IAS PARLIAMENT

TARGET 2024

GEOGRAPHY

MAY 2023 TO DECEMBER 2023

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TARGET 2024

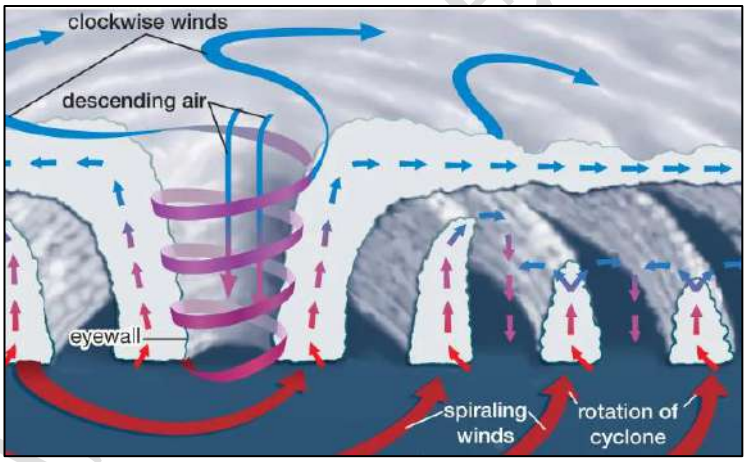
GEOGRAPHY

May 2023 to December 2023

1. GENERAL GEOGRAPHY

1.1 Cyclone

Due to rapid intensification of cyclones, there is a need for change in forecasting the cyclones.



- Cyclones are caused by atmospheric disturbances around a ***low-pressure area*** distinguished by swift and often destructive air circulation.
- **Eye of the cyclone** - The low-pressure center of the cyclone is called the eye.
- Eye **provides energy** to the cyclones.
- The lower the pressure in the eye, the more intense is the cyclone.
- **Eye-wall** - Surrounds the eye withthe strongest winds and heaviest rain and is the ***most destructive part*** of the cyclone.
- As per NDMA, a cyclone is characterised by inward spiralling winds that rotate ***anticlockwise*** in the ***Northern Hemisphere*** and *clockwise* in the *Southern Hemisphere*.
- **Conditions for formation of cyclone** - Temperature must be (> 26 degree Celsius) to a depth of 60 m with turbulent transfer of water vapour and the atmospheric instability could create massive vertical cumulus clouds.
- The *NDMA* classifies cyclones broadly into 2 categories - ***Tropical cyclones and Extratropical cyclones***

Cyclone Category	Wind Speed in Km/h	Damage Capacity
01	120-150	Minimal
02	150-180	Moderate
03	180-210	Extensive
04	210-250	Extreme
05	250 +	Catastrophic

Type of Disturbances	Wind Speed in Km/h
Low Pressure	Less than 31
Depression	31-49
Deep Depression	49-61
Cyclonic Storm	61-88
Severe Cyclonic Storm	88-117
Very Severe Cyclone	118-221
Super Cyclone	More than 221

Tropical Cyclones	Extratropical Cyclones
• Tropical cyclones are those which develop in the regions between the ***Tropics of Capricorn and Cancer*** and are the most devastating storms on Earth. • **Characteristic features** - Eye , Eyewall and Rainbands • They blow *counterclockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere.*	• It is also known as ***mid-latitude cyclones or temperate cyclones***. • They occur in temperate zones and high latitude regions, though they are known to originate in the ***Polar Regions***. • They have cold air at their core, and derive their energy from the release of

- Moreover, warm fronts or cold fronts aren't associated with tropical cyclones.

Name	Area
Hurricanes	North Atlantic Ocean and eastern North Pacific
Typhoons	Western North Pacific around Philippines, Japan, and China
Tropical cyclones	Western South Pacific and Indian Ocean

potential energy when cold and warm air masses interact.

- These storms always have one or more fronts connected to them, and can occur over land or ocean.
- An extratropical cyclone can have winds as weak as a tropical depression, or as strong as a hurricane.
    - Examples - ***Blizzards, Nor'easters, etc***.

1.2 Cyclone genesis

After 1990s the cyclone formation is said to be affected by anthropogenic trends.

Cyclone-genesis or cyclogenesis

- It is initiated by a disturbance occurring along a stationary or very slow-moving front ***between cold and warm air.***
- It is an indicator that denotes the *chance of a cyclone forming.*
- As the atmospheric pressure within the disturbance continues to decrease, it assumes the appearance of a cyclone and forces poleward and equatorward movements of warm and cold air, respectively.
- **Parameters**
    1. The sea surface temperature
    2. The ocean heat content
    3. Change in winds from the surface into the upper atmosphere (or the vertical shear)
    4. Rotation of winds near the surface
- If the conditions are supportive, it may lead to cyclone formation.

Warm Arctic Cold Eurasian (WACE) pattern

- WACE is a pattern of ***warm surface temperatures over the Arctic*** and a large blob of cold surface temperatures over Eurasia.
- This pattern is associated with upper air circulation changes that reach into the Indian Ocean sector.

- The rapid increase in the cyclogenesis potential over the Arctic Sea coincides with a shift in the ***Warm Arctic, Cold Eurasian (WACE) pattern.***

1.3 Effects of Cyclone on the Monsoon

Cyclone formations are seen in the pre-monsoon cyclone season, closer to the monsoon onset.

- Indian Monsoon is the ***seasonal reversal of winds*** during a year accompanied by corresponding changes in precipitation.
- The ***southwest monsoon*** is a sea-breeze from the Arabian Sea and the Bay of Bengal that officially onsets over Kerala on June 1 and retreats from Rajasthan by the end of September.
- It is then replaced by the ***retreating, or northeast monsoon*** in November which is the key source of rainfall for several parts of Tamil Nadu, Andhra Pradesh and north interior Karnataka.
- The monsoon is affected by
    1. The 3 tropical oceans namely, Indian, Atlantic, and Pacific.
    2. The 'atmospheric bridge' from the Arctic.
    3. The oceanic tunnel as well as the atmospheric bridge from the Antarctic Ocean.
    4. Global warming also affects the cyclones over the Indian Ocean and the typhoons over the north-western Pacific Ocean.

Impact of southwesterly winds on monsoon

- ***Southwesterly*** are the winds that blow from the Southwest direction.

- Southwesterly winds over the Arabian Sea bring large quantities of moisture onto the Indian subcontinent.
- On the other hand, southwesterly winds over the Bay of Bengal are bad news for the monsoon.
- The monsoon winds over the southern Bay of Bengal sweep in from the southwest and west, but they turn around and head northwest towards India from the southeast.

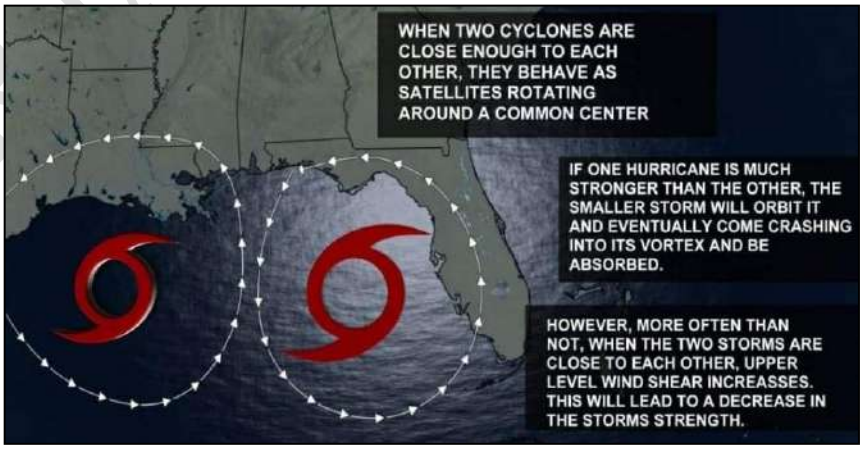
1.4 Severe Tropical Cyclones, 2023

Severe Tropical Cyclones	Regions
Mawar and Bolaven	Western Pacific Ocean
Hurricanes Jova and Otis	Eastern Pacific Ocean.
Hurricane Lee	Atlantic Ocean.
Cyclone Mocha	North Indian Ocean.
Cyclone Freddy	Southern Indian Ocean.
Cyclone Jasper	North coast of Queensland in Australia

1.5 The Fujiwhara Effect

Recently, powerful winds had haunted the Bay Area and other parts of Central and Southern California because of the Fujiwhara effect.

- The Fujiwhara effect was first described by Japanese meteorologist *Sakuhei Fujiwhara* in the 1920s.
- **Fujiwhara effect** - When two hurricanes (or cyclones) ***spinning in the same direction*** pass close enough to each other, they begin an intense ***dance around their common center***. This interaction between two cyclones is called the Fujiwhara effect.
- **Happenings** - If one hurricane is a lot stronger than the other, the smaller one will orbit it and eventually come *crashing into its vortex* to be absorbed.
- Two storms closer in strength can gravitate towards each other until they reach a common point and *merge, or merely spin each other* around for a while before shooting off on their own paths.
- In rare occasions, the effect is additive when the *hurricanes come together*, resulting in one larger storm instead of two smaller ones.



- **Reasons** - The rising frequency of this unusual effect has been attributed to a rapidly warming world and the subsequent heating of ocean waters.
- **Examples** - *Typhoon Hinnamnor*, the strongest tropical cyclone of 2022, underwent fujiwhara effect with *tropical storm Gardo* in the eastern Pacific Ocean.
- Eventually, Gardo was assimilated in Hinnamnor.

Reasons	States
Depression & cyclonic storms	Coastal areas of Orissa, West Bengal, Andhra Pradesh, Karnataka, Tamil Nadu
Cloud bursts	Arunachal Pradesh, Assam, Orissa, Himachal Pradesh, Uttarakhand, Western Ghats, Kerala
Breaches in embankments	Assam, Bihar, Uttar Pradesh, Orissa and Andhra Pradesh

1.6 Flash Floods

Flash floods were witnessed in Khotinallah near Aut (in HP) on the Pandoh–Kullu stretch due to a heavy downpour and the Chandigarh-Manali highway was blocked.

- Flash floods are ***sudden and rapid flooding*** events that happen within a short period of time.
- Flash floods are *highly localised* but causes *high damages* because of suddenness.
- This occurs in hilly regions and sloping lands where heavy rainfall and thunderstorms or cloudbursts are common.
- Low-lying areas, such as riverbeds, canyons, and urban areas with poor drainage systems are also prone to it.
- Himalayan states and Western Ghats in Maharashtra and Kerala are more vulnerable to flash floods caused by cloud bursts.
- Himalayan states further face the challenge of *overflowing glacial lakes*, formed due to the melting of glaciers.
- Other factors of flash floods includes sudden release of waters from upstream reservoirs, breaches in landslide dams, embankments on the banks of the rivers, depression and cyclonic storms

Quick Facts

- **Cloudbursts** - Sudden, intense rainfall in a short period of time.
- **Landslides** - Sudden movements of rock, boulders, earth or debris down a slope.
  - **Natural causes** - Heavy rainfall, earthquakes, snow melting and undercutting of slopes due to flooding.
  - **Manmade causes** - Excavation, cutting of hills and trees, excessive infrastructure development, and overgrazing by cattle.

Reasons for frequent floods

Season
- According to the NDMA, nearly 75% of the total Indian rainfall is concentrated over the monsoon season of 4 months (June to September)

Climate change
- Rapid melting of glaciers in glacial lakes as an impact of global warming.

Manmade reasons
- Factors such as population growth, rapid urbanisation, increased developmental and economic activities in flood plains contribute to the increasing flood damage.

Wildfires
- Wildfires destroy forests and other vegetation, which in turn weakens the soil and makes it less permeable for water to seep through.

1.7 Libya Floods

More than 5,000 people were killed, and several were displaced in Libya after torrential rains caused flooding.

- The flooding has occurred in Libya's eastern region, city of ***Al-Bayda & Derna.***
- **Reason - *Cyclone Daniel,*** formed in Greece, is responsible for causing floods and deaths in Spain, Turkey and Bulgaria earlier this month.
- Before reaching Libya, the storm Daniel transitioned into a ***'medicane'.***
- Medicane is a tropical-like cyclone that occasionally forms over the Mediterranean Sea *and* are known to be ***weak storms.***

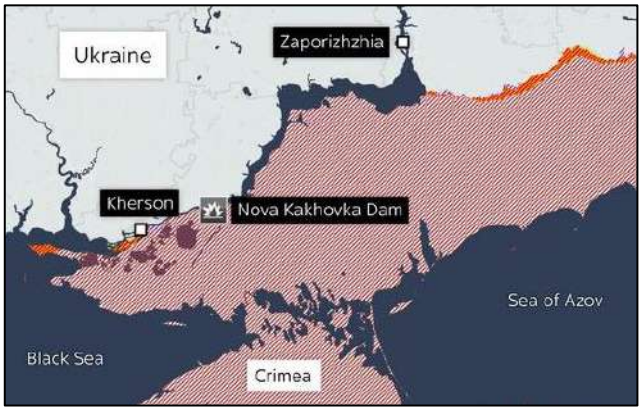
Libya

- A North African Country with its capital, ***Tripoli***.
- **Border countries – 5** - Egypt, Sudan, Chad, Niger, Algeria, and Tunisia.
- The country also has a coastline on the Mediterranean Sea to the north.
- The ***Mediterranean coast*** and the ***Sahara Desert*** are Libya's prominent natural features.
- There are *no permanent rivers* in Libya and there are numerous ***wadis*** (valley or passage in the Middle East and North Africa that is dry except when it rains.)

- However, higher sea surface temperatures help them become stronger and last longer when storms travel across hot oceans.
- They gather more water vapor and heat, resulting in more powerful winds, heavier rainfall and more flooding when they reach the land.

1.8 Kakhovka Dam

Kakhovka dam in southern Ukraine was collapsed recently, causing extensive flooding.



- The dam is built on ***Ukraine's Dnipro River.***
- **Dnipro River** – Separates Ukraine into east and west.
- It flows north to south connecting the capital, ***Kiev***, to the Black Sea.
- It was built in 1956 as part of the Kakhovka hydroelectric power plant.
- Bursting the dam could send a wall of water flooding settlements below it, including Kherson.
- Water from the reservoir supplies the ***Crimean peninsula***, which was annexed by Russia in 2014, as well as the ***Zaporizhzhia nuclear plant***, Europe's largest nuclear power plant.

- **Avdiivka** - An industrial hub in ***Donetsk region*** and is a former coal hub and is home to the large Avdiivka Coke Plant.
- **Robotyne** - A village in ***Ukraine***, located in Polohy Raion, Zaporizhzhia Oblast and was the 1st Ukrainian breach in Russian lines of defense.

1.9 Flash Droughts

There has been an increased occurrence of flash droughts across the globe.

- **Droughts** - Periods of continuous water deficit, often caused by a lack of precipitation in a given area.
- **Flash drought** - Rapid onset or intensification of drought.
- **Causes** - Low rates of precipitation, along with abnormally high temperatures, winds, and solar radiation
- It can also be linked to climatic patterns like La Niña.
- An early warning sign of flash droughts is evapotranspiration, which leads to a decrease in soil moisture.
- ***Evapotranspiration*** is the process of water transfer from land to atmosphere by evaporation from soil and transpiration from plants.
- **Impacts** - May lead to irreversible changes in terrestrial ecosystems. In such conditions, ecosystems may not have enough time to adapt to a large water deficit and extreme heat, leading to lower productivity.
- Flash droughts can also significantly challenge drought monitoring and prediction.

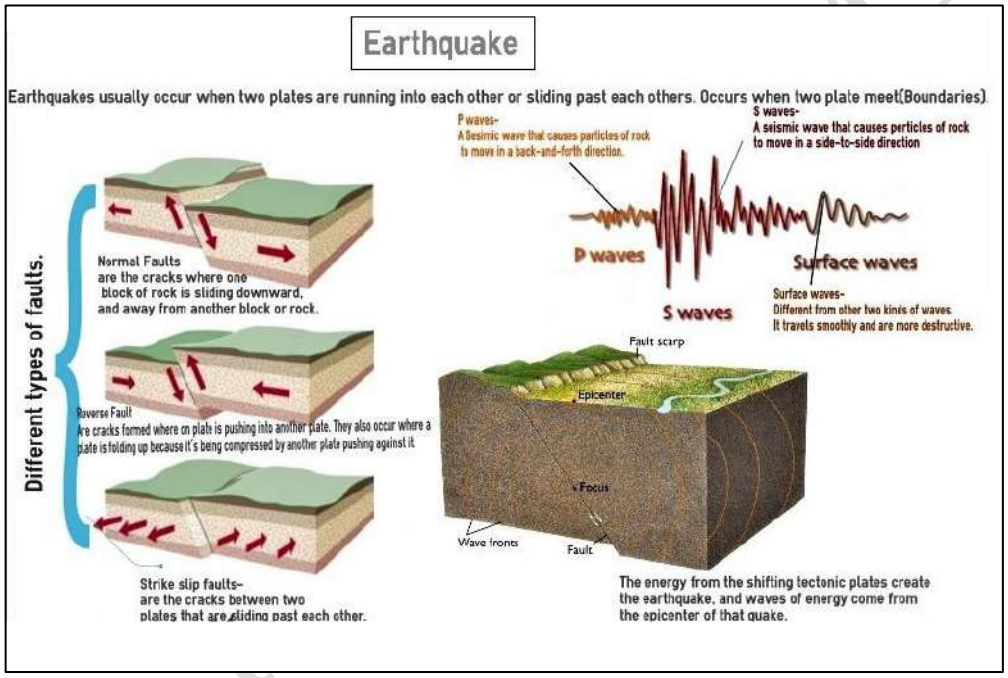
1.10 Earthquake in Morocco

An earthquake of magnitude 6.8 struck Morocco claiming the death toll at over 600.

Important Terms in Earthquake

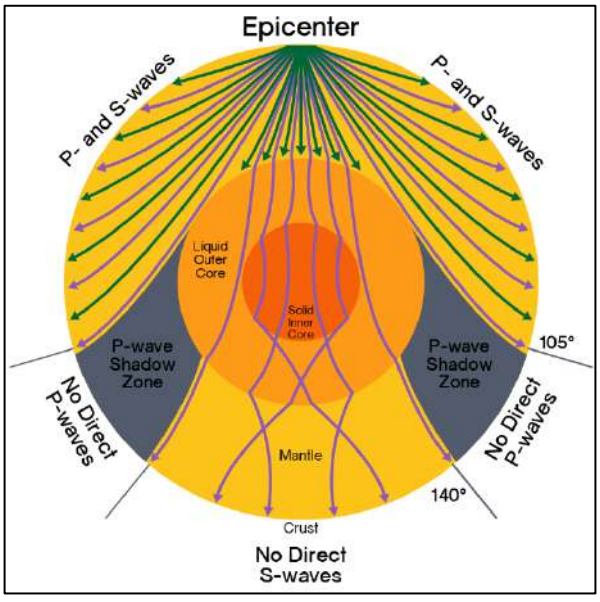
- **Fault** - A fracture in the rocks that make up the Earth's crust
- **Epicenter** - The point at the surface of the Earth above the focus
- **Plates** - Massive rocks that make up the outer layer of the Earth's surface and whose movement along faults triggers earthquakes
- **Seismic waves** - Waves that transmit the energy released by an earthquake
- **Focus (Hypocenter)** - The point within the Earth where an earthquake rupture starts.

Earthquakes



- Earthquakes are caused by a sudden release of stress along faults in the earth's crust.
- The Earth's crust consists of 7 large lithospheric plates and numerous smaller plates **(tectonic plates)** that move
  - Towards each other (a convergent boundary)
  - Apart (a divergent boundary) or
  - Past each other (a transform boundary)
- The continuous motion of tectonic plates causes a steady build-up of pressure in the rock strata on both sides of a fault.
- It gets released as waves of seismic energy and propagate through the ground and over its surface and causes shaking as earthquakes.

Types of energy waves



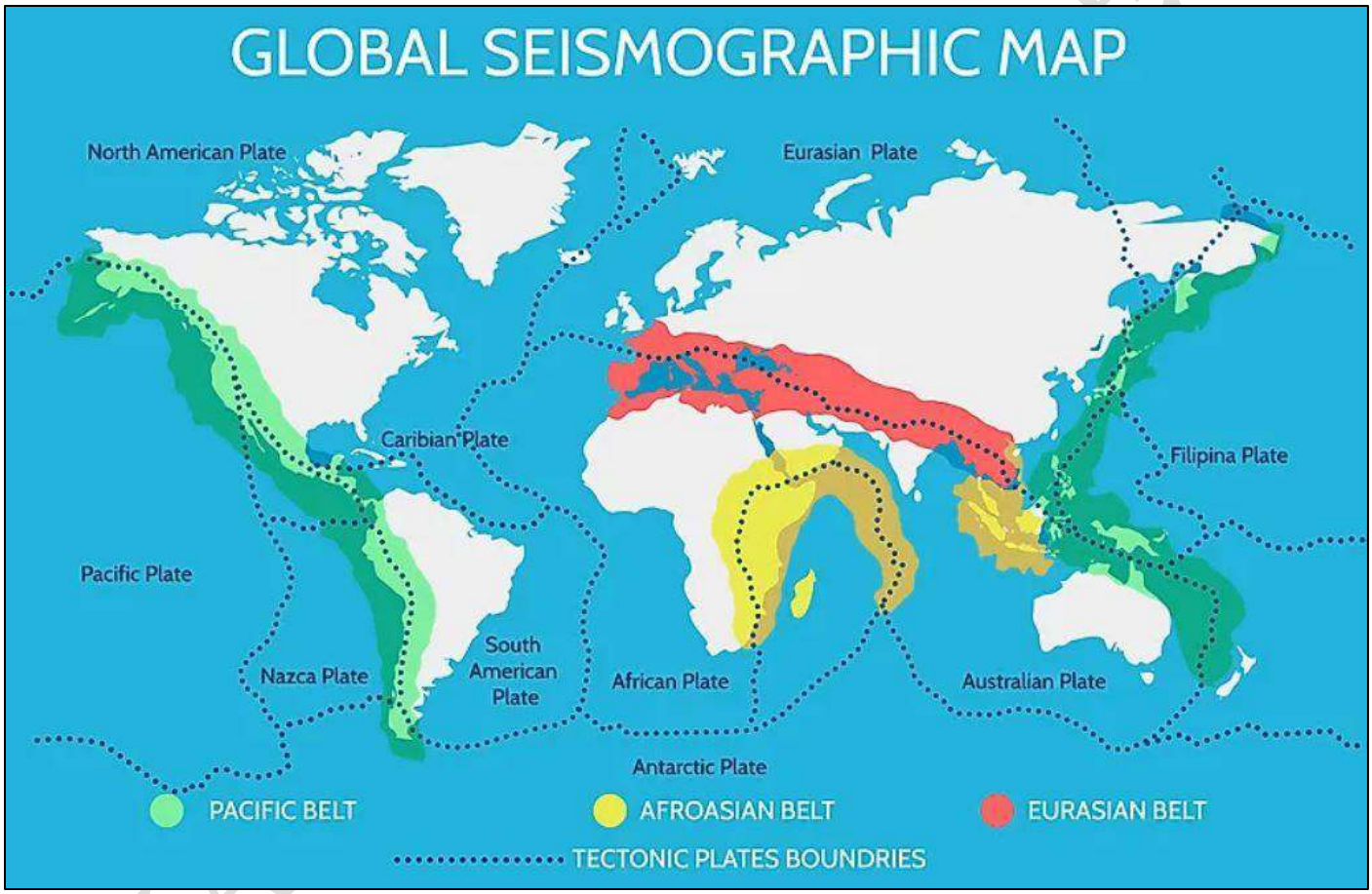
- **P waves or primary waves** – They are the first waves to be detected.
- These are compressional waves that push and pull as they move through rock and fluids.
- **S waves or secondary waves** - They are the next waves to be detected.
- These waves move **only through solids**.
- They move up and down or side to side, perpendicular to the direction in which the wave is moving.
- **Surface waves** - It follow P and S waves and travel along the surface of the earth and thus cause the most damage.
- Surface waves can be characterized as
  - **Love waves** - Faster and move the ground from side to side, and
  - **Rayleigh waves** - Roll like waves on the surface of oceans and lakes

Types of earthquake

- **Tectonic -** Earthquakes that occur when the edges of the tectonic plates slide against each other in fault zones
- **Volcanic** - Earthquakes that occur in conjunction with volcanic activity
- **Collapse** - Smaller-scale earthquakes that result from the subterranean collapse of caverns or mines
- **Induced** - Quakes caused by human activity, like tunnel construction, filling reservoirs and implementing geothermal or fracking (hydraulic fracturing) projects

Earthquake prone zones

- The regions regularly exhibiting earthquakes include the
  - **Circum-Pacific seismic belt** - along the rim of the Pacific Ocean
  - **Alpide belt** - along the southern margin of Eurasia through the Himalayan Mountains, Sumatra, and Java
  - **Mid-Atlantic Ridge** - along the floor of the Atlantic Ocean



- **Reason for Moroccan earthquake -** The US Geological Survey attributed that the reason might be *oblique-reverse faulting* at shallow depth within the Moroccan High Atlas Mountain range.
- **Shallow quake** - The epicentre was roughly 11 to 18.5 km below the Earth's surface, thus being a fairly shallow quake.
- Shallow quakes are generally more dangerous as they carry more energy than when they emerge to the surface, when compared to quakes that occur deeper underneath the surface.

Oblique-reverse faulting

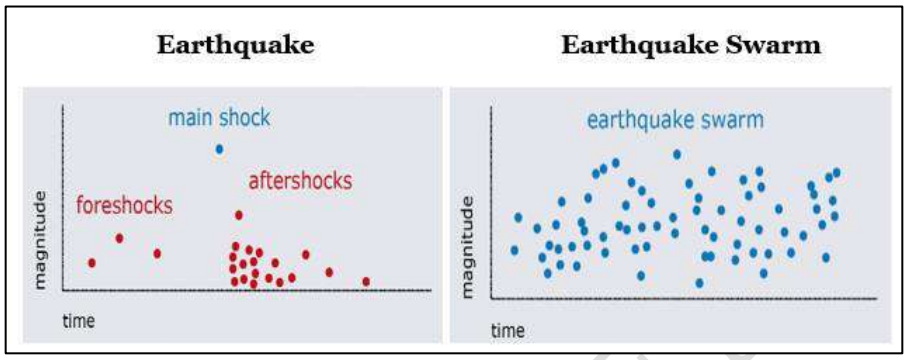
- A fault that shows the characteristics of both ***dip-slip and strike-slip motion*** caused by a combination of shearing and compressional forces.
- It forms when hanging wall slides over the footwall due to compressional forces bringing the sides together.

- **Rare in North Africa –** Earthquakes are not very common in North Africa, with seismicity rates comparatively low along the northern margin of the African continent.

1.11 Earthquake Swarm

Recently, a seismic swarm has hit the Reykjanes peninsula in southwest Iceland with more than 5,500 small earthquakes raising the prospect of a volcanic eruption.

- **Earthquake Swarm** – It is a series of many low magnitude earthquakes without a noticeable main shock.
- **Causes** – Occurs when the piled up seismic energy inside the earth is released in small amounts
- Seismic energy are related to the *movement of fluid gases and liquids* in the Earth's crust



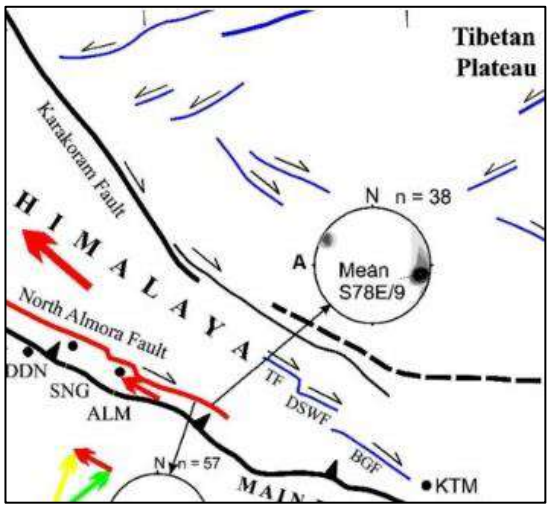
- **Fluid movement** – When fluids (e.g., water) migrate and interact with pre-existing faults, it enables the fault to slip creating tremors.
- **Active volcanism** – Tremor occurs when magma-filled cracks push their way through the Earth's crust.
- **Slow-slip events** – It is essentially an earthquake in slow-motion, which involves centimetres to tens of centimetres of movement along a fault, over weeks to years.
- **Duration** – It may range from days, weeks to even months.
- **Occurrence** – It occur in a localised region without a clear sequence of foreshocks, main quakes and aftershocks.

Earthquake swarm in Palghar district of Maharashtra has occurred over the period from 2018 to 2019, with around 30 low-intensity earthquakes.

1.12 Almora Fault

Data indicates an increase in earthquake activity in 2023 was mainly attributed to the activation of the Almora fault.

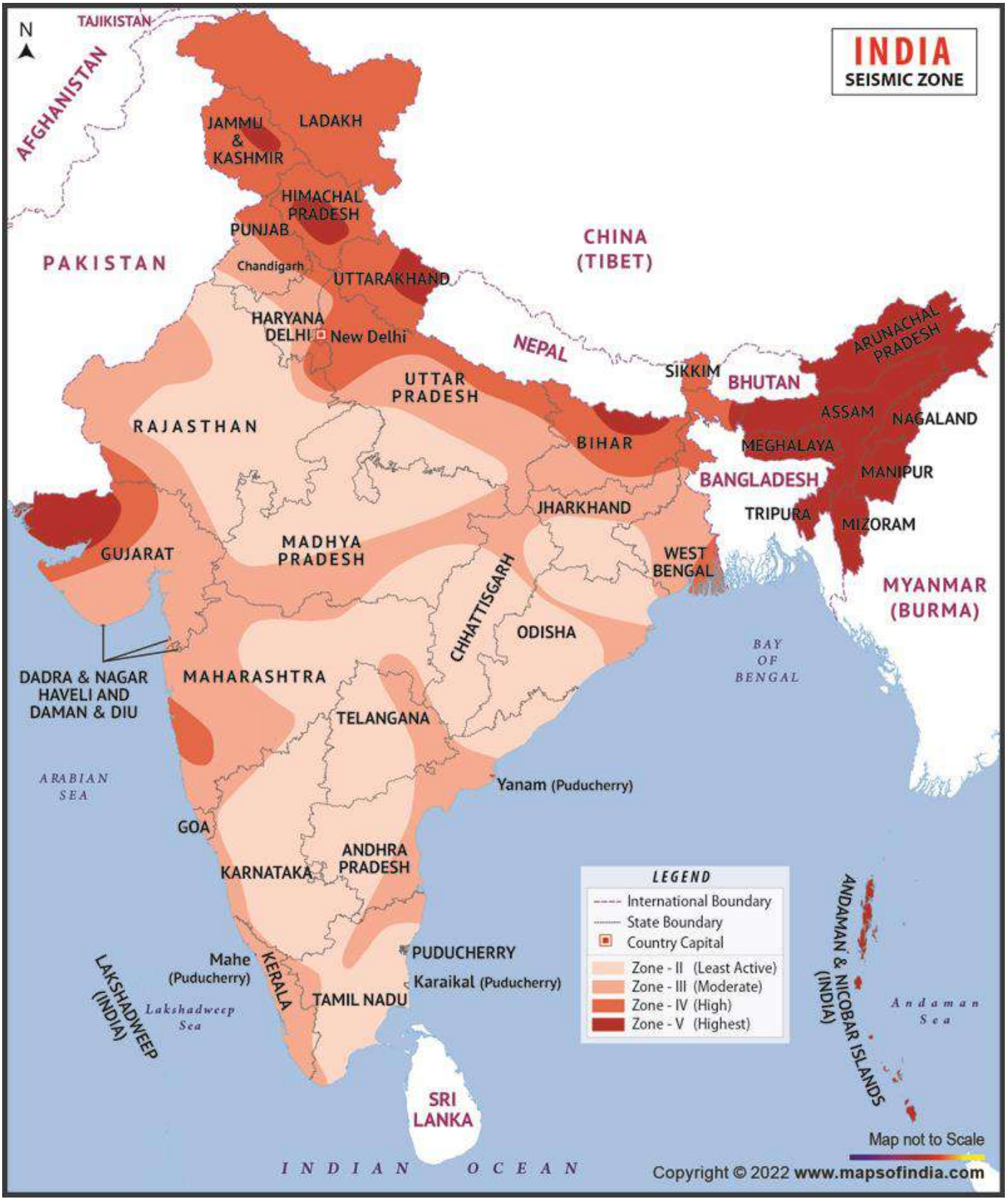
- Nepal and the adjoining northern part of India, are highly seismically active areas prone to earthquakes due to ***collision tectonics***, where the Indian plate subducts beneath the Eurasian Plate.
- **Almora Fault** – Located in ***Western Nepal.***
- It separates the inner lesser Himalayas in the north from outer lesser Him alayas in the south.
- **Activation of Almora fault-** 3 significant earthquakes above 5.8 magnitude occurred in 2023 leading to an increased frequency of earthquakes in 2023.
- **Agency responsible** - The ***National Disaster Management Authority (NDMA)*** is responsible for taking precautionary measures and response to earthquake related incidents.



NDMA	A fault
• NDMA is created by ***NDMA Act 2005.***	• It is a *fracture* or zone of fractures between two blocks of rock.
• NDMA is headed by ***Prime minister.***	• **Movement** – It allow the blocks to *move relative to each other* which may occur *rapidly, in the form of an earthquake* or may occur slowly, in the form of creep.
• NDMA is mandated to lay down the policies, plans and guidelines for Disaster Management to ensure timely and effective response to disasters.	

1.13 Kopili Fault (KF) zone

- The Kopili Fault, a lineament situated in the ***northeastern region (NER***), extends from the western part of Manipur to the tri-junction of Bhutan, Arunachal Pradesh, and Assam.
- It is one of the active faults which experienced large earthquakes and falls into the Highest Seismic Hazard ***Zone V.***



1.14 Volcano

Lava flows from a volcano in Iceland were slowing down recently, although new vents could open at short notice.

- Volcanoes are openings, or vents where lava, tephra (small rocks), and steam erupt onto the Earth's surface.
- **Occurrence –** It can be on land and in the ocean in Earth.
- Scientific evidences also show their presence in other planets like Mars and Venus.
- **Formation –** They are formed when material significantly hotter than its surroundings is erupted onto the surface of the Earth.
- **Earth Core –** Earth's interior has outer crust, middle mantle and inner core layer.
- Mantle is denser than that of the crust and contains a weaker zone called asthenosphere from which the molten rock materials find their way to the surface.
- Liquid rock is known as magma when it is underground and called as lava when it breaks through the surface.
- **3 ways of magma rise**
    1. **Divergence of tectonic plates –** Here, the magma rises up to fill in the space and when this happens underwater volcanoes can form.
    2. **Convergence of tectonic plates –** When this happens, part of Earth's crust can be forced deep into its interior, which under high heat and pressure melts, and rise as magma.
    3. **At hotspots –** They are hot areas inside of the Earth, where magma gets heated up and it becomes less dense, leading to its rise.
- **Erupted material –** It includes lava flows, pyroclastic debris, volcanic bombs, ash and dust and gases (nitrogen, sulphur and minor amounts of chlorene, hydrogen and argon).

Types of volcanoes

- According to the British Geological Survey, the type of volcano depends
    - On the viscosity of the magma
    - On the amount of gas in the magma
    - On the composition of the magma
    - On the way the magma reaches the surface
    - On basis of their activity – Active dormant and extinct

- **Shield Volcanoes** – They form very large, gently sloped volcanoes with a wide base. Example: Mauna Loa in Hawaii.
- **Cinder cones** – They are the smallest volcanic landform, formed from accumulation of many small fragments of ejected material.
- **Composite Volcanoes (Stratovolcanoes)** – They are characterised by eruptions of cooler and more viscous lavas than basalt and have steep sides and are more cone-shaped than shield volcanoes.
- **Caldera** – The most explosive of the earth's volcanoes.
- When they erupt, they collapse on themselves rather than building and this collapsed depressions are called calderas.

Advantages of volcanic eruptions	Disadvantages of volcanic eruptions
• Leads to the formation of geysers, sources of geothermal electricity. • Help to stabilize the heat of the core part of our planet. • Form new land forms after the drying process of liquid lava. • The lava contains different minerals which enriches existing soil. • Moderates climate and receives higher rainfall than flat areas.	• Leads to destruction to life and property. • Create other natural hazards like Tsunami. • Produce harmful gases and the heat boosts global warming. • The lava flow often cause wild fire in the nearby forestlands.

- **Basaltic eruptions** – Characterized by *low gas content and low viscosity* magmas where basalt is highly fluid and spread across quietly.
- **Andesitic eruptions** – They are explosive volcanoes characterised by *high gas content* where andesitic is less fluid mobile and solidifies at short distance.
- **Mid-Ocean Ridge Volcanoes** – They occur in the oceanic areas where the central portion of this ridge experiences frequent eruptions.
- Active volcano – It is called so if the materials mentioned are being released or have been released out in the recent past.
    - ***Iceland***, a volcanically active regions on the Earth witnesses an eruption every 4 to 5 years but since 2021, it has spiked to almost 1 eruption per year.

Long-term Volcanic Eruptions		Recent Volcanic Eruptions	
Volcanoes	**Location**	**Volcanoes**	**Location**
Mount Etna	Italy	**Mount Ulawun**	Papua New Guinea
Kilauea	Hawaii	**Semeru**	Indonesia
Mauna Loa	Hawaii	**Mount Merapi**	Indonesia
Dukono	Indonesia	**Mayon Volcano**	Philippines
Santa Maria	Guatemala	**Fuego**	Guatemala
Yasur	Vanuatu	**Klyuchevskoy**	Russia

Volcanoes of Iceland	
Skaftareldar	It was erupted in 1783 near the Vatnajokull glacier. As a result, 25% of the country's population died at the time.
Grimsvotn	It is the most active volcano in Iceland. At the time of its eruption, it was the largest in Iceland. (Eruptions – 1902, 2004, 2011).
Vesuvian	It is also known as Plinian eruption. These eruptions are distinguished by powerful bursts of gas, and volcanic material like rocks and hot gases shot up into the stratosphere.
Eyjafjallajokull	It is an icecap in in Iceland that witnessed 3 months of volcanic activity. The activity heated a nearby glacier river, called Krossa, by 6 degrees C.
Herdubreid	It is a rare example of a tuya volcano (active at the same time it had glacier cover). This one is located in Vatnajokull National Park.

1.15 Reykjanes Peninsula

- **Location** - South West ***Iceland,*** on the floor of the Atlantic Ocean.
- It is a volcanically active region that runs along the Mid-Atlantic Rift, where the Eurasian and the North American tectonic plates are drifting apart.
- Recently, the ***Fagradalsfjall volcano*** erupted in this region.
- Iceland is home to 33 active volcano systems, the highest number in Europe.

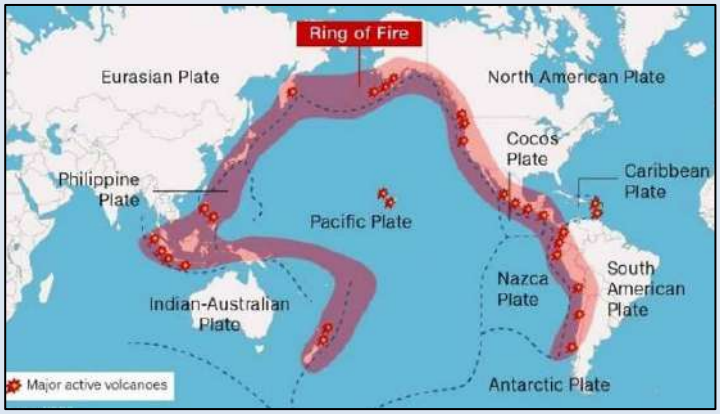
1.16 Mayon Volcano

A gentle eruption of the most active volcano in Philippines has forced nearly 18,000 people to flee to emergency shelters.

- **Mayon Volcano -** It is a *highly active stratovolcano* in the southeastern Luzon, ***Philippines.***
- It is called the ***world's most perfect volcanic cone*** because of the symmetry of its shape.
- It is located on the ***Pacific Ring of Fire***, the rim of seismic faults where most of the world's earthquakes and volcanic eruptions occur.

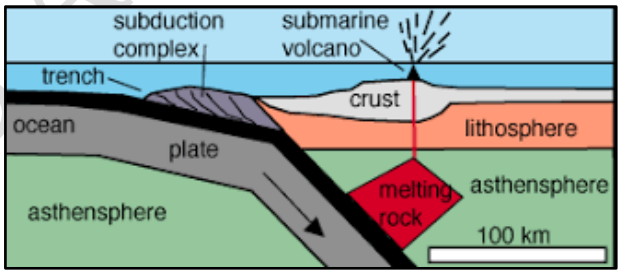
Pacific Ring of Fire

- *Pacific Ring of Fire or Circum-Pacific Belt* is a long seismically active belt along the Pacific Ocean characterized by earthquake epicentres, active volcanoes, and tectonic plate boundaries.
- It is home to about *75% of the world's volcanoes and about 90% of earthquakes* occur here.
- It traces boundaries between several tectonic plates - The Pacific, Cocos, Indian-Australian, Nazca, North American, and Philippine Plates.
- The abundance of volcanoes and earthquakes along the Ring of Fire is caused by the amount of *movement of tectonic plates* in the area.



1.17 Submarine Volcano

In a recent discovery, scientists have reported finding 19,325 new seamounts created by volcanic activities.

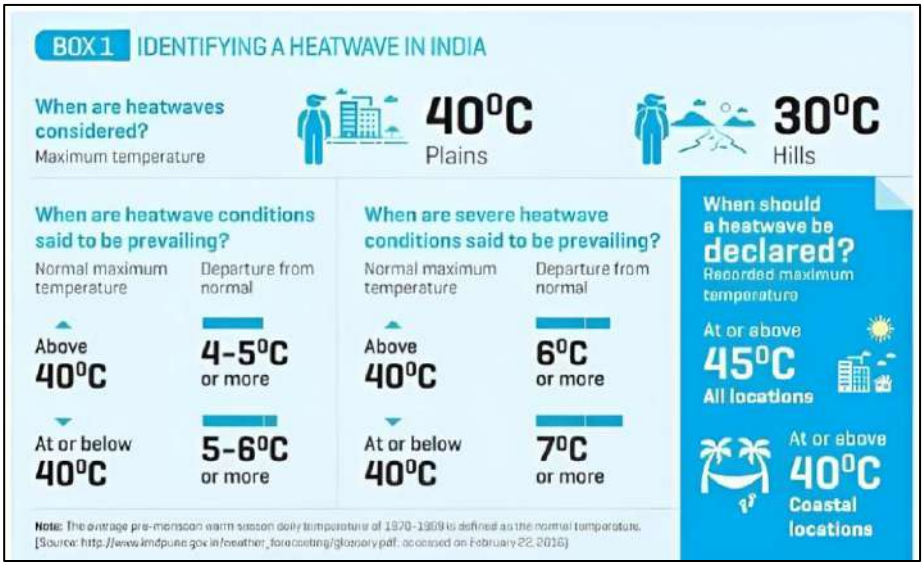


- Submarine volcanoes are exactly what they sound like volcanoes located beneath the ocean's surface.
- Because they erupt into water instead of air, submarine volcanoes behave quite differently than terrestrial volcanoes.
- For instance, it's uncommon for submarine volcanoes to have ex plosive eruptions.
- The sheer weight of the water above them creates very high pressure, usually resulting in what are known as ***passive lava flows*** along the seafloor.
- Eruptions and lava flow from submarine volcanoes allow volcanic islands to grow and develop thriving ecosystems.
- Most submarine eruptions ***do not disturb the ocean surface.***

1.18 Heat Waves across the World

Continents like North America, Africa, Asia and Europe have been experiencing heat waves, caused by either formation of heat domes or arrival of anticyclones in most cases.

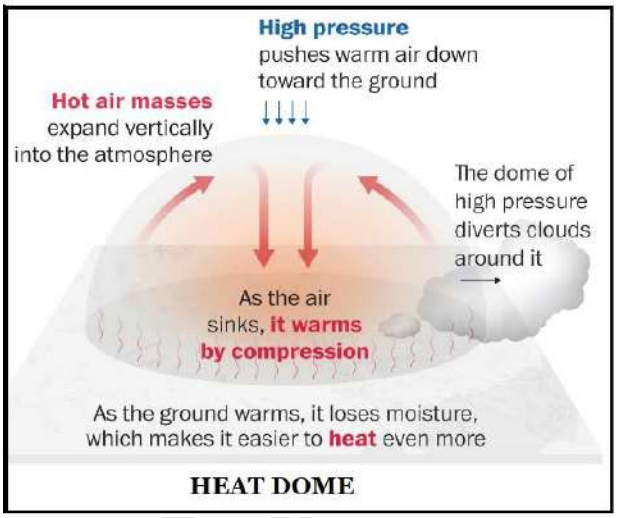
- A heat wave is a period of abnormally high temperatures, more than the normal maximum temperature that occurs.
- Heat waves typically occur between March and June, and in some rare cases even extend till July in India.
- They are particularly lethal when they become ***wet bulbs.***



- Wet bulb is a condition when *high temperatures combine with high humidity*.

Causes of heat waves

- **Global warming** - Extreme weather events have a direct correlation with global warming.
- Climate change has increased the frequency and intensity of extreme weather events like heat waves and mass scale floods.
- **Heat domes** - Heat domes were responsible for unleashing heat waves the USA and Algeria.
- Heat dome occurs when an area of high-pressure stays over a region for days and weeks.
- It traps warm air, just like a lid on a pot, for an extended period producing warmer conditions with every passing day.
- Heat domes, if they last for a long period, may cause deadly heat waves.
- **Anticyclones -** Europe has suffered due to the arrival of two consecutive anticyclones that originated in Africa.



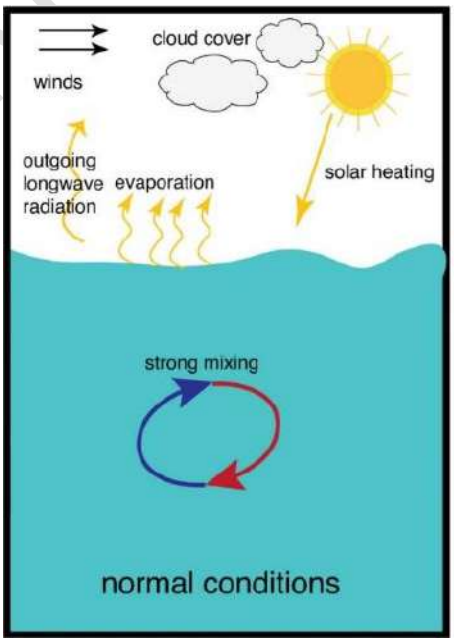
- Anticyclone is a *high-pressure system* in which the air goes downwards towards the Earth's surface.
- As the air sinks, its molecules get compressed, which increases the pressure, making it warmer and causing dry and hot weather.
- **High sea surface temperatures** - El Nino is a weather pattern that refers to an abnormal warming of surface waters in the equatorial Pacific Ocean.
- The El Nino conditions have developed for the first time in 7 years and are exacerbating the extreme heat around the world.

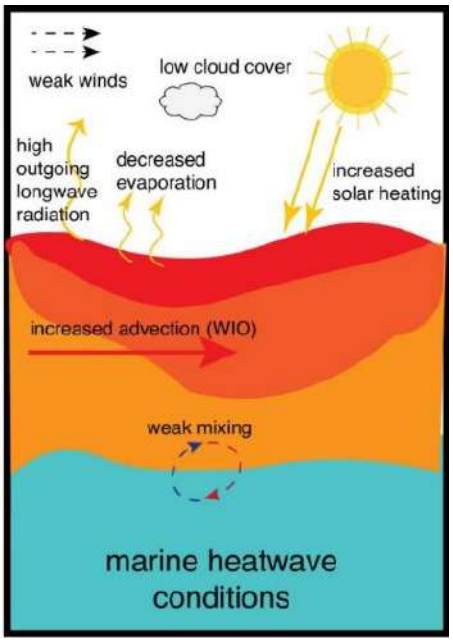
June 2023 was the Earth's hottest June since the record-keeping of global temperatures began 174 years ago by National Oceanic and Atmospheric Administration (NOAA).

1.19 Marine Heat Waves

An increase of 3 or 4 degrees Celsius in average temperatures can be catastrophic for marine life and cause marine heat waves.

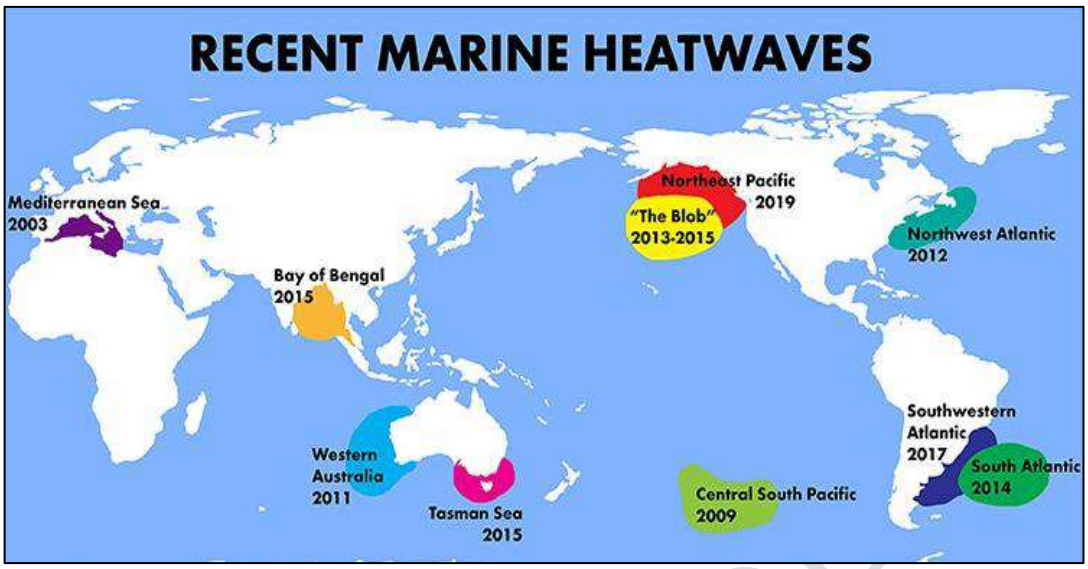
- **Marine Heat Waves -** The IPCC 6th Assessment Report defines marine heatwave as "a period during which water temperature is abnormally warm for the time of the year relative to historical temperatures, with that extreme warmth persisting for days to months.
- If the surface temperature of sea rises to ***3 or 4 degree Celsius above the average temperature for at least 5 days***, it causes MHW.
- The phenomenon can manifest in any place in the ocean and at scales of up to thousands of kilometres.





- **Occurrence-** Marine heatwaves can occur in summer or winter and are defined based on differences with expected temperatures for the location and time of year.

Causes of MHW



- **Global warming**- The planet is heating up fast, with 70% of water distribution in Earth, its impact as MHWs is huge.
- **Ocean currents-** It has major influence on the ocean, it can drive MHWs by moving around warm water.
- **Winds-** Warm air (normal heatwaves) can drive MHWs by warming the ocean surface.
- **El Nino models-** It is a climate phenomenon that causes warm water to shift to Pacific Ocean. This regional climate pattern caused MHWs event Blob in North eastern Pacific.

1.20 Maritime Continent (MC)

According to a new study, deforestation in the Maritime Continent (MC) can strengthen subtropical El Nino-Southern Oscillation (ENSO) dynamics, causing more Central Pacific and multi-year ENSOs.

- **Geography** – A region ***around Southeast Asia between the Indian and Pacific oceans*** (Indonesia, Philippines, Papua New Guinea and 1000's of islands and many seas).

- **Climate** – It is the warmest large span of ocean in the world, with an average temperature of about 82 degrees Fahrenheit.
- A lot of water evaporates and carried by tropical breezes, it drifts over the islands.
- **Importance** - It drives air currents circling around the planet, and also helps *drive El Niño and La Niña* thereby influencing the climate and weather in much of the world.
- **Impact of deforestation** – It reduces evapotranspiration and surface albedo which impacts land-atmosphere-ocean interactions such as the land-sea breeze.
- It might lead to 13.8% increase in La Nina events and 44.7% increases in multi-year El Nino events.

1.21 Ocean's cooling of Planet

A recent study says that oceans cool the planet by releasing short-lived halogens that contribute 8-10% of cooling.

Halogens

- A halogen is a chemical element that forms a salt when it reacts with metal.
- Halogens are all ***non-metallic*** substances and create brittle solids and have poor heat and electrical conductivity.
- The halogen elements are the six elements in ***Group 17*** of the periodic table.
- Short-lived halogens are ***chlorine, bromine and iodine*** compounds with a lifetime of ***less than 6 months*** in the atmosphere and are naturally produced by the oceans.

Findings

- **Increase in warming** - The short-lived halogens
  - Increases the global *methane* burden by 14 % and 9 % for pre-industrial and present-day conditions
  - Increases the levels of *water vapour*, a greenhouse gas

- Reduces the formation of cooling *aerosols*, minute particles suspended in the atmosphere that reflect sunlight

- **Cooling the planet** - Halogens cause a depletion of ozone (a greenhouse gas that traps outgoing radiation) leading to warming in the troposphere.
- Short-lived halogens from oceans reduces warming by depleting ozone contributing to its cooling effect.

1.22 Ozone Hole over Antarctica

European Space Agency Copernicus Sentinel-5P satellite measurements over Antarctica have detected a giant hole which is one of the biggest ozone holes observed so far which was roughly 3 times the size of Brazil.

- **Ozone Hole** - It is not technically a "hole" where no ozone is present, but is actually a ***region of exceptionally depleted ozone*** in the stratosphere over the Antarctic.
- Its *size fluctuates every year*, opening in August and closing again in November or December.
- **Opening of hole** - In the long months of polar darkness over Antarctica in the winter, an endlessly circling whirlpool of stratospheric winds called the polar vortex isolates the air in the center.
- Because it is completely dark, the air in the vortex gets so cold that clouds form and enables chemical reactions to take place.
- This converts the inactive Cl reservoir chemicals into active chlorine gas (Cl2) in atmosphere.
- In spring, the UV light from sunlight rapidly breaks Cl gas into free Cl in the stratosphere which destroys ozone.
- A free chlorine atom in atmosphere participate in a series of chemical reactions called as catalytic reaction and thus a single chlorine atom to destroy thousands of ozone molecules.

Ozone Layer

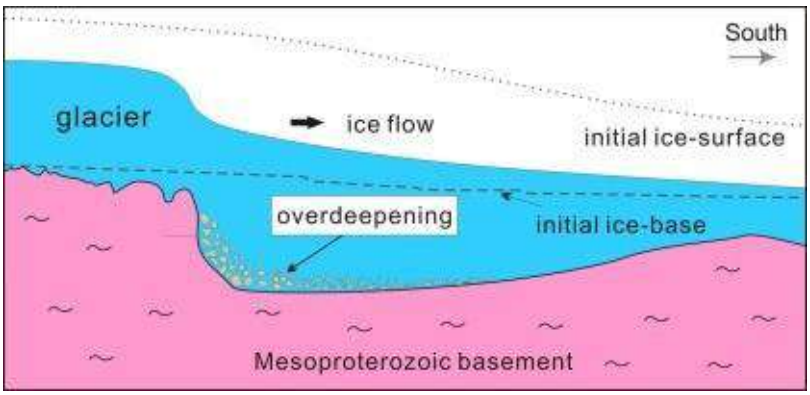
- Ozone is a molecule of 3 oxygen atoms which sits in our planet's stratosphere between 15 and 30 kilometres above the earth surface.
- They are constantly formed and destroyed in the stratosphere.
- Ozone layer absorbs a portion of the radiation from the Sun and prevents UVB radiation from reaching the Earth that might harm living beings.
- The total amount of ozone in the layer would remain constant over time if there aren't any human induced impacts.
- Human made chemicals which releases bromine (Br) and chlorine (Cl) atoms react with ozone and breaks it down and thus the rate of destruction becomes faster than rate of creation of ozone.
- The Montreal Protocol of 1989 brought together world governments to protect the ozone layer by phasing out many ozone-depleting substances (ODS).

- **Closing of hole** – When temperatures warm and the polar vortex weakens, it ends the isolation of the air in the polar vortex and thus hole starts to close.
- As air from the surrounding latitudes mixes into the polar region, the ozone-destroying forms of chlorine disperse. The ozone layer stabilizes until the following spring.

1.23 Sub Glacial Over deepening

A recent study on Himalayan Geology found that 3 new lakes may form in Parkachik Glacier in Ladakh due to glacial retreat.

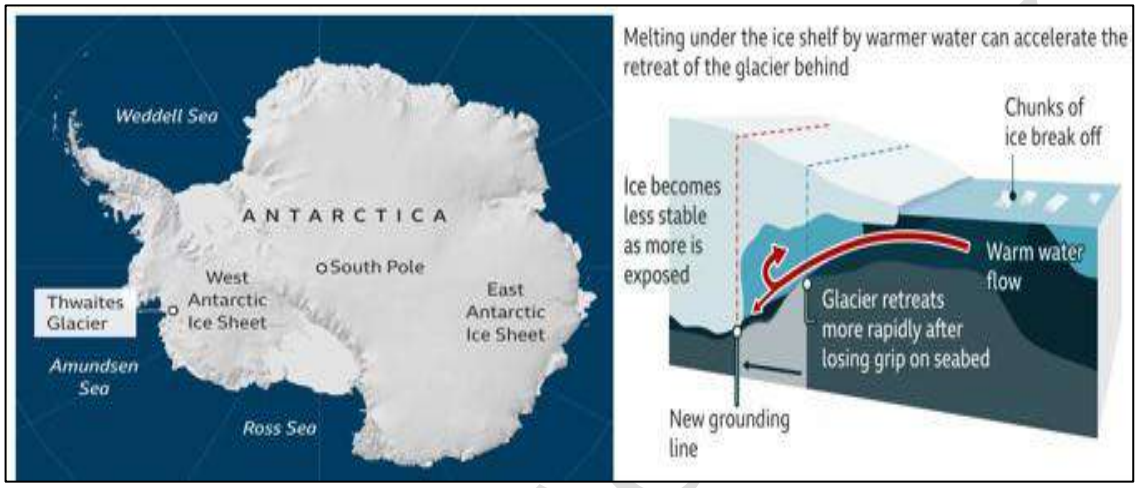
- It is a characteristic feature of basins and valleys that are ***eroded by the glaciers.***
- They are found at all elevations in a glacial landscape, from glacial cirques to large depressions along valley floors.
- The distinguishing feature is the adverse slope that forms at the lip of the basin or cirque.
- ***Cirque glaciers*** are bowl-shaped depression on the side of or near mountains.



1.24 West Antarctic Ice Shelf Melt

According to new research, the rate of melting of the West Antarctic ice sheet will increase over this century irrespective of reduction of fossil fuel use.

- **West Antarctic Ice Sheet** – It is *Antarctica's largest contributor to sea-level rise* which has enough ice to increase the global mean sea level by as much as 5 metres (m).
- **Cause of melting** – Due to the warming of the Southern Ocean mainly the Amundsen Sea region.
- **Amundsen Sea**, off the coast of West Antarctica, will warm roughly 3 times faster than the historical rate through the rest of this century which will lead to much more rapid melting of ice shelves.
- **Impacts** – Sea-level rises of around 1 metre may threat hundreds of millions of people worldwide at risk of coastal flooding.



Ice sheet *is a mass of glacial ice more than 50,000 square kilometers (19,000 square miles) which contain about 99% of the fresh water on Earth, and are sometimes called continental glaciers.*

Ice Shelves *are the extension from main ice sheets into the ocean which play a key role in holding back the glaciers behind. But as ice shelves melt, it can mean that the ice behind speeds up, releasing more into the oceans.*

1.25 Arctic Research

India will have around-the-year manning of the Arctic with the launch of the first-ever winter expedition in this region.

Scientific research in Arctic region

- **UN Convention on the Law of the Sea (UNCLOS)-** It allows for the freedom of marine scientific research in the high seas of the central Arctic Ocean.
- **Arctic Council-** It is an intergovernmental forum for cooperation and coordination on Arctic issues, including scientific research.
- **Svalbard Treaty, 1920-** It recognizes the sovereignty of Norway over Svalbard, but also grants equal rights to all parties to engage in economic activities, such as mining and fishing.
- **Individual jurisdictions**- The Arctic region is divided into different zones of sovereignty and jurisdiction, depending on the location and nature of the activities.

India's engagement in the Arctic region

- India signed the ***Svalbard Treaty*** in 1920 and is an observer state in Arctic Council.
- **Himadri -** India's 1st permanent Arctic research station is located at Spitsbergen, Svalbard, Norway.
- It is located at the *International Arctic Research base,* ***Ny-Alesund*****.**

- **Arctic Policy of 2022**- It mentions that the country's approach to economic development of the region is guided by UN Sustainable Development Goals.
- **Institutional support**- In 2018 India renamed National Centre for Antarctic and Ocean Research to National Centre for Polar and Ocean Research.
- **Infrastructural base-** Multi-sensor moored observatory was inaugurated in 2014. Northernmost atmospheric lab was launched in 2016.

1.26 Parkachik Glacier

- The Parkachik glacier is one of the largest glaciers in the ***Suru River valley, Kargil, Ladakh.***
- The Suru River valley is a part of the ***Southern Zanskar Ranges*** in the western Himalayas.
- **Reasons for melting ice –** Global warming and increasing temperatures in the region
- It is at a lower altitude than other glaciers in the Zanskar region Suru River Valley, Ladakh Himalaya.
- **Glacial melt problems –** If the volume of water is large, there is a possibility of glacial lake outbursts.
- The loss of a valuable water resource since Ladakh primarily depends on glacial melt for water.

Arctic region is the region, which is above the Arctic Circle and includes the Arctic Ocean with the North Pole at its centre.

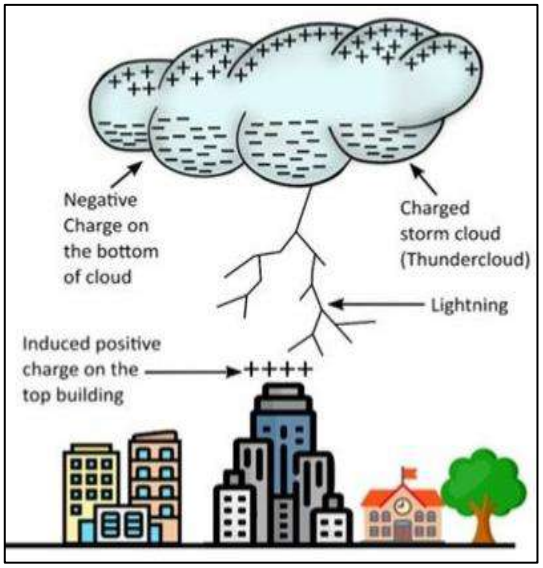
1.27 Ground frost

- Ground frost is a covering of ice that forms on objects, trees, or the ground when their surfaces are ***below the freezing point of water.***
- It can occur when the ground cools faster than the air.
- It can also occur when water vapor directly deposits on objects and trees with surfaces colder than 0°C.

1.28 All About Lightning

Unseasonal and sudden heavy rainfall, accompanied by thunderstorms, hailstorms and lightning strikes, have claimed 27 lives in Gujarat.

- Lightning is a natural phenomenon where the ***electric charges travel from one point to the other*** within the clouds or between a cloud and the earth.
- It is accompanied by a bright flash and sometimes thunderstorms.
    - **Inter cloud or intra cloud lightning-** They are visible and are harmless.
    - **Cloud to ground lightning**- It is harmful as the 'high electric voltage and electric current' leads to electrocution.
- When the temperature drops, the water droplets that are held in the clouds begin to become ice crystals.
- These ice crystals will rub against one another, creating a static charge in the clouds.



Lighter positive charge	Migrate towards the higher end of the cloud
Heavier negative charge	Move towards the lower end of the cloud
Big positive charged surface	Earth's surface

- **Electrostatic discharge**- The positive and negative charges (opposite charges) attract one another. However, there will be air between the ground and the cloud.
- Because *air is a poor conductor*, it opposes the passage of charge.

- Beyond a certain point, the charge build-up gets massive and the discharge happens in a split second. This is known as an electric discharge.
- This massive charge flow generates heat and light.

30-30 rule- *Advises people to take shelter if they hear thunder within 30 seconds of seeing lightning.*

Causes of Lightning

India Meteorological Department (IMD) has attributed the lightning flashes to ***3 weather systems*** namely - Cyclonic circulation, Western Disturbances and Easterly trough.

- **Cyclonic circulation**- It is over Northern Arabian Sea and adjoining Saurashtra and Kutch, which is a *low-pressure area* that draws moist air from surroundings.
- **Western disturbances**- They are storms that *originate over the Mediterranean Sea* region and may bring rainfall to North-Western India in the winter.
- They were stronger this time and descended to lower latitudes, affecting Gujarat and Madhya Pradesh.
- **Easterly trough**- It is a zone of *low pressure in the easterly winds* that flow from the east in the equatorial region throughout the year.
- **Active ITCZ**- Intertropical Convergence Zone (ITCZ, located *slightly north of the Equator*) is very active which may have provided sufficient moisture to the area, resulting in thunderstorm.

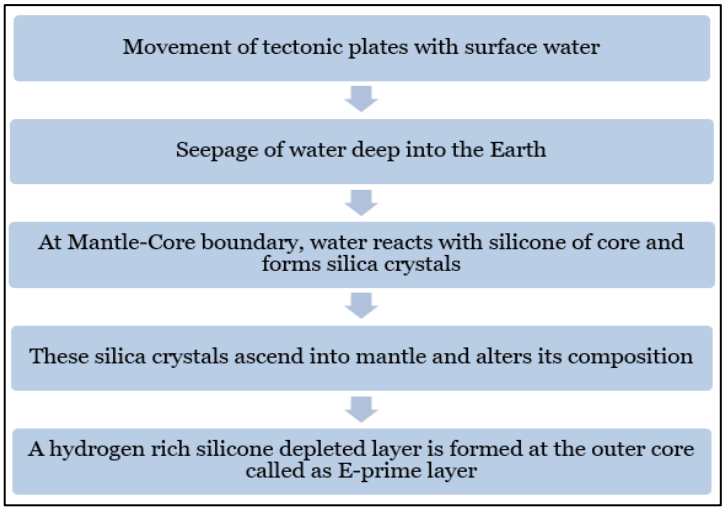
1.29 Nacreous clouds

- Nacreous clouds, also known as the ***Polar stratospheric clouds***, are among the rarest and most stunning atmospheric phenomena.
- They are ***iridescent clouds*** that form only ***below -78C*** and usually develop in extremely cold air above Polar Regions.
- Nacreous clouds are in *indicator of especially cold air* high in the atmosphere.
- **Formation** – It is formed when the temperatures in the stratosphere becomes so low and water particles turn into tiny ice crystals in the sky.
- These water particles scatter high-altitude sunlight, producing a brilliant display of iridescent colours that can be seen even when the sun is below the horizon.
- **Range** – Because of the very low temperatures required for their formation, the clouds are usually seen over Scandinavia, northern Canada and northern Russia.

1.30 E-prime Layer

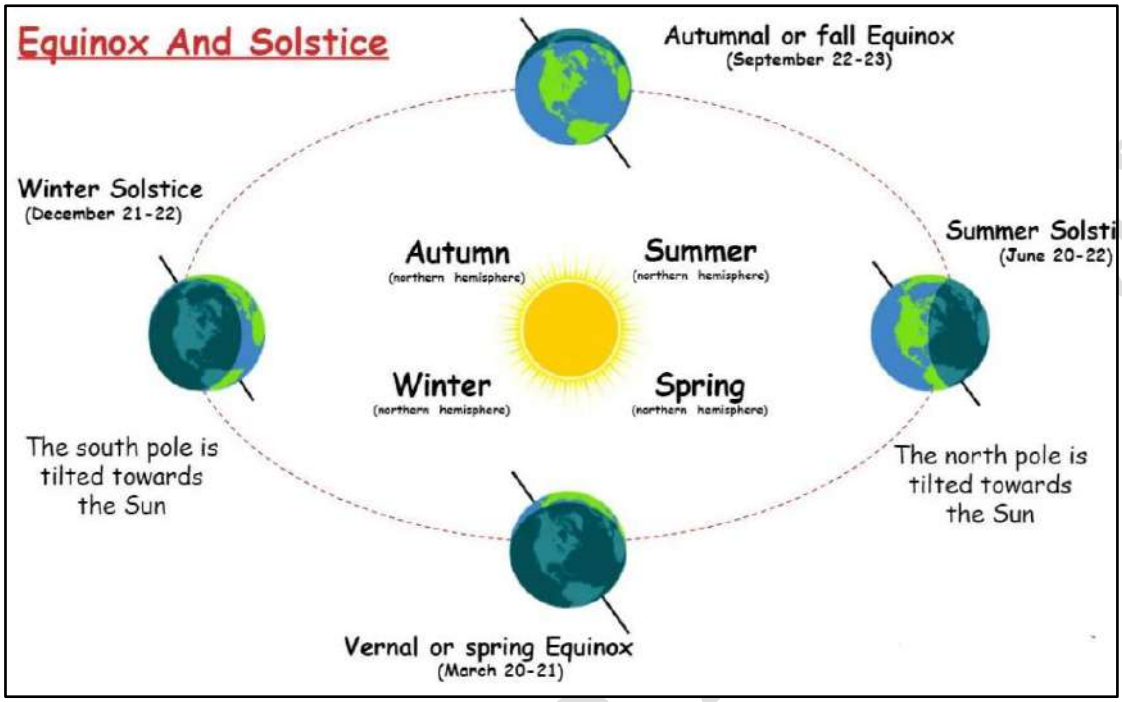
According to a new study, Earth core's mysterious new layer was formed due to surface water diving deep.

- **Inner Earth** has 4 primary layers - Inner core (innermost layer), Outer core, Mantle (middle layer) and Crust (outermost layer)
- **E-prime layer** – It is the new enigmatic layer which is formed at the ***Earth's outer core*** as a result of surface water penetrating deep into the planet.
- It is more than 60 miles (100 kilometers) thick, relatively slim than other sections.
- **Impact** – Modifications in the liquid metallic layer could potentially result in reduced density and altered seismic characteristics.
- The transformed layer in the core holds significant implications for the interconnected geochemical processes linking surface water cycles with the deep metallic core.



1.31 Winter Solstice

- The Winter Solstice is a phenomenon when the Northern Hemisphere is tilted farthest away from the sun, resulting in the ***longest night and the shortest day*** of the year.
- It occurs annually on ***December 21 or 22.*** It marks the 1st day of winter.



1.32 Congo Rainforest

A recent report says that the Congo rainforest continues to vanish with half a million hectares lost in 2022.

- It is the ***world's 2nd largest tropical rainforest*** after the Amazon rainforest.
- The rainforest is spread across ***6 African countries*** - Cameroon, Central African Republic, Republic of Congo, Democratic Republic of Congo (DRC), Equatorial Guinea, and Gabon.
- 60% of rainforest lies in the *Democratic Republic of the Congo*.
- It is the ***world's largest carbon sink*** (anything that absorbs more carbon from the atmosphere than it releases) hence they are known as the "***lungs of Africa***".

Quick Facts

- **Peat Lands -** They are wetlands that contain a mixture of decomposed organic material, partially submerged in a layer of water, lacking oxygen.
- **Brazzaville declaration** - To *promote better management and conservation of world's largest tropical peatlands*-Cuvette Centrale region in Congo Basin from unregulated land use and prevent its drainage and degradation.
- Brazzaville - Capital of ***Democratic Republic of Congo.***
- The Democratic Republic of Congo (DRC), the Republic of Congo and Indonesia have jointly signed the Brazzaville declaration.
- **Amazon Rainforest** - It is the *world's largest tropical* rainforest and is considered the ***'Lungs of the Earth'***.
- Spans over **9 countries** - Brazil, Bolivia, Peru, Ecuador, Guyana, French Guiana, Suriname, Colombia, Venezuela. Amazon River is the *largest river* in the world.

1.33 Lake Victoria Basin

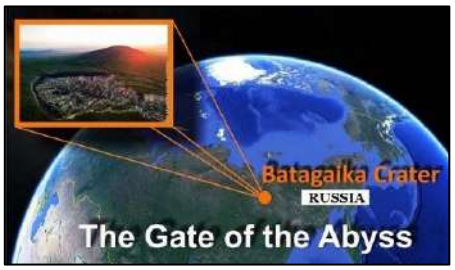
A recent report shows that heavy rains, wind storms, and floods threaten the survival and water access of the communities living in the Lake Victoria Basin (LVB), East Africa.

- **Location** - The basin's catchment area traverses through ***5 East African Countries*** - Tanzania (44%), Kenya (22%), Uganda (16%), Rwanda (11%) and Burundi (7%).
- This trans-boundary asset is shared by Tanzania (51%), Uganda (43%) and Kenya (6%).
- **Features** - Lake Victoria is the
  - Largest freshwater lake in Africa
  - World's largest tropical lake
  - Second largest freshwater lake in the world, after *Lake Superior* in North America
  - Largest inland water fishery sanctuary in East Africa

- **Climate** - It has modified equatorial climate, regional rainfall regulates the water levels in the lake.
- Most of the lake's water comes from rainfall, while almost the same amount of water is lost through evaporation and carried out by the Nile.
- **Rivers** - River Mara, Kagera, Yala, Nyando, Bukora and Katonga.
- The ***White Nile*** is the only river flowing out of the Lake.
- The ***Kagera (Akagera) River***, which drains the mountains of Burundi and Rwanda, is considered as the source of the Nile.

1.34 Batagaika Crater

Drone footage has revealed details of Batagaika crater, a 1-km long gash in Russia's Far East that forms the world's biggest permafrost crater.



- Batagaika crater is also known as the "***Gateway to the Underworld***" and has the scientific name: ***a mega-slump***.
- It is the world's largest permafrost crater located in ***Russia's Sakha Republic.***
- It developed first as a ravine, then by thawing in the heat of sunny days, it started to expand.
- **Permafrost thawing** - A permafrost is a ground that remains frozen at ***32°F (0°C) or colder for at least two years in a row***, as per NASA.
- It comprises soil, rocks and sand that are held together by ice. The soil and ice in permafrost stay frozen all year long.
- Thawing is the process of going from a ***frozen state to a liquid state.***
- The warming is melting the long-frozen tundra that covers about 65% of the country's landmass, releasing the greenhouse gases stored in the thawed soil.

1.35 Julian Felipe Reef

- Julian Felipe Reef is a reef in the ***Spratly Islands of the South China Sea.***
- It lies in the Exclusive Economic Zone of ***Philippines.***
- It is also known as Whitsun Reef, Whitson Reef, and Whitsum Reef.

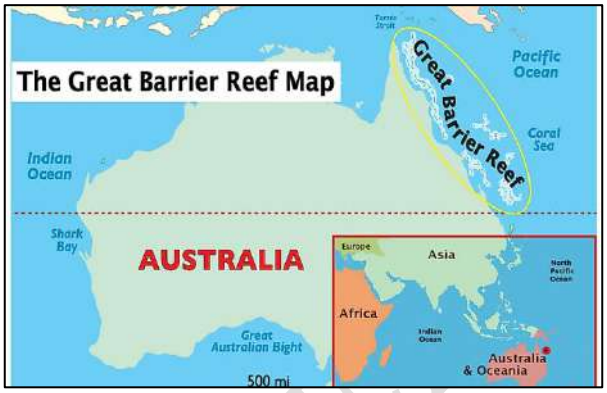
1.36 Thitu Islands & Subi Reef

- Thitu Islands is located in the ***Spratly Islands*** of ***South China Sea***.

- Subi Reef t is a low-tide elevation in the ***Spratly Islands.***

1.37 Great Barrier Reef

A UNESCO heritage committee recently took off Australia's Great Barrier Reef from UNESCO danger list but warned the ecosystem is still remained under serious threat.



- ***Australia'***s Great Barrier Reef is the world's largest reef system.
- It stretches across 2,300 km and has nearly 3,000 individual reefs.
- Coral reefs support over 25% of marine biodiversity even as they take up only 1% of the seafloor.

1.38 Suez Canal and Ben Gurion Canal Project

Israel has come up with plans to create Ben Gurion Canal Project, an alternative to the Suez Canal.

Suez Canal

- **Location-** The Suez Canal is a ***man-made*** canal that connects the ***Mediterranean Sea to the Red Sea***, providing a crucial shortcut for shipping between Europe and Asia.
- It cuts north-south across the *Isthmus of Suez* in Egypt.
- **Year of construction** - Construction of the canal began in 1859 and it took around 10 years to complete it.
- **Management**- The canal is owned and maintained by the *Suez Canal Authority* (SCA), which is under the government of ***Egypt.***
- **Convention of Constantinople-** Signed in 1888 by the maritime powers, it stated that the canal should be *open to ships of all nations* in times of both peace and war.
- Acts of hostility in the waters of the canal and the construction of fortifications on its banks were forbidden by the convention.

Established in 2015, Suez Canal Economic Zone is a special economic zone located in Egypt to promote economic growth and to attract foreign investment to the country.

- The British and French owned most of the shares in the canal company and used their influence to protect their interests.
- **Suez Crisis -** In 1956, *Egypt took over the Suez Canal* from the British and French shareholders to fund a dam project on the *Nile River.*
- This nationalization triggered a military attack by UK, France and Israel on Egypt, marking the 1st deployment of the UN Peacekeeping Forces anywhere in the world.
- They were stationed in *Sinai* to maintain peace between Egypt and Israel after the withdrawal of the invading forces.
- **Egypt-Israel conflict**- In 1967, Egypt expelled UN peacekeepers from Sinai and fought with Israel.
- Israel captured Sinai and Egypt blocked the Suez Canal for 8 years.
- In 1975, Egypt and Israel signed an agreement to end the hostilities and reopen the canal.
- **Arab-Israeli War** - The canal was also a key battleground in the *1973 Arab-Israeli War*, where Egypt and Syria attacked Israel.

Ben Gurion Canal Project

- Ben Gurion Canal Project is a proposal to create a canal through the *Negev Desert in Israel*, connecting the *Gulf of Aqaba and the Eastern Mediterranean.*
- Named after the Israel's founding father David Ben-Gurion, it was 1st envisioned in 1960s to create an alternative route to the Suez Canal.

1.39 Panama Canal

Two important shipping routes the Suez Canal and the Panama Canal are facing blockages.

- It is a lock-type canal, owned and administered by the ***Republic of Panama.***
    - ***Lock-type canal*** is a system in which an enclosure or basin located in the course of a canal or a river (or in the vicinity of a dock) with gates at each end, within which the water level may be varied to raise or lower boats.
- The Panama Canal connects the ***Atlantic and Pacific oceans*** through the narrow Isthmus of Panama.
- The canal does not cross the isthmus from east to west but runs due south from its entrance at Colón on the Atlantic side through the Gatún Locks to a point in the widest portion of Gatún Lake.

1.40 Sulina Channel

The Sulina Channel is the new alternative trade route after Russia's drone strikes on ports and grain storage facilities along the Danube River in Ukraine.

- **Danube River -** Danube is the ***Europe's second longest river*** which has been historically crucial for the movement of freight.
- It starts at the intersection of two smaller rivers in Southwestern Germany - Brigach and Brech Rivers.
- It passes through countries including *Austria, Bulgaria, Croatia, Germany, Hungary, Moldova, Romania, Serbia, Slovakia, and Ukraine.*
- Recently, Russia attacked the inland Danube ports of *Reni and Izmail.*
- **Channels -** Chilia, Sulina and St George.
- **Sulina Channel -** It is situated in ***Romania*** *(a NATO member).*
- It is a sort of a riverine 'expressway' crucial for transport of goods from Ukraine (one of the world's top grain exporters) to the Black Sea.

1.41 Red Sea & Bab-el-Mandeb

Houthi attacks on tankers passing through the Bab-el-Mandeb has disrupted one of the busiest global shipping lanes, dragging the U.S. deeper into the conflict.

- **Red Sea –** A narrow strip of water extending for about 1,200 miles.
- It extends between the Mediterranean Sea, to the north-west, and the Indian Ocean, to the south-east.
    - In north, it separates into the ***Gulf of Aqaba and the Gulf of Suez*** and in south, it is connected to the ***Gulf of Aden***, and the outer Indian Ocean, via the ***Strait of Bab-el-Mandeb.***
- **6 bordering countries** – Egypt, Saudi Arabia, Yemen, Sudan, Eritrea and Djibouti.
- **Physiography** – It lies in a ***fault depression*** that separates 2 great blocks, Arabia and North Africa and its height can reach more than 6,560 feet above sea level, with the highest in the south.
- **Higher salinity** – It has high evaporation, low precipitation and has no major freshwater inflow.
- **Resources** – It is high in nutrient, planktons and also has ***5 major types of mineral resources*** (petroleum deposits, evaporite deposits, sulfur, phosphates, and the heavy-metal deposits).
- **Sea Route** – It is a part of an important trade route connecting Europe to Asia (through Suez Canal).

Bab-el-Mandeb

- It is ***a strait*** that separates the Arabian Peninsula from East Africa and is just 29-km wide at its narrowest point.
- **Control** – Throughout 19th and until mid-20th century, Britain protected it through the ***island of Perim (Mayyum) in the Strait*** but in 1990, it came under the control of Sana'a, the capital of the united country of Yemen.
- As Houthis captured Sana'a in 2015, they pose a greater threat due to their close proximity to Bab el-Mandeb strait.

> ***Bab-el-Mandeb*** *is also known by the names Gateway of Tears and Gatway of Grief.*

1.42 Kra Isthmus

Recently the Thailand prime minster proposed a route that would cut across the Isthmus of Kra and would provide an alternative to the longer and congested shipping route through the Strait of Malacca.

- The Kra Isthmus in ***Thailand*** is the narrowest part of the ***Malay Peninsula.***
- An isthmus is a narrow strip of land that connects two larger landmasses and separates two bodies of water.
- It is narrow neck of southern Myanmar (Burma) and Thailand, connecting the Malay Peninsula to the Asian mainland.
- The isthmus lies between the Gulf of Thailand to the east and the Andaman Sea to the west.

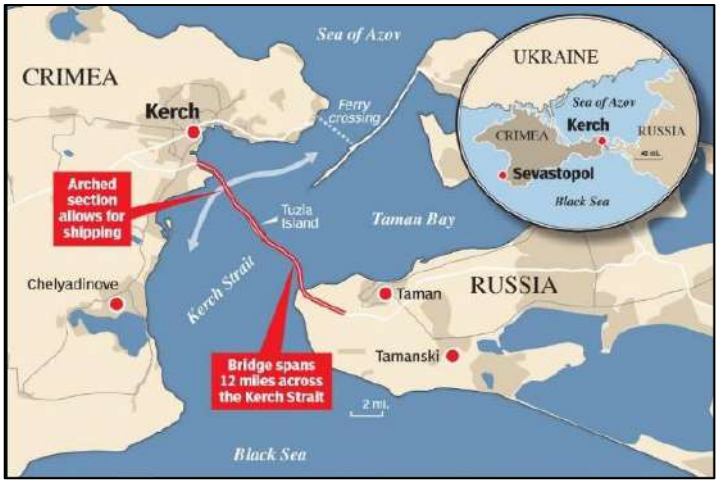
1.43 Taiwan Strait

- The Taiwan Strait also known as the ***Formosa Strait*** is the arm of the Pacific Ocean.
- Taiwan, officially known as the Republic of China (ROC), is an island separated from China by the Taiwan Strait.
- The strait is part of the South China Sea and connects to the East China Sea to the north.
- Taiwan has been governed independently from mainland China, officially the People's Republic of China (PRC), since 1949 but Beijing views the island as part of its territory.

1.44 Crimea Bridge & Kerch Strait

One of the sections of the rail-and-road Crimea Bridge, which links Russia to the occupied Crimea peninsula, was blown up again.

Crimea Bridge



- The Crimea Bridge is a crucial structure for Russia as it is the ***only direct link*** between the transport network of the country and the Crimean Peninsula.
- It is the ***longest bridge*** in Europe and is also known as the *Kerch Bridge*.
- It was inaugurated on 2018, 4 years after Russia annexed Crimea.
- ***Port of Sevastopol*** is the historic home base of Russia's Black Sea Fleet.
- Through this port fuel, food and other products are being supplied.

- Since last year, the bridge has also been an important conduit for reinforcements and supplies to Russian troops who have seized control of territory in southern Ukraine.
- For the Kremlin, the bridge is a symbol of the connection it is attempting to forge between Crimea and Russia.

Kerch Strait

- It is a strait in Eastern Europe that ***connects the Black Sea and the Sea of Azov.***
- It also separates the Kerch Peninsula of Crimea and Russia.

1.45 Black Sea

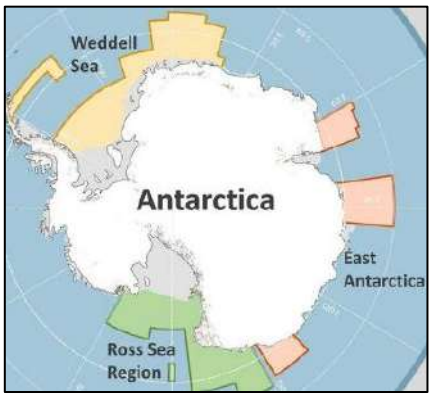
- The Black Sea also known as the ***Euxine Sea*** is a large inland sea located at the south-eastern tip of Europe.
- The Black Sea is a marginal sea of the Atlantic Ocean, located between Eastern Europe and Western Asia.
- The Black Sea is bordered by Ukraine, Russia, Georgia, Turkey, Bulgaria, and Romania.
- It is the ***world's largest meromictic basin,*** meaning that the upper and lower layers of water exchange very little.

1.46 Novorossiysk Port

A Russian naval ship has been damaged in a Ukrainian naval drone attack in the Novorossiysk Port in the Black Sea.

- The Novorossiysk commercial seaport is one of ***Russia***'s largest by volume and among the biggest in Europe.
- It is a major node in the export of Russian grain, oil, and other products to countries around the world.
- The port is one of the country's main naval hubs for the Black Sea.
- ***Russia is the world's largest wheat exporter.***

1.47 Ross Sea



- The Ross Sea exists between Marie Byrd Land and Victoria Land of Antarctica in the ***Southern Ocean.***
- The majority of the Ross Sea Region MPA is fully protected under a General Protection Zone (GPZ).
- Around 72% of the MPA is a no-take zone, excluding areas under ice shelves.
- A no-take zone is an area set aside by the government where no extractive activity is allowed.
- **Extraction activities** - Fishing, hunting, logging, mining, shell collecting, archaeological digging and drilling.

1.48 Caspian Sea

- The Caspian Sea is the ***world's largest inland body of water***, located between Asia and Europe, and is shared by Azerbaijan, Iran, Kazakhstan, Russia, and Turkmenistan.

- The Caspian Sea is a ***landlocked sea*** and is also known as the ***Mazandaran Sea.***
- It lies to the east of the Caucasus Mountains and to the west of the vast steppe of Central Asia.
- ***Baku*** is the largest port on the Caspian Sea and the largest capital city on the southern shore of the Absheron peninsula.

1.49 Atlanta Bay

- Atlanta Bay is located near Diglipur in ***Andaman and Nicobar Islands*** of Indian Ocean.
- The other important bay in Nicobar Islands include ***Galathea Bay and Campbell Bay.***
- Galathea Bay is also the name of a National Park that was established in 1992 as a part of the Great Nicobar Biosphere Reserve.

1.50 Erg Chech 002

In May 2020, some unusual rocks containing distinctive greenish crystals were found in the Erg Chech sand sea.

- **Erg Chech** - It is a sandy region of the *Sahara* in ***western Algeria and northern Mali*.**
- It consists largely of shifting dunes.
- **Erg Chech 002** - On close inspection of the rocks containing distinctive greenish crystals, it turned out to be from outer space, left over from the dawn of the Solar System.
- They were all pieces of a meteorite known as Erg Chech 002, which is the ***oldest volcanic rock*** ever found.
- Erg Chech 002 is an "***ungrouped achondrite***" (its parent body and family relationship is unknown.)
- Achondrites are rocks formed from melted planetesimals, which is what we call solid lumps in the cloud of gas and debris that formed the Solar System. **Ex** – *Angrites, Erg Chech 002.*

1.51 Sahel Region

The ongoing fighting in the Sudan threatens the entire Sahel region.

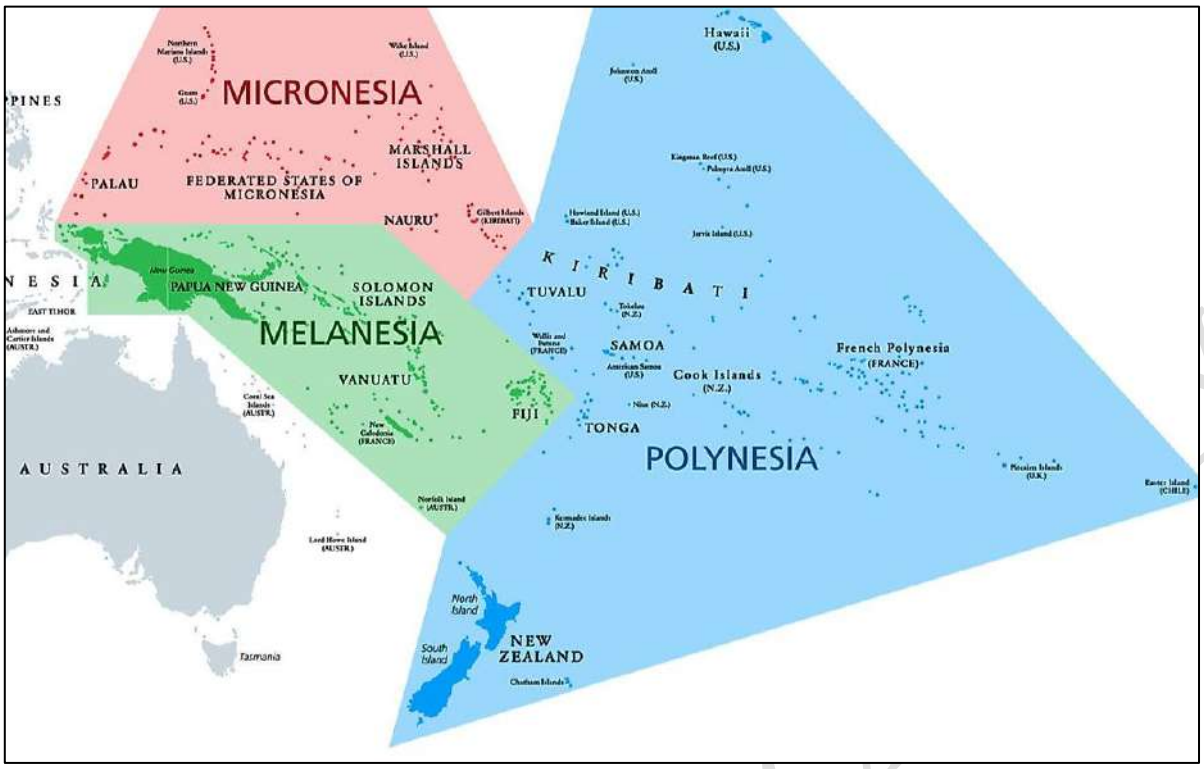
- The ***Sahel region of Africa*** is a 3,860-kilometre arc-like land mass lying to the immediate ***south of the Sahara Desert*** and stretching east-west across the breadth of the African continent.

- It is a largely semi-arid belt of barren, sandy and rock-strewn land.
- It forms a transitional zone between the arid Sahara (desert) to the north and the belt of humid savannahs to the south.
- Sahel stretches from Atlantic Ocean eastward, from Senegal to Sudan.
- In between, it covers southern Mauritania, the great bend of the Niger River in Mali, Burkina Faso (formerly Upper Volta), southern Niger, north-eastern Nigeria, and south-central Chad.
- Culturally and historically, the Sahel is a shoreline between the Middle East and sub-Saharan Africa.
- This means it is the site of interaction between Arabic, Islamic and nomadic cultures from the north, and indigenous and traditional cultures from the south.

1.52 Pacific Island Countries (PICs)

The visit of the Indian PM to south pacific region, reflects India's global status, and its significance of its engagement with Pacific Island Countries (PICs) and the Forum for India-Pacific Islands Cooperation (FIPIC).

- PICs is a cluster of ***14 island nations*** dotting the ***Southwestern Pacific:*** the Cook Islands, Fiji, Kiribati, the Marshall Islands, Micronesia, Nauru, Niue, Samoa, the Solomon Islands, Palau, Papua New Guinea, Tonga, Tuvalu, and Vanuatu.
- Of the 14 PICs, Fiji and Papua New Guinea (PNG) are the ones with the biggest populations and the most heft.

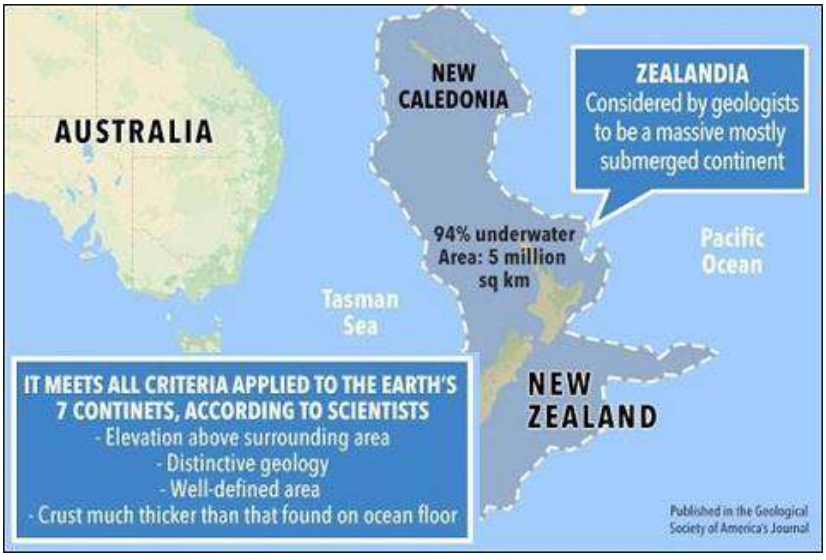


1.53 Tuvalu

- Australia has offered refuge to citizens of Tuvalu, under which citizens of Tuvalu will have the right to live, work and study in Australia.
- Tuvalu is a nation of *9 coral islands* nestled in the ***South Pacific***, formerly known as the ***Ellice Islands.***
- It has been defined by the United Nations as "extremely vulnerable" to the effects of climate change.

1.54 Zealandia

An international team of geologists and seismologists have now created a new map of Zealandia, the ***Earth's forgotten 8th continent***.



- **Historical Formation** – Approximately 83 million years ago, the *supercontinent* ***Gondwana*** *was pulled apart* resulted in the beginning of the present-day continents and also with the creation of Zealandia.
- **Geographical phenomena** – By approximately 23 million years ago, the landmass may have completely submerged.
- Currently, *94% is under the sea* and the remaining 6% is what we identify as New Zealand and neighboring islands.
- It is also substantially *larger than the Arabian Peninsula*, the world's largest peninsula, and the Indian subcontinent.
- **Economic Significance** – It supports *substantial inshore fisheries and contains gas fields*, of which the largest known is the New Zealand Maui gas field, near Taranaki.

1.55 East of Horn of Africa and the Great Lakes (EHAGL) region

According to the United Nations High Commissioner for Refugees (UNHCR), there were approximately 11.71 million Internally Displaced Persons (IDPs) in East and Horn of Africa and the Great Lakes (EHAGL) region as of March 31, 2023.

- **Horn of Africa -** It is a region in eastern Africa. Almost equidistant from the Equator and the Tropic of Cancer, it is an arid region.
- **Countries included** - Djibouti, Eritrea, Ethiopia, and Somalia.
- **Coastlines included** - Red Sea, Gulf of Aden, and Indian Ocean.
- **Rivers flowing in the region** – Blue Nile, White Nile, Dawa River.
- **Lakes present in the region** –Lake Tana, Lake Turkana.
- **Ogaden desert** – Situated between the Somalia-Ethiopia border and the Ethiopian Eastern Highlands.

The African Great Lakes Region	Great Lakes of North America
• The African Great Lakes are a series of lakes constituting the part of the Rift Valley lakes in and around the ***East African Rift.*** • **Lists of the African Great Lakes** - Lake Victoria, Lake Tanganyika, Lake Malawi, Lake Turkana, Lake Albert, Lake Kivu, and Lake Edward. • The countries that make up the Great Lakes region are the Democratic Republic of the Congo, Burundi, Rwanda, and Uganda. • ***Lake Victoria*** is the 2nd largest fresh water lake in the world in terms of surface area. • ***Lake Tanganyika*** is the world's 2nd largest in volume as well as the depth.	• It comprises 5 lakes - Superior, Michigan, Huron, Erie, and Ontario. • They provide a natural border between ***Canada*** **and** ***the United States*****.** • *Lake Superior* is the largest of the five Great Lakes of North America. • *Niagara River*, including Niagara Falls, connects Lake Erie to Lake Ontario. 

1.56 Liberia

- Joseph Boakai was recently declared winner of Liberia's presidential election, beating incumbent George Weah.
- Liberia is a country in ***West Africa*** that shares its borders with Sierra Leone, Guinea, and Ivory Coast.
- Liberia is the only Black state in Africa ***never subjected to colonial rule*** and is Africa's oldest republic.

1.57 Madagascar

- Andry Rajoelina has been re-elected as the President of Madagascar recently.
- Madagascar is the ***world's 4th largest island*** after Greenland, New Guinea, and Borneo and the ***2nd largest island country***.
- Located in the ***Indian Ocean*** off the southeastern coast of Africa.
- Madagascar is surrounded by the Indian Ocean on all sides except for its western border, which lies along the Mozambique Channel.
- ***Andriamamelo Cave*** is located in Western Madagascar and contains ancient rock art.

1.58 Nicaragua

- It is the ***largest country in Central America***, located between the Caribbean Sea and the Pacific Ocean.
- It is known as the land of lakes and volcanoes.
- Nicaragua is home to the ***Bosawas Biosphere Reserve***, the 2nd largest rainforest in the American continent.
- It was the only country in Latin America to be colonized by both the ***Spanish and the British.***
- The country's name is derived from Nicarao, chief of the indigenous people.

1.59 Chila in Peru

- The Chila mountain range lies in the Arequipa Region in the ***Andes of Peru.***
- This mountain range is home to key first waters that give rise to the Amazon River, the longest and mightiest in the world, descend from the glacier, it has lost 99% of its glacial surface since 1962.

1.60 Ecuador

- Daniel Noboa sworn in as Ecuador's President recently.
- Ecuador is a country in ***South America*** that's named after the ***equator,*** which splits the country in two.
- Capital – ***Quito.***
- It's bordered by Colombia and Peru.
- It is home to *Amazon rainforest, Andean paramos, Cloud forests, Galápagos Islands.*

1.61 Essequibo region

The U.N. Security Council scheduled an emergency closed meeting at the request of Guyana following Venezuela's weekend referendum claiming Essequibo region.

- **Geography –** It a *61,600-square-mile area* located in the heart of the ***Guiana Shield***, a geographical region in the northeast of South America.
- It accounts for *two-thirds of Guyana.*
- The area is one of the 4 last pristine tropical forests in the world.
- **Economical value –** It has vast oil and mineral resources.
    - Guyana is set to surpass the oil production of Venezuela, and by 2025, it would become the world's largest per-capita crude producer.
- **Contention –** It is a disputed territory between ***Guyana and Venezuela.***
- *1899 arbitration* demarcated their boundaries which was formally accepted in *1905 agreement*.
- While Venezuela challenged the 1899 arbitration in 1962, the ***1966 Geneva Agreement*** aimed at maintaining the status quo.
- **Recent contention** – Through referendum, Venezuelans approved the claim of sovereignty over Essequibo and were about to immediately begin exploration in the disputed region.
- **International response** – Guyana approached the *International Court of Justice (ICJ)* which refused to ban the referendum but urged ***Venezuela not to alter the status quo***.

Currently, Venezuela has the world's largest proven oil reserves.

*Under **Article 94 of the U.N. Charter**, if any party to a case fails to perform its required obligations, the other party (in this case Guyana) may take the issue to the Security Council.*

1.62 Poland

- Donald Tusk becomes Poland's Prime Minister recently.
- Poland is the *9th largest Country in Europe*. It's bordered by the Balti c Sea to the north.
- **Borders** - Germany, Czech Republic, Slovakia, Ukraine, Belarus, Lithuania and the Russian enclave of Kaliningrad.

1.63 Mount Vinson

- Mount Vinson, also known as Vinson Massif, is the highest mountain in ***Antarctica***.
- It is one of the 7 Summits that are the highest peaks on each of the world's 7 continents.

1.64 Laundromat countries

India leads five countries named as the Laundromat countries that buy Russian oil and sell processed products to European countries, sidestepping European sanctions against Russia.

- Laundromat countries include the 5 countries of ***India, China, United Arab Emirates, Singapore and Turkey*** that are responsible for 70% of Russia's crude oil exports.
- The Price Cap Coalition comprise ***Australia, Canada, the European Union, Japan, the United Kingdom and the United States.***
- India emerged as the leading exporter of refined oil products at 3.7 million tonnes to Price Cap Coalition countries in 2022.
- Among laundromat countries, India, which in April remained the highest global consumer of seaborne Russian crude.

1.65 Operation Karuna

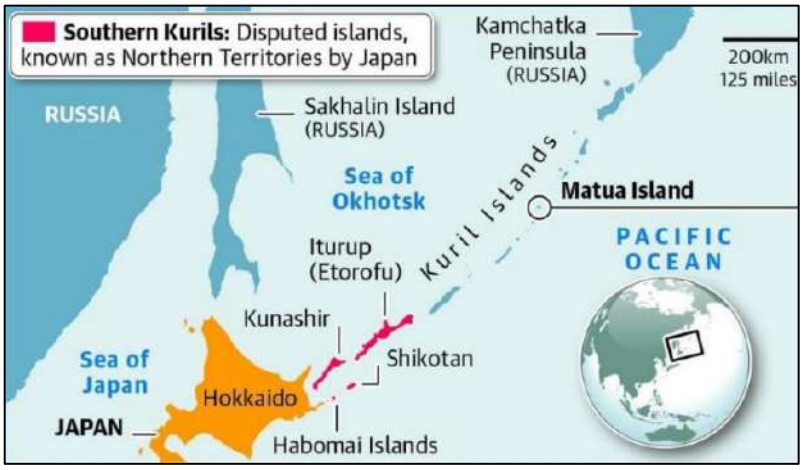
India launched 'Operation Karuna' to assist Myanmar which has been devastated by Cyclone Mocha.

- Super cyclone Mocha hit Bangladesh and Myanmar causing widespread devastation.
- In Myanmar, Rakhine state is the worst-hit while in Bangladesh the Cox's Bazar which shelters in the world's largest refugee camp is worst-hit.
- India launched 'Operation Karuna' to provide ***assistance to Mocha-hit Myanmar.***

1.66 Kuril Islands

The Ukraine war has given some hope to Japanese that the Kuril Islands can be wrestled out of Russia's control.

- The Kuril Islands are strategically located islands stretching between the north of ***Japan's Hokkaido island*** and the southern tip of ***Russia's Kamchatka Peninsula.***
- These are a set of 4 islands situated between the Sea of Okhotsk and the North Pacific Oce an.
- They are - ***Iturup*** (Etorofu in Japanese), ***Kunashir*** (Kunashiri), ***Shikotan*** and ***Habomai Islets.***
- These islands are a point of contention between *Russia and Japan.*



- **Japan's claim -** The islands have been part of it since the early 19th century.
- **Russia's claim -** These islands were seized by Soviet forces in the closing days of WWII.

- Japan, Russia and South Korea calls them in 3 different names.
  - Japan - **Northern territories**
  - Russia - **Kuril Islands**
  - South Korea - **Dokdo islands**

1.67 South China Sea Dispute

Recently, Philippines coast guard removed the floating barrier placed by China that prevented Filipino fishing boats from entering a disputed area in South China Sea.

- South China Sea is an arm of the western Pacific Ocean that borders the Southeast Asian mainland.
- It is bordered by Brunei, China, Indonesia, Malaysia, Philippines, Taiwan and Vietnam.
- It is connected by ***Taiwan Strait*** with the East China Sea and by ***Luzon Strait*** with the Philippine Sea.
- The major rivers draining into the South China Sea are the tributaries of the *Pearl (Zhu) River Delta* including the *Xi River*, the *Red River and the Mekong River*.
- The main route to and from Pacific and Indian Ocean ports is through the *Strait of Malacca and the South China Sea.*
- South China Sea and East China together form China Sea.

Scarborough Shoal dispute

- **Dispute between** – China & Philippines
- **9 dash line** –In 1947, the nationalist Kuomintang party of China issued a map with the so-called "*nine-dash line*".
- It runs as far as 2,000 km from the Chinese mainland and encircles Beijing's claimed waters and islands of the South China Sea claiming as much as 90% of the sea.
- **China's claim** - Claiming historic rights as one of the first people to explore the area, China claimed the sea feature as part of its territory in recent decades and referred it as *Huangyan (Yellow Rock) Island.*
- **Philippines' claim** - The Philippines continues to insist that it has fishing rights over the disputed area because it is part of its EEZ.

> *The 1982 UNCLOS, which China ratified in 1996, defines EEZs as extending 200 nautical miles (370km) from shore, within which the coastal state has the exclusive right to explore, exploit, and manage the living and non-living resources there.*

Other Claims of China

- **Paracel Island dispute** - Between China, Taiwan and Vietnam
- **Spratly island dispute** - Between China, Taiwan, Vietnam, Philippines and Malaysia
  - Second Thomas Shoal is a submerged reef in the Spratly Islands of the South China Sea.
- **Scarborough Shoal dispute** – Between China and the Philippines
- **Senkaku or the Daioyu Islands dispute** – Between China and Japan in East China Sea

1.68 Nagorno-Karabakh Conflict

The European Union lawmakers has urged the bloc to impose sanctions on Azerbaijan for carrying ethnic cleansing against Armenian residents of Nagorno-Karabakh region.

- **Location-** Nagorno-Karabakh is a landlocked, mountainous and forested region falling within the boundaries of ***Azerbaijan*.**
- It is located in the South Caucasus region, which straddles the border between Eastern Europe and western Asia.
- It is roughly made up of Armenia, Azerbaijan, and Georgia.
- **Predominant population**-Nagorno-Karabakh, called Artsakh in Armenian, hosts a predominantly ethnic *Armenian population* having close cultural, social, and historical ties with Armenia.
- It is connected to Armenia through *Lachin Corridor.*
- **Religion**- Armenians are *Christians*, and Azeris are *Muslims.*
- **Places** - The capital of Nagorno-Karabakh is *Stepanakert*, with *Susha* being another major city in the region.

1.69 Agartala-Akhaura Rail Link

A new rail link connecting Northeast India with Bangladesh for a distance of 12.24 kms was inaugurated recently.

Tripura shares an 856-km international border with Bangladesh, the 2nd highest after West Bengal.

- The project is part of India's ***"Act East Policy",*** which aims to promote economic cooperation and develop strategic ties with countries in the Asia-Pacific region.
- Sanctioned in 2003 and signed by both countries in 2013
- **Transport** –From Agartala (Tripura, India) to Akhaura (Bangladesh)
- Immigration checks will be held at *Nischintapur*, the Indian-Bangladesh border.
- 1st station on the Bangladesh side will be ***Gangasagar*.**
- **Funding** – Rs 1255.10 crore (entirely funded by India)
- Existing train link between West Bengal (India) and Bangladesh were Bandhan Express, Maitree Express and Mitali Express.

Agartala-Akhaura Rail Link		
	In India	**In Bangladesh**
Distance	5.46 km	6.78 km
Funding	Ministry for Development of North East Region (DoNER)	Ministry of External Affairs (MEA) as 'Aid to Bangladesh'
Constructed by	Indian Railway Construction International Ltd. (IRCON), a public sector unit under the Indian Railways	Texmaco, a private Indian firm

1.70 Torkham border crossing

- The Torkham border crossing is a major border connecting Nangarhar province of ***Afghanistan with Pakistan's*** Khyber Pakhtunkhwa province.
- After Pakistan's deadline expired for undocumented foreigners, about 1.7 million people were forced to leave Pakistan across the Torkham border.

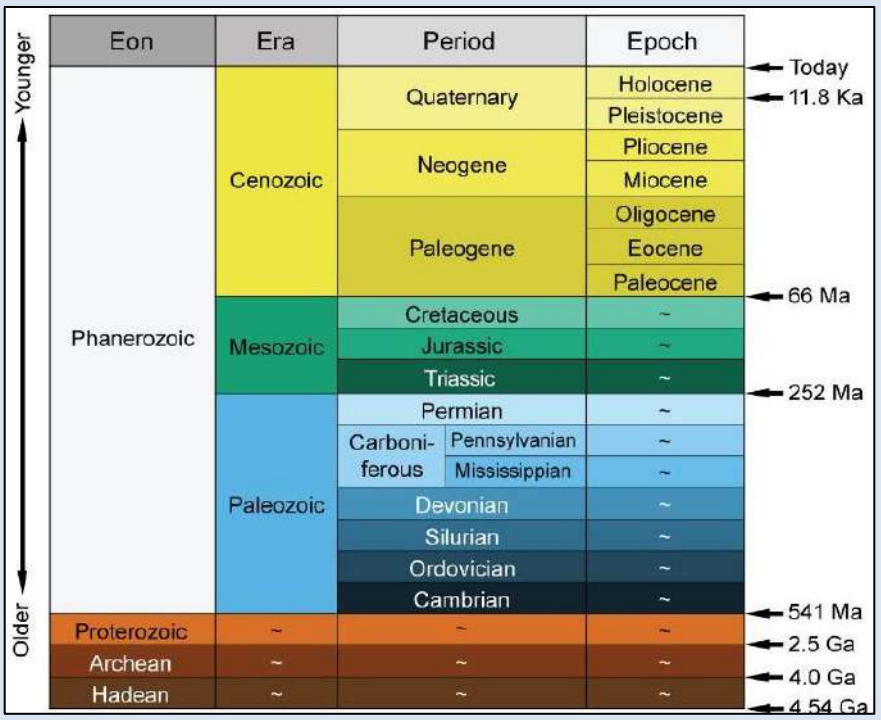
1.71 Anthropocene epoch

Geologists have said that sediments at Crawford Lake in Canada's Ontario have provided evidence that the beginning of the Anthropocene epoch is between 1950 and 1954.

- The Anthropocene epoch as a term was first coined by Nobel Prize-winning chemist ***Paul Crutzen*** and biology professor ***Eugene Stoermer*** in 2000.
- It is an unofficial unit of geologic time that denotes the ***most recent period*** in which the Earth's ecosystem has gone through radical changes due to human impact, especially since the onset of the Industrial Revolution.
- There are numerous phenomena associated with this epoch, such as global warming, sea-level rise, ocean acidification, mass-scale soil erosion, the advent of heat waves, and deterioration of the biosphere.
- The term "Anthropocene" has not been formally adopted by the ***International Union of Geological Sciences (IUGS)***, the international organization that names and defines epochs.

Earth's Geological Time

- The planet's geological time scale is divided into 5 broad categories - ***eons, eras, periods, epochs, and ages*** (Larger to smaller).
- While eon is the broadest category of geological time, age is the smallest category.
- Each of these categories is further divided into sub-categories.
- These units are classified based on Earth's rock layers, or strata, and the fossils found within them.
- We are currently living in the
  - Phanerozoic eon
  - Cenozoic era
  - Quaternary period
  - Holocene epoch
  - Meghalayan age



Crawford Lake

- Crawford Lake is a small, deep lake within a protected conservation area in ***Southern Ontario, Canada*** as part of a UNESCO Biosphere Reserve.
- **Meromictic Lake** - Because of the lake's great depth (24 meters) relative to its surface area it is known as a meromictic lake.
- It refers to a permanently stratified body of water where the bottom layer of water does not mix with the upper layers because of differences in chemical composition.

2. INDIAN GEOGRAPHY

2.1 Indian Metrological Department

- The national meteorological service and the principal government agency in all matters relating to meteorology and allied subjects.
- **Established**- 1875
- **Headquarters**- New Delhi

- **Aegis**- Ministry of Earth Science
- **Mandate** - To take meteorological observations and to provide current and forecast meteorological information for optimum operation of weather-sensitive activities like agriculture, irrigation, shipping, aviation, offshore oil explorations, etc.
- To warn against severe weather phenomena like tropical cyclones, norwesters, duststorms, heavy rains and snow, cold and heat waves, etc., which cause destruction of life and property.
- To provide meteorological statistics required for agriculture, water resource management, industries, oil exploration and other nation-building activities.
- To conduct and promote research in meteorology and allied disciplines.

2.2 Southwest Monsoon

India Meteorological Department (IMD) has predicted that the monsoon will be delayed this year.

- **Southwest monsoon** - It is a sea-breeze from the Arabian Sea and the Bay of Bengal that officially onsets over Kerala on June 1 and retreats from Rajasthan by the end of September.
- **Northeast monsoon** - It is the retreating monsoon, which is the key source of rainfall for several parts of Tamil Nadu, Andhra Pradesh and north interior Karnataka.
- **Rainfall** - Southwest monsoon brings more than 75% of India's annual rainfall.
- **Interdependent** - An early or delayed onset of southwest monsoon over Kerala does not in any way dictate monsoon performance over the rest of the season.
- **Movement** - The monsoon then moves northwards, the speed of its movement dictated by local atmospheric conditions and the development of low-pressure areas.
- **The Andaman and Nicobar Islands** - Start getting the rains at least two weeks before Kerala does.
- **No correlation** - There is no correlation between the date of arrival and intensity of the monsoon.

The interplay of the wind and the monsoon system combined with the Earth system produces twin synchronous cyclones and the twin tropical cyclones are caused by what are called equatorial Rossby waves.

Reasons for the delayed onset of southwest monsoon

- **Cyclone Mocha** - Have weakened the conditions for the arrival of southwest monsoon over the Bay of Bengal region.
- **Cyclone Fabien** - The twin cyclone of Mocha just below the Equator is disrupting the incoming monsoon flows.
- **Strong positive Indian Ocean Dipole (IOD)** - For the past 5 years the strong positive IOD haven been delaying the monsoon.
- **El Nino** - The warming of the equatorial Pacific Ocean that impacts weather events worldwide, is likely to develop earlier than expected.
- El Nino has the effect of suppressing the Indian monsoon rainfall. An El Nino event can increase the risk of a delayed monsoon in India.

The Indian Ocean dipole (IOD) is the difference in temperature between the Eastern (Bay of Bengal) and western Indian oceans (Arabian Sea).

2.3 Summer Cyclones

Cyclone Mocha, a summer cyclone is likely to take place in the Bay of Bengal.

Monsoon Cyclone	Summer Cyclone
Cyclone that occur during the monsoon season.	Cyclone that occur during the summer season.
September, October and November are monsoon cyclone months	April, May and June are considered as summer cyclone months
Monsoon cyclones have regularly hit the east coast of India	Summer cyclones are extremely rare events in the Bay of Bengal

Recent summer cyclones that hit India

- **Cyclone Fani** (May 2019) - The longest-lived cyclone in the Bay of Bengal and the worst cyclone to hit Odisha in this century.
- **Super Cyclone Amphan** (May 2020) - First super cyclone in the Bay of Bengal in the last 21 years and made landfall near Digha in West Bengal.
- **Cyclone Nisarga** (June 2020) - Originated in the Arabian Sea and made landfall on the Maharashtra coast.
- It was the strongest tropical cyclone to strike Maharashtra in June since 1891.
- **Cyclone Yaas** (May 2021) - Formed in the Bay of Bengal, devastated several parts of West Bengal.
- **Cyclone Tauktae** (May 2021) - Originated in Arabian Sea and made landfall along Gujarat's Saurashtra coast.
- **Cyclone Asani** (May 2022) - Formed in the Bay of Bengal and brought heavy rains in Kerala, Andhra Pradesh and Odisha.

2.4 Increase of Cyclones in Arabian Sea

According to a new study, human induced climate change is causing more frequent and intense cyclones in the Eastern Arabian Sea.

- **Cyclone** - Any large system of winds that circulates about a centre of low atmospheric pressure in a counter-clockwise direction north of the Equator and in a clockwise direction to the south.
- **Occurrence** - Cyclonic winds move across nearly all regions of the Earth except the equatorial belt.

There has been an 80% increase in the total duration of cyclones in the Arabian Sea during the last two decades.

- **Cause** - By atmospheric disturbances around a low-pressure area distinguished by swift and often destructive air circulation.
- The Bay of Bengal and Arabian Sea which make up the North Indian Ocean, accounts for *6% of all global tropical cyclones* annually.

Important cyclones in Arabian Sea

- Cyclone Tej - 2023
- Cyclone Biparjoy - 2023
- Cyclone Tauktae – 2021
- Cyclone Nisarga – 2020
- Cyclone Kyarr- 2019
- Cyclone Maha
- Cyclone Maha
- Cyclone Vayu

Reasons attributed to increasing cyclones in Arabian Sea

- **Global warming** - It is causing surface sea temperatures to rise and causing a change in the Arabian Sea's character.
- This is leading to more severe cyclones forming and sustaining over it.
- **Vertical shear** - It refers to how strongly the winds can change from the surface to the top of the atmosphere.
- Weak vertical shear promotes the formation of cyclones.
- **Positive Indian Ocean dipole (IOD) phase** – It refers to warmer sea surface temperatures in the western Indian Ocean relative to the east.
- Warming of Arabian Sea can increase the frequency and intensity of tropical cyclones in the North Indian Ocean.

2.5 Cyclone Mocha

The cyclone Mocha is the strongest cyclone on earth so far in this year.

- Cyclone Mocha, which formed over the southeast Bay of Bengal, intensified into a very severe cyclonic storm.
- It made landfall on the Myanmar coast near Sittwe and Cox's Bazar (Bangladesh).
- The India Meteorological Department (IMD) categorised Cyclone Mocha as an '***Extremely Severe Cyclonic Storm'.***
- Mocha became the strongest cyclone ever recorded in the North Indian Ocean, including for all seasons and in both Arabian Sea and Bay of Bengal, since 1982.

Quick Facts

'Stalling' is a phenomenon where a cyclone sustains on a water body, gaining moisture for a longer time before entering the land

- It also became the strongest cyclone in the North Indian Ocean during the pre-monsoon season, tying with Cyclone Fani.
- It did not undergo 'stalling', but brought heavy rainfall over the north Myanmar-southeast Bangladesh coasts.

2.6 Cyclone Biparjoy

After Mocha in the Bay of Bengal, the second storm of the 2023 North Indian Ocean named Biparjoy has developed in the Arabian Sea.

- A very severe cyclonic storm along the coastline of Karnataka, Goa and Maharashtra in the Arabian Sea
- The cyclone is expected to keep the monsoon a little subdued.
- The name "Biparjoy" was suggested by ***Bangladesh*** and the word means 'disaster' or 'calamity' in Bengali.
- **Naming of tropical cyclones** - Worldwide, there are 6 Regional Specialised Meteorological Centres (RSMCs) and 5 regional Tropical Cyclone Warning Centres (TCWCs) mandated for issuing advisories and naming of tropical cyclones.
- Indian Metrological Department (IMD) is one of the six RSMCs to provide tropical cyclone and storm surge advisories to 13 member countries under the WMO/Economic and Social Commission for Asia-Pacific (ESCAP) Panel.
- Countries include Bangladesh, India, Iran, Maldives, Myanmar, Oman, Pakistan, Qatar, Saudi Arabia, Sri Lanka, Thailand, United Arab Emirates and Yemen.

2.7 Cyclone Michaung

Cyclone Michaung made landfall over Nellore in Andhra Pradesh as a super-cyclonic storm.

- **Origin-** The cyclone developed from a *low pressure area* in the southwest ***Bay of Bengal.*** It gradually intensified into a deep depression, a cyclonic storm, and finally a super-cyclonic storm.
- **Intensification-** They were aided by warm sea surface temperatures and the *Madden-Julian oscillation*, a weather anomaly that influences rainfall patterns.
- **Course of action**- It moved northward towards the Andhra Pradesh coast, while bringing heavy rain and strong winds to north Tamil Nadu. It made landfall near Bapatla district, and weakened into a depression over land.
- **Naming convention**-The name Michaung was suggested by ***Myanmar*** symbolises *strength and resilience* following the list of names prepared by *World Metrological Organisation* and the United Nations Economic and Social Commission for the Bay of Bengal and the Arabian Sea.
- The name of each cyclone is picked from this list and cycles through each country's suggestion.
- **Super-cyclonic storm**- It was the 4th tropical cyclone of the year over the Bay of Bengal, and the *first super-cyclonic storm since 1999*. It reached a peak intensity of 90-100 km/hr winds gusting to 110 km/hr at the time of landfall.

2.8 Cyclone Midhili

- It is a cyclonic storm over the ***Bay of Bengal*** and the name Midhili was proposed by ***Maldives.***

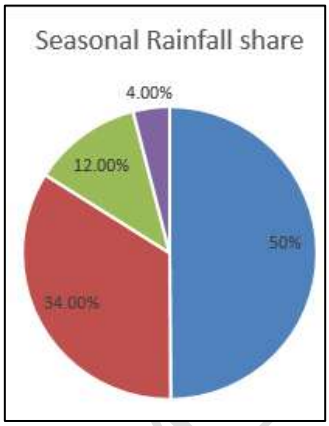
2.9 Extreme December rainfall in Tamil Nadu

Tamil Nadu has witnessed heavy rainfall in December 2023.

- **Weather conditions** – The state is vulnerable to extreme weather conditions, while coastal districts experience flooding, other areas experience severe droughts.
- **Annual rainfall – About 987mm** with a range varying from 317.4 mm to 1890.5 mm over the 63 years period (1951-2013).
- **Coefficient of variation in annual rainfall** – It lies in the range of 0.21 to 0.37 (21 to 37%) across the districts of Tamil Nadu.

Unlike Tamil Nadu, the rest of India receives the maximum rainfall in the months of June, July, August, and September months (monsoon).

- **Rainfall share** – Tamilnadu receives the maximum rainfall (around 443.3mm) during post-monsoon (October, November, and December) mainly due to cyclones formation in Bay of Bengal.
- Since October 1, Tamil Nadu has received 450mm of rainfall.



Causes of extreme rainfall over southern TN

- **Strong northeast monsoon** – It remained vigorous over Tamil Nadu since mid-December, bringing in steady rain bands, especially over the south Tamil Nadu and neighbouring Kerala.
- **Movement of cyclonic circulation** – It was developed in the southwest Bay of Bengal in December 16, located off the western Sri Lankan coast.
- As this system moved westwards and reached southern Tamil Nadu, it gave impetus to the northeast monsoon winds, persisted over the southern Tamil Nadu region.
- A **heavy cloud convection** was observed here, resulting in exceptionally heavy rainfall (more than 200mm in 24 hours) over Thoothukudi, Tirunelveli and Kanyakumari districts of Tamil Nadu and Idukki district of Kerala.

2.10 Peninsular and Transboundary Rivers

- *As per recent study, peninsular river basins in India are more likely to face flooding than transboundary rivers*

Aspects	Peninsular Rivers	Transboundary Rivers
About	It originates and flow within the Indian subcontinent, mainly in the peninsular region.	They are the rivers that crosses one or more international boundaries such as the Indus, the Ganga, and the Brahmaputra.
Place of origin	Peninsular plateau and central highland.	Himalayan mountain covered with glaciers.
Nature of flow	Mainly rain-fed and ***non-perennial*** as it is dependent on monsoon rainfall.	***Perennial*** as it receives water from glacier and rainfall.
Nature of river	Smaller, fixed course with well-adjusted valleys.	Long course, flowing through the rugged mountains experiencing head ward erosion
Catchment areas	It is relatively smaller basin than transboundary rivers.	Very large basins.
Age of the river	Old rivers and have less water flow than transboundary rivers.	Young and youthful, they have more water flow than peninsular river.
Characteristics	They have reached their base level and have gentle slopes, broad valleys, and shallow channels. They form deltas at their mouth where they deposit their sediments.	They are still in the process of reaching their base level and have steep slopes, narrow valleys and deep channels. They form estuaries at their mouth where they meet the seawater.

2.11 Flood Management

Recently, North India including Delhi witnessed heavy rainfall resulting in flood.

- Flooding is an *overflowing of water* onto land that is normally dry.
- **Types of Floods**
  - **Flash floods -** It is caused by rapid and excessive rainfall that raises water heights quickly, and rivers, streams, channels or roads may be overtaken.
  - **River floods -** It is caused when consistent rain or snow melt forces a river to exceed capacity.
  - **Coastal floods** - It is caused by storm surges associated with tropical cyclones and tsunami.

- **Causes of flooding -** Flood is often caused by
    - **Natural causes -** Heavy rainfall, rapid snowmelt, storm surge from a tropical cyclone, tsunami in coastal areas, etc.
    - **Manmade causes** - Factors such as population growth, rapid urbanisation, increased developmental and economic activities in flood plains.

CAUSES OF FLOODING

Meteorological Factors

- **Extreme rainfall -** It results in flash flood which is a cause of concern in low lying areas and urban cities where the damage inflicted is huge.
- **Sea surge -** Storm surge is caused by tropical cyclones where it causes sea water to overflow into coastal regions.
    - As per the Intergovernmental Panel on Climate Change (IPCC), it is estimated that before 2030, large parts of Kolkata could face immense flooding, causing the city to submerge.
- **Cloud Burst** - It occurs due to intense precipitation in a short duration which can sometimes be accompanied by hail and storm and can cause a flood.
    - **Example** - In 2022, several people were killed in the cloud burst and flash flood incident in Himachal Pradesh and Uttarakhand.
- **Global Warming** - Due to the increased rise in global temperature, glaciers of the Himalayan range start to melt.
- As a result, the seawater level also rises, causing floods in surrounding years.
- **Earthquakes and Landslides** - A shift in tectonic plates can lead to alteration in the volume and course of surface water resulting in flood hazard.
    - **Example** - In 2013, heavy rain in Uttarakhand caused flood due to landslide and flash flood.

Physical Factors

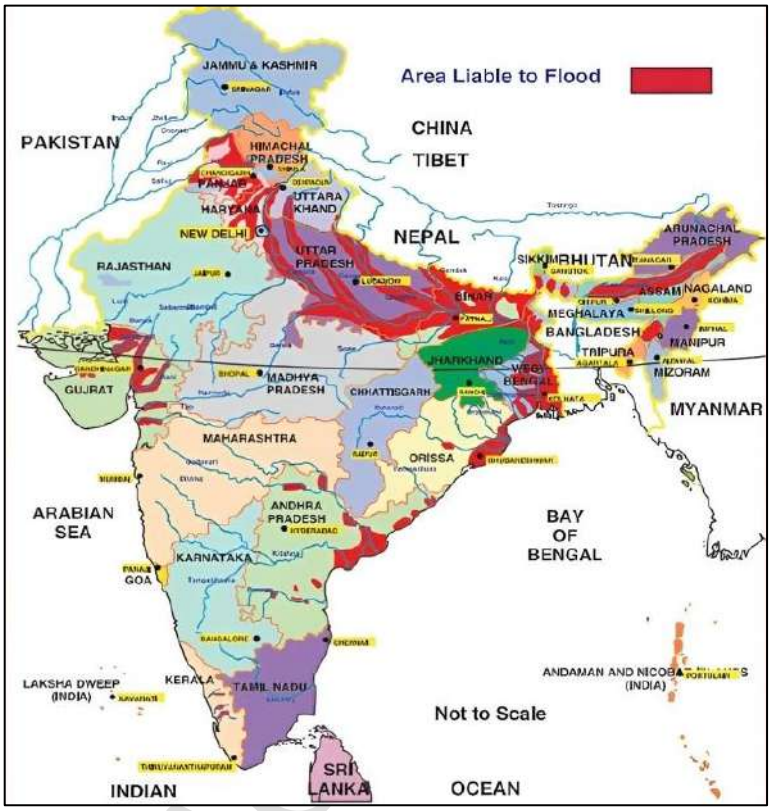
- **Insufficient drainage management -** Due to this, areas are flooded by accumulation of water from heavy rainfall.
- **Change in river course** - Due to erosion of the banks, rivers change course and causes flood.
    - **Example** - Recent Yamuna flooding in Delhi 2023 one of the reason is change in river course.
- **Catchment area -** During monsoon, when excess water exceeds the limit of holding capacity of the catchment area (area from where the rainfall water flows into a river), it leads to floods.

Human Factors

- **Siltation -** As particles remain suspended in the river and accumulated in the riverbed, it disrupts the flow of the river, causing a flood.
- **Improper Agricultural Practices -** Excessive irrigation applied to command areas and increase in ground water levels due to seepage from canals and irrigated fields lead to floods.
- **Deforestation -** Trees act like a sponge that helps to hold soil and water and prevent flooding.
- As trees are being cut down at a fast pace, more water runs towards a river during heavy rainfall and causes flood.
- **Collapse of Dams -** Dams are built to store water and provide water to people. As dams are human-made, these can be worn out and subsequently collapse causing floods.
    - **Example -** In 2018, Kerala flood is due to opening dam floodgate which is the worst flooding episode.
- **Floodplain encroachment -** This reduces the water carrying capacity of rivers which is brought from upper catchment areas and cause flooding.
    - **Example** - In 2015, Chennai was worst hit by floods, one of the reason is encroachment

Efforts taken regarding flood management

Government measures



- Flood management falls under the purview of ***State Government.***
- The Union Government supplements the efforts of the States by providing technical guidance and also promote financial assistance for management of floods in critical areas.
- **NDMA -** National Disaster Management Authority was set up in 2005 for prevention and mitigation effects of disasters including flood disasters.
- **Central Water Commission (CWC) -** It was set up in 1945 for achieving the goal of furthering and promoting measures of flood control, conservation and utilization of water resources.
- **Ganga Flood Control Commission -** It was set up in 1972 for preparation of comprehensive plan of flood control for Ganga Basin States
- **Brahmaputra Board -** The Government set up Brahmaputra Board under Brahmaputra Board Act, 1980 to survey and conduct investigations in Brahmaputra and Barak valley.
- **National Water Policy (2012) -** It suggested that through reservoir operation, the flood cushion can be set up to reduce the trapping of sediment during the flood season.
- **National Hydrology Project (2016) -** World Bank funded Central sector scheme which gathers hydro-meteorological data that will be stored and analyzed on a real-time basis.
- **Flood Management and Border Areas Program (2017-20) -** It is implemented for effective flood management, and soil and anti-sea erosion.

Engineering /Structural Measures

- **Dams -** Example - Idukki dam across river Periyar, Gandhi sagar dam across river Chambal etc.,
- **Dykes -** Dikes, also called levees, are earthen embankments that are raised parallel to the river flow at some suitable distance from the deep river.
- **Reservoirs -** Reservoir is formed upstream when a dam or a bund is built across a river. Such a reservoir will store ample water that enters the river upstream of the dam.

Administrative / Non-structural Measures

- **Early warning system -** It will help in timely evacuation of people and movable property to safer grounds.
- **Flood plain zoning -** Flood-plain zoning measures aim at demarcating zones or areas likely to be affected by floods of different magnitudes or frequencies and probability levels.

2.12 Urban Flooding

Due to climate change, urban population growth there has been increase in the urban flooding.

- The flooding of land or property in a built environment, especially in densely populated cities where rainfall exceeds capacity of drainage system is known as ***urban flooding.***
- It is a ***man-made disaster*** which is caused not only by higher precipitation but also by unplanned urbanization.
- Urban flooding is significantly different from rural flooding as urbanization leads to developed catchments, which increases the

- Flood peaks from 1.8 to 8 times and
- Flood volumes by up to 6 times

- There has been an *increasing trend of urban flood disasters* in India over the past several years whereby major cities in India have been severely affected.
- **Special feature in India**
  - Heavy rainfall during monsoons
  - Storm surge affect coastal cities/ towns
  - Urban heat island due to global warming
  - Sea surge increase the level of sea in coastal cities

Urban floods in India	Reasons
2015 Chennai flood	Floodplain encroachment
2020 Hyderabad flood	Depression and flash flood
2022 Bengaluru flood	Poor urban management
2023 Delhi flood	Prolonged rainfall and floodplain encroachment

Causes of urban flooding

- **Hydrological factors-** It is caused by change in river course, presence of high tide and synchronisation of runoffs of various parts of watershed.
- **Urban heat island-** It resulted in increase in rainfall leads to flash flood which is a cause of concern in low lying areas and urban cities where the damage inflicted is huge.
- **Sea surge-** Storm surge due to tropical cyclones causes sea water to overflow into cities nearby coastal regions.
- **Concretisation-** Building huge structures in urban areas leads to insufficient drainage infrastructure leading to urban flooding.
  - Example- 2021 Chennai flood.
- **Pluvial flooding-** It is a rain-driven flooding that results from the excess of natural or engineered drainage capacity.
- **Deforestation**- Trees act like a sponge that helps to hold soil.
- As trees are being cut down at a fast pace to make way for urbanisation to grow, more water runs towards a river during heavy rainfall and causes flood.
- **Floodplain encroachment-** This reduces the water carrying capacity of rivers which is brought from upper catchment areas and cause flooding.
  - One of the reasons for *2015 Chennai floods* is floodplain encroachment.
- **Drainage systems** - Stormwater drainage systems in the past were designed for rainfall intensity of 12 – 20 mm.
- These capacities have been getting very easily overwhelmed whenever rainfall of higher intensity has been experienced.
- **Unplanned release of water from dam**-Kerala flood in 2018 is due to prolonged rainfall accompanied by unplanned release of water from Idukki dam.
- **Climate change** - Influence of urban microclimate and climate change are other factors.

Urban flooding is the highest reported climate hazard facing C40 cities with 92% of C40 cities experiencing flash or surface flooding due to rainfall or riverine flooding.

International Practices to Mitigate Urban Flooding	
Country	**Best practices**
South Africa	Water Sensitive Urban Design and Sustainable Drainage Systems
China	Sponge city initiative to reduce flood and enhance water supply security
Rotterdam	Raingardens and permeable pavements
Dutch model	The country is dotted with ponds, lakes, seaside parking garages and city plazas that double up water storage

Steps taken to mitigate urban flooding

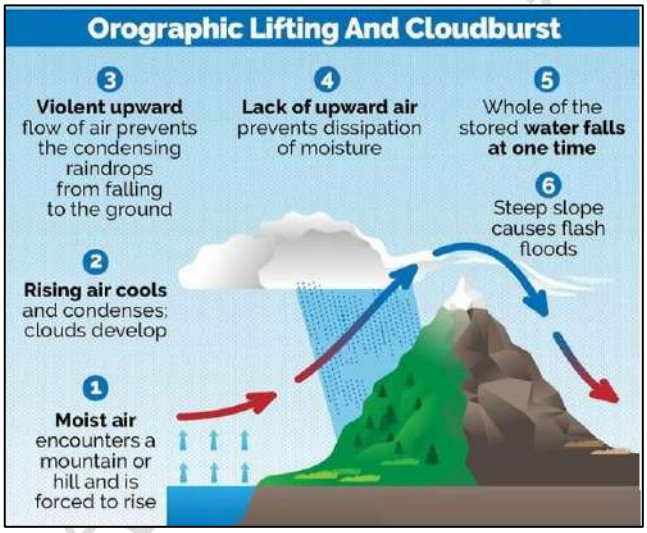
- **NDMA –** After the Mumbai floods of 2005, NDMA has for the first time decided to address urban flooding as a separate disaster, delinking it from floods.
- **Atal Mission for Rejuvenation of Urban Transformation (AMRUT) -** It is an initiative to provide basic civic amenities to the urban areas to improve the quality of life.
- **Smart Cities Mission-** It is initiated to drive economic growth and improve the quality of life of people by enabling local development and harnessing technology as a means to create smart outcomes for citizens.
- **HRIDAY Misison-** National Heritage City Development and Augumentation Yojana which aims to conserve heritage, urban planning and increase the economic growth of the heritage cities.

2.13 Cloud Burst in Himachal Pradesh

Himachal Pradesh witnessed a heavy rainfall along with landslides in which at least 22 people died.

According to the Indian Meteorological Department, an event of extremely heavy rainfall is determined as a cloudburst when "10 cm rainfall is received at a station in one hour"

- It is an extremely high amount of precipitation in a *short span* of time.
- It is a localised but intense rainfall activity that can cause widespread destruction, especially in hilly regions.
- **Region-** It usually occurs over a small geographical region (20-30 sq.km).
- **Criteria**- Rainfall of *10 cm or more in an hour over a roughly 10 km x 10-km area* is classified as a cloudburst event.
- By this definition, 5 cm of rainfall in a half-hour period over the same area would also be categorized as a cloudburst.
- **Mechanism-** It happens when saturated clouds are unable to produce rain because of the upward movement of very warm current of air.
- **Cloud formation**- This updraft movement of warm wind along with clouds forms the *Cumulonimbus clouds*.



- It can grow up to 12-15 km in height through the entire troposphere (occasionally up to 21 km) and can hold huge amounts of water
- Instead of dropping down, raindrops get bigger in size and get pushed up due to the air current.
- Eventually they become too heavy to hold and drop down, leading to more rain than usual.

Causes of cloud burst

- **Monsoon-** It often occurs during monsoon season when the South West Monsoon winds bring in large amount of moisture which fuels the cloudburst.
- **Orographic lift-** It is affected by factors like local topology, wind systems, and temperature gradients between the lower and upper atmosphere.
- **Thunderstorm-** It is caused due to excessive amount of condensation in the cloud during thunderstorm.
- **Climate change**- Global warming is leading to more evaporation of water and because of this dense cumulonimbus clouds are forming, resulting in intense rainfall.
    - Even 1 degree Celsius rise in global temperature can cause change in monsoon extremes and frequent cloudburst.
- **Regions more prone-**
    - The Himalayas
    - Western Ghats
    - Northeastern hill States of India
    - Coastal regions

Recent cloudbursts

- *Himachal Pradesh-2003*
- *Ladakh-2010*
- *Uttarakhand-2013*
- *Northeastern states and Western Ghats- 2022 monsoon*

- **Landslides-** The heavy spells of rain on the fragile steep slopes trigger landslides, debris flows, and flash floods, causing large-scale destruction and loss of people and property.
- **Coastal cities-** They are particularly vulnerable to cloudbursts since the flash floods make the conventional stormwater and flood management policies in these cities dysfunctional.
    - Example- Chennai Floods 2015.

2.14 Sikkim Flash Floods

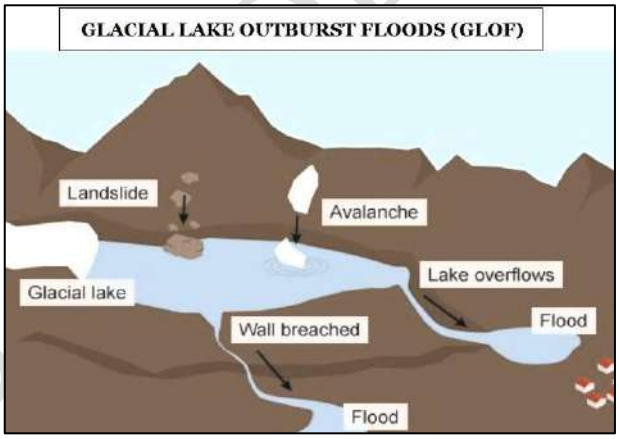
A cloud burst over Lhonak Lake in North Sikkim resulted in a flash flood in the Teesta River in Lachen Valley killing around 14 people.

> *A flash flood is a sudden flood of water that occurs within a short frame of time after a precipitation event, which is generally less than 6 hours.*

Causes of Sikkim floods

- **GLOF & excess rainfall** - The primary reason appears to be a likely combination of excess rainfall and a Glacial Lake Outburst Flood (GLOF) at South Lhonak Lake.
- **Rough weather -** According to National Disaster Management Authority (NDMA), out of the 7500 glacial lakes in the Himalayan ranges, Sikkim has 10% of it.
- Further, this region is known for highly localised heavy rainfall events.
- **Melting of glaciers -** The lake is rapidly growing in size due to the melting of glaciers.
- GLOFs occur when lakes formed by melting glaciers suddenly burst open.
- **Nepal earthquake -** Scientists are also exploring whether the recent earthquake that struck Nepal is responsible for the south Lhonak lake outburst.

Glacial Lake Outburst Flood



- **Glacial lakes-** They are large bodies of water that sit in front of, on top of, or beneath a melting glacier.
- **Example-** Uttarakhand's Kedarnath flash floods along with GLOF in 2013 caused by Chorabari Tal glacial lake.
- **GLOF** - Glacial lakes are mostly dammed by unstable ice or sediment composed of loose rock and debris.
- If the boundary around them breaks, huge amount of water rush down the mountains, causing flood in the downstream areas.
- It is fast, and can be triggered by various causes, including glacial melting, rising water levels, and earthquakes.
- The lake outburst led to the breach of the ***Chungthang dam***, which is the largest hydropower project in the state.
- Bridges such as the ***Indreni bridge, Ritchu Bridge, Sangkhalang bridge***, etc. were washed away.

Steps taken to prevent GLOFs

- **The Sendai Framework (2015-2030)** – It is a global blueprint for disaster risk reduction and prevention.
- **Coalition for Disaster Resilient Infrastructure -** CDRI is an international climate initiative by India in 2019 to promote resilient climate-proof critical infrastructure in member countries.
- **National Disaster Management Authority (NDMA)** - NDMA, headed by the Prime Minister of India, is the apex body for Disaster Management in India.
- Central Water Commission (CWC)/ National Remote Sensing Agency (NRSA)/ State governments also check for landslides and blockages in rivers with the help of satellite imageries.

Teesta River

- It is a major transboundary river that flows through ***India and Bangladesh.***
- It originates from the Pahunri (or Teesta Kangse) glacier and flows through Sikkim and West Bengal before flowing into Bangladesh.
- It is a ***tributary of Jamuna River (Brahmaputra River).***

- **Aapda Mitra** – Launched in 2016, it is a *central sector scheme* implemented by NDMA to train community volunteers in disaster response in selected 30 most flood prone districts of 25 states including Sikkim.
- **Doppler radars** - The India Meteorological Department (IMD) has been using Doppler radars, a flash floods forecasting and warning systems.
- **Sikkim State Disaster Management Authority (SSDMA)** – It is the nodal institution for planning, co-ordination and monitoring for disaster prevention, mitigation, preparedness and management in the State.

- **Flood Management Programme** – Under the scheme, critical anti-erosion works have been undertaken in Ganga Basin, Brahmaputra and Barak Valley States.

2.15 Flood Watch Application

India launches Flood Watch app for real-time flood updates.

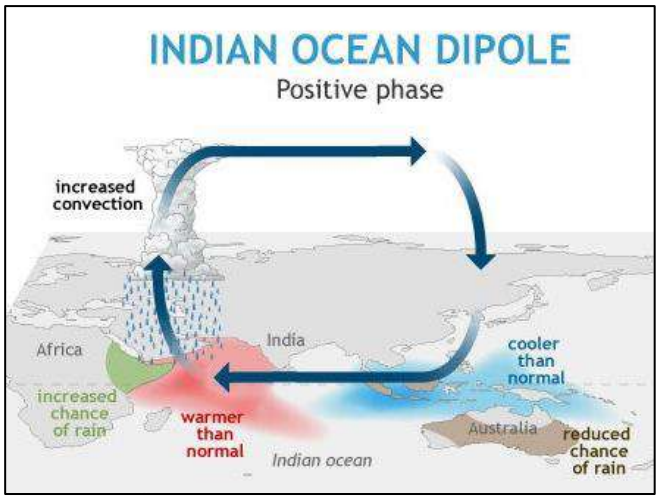
- **Launched by – *Central Water Commission (CWC)***
- It provides a ***7-day advisory*** on the chances of floods at various stations in the country where the CWC maintains its measurement gauges.
- The app has a map of India with coloured circles at water stations across the country indicating the current risk of flooding.
- **Colour Coding –** A 'green' circle indicates 'normal'; yellow, above normal; orange, 'severe' and red, 'extreme'.
- The warnings are in English or Hindi with an option for a voice-enabled prompt.
- The app will also provide State-wise/basin-wide flood forecast up to 24 hours or flood advisory, up to 7 days, that can be accessed via selecting specific stations.

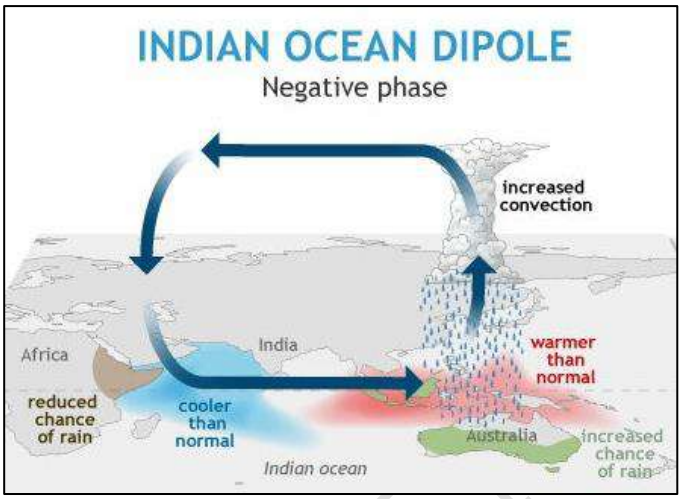
2.16 Indian Ocean Dipole and its effect on El Nino

Experts have predicted a positive Indian Ocean Dipole (currently, it is neutral) in the coming months

- The Indian Ocean Dipole (IOD) is a coupled ocean atmosphere phenomenon in the Indian Ocean.
- IOD is defined by the ***difference in sea surface temperature*** between the western pole in the Arabian Sea (western Indian Ocean) and an eastern pole in the eastern Indian Ocean south of Indonesia.
- The IOD is sometimes called ***India's El-Nino*** and its impact can be seen in weather and climate patterns in India and as far as Indonesia, Australia, New Zealand and Africa.

Positive event	Neutral event	Negative event
• Warmer sea surface temperatures in the western Indian Ocean relative to the east. • It brings ***more rainfall to India.***	• Water flows from the Pacific between Indonesia's islands, keeping seas warm to the northwest of Australia. • Air rises above this area and falls across the western half of Indian Ocean basin, blowing westerly winds along the equator. • This has ***very less impact of Indian monsoon.***	• Cooler sea surface temperatures in the western Indian Ocean relative to the east. • It brings ***less rainfall to India.***





- **El Nino** - El Nino is the warming of sea waters in Central-east Equatorial Pacific that occurs every few years (Warm phase off the coast of Peru).
- Over India, the El Nino has the impact of suppressing monsoon rainfall.
- **La Nina** - La Niña sees cooler than average sea surface temperatures in the equatorial Pacific region (Cool phase).
- In the Indian context, La Nina is associated with good rainfall during the monsoon season.
- Both these conditions, together called El Nino Southern Oscillation or ENSO, affect weather events across the world.

To know more about El Niño-La Niña Weather Patterns, click here

Effect of IOD on ENSO

- A ***positive IOD event*** is often seen developing at times of an ***El Nino,*** while ***a negative IOD*** is sometimes associated with ***La Nina.***
- During El Nino, the Pacific side of Indonesia is cooler than normal because of which the Indian Ocean side also gets cooler.
- That helps the development of a positive IOD.
- If both IOD and ENSO are strong their circulation can impact each other.
- Compared to ENSO events, the impacts of IODs are much weaker.

2.17 Southern Annular Mode (SAM)

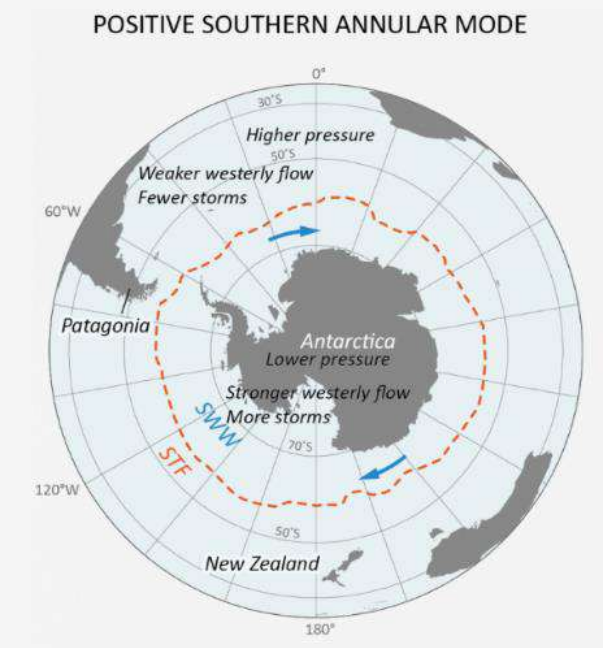
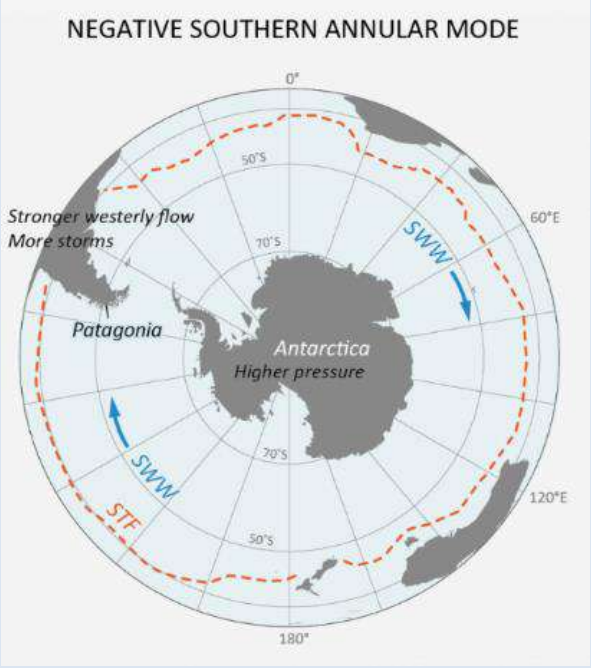
Indian National Centre for Ocean Information Services (INCOIS) has discovered that the Southern Annular Mode (SAM) plays a pivotal role in shaping the sea conditions across the Indian Ocean.

- **SAM** – It refers to the ***north-south movement of Southern Westerly Winds*** over timescales of 10 to 100 of years.
- They blow almost continuously in the mid- to high-latitudes of the southern hemisphere and so called as ***Antarctic oscillations***.

Swell waves *are the regular, longer period waves which are self-sustaining and generated by energy beneath the ocean's surface, no longer needing local wind. The crucial swell generation regions in Indian Ocean- extratropical southern Indian Ocean (ETSI) and tropical southern Indian Ocean (TSIO).*

- Usually defined as the difference in zonal mean sea level pressure at 40°S (mid-latitudes) & 65°S (Antarctica).
- **Importance** – It shapes the wave patterns over extended time frames and a climate driver by influencing rainfall and temperature.

Positive SAM phase	Negative SAM phase
There is *lower anomalous air pressure over Antarctica*, and higher anomalous air pressure over the mid-latitudes.	The *Southern Westerly Winds expands northwards towards equator.*

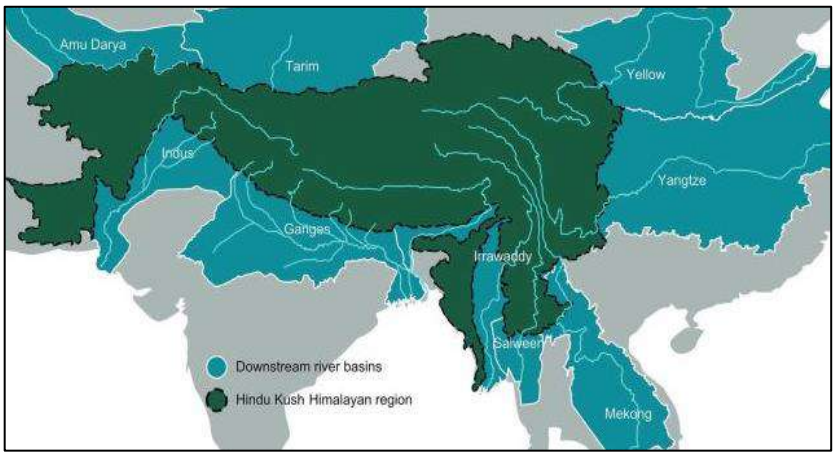
	Thus, bringing cold, wet weather to Patagonia and decreased Circumpolar Deep Water upwelling on the Antarctic Continental Shelf.
Increased wave activity is witnessed in Indian Ocean with *increased wave height* in the Arabian Sea.	*Reduced wave heights* are witnessed in the Arabian Sea.
	

- **Significance of SAM study –** Predicting the phases of SAM helps in identifying the fair Sea state windows in monsoons that can be utilised by oil and shipping industries for their operations.
- It helps in better coastal planning, resource management and also in disaster preparedness.

2.18 Hindu-Kush Mountains

The report 'Water, ice, society, and ecosystems in the Hindu Kush Himalaya' was released by the International Centre for Integrated Mountain Development (ICIMOD).

- The Hindu Kush Himalaya (HKH) region extends 3,500 km ***over 8 countries*** from Afghanistan in the west to Myanmar in the east.
- **Range Countries -** Afghanistan, Pakistan, India, Nepal, Bhutan, China, Bangladesh and Myanmar.
- The HKH region, harbours the highest mountain ranges in the world.
- It also contains the largest volume of ice on earth outside of the polar areas and is called ***'Third Pole'***.
- The range is also the source of major Asian river system and called as ***'Water tower of Asia'***.
- Ice and snow in the HKH are an important source of water for *12 rivers* that flow through *16 countries* in Asia.
- The basins of these rivers provide freshwater and other vital ecosystem services to *1.9 billion people*, a fourth of the world's population.
- Glaciers act like a '***buffer'*** in the hydrological cycle.



HKM in India

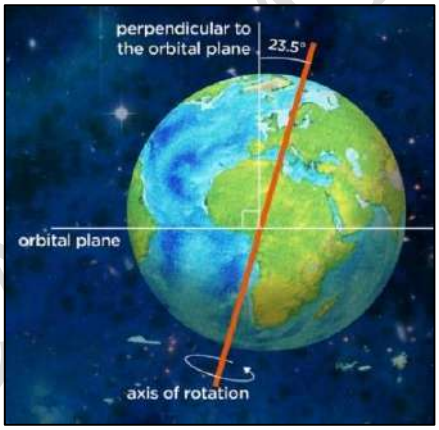
- The entire territory of 11 mountain states & Darjeeling district of West Bengal state are included in the HKH region.
- The 11 states are Assam, Uttarakhand, Himachal Pradesh, Manipur, Jammu & Kashmir, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura, and Arunachal Pradesh.

2.19 Groundwater Extraction & the Earth Axis

A recent study says that humans have used enough groundwater to shift Earth's tilt.

- **Earth's Axis and Poles -** The earth spins about its axis which passes through its centre, this movement is called rotation.
- The ends of the axis are the *North Pole* and *South Pole* respectively.
- This axis is inclined ***23.5 degrees*** away from the vertical that is 66.5 degrees from the horizontal plane of its orbit.
- The earth rotates from west to east, and *once every 24 hours.*
- These are important fixed reference points we use in telling directions on the earth.

According to NASA, data from 20th century shows that spin axis drifted about 10 centimetres per year.

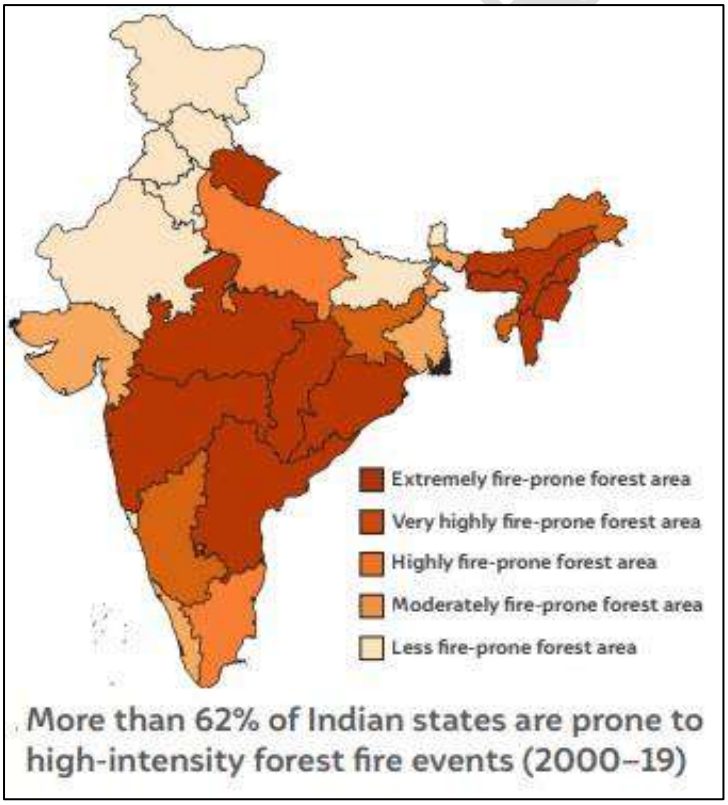


- **Polar Motion** - The phenomenon of shifting of poles and the axis naturally because of the mass distribution of planet changes, is known as polar motion.
- Reasons for polar motion **-** Ocean currents, hurricanes, climate-driven changes in water mass distribution, climate change, etc.
- **Recent Findings** – Between 1993 and 2010, a total of 2,150 Gigatons of groundwater has been removed from earth.
- This has shifted Earth's tilt *31.5 inches eastward.*
- The calculations matched with previous research, which estimated that groundwater extraction *raised global sea levels by 6.24mm* between 1993 and 2010.
- Groundwater extraction from North America and northwestern India (located at the Earth's mid-latitudes), had an enormous impact on the polar motion compared to the extraction in poles or equators.

2.20 Forest Fires

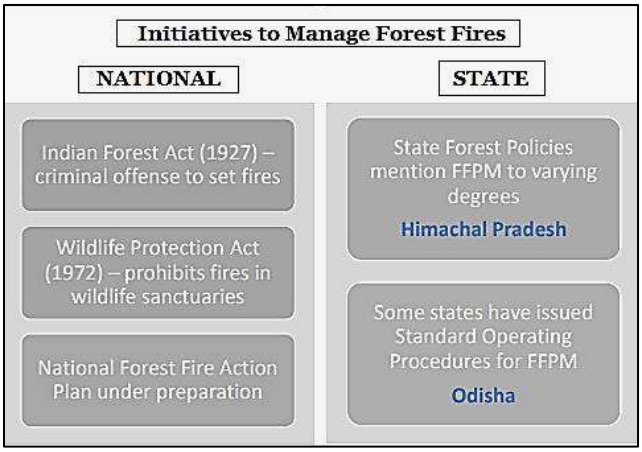
A forest department probe into the bushfires that impacted an area of about 4 sq km in Goa in March concluded that the fires were largely triggered by natural causes.

- Wildfire is also called forest, bush or vegetation fire.



International Centre for Integrated Mountain Development (ICIMOD)

- It is an intergovernmental institution leading the global effort to protect the Hind-Kush Mountains.
- ICIMOD is based in *Kathmandu, Nepal.*
- It has 8 regional member countries - Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan.



- It can be described as any ***uncontrolled and non-prescribed combustion*** or burning of plants in a natural setting such as a forest, grassland, brush land or tundra.
- Wildfire can be incited by human actions, such as land clearing, extreme drought or in rare cases by lightning
- **Types -** There are 3 basic types of wildfires:
    - ***Crown fires*** burn trees up their entire length to the top. These are the most intense and dangerous wildland fires.
    - ***Surface fires*** burn only surface litter and duff. These are the easiest fires to put out and cause the least damage to the forest.
    - ***Ground fires*** (underground or subsurface fires) occur in deep accumulations of humus, peat and similar dead vegetation that become dry enough to burn. - Very difficult to fully put out.

2.21 Chittagong Hill Tracts

Jyotirindra Bodhipriya Larma, an important leader of the Chittagong Hill Tracts (CHT) in Bangladesh has arrived in India.

- It is located in the southeastern part of Bangladesh bordering ***Myanmar and India.***
- CHT combine 3 hilly districts of Bangladesh: Rangamati, Khagrachhari and Bandarban districts.
- CHT is bounded by Tripura on the north, Arakan Hills of Myanmar on the south, Lushai Hills of Mizoram and Arakan Hills of Myanmar on the east and by Chittagong District on the west.
- **Significance -** The CHT region is home to a diverse population that includes the Buddhist, Hindu and Christian minority ethnic groups.
- It is home to the ***Chakmas, Moghs, Lushais, Kuki and Chin communities*** who are common to north-eastern states as well as Bangladesh and Myanmar.
- The region witnessed decades of ethnic insurgency which came to an end through the 1997 CHT Agreement.

Related Topics - Kuki-Chin Refugees, Chittagong Port at CHT, Kuki tribes

2.22 Pakkasuran Malai

Conservationists have criticized the Tamil Nadu Tourism Development Corporation's plan to open up the eco-sensitive area surrounding Pakkasuran Malai to tourism.

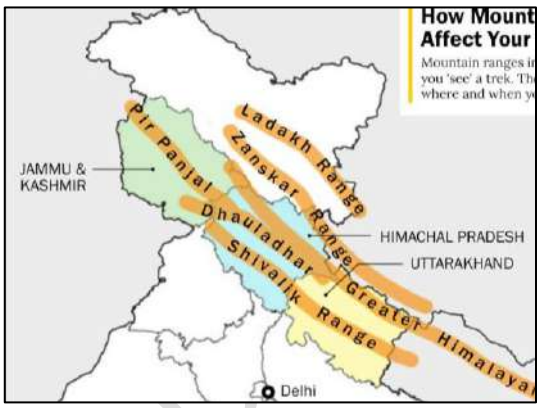
- Pakkasuran Malai is a mountain which is also called as Hullikal Drug.
- It is situated in ***Coonoor, Nilgiri Mountains of Tamil Nadu.***
- It is a *biodiversity hotspot* primarily composed of rocks and grasslands.
- ***Droog Fort*** is a historic fort on the peak of Pakkasuran Malai and it has significant historical, cultural and religious values and qualifies as a sacred grove.
- Sacred groves are patches of primeval forest that some rural communities protect as abodes of deities and it helps in the protection of many rare, threatened and endemic species of plants and animals in the area.

Species in Pakkasuran Malai	
• Gunther's burrowing snake (Plecturus guentheri) • Valeriana leschenaultii, an endemic species (Critically Endangered) • Nesting site for the Shaheen falcon (Falco peregrinus peregrinator)	• Nilgiri martens • Mouse deer • Indian gaurs • Barking deer • Sloth bears • Indian giant flying squirrels • Indian giant squirrels • Brown palm civets • Indian crested porcupines

2.23 Pir Panjal Range

The recent killing of 2 Army officers and a J&K police officer spotlights the areas south of the Pir Panjal range, which have seen more focus of counter-terror operations in the valley.

- The Pir Panjal Range is a group of mountains in the ***inner Himalayan region***, the largest in the lower group of the majestic Himalayas.
- The Pir Panjal range is also called ***Pir Ki Gali*.**
- **Extension -** Extends from ***Nilam (Kishanganga) River*** in Pakistan administered Kashmir, running southeast through Jammu & Kashmir to the upper Beas River in the north-western part of Himachal Pradesh.
- The Himalayas show a gradual elevation towards the Dhauladhar and Pir Panjal ranges.
- **Direction -** It runs from the west-northwest direction to east-southeast direction.
- **Peaks -** Deo Tibba and Indrasan are the tallest peaks in the Pir Panjal Range.



- **Passes -** Pir panjal, Banihal, Sinthan, Rohtang La.
- **Significance -** The Pir Panjal Range serves as an effective climatic barrier and blocks the monsoon winds to reach the higher Himalayan slopes and the main valley of Kashmir.

2.24 Palghat Gap

The Palghat Gap is a significant discontinuity in the Western Ghats, which has unique features from the rest of Western Ghats.

- The Palghat Gap is a significant discontinuity in the ***Western Ghats*** of about 40 km wide.
- The steep ***Nilgiris and Anamalai hills*** both rising above 2,000 MSL, on either side of the Palghat gap.
- The Gap is a geological *shear zone* that runs from east to west. (Shear zones are weak regions in the earth's crust).
- **Origin -** After Australia and Africa broke off from the Gondwana landmass, India and Madagascar remained as one landmass.
- A large-scale volcanic activity split the two and the split occurred where the Palghat Gap is located.
- This is mirrored in the ***Ranotsara Gap*** on the eastern face of Madagascar.
- **Significance –** A significant gateway into the State of Kerala.
- A corridor for both roads and railways that connects Coimbatore with Palakkad.
- The ***Bharathappuzha River*** flows through the Palghat Gap.

- **Differences -** The vegetation in the Palghat Gap is classified as ***dry evergreen forest*** whereas the Western Ghats is a tropical rainforest.
- The Western Ghats in north of the Palghat Gap receive more rain annually, but the south gets rain more evenly throughout the year.
- Elephant populations on the Nilgiris side differ in their mitochondrial DNA from elephants in the Anamalai and the Periyar sanctuaries.

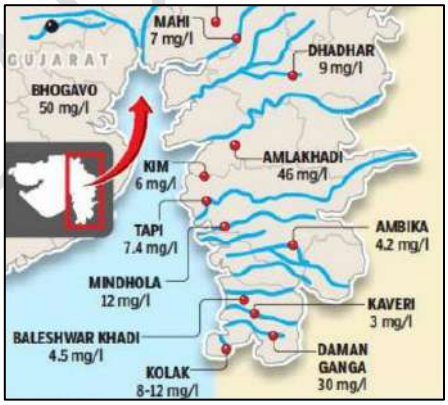
2.25 Kaas Plateau

A new study of the sediments from a seasonal lake in the Kaas Plateau, Maharashtra has indicated a major shift in the Indian Summer Monsoons during the Early-Mid–Holocene, around 8664 years B.P. (Before the Present)

- Kaas Plateau is made of igneous rock, situated in the ***Western Ghats of Maharastra.***
- Locally called as ***'Kas Pathar'*** or ***'Plateau of Flowers'.***
- Its name is derived from the *Kaasa tree*, botanically known as *Elaeocarpus glandulosus* (rudraksha family).
- It is designated as a *biodiversity hotspot* and is included in the ***UNESCO World Natural Heritage Site*** under the name "*The Western Ghats*" in 2012.
- The major portion of the plateau is reserve forest and the plateau contains 6% of the *Red data species*.
- ***Kas Lake*** is a perennial source of water supply for western part of Satara.
- It is popular for its stunning display of wildflowers (***Flower Wonder)*** that come to life during monsoon in Maharashtra, this unique characteristic has earned it the endearing nickname of "***Maharashtra's Valley of Flowers***".
- ***Thoseghar Waterfalls*** and ***Sajjangad Fort*** is located in this plateau.

2.26 River Kolak

Kolak fisherfolk living along the banks of River Kolak is in distress as chemicals from Vapi industries destroy river catch.



- Kolak River is a ***west flowing river*** in ***Gu jarat***.
- It flows into the Arabian Sea near Udwada.
- Its basin has a maximum length of 50 km.
- It is also connected to ***Madhuban reservoir*** of Damanganga River.
- It flows through the north side of Vapi city in Gujarat.
- **Other major west flowing rivers** – Luni, Sabarmati, Mahi, Narmadi, Tapi, Mandovi, Periyar, etc.

2.27 Dal Lake

The J&K government has attributed the death of thousands of fish in the Dal Lake in Srinagar to thermal stratification.

- Dal Lake is an urban lake situated in the northeast of Srinagar in ***Kashmir valley.***
- It is the ***2nd largest lake*** *in Jammu and Kashmir* after ***Lake Wular.***
- The lake is probably of *fluvial origin*, formed from the oxbows of river Jhelum.
- Due to its beauty and attraction, Dal Lake is also known as the "***Jewel in crown of Kashmir or Srinagar's Jewel".***
- It is declared as a protected wetland and a commercial fishing point.
- It has witnessed shore line Mughal gardens, such as ***Shalimar Bagh and Nishat Bagh*** built during the reign of ***Mughal Emperor Jahangir.***
- The floating gardens, known as **Raad i**n Kashmiri, blossom with lotus flowers.
- The wetland is divided by causeways into 4 basins; Gagribal, Lokut Dal, Bod Dal and Nagin (although Nagin is also considered as an independent lake).
- Lokut-dal and Bod-dal each have an island in the centre, known as Rup Lank (or Char Chinari) and Sona Lank respectively.

2.28 Pangong Tso Lake

China is rushing to complete a bridge across the Pangong Tso, simultaneously India is also building a black-topped road on its side on the north bank.

- Pangong Tso is a high-altitude saltwater lake in ***Ladakh*** and is the *world's highest saltwater lake.*
- Pangong Lake, derives its name from the Tibetan word, "Pangong Tso", which means "high grassland lake".
- Formerly, Pangong Tso had an outlet to the ***Shyok River***, a tributary of the Indus River, but it was closed off by natural damming.
- **Distribution** - 1/3rd of the lake is lying in India & the other 2/3rd is in China.
- It is a disputed territory between ***India and China*** as the Line of Actual Control passes through the lake.
- Though it is a saline water lake, it freezes completely during winters.

2.29 Perur Lake

- Perur- Sundakamuthur Lake or Perur Lake located in the southwestern edges of ***Coimbatore, Tamil Nadu.***
- It stores water from ***Noyaal River*** and distributes to the other lakes in the surrounding lakes of Coimbatore.

2.30 Pazhaverkadu (Pulicat) Estuary

- Pazhaverkadu or Pulicat is a vast *brackish water lake* with 3 estuaries situated in ***Tamilnadu.***
- Pulicat Lake is the ***2nd largest brackish water lake*** in South Asia, after the ***Chilika Lake in Odisha.***

2.31 Kadalundi Mudflats

Sand sedimentation is causing the mudflats of Kadalundi to vanish.

- **Kadalundi** – A village on the southwest coast in ***Kozhikode, Kerala*** that had about 8 hectares of nutrient rich ***intertidal mudflats*** in the early 2000s.
- **Threats**
  - ***Sedimentation of sand*** deprives prey to migrant birds.
  - ***Mangrove proliferation*** is aggressively invasive and they never attracts migratory birds because of predator's presence.
  - ***Kerala floods of 2018 and 2019*** hastened the process of degradation in Kadalundi.

Quick facts

- Kadalundi River is the 6th longest river of Kerala. It originates from the Western Ghats and has 2 tributaries - Olipuzha and Veliyar.
- The Kadalundi River and the Chaliyar River merges with the Arabian Sea at Kadalundi.
- The Kadalundi Bird Sanctuary is home to many native and migratory birds.
- Kadalundi-Vallikunnu Community Reserve is India's 1st river front community reserve.

Mudflats

- Also known as *tidal flats*, they are *coastal wetlands* that form when mud is left behind by tides or rivers.
- They are found in sheltered regions such as bayous, lagoons, estuaries, and bays.
- The majority of the sediment in a mudflat is *within the intertidal zone*, therefore the flat is submerged and exposed about twice per day and is *usually barren (without any vegetation).*
- **Importance** - It is vital in *preventing coastal erosion* and act as habitat for birds.

2.32 Mullaiperiyar Dam

The Supreme Court recently directed the Survey of India (SoI) to examine whether a mega car park constructed by Kerala at Mullaiperiyar Dam is encroaching property covered under the Periyar Lake Lease Agreement.

- **About -** It is a ***masonry gravity dam*** in Idukki district of ***Kerala***, where Periyar and Mullayar rivers meet.
- **Construction -** The dam was constructed during *1887-1895* across ***Periyar River*** in the then Travancore state.
- Although the dam is in Kerala, it is ***operated by Tamil Nadu*** following an 1886 lease indenture for 999 years.

- The lease indenture was signed between the *Maharaja of Travancore and the Secretary of State for India.*
- The Periyar Dam with full reservoir level of ***152 ft***. provides for diversion of water from the reservoir through a tunnel to Vaigai basin in Tamil Nadu.
- **Rule Curve -** According to Tamil Nadu Water Resources Organisation, Mullaperiyar is the ***1st reservoir to have Rule Curve*** implemented in India.
- Rule Curve is a tabulation that specifies quantum of storage of water or empty space to be maintained in a reservoir during different times of a year, based on the rainfall data for 35 years.
- The dam is located in the ***Seismic Zone III area*** (moderate damage risk zone)
- There lies a bone of contention between ***Tamil Nadu and Kerala*** regarding the safety of the dam, release of water etc.

2.33 Sone (Son) River

Bihar police have arrested smugglers and seized sand-laden boats in a major crackdown against illegal sand mining near the Sone River.

- The Son is the ***2nd largest right bank tributary of River Ganga*** after River Yamuna.
- **Origin** - Amarkantak plateau, Chattisgarh.
- The valley is bordered by the Kaimur Range to the north and the Chota Nagpur plateau to the south.
- After forming a series of waterfalls, it reaches Arrah, west of Patna, to join Ganga.
- **Tributaries** - Rihand, Kanhar and the North Koel.

North Koel Irrigation Project *is an inter-State major irrigation project with command area lying in* ***Bihar and Jharkhand****. Its components include Mandal dam and Mohammadganj barrage.*

2.34 Pappathi Chola

There is an urgent need to protect Pappathi Chola, a biodiversity hotspot.

- **Location** - Kerala
- It is located right in the middle of the Chathurangappara hills and Mathikettan shola.
- While Pappathi means butterfly, Chola means shola land.
- Pappathi Chola is also regarded as a hub of ***balsams (Impatiens balsamina***) and rare varieties of orchids.
- The region also witnessed the blooming of ***Neelakurinji.***

Biodiversity Hotspots

Regions that are exceptionally rich in biodiversity and contain numerous endemic species. Criteria to qualify as a hotspot:

- Should have at least 1500 species of vascular plants (should have a high degree of endemism).
- Must contain 30% (or less) of its original habitat, i.e. it must be threatened.

4 biodiversity hotspots in India:

- The Himalayas
- Indo-Burma Region
- The Western Ghats
- Sundaland

2.35 Khazans of Goa

The National Green Tribunal (NGT) dismissed the proceedings for carrying out illegal construction and illegal filling of eco-sensitive, low-lying khazan lands.

- Any ***low-lying land close to a mangrove-fringed estuary*** reclaimed by salinity control structures can be called as khazan land.
- Khazans are reclaimed lands from the river or the sea; Khazans in Goa are ***coastal wetlands.***

- The most important aspect of the structure of these lands is based on the principle of *salinity regulation* and *knowledge of the tidal clock*.
- The control of balance between the availability and flow of freshwater (rainfall+aquifer): saline (estuarine) water that determines the existence of the Khazan lands.
- Khazan lands have 3 main features - sluice gate, poim and 2 types of bunds.
    - **Bunds** are classified as Inner and Outer bunds.
        - The outer bund protects the field from the tidal flows of the river.
        - The inner bunds protect from any form of nutrient leaching.
    - Clay known as chanoy is used as a filler in between 2 outer layers of the outer bund to withstand any vulnerability from the tidal waves.
    - **Poim -** A depression at the end of the khazan lands to act as a repository for excess water and protects agricultural fields from high tides.
    - **Sluice gate -** Located at the mouth of the rivulet entering a farmland to control the water levels.

Sangha Virtual Constituency

- Sangha Assembly constituency is one of the constituencies in the 32-member Assembly of ***Sikkim***, a State in the northeast region of India.
- The Sangha constituency doesn't exist on the map. This seat is reserved for the Buddhist monastic community of Sikkim, Buddhist monks and nuns.
- Voters recognized with monasteries in Sikkim State are the only ones who can contest and cast their votes for the Sangha constituency seat.

2.36 Kodava Community

Members of the Kodava community are demanding constituencies in Parliament and the Karnataka Assembly on the lines of the Sangha virtual constituency.

- **Habitat** - Kodavas are a unique race of people who live in Kodagu (Coorg), the smallest district in ***Karnataka.***
- This land-owning community known for its martial traditions,
- **Language** - Kodava language does not have a script, is a mixture of Kannada, Tamil and Malayalam.
- **Society -** The Kodava community of Coorg is a ***patrilineal society*.**
- **Religion** - Kodavas are Hindus, but priests have no role in their marriages.
- **Worship** - Ancestor and nature worship.
- There are no idols in the kaimada, the central place of ancestor worship
- **Festivals** - Puthari (harvest festival ushered in with a gunshot) Keil Murtha (festival is dedicated to guns) and Kaveri Sankramana.

2.37 Soliga, Betta Kurumba and Paniyan

Recently Lantana jumbos statute was placed at the legislative assembly of Karnataka and Craftsmen from Soliga, Betta Kurumba and Paniyan tribal communities are known for carving the statue using lantana logs.

- **Soligas** – Are the major indigenous tribes of BR Hills situated in Chamarajanagar district of ***Karnataka***.
- Soligas lead a semi-nomadic life and are engaged in shifting cultivation or subsistence agriculture.
- **Betta Kurumba** – They are an ethnic group who live in the **Nilgiri-Wayanad** region of South India.
- **Paniyan** – They are found in Wayanad, Kannur, Kozhikode and Malappuram districts of ***Kerala*** and adjoining districts of Coorg in ***Karnataka*** and the Nilgiris in ***Tamil Nadu***.
- Historically, Paniyas have been agrestic slaves who worked in the agricultural field of the janmis or landlords.

2.38 Dhangar Community

The Dhangar community's demand for ST status has been dismissed.

- **Dhangars** – They are large cluster of ***pastoral groups*** and they live mostly in ***Western Maharashtra and Marathwada.***

- **Population** – In Maharashtra, they are estimated to range from ***4 to 12% of the total*** population (unofficially estimate).
- **Social status** – British recognised them as a tribe for their nomadic nature and lower status in Maharashtra.
    - **Ahilyabai Holkar,** the queen who reigned the Malwa region in the 18th century was a Dhangar.
- **Reservation status** – In Maharashtra, there is an exclusive quota of 3.5% under a separate category called NT (No Tribe).
- In central list, they are recognised as Other Backward Classes (OBC) community.
- **Demand for ST status –** It started in 1955, when there was no reservation for them either in the state or at the Centre.
- **Reason for demand –** Better constitutional safeguards to SC and ST than to OBCs.
- Discretion of executive government in implementing welfare activities for OBC
    - The 1st BC commission's ***(Kaka Kelkar)*** report came in 1955, whose recommendations were never implemented.
    - The 2nd BC Commission's ***(Mandal)*** report came in 1980 whose recommendations were implemented partially only in 1990.

> ***Article 340*** *directs the President to constitute a commission to identify backward communities and make recommendations for their upliftment.*

2.39 Kakad Bhairav or Bhilat Baba

A stone deity worshipped by the Bhils in Madhya Pradesh's Bagh was recently proved to be a fossilized dinosaur egg.

- Generations of Bhils had worshipped this sunbaked, reddish-brown Kakad Bhairav or Bhilat Baba.
- Sacrifices of chickens and sheep marked their whispered pleas to the roughly oval-shaped deity.

Bhil Tribes

- Bhils are popularly known as the ***bow men of Rajasthan.*** Their name is derived from the word villu or billu.
- They are the most widely distributed and the ***largest tribe of the South Asia.***
- **Presence**- Madhya Pradesh, Maharashtra, Gujrat, Rajasthan and also in the north eastern parts of Tripura.
- The name Bhil is also finds mentioned in the great epic called Mahabharata and Ramayana in context of Eklavya.
- The endogamous tribe speak ***Bhili***, an Indo Aryan language.
- Earlier they were the great hunters but they now practice agriculture as the source of livelihood.
- They are also demanding a separate state of Bhil Pradesh.

Dinosaur Fossils National Park

- The Dinosaur Fossils National Park is a protected area located in ***Madhya Pradesh***, India.
- The park is renowned for its rich fossil deposits, which provide valuable insights into the prehistoric world.

UNESCO Global Geopark tag

- Awarded by the United Nations' body since 2015, the Geopark tag is given to territories for sites with global relevance to geology, geomorphology or paleontology.
- If selected, the Bagh site will join a select club of 195 UNESCO Geoparks in 48 countries.

> *Currently, India does not have any UNESCO Global geopark.*

2.40 Cloud Seeding

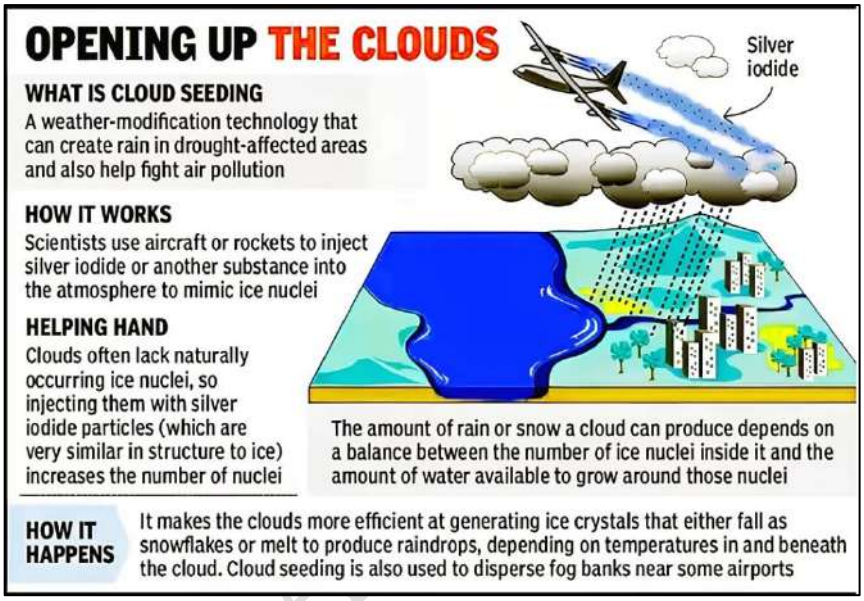
Recently, Indian Institute of Tropical Meteorology (IITM) based in Pune demonstrated cloud seeding experiment in Solapur city to bring rainfall.

- **Cloud seeding** – It is a *weather modification technique* that improves a cloud's ability *to produce rain or snow*.

- **Working mechanism** – A *tiny ice nuclei is introduced* into certain types of subfreezing clouds.
- These *nuclei provide a base for snowflakes to form* which grow and fall from the clouds back to the surface of the Earth.
- **Hygroscopic cloud seeding** – It disperses salt particles to *speeds up droplet coalescence in liquid clouds to produce of large droplets* to start precipitation.

> ***Cloud seeding*** *was started in 1946 in USA by using* ***silver iodide and dry ice*** *(solid carbon dioxide) to improve the creation of ice crystals in clouds.*

- **Glaciogenic cloud seeding** – It disperses ice nuclei to *trigger ice production in super cooled clouds*, leading to precipitation.
- **Applications** – It can create *more winter snowfall*.
- It enhances the *natural water supply* to communities
- *It lessens hailstorms* by reordering water vapour in clouds to breakdown large hailstones
- It is used to *tackle air pollution*.
    - Central Pollution Control Board (CPCB), India mulled the use of cloud seeding to tackle Delhi's air pollution.



- **Challenges** – The chemicals used in seeding can cause potential side effects to living organisms.
- It can change climatic patterns of the earth.
- It involves huge costs and logistics preparations.

> ***Cloud Aerosol Interaction and Precipitation Enhancement Experiment (CAIPEEX phase-4)*** *was a scientific investigation conducted in Solapur city by IITM to investigate the efficacy of hygroscopic seeding in deep convective clouds and to develop a cloud seeding protocol.*
>
> ***Varshadhare Project*** *is a cloud seeding project of Karnataka government to enhance the amount of precipitation from the clouds to generate more rain.*

2.41 Uttarakhand Tunnel Collapse

All 41 workers trapped due to the collapse of an under-construction Silkyara-Barkot tunnel in Uttarakhand were rescued recently.

Silkyara-Barkot tunnel

- **Location**- The 4.5-km tunnel is being constructed between Silkyara and Dandalgaon on the Brahmakhal-Yamunotri portion of the National Highway.
- It is a part of the Char Dham all-weather road project connecting 4 sacred sites of Hindus.
- **Chardham Mahamarg Vikas Pariyojana** is a Central government initiative to improve the road connectivity of 4 sacred sites in Uttarakhand - Gangotri, Yamunotri, Kedarnath and Badrinath.
- **Aim-** To upgrade and widen the 1100 km of highways into all-weather roads.

Excavation Methods		
	Drill and Blast method (DBM)	**Tunnel boring machine method**
Description	Involves drilling holes into the rock face and blasting it with explosives to break it into fragments	Involves a shielded machine that bores through the rock with a rotating cutter head
Tunnel length	Adopted for shorter tunnel range up to 3km	Adopted for long tunnel up to 25 km
Suitability	For hard rocks and high mountain tunnel	For soft rock and low mountain tunnel
Environmental impact	Causes more vibrations, noise, dust, and gas emissions	Faster, safer and environment friendly than DBM
Cost	Cost effective for shorter tunnels and smaller projects	Requires high initial investment and more technical expertise
Example	Himalayan regions including Jammu & Kashmir and Uttarakhand	Underground tunnels for the Delhi metro

- **Rescue operation**- Defence Research Development Organisation (DRDO) deployed the *Remote Operated Vehicle* - ***Daksh*** that is specifically designed to be used on a pan-tilt platform to help reach the risky terrain.
- It can operate continuously for 3 hours, covering distances ranging from 100 to 500 meters.

Related links - Sikkim flash floods, Joshimath crisis

2.42 Mountain Railways of India

Heavy rain and floods batter famed Kalka-Shimla heritage railway line.

Kalka-Shimla Railway Line

- It is a 96-km long, single track working rail link built in the mid-19th century to provide a service to the highland town of Shimla, ***Himachal Pradesh.***

Kangra Valley Railways

- It is located in the sub-Himalayan region of Kangra Valley extending from Pathankot, Punjab to Jogindernagar in ***Himachal Pradesh***.

Darjeeling Himalayan Railway

- Located in ***West Bengal,*** it was the first hill passenger railway in India.
- It was opened in 1881 and its design applies ingenious engineering solutions to the problem of establishing an effective rail link across a mountainous terrain.

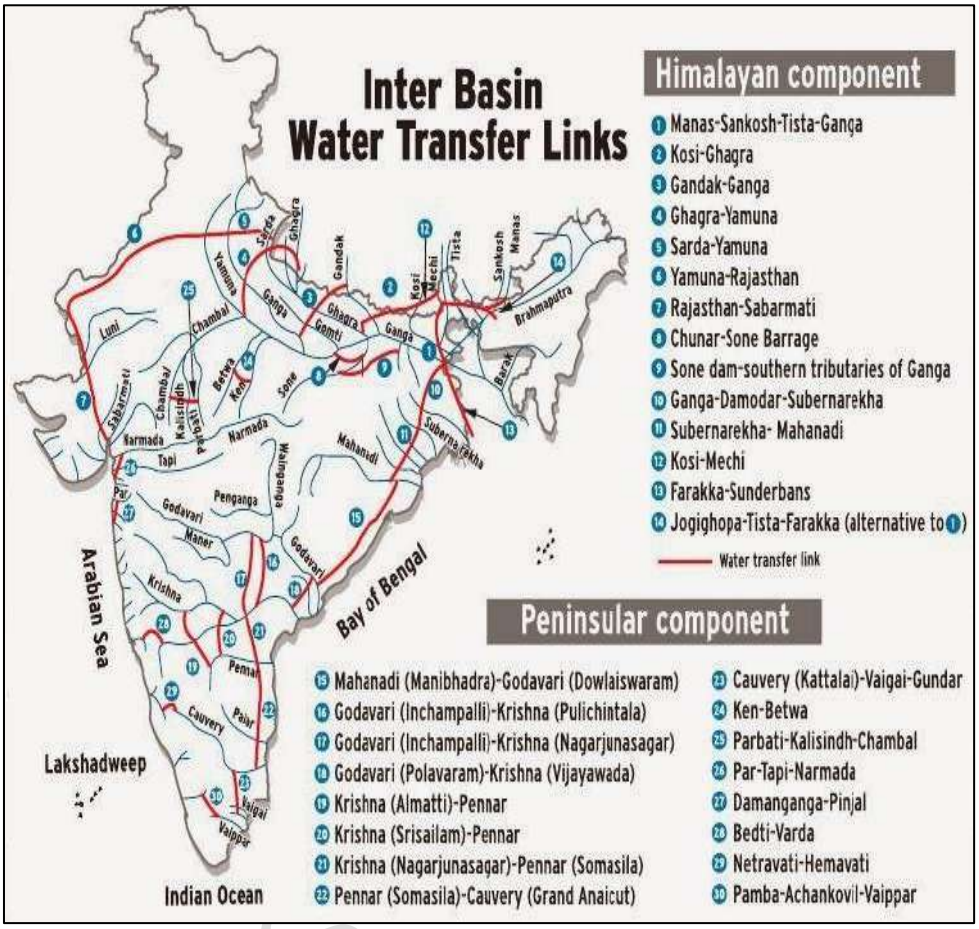
Nilgiri Mountain Railway

- It is a 46-km long metre-gauge single-track railway in ***Tamil Nadu*** that was completed in 1908.
- This railway, scaling an elevation of 326 mto 2,203 m, represented the latest technology of the time.

2.43 Interlinking of Rivers

India's river interlinking projects, aimed at addressing droughts and floods, may worsen water stress and disrupt monsoon patterns, according to a study in Nature.

- **Inter-basin water transfers**- It tracks with mathematical concepts of surplus and deficit. Excess water is routed from "donor river basins" (to "recipient" dry regions.
- **Conventional assumption**- The river basins operate in silos without affecting the land or the atmosphere
- **Mandate**- National Water Development Agency, Ministry of Jal Shakti.
- **Components**-
    - **Himalayan component**- Kosi-Ghagra, Kosi-Mechi etc.,
    - **Peninsular component**- Ken- Betwa, Par-Tapi-Narmada etc.,



- **Himalayan component-** It aims to construct storage reservoirs on the Ganga and Brahmaputra rivers, as well as their tributaries in India and Nepal.
- **Peninsular component**- It propose to connect the rivers of South India. It envisages linking the Mahanadi and Godavari to feed the Krishna, Pennar, Cauvery, and Vaigai rivers.
- **National Perspective Plan (NPP)** - It has identified 16 links under the peninsular rivers component and 14 links under the Himalayan component, charged with transporting 174 billion cubic metres of water each year using some 15,000 km of canals and 3,000 reservoirs.
- **The National River Linking Project (NRLP)-** It was formally known as the National Perspective Plan, envisages the transfer of water from water 'surplus' basins where there is flooding to water 'deficit' basins where there is drought/scarcity, through inter-basin water transfer projects.

2.44 Vadhavan Port project

- Located in ***Maharashtra***, it is India's 13th major port, developed as a joint venture by the Jawaharlal Nehru Port Authority (JNPA) and the Maharashtra Maritime Board (MMB).
- It is a *Public-Private Partnership* (PPP) project (JNPA - 74% stakes and MMB - 26% stakes).

Major Ports in India

- Any port ***under the control of the Central Government*** through the Ministry of Ports, Shipping and Waterways is known as a major port of India.
- The intermediate and minor ports are under the control of their respective state governments.
- ***Indian Ports Association (IPA)*** began its operations in 1966 as the regulating body for the major ports under the Indian Government.
- The major ports identify as member ports of the IPA.

Major ports on the western coast	Major ports on the eastern coast
• Cochin port (Kerala) • New Mangalore port (Karnataka) • Mormugao port (Goa) • Mumbai port (Maharashtra) • Jawaharlal Nehru port (Maharashtra) • Deendayal/ Kandla port (Gujarat)	• Kolkata port (West Bengal) ○ Haldia port (West Bengal) • Paradip port (Orissa) • Visakhapatnam port (Andhra Pradesh) • Kamarajar port (Ennore, Tamil Nadu) • Chennai port (Tamil Nadu) • V. O. Chidambaram or Tuticorin port (Tamil Nadu)

- Deendayal port stands as the ***busiest port*** in India with the highest cargo tonnage.
- Jawaharlal Nehru port is the ***largest container port*** in India.
- Mumbai port is the ***largest port in India*** in terms of size and traffic.
- Ennore port, an artificial port is ***India's first corporate port***.
- Kolkata port is the ***earliest major port*** in India.

2.45 Inland fishing in India

- ***India has overtaken China*** to become the largest contributor of inland capture water fisheries.
- In 2021-22, India's annual fish production reached an all-time record of 162.48 lakh tons.
- India's inland fisheries resource - Godavari, Krishna, Cauvery, Bhima, West Coast Narmada, Tapti, Mahi.

2.46 National Geoscience Data Repository Portal

- NGDR is a comprehensive online platform for accessing, sharing, and analyzing geospatial information across the nation.
- The initiative is spearheaded by the ***Geological Survey of India (GSI)*** and Bhaskarachaya Institute of Space Applications and Geoinformatics (BISAG-N).
- GSI is a scientific agency that conducts geological surveys and studies of India established in 1851 by Thomas Oldham. (***Ministry of Mines***)

2.47 SAMUDRA

- "SAMUDRA" (Smart Access to Marine Users for ocean Data Resources and Advisories) is a mobile app that provides comprehensive ***information on all ocean-related services.***
- The app was launched by the ***Indian National Centre for Ocean Information Services (INCOIS),*** an autonomous body under the ***Ministry of Earth Sciences*** located in *Hyderabad.*

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