 10. It is regarded as the chief instrument for the fulfillment of developed world's annual support of $100 billion annually till 2025.
    - » **COP-21 held at Paris** also decided that **GCF shall serve the Paris Agreement**.

- **Global Environment Facility (GEF)**
    - » Created at Rio Earth Summit in 1992 to help tackle planet's most important environmental problems.
    - **What has it done so far? / What does GEF do?**
        - » GEF also serves as financial mechanism for the following conventions:
            - CBD
            - UNFCCC
            - UNCCD

- Stockholm Convention on Persistent Organic Pollutants (POPs)
- Minamata Convention on Mercury
- It also supports implementation of Montreal Protocol on substances that deplete the ozone layer in countries with economies in transition.

- **Current Funding Situation**:
  - **Requirement: As per COP27** (Sharm el-Sheikh agreement), the global transition to a low-carbon economy would likely require about US$ 4-6 trillion every year till 2050. This is 5% of the global GDP.
    - The cumulative requirement of developing countries, just for implementing their climate action plans, was **about US$ 6 trillion between now and 2030**.
  - **Availability:**
    - The $100 billion amount, that the developed countries have promised is the only money in play right now. And of this only around US$50-80 billion per year is being mobilized. This indicates that the **fund available in less than 10% of what is required.**

- **Key Problems of current climate funding are:**
  - **Requisite finance** hasn't been mobilized.
  - **Funding bias in favour of climate change mitigation activities**. This bias is there because mitigation efforts are easily visible in short run and returns from adaptation efforts will be visible after long time.
    - For e.g., if we adapt by moving away from coasts, the benefit of this adaptation efforts would be visible much later.
  - **Developing world** in itself cannot fight the climate crisis as they are still struggling for finance for their development needs.
  - **A number of countries** are unable to access global finance. Present rules and regulations of global financial systems, make it difficult for many countries to access international finance, particularly those with political instabilities
  - **Lack of transparency** is leading to problems of double counting and green washing.

- **Way Forward:**
  - **Availability and Access** are two main dimensions to the problem of climate finance.
  - **Increasing Availability:**
    - **Developed countries** need to increase their contribution.
      - But, even if this happens, this won't be able to fulfill the requirement of around $6 trillion needed annually.
    - **Mobilize resources from private sector**: Businesses and Corporations need to invest money into green projects.
      - In climate finance thus far, private investment have lagged behind public money. Barely 30% of current financial flows are coming from private sources.
    - **Creation of right environment for investments in green project** -> Private sector will not invest unless they are reasonably sure of healthy returns.
      - Here, international financial institutions should engage with governments, central banks, commercial banks etc. to incentivize climate friendly investments and discouraging, or even penalizing, dirty investments.

- **Carbon Tax** - Common citizens will have to contribute to the bulk of the additional financial resources.

- **Increasing Access:** There is a need to simply lending mechanisms and overhaul credit rating systems.
- **Increased Transparency**:
  - Climate finance flows through a maze of channel - bilateral, regional, multilateral. It is in the form of grants, concessionary loans, debt, equity, carbon credit, and more. As a result, there are widely different opinion on the quantum of climate finance currently being mobilized. This needs to be addressed.

8. OTHER EFFORTS TO FIGHT CLIMATE CHANGE

1) REDD+

- **Need of REDD+**
  - Deforestation and forest degradation account for 17% of carbon emissions, more than the entire global transportation sector and second only to energy sector. Therefore, **conservation of forests can play a very crucial role in controlling climate change**.

- **Introduction to REDD+**
  - **REDD+** is a climate change mitigation solution developed by parties to UNFCCC. It **incentivizes developing countries** to **keep their forest standing** by offering results-based payments for actions to reduce or remove forest carbon emissions.
    - The idea is that developing nations should be able to financially benefit from the ecosystem services that their forests provide, such as carbon storage and as reservoirs of biodiversity.

  - The payment is targeted at five activities:
    - **Reducing Emissions** from Deforestation
    - **Reducing Emissions** from forest degradation.
    - Conservation of carbon stocks
    - Sustainable management of forests
    - Enhancement of Carbon stocks.

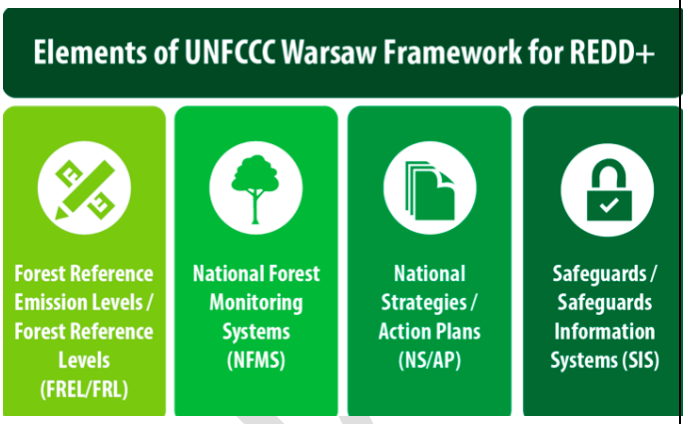
  - REDD+ **goes beyond** simply deforestation and forest degradation and **includes** the role of conservation, sustainable management of forests and enhancement of forest carbon stocks.

  - **In 2019**, **Brazil** became one of the first countries to receive results-based aid.
  - **In 2020**, **Uganda** has become the first African country to **submit the results** for Reducing Emissions from Deforestation and forest degradation (REDD+) to the UNFCCC.
    - Uganda has now become eligible for results based payments.
    - In 2020, **Uganda became eligible** for REDD+ payments, the first African country to do so.

A) REDD+ IN UNFCCC

- First negotiated in UNFCCC 2005 (COP-11).
- Adopted at COP-13 in 2007 in Bali.
- In 2013, **COP-19** produced at least seven decisions on REDD+, which are jointly known as the "**Warsaw Framework on REDD-Plus**".

- And finally, the remaining decisions on REDD+ was **completed at COP21** in 2015 and the UNFCC rulebook on REDD+ was completed. **All countries were also encouraged to implement and support REDD+ in Article 5 of the Paris Agreement**. This was part of the broader article that specified that all countries should take action to protect and enhance their greenhouse gas sinks and reservoirs (stores of sequestered carbon).



- **UNFCCC requests All developing countries aiming to undertake REDD+ to develop the following elements:**
  1. **A national strategy** or **action plan**;
  2. **A national forest reference emission level** and/or forest reference level.
  3. A **national forest monitoring system** for monitoring and reporting on REDD+ with if possible subnational monitoring

B) REDD AND REDD+

- REDD originally referred to "**reducing emissions from deforestation in developing countries**" the title of the original document on REDD. It was superseded in the negotiation by REDD+.
- REDD+ refers to "**reducing emissions from deforestation, and forest degradation in developing countries, and the role of conservation, sustainable management of forests, and enhancement of forest carbon stocks in developing countries**". This is the most recent elaborated terminology used by COP.

C) INDIA'S REDD+ STRATEGY (RELEASED IN AUG 2018)

- The strategy has been **prepared** by **Indian Council for Forestry Research & Education** (ICFRE), Dehradun.
- The strategy builds upon existing national circumstances which have been updated in line with India's National Action Plan on Climate Change, Green India Mission, and India's NDC to UNFCCC.
- **Key focus**
  - Cooperation and involvement of the tribals, other forest dwelling communities and the society as a whole
- **Significance**
  - Reiterates India's commitment to Paris Agreement on CC
  - It will help in conservation of forests and enhance productivity of forest ecosystem.
  - REDD+ strategy will help India fulfill its NDC commitment and contribute to the livelihood of the forest dependent population.

2) THE UN REDD PROGRAM (THE UN COLLABORATIVE PROGRAM ON REDUCING EMISSIONS FROM DEFORESTATION AND DEGRADATION IN A DEVELOPING COUNTRIES)

- It is a multilateral body which partners with developing countries by assisting them to develop the capacities needed to meet the UNFCCC REDD+ requirements.
    - It does so through a country based approach that provides advisory and technical support services tailored to national circumstances and needs.
- It is a collaborative initiative of FAO, UNDP, and UNEP. It also harnesses technical expertise of other UN agencies.

3) CENTRAL AFRICAN FOREST INITIATIVE (CAFI)

- **CAFI** was founded in 2015 as a collaborative agreement between **six Central African Countries** - the Central African Republic, the Democratic Republic of Congo, the Republic of Congo, Gabon, Equatorial Guinea and Cameroon - and **six financial partners**: the European Union, France, Norway, Germany, South Korea and the Netherlands.
    - It is **based around the REDD+ mechanism** developed by the parties to the UNFCCC.

9. MITIGATION STRATEGIES

Key issues covered – Carbon Sequestration, Carbon Sink, Carbon Credit, Carbon Offset, Carbon Tax, and Geo-Engineering

1) CARBON SEQUESTRATION

- It is the process of capturing and storing atmospheric carbon dioxide. It is one of the methods of reducing the amount of carbon dioxide in the atmosphere with the aim of fighting climate change.
- **There can be two major types of carbon sequestration:**
    - » **Biological:**
        - Biological Carbon Sequestration is the storage of carbon dioxide in **vegetation** such as grasslands, or forests, as well as in **soils and oceans**.
            - **Plant rich landscapes** like forests, grasslands etc. capture 25% of the global carbon emissions.

- **Soil** can store carbon in the form of Soil Organic Carbon.
  - Soil can also store carbon as carbonates.
- **Colder and nutrient rich part of ocean** can absorb more carbon dioxide than warmer parts. Therefore, polar regions generally serve as carbon sink.

» **Geological Carbon Sequestration**

- It is the process of storing carbon dioxide in underground geologic formations, or **rocks**.
- **Naturally, Carbonates** are created over thousands of years when carbon dioxide dissolved in water and percolates in soil, combining with calcium and magnesium minerals, forming '**caliche**' in desert and arid soil.
- **Artificially**, CO2 captured from industrial, or any other sources may be injected into porous rocks for long-term storage.
  - **Hydrodynamic Trapping**: It refers to a time-dependent hydrogeological process where injected CO2 is effectively trapped by the existence of very long travel times to the surface.
  - **Solubility Trap**: CO2 dissolved in liquid like water or oil.
  - **Mineral Carbonation:** CO2 can be made to react to naturally occurring minerals to form stable compound which can stay like that for years (e.g. Calcium carbonate)

» **Technological Carbon Sequestration**

- These are the new ways being explored by scientists to capture and store carbon using innovative technologies and to make useful products out of it.
- **Graphene Production**
- **Direct Air Capture** - Capturing carbon directly from air using advanced technology plants.
  - For now the technology is highly expensive and energy intensive. But with more advancement in technologies, this may become a viable option.
- **Engineered Molecules** - These molecules can change shape by creating new kinds of compounds capable of singling out and capturing carbon dioxide from the air.

2) CARBON SINK (GREEN AND BLUE CARBON)

- **Green Carbon**: It is the carbon which is stored by vegetation (forests, grasslands, etc.). It is basically **biological carbon sequestration**. Reforestation and Afforestation are mechanisms to enhance Green Carbon

- **Blue Carbon**: Carbon stored by coastal, aquatic or marine ecosystems. These include mangroves, seagrasses etc.
  - Coastal ecosystems are more efficient carbon sinks when compared to tropical rain forests.

1) CARBON CREDIT AND CARBON OFFSETTING (ALREADY DISCUSSED WITH MARKET BASED MECHANISM)

2) CARBON PRICING INCLUDING CARBON TAX

- **Carbon Pricing** is a method which captures the external cost of green house emissions - i.e. the losses to different sectors like agriculture, health, property etc. due to addition of Greenhouse gas in atmosphere. There are **two major types** of Carbon Pricing - **Emission Trading System** (or Cap and Trade System) and **Carbon Tax**.
- **Advantages of Carbon Pricing:**
  - » **Shifts the cost on polluters** -> internalize the external cost of pollution

- **Carbon tax** is a potential alternative to the 'cap and trade' method currently used by the Kyoto protocol to reduce the carbon emission.
  - » A carbon tax aims to **internalize the externality of climate change** by setting a price on the carbon content of energy consumed or greenhouse gas emitted in the production of consumption of goods.

- **Advantages of carbon taxes over 'Quantitative limits' or 'Cap and trade' system**
  1. **Avoids the problem of choosing a baseline :** In a price approach, the natural baseline is a zero carbon tax.
  2. **Better adaptation to element of uncertainty** which pervades the science of climate change.
     - Quantitative limits are related to the stocks of greenhouse gas emissions, while the price limits are related to the flow of emissions.
  3. **Less volatility and more predictability :** From uncertainty (point 2) arises volatility. Carbon tax regime is likely to cause less volatility in the prices of carbon emission
  4. **Less administrative arbitrariness - easier implementation - lack of manipulation**
     - Quantity limiting policies are often accompanied by administrative arbitrariness and corruption through rent seeking. This sends of wrong signals to investors.
     - In a price based system, the investors has an assured long-term regulation to adapt to and can weigh in the costs involved.
  5. **Addresses the problem of equity**
     - Equity is the most contentious issue in any international negotiation on climate change mitigation either at the level of WTO or UNFCC.
     - The price based approach in the form of carbon tax makes it easier to implement the equity based international adjustments than the quantity based approach.
  6. **Carbon tax will essentially be a Pigovian tax** which balances the marginal costs and benefits of additional emissions, thereby internalizing the cost of environmental damage.
  7. **Better understandability**: the carbon tax is simpler to understand and therefore may be braced by more people

- **Limitations of Global Carbon Tax**
  - **No CBDR:** It penalizes incremental carbon emissions rather than those who have **already spewed into the atmosphere** since the Industrial revolution.
  - **Taxes are part of national social contracts** that emerge out of very specific conditions that can't necessarily be replicated on a global scale.
- **Has India imposed any carbon tax yet?**
  - A carbon tax increases the price that consumers pay for energy. Increase in **fuel taxes** as well as **quadrupling of the coal cess** is sometimes interpreted as a variant of a carbon tax.

- Similarly, not decreasing the petrol/diesel prices according to the decrease in crude oil prices can also be seen as a method of imposition of carbon tax.

3) GEO-ENGINEERING

- **Introduction:**
  - » **Definition:** Geo-engineering is a theoretical concept which aims to modify and cool environment to defeat the global warming. It may involve reduction of Sunlight reaching earth or absorption of CO2 to reduce global warming (Carbon Capture Technologies).
  - » Since the global community is looking for a Net Zero target by 2050, the Geo-engineering technologies are expected to play a key role in this.

- **Reduction of sunlight reaching Earth:**
  1. **Stratospheric Aerosol Injection:** Injecting the atmosphere with Sulphur/ Hydrogen Sulphide (copies volcanic effect and scatters sunlight).
  2. **Putting Large Mirrors in Space -** reduce the amount of sunlight reaching earth.
  3. Using Wind-Powered Motors to **whiten the cloud** -> by spraying water into the sky -> reflect solar radiation.

- **Carbon Capture and Storage (CCS)** (Or Carbon Capture Utilization and Storage (CCUS)) refers to technologies that can capture CO2, at a source of emissions before it is released into atmosphere.
  - » The process starts with capture of CO2 which undergoes a compression process to from a dense fluid. This eases the transport and storage of the captured CO2.
  - » This dense fluid is transported via pipelines and then injected into the underground storage facilities. It can also be used as a raw material in other industrial processes such as bicarbonates.

- **CDR** takes the form of both natural means like afforestation or reforestation, and technologies like direct air capture where machines mimic trees by absorbing CO2 from their surrounding and storing it underground.
  - » **E.g. Fake Trees** containing compounds which can react with CO_2 to absorb it and store it in solid from.

- **Other Carbon Capture Technologies**
  - i. **Ocean Iron Fertilization:** Seeding the Sea with Iron
    - Phytoplankton prefer iron and flourish in its presence, thus absorbing a lot of CO_2.

- **How significant is the role of CCS and CDR** in achieving net-zero by 2050?
  - » In IPCC AR6, there is no pathway to 1.5 degrees C that doesn't use CDR.

- **Limitations/Problems with these CCS and Geoengineering method**:
  - » **CCS and CDR** are still technologies under development **without demonstrated feasibility** at large scale despite decades of development.
    - It also suffers from **other challenges** like high energy requirements; high cost; challenges in the transport and long-term storage of carbon.
  - » **CDR** methods like afforestation, reforestation, **Bioenergy with Carbon Capture and Storage (BECCS)** are constrained by their **need of land**. It may aso hamper food and water security.

» **Ocean Iron Fertilization:** The Convention of Biological Diversity has already imposed a de facto moratorium based on precautionary principle. It could result in eutrophication, which may adversely affect the ocean ecosystem.
» **Stratospheric Aerosol Injection** is also highly controversial as this could have unintended effects on global and regional climates.
» Further, there are concerns related to **fairness, equity, and justice** in the adoption of geo-engineering technologies as most of the R&D is dominated by North American and Western Euro.

- So far, there has been very little progress on these technologies and most of the R&D is dominated by North American and Western European Nations. Emerging economies like China and India have also begun to look into these options more seriously.
    - CCS is **absent from INDCs of most of the countries**, indicating that most of the countries have not yet accepted it as promising technology.
    -
- **Why very little progress? -** Lake of policy support and spending on R&D.

4) OCEAN CARBONDIOXIDE REMOVAL

- **Introduction:**
    » Ocean stores about 50 times more carbon than the atmosphere. So, for taking carbon out of atmosphere and storing it someplace where it won't continue to warm the planet, the ocean is the single biggest place it can go.
    » **Ocean Carbon dioxide Removal (Ocean CDR)** uses the ocean's natural ability to take up carbon on a large scale and amplifies it.
        ▪ **Carbon gets into ocean from atmosphere in two ways**:
            1. Air dissolves in the ocean surface. Because sea water is slightly alkaline, the CO_2 is absorbed into the ocean.
            2. The second involves **biologic pump**.
                - Ocean is a living medium and has algae, crustaceans, fish, whales etc. When organic material is eaten or dies, it gets recycled. It rains down through the ocean and makes its way to the ocean **twilight zone**, a **level around 200 to 1,000 meters deep**.
                - This twilight zone sustains the biological activities of the ocean. It is the soil of the ocean where organic carbon and nutrients accumulate and are recycled by microbes.
                - It is also home to the largest animal migration on the planet. Each day, trillions of fish and other organisms migrate from the depths to the surface to feed on the phytoplankton and one another and go back down, acting like a large carbon pump that captures carbon from the surface and shunts it down into the ocean where it is stored away from the atmosphere.
- **Why is OCEAN CDR drawing so much attention right now?**
    » Some experts feel that because of its volume and carbon storage potential, the ocean is really the only arrow in our quiver that has the ability to take up and store at the scale and urgency required.

» **A 2022 report** by the national academies outlined a research strategy for ocean carbon dioxide removal. The **three most promising methods** highlighted are:
  - **Ocean Alkalinity enhancement**: Oceans are naturally alkaline, with a pH of about **8.1**. Increasing alkalinity by dissolving certain powder rocks and minerals makes the ocean a chemical sponge for atmospheric CO2.
  - **Add micro-nutrients to ocean surface**, particularly soluble iron.
    - Very small amount of soluble iron can stimulate great productivity (algal growth), which drives a more vigorous biological pump.
    - Over a dozen of these experiments have been done, so the scientists know that it works.
  - **Grow Kelp in the Ocean**: It captures carbon at the surface through photosynthesis, then bale it and sink it to the deep ocean.
» But, **all these methods** have **drawbacks** for large scale use, including cost and unanticipated consequences

10. EFFORTS BY AVIATION AND SHIPPING SECTOR

1) ICAO – CORSIA

- **Introduction**
  » The International Civil Aviation Organization (ICAO) is a specialized agency of UN which deals with administration and governance of **the Convention on International Civil Aviation (Chicago Convention)**.
  » It was established in **1944** and is headquartered at **Montreal Canada**.
  » It works with 192 Member states of convention and other industry groups to come to a consensus on **International Civil Aviation Standards and Recommendation Practices (SARPs)** and **Policies** to ensure safe, efficient, secure, economically sustainable and environmentally responsible civil aviation.
  » It also assists member states in capacity building towards various aviation development objectives.

- **Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)**
  » **In 2016**, ICAO finally (after years of negotiations) sealed the first deal for limiting green-house gases from international aviation. The decision was taken during 39th ICAO general assembly meeting attended by 191 countries.
  » **Details of the Offsetting Scheme: From 2021**, any increase in airline CO_2 emission will be offset by activities like tree planting, which soak up CO_2.
    - CO_2 will be allowed to grow to 2020 but after that, emissions will need to be offset.
    - Three Phases:
      - **Pilot Phase:** 2021-2023 (Voluntary)
      - **First Phase:** 2024-2026 (Voluntary)
      - **Second Phase:** 2027-2035 (Mandatory for all member states)
    - The deal will be voluntary till 2026 but most major nations are expected to take part.
    - Review period every three years and it rules out "double counting" of offsets to ensure that forest protection efforts elsewhere aren't used to negate aircraft emissions.

- » Applicable to Civilian passenger and cargo flights.
- » **Exceptions:** Humanitarian, Medical, Firefighting flights etc.

- **Developing countries like** India, China, Brazil etc had opposed the provisions. Why? ?
- **CORSIA is part of the effort from ICAO** to halve the carbon emissions by 2050 compared to 2005 levels.
  - » **Other efforts** include adoption of new technology - including deployment of sustainable alternative fuels, more efficient aircraft operations, infrastructure improvements including modernized air-traffic management systems.
- **DGCA Guidelines to airlines operators** (Oct 2018)
  - » Under these guidelines, all operators engaged in international operations have to capture their fuel consumptions and carbon emissions data annually, starting from Jan 1, 2019.
  - » Further, beginning 2021, the operators will have to meet offsetting requirements by purchasing and cancelling "emission units".

2) INTERNATIONAL MARITIME ORGANIZATION (IMO) REACHES A DEAL TO CUT EMISSIONS

- **Key Highlights of the deal:**
  - » More than 170 countries under the aegis of IMO have agreed to a target to **reduce greenhouse gas emissions** from shipping by **at least 50% of 2008 levels** by **2050**. This is being called as **"initial strategy**".
  - » The **strategy** also proposes to **reduce carbon intensity** from shipping - the amount of CO_2 emitted from each unit of transport - by at least 40% by 2030, and 70% by 2050.
  - » The **final IMO Plan** is not expected by 2023.
  - » **Some possible medium term measures** discussed include:
    1. Low carbon and zero carbon fuels
    2. Improved energy efficiency of new and existing ships
    3. Possible market based mechanism to encourage shift to lower carbon fuels.

- **Analysis**
  - » Experts feel that IMO should and **could have gone much further** in their contribution. Opposition from some countries especially USA, Saudi Arabia and Panama had limited what could be achieved at the IMO session.
    1. To align with **Paris goals**, the reduction target should be 70-100%.
  - » **Developing countries** like India are worried that a target to reduce emission from shipping sector will **negatively hamper their yet to fully develop sector**.
- **Note: Shipping and Aviation sector** avoided specific emission-cutting targets in a global climate pact agreed in Paris in 2015.

11. EFFORTS BY INDIA TO FIGHT CLIMATE CHANGE

1) NATIONAL ACTION PLAN ON CLIMATE CHANGE (NAPCC)

- **Introduction**
  - » Challenges emerging from climate change are complex and multi-sectoral, and therefore these have to be dealt with a multi-dimensional approach.

» Keeping this in mind, **GoI in 2008, adopted NAPCC** which is aimed at promoting development objectives and at the same time tackling climate change effectively.
» There are 8 missions which form the core of NAPCC. These missions represent the multipronged and integrated approach required to deal with climate change.

- **How NAPCC was supposed to deal with Climate Change**
  - Development and use of **new technologies**.
  - **Involving multiple ministries** which will focus on different mission objectives
  - **Involving private sector** through PPP projects and civil society actions.
  - **Promoting awareness** about climate change, adaptation, energy efficiency etc.

- **Understanding Achievements and Limitations of Individual Missions**

i. National Solar Mission is aimed at increasing the solar energy capacity in the country and thus reducing the emission of GHGs.
- Governed by Ministry of New and Renewable energy.
- The target of JNNSM was enhanced to 100 GW by 2022 which includes 60 GW through large and medium scale grid connected solar power projects and 40 GW through rooftop solar.

ii. **National Mission for Enhanced Energy Efficiency (NMEEE)** is aimed at improving energy efficiency and thus meeting energy demands of the country.
- **Ministry:** Ministry of Power
- The mission commenced in 2010 with a target to achieve the following:
  - GHG reduction of 98.55 million tonnes/ year at full implementation stage.
  - Annual fuel savings of 23 million tons.

iii. National Mission for Sustainable Habitat
- **Ministry of Housing and Urban Affairs**
- The mission commenced in 2010 with an aim to reduce emission in cities.
- It focuses on GHG reduction opportunities by increasing energy efficiency of the building, improving municipal solid waste management, and encouraging people to use public transport.
  - Some specific initiatives to achieve these objectives are Adaptation of the existing Energy Conservation Building Code and promoting investments in development of high capacity public transport system.

iv. National Water Mission
- Ministry of Jal Shakti.
- The mission commenced in 2011 with an aim to ensure water security and improve access to water resources. It aims to achieve this by promoting water conservation and water use efficiency.
- It covers the entire sweep of water management to fight climate change impacts: from water conservation to water use efficiency.

v. **National Mission for Sustaining Himalayan Ecosystem**

- Governed by **Department of Science and Technology**
- Commencement in 2011
- Aimed at developing capacity to assess the health status of Himalayan Ecosystem and helping Himalayan states in policy formulation and implementation.

vi. **The National Mission on Strategic Knowledge for Climate Change**

- Governed by **Department of Science and Technology**
- Commencement in 2014
- Aimed at establishment of knowledge network among the existing knowledge institutions engaged in R&D related to climate change.
- The two missions (NMSHE and NMSKCC) operated under **DST** and aims to generate new information, building scientific and technical capacity, and produce new channel of collaboration between scientists, policy makers and law makers to ensure that climate action is based on sound knowledge and science.

vii. **National Mission for Green India**

- **MoEF&CC**
- Commencement: 2014
- Aims: To increase forest and tree cover.
    - Under this the focus is on reviving degraded forests with a focus on increasing forest cover & density and conserving biodiversity.

viii. **National Mission for Sustainable Agriculture**

- Commenced in 2012 with aim to climate-proof agriculture and reduce emission from the sector.
- There are **four components** under NMSA
    1. **Soil Health Management** aims at nutrient management through judicious use of chemical fertilizers for improving soil health and productivity.
    2. **Rainfed Area Development** to develop or bring agri-land under integrated farming system.
    3. **Sub-Mission on agro-forestry** to promote plantation along with crops.
    4. **Climate Change and Sustainable Agriculture: Monitoring Modeling and Networking** (CCSAMMN) for creating models on adaptation and dissemination of information about climate change.

3) MISSION LIFE

- **Why in news?**
    - » PM Modi launched Mission LiFE (Lifestyle for Environment), in the presence of UN Secretary General Antonio Guterres (Oct 2022)

- **Details about Mission LiFE**
    - » It was first proposed by PM Modi at **COP 26 of UNFCCC** in Nov 2021. It is envisioned as **an India led global mass movement** that will **nudge individual and collective action to protect and preserve the environmen**t.
        - PM Modi has underlined that Mission LiFE makes the fight against climate change democratic, in which everyone can contribute with their respective capacities.

- It emboldens the spirit of the P3 Model: Pro Planet People.
- It functions on the basic principles of '**Lifestyle of the planet, for the planet and by the planet**'.

» At the launch, PM Modi also highlighted that the concept of **'Reduce, Reuse and Recycle' and circular economy**; and mentioned that it has been part of the Indian Lifestyle for thousands of years.

» LiFE also resonates with **climate justice** -> it highlights enhanced obligations for those in developed countries and supports climate adaptation and mitigation for those most affected and yet least responsible.

- **NITI Aayog and MoEF&CC**, in collaboration with Government of Gujarat, organized the global launch of Mission Life.
  - » NITI aayog will curate and incubate Mission Life in the first year, and it will subsequently be implemented by MoEF&CC.
  - » It is a five year program.

- **Significance:**
  - » According to UNEP, more than 2/3rd of the GHG emissions can be attributed to household consumption and lifestyles -> therefore the urgent cuts to global emissions we need can only be achieved through widespread adoption of greener consumption habits.
  - » Life recognizes that small individual actions can tip the balance in the planet's favor.
    - Actions such as saving energy at home; cycling and using public transport instead of driving; eating more plant-based foods and wasting less; and leveraging our position as customers and employees to demand climate-based friendly choices.
  - » Many of the goals of LiFE can be achieved by deploying 'nudges', gentle persuasion technique to encourage positive Behaviour.
    - The UNEP employs proven nudging techniques:
      - Discouraging Food waste by offering smaller plates in cafeterias;
      - encouraging recycling by making bin lids eye-catching;
      - and encouraging cycling by creating cycle paths

- **Note: Other Recent global initiatives launched/initiated by India:**
  - Panchamrita Targets announced by Mr Modi at COP26
  - International Solar Alliance
  - The Coalition for Disaster Resilient Infrastructure

4) GREEN BONDS: MOBILIZING FUNDS

- Though the Paris Agreement provides for mobilization of resources from developed countries, the process has been very slow.
- Thus, India has scaled up its efforts towards greater mobilization of private capital to meet its ambitious climate action goals.
- Green Bonds are financial instruments that generate proceeds for investment in environmentally sustainable and climate suitable projects.
  - Developed countries such as UK, France, Germany etc have been using Green bonds to raise billions of dollars of sovereign green debts.

- In India, as per SEBI's data between 2017 and Sep 2022, 15 Indian corporates have issued green bonds of value of Rs 4,539 crores. Most of this is related to renewable energy generation.
- Union Budget 2022-23 announced the issuance of Sovereign Green Bonds.
    - The final sovereign Green bond framework of India has been issued.
    - The Green Financing working committee has also been set up to oversee and validate key decisions on the issuance of Sovereign green bonds.
        - The committee has the mandate to select the projects for allocation of proceeds, do a time-bound review of the allocation and carry out annual reporting along with an impact assessment of the proceeds from sovereign green bonds issued

A) REGULATORY FRAMEWORK FOR ISSUANCE OF GREEN DEBT SECURITIES

- **Reserve Bank of India:**
    - In Nov 2021, the RBI published its '**Statement of Commitment to Support Greening India's Financial System' - NGFS**. Here, the Reserve Bank of India (RBI) laid out, keeping in view its national commitments, priorities, and complexity of our financial system, committed to, among others, exploring how climate scenario exercises can be used to identify vulnerabilities in RBI-supervised entities' balance sheets, business models and gaps in their capabilities for measuring and managing climate-related financial risks.
    - **Also, in 2007, the RB advised banks to put in place an appropriate action plan for making a meaningful contribution** to sustainable development.
        - Over time, **RBI has incentivised bank lending towards greener industries** and projects.
            - For example, renewable energy projects have been included under Priority Sector Lending (PSL).

B) SECURITIES AND EXCHANGE BOARD OF INDIA (SEBI)

- SEBI **introduced the regulatory framework for issuance of green debt securities** as a mode of sustainable finance under the erstwhile SEBI (Issue and Listing of Debt Securities) Regulations, 2008, **(ILDS Regulations),** in 2017**.**
- **At the time of review of the ILDS Regulations, the provisions of the erstwhile circular** were subsumed, and the definition of "green debt security" was incorporated as Regulation 2(1)(q) in the SEBI (Issue and Listing of Non-Convertible Securities) Regulations, 2021 ('**NCS Regulations**'). The disclosure requirements were prescribed vide Operational Circular dated August 10, 2021.
- In Nov 2022, SEBI has allowed an issuer under the SEBI (Issue and Listing of Municipal Debt Securities) Regulations, 2015 **('ILMDS Regulations')** to issue a green debt security if it falls within the definition of "green debt security" as per Regulation 2(1)(q) of the NCS Regulations. Such an issuer has to comply with both ILMDS Regulation and NCS Regulation

- In the backdrop of increasing interest in sustainable finance in India as well as around the globe, and **with a view to aligning the extant framework for green debt securities with the updated Green Bond Principles recognised by International Organisation of Securities Commission (IOSCO)**, SEBI undertook a review of the regulatory framework for green debt securities. Based on the review, it has been **decided in the SEBI board meeting** dated December 20, 2022, to:

- Enhance the scope of the definition of green debt security by including new modes of sustainable finance in relation to pollution prevention and control, eco-efficient products, etc.;
- **Introduce the concept of blue bonds** (related to water management and marine sector), yellow bonds (related to solar energy) and transition bonds as subcategories of green debt securities.

12. DESERTIFICATION AND LAND DEGRADATION

- **Introduction**
  - Desertification is a type of land degradation in which relatively dry land region becomes increasingly arid, typically losing its bodies of water as well as vegetation and wildlife.
  - Currently, **41% of the landmass worldwide** is prone to desertification and more than 2 billion people are affected by desertification and land degradation.

- **Key causes**
  i. **Deforestation**
  ii. **Overgrazing and unsustainable agri practices** are other major factors leading to desertification.
  iii. **Increasing Pollution** also negatively hampers biodiversity (including biodiversity), causes infertility of soil and promotes desertification
  iv. **Climate Change and higher probability of droughts** have made more areas vulnerable to desertification
  v. **Salination** caused by **overuse of water,** degrades soil and promotes desertification.
  vi. **Unsustainable Mining practices** also degrades the geographic region and promotes desertification.
  vii. **Invasive species** of plants such **as Proposis Juliflora** have also resulted in the decline of natural vegetation and expansion of deserts.
    - This can be specifically seen in case of Banni Grassland, of Kutch Gujarat.
  viii. **Forest fires** are the other major drivers of desertification.
  ix. **Lack of Resources** to fight desertification
    - The issue was also raised recently in the 14th COP on UNCCD. Only $6.4 billion have been spent in last 2 years to combat desertification, the real cost should be as much as $450 billion annually.

- **Impact**
  i. **Threatens socio-economic development** by threatening food security, increasing poverty and unemployment due to land degradation.
  ii. **Increases vulnerability of already vulnerable groups**
  iii. **Promotes the vicious cycle of degradation**
    - Poverty force people to go for unsustainable agri practices, further promoting desertification.
  iv. **Desertification adds to and worsens the impact of climate change**
    - It reduces forest cover and thus reduces the sinks for CO_2.

1) UNITED NATION CONVENTION ON COMBATING DESERTIFICATION (UNCCD)

- UNCCD is one of three important conventions finalized in 1992 Earth Summit (the other being CBD and UNFCCC)

- It was **established in 1994** and is the **sole legally binding international agreement linking environment and development to sustainable land management**.
    - The convention addresses specifically the arid, semi-arid and dry sub-humid areas, known as drylands, where some of the most vulnerable ecosystems and peoples can be found.

- The convention has **197 members** who work together to:
    a. **Improve the living condition of people** in drylands
    b. **Maintain and restore soil productivity**
    c. **Mitigate the effect of drought**

2) THE NEW UNCCD 2018-30 STRATEGIC FRAMEWORK

- It is the most comprehensive global commitment to achieve **Land Degradation Neutrality** (LDN) to achieve a land degradation-neutral world consistent with the 2030 Agenda for Sustainable Development.

- **Land Degradation Neutrality**
    - A state whereby the **amount and quality of land resources**, necessary to support ecosystem functions and services and enhance food security, **remains stable or increases** within specified temporal and spatial scales and ecosystems.

- **The LDN Target Setting Program**
    - Through this, the Global Mechanism (GM) and Secretariat on UNCCD, in collaboration with multiple international partners, are supporting interested countries in their national LDN target setting process.

- **The LDN Fund**
    - It is an impact investment fund, blending resources from the public, private and philanthropic sectors to support achieving LDN through sustainable land management and land restoration **projects implemented in private sector**.
        - It is the first of its kind investment vehicle leveraging public money to raise private capital for sustainable land projects.
    - It was officially launched at COP 13 in Ordos, China.

3) WORLD DAY TO COMBAT DESERTIFICATION AND DROUGHT: 17TH JUNE

- **Background**

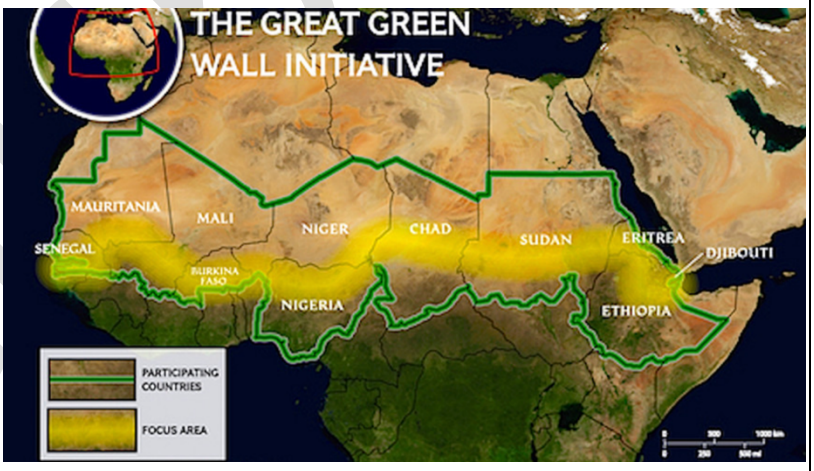
- In 1994, General Assembly established the United Nations Convention to Combat Desertification (UNCCD), the sole legally binding international agreement linking environment and development to sustainable land management, and declared 17th June "World Day to Combat Desertification and Drought".
- Later, in 2007, UNGA declared the decade 2010-2020 as the **UN Decade for Deserts and Find Against Desertification to mobilize global action to fight land degradation**.

- The 2021 Desertification and Drought day focused on turning degraded land into healthy land.

4) THE BONN CHALLENGE

- It is a global goal to bring 150 million hectares of degraded and deforested landscapes into restoration by 2020 and 350 million hectares by 2030.

5) GREAT GREEN WALL INITIATIVE



- This initiative was **launched in 2007 by African Union** and is aimed at restoring Africa's degraded landscapes and transform millions of lives in one of the world's poorest regions, the **Sahel**.
- It will be covering the Sahel region, from Senegal in the west to Djibouti in the East of Africa.
- Once, complete the wall will be the largest living structure on the planet - an 8,000 km natural wonder of the world stretching across the entire width of the continent.
- The initiative has brought together African Countries and International Partners, under the leadership of African Union Commission and Pan-African Agency of the Great Green Wall.
- **Objectives:**
  - By 2030, restore 100 million ha of currently degraded land; sequester 250 million tons of carbon; and create 10 million green jobs.

6) UN HIGH LEVEL DIALOGUE ON DESERTIFICATION, LAND DEGRADATION, AND DROUGHT

- **Why in news?**
  - PM Modi gave a keynote address at the UN 'High-Level Dialogue on Desertification, Land Degradation and Drought' (June 2021)

- **Details**

- The President of General Assembly convened a High-Level Dialogue to assess the progress made in the fight against DLDD during the UN Decade for Deserts and the Fight Against Desertification (2011-2020) and map the way forward. This dialogue took place in May 2021.

- **Key Purpose**
  - Bring attention to how COVID-19 recovery process can be aligned to address DLDD through job creation project in land restoration, regenerative agriculture, renewable energy and energy efficiency, and investments in sustainable land management.
  - Elevate the discourse on DLDD issues' global significance for the entire SDG agenda and for climate, biodiversity and disaster risk reduction.
  - Build upon the commitments made by member states during CBD summit, UNFCCC summit and so on.
  - Encourage all UN members to adopt and implement Land degradation Neutrality targets and National Drought Plans as part of their NDCs to Paris Agreement.
  - Call member countries to support the Land Degradation Neutrality Fund and other funding mechanisms to scale up land restoration by all sectors of society
  - Share experiences, best practices, cutting edge technologies and innovative business models that advance green, resilient and inclusive recovery strategy.

- **Key Highlights of PM Modi's Address**
  - In India, we have **always given importance to land and considered the sacred Earth as our mother**.
  - **Key steps by India:**
    - » **Afforestation**: Over last 10 years, India has added 3 million hectares of forest cover.
    - » India is on track to achieve our national commitment of Land Degradation Neutrality [SDG target 15.3].
    - » India is also working towards restoring 26 million hectares of degraded land by 2030.
      - This would also contribute to India's NDC commitment of an additional 2.5 to 3 billion tonnes of carbon dioxide equivalent.
    - » In the spirit of south-south cooperation, India is also helping fellow developing countries to develop land restoration strategies.
    - » A centre of excellence is being set up in India to promote scientific approach towards land degradation strategy.

  - **Restoration of land** can start the virtuous cycle of good soil health, increased land productivity, food security and improved livelihood.

7) DESERTIFICATION AND LAND DEGRADATION ATLAS OF INDIA

- It has been published by Space Application Centre, ISRO Ahmedabad (June 2021)
- The Atlas provides state wise area of degraded lands for the time frame 2018-19. It also provides change analysis for the duration of 15 years, from 2003-05 to 2018-19.
- **Key Highlights**
  - 29.7% of India's land is degraded.
    - i.e. 97.8 million hectares of India's total geographical area (TGA) of 328.72 mha underwent land degradation

- Area under **desertification** have also increased to 83.69 million hectares in 2018-19 from 82.64 mha in 2011-13.
  - Note: Land degradation within dry land regions (arid, semi-arid, and dry sub-humid regions) is termed as desertification.
- **Statewise breakup**
  - **Increase in level of desertification** have been seen in 28 out of 31 states and UTs between 2011-13 and 2018-19.
    - Even in **Goa and Odisha** where desertification had earlier declined (between 2003-05 and 2011-13), it has increased now.
  - Land degradation and desertification was **declining** in UP, Rajasthan and Telangana in 2018-19.

Around 23.79% of the area undergoing desertification with respect to the TGA of the country was contributed by Rajasthan, Maharashtra, Gujarat, Karnataka, Ladakh, Jharkhand, Odisha, Madhya Pradesh, and Telangana.

13. OZONE LAYER

- Ozone is a natural gas, it is an allotrope of oxygen consisting of three atoms of oxygen bound together in a non-linear fashion. The chemical symbol for ozone is O_3.

- It's a pale blue gas with distinctive pungent smell.
- **Pollutant at ground level** - discussed with air pollution

- **Ozone Layer**
  - The ozone layer or ozone shield is a region of Earth's stratosphere that absorbs most of the sun's ultraviolet (UV) radiation. It contains high concentration of Ozone (O_3) in relation to other parts of the atmosphere, although still small in relation to other gases in the stratosphere.
  - Ozone layer is mainly found in lower stratosphere (approx. 20-30 km above earth)

- **Usefulness of ozone layer:** Prevents damaging Ultraviolet from reaching earth thus benefitting both plants and animals; Protects oxygen of lower layer which would break up by the action of ultraviolet rays otherwise.

1) OZONE LAYER DEPLETION

- **What caused Ozone Layer depletion?**
  - In 1970s scientists discovered that Chlorofluorocarbons (CFCs), broke apart in the atmosphere and released **chlorine atoms**. This caused the ozone depletion. The same effect resulted when **bromine** atoms were released by halons. Thus, **CFCs and halons** are examples of Ozone depleting substances.

- **What are the uses of Ozone depleting substances/ when and why they are produced?**
  - **Chlorofluorocarbons (CFCs)**: Used as refrigerants and aerosol propellants, for making plastic foam, cleaning of electronic equipment.

- Lifetime and removal of CFCs: Unlike other chemicals, CFCs cannot be eliminated from atmosphere by the usual scavenging processes like photo dissociation, rain-out and oxidation.
- Escape of CFCs: The CFC enter into atmosphere by gradual evaporation from their source (discarded refrigerators etc.) Since the CFCs are thermally stable, they can survive in the troposphere. But in the stratosphere, they are exposed to UV radiation.

- **Bromine containing compounds:** Bromine containing compounds called halons and HBFCs, i.e., hydro Bromo fluorocarbons [both used in fire extinguishers] and methyl bromide (a widely used pesticide).

- **Carbon Tetrachloride**: It is a cheap, highly toxic solvent. Used in manufacture of synthetic rubber, the production of pesticides and pharmaceuticals.

- **Methyl Chloroform**: Used as cleaning solvent for clothes and metals, and a propellant in a wide range of consumer products, such as correction fluid, dry cleaning sprays, spray adhesives) and other aerosols.

- **Trichloroethane**: A versatile, all-purpose solvent.

- **Hydrochlorofluorocarbons (HCFCs)**: Developed as an **interim replacement for CFCs.** Much less harmful then CFCs. But have high global warming potentials.

- **Nitrous Oxide (N2O):** It can gradually reach the middle of the stratosphere, where it is photolytically destroyed to yield nitric oxide which in turn destroys ozone.

- **Sulphuric Acid Particles**:
  - The most prominent acid used in various industries
  - These particles free chlorine from the molecular reservoirs, and convert reactive nitrogen into inert forms thus preventing the formation of chlorine reservoirs.

2) SCIENCE OF OZONE DESTRUCTION

- **Through Chlorine atoms**
  - The molecules of CFCs when exposed to UV radiation break up, thus freeing chlorine atoms. A free chlorine atom reacts with an ozone molecule to form chlorine monoxide (ClO).
  - **The depletion of ozone is catalytic (**(ClO) further combine with an atom of oxygen to form O2 and Cl. This Cl can further react with O3 and the cycle continues. Thus, a single chlorine atom can destroy thousands of ozone molecules**)**

- **Bromine atoms**
  - Each bromine atom **destroys hundred times of more ozone molecules** than what a chlorine atom does.
    - Bromine + Ozone ---> Bromine monoxide + Oxygen
    - Bromine monoxide + Chlorine Monoxide ---> Oxygen + Bromine + Chlorine

- **Nitric Oxide (NO)**
  - Nitric oxide also catalytically destroys ozone
    - Nitric Oxide (NO) + Ozone (O_3) -> Nitrogen dioxide (NO_2) + Oxygen (O_2)

» Nitrogen dioxide (NO_2) + monoxide (O) ---> Nitric Oxide (NO) + oxygen (O_2)

3) EXTENT OF MAXIMUM DAMAGE OF OZONE LAYER

In 2000, the areas of Antarctic Ozone hole reached a record **of 29 million sq km**

4) POLAR STRATOSPHERIC CLOUDS AND OZONE DEPLETION

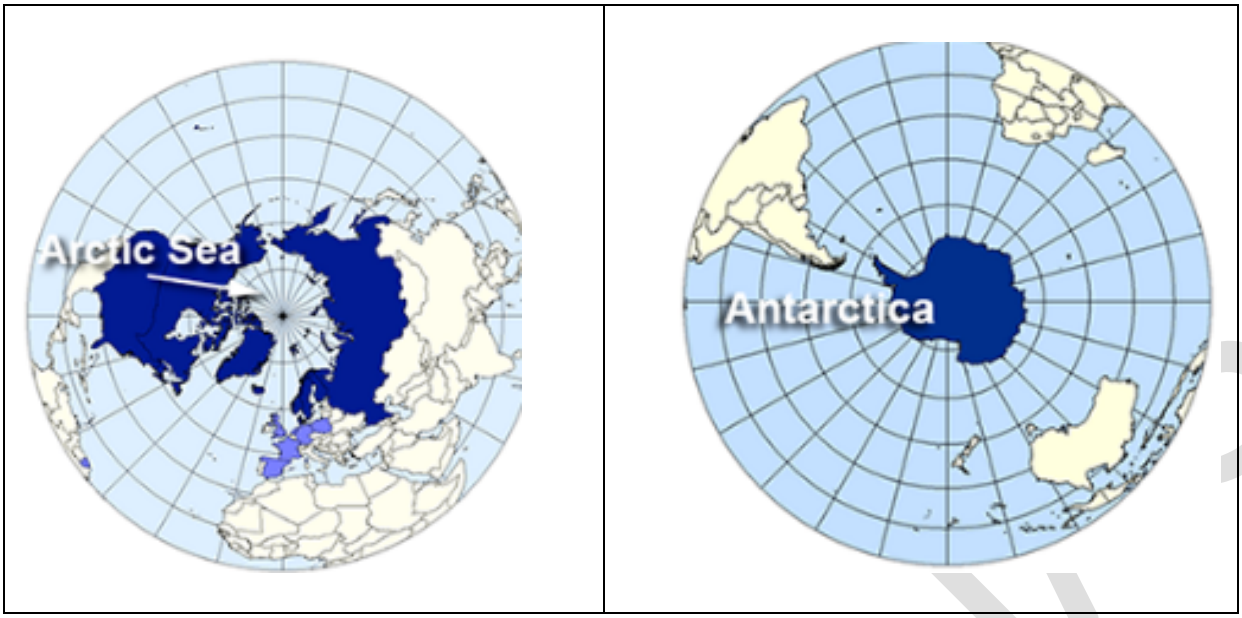
- What is Polar Stratospheric Cloud?
  - PSCs, also known as nacreous clouds (or mother of pearl, due to its iridescence), are clouds in the winter polar stratosphere at altitude of 15 - 25 kms. They contain water, nitric acid and/or sulfuric acid.

- **Role in ozone depletion**
  - **Situation without PSCs**
    - **Chlorine** released by the breakdown of CFCs exists initially as pure chlorine or as chlorine monoxide but these two react further to form compounds Chlorine nitrate and HCL that are stable (inactive chlorine)
    - The stable compounds HCL and $CLONO_2$ reservoirs of chlorine, and therefore for chlorine to take part in reactions of any sort, it has to be freed.

- **Role of PSCs: Activating chlorine and absorbing nitrogen**
  - Ice particles of the PSC provides **substrates for chemical reaction** which frees chlorine from its reservoirs. Usually, the reaction between HCL and $CLONO_2$ (Chlorine Nitrate) is very slow, but this **reaction occurs at a faster rate in the presence of suitable substrate which is provided by the stratospheric clouds at the poles**.
  - HCL + Chlorine Nitrate ---> Cl_2 (Molecular chlorine) + HNO_3 (Nitric Acid)
  - PSCs not only activate chlorine, but **they also absorb reactive nitrogen**. If nitrogen oxides were present they would combine with chlorine monoxides to form a reservoir of chlorine nitrate ($ClONO_2$).

5) WHY IS OZONE DEPLETION PREDOMINANT OVER ANTARCTIC (AND NOT ARCTIC) AND OTHER AREAS WHICH PRODUCE MORE OZONE?

1. **Antarctic is more cold than arctic:** The Antarctic stratosphere is **much colder**. The low temperature enables the formation of PSCs, below 20 km.
   - **Why Antarctic is colder than Arctic?**



2. **Stability of Vortex is longer here**
    - The vortex is a ring of rapidly circulating air that confines the ozone depletion in the Antarctic region.
    - The l*ongevity of the Antarctic vortex is another factor, enhancing favorable conditions for the depletion of ozone*.
    - The vortex in Antarctic remains, in fact, throughout the polar winter, well into midspring whereas the vortex in the Arctic disintegrate by the time of polar spring (March-April)

6) ENVIRONMENTAL IMPACT OF OZONE DEPLETION: IMPACT OF UV-B RADIATION ON LIVING AND NON-LIVING THINGS ON EARTH

- Decrease in the quantity of total-column ozone tend to cause increased penetration of solar UV-B radiation (290-315 nm) to the earth's surface. It has profound effect on human health, animal plants, microorganisms, material, and air quality.

i. **Effect on Human and Animal Health**
    - Eye disease, skin cancer and infectious morbidity
    - In susceptible (light skinned colored) population UV-B radiations is the key risk factor for development of non-melanoma skin cancer (NMSC).

ii. **Effects on terrestrial plants and Aquatic Ecosystem**
    - Physiological and developmental process are affected

iii. **Effects on biogeochemical cycles**
    - Alternates both source and sinks of greenhouse and chemically important trace gases

iv. **Effects on air quality**
    - **Higher photo dissociation rates of key trace gases** that controls the chemical reactivity of the troposphere.
    - Increase both production and destruction of ozone (O_3) and related oxidants such as hydrogen peroxide (H_2O_2), which are known to have adverse effect on human health, terrestrial plants, and outdoor materials.

- Can lead to increased production of particulates such as cloud condensation nuclei.

v. **Effects on Materials**
   - Synthetically occurring polymers and naturally occurring bio-polymers as well as other materials are adversely affected by solar UV radiation.
   - It increases photodegradation of these materials, limiting their life outdoors.

7) VARIOUS INITIATIVES TO CONTAIN OZONE DEPLETION

A) VIENNA CONVENTION

- **Background**: Signed in 1985 and came into force in 1988
- **Convention**
   - The objective of the convention was for countries to **promote cooperation** by means of systematic observations, research and information exchange on the effects of human activities on the ozone layer and to adopt legislative and administrative measures.
      - Did **not contain legally binding controls and targets**.
   - However, it set an important precedent. For the **first time, nations agreed in principle to tackle a global environmental problem** before its effects were felt or conclusively proven by science.
   - In 2009, the Vienna Convention became the first convention of any kind to achieve universal ratification.

B) MONTREAL PROTOCOL

- Once the scientific observation confirmed the ozone hole, governments recognized the **need for stronger measures** to reduce production and consumption of several CFCs and halons.
- Thus the Montreal protocol was **signed in Sep 1987**. It is an international treaty designed to protect the ozone layer through reduction of production and consumption of ODS. It came into **force in 1989.**

- **Key features**
   1. It required all parties to **eliminate the production and import of nearly 100 substances** that deplete the ozone layer, in accordance with agreed timelines.
   2. Special provisions for **developing countries -> grace period** of 10-15 years.
   3. **Multilateral funds -** a financial mechanism to help qualifying developing countries to phase out their consumption of ozone depleting substances.
   4. It required **parties to report annually on production**, **import and export** of ODSs.
   5. Precludes parties from trading ozone-depleting substances with non-parties.
   6. Requires **regular assessments** to enable parties to make informed decisions with the most up to date information.

- **Chemicals covered**
   - The Montreal protocol controls nearly 100 chemicals, grouped in the following categories:
      - CFCs
      - Halons
      - Carbon tetrachloride (CTC)
      - HCFC
      - Methyl Chloroform
      - Methyl Bromide

- It has been ratified by 197 parties making it first and only universally ratified protocol in UN history.

- **Impact of Montreal Protocol**
  - It has also been a **highly successful** international arrangement, as it has phased-out more than 98% of the ODS which was part of its main mandate by 2021. The remaining ODS are HCFCs which are in the process of being phased out.

- **What has India done under the Montreal Protocol**
  - India has already phased out CFCs, and CTC.
  - In Jan 2020, India also achieved complete phaseout of Hydrochlorofluorocarbon (HCFC)-141 b, which is a chemical used by foam manufacturing enterprise and is one of the most potent ODS after CFCs.
    - It is mainly used as a blowing agent in the production of rigid polyurethane (PU) foams.
  - **Currently** India is engaged in the phase-out of production and consumption of other Hydrochlorofluorocarbons (HCFCs) with an accelerated phase out schedule as per the Montreal Protocol.
    - India's current plan will result in 60 percent phase out of HCFCs by Jan 1, 2023.

C) KIGALI AMENDMENT TO MONTREAL PROTOCOL

- **About Kigali Agreement to Montreal Protocol**.
  - During the 28th Meeting of Parties (MoP) of the Montreal Protocol in 2016, Kigali Agreement was finalized.
  - Kigali agreement refers to an amendment to the 1989 Montreal Protocol to **eliminate planet-warming HFC gases**.
    - » It calls for phasing-out of HFCs, a set of 19 gases in Hydrofluorocarbon family that are used extensively in air-conditioning and refrigerant industry.
      - These gases are not ozone depleting but are thousands of times more dangerous than carbon dioxide in causing global warming.
      - Currently, they may have a small contribution in global warming, but with increase in the use of Air-Conditioning and Refrigeration, its contribution will be huge. Some estimates show that if the growth in the use of HFCs continue at the current rate, their contribution to global warming may reach 19% by 2050.
    - » **Why put the target in Montreal Protocol and not UNFCCC?**
      - Montreal Protocol is much more successful than the UNFCCC and have fairly good track record in controlling various kinds of emissions.

  - **Legally binding commitments**
    - » Rich and industrialized countries bring down their HFC production and consumption by at least 85 percent by 2036 compared to their annual average values in the period 2011-13 starting **from 201**9.
    - » A group of developing countries (more than 100) including China, Brazil and South Africa are mandated to reduce their HFC use by 80 percent of their average value in 2020-22 by the year 2045 starting from 2024.

» India and some other developing countries - Iran, Iraq, Pakistan, and some oil economies like Saudi Arabia and Kuwait - will **cut down their HFCs by 85 percent of their values in 2024-26 by the year 2047 starting from 2028**.

- **The Parties to the amendment agreed to provide financing for HFCs reduction**

- **Significance:**
  - Fight Climate Change; CBDR to ensure developmental needs of countries like India; Target approach to better monitor progress

- **India's decision to ratify the Kigali Amendment** (Aug 2021)
  - Union Cabinet has decided to ratify the Kigali agreement. It comes close on the heels of similar decisions by the USA, and China - the world's largest producers and consumers of HFCs.
  - India has also announced that it will draw up a national strategy for phase-down of HFCs by the year 2023 in "consultation with all industry stakeholders". India will also amend the existing domestic laws that govern the implementation of the Montreal Protocol by the middle of 2024 to facilitate the HFC phase-down.
  - **Note-1:** India's reductions have to begin only after 2028
  - **Note-2:** By July 2021, **122 countries have ratified** the Kigali Agreement.

TARGET PRELIMS 2024
BOOKLET-17; EB&CC-7
BIODIVERSITY-BASICS; IMPORTANT MAMMALS

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2. BIODIVERSITY-BASICS

1) DEFINITION

- **Biodiversity** is the term popularized by the socio-biologist **Edward Wilson** to describe the **combined diversity at all levels of biological organization**.

- Biodiversity is defined as 'the **variability among living organisms** from all sources, including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this include diversity **within species**, **between species** and of **ecosystems**'. (UN Earth Summit).

2) HOW IS BIODIVERSITY DISTRIBUTED ON EARTH?

- The **vast majority** of all species are found in the **tropics, and subtropics**, where most of the developing countries are also located. Infact, **50-75%** of all species are found in **tropical rainforests** that account for j**ust 6% of the land areas**.
  - The **genetic diversity needed to maintain the world's agricultural system** is found mainly in **tropics, and sub-tropics**. These areas also contain most of the important medicinal plants from which new pharmaceutical products are extracted.
  - In the **northern regions**, **the recurrent ice ages did not permit the flowering of many life forms**.

- **Variation with altitude:** In general biodiversity **increases with altitude until a certain threshold** and then decreases. This is due to environmental factors such as temperature, air pressure, and precipitation.
  - Many mountain ecosystems show greater biodiversity and higher levels of endemism than adjacent lowlands.
  - **Mountain at lower altitudes can support exceptional biodiversity, due to compression of a wide range of ecosystems into a relatively short distance**. Mountains also often provide islands of suitable habitat, isolated from unfavourable surrounding lowlands.

  - **Humboldt's Enigma**:
    - **Background**: Conventionally, it was understood that biodiversity will be highest around the equator, in tropics, as this region has higher primary productivity as it receives the highest sunlight (energy). As one moves away from equator biodiversity decreases. Tropical rainforests thus hold the crown for species richness.

  - **Humboldt's Observation**: Alexander von Humboldt, a German naturalist, during his extensive travels through South America in the early 19th century, noticed something intriguing. **Mountain ranges**, despite occupying relatively small areas compared to vast tropical forests, displayed exceptionally diverse plants and animal life. This stood in stark **contrast to the predicted decrease in higher latitudes**.
    - Two centuries later, group of bio-geographers - scientists who explore the relationship of diversity with geography - used modern tools to take another look at the drivers of

biodiversity. Based on their findings, they proposed their own version of the link between biodiversity and mountains and called it **Humboldt's enigma**.

» **Examples** of Humboldt's enigma in India:

- **Eastern Himalayas**: These are the second-most diverse area of perching birds in the world. For river birds, the eastern Himalayas may be the most diverse.

▫ **Reasons for the Enigma**:

» **Compression of a wide range of ecosystem into relative short distance**: Mountains boast diverse landscapes with varied terrain, elevation, and microclimates. This creates a mosaic of distinct habitats, fostering speciation and niche adaptation among organisms.

» **Geological Process like Uplifts**, result in new habitats where new species arise, so the habitats are 'cradles'.

» **Climatic Stability**: Some climatologically stable mountains persist there for a long time, so these spots are **'museum'** that accumulate many such species over time.

- This provides refuge and protection to species during changing environment and thus aids biodiversity.

» **Unique Resources**: Mountains have resources like nutrient rich volcanic soils and unique water regimes which gives sustenance for specialized species.

▫ **E.g.**:

» **Coastal Tropical Sky Islands** (mountain surrounded by lowlands), like the Shola Sky Islands in the Western Ghats, are good examples of 'museum'**.** Here old lineage has persisted on the mountains tops as climates and habitats fluctuated around them in lower elevations. This is the reason, some of the oldest bird species in the western ghats, such as the ***Sholicola,*** and the ***Montecincla,*** are housed on the Shola Skey Islands.

» The **Northern Andes Range -** including Chimborazo - is considered the most biodiverse place in the world. If we start from the foothills of the Andes and climb, we're going to counter different temperature and rainfall levels that support everything from **tropical evergreen biomes in the lower elevation to the alpine and tundra biomes near the top**. Such a large variation over short distances supports the immense biodiversity found in mountain regions - and worldwide.

3) MEGA DIVERSE COUNTRIES

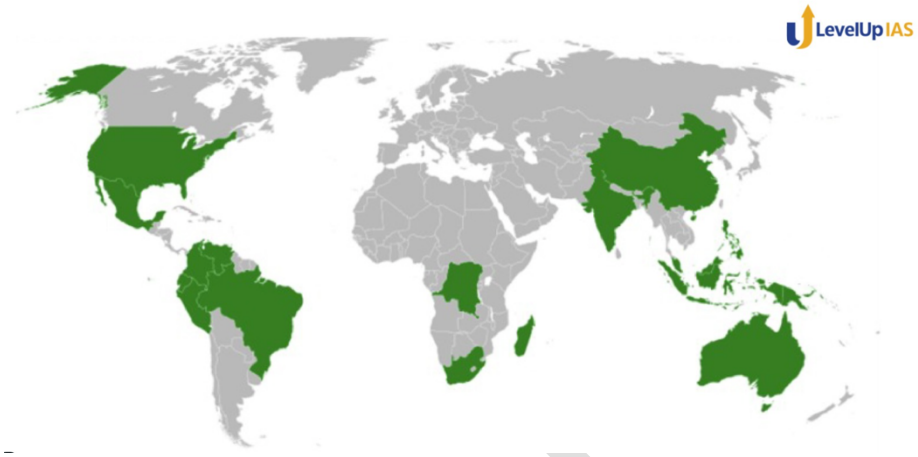
- The megadiverse country is a term used to refer to the **world's top biodiversity-rich countries**. These were identified in 1988 by **Conservation International (CI)**, to promote the **awareness for biodiversity conservation** among world nations. According to CI, there are **17** of these nations, which are mostly located in the tropical and subtropical region.

- **Criteria**
  - The principle criterion is **endemism**, first at the species level and then at higher taxonomic levels such as genus and family. To qualify as a Megadiverse Country, a country must:
    i. Have at least **5,000 of the world's plants as endemics** (native restricted to a certain place)
    ii. Have **marine ecosystem** within its border.

- **Purpose of this classification [**Raises awareness about biodiversity conservation; complements biodiversity hotspots and HBWA in protection of biodiversity; Demonstrates how a few countries hold a large portion of global biodiversity and therefore have disproportionate political responsibility**]**

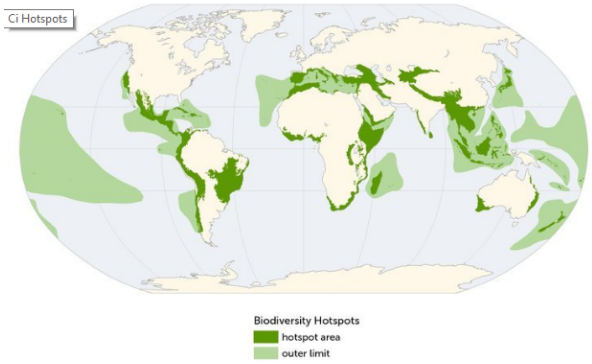
List of 17 megadiverse countries according the conservation international:

- USA
- Mexico
- Brazil
- Venezuela
- Colombia
- Ecuador
- Peru
- Democratic Republic of Congo
- South Africa
- Madagascar
- India
- China
- Malaysia
- Indonesia
- Philippines
- Papua New Guinea
- Australia



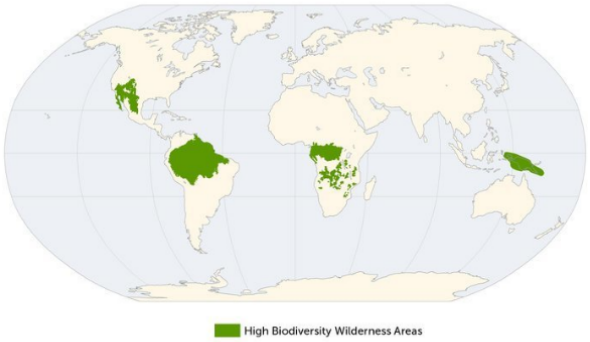
4) BIODIVERSITY HOTSPOTS

- Biodiversity hotspots are **regions containing exceptional concentrations of plant endemism and experiencing high rates of habitat loss**.
- Of the total 35/36 globally identified biodiversity hotspots India has 4 of them i.e. **Eastern Himalayas**, Nepal, India; **Indo-Burma**, India and Myanmar, **Western Ghats**, India; **Sundalands:** include Nicobar group of islands (and Indonesia, Malaysia, Singapore, Brunei and Philippines)



- Norman Meyers wrote about the concept in two articles in "The Environmentalist" (1988) & (1990)
- **Description:** Biodiversity hotspots are a method to **identify those regions of the world where attention is needed** to address biodiversity loss and to guide investment in conservation.
- To qualify as a biodiversity hotspot on Meyers 2000 edition of the hotspot-map, a region must meet **two strict criteria**
  i. **Plant Endemism:** It must contain **at least 0.5% of the world's total or 1500 species of vascular plants as endemics**.
  ii. **Serious Habitat Loss :** It has to have lost at least 70% of its primary vegetation.
- Around the world 36 areas qualify under this definition, with some other possible candidates.
- Supported by Conservation International

5) HIGH BIODIVERSITY WILDERNESS AREA



- The large intact ecosystems of the world that hold significant levels of global biodiversity.
- Approach developed by **Conservation International**.
- HBWAs consist of 5 of the 24 major wilderness areas that hold globally significant levels of biodiversity.
- The 5 HBWAs are Amazonia, the Congo forest of Central Africa, New Guinea, the Miombo-Mopane woodlands of Southern Africa (including the Okvango delta), Northern American desert complex of northern Mexico and South Western part of USA.
- In the **past**, the HBWAs were mostly considered to have **'low vulnerability'** because of their low level of past habitat loss. However, recent analysis suggests that the high cultivation potential of many HBWAs makes them a target for future agri-expansion.

6) THREE LEVELS OF BIODIVERSITY

a. Genetic diversity

- Genetic diversity refers to variety at the level of genes. It consists of variation of genes in a particular **species**.
- Significance of genetic diversity
  - High Genetic Diversity -> Higher Adaptability -> Higher chance of survival
- **E.g.**
  - India has more than 50,000 genetically different strains of rice, and 1,000 varieties of mangoes.
- **E.g. of low genetic diversity :**
  - Only one species of Asiatic Cheetah survives in the world today and due to **inbreeding**, this species has lost genetic diversity.
    - Hence Cheetahs are prone to genetic disorders and low reproductive success.
  - Koalas in Europe

b. Species diversity

- Diversity at the **species level**.
- Species diversity refers to variety of plants and animals' species present in a community or ecosystem.
- Species differ from one another, markedly in their **genetic makeup**, **do-not interbreed in nature**.
- Closely-related species however have in common much of their hereditary characteristics. For instance, about 98.4% of the genes of humans and chimpanzees are the same.
- It is the **ratio of one species population over total number of organisms across all species in the given biome**.
  - 'Zero' would be infinite diversity, and 'one' represents only one species present.

- For e.g.
  - Western Ghats have greater amphibian species diversity than the Eastern Ghats.

- **Species diversity is high** in:
  - Tropical rain forests
  - Coastal zones

- **Species diversity is low in**:
  - Small isolated islands
  - Polar regions

c. Ecosystem Community Diversity (Ecological Diversity)

- Ecosystem diversity refers to **variety of ecosystems** found in a given area or region.
- This refers to the different type of habitats. A habitat is the cumulative factor of the climate, vegetation and geography of a region.
- There are several kinds of habitats around the world. Corals, grasslands, wetlands, desert, mangrove and tropical rain forests are example of ecosystems.
- As the environment changes, species best adapted to that environment becomes predominant. Thus, the variety of diversity of species in the ecosystem is influenced by the nature of the ecosystem.
- E.g.
  - India with its deserts, rain forests, mangroves, coral reefs, wetlands, estuaries, and alpine meadows has a greater ecosystem diversity than a Scandinavian country like Norway.

7) FACTORS WHICH DETERMINE THE DEGREE OF DIVERSITY

- **Habitat stress:** Diversity is low in habitats under any stress like harsh climate or pollution
- **Geographical isolation:** Diversity is less in isolated regions like an island. If a species in an island disappears, it can't be easily replaced.
- **Dominance by one species:** The dominant species consumes a disproportionate share of the resources. This does not allow many species to evolve and flourish.
- **Availability of ecological niches:** A complex community offers a greater variety of niches than a simple community and promotes greater diversity.
- **Edge Effect:** Always **greater diversity at ecotones** or transition areas between ecosystem.
- **Geological history:** Old and stable ecosystems like rain forests that have not experienced many changes have high diversity. An ecosystem like the Arctic has undergone many changes and this does not allow species to establish themselves.

8) SIGNIFICANCE OF BIODIVERSITY

A) BIODIVERISTY AND FOOD SECURITY

- Biodiversity is the cornerstone of healthy and sustainable food system.
  - » It plays a role in protecting pollinators; improving soil fertility; and building resilience of food system to the effects of climate change. It is thus crucial for fighting global hunger.

B) BIODIVERSITY PROVIDES A NUMBER OF NATURAL SERVICES FOR HUMANS

a. **Ecosystem Services**
   - Protection of water resources

- Soil formation and protection
- Nutrient storage and recycling
- Pollution breakdown and absorption
- Contribution to climate stability
- Maintenance of ecosystem
- Recovery from Unpredictable events

b. **Biodiversity Services**
- Food
- Wood Products
- Ornamental Plants
- Medicinal resources and pharmaceutical drugs
- Breeding stocks, population reservoirs
- Future resources
- Diversity in genes, species and ecosystems

c. **Social Services**
- Research, education and monitoring
- Recreation and tourism
- Cultural values

9) ENDEMIC SPECIES

- An endemic species is **found only in a specific geographical location**, and not found anywhere else. A species may be native to an area, but is not endemic to that areas, if it is found elsewhere too.
  - For e.g., the **Lion-tailed macaque** (Macaca silenus), and the **Nilgiri Langur** are endemic to the **western Ghats of India**.

10) KEYSTONE SPECIES

- Keystone species are those species which have **disproportionately large effect** on the communities in which it occurs. It plays an essential role in the structure, functioning in fact, it determines the ability of a large number of species in the community to survive.
- When a keystone species disappears, it could result in a series of extinction of other species.

- **E.g. 1:** An example is the **wild durian**, a tree endemic to the western Ghats.
  - Its fruits attract insects and birds come in to eat insects. Reptiles consume both insects and birds. The tree is also the habitat of monkeys, which eat the fruits, leaves and insects. Even tigers may come to eat the animals that are attracted by all the food in the tree ecosystem.
  - **If the wild durian tree is removed from the ecosystem, many of the species will be adversely affected and some may disappear.**

- **E.g. 2: Wolves**

- If wolves go extinct in an ecosystem, the population of deer and other herbivores will increase exponentially. Due to excessive grazing by the herbivores, many plants may go extinct. Then, the small animals and insects that feed on the plants may disappear.

11) INDICATOR SPECIES

- Indicator species is one whose **presence, absence, or abundance** reflects a specific environmental condition. They are very **sensitive indicators of environmental problems**. They give early warning of problems that could potentially affect other species. They are also called **sentinel species**.
  - E.g. **Lichen,** which is sensitive to the presence of heavy metals or acids in rain. It's behaviour may indicate that acid rain is falling in the area.
    - Lichens are mutualistic association of **fungus and algae** or cyanobacterium and occurs as a crusty patch or busy growths on trees, rocks and bare grounds.
    - Lichens are very sensitive to SO_2 pollution and since industrial revolution a number of their population have become extinct. **So, if air is badly polluted by SO_2, no lichens may be present**.

- **Top predators like tigers and snow leopards** are also indicator species. Their presence indicates that entire ecosystem is healthy.
- **Frogs and other amphibians** may also be indicator species

12) FLAGSHIP SPECIES

- A flagship species is a species selected to act as an **ambassador, icon or symbol** for a defined habitat, issue, campaign or environmental cause. It is chosen to raise support for biodiversity conservation in a chosen place or context. These species have the ability to capture the imagination of public and induce people to support conservation action and/or to donate funds.
- By focusing on, and achieving conservation of that species, the status of many other species which share its habitat - or are vulnerable to the same threats - may be improved.
- They are usually relatively large and considered to be **charismatic** in western countries.
- They may or may not be keystone species and may or may not be good indicators of biological process.

- **E.g.**
  - **Bengal Tiger**
  - **Jerdon's Courser** (a CR bird found only in Andhra Pradesh)

- **Some limitations**
  - May skew the management and conservation priorities in their favour and to detriment of more threatened species.
  - The disappearance of the flagship can have negative impact on the attitude of conservation stakeholders.

13) PRIORITY SPECIES

- It is a **WWF** term which is **solely for the purpose of planning and simple communication**.

- For WWF, a priority specie may be either a **flagship specie or a keystone specie** and is chosen to represent an ecoregion or region.
- A priority specie is reflective of a key threat across that eco-region - such that conservation of the species will contribute significantly to a broader threat mitigation outcome. It is often crucial to the economic and/or spiritual well-being of people within that eco-region.
    - **Note: World Wide Fund** for Nature was originally called World Wildlife Fund (WWF), a term which is still used in Canada and USA. It is **an international NGO founded in 1961** working in the field of biodiversity preservation and the reduction of human impact on environment.

- **WWF Priority species of India**
    - Asian Elephant (EN)
    - Bengal Tiger (EN)
    - One-horned Rhino (VU)
    - Ganges River Dolphin
    - Snow Leopard
    - Red Panda

14) INVASIVE SPECIES

- **Introduction:**
    - **An alien** plant/animal also referred to as exotic, introduced, foreign etc. is one that has been introduced by humans intentionally or otherwise through human agency or accidentally form one region to another.
    - An alien plant/animal that has escaped from its original ecosystem and is reproducing at its own in the regional flora is considered a **naturalized species**.
    - Those naturalized aliens that become **so successful as to spread in the flora/fauna and displace native biota or threaten valued environmental, agricultural or personal resources** by the damage it causes are considered **invasive**.
        - **To be called invasive, it should also be a threat** to the native species of the area by rapidly growing in population. This happens when the invasive species has no predator in the area.

A) ASSESSMENT REPORT ON INVASIVE ALIEN SPECIES AND THEIR CONTROL: BY INTERGOVERNMENTAL PLATFORM ON BIODIVERSITY AND ECOSYSTEM SERVICES (IPBES)

- Human beings have introduced 37,000 alien species, including plants and animals. Of these 3,500 are invasive alien species that have played a key role in 60% of global plant and animal extinction recorded.
- The report has noted that the **number of alien species** (species introduced to new regions through human activities) has been rising continuously for centuries. But now, they are rising at unprecedented rate, with increased human travel, trade and expansion of global economy.
- **E.g.:**
    - » **Water Hyacinth** is the world's most widespread invasive alien species on land.
    - » **Lantana**, a flowering shrub, and the **black rat** are the second and third most widespread globally.
- Invasive alien species are one of the five major direct drivers of biodiversity loss globally, alongside land and sea use change, direct exploitation of organisms, climate change, and pollution.

B) EXAMPLE OF INVASIVE SPECIES

DOMESTICATED CATS (*FELIS CATUS*):

- The State of Indian Birds, 2023 have highlighted that cats are a silent bird killer lurking in India's urban areas. SO along with other threats like industrialization, forest degradation, and climate change, climate change is also a threat for birds in India.
- **But,** detailed studies are **lacking in India**. In the USA, where detailed studies have been done, it is estimated that **free ranging domestic cats kill billions of birds every year**.
  - One study says that cats may be the single greatest source of anthropogenic mortality for the birds and mammals in the USA.
- **Worldwide**, free ranging domestic cats have caused or contributed to dozens of extinctions of birds species recorded in the IUCN red list.
- **Cats are more dangerous than free ranging dogs**:
  - As they can climb easily and thus reach the bird habitat.
  - Cat saliva is also more likely to contain bacteria **(*Pasteurella multocida)*** that are lethal to birds. So, if the cat attack doesn't kill the bird, the bacteria does.
  - Cats also maintain a landscape of fear making birds avoid or nesting in these regions.
- **Origin of Domestic Cats**:
  - **Domestic Cats** (*Felis catus*) are the only domesticated species in the family **Felidae**.
  - Studies show that **Wild Cats (*Felis sylvestris)*** were probably first domesticated in West Asia around 10,000 years ago and since then they have spread to different parts of the world.
  - Today, they are **one of the world's 100 worst invasive alien species**.
- **Handling Domestic Cats**:
  - A popular method in the West has been **Trap-Neuter-Return (TNR) policy**, whereby stray dogs and cats are trapped, sterilized and returned in the hope that this will reduce their population. But this hasn't been very successful.

RABBITS IN AUSTRALIA

AFRICAN CATFISH:

- The fish species is not native to India and is originally found in Africa and the middle east.
- It is known to be aggressive feeder, eating even the chicks of waterfowl. It poses **a major threat to native fauna**.
- The female matures in about 3 years and can bear 10s of thousands of eggs.
- The species has now **spread to subcontinent** and is found in Cauvery, Ganga, Yamuna and even the streams of western Ghats.
- This was introduced by businessmen for commercial fish cultivation in the National Park as it could adapt to poor quality of water, raised in high densities, and reproduce well in captivity, making it ideal for those looking to sell the fish for food. Though, **the cultivation of this specie was banned by Agriculture Ministry in 2000 itself.**

RED EARED SLIDER TURTLE IN NORTH-EAST INDIA

» This is a cute American turtle popular as a pet. But it is threatening to invade the natural water bodies across the northeast, home to 21 of the 29 vulnerable native Indian species of freshwater turtles and tortoises.

CARIBBEAN FALSE MUSSEL (*MYTILOPSIS* SALLEI):

Origin: The Caribbean false mussel is originally from the Atlantic and Pacific coast of South and Central America. They may have travelled to Indian subcontinent via ships (ballast water) and then using small vessels spread to estuaries.

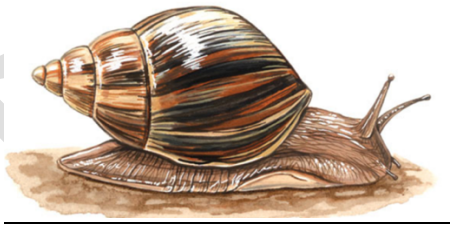
Damage: It is damaging locally important fishery in Kerala, by wiping out native clams and oysters.

ACHATINA FULICA (AFRICAN APPLE SNAIL)

The snail (a mollusk) is native to coastal areas and islands of **east Africa**.
It is invasive species across the world. It has a broad diet preference and cause heavy loss to farmers.
In India, it is **most invasive of all faunas**.

Most invasive of all fauna

It was first reported in A&N island but today it is found all across the country and is threatening habitats of several native species.



C) IN 2017, ZOOLOGICAL SURVEY OF INDIA (ZSI) HAS FOR THE FIRST TIME COME UP WITH LIST OF 157 ALIEN INVASIVE SPECIES IN INDIA

- While invasive plant species have been studied in the past, the **animal species was analysed in detail for the first time**. Invasive animal species like the plant species pose threat to biodiversity.
- **Key Highlights**
  i. Of the **157 species** 58 are found on land and the remaining 99 in Marine ecosystem.
  ii. Of the 58 invasive species on land, 38 are arthropods, 19 of fish, three of Mollusks and birds, **one reptile and two mammals**.
- **Examples of Alien species found on Land** (including rivers)
  i. **Paracoccus Marginatus (Papaya Mealy Bug)**
    - Destroyed crops of Papaya in Assam, WB and TN.

- Originally from Mexico and Central America

ii. **Phenacoccus Solenopsis (Cotton Mealybug)**
- Severely affected cotton crops of deccan
- Native to North America.

iii. **Invasive Fish Species**
- **Pterygoplichthys pardalis (**Amaxon sailfin Catfish)
  - Destroying fish population in wetlands of Kolkata.

- **Examples of Alien Species found in Marine Ecosystem**

i. Tubastrea Cocciea (Orange Cup- Coral)
- Originated in Indo-east-pacific but has now been reported in the A&N Islands, the Gulf of Kutch, Kerala, and Lakshadweep.

15) SPECIATION

- Speciation refers to formation of new species due to genetic changes in an existing species. Speciation occurs when a group within a species separates from other members of its species and develops its own characteristics. In the process of a species adapting itself to changing environmental conditions, a new species may emerge.

- **There are five types of speciation**:
  - **Allopatric Speciation**: It occurs when a species separates into two separate groups which are **isolated from one another**. A Physical barrier, such as mountain ranges or a waterway, makes it impossible to breed with one another. Each species develops differently, based on the demand of their unique habitat or the genetic characteristics of the group that are passed to the offsprings.
    - **For e.g.:**
      - Four distinct sub-species of the Asian elephant probably emerged due to allotropic speciation.
      - Squirrels and other small mammals on the two sides of Grand Canyons

  - **Peripatric Speciation**: When small group of individuals break off from the larger group and form a new species. This is called peripatric speciation. Like allopatric speciation, here also, physical barriers make it impossible for members of the group to interbreed with one another.
    - **Main difference** between Allopatric Speciation and peripatric Speciation is that in peripatric speciation, one group is much smaller than the other.

  - **Parapatric Speciation**: In this method, a species is spread over large geographical area. Although, it is possible for any member of the species to mate with another member, individual only mate with those in their own geographical region. Like allopatric and peripatric speciation, different habitats influence the development of different species in parapatric speciation. **Instead of being separated by a physical barrier**, the species are **separated by differences in the same environment**.

  - **Sympatric Speciation**: It is **controversial.** Some scientists don't believe that it exists. It occurs when there are no physical barriers preventing any members of species from mating with

another, and all the members are in close proximity to one another. A new species, perhaps based on a different food source or characteristic, seems to develop spontaneously. The theory is that some individuals become dependent on certain aspects of environment - such as shelter or food source, while others don't.

- For e.g., the parasitic great spotted cuckoo, and its magpie host, both native to southern Europe, are considered to be sympatric species.

- **Artificial Speciation**: It is creation of new species by people. This is achieved through lab experiments, where scientists mostly research insects like fruit flies.

16) MEASUREMENT OF BIODIVERSITY

- **Diversity is a single statistic** in which the number of species richness and evenness are compounded. Biodiversity is measured in two components:
  - Species Richness
  - Species Evenness

- **Species Richness**
  - It is the measure of number of species found in a community
    - **Alpha Diversity**
      - The diversity **within a particular area or ecosystem** and is usually expressed by the **number of species** (i.e., species richness) in that system.
    - **Beta Diversity**
      - It represents **differences in species composition among sites (ecosystem)**.
        - It is something of a bridge from local (alpha) to the regional (gamma) scale.
        - It can be considered a metric of dissimilarities between sites.
        - It can also be interpreted as rate of accumulation of diversity with an increasing number of sites sampled.
      - In simple terms it is ratio between gamma (regional) and alpha(local) diversities.
    - **Gamma Diversity**
      - It is the measure of **diversity of the entire landscape** (regional species pool).

- **Species Evenness**
  - It measures the proportion of species at a given site, e.g. low evenness indicates that only few species dominate the site.

17) CLASSIFICATION OF LIFE FORMS

- **Kingdom (**Monera, Protista, Fungi, Plantae, Animalia**)**
- **Phylum (**For animals) / **Division** (for plants)
  - **Class**
  - **Order**
  - **Family**
  - **Genus**
  - **Species**

E.g. For tiger

Kingdom: Animalia
Phylum: Chordata
Class: Mammalia
Order: Carnivora
Family: Felidae
Genus: Panthera
Species: P. Tigris

E.g. For Humans

Kingdom: Animalia
Phylum: Chordata
Class: Mammalia
Order: Primates
Family: Hominidae

- Members of this family are known as great apes or hominids. Currently it consist of four genera.
  - **Pongo** (Bornean, Sumtran, and Tapanuli Orangutan); ***Gorilla*** (the eastern and western Gorilla); ***Pan*** (the Chimpanzee and the bonobo); and **Homo** (of which only Homo Sapiens remain)

Genus: Homo
Species: H. sapiens

3. IUCN CLASSIFICATION

1) THE RED DATA BOOK

- Species judged as threatened are listed by various agencies as well as by some private organizations. The most cited of these lists is the Red Data Book.

- It's a loose-leaf volume of information on the status of many kinds of species. This volume is continuously updated and is issued by International Union for Conservation of Nature (IUCN) located in Merges, Switzerland.

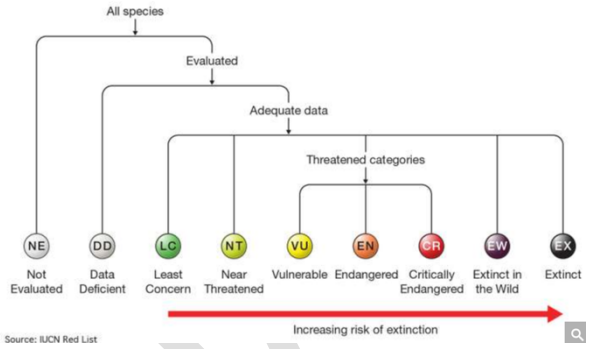
- The red data book was **first issued in 1966** by the IUCN's special Survival Commission as a **guide for information, preservation and management** of species listed. In this book, information for endangered mammals and birds are more extensive than for other groups of animals and plants, coverage is also given to less prominent organisms facing extinction.

- **"Red"** of course is symbolic of danger that species both plants and animals presently experience throughout the globe.
  - **The Pink page** in this publication include the critically endangered species. As the status of the species change, new pages are sent to the subscribers.

- **Green pages** are used for those species that were formerly endangered, but have now recovered to a point where they are no longer threatened. With passing time the number of pink pages continue to increase. There are pitifully few green pages.

2) DETAILS ABOUT IUCN

- IUCN is a membership union composed of both government and civil society organizations.
- It harnesses the experience, resources, and reach of its more than 1,400 member organizations.
- It is a **democratic union** that brings together the world's most influential organizations and top experts in a combined effort to conserve nature and accelerate the transition to sustainable development.



- The **Red Databook** of IUCN is the most cited list of threatened species.
- It classifies the **conservation status** of individual species based on their probability of extinction.

3) IUCN DATABASE OF CONSERVATION PRIORITY

1. **Extinct (EX):** A taxon is extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual.

2. **Extinct in Wild (EW):** A taxon is extinct in wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range. A taxon is presumed extinct in wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual.

3. **Critically Endangered (CR):** A taxon is critically endangered when the best available evidence indicates that it meets any of the criteria for critically endangered.
   - **Criteria**
     - **A. Reduction in population size**
       - (>=90% over the **last** 10 years or three generations, whichever is longer), where the causes of reduction is clearly reversible AND understood AND ceased.
       - (>= 80% over the **last** 10 years of three generations, whichever is longer), where the causes of reduction may not have ceased to exist OR may not be understood OR may not be reversible
       - (>=80%, projected or suspected to be met within the **next 10 years** or three generations, whichever is longer (upto a maximum of 100 years)
       - An observed **estimated inferred**, projected or suspected population size reduction of >= 80% over any 10 year or three generation period, whichever is longer (upto a maximum of 100 years in future), where the time period must include **both the past and the future, a**nd where the reduction and its causes may not have ceased OR may not be understood OR may not be reversible.

B. **Geographical Range** in the form of either B1 **(extent of occurrence)** OR B2 (**area of occupancy**) OR both:

- **Extent of occurrence** estimated to be less than 100 Km^2, and estimate indicating atleast two of the following
  - Severely fragmented or known to exist only at a single location
  - Continuing decline
    - Extent of occurrence
    - Area of occupancy
    - Area, extent and/or quality of habitat
    - Number of locations and subpopulations
    - Number of mature individuals
  - Extreme fluctuation in any of the following
    - Extent of occurrence
    - Area of occupancy
    - Number of locations or subpopulations
    - Number of mature individuals
- **Area of Occupancy** estimated to be less than 10 Km^2, and at least 2 of the following
  - Same three criteria as above (extent of occurrence)

C. **Population size estimated to number fewer than 250 mature individuals and either**

- An estimated continuing **decline of 25% within three years** or one generation, whichever is longer,(upto a maximum of 100 years in future)
- A continuing decline, of mature individuals AND atleast one of the following
  - Population structure in the form of one of the following
    - No subpopulation estimated to contain more than 50 mature individuals, OR
    - Atleast 90% of mature individuals in one subpopulation
  - Extreme fluctuation in number of mature individuals

D. **Population size** (number **less than 50 mature individuals**)

E. Quantitative analysis showing the **probability of extinction** in wild **at least 50%** in their 10 years or three generations, whichever is longer(upto maximum 100 years)

4. **Endangered**
5. **Vulnerable (VU)**
6. **Near Threatened (NT)**
   - A taxon is near threatened when it has been evaluated against the criteria but does not qualify for CR, EN, VU now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.

7. **Least Concern (LC)**
   - A taxon is least concern when it has been evaluated against the criteria and does not qualify for CR, EN, VU, or NT. Widespread and abundant taxa are included in this category.

8. **Data Deficient (DD)**

- A taxon is DD when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution or population status. Appropriate data on abundance and/or distribution is lacking. Not a category of threat.
- Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate.

9. **Not Evaluated (NE)**
   - When it has not yet been evaluated against the criteria.

4) IUCN HAS RELEASED THEIR NEW RED LIST OF THREATENED SPECIES DURING UNFCCC COP28 IN DEC 2023

- **Over 44,000 species** are threatened with extinction (around 2,000 more than last year) of the total 157,190 species in the IUCN Red List.
- **The update includes the First Broad Assessment of the health of freshwater fish species**. Around **25% of the species (around 3,000) are facing risk of extinction**.
  - » Climate change, pollution, overfishing and invasive species are the major challenge.
- **Atlantic Salmon** (a ray-finned species) found in northern Atlantic Ocean Basin has declined by 23% (2006-2020) thus moving it to **Near Threatened** (from LC)
- **Green Turtles** (of Central South Pacific and East Pacific) populations are respectively Endangered and Vulnerable.
- **Mahogany Tree (Swietenia macrophylla)**, also known as Honduran Mahogany or big leaf mahogany, has become **Endangered**.
  - » It is one of the species that yields genuine mahogany timber.
  - » It is native to South America, Central America and Mexico. It is also naturalized in Phillipines, Singapore, Malaysia and Hawaii and is cultivated in plantations and windbreak elsewhere.
  - » **Note:** *Swietenia mahogani*, is another species which is also found in India and is NT

- **Some Success Stories:**

Scimitar-horned oryx: It has moved from EW to EN showcasing **the reintroduction efforts the republic of Chad.**

Saiga Antelope improves from CR to NT due to conservation measures.
In past it inhabited a vast area of Eurasian Steppe.
Today, it is only found in Russia, Mongolia, Kazakhstan, Turkmenistan, Uzbekistan etc.
Key Feature: Unusual hanging nose.

A male at the Stepnoi Nature Sanctuary of Astrakhan Oblast, Russia

A female at the Askania-Nova Biosphere Reserve of Kakhovka Raion, Ukraine

5) NATIONAL ENDANGERED SPECIES DAY

- The National Endangered Species Day is celebrated on the **third Friday of May every year** across the USA. It was established by the US Senate, in 2006.
- **2023 Theme**: "Celebrating 50th anniversary of endangered species act".
  Note: In USA, the Endangered Species Act was enacted in 1973.

4. MAMMALS – EXTINCT

1) ASIATIC CHEETAH (EXTINCT IN INDIA)

- **IUCN Status of Asiatic Cheetah**
  - **CR** in Iran (Iran has a subspecies of Asiatic Cheetah, but has refused to share it with India)
  - **EX** in India.
  - It is the only large carnivore that got wiped out of India, mainly due to over-hunting and habitat loss.
  - The last **physical evidence** of Asiatic Cheetah in India was from Madhya Pradesh in 1947 when it was hunted by Maharaja Ramanuja Pratap Deo of Surguja State. A female is also said to have been sighted in **Koriya District** of Chhattisgarh, in 1951.

- **Why extinct?**
  - Hunting (excessive from Mughal Era to British Period)
  - Two key characteristics:
    - The Cat was very easy to tame. Therefore, it was regularly caught for sports.
    - It was nearly impossible to breed in captivity.
      - There is only 1 formally recorded instance of captive breeding in Emperor Jahangir's Tuzuk-i-Jahangiri.
  - **Classification as Vermin** by Britishers in 19th century was the last nail in the coffin.

A) ACTION PLAN FOR INTRODUCTION OF CHEETAH IN INDIA: PROJECT CHEETAH

- Project Cheetah is the world's first inter-continental large wild carnivore translocation project. Under this there is a plan to introduce 50 African Cheetahs in various protected areas of India under 'Action Plant for Introduction of Cheetah in India'.
- **Goals of Reintroduction**:
  - **Establish viable Cheetah metapopulation** in India that allows the Cheetahs to perform its functional role as a top predator and provide space for the expansion of the Cheetah within its historical range thereby contributing to its conservation efforts.

- **Reintroduction**:

    - » **20 African Cheetah** have been imported so far.
        - **The first batch** of 8 Cheetah arrived in Sep 2022 from **Namibia**.
        - **Another batch** of 12 Cheetah arrived in Feb 2023 from South Africa.

- **Now,** Cheetah is the **sixth in the list of Big cats found in India** after Royal Bengal Tiger (Panthera Tigris tigris), Asiatic Lion (*Panthera leo leo),* Indian Leopard (Panthera pardus fusca), Snow Leopard (Panthera uncia), and Clouded Leopard (Neofelis nebulosa).

- **Cheetahs were not directly released into wild:**
    - They were first kept in quarantine for a month. Then they are released into large electronically fenced area to get acclimatized. Finally, they were released into wild.

- **One Year of Project Cheetah** (Sep 2023)
    - **The Project** has achieved success on **four fronts**:
        - » **50% survival** of the introduced Cheetahs
        - » **Establishment of home ranges**
        - » **Birth of cubs in Kuno**
        - » **Increased tourism and revenue for local communities**.
    - **Yet,** as of Jan 2024, the project lost 45% of its functional adult population. Of the 20 Cheetahs that arrived in India, **7 died** (Dhatri, Shasha and **Shaurya** from Namibia and Suraj, Uday, Daksha, and Tejas from South Africa); 2 (Jwala and Nabha from Namibia) were deemed unfit for wild.
    - **Four cubs** were born in India March 2023, **three of which died** due to heatwaves, and the fourth is being raised in captivity.
    - **3 more cubs** were born in Jan 2024 to Namibian Cheetah **Aasha**. This was also born in captivity.
    - **3 more cubs were** born in Jan 2024 to Namibian Cheetah **Jwala**.
    - As of 16th Feb 2024, there are 20 Cheetahs at Kuno Palpur (13 adults (7 females, 6 males), 7 cubs)

- **Why so many deaths?**
    - **Different weather pattern** between home and host countries.
        - » The cheetahs introduced to India, were from countries in southern hemisphere, where the weather cycle is opposite.
        - » Namibia and South Africa had much drier conditions when compared to India. Namibian and south African Cheetah had never experienced heavy rains which they had to face in Kuno.
        - » **Collars** also became a problem. The Cheetahs were unable to lick and clean their wounds as the collars posed an obstruction which then gave rise to bacteria and maggots.
        - » For e.g. Dhatri died on 12th Aug 2023, because of infection due to maggot infestation due to humidity. Earlier, two male cheetahs had died of the same cause.
    - **Negligence** by authorities.

- **Steps being taken**:
    - Cheetahs were brought back to enclosures and were properly being monitored. Their collar has also been removed.
    - Experts suggest that India may need to bring Cheetah from northern hemisphere from countries like Somalia.
    - There is a suggestion for developing much bigger habitats before bringing in more Cheetahs.

- **Where are Cheetahs being reintroduced?**
    - They are being brought to Kuno Palpur National Park (KNP) in MP. This site was rated the highest among the 10 surveyed sites.
        - KNP is 748 sq km in area, devoid of human settlements.
            - It is probably the only wildlife site in the country where there has been a complete relocation of villages from inside the park. It forms part of Sheopur-Shivpuri deciduous open forest landscape and is estimated to have a capacity to sustain 21 cheetahs.
        - It also has good population of Chinkara, spotted deer, and blackbuck, on which Cheetahs can prey and grow in the wild.
        - Here facilities for the big cats have been developed, staff have been trained, and larger predators, such as leopards, have been moved away.

    - The **Other Sites** recommended for holding and conservation breeding of Cheetahs in India, in controlled conditions are:
        i. Nauradehi Wildlife Sanctuary (1,197 sq. km, habitat 5,500 sq.km), Madhya Pradesh
        ii. Gandhi Sagar Wildlife Sanctuary – Bhainsrorgarh Wildlife Sanctuary complex (~2500 sq.km), Madhya Pradesh
        iii. Shahgarh bulge in Jaisalmer, Rajasthan (4,220 sq.km)
        iv. Mukundara Tiger Reserve as fenced enclosure (~80 sq.km), Rajasthan

- **Where are Cheetahs coming from?**
    - Since, it is not possible to source the CR Asiatic Cheetah from IRAN without affecting this sub-species, India has sourced Cheetahs from Namibia and South Africa.
    - **African Cheetahs have other advantages** (why they are suitable for introduction in India)
        - They have maximum observed genetic diversity among extant cheetahs, an important attribute for a founding population stock.
        - They are also ancestral to all the other cheetah lineage including those found in Iran.
    - **Note:** Cheetahs being introduced are **African Cheetah** and Cheetahs which had gone extinct from India were **Asiatic Cheetah** and they are today found in small numbers only in Iran.

- **Background: Genesis of the Plan**
    - Cheetah reintroduction project was first conceived in 2009 and an expert panel formed in 2010 recommended KunoPalpur (MP), Velvadar National Park (Gujarat) and Tal Chappar Sanctuary (Rajasthan) for reintroducing Cheetah.
    - But the plans were quashed by the SC as it may have conflicted with reintroduction of Lions here.
    - After many hurdles, in Jan 2020, the SC had given the green signal to introduction of African Cheetah on pilot basis to a suitable habitat in India.

5. BIODIVERSITY IN INDIA: MAMMALS – CRITICALLY ENDANGERED

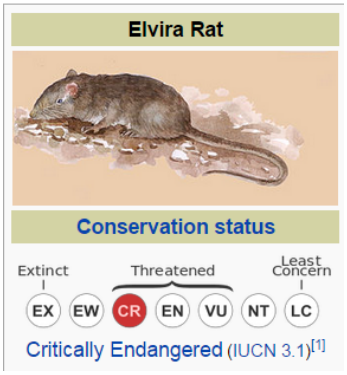
1) ANDAMAN WHITE TOOTHED SHREW (CROCIDURA ANDAMANENSIS), JENKIN'S ANDAMAN SPINY SHREW (CROCIDURA JENKINSI) AND NICOBAR WHITE TAILED SHREW

- **Distribution**
  - Andaman White toothed shrew is found on Mount Harriet in the South Andaman Islands. It is endemic to South Andaman Island.
  - Jenkin's Andaman Spiny Shrew is found on Wright Myo and Mount Harriet in the South Andaman Islands
  - Nicobar White Tailed Shrew is found in the southern tip of Greater Nicobar Island and is also recorded in the area extending from the Campbell Bay National Park to the Galathea River in the Andaman and Nicobar Islands.

- **All three of them are** endemic to India.
  - They are usually active by twilight or in the night and have specialized habitat requirements.

- **Habitat:** Leaf litter and rock crevices
- **Threats :** Habitat loss due to selective logging, natural disasters such as the tsunami and drastic weather changes.
- **WPA:** Schedule-2 (as amended in 2022)

2) THE LARGE ROCK RAT (ELVIRA RAT) (CREMNOMYS ELVIRA)



- It is a medium size, nocturnal and burrowing rodent, endemic to India.

- **Habitat:** Tropical dry deciduous shrubland forest, seen in rocky areas. **Distribution:** Known only from eastern Ghats of Tami Nadu, India.

- **Threats:** Major threats are habitat loss, conversion of forests and fuel wood collection.

3) THE NAMDAPHA FLYING SQUIRREL (BISWAMOYOPTERUS BISWASI)

The Namdapha flying squirrel is an **arboreal, nocturnal** flying squirrel **endemic** to India.
It was sole in the genus Biswamoyopterus until the description of the **Laotian giant flying squirrel (Biswamoyopterus laoensis)** in 2013.
It was first recorded in 1981 where a single individual was found in Namdapha Tiger Reserve. After that it wasn't not seen till 2022.

Updates: Missing for 42 years, Namdapha flying squirrel resurfaces in Arunachal (Dec 2023)

IUCN: CR
WPA: Schedule-1 (after 2022 amendment)

Habitat: Tropical forests

Distribution : It is now restricted to as single valley in the **Namdapha N.P. (or) W.L.S. in Arunachal Pradesh**.
Namdapha National park is the **largest protected area in the Eastern Himalayan Biodiversity hotspot** and is located in Arunachal Pradesh. It is also **one of the largest National Park in India in terms of area** (after hemis, desert, Simlipal and Gangotri)

Threats: It is CR due to habitat loss. In addition it is **hunted for food, and skins/fur**.

Note: Namdapha is home to another flying squirrel (Red Giant Flying Squirrel) (*Petaurista petaurista)*, whose IUCN status is LC. Like other flying squirrels, Red Giant Flying Squirrel is also mostly nocturnal and is able to glide long distance between trees.

4) MALABAR CIVET (VIVERRA CIVETTINA) ALSO KNOWN AS MALABAR LARGE SPOTTED CIVET

- It is considered one of the **world's rarest mammals**. It is **endemic** to India and was first reported from Travancore, Kerala.
- Nocturnal in nature
- **Distribution:** Found exclusively in **western Ghats**.
- **Habitat :** Wooded plains and hill slopes of evergreen forests.
- **Threats :** Deforestation and commercial plantations are major threats.
- WPA (as amended in 2022): Schedule-1

5) HIMALYAN BROWN BEAR/ RED BEAR (URSUS ARCTOS ISABELLINUS)

- **Why in news?**
  - » A Himalayan brown bear (Ursus arctos isabellinus) as captured by J&K Wildlife Department on May 13, 2023, at Rajwara in the North Kashmir district of Handwara, days after it was found wrecking graveyards, reportedly in search of human cadavers to eat (June 2023: Source - DTE)

It is the largest animal in Himalayas and is usually reddish brown in color. They inhabit altitudes ranging from 2,000 to 2,500 metres, predominantly above the tree line.

It also shows sexual dimorphism (Males (1.5 - 2.2m), Females (1.37 - 1.83m).

Distribution: Nepal, Pakistan, and Northern India. In Hemis National Park, Great Himalayan National Park, Nanda Devi Park -> this may be seen as the giant mammal walking upright.

IUCN Status: CR

Please note that IUCN status of Brown bear is LC (due to its wide distribution). But the Himalayan subspecies is CR.

Updates:
Human encroachment in wildlife has led to bears straying more often into human-dominated areas. Several incidents from various villages of J&K such as Behnipora, Budshungi, and Shatiam have been reported, where more than one bear may have entered.
Key reasons: Insufficient food in their habitats;

6) HANGUL/KASHMIR RED STAG (CERVUS ELAPHUS HANGUL)

- A sub specie of red deer which is native to India.
- Hangul has red-brownish coat bringing them in the fold of red deer. The **color, however, changes with season and age**.
- **Note:** Earlier it was believed to be a subspecies of red deer. But Mitochondria DNA genetic studies have revealed that is part of the Asian Clade of elk.
- It is native to Jammu and Kashmir, where it is the **state animal**.
- Known for its giant antlers bearing 11 to 16 points. Hangul has been hunted over centuries and its habitat destroyed.

- **Habitat/Distribution:** In dense riverine forests, high valleys, and mountains of the Kashmir valley and northern Chamba in Himachal Pradesh.

- **Threat:**
  1. habitat destruction
  2. Over-grazing by domestic livestock
  3. Poaching.
- **In 2016, Hangul was classified as CR by IUCN**

- Once found in thousands in the mountains of Kashmir Valley, the population of the famed Kashmir red deer, has dwindled to less than 150, according to senior wildlife scientists.
- Its **last bastion is Dachigam National Park** located on foothills of Zabarwan range on the outskirts of Srinagar, J&K.

7) CHINESE PANGOLIN

The Chinese Pangolin is a pangolin found in Northern India, Nepal, Bhutan, Bangladesh and Myanmar, northern Indo China, through most of Taiwan, and Southern China.

Main threat:

- Poaching
- Susceptible species due to its food specialization, and stenophagy (only eating several species of ants and termites).

7) SUMATRAN RHINO AND JAVAN RHINO – EXTINCT IN INDIA

More About Sumatran Rhino

- It is the **smallest hairiest and most endangered** of the five rhinoceros species.
- It is now thought to be **regionally extinct in India**, though its ones occurred in foothills of Himalayas and north east India.
- They are now critically endangered, with only five substantial populations in the wild: four on Sumatra, and one in Borneo (Indonesian Borneo).
- In total **only 80 Sumatran Rhino** are thought to exist in the wild now. All are found in Indonesia.

Key threats

- **Isolation** is the biggest threat this species face. This is because the females of this species can develop cysts and fibroids in their reproductive tracts if they go too long without mating.
  - It is because of this, in 2018, the world's leading conservation non-profits, including the National Geographic society, announced an unprecedented collaboration called the Sumatran Rhino Rescue. The aim was to find and safely capture as many Sumatran Rhino as possible so that they can be brought together for captive breeding.
- **Habitat destruction** have remained a major concern for long.

The Javan Rhinoceros (Rhinoceros sondaicus) is also believed to be extinct in India and only a small number survive in Java and Vietnam

Other Important Rhino species (not found in India)

1. **Northern White Rhino (Ceratotherium simum cottoni)**

Introduction:

- The northern white rhinoceros, or northern square-lipped rhinoceros, was one of the two subspecies of the white rhinoceros.
- Formerly, found in several countries in East and Central Africa of the Sahara, it is listed as **Critically Endangered**.

- Other subspecies of white Rhino, the Southern White Rhino has the conservation status of **Least Concerned**.

Main Reasons for decreased population

- **Poaching:** Demand for northern white Rhino Horns which can be sold at $50,000 per kg making them more valuable than gold. The demand was fueled by belief in Asia of it treating various ailments.
- **Habitat Loss**

There are only **2 rhinos of this subspecies** left.

- Both belong to the Dvur Kralove Zoo in the Czech Republic but live in the **Ol Pejeta Conservancy in Kenya** and are protected round the clock with armed guards.
- These two rhinos are
  - Two females (mother-daughter) Najin and Fatu.
- Existence of no males makes the species **functionally extinct**.
  - It is "possibly extinct in the wild".

In March 2018, Sudan the last male white Rhino Died

Future Prospects

- Developing **in-vitro-fertilization techniques** using eggs from the last two remaining females, stored northern-white rhino semen from males and surrogate southern white rhino females.
- There is a chance that females of Northern white rhino can mate with males of Southern white Rhino a subspecies. Offspring will not be a 100% northern white Rhino; it would be better than nothing.

Northern white rhinoceros

Angalifu, a male northern white rhinoceros at the San Diego Zoo Safari Park. Angalifu died 14 December 2014[1]

Conservation status

Critically Endangered (IUCN 3.1)[2]

Note: there are **five Rhino species in the world**: White Rhino (Southern White Rhino (LC) and Northern White Rhino (EW) are two subspecies of this); Black Rhino (CR); Greater One Horned Rhino (VU); Sumatran Rhino (CR); and Javan Rhino (CR).

6. BIODIVERSITY IN INDIA: MAMMALS – ENDANGERED

1) TIGER – COVERED

2) PIGMY HOG

- **Geographical Range**
  - » It is only known from India.
  - » Its presence is uncertain in Bhutan and is extinct from Nepal and Bangladesh.

- **More Details about Pigmy Hog**
  - » World's smallest wild pig, with adults weighing only 8 kg.
  - » **Habitat: Grassland** - Found in relatively undistributed **tall Tarai grasslands**
  - » **Distribution:** Formerly, the species was more widely distributed along the southern Himalayan foothills but now is restricted to only a single remnant population in **Manas wildlife sanctuary** and its **buffer reserves**.
  - » **Threats:** The main threats are the loss and **degradation of grasslands, dry season burning, livestock grazing and afforestation of grasslands**. Hunting is also a threat to the remnant population.
  - » It is one of the most useful **indicators** of the management status of the grass land habitats. The grassland where the pigmy hog resides are crucial for the survival of another endangered species such as Indian Rhinoceros, Swamp Deer, Wild Buffalo, Hispid Hare, Bengal Florican and Swamp Francolin.
  - » In 1996, a captive breeding program was initiated in Assam, and some hogs were reintroduced in Sonai Rupai area in 2009.

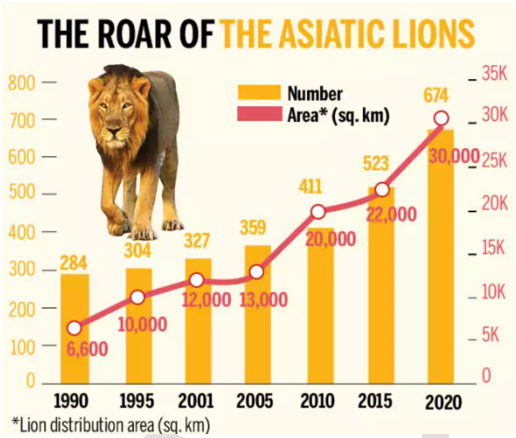
- **Conservation Status**
  - » IUCN - EN
  - » WPA (as amended in 2022) - Schedule-1

- **Pygmy Hog Sucking Louse**, a parasite that feeds only on Pygmy Hogs will also fall in the same risk category of **EN** as its survival is linked to that of the host species.

3) ASIATIC LION

- Asiatic lions once ranged from Persia to Eastern India, but were almost drawn to extinction by indiscriminate hunting and habitat loss.
- **By 1890s**, a **single population of about 50 Lions** remained in the Gir Forests of Gujarat.
- **With timely and stringent protection offered** by the state government and the central government, they have increased to **over 674 now.**
  - » **Of this** around 50% are found outside protected areas.

» Note: The Gir Protected Area Network includes **Gir National Park**, **Gir Sanctuary**, **Pania Sanctuary**, **Mitiyala Sanctuary** adjoining forest reserves, protected forests and unclassed forests.
» Lions has been recorded in a total area of about 30,000 sq kms of which, only about 1,650 sq km is in five Protected areas. The protected areas carrying capacity seems to be exceeded.



- **Over last several years, the lion population in Gujarat** has been steadily rising.
- Male female ratio: 161:260

- **Asiatic Lions and African Lions**
  » They are both distinct subspecies of Lion. They are the **second largest cats in the world after tigers**. Male Lions are characterized by thick mane of hairs around their head which is absent in females.

Characteristics	Asiatic Lion	African Lion
Distribution:	Only in Gujarat, India	Several countries across Africa, from the Savannah in east Africa to dry grasslands of South Africa
Physical Appearance	Slightly smaller than African Lion, with a shorter mane and fold of skin on their bellies	African Lions have larger manes.
Genetics	The two subspecies have distinct genetic profile. They diverged from the same ancestor around 1,00,000 years ago	
Behaviour	Asiatic Lions are more solitary and live in pairs or small groups of related females and their cubs.	The African Lions are known for their social behaviour and live in large groups called **Prides**, consisting of several females, their cubs, and one or more males.
IUCN Status	EN	VU

B) WORLD LION DAY: AUG 10 `

» Celebrated on Aug 10 of every year to **raise awareness about lions and to mobilize support** for their protection and conservation.
» World Lion Day is the brainchild of co-founders Dereck and Beverly Joubert, a husband-and-wife team with a passion for big cats. They began the initiative in 2013, bringing together both **National Geographic and the Big Cat Initiative under a single banner** to protect the remaining big cats living in the wild.

C) CONSERVATION STATUS:

- **IUCN:** Endangered
- **WPA (**as amended in 2022**):** Scheduled 1
- **CITES:** Appendix 1

D) 8 ASIATIC LIONS TESTING POSITIVE FOR COVID-19 (MAY 2021)

- **Where?** Nehru Zoological Park, Hyderabad
- This was the first case of the human infecting the feline and making them sick in India.

E) PROJECT LION

- It was announced by PM on Aug 15, 2020. It will be on the **lines of Project Tiger and Project Elephant**.
- The project has been launched for the conservation of Asiatic Lion and will focus on habitat development by engaging modern technologies in management as well as in addressing the issue of disease in lion.
- The **Wildlife Institute of India** with the Gujarat Forest Department have created a Project Lion Proposal and set it to the Union MoEF&CC.
- **Six new sites** apart from the Kuno-Palpur WLS have been identified under Project Lion for possible lion relocation.
    - Madhav National Park, Madhya Pradesh
    - Sitamata Wildlife Sanctuary, Rajasthan
    - Mukundra Hills Tiger Reserve, Rajasthan
    - Gandhi Sagar WLS, Madhya Pradesh
    - Kumbhalgarh WLS, Rajasthan
    - Jessore-Belaram Ambaji WLS and adjoining landscape, Gujarat.
- In Dec 2022, Minister of State for EF&CC, Shri Ashwini Choubey, informed that the Project Lion document titled "**Lion@ 47: Vision for Amrit Kal"** has been prepared with the following objectives to secure and restore lions' habitats for managing and growing population; scale up livelihood generation, and participation of local communities; become global hub of knowledge on big cat disease diagnostics and treatment and create inclusive biodiversity conservation through project lion initiative.

F) ISSUE OF RELOCATION OF LIONS

- **IUCN** has raised concerns here "The Asiatic Lion currently **exists as a single subpopulation**, and is thus **vulnerable to extinction from unpredictable events**, such as an endemic or large forest fire."

- **Other Reasons to support translocation:** A large number of lions are **outside the PA**. These places are human dominated and have very little prey population. Thus, they depend on livestock which they kill or livestock carcass which are dumped outside the villages.

- **The Project Lion document of 2020** have also mentioned that babesiosis and CDV in Gir and that it has resulted the death of at least more than 60 lions in 2018-19.
    - It cautions that "the CDV can also spread very fast within the entire lion population of Gir, especially when containment is not possible due to feral animal vectors in a landscape that remains connected for disease transmission.

- Therefore, IUCN has recommended "establishment of at least one other wild population for population safety, for maximizing genetic diversity and in terms of ecology (re-establishing of the lion as a component of the fauna in its former range).

- **Wildlife activists** have been demanding transfer of lion to a second home **since 1990s**.

- **Studies** of three potential sites with the historical range of the Asiatic Lion **identified Kuno-Palpur sanctuary** in MP to be the most suitable for introducing the species.
    - **In 2004**, the Center had written to Gujarat for the first time for this relocation, but Gujarat kept dragging the issue and the matter reached Supreme Court.

- **Supreme Court of India** in April 2013, after several recommendations by various expert groups had ordered translocation of Gujarat Lions to Madhya Pradesh. This was done to ensure a second home for the endangered species and to save it from extinction, due to catastrophe like extinction.
    - The review and curative petitions by Gujarat were rejected by the court in 2014.

- **But the transfer hasn't happened yet**. In 2022, government officials have stated that there are no plans to translocate lions outside Gujarat and they will facilitate natural dispersal of lions within Gujarat.
    - These statements completely disregard 2013 SC verdicts and doesn't make any ecological sense.

- **Reason for non-removal** - it has more to do with **politics** than the effectiveness of translocation.

G) ISSUE OF DEATHS OF LION - CANINE DISTEMPER VIRUS (CDV)

- **More than two dozen** lions died in 2018 due to outbreak of canine distemper virus (CDV) and babesiosis.

    - **Canine Distemper Virus**
        - » Canine distemper is a contagious and serious disease caused by virus that attacks the respiratory, gastrointestinal, and nervous system of puppies and dogs. The virus has also been reported in Lions, tigers and other wild animals.
    - **Babesiosis:**
        - » It is caused by microscopic parasites that infect red blood cells and are spread by certain ticks.

- **Incidence of death due to disease in past**
    - In 2007, there were evidence of the Peste Des Petits Ruminants virus (PPRV) which had caused some death. PPRV (also known as Goat Plague) is highly contagious and can be deadlier that even CDV that wiped out a third of Africa's lion.

4) ELEPHANT

- **Introduction**
    - Elephant (Elephas maximum) is the **largest terrestrial mammal of India**.
    - **In past centuries**, forests of India literally teemed with elephants. Mughal emperors are known to have more than 1,00,000 elephants in their services giving us an idea about huge population of elephant in our country then.

- Today's population is obviously a fraction of the population of that time, but large numbers of sustainable herd exist - particularly in south and northeast.
- India has also declared elephant as '**National Heritage Animal**'.

- **Conservation Status:**
  - **IUCN: Endangered**
  - WPA: Schedule 1
  - CITES: Appendix 1

A) POPULATION OF ELEPHANTS (ELEPHANT CENSUS, 2017 REPORT ("SYNCHRONIZED ELEPHANT POPULATION ESTIMATION INDIA, 2017"))

- The census pegs India's total Asian Elephant population at **27312** across **23 states** (a decrease over 2012 numbers of around 30,000 - but previous counts were **not synchronized** and may have had duplications. Therefore, experts say that comparisons should not be drawn). This was the first all India synchronized census which avoided many errors in estimation due to movement of elephants across different states.
- **State wise:** Karnataka has the highest number of elephants, followed by Assam and Kerala
  - » Karnataka (6,049)
  - » Assam (5,719)
  - » Kerala (3,054)

- **Region wise:** Highest in Southern (11, 960), followed by northeast (10,139), east central (3,128) and northern region (2,085)
  - » Further another survey in 2000 found that there are around **3,400 domesticated** animal in the country.

B) INITIATIVES: PROJECT ELEPHANT

- Launched by GoI in 1992 as a centrally sponsored scheme.
- **Objectives**
  - » **To assist states** having free ranging population of wild elephants.
  - » To **protect elephants, their habitat & corridors**.
  - » Addressing the human-elephant conflict issues
  - » Improving the welfare of captive animals.

- **16 states/UT in focus**
  - » The projected is being mainly implemented in 16 states
    - Andhra, Arunachal, Assam, Chhattisgarh, Jharkhand, Karnataka, Kerala, Maharashtra, Meghalaya, Nagaland, Orissa, TN, Tripura, Uttaranchal, UP and WB.

- **Steps taken**
  - » **Elephant Reserves:**
    - Establishment of **33 elephant reserves** throughout the elephant's traditional range and covering a total area of more than 30,000 km^2.
    - **Tamil Nadu and Assam** have the highest number of elephant reserves (five each), followed by Kerala (4), Odisha (3), UP (2), Arunachal (2), Chhattisgarh (2), Karnataka (2), Nagaland (2), and West Bengal (2), Andhra (1), Jharkhand (1), Meghalaya (1), and Uttarakhand (1).

- In 2022, on the 30th anniversary of Project Elephant, government announced formation of three Elephant Reserves (LEMRU ER (Chhattisgarh), Agasthyamalai ER (TN) and Terai ER (UP).

TERAI ELEPHANT RESERVE: INDIA'S 33RD ELEPHANT RESERVE IN UTTAR PRADESH (OCT 2022)

- The Centre has approved setting up of Terai Elephant Reserve (TER) at Dudhwa-Pilibhit in Uttar Pradesh.
  - The TER will be developed in joint forest area of Pilibhit tiger reserves and Dudhwa TR, covering conservation of four wild species such as Tiger, Asian Elephant, Swamp Deer, and One-horned Rhinoceros in the entire landscape that also includes Kishanpur and Katarnighat WLS.
  - It is situated on India-Nepal border.
- The TER will also implement human-elephant conflict mitigation strategy and protect villagers living in the Indo-Nepal border areas of Uttar Pradesh.

LEMRU ELEPHANT RESERVE – CHHATTISGARH

AGASTHYAMALAI ELEPHANT RESERVE

- Central government has accepted the proposal of the TN government to establish one more elephant reserve in the state in Agasthyamalai.
- Its total area would by 1,197 sq km.
- It is TN's 5th Elephant Reserve

C) INITIATIVE: MIKE

- **MIKE (Monitoring of Illegal killing of Elephants)** program of CITES.
- Discovered a significant increase in the poaching of bull tuskers, which has damaged population dynamics by disturbing the sex ratio.
  - In some areas the normal level of 1:12 ratio has been so distorted that 1:100 has been known.
  - This abnormality seriously affects the genetic viability of what on the surface can look like healthy sustainable population.

D) ODISHA TURNS TO SEED BOMBS TO FIGHT ELEPHANT PROBLEM

E) WORLD ELEPHANT DAY: 12TH AUG

- It was launched on 12th of August 2012 globally to mobilize attention and support for conservation of Asian and African Elephants.

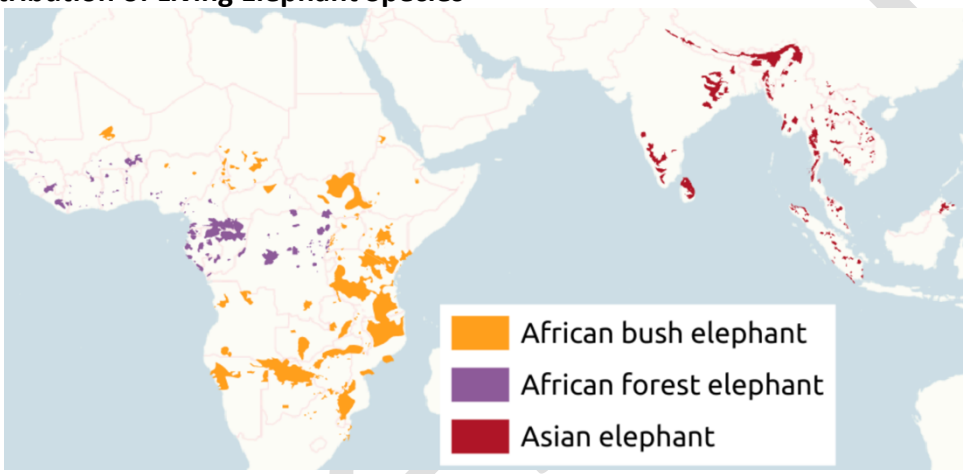
- As per the available population estimates there are 4,00,000 African Elephants and 40,000 Asian elephants on earth.

- **India adopted the World Elephant Day** in **Aug 2016** to conserve and protect elephant in India and improve their welfare.
- **Nationwide Campaign "Gaj Yatra"**
  - Was first launched on Aug 12, 2017, by WTI (Wildlife Trust of India).

- **Aims to** protect elephant population.
- **Runs campaign** in 12 elephant range states

F) SOME GYAN ABOUT AFRICAN ELEPHANT

- African elephants are the largest elephant walking the earth. Their herd wander through 37 countries.
  - There are **two species of African Elephants**.
    - » The Savanna (or bush) elephant
    - » The Forest Elephant
  - **Savanna elephant** are larger than the forest elephants and their tusk curve outwards. They are the largest species of elephants and the biggest terrestrial animal on earth.
    - » **IUCN: EN**
- **Forest elephants** are smaller and darker; their tusks are straighter and point downwards. There are also difference in the size and the shape of the skull and skeleton between the two species.
    - » **IUCN: CR**
- **Distribution of Living Elephant Species**



5) CAMELS IN RAJASTHAN

- **Different Types of Camels in India:**
  - The National Bureau of Animal Genetic Resources (NBAGR) lists **nine dromedary (Camelus dromedarius) breeds** of camel in India.
    - » **Five** (Bikaneri, Jaisalmeri, Jalori, Marwari, and Mewari) originated in Rajasthan
    - » **One** - **Mewati** can be seen in both Rajasthan and Haryana.
    - » **Two** (Kutchi and Khrai) are Gujarati
    - » **One** (Malvi) belongs to Madhya Pradesh.

- India also has **a small population of the double-humped Bactrian Camel *(Camelus bactrianus)*,** found **mostly in the Nubra valley in Ladakh**.

- **India's total camel population** - all of them **descendants of wild dromedary, or Arabian, Camels** - decreased by 37% between 2012 and 2019.
  - Current estimates suggest that there are fewer than 200,000 camels left among the nine breeds, and 80% of these animals live in Rajasthan, where they are bred to provide transport, wool, and milk, as well as plough field.
  - **Why decrease in Camel population?**
    - Development in Western India -> new roads, vehicles etc. -> reduces the need of camel transportation.
    - Irrigation projects; Solar and Wind Farms etc. have reduced the land available for grazing of camels.
    - Collapsing tourism (COVID-19 pandemic)
    - Ban on export and sale of male camels including blanket ban on the sale of camel meat.
- **Can Camel milk bring a solution?**
  - Camel milk is touted as the next superfood. It has low amounts of sugar, is rich in vitamins and minerals, such as Vitamin C and potassium, and is alternative for lactose intolerance.
  - Some studies have also shown that Camel milk may reduce a person's need for Insulin (in case of Type-1 diabetes).
  - **Hurdles in promotion of use of Camel Milk?**
    - Supply and potential demand centres are very far away.
    - To transport raw camel milk to cities, it must be pasteurized and refrigerated, a costly process.
    - Learn from Gujarat model where camel milk dairies have proven profitable. Camel herders from Kutch region have partnered with Amul, which launched camel milk in 2019.

A) KHARAI CAMEL

- **Details**
  - » Kharai Camel are a unique breed of camels found **only in Kutch**. They are known for their ability to **swim in water**. They have webbed feet like that of a frog.
  - » The name is derived from the local world **Khara**i which means Saline. They are also known as **dariyataru** (meaning sea-swimmer).
  - » During the rainy season, they swim along the Gulf Of Kutch, an inlet of the Arabian sea, to small forest islands and graze on mangroves and other saline-loving plants.
  - » **IUCN: EN**
  - » **WPA: Schedule-1**
  - » **Key threats:**
    - Habitat destruction (mangrove forests they feed on are being destroyed)

- Salt pans have increased in the area, and they have destroyed habitat and blocked to path of travel for the camels.

- **Recognition as separate Breed:**
  - » The Kharai camels were recognized as a separate breed only in 2015.

- **Declining numbers**
  - » In 2010, there were about 10,000 camels in the region, which has now (2020) declined to around 5,000.

- **Key recent efforts**
  - » Amul have started making camel milk products to support camel herders.

- **Altercations between Kharai Camel Owners** (Of Jamnagar and Devbhumi Dwarka) **and Forest Department (Sep 2021) -> Grazing in Marine National Park**

6) KONDANA SOFT FURRED RAT (ALSO KNOWN AS KONDANA RAT OR LARGE METAD)

- Nocturnal burrowing rodent that is **found only in India**. It is sometimes known to build nests.

- **Habitat:** Its natural habitat are **subtropical and tropical dry forests, subtropical or tropical dry lowland grassland, and urban areas**.

- **Distribution:** Known only from the small **Sinhagarh Plateau (about 1 km^2), near Pune in Maharashtra**.

- **Threats:** Major threats are habitat loss, overgrazing of vegetation, and disturbance from tourism.

7) DHOLE/ ASIATIC WILD DOG OR INDIAN WILD DOG (CUON ALPINUS)

- **Other Names:** Indian wild dog, whistling dog, Chennai dog, Asiatic Wild Dog, red wolf etc.

- **Distribution:** Native to central Asia, South-East Asia.
  - » In India there are few remaining adults in the wild. They can be seen in protected areas of Karnataka, Maharashtra, and Kerala.

- **Population**: With less than 2,500 individuals surviving in the wild globally, the dhole is already extinct in about 10 Asian countries.

- **Very efficient predators:** They are so efficient as predators that there have been reports of them even attacking tigers.
- **Threat**
  - » Habitat loss
  - » Loss of prey

» Competition with other species
» Persecution
» Possibly diseases transfer from other dogs (domestic and feral dogs).

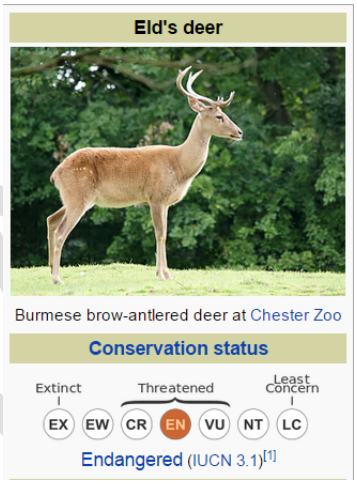
8) BROW-ANTLERED DEER/SANGAI DEER (PANOLIA ELDII)

Specific Habitat requirements: They inhabit the floating biomass in Loktak Lake Manipur.

Key threats: Hunted for their bow-shaped antlers.

Note: Sangai Deer (EN) is an endemic and endangered subspecies of brow-antlered deer found only in Manipur, India.

- It's original habitat is the **floating marshy grasslands of the Keibul Lamjao National Park**, located in the southern part of the **Loktak lake**, which is the largest freshwater lake in eastern India.
- **State animal of Manipur**.
- They are also known as **dancing dear**. This is because while walking on the floating island it often balances itself and appear to be dancing.



A) SANGAI FESTIVAL

- It is a **10-day annual cultural festival** organized by Manipur Tourism department every year from Nov 21 to 30.
- It was first celebrated in 2010. It was earlier called tourism festival which has been renamed to **Sangai festival** to promote the uniqueness of brow-antler deer.
- The festival also promotes Manipur's unique art, handicraft, sports, cuisine.
- Some **folk dances** of Manipur like **Kabui Naga Dance**, **Bamboo Dance**, **Maibi Dance**, **Lai Haraoba Dance**, **Khamba Thoibi Dance** etc could be seen here.
- **Manipur's martial art** form **Thang Ta** can also be seen here.
- **Some games** include:
  - **Yubi-Lakpi,** which is a game played like a rugby with greased coconut;
  - **Mukna Kangjei**, a game combining hockey and wrestling.
  - **Sangol Kangjei**, or Polo - It is believed that modern polo came from Manipur Polo, Sagol Kangjei.
- **Manipur cuisines** such as **Nga-thongba** (fish curry), and the popular **Eromba** (a mixture of boiled veggies with fermented fish) are also available at the festival.

B) LOKTAK LAKE

About the Lake

- It is one of the largest freshwater lakes in India. It is **pulsating lake** with surface area varying from 250 sq km to 500 sq km during the rainy season with a typical area of **287 sq km**.
- It is lake in Manipur, which is located 40 kms south of Imphal.
- **The town of Moirang**, on its bank, was the headquarter of the Indian National Army where they established a provisional independent government after defeating the British.
- **The lake** covers 61% of the total identified wetlands of the state. It plays a significant role in socio-economic and cultural life of Manipuris.
- It is famous for **Phumdis** (soil and organic matter at various stages of decomposition) floating over it. The largest of all the phumdis covers an area of 40 km2 and is situated on the southeastern shore of the lake. Located, on this Phumdi, **Keibul Lamjao National Park** is the only floating national park in the world. The park is the last natural refuge of the endangered Sangai (state animal).
- Once considered extinct, the **population of brow-antlered deer found only on Keibul Lamjao National Park**.
- Loktak lake is also one of the Ramsar sites in India.
    - It is also in Montreux Record and government is taking a lot of steps to get it delisted.

Key threats:

- **Human Pressure -** Floating houses and fishing structures.
- **Ithai Barrage** - brought about drastic changes in the characteristics of the wetlands.
- **Pollution**: Moreover, River Nambul that flows from Imphal into the lake, dumps in the untreated sewage of the entire city.

About Ithai Barrage

In 1983, NHPC constructed a barrage at the confluence of the **Manipur and Khuga river** - two of the five major rivers that drain into Loktak lake.

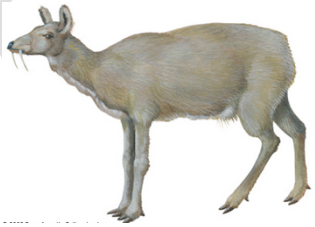
This barrage has provided electricity and irrigation water to the region, but has created a number of problems for Loktak lake.

- Now even during dry season water level is high in Loktak lake and the Phumdis are not able to reach ground and absorb nutrition from there.
- Further, the dead biomass remains in the Lake only as the outflow has been blocked due to the barrage.
- The barrage has also blocked the route of migratory fish coming into the lake from Myanmar and so Loktak can no longer meet the demand of the entire state.

9) GEE'S GOLDEN LANGUR (TRACHYPITHECUS GEEI)

- **Distribution:** Golden langur is an old-world monkey, found in small regions of **western Assam, India and neighboring foothills of the Black Mountains of Bhutan**.
  - Manas National Park provides good sighting of this animal.
- **Status:** Endangered. One of the most endangered primate species of India.
- They have been named for their luscious coats and are considered sacred by Himalayan people.

10) HIMALAYAN WHITE BELLIED MUSK DEER



- **Habitat/Distribution:** Kashmir, Kumaon, Sikkim in India. Himalayas of Nepal and China.
- **Threats**
  - **Poaching and illegal trade for its musk**
  - **Musk:** is a substance with a persistent odor obtained from a gland of the male musk deer (only male produces the musk). The substance has been used as perfume fixative, incense material and medicine.

11) ALPINE MUSK DEER (MOSCHUS CHRYOSOGASTER)

- Alpine musk deer is a musk deer species native to the eastern Himalayas in **Nepal, Bhutan and India** to the highlands of Tibet.
  - It is now considered a separate species, to Himalayan Musk Deer. It is the **state Animal of Uttarakhand**.
  - IUCN Status: EN

12) KASHMIR MUSK DEER *(MOSCHUS CUPREUS)*

- It is an endangered species of musk deer native to Afghanistan, India, Pakistan and Nepal.
- **In the past**, the species was described as a subspecies to the alpine musk deer, but is now classified as a separate species.
- **IUCN: EN**

13) HISPID HARE

- **Details:** The Hispid hare, also called Assam rabbit, is a leporid, native to South Asia.
- **Habitat/Distribution:**
  - **Historically** it had wider range in southern Himalayan foothills, now distributed only patchily in India, Bangladesh, Nepal and Possibly Bhutan.
  - A significant population is found in **Shuklaphanta National Park in Nepal**, elsewhere it only occurs sporadically.
  - Habitat is highly fragmented due to increasing agriculture, flood control, and human development.

14) HOG DEER

- **Habitat/Distribution:** Habitat ranges from Pakistan, through northern India, to mainland southeast Asia.
  - But it has lost ground in most of its range.
  - **Two sub species** of hog deer have been reported from its range
    - **The western race** is distributed from Pakistan and Terai Grassland (along the Himalayan foothills), from Punjab to Arunachal Pradesh.
    - **The Eastern Race** of hog deer is found in Thailand, Indo-China, Laos, Cambodia, and Vietnam.
- **Name:** The hog deer runs through the forests with its head hung low (hog-like manner) so that it ducks under obstacles instead of leaping over them like most other deer do.

- **Eastern Hog Deer (Axis Porcinus annamiticus) - A rare subspecies of hog deer found in Keibul Lamjao National** Park (2018)
  - The sub-species was earlier believed to be confined to the eastern part of Thailand.
  - **Genetic Study** by researchers at WII, Dehradun have reported presence of small population of Hog Deer at Keibul Lamjao National Park in Manipur.

15) LION TAILED MACAQUE / WANDEROO (MACACA SILENUS)

- **Details:** It's an old-world monkey, **endemic to the Western Ghats of South India**. They avoid human presence and they do not live, feed or travel through plantations.

- **Habitat:**
  - They live in Southwest India in pockets of evergreen forests, called **Sholas**, in the Western Ghats range. Today, they only live-in mountain forests scattered across three Indian states: Karnataka, Kerala and Tamil Nadu.
- **Threat**
  - **Habit Fragmentation:** Due to spread of agriculture and tea, coffee, teak, and Cinchona, construction of water reservoirs and human settlements to support such activities.
- **Conservation Efforts**

- **Captive Breeding:** Aringnar Anna Zoological Park, Chennai and in Mysore Zoo.

16) NILGIRI TAHR

It is the only mountain ungulate in southern India amongst the 12 species present in India. It is also the **state animal of Tamil Nadu**. It is a sure-footed ungulate that inhabits the open montane grasslands habitats at elevations from 1200 m to 2600 m of the **Southwestern ghats**.

Distribution:

- Earlier, it was found throughout western ghats.
- But, today, it is distributed along a narrow stretch of 400 km between Nilgiris in the north and Kanyakumari in South. It has become locally extinct in around 14% of its traditional shola forests -grassland habitats.
- There are smaller populations found in the **Palani Hills**, **Srivilliputtur**, and the Meghamalai and Agasthiyar ranges, only **two well protected large population** is documented - one from the **Nilgiris** and the other from the **Anamalais, i**ncluding the high range of Kerala.
    - The **Eravikulam National Park** in Anamalai hills, Kerala, is home to the largest population of Nilgiri Tahr, with more than 700 individuals.
    - **Mukurthi National Park (TN)**, was created to protect this endangered species

Conservation Status

- IUCN/WPA/CITES: EN/Schedule-1/Appendix 1

Threats

- Habitat loss, overgrazing, illegal hunting.

Historical references:

- Referred in Tamil Sangam literature 2,000 years back.
- Late Mesolithic paintings (10000-4000 BCE) also highlight significance of Tahr in the folklore, culture and life.

A) NILGIRI TAHR CONSERVATION PROJECT (DEC 2022)

- It is an initiative launched by TN government, at a cost of Rs 24.14 crores.
- Under this, the government wants to:
    - » Develop a better understanding of the Nilgiri Tahr Population through surveys and radio telemetry studies.
    - » Reintroduce the Tahrs to their historical habitats
    - » Address Proximate threats
    - » Increase public awareness of species.
- The **funds**, for the project is provided by the TN Pollution Control Board (TNPCB).
- Further, **Oct 7**, will be celebrated as '**Nilgiri Tahr Day**' in honour of E.R.C. Davidar, who was responsible for pioneering one of the first studies of the species in 1975.

17) INDIAN PANGOLIN

- **About Indian Pangolin**
  - The Indian Pangolin, thick tailed pangolin, or scaly pangolin is a pangolin found in the **plains and hills of India, Sri Lanka, Nepal, and Bhutan**.
  - It is an **insectivore** that feeds on ants and termites, digging them out of mounds and logs using its long claws, which are as long as its fore limbs. It is a solitary, shy, slow moving, nocturnal mammal.

- Main Threats
  - Hunting for its meat and scale
  - Various body parts used in traditional medicines

- Conservation Status
  i. IUCN: Endangered
  ii. WPA: Scheduled 1
  iii. CITES: Appendix 1 (reclassified in 2016 from Appendix 2 to Appendix 1)

- Pangolins and India
  i. Among 8 species of Pangolin found globally, four each are found in Asia and Africa. **India is home to two species - the Chinese Pangolin and the Indian Pangolin**.
- Recently, CITES COP19 has urged member countries to remove references to Pangolins from Pharmacopoeia – an official collection of approved pharmaceutical standards.

18) RED PANDA (AILURUS FULGENS) (LESSER PANDA, RED BEAR-CAT, AND RED CAT-BEAR

It is a small arboreal mammal native to **eastern Himalayas** and **south-western China**.
Habitat/ Distribution: Sikkim, Assam, Meghalaya, Northern Arunachal Pradesh and Darjeeling. Almost 50% of the Red Pandas inhabit eastern Himalayas.

Physical features: It has reddish brown fur and a long shaggy tail.
Diet: Omnivorous (mainly on bamboo)
Conservation Status

- IUCN/WPA/CITES: EN/Schedule 1/ Appendix 1

Threats: Habitat loss and fragmentation; Poaching for Furs; Inbreeding Individuals;

A) THE PADMAJA NAIDU HIMALAYAN ZOOLOGICAL PARK (PNHZP) (DARJEELING ZOO) HAS STARTED AN INITIATIVE TO RELEASE 20 RED PANDAS IN FORESTS IN THE NEXT FIVE YEARS.

- **About the Zoo:**

- It is a zoological park located in Darjeeling. It is named after Padmaja Naidu, the former Governor of West Bengal, India. She is also the daughter of Indian Independence leader Sarojini Naidu.
- It is a park situated 2,000 meters above the sea level. It was established in 1958 and is the largest high-altitude zoo in India.
- It has been quite successful in captive breeding of **the Red Panda**. As of July 2022, there are 27 Red Pandas in the zoo.

- **Release of Red Pandas in Wild**:
  - In the first re-wilding program of red Pandas in India, the PNHZP has started an ambitious program to release 20 of these mammals in about five years to the forests. They will be released in Singalila National Park.
  - In the past, two pairs of Red Pandas were released in 2021. Two animals managed to survive.

B) A RECENT PUBLICATION BY SCIENTISTS OF ZOOLOGICAL SURVEY OF INDIA (ZSI) HAVE RESOLVED THE MYSTERY AROUND DEMOGRAPHY AND SPECIATION OF RED PANDA.

- India is home to both the (sub) species - Himalayan Red Panda (Ailurus fulgens) and the Chinese red Panda (Ailurus Styani) and the **Sang River in Arunachal Pradesh** splits the two phylogenetic species.

19) ASIAN WILD BUFFALOE

- It is the large bovine native to the Indian subcontinent and Southeast Asia.
- It has been listed as endangered since 1986 and remaining population totals less than 4,000. More than 90% of its population is found in India, mostly in Assam.

7. TIGER (IUCN: EN, WPA – SHEDULE-1; CITES – APPENDIX-1)

- **Introduction**
  - » The tiger can be called a **keystone species** because it has a strong influence on other animals and plants in the ecosystem, especially deer and boar. From the conservation perspective it is also called **Umbrella Species** because when its ecological needs are met, so are those of myriad other living things that share its landscapes.
  - » It is estimated that India had 40,000 tigers in 1900, and the number declined to 1800 in 1972. Similarly, world had around 1,00,000 tigers in 1900's, to less than 4,000 in the 1970's.
  - » Tigers have the species name **Panthera Tigris**. There are nine sub-species of tigers, three of which are extinct.

- **Tiger Sub-Species**

Species (non-extinct)	Other details
Bengal (Panthera tigris tigris)	India, Nepal, Bhutan and Bangladesh; most numerous, about 4,000
Indo-Chinese	Thailand, Cambodia, Vietnam, Laos, Myanmar, China etc fewer than 300 remain
Malayan	Malay peninsula and in the southern tip of Thailand; 500
Siberian or Amur	Russian Far East; 300
South China	China; probably extinct in the wild
Sumatran	Sumatra, Indonesia; 500-600
Species (Extinct)	
Bali	
Caspian	
Javan	

  - **IUCN** has recently (2022) confirmed that tigers have gone extinct in Cambodia, Laos, and Vietnam. Poaching and habitat loss are the key reasons.

- **Major Threats faced by Tigers.**
  1. **Poaching** driven by illegal international demand for tiger parts and products.
     - For e.g. Bangladesh has also emerged as a major hub in the illicit poaching and trafficking of tigers.
  2. **Depletion of prey** caused by illegal bush meat consumption
  3. **Habitat loss** due to ever increasing demand of forest lands
  4. **Inbreeding**
  5. **Human-Animal Conflicts**

1) INTERNATIONAL TIGER CONSERVATION EFFORTS

A) GLOBAL TIGER INITIATIVE, 2008

Global Tiger Initiative (GTI), 2008 is a global alliance of governments, international organizations, civil society, the conservation and scientific community, and the private sector committed to working together towards a common agenda to save wild tigers from extinction.

» It was launched in **2008** by founding partners **the World Bank, Global Environmental Facility, Smithsonian Institution, Save the Tiger Fund** and **International Tiger Coalition** (representing more than 40 NGOs).

» It is led by **13 tiger range countries** (TRCs).

- Russia, China, India, Nepal, Bhutan, Bangladesh, Myanmar, Thailand, Laos, Cambodia, Vietnam, Indonesia and Malaysia.

» GTI secretariat, based at the World Bank in Washington, DC, assists 13 tiger range countries to carry out their conservation strategies and drive the global tiger conservation agenda, through planning, coordination and continuous communication.

» The TRCs came together in an unprecedented pledge to **double the world's tiger population by 2022** (which is the year of the Tiger on the Asian lunar Calendar), with a goal of achieving at least 6,000 tigers.

» **GTI is contributing through** protection of habitat, fighting wildlife crime, building capacity, reducing demand, engaging community, and Innovation.

B) GLOBAL TIGER RECOVERY PROGRAM 2.0 (GTRP 2.0)

» **Why in news?**

- Countries submit population numbers from 2010-2022 to Global Tiger Recovery Program, CITES (Jan 2024)

» **About GTRP**:

- GTRP (2010-22) was launched in 2010 under the GTI by the World Bank to save wild tigers. Tiger Range countries committed to doubling the tiger population by 2022.
- **How effective was it?**
  - **Successes** in South Asia and Russia.
  - **Failures (decline)** in Southeast Asia.

» **GTRP 2.0**:

- On 29th July 2023, marking Global Tiger Day, the Global Tiger Initiative (GTI) introduced the latest iteration of the **Global Tiger Recovery Program (GTRP 2.0) For the Year 2022 to 2034**. it aligns with Post-2020 Global Biodiversity Framework (GBF), providing an opportunity for TRCs to integrate tiger conservation with global goals.
- The **following outcomes** are expected from the GTRP 2.0:
  - Cross Sectoral Conservation
  - Increased Investment
  - Habitat protection
  - Conflict Management
  - Reduced Wildlife Trade

» **Submission of Numbers by Countries:**

- The submissions were made under GTRP 2.0 and CITES.
- There has been **overall increase in tiger population** by 60%, taking the number to **5,870**.
  - However, **Bhutan, Myanmar, Cambodia, Lao-PDR, and Vietnam** showed decline in tiger population. It makes the situation grim in the Tiger Range Countries (TRC) of southeast Asia.

C) TX2

GTI adopted St Petersburg declaration on Tiger Conservation and endorsed TX2 in 2010.

- Goal of TX2 is to double the number of tigers across their geographical areas.

D) TX2 TIGER CONSERVATION AWARD (TTCA)

- The Awards celebrate the 10-year anniversary of all 13 Tiger Range countries committing to double the global population of wild tigers by 2022 - a goal called TX2.

- It is given in two categories.
  - » **TX2 Conservation Excellence Award**
    - The award recognizes **a site that has achieved excellence in two or more of five themes**:
      - » Tiger and prey population monitoring and research (tiger translocation/prey augmentation);
      - » Effective site management.
      - » Enhanced law enforcement, protection and ranger welfare improvement;
      - » Community-based conservation, benefits and human-wildlife conflict mitigation and.
      - » Habitat and prey management.
  - » **TX2 Award -** It is given for **efforts to increase tiger population** and includes a financial grant to assist the ongoing conservation efforts.
    - These awards are supported by Conservation Assured | Tiger Standards (CA|TS), Fauna & Flora International, Global Tiger Forum (GTF), IUCN Panthera, UNDP, WildLife Conservation Society (WCS), and WWF.

- In 2023, Pench Tiger Reserve (PTR), Maharashtra, is among the three tiger reserves to win the TX2 Award for a fivefold increase in its tiger population from 9 individual in 2006 to 44 in 2021.
  - » The other two tiger reserves include Pench (Madhya Pradesh) and Satpura Tiger Reserve. While Pench (MP) increased its tiger population from 33 (2006) to 87 (2018), STR increased its numbers from 13 in 2010 to 48 in 2021.

E) INTEGRATED TIGER HABITATION CONSERVATION PROGRAM (ITHCP)

- **Why in news?**
  - IUCN Tiger Program launches phase-IV (Aug 2023)

- It is a strategic funding mechanism which aims to save tiger in the wild, their habitats and to support human populations in key locations throughout Asia. It was launched in 2014.

- **IUCN** is the program implementing agency.
  - » It is supported by **German Government** and the **German Development Bank** (KfW) and was launched in late 2014.
  - » The program contributed to the international goal set up during the 2010 St Petersburg Summit to double wild tiger population by 2022.

- **In India**, it was launched in Karnataka in 2016.
  - » In 2018, it was extended for further five years.

- **Updates**: Launch of Phase IV (Aug 2023)
  - » ITHCP has launched a call for Concept Notes for Phase IV of the Tiger Program.
    - It aims to allocate a **total of Euro 10.7 million** and, for the first time, the program will **extend eligibility to other species** that significantly contribute to the intricate tapestry of tiger conservation.
    - Projects can target one of the following species: Tigers (*Panthera tigris)*, leopard (Panthera Pardus), and Clouded leopards (both mainland and Sunda)
    - Countries eligible under this call for concept notes include Nepal, Bhutan, India, Bangladesh, Myanmar, Thailand, Cambodia and Indonesia.
    - It should be noted that funding will exclusively be channeled towards specific Designated Program Areas, ensuring a focused and targeted approach to conservation efforts.
  - » By embracing a comprehensive and diversified strategy that encompasses a wider array of species, the program will continue to secure a viable future for these Species, their Habitats and the people that live in and around them.

F) CONSERVATION ASSURED TIGER STANDARDS (CA|TS)

- **CATS** is a conservation tool that specifies best practices and standards to manage target species and encourages assessments to benchmark progress.
  - It is a **partnership of 13 Tiger range governments**, inter-government agencies, NGOs, and conservation organizations.
  - WWF is helping the Tiger range countries to implement CATS.
  - It was launched in 2013 and Tigers are the first species selected for the initiative.

- **In July 2020:**
  - NTCA has decided to adopt the Conservation Assured Tiger Standards (CATS) across **all fifty tiger reser**ve across the country.
    - » The Global Tiger Forum (GTF) and World Wildlife Fund India are the two implementing partners of the NTCA for CATS assessment.
  - This makes India the first among 13 Tiger range countries to nationally adopt CATS, which are a set of minimum standard setting benchmark for managing conservation sites.
    - » This will bring India's total number of registered sites to 94 including sites outside tiger reserves.

G) WORLD TIGER DAY/ INTERNATIONAL TIGER DAY: 29TH JULY

- **Why 29th July**?
  - It was a reminder of agreement signed by countries at St Petersburg Tiger Summit in Russia, 2010, to raise awareness about decline of global tiger population.
  - It was established in 2010 to raise awareness about the decline of wild tiger numbers.
- Tadoba Tiger Reserve, Maharashtra plays host for National Global Tiger Day Celebrations 2022

2) NATIONAL EFFORTS FOR TIGER CONSERVATION

A) PROJECT TIGER

- **News:** Project Tiger completes 50 years in 2023.

- It is a centrally sponsored tiger conservation programme launched in 1973 by the MoEF&CC, GoI.

- **Objectives / Aims**
  - » **Ensuring a viable population** of Bengal Tigers in their natural habitats and also to protect them from extinction.
  - » **Preserving areas** of biological importance as a national heritage for the benefit education and enjoyment of people.
  - » **Harmonizing the rights of tribal people** living in and around tiger reserves.

- **Tiger Reserves**
  - Tiger reserves are the areas that are notified for the protection of the tiger and its prey, and are governed by Project Tiger and administered by the National Tiger Conservation Authority.

- Tiger reserves are constituted on a **core/buffer strategy**:
  - The **Core Area** have the **legal status of a national park or a sanctuary** with an **exclusive tiger agenda**.
    - These areas are **required to be kept inviolate** for the purposes of tiger conservation, without affecting the rights of Scheduled Tribes or such other forest dwellers.

- The **Buffer or peripheral areas** are a mix of forest and non-forest land, managed as a multiple use area with an inclusive people-oriented agenda.
  - » It aims to **promote coexistence** between wildlife and human activity with due recognition of the livelihood, developmental, social and cultural rights of the local people.
  - » **Limits of such area** are determined on the basis of scientific and objective criteria in consultation with the concerned Gram Sabha and an Expert Committee constituted for the purpose.

- **Corridor Habitat**
  - » 2010 tiger census showed a decline in tiger occupied area. This decline in tiger occupancy area was recorded in areas outside the tiger reserves, indicating loss of habitat quality and extent - a crucial element essential for maintaining genetic connectivity between Individual tiger population.
  - » To address this vital conservation concern, the **NTCA in collaboration with the WII** delineated the minimal tiger habitat corridors connecting tiger reserves for implementing landscape scale tiger conservation.
  - » Now all tiger reserves manage their tiger populations based on a Tiger Conservation Plan (TCP), which addresses specific prescriptions for core, buffer, and corridor habitats.

- **Currently**, there are **54 tiger reserves** spread across 75,796 km^2, effectively covering 2.3% of India's total land area.

B) NATIONAL TIGER CONSERVATION AUTHORITY (NTCA)

- Wildlife Protection Act of 1972 was amended in 2006 to provide for the formation of National Tiger Conservation Authority to aid in the implementation of measures for the conservation of tiger. It comes under MoEFCC.

- **What does it do?**
  - » Providing **central assistance to states** under the ongoing Project Tiger, for activities based on Tiger Conservation Plan.

  - » **Conducting countrywide tiger census every four years.** It does assessment of the status of tiger, co-predators, prey, and habitat using the refined methodology approved by the Tiger Task Force.

  - » Taking **steps for protection and act against poaching**
    - **Alert states** as and when required; Transmit backward/forward linkages of information relating to poachers.
    - Use **IT for improved surveillance (e-Eye system**) using thermal cameras.
    - Launch **tiger reserve level monitoring using camera trap** to keep a **photo ID database** of individual tigers.
    - Prepare a national database (**Tiger Net**) of individual tiger photo captures to establish linkage with body parts seized or dead tigers.
    - Assist states to refine protection oriented monitoring through Monitoring System for tiger's intensive protection and ecological status (**M-STrIPES**).
      - It is an android app which was launched in 2010.
    - Support states for raising, arming and deploying the **Special Tiger Protection Force**.

  - Address **issues such as the movement of tigers out of their habitat**s into human settlements.

C) MANAGEMENT EFFECTIVE EVALUATION (MEE) OF TIGER RESERVES IN INDIA

- **MEE** is a globally accepted framework for **measuring the conservation efforts of tiger reserve**s. It has been adopted from the framework of the **IUCN World Commission on Protected Areas** and has emerged as the most important tool to assist and improve management perspectives of Tiger Reserves and their associated landscape connectivity.

- In India MEE is being jointly conducted by the **NTCA** and **WII** and has paved the way for a successful evaluation of national tiger conservation effort.

- **India** is the only country in the world to have institutionalized and effectively **completed five cycles of MEE of Tiger Reserves in the country**.

- **Key Highlights of the fifth cycle of Evaluation**:
  - A total of 51/53 tiger reserves have been independently evaluated through the MEE process in the fifth cycle in 2022.
  - 10 independent regional expert committees (RECs) were constituted and deputed in 10 different clusters of five tiger landscapes to evaluate the 51 tiger reserves of the country.
    - Each team consisted of a chairperson and 2-3 members (retired IFS officers having experience in wildlife management, especially in the field of tiger reserves).