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TARGET 2025

GEOGRAPHY

MAY 2024 TO FEBRUARY 2025

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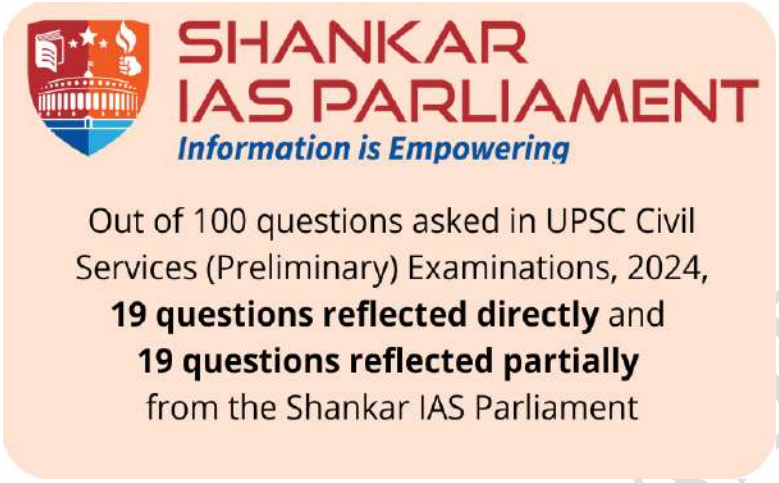


Total number of questions directly reflected from Shankar IAS Parliament (including Target 2024 series)	19
Number of questions directly reflected from the Target Series 2024	14
Total number of questions partially reflected from Shankar IAS Parliament	19

1. GENERAL GEOGRAPHY

1.1 River Basins of Afghanistan

A new study has revealed interesting insights about water in Afghanistan, which has suffered recurrent droughts since the 1990s.

- Afghanistan is *landlocked country* with ***Kabul*** being its *capital*.
- **Physiographic region** – The central highlands is actually a part of the Himalayan chain including the main *Hindu Kush range*.
- **Major pass** – Shebar pass, *Khyber Pass* (It leads to Indian subcontinent).
- *Amu Darya and Kabul river* basins are major sources of water for Afghanistan.

Major river basin	Location	About
Harirod- Murghab River Basin	Afghanistan, Iran and Turkmenistan.	• The basin is named after two major rivers, the Hari River and the Murghab River, which flow through this region. • **Hari River –** It originates in the mountains of central Afghanistan and flows south-westward into Turkmenistan, where it is known as the *Tejen River*. • **Murghab River** – It originates in Afghanistan and flows through Turkmenistan before eventually draining into the Karakum Desert.
Helmand River Basin (HRB)	Afghanistan and Iran	• Covering 51% of the country, HRB is the *longest river basin* in Afghanistan. • **Historical significance**- The Helmand valley region is mentioned in ancient texts such as the Avesta, highlighting its significance since early civilization. • The river originates in Hindu-Kush Mountains of central Afghanistan and flows south-westward and reaches Sistan Basin in Iran.
Kabul River Basin	Afghanistan and Pakistan	• Kabul River is the largest drainage system in the south-eastern region. • The river is also known as *Cophen*, it originates in the Paghman Range and flows eastward to join the Indus River in Pakistan. • **Major cities** – It passes through the cities of *Kabul and Jalalabad* in Afghanistan.
Northern River Basin (NRB)	Afghanistan	• Unlike other river basins NRB is *not transboundary*, it remains within Afghanistan's borders. • Shirin, Sarepul, and Balkh are the notable rivers. • The basin supplies the *least water* compared to other basins.
Panj- Amu River Basin	Afghanistan, Kazakhstan, Tajikistan, Turkmenistan, Uzbekistan and to lesser extent shared by China and Pakistan	• The Panj-Amu River Basin is part of the Amu Darya, which is the *largest river* in Central Asia. • **Amu Darya**- It is also known as the *Oxus River*, and one of the longest rivers in Central Asia that originates in Pamir Mountains and flows into *Aral Sea*. • **Panj river**- It is one of the major tributaries of the Amu Darya that originates in the Pamir Mountains, near the borders of Afghanistan, Tajikistan, and China.

1.2 La Cumbre Volcano

- **La Cumbre volcano** – It is ***shield volcano***, situated *on Fernandina Island of* ***Galapagos Islands*** and around 1,125 km off ***Ecuador***.
- **Impacts** – As Fernandina Island is *uninhabited*, there is no risk to people or infrastructure.
- It is home to a large population of rare *land iguanas* which nest and lay eggs on the rim of the volcano's large crater or caldera and deep within it.
- Thus lava flow has damaged the island's endemic vegetation, including the habitat of the land iguanas and its flow into the ocean could potentially damage marine life.
- **Galapagos Islands** – Composed of *19 islands*, *a UNESCO heritage site lie*, 1,000 km from the coast of Ecuador in the Pacific Ocean.
- This region helped Charles Darwin develop his theory of evolution by natural selection.

1.3 Mount Lewotobi Laki-Laki Volcano

Indonesia's Mount Lewotobi Laki-Laki volcano continues to erupt, spewing ash clouds and causing widespread disruption.

- Mount Lewotobi Laki-Laki is an *active volcano* located on Flores Island in Indonesia's East Nusa Tenggara province and one of the two main peaks of the twin volcano Lewotobi.
- **Twin Volcanoes** – Lewotobi Lakilaki (man) and Lewotobi Perempuan (woman).
- It is known for its ***stratovolcano structure*** and is situated close to its counterpart, Lewotobi Perempuan (Female Lewotobi).
- It is Part of the ***Pacific "Ring of Fire"***.

Volcanoes

- Volcanoes are openings or vents where lava, tephra (small rocks) and steam erupt onto the Earth's surface.
- **Occurrence** – It can occur both on land and Ocean.
- **Types of volcanoes** – Shield Volcanoes, Cinder cones, Composite Volcanoes (Stratovolcanoes), Caldera, Flood Basalt Provinces, Mid-Ocean Ridge Volcanoes, Active volcano.
- According to the British Geological Survey, the type of volcano depends on the following:
  - Viscosity of the magma,
  - Amount of gas in the magma,
  - Composition of the magma,
  - The way the magma reaches the surface and
  - Basis of their activity – Active, dormant and extinct.

> *Pacific Ring of Fire is a horseshoe-shaped region around the Pacific Ocean that is known for its high levels of seismic and volcanic activity, home to more than 75% of the world's volcanoes and 90% of its earthquakes.*

Strato volcanoes

- They are *characterized by a steep, conical shape* formed from alternating layers of lava flows, volcanic ash, and other volcanic debris.
- This layered structure contributes to their towering height.
- **Eruption Style** – Stratovolcanoes typically exhibit explosive eruptions due to the thick, viscous nature of their magma, which is often rich in silica.
- This viscosity can trap gases, leading to pressure buildup and explosive eruptions, as opposed to the gentler eruptions seen in shield volcanoes.

- **Lava Composition** – The lava produced is usually ***andesitic to rhyolitic*** in composition, meaning it has a moderate to high silica content, contributing to its viscous nature.
- **Activity** – Stratovolcanoes can have long periods of dormancy between eruptions, but when they do erupt, it can be highly explosive. This can create pyroclastic flows, ashfall, and lava domes.
- **Geographic Distribution** – They are commonly found at ***convergent plate boundaries,*** where an oceanic plate subducts beneath a continental plate, leading to magma generation.
- Many well-known volcanoes, like Mount St. Helens and Mount Fuji, are stratovolcanoes.

1.4 Humboldt Glacier

Recently, scientists reclassified the Humboldt glacier as an ice field.

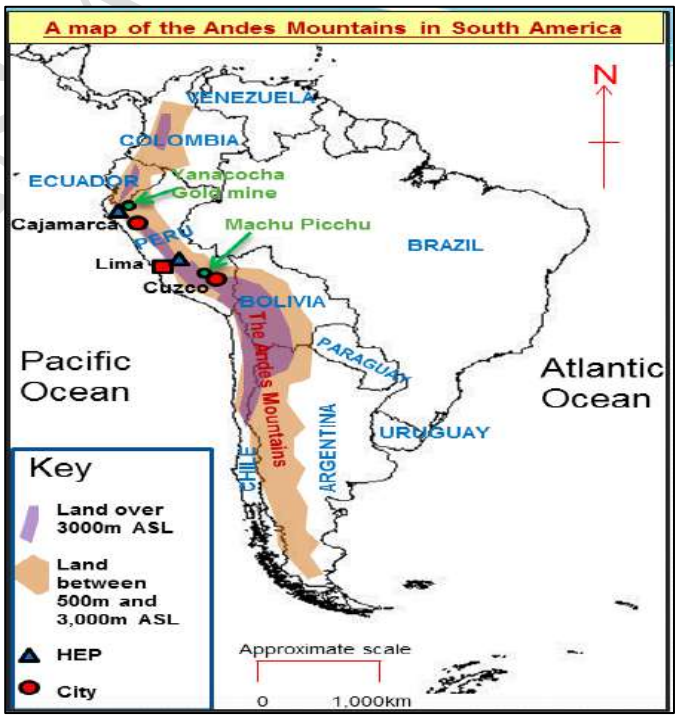
*An **ice-field** is generally larger than a single glacier as it usually a combination of multiple glaciers.*

- **Located in** – The *Andes Mountain in Venezuela*.
- **Causes of melting** – Due to *a temperature increase* of a high rate of 0.10 degree Celsius in the past 7 decades.
- The melting was *accelerated by El Niño in 2023*, an abnormal warming of surface waters in the equatorial Pacific Ocean.
- It has shrunk to an area of ***less than 2 hectares***, leading to its *downgrade from a glacier to an ice field*.
- **Impact** – It affects the source of freshwater in the area and affect the living organisms dependent on it.
- Experts suggest that Venezuela's Humboldt glacier did *not have enough ice* to substantially raise sea levels.

***Venezuela** has become the 1st country in modern history to lose all its glaciers.*

The Andes

- It is a *mountain range* located along the *entire western coast of South America*, about 7,242 kms long.
- **Formation** – Due to the convergence of the oceanic *Nazca plate* and the continental *South American plate*.
- **Spans 7 countries** – Argentina, Bolivia, Chile, Colombia, Ecuador, Peru and Venezuela.
- **Features** – The highest elevation in the Andes is *Mount Aconcagua* in Argentina, which is 6,962 m above sea level.
- **Significance** – They are home to *99% of tropical glaciers* and is the *longest mountain range* in the world.



Quick facts

- ***Humboldt Current*** – Also called the *Peru Current*, is a *cold*, low-salinity ocean current that flows north along the western coast of South America.
- **Humboldt's enigma** – A term to describe the puzzle of why some mountain regions, especially in the tropics, have exceptionally high biodiversity, contrary to the expected decrease in diversity.

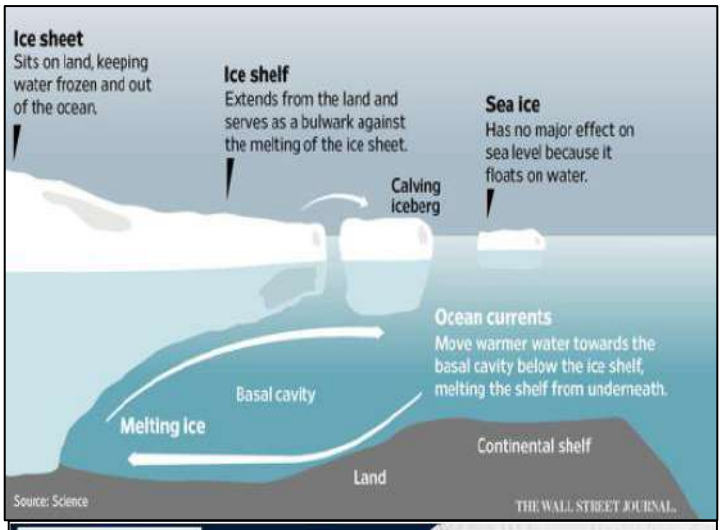
1.5 Ice Calving & Halloween Crack

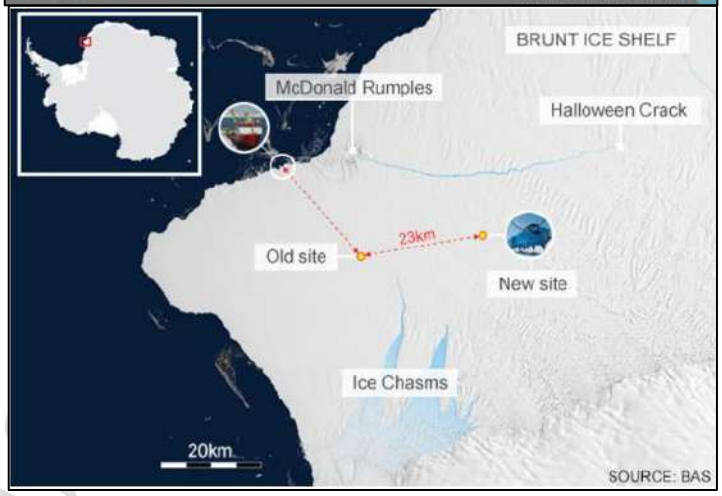
A large iceberg A83, measuring 375 square kilometres, broke off from Antarctica's Brunt Ice Shelf last week in a major ice calving event.

***Ice shelves** are floating ice platforms connected to a landmass, found in Polar Regions like Antarctica and Greenland.*

- **Ice Calving** – A process whereby intact *chunks of ice* are *discharged to the oceans* from the termini of glaciers or ice shelves.
- **Occurrences** – Over a huge range of time & length scales on glaciers around the world.

- **Rate of calving** – It often change annually, with calving slowing or *shutting down entirely over the winter*.
- **Determining factors** – Melting of the glacier surface, undercutting of the calving face by warm fjord water or the resistance from sea ice in fjords and amount of sea ice.
    - When less sea ice is present, ice shelves are more exposed to destabilising wind and wave action.
- **Impact** – It leads to mass l*oss for the world's ice sheets.*
- It is important in the *stability of marine-terminating glaciers*, with an initial calving retreat potentially able to destabilise the grounding line and trigger acceleration of the glacier.





The Halloween Crack

- It is a rift which was *1st spotted off the Brunt Ice Shelf* in the eastern *Weddell Sea in the Antarctica*.
- The iceberg is named as *Iceberg A-83.*
- It runs from an area known as *McDonald Ice Rumples*, which is where the underside of the floating ice sheet is grounded on the shallow seabed.
- This pinning point slows the flow of ice and fractures the ice surface.

1.6 Island of Crete

A 4000-year-old circular monument was discovered during airport excavations on Crete, island.

- **Location** – Crete is the *largest and most populous of the Greek islands* and 5th largest island in Mediterranean Sea, located in the ***eastern Mediterranean Sea***.
- **Bordered by** – The Sea of Crete in the north, the Libyan Sea in the south, the Myrtoan Sea in the west and the Carpathian Sea in the east.
- **Rivers** – Anapodiaris, Almiros, Giofyros, Koiliaris, Ieropotamos, and the Megas Potamos rivers.
- **Lakes** – Lake Agia and Lake Kournas are the two freshwater lakes on the island.

> ***Mediterranean Sea*** *is an intercontinental sea that stretches from the Atlantic Ocean on the west to Asia on the*

1.7 Guam Island

Recently, INS Shivalik arrived in Guam for an Operational Turnaround after successfully participating in RIMPAC 2024, the world's largest multinational maritime exercise.

- **Guam Island –** Largest and southernmost of the Mariana Islands, United States.
- **Capital** – Hagatna.
- **Location –** Situated in *east of the Philippines and west of Hawaii* in the North Pacific Ocean.
- **Status –** Guam is *not a country but a U.S. territory*.
- It is governed by an elected governor and legislature but is under federal control, similar to U.S. states.
- **Climate –** Tropical climate tempered by the northeast trade winds and the north equatorial ocean current.
- **Ancient Inhabitants –** The indigenous *Chamorro people* have lived on Guam for over 4,000 years.
- **Colonial Era –** Guam was first discovered by Europeans when Ferdinand Magellan arrived in 1521.

- It was later colonized by Spain in 1668 and remained under Spanish control for over 200 years.
- **Flora and Fauna –** It includes some endangered species like the *Guam rail.*

1.8 Island of Madeira

Wildfires in Madeira have endangered world-heritage forests and stranded tourists, with nearly 6% of the island's total area burned.

Aspect	Details
Location	• Madeira is a *Portuguese island* located in the *North Atlantic Ocean*, part of the Madeira Archipelago. • It comprises the volcanic islands of Madeira, Desertas and the Porto Santo. • The Portuguese archipelago of Madeira is located to the west of Morocco and to the southwest of the Portuguese capital of Lisbon. 
Region	Iberian Peninsula (Spain and Portugal)
Capital	Funchal
Geography	It is the top of a massive, submerged shield volcano rising about 6 km from ocean floor
Area	It is the largest and most populous island of the Madeira Archipelago
Tourism	A highly popular tourist destination, known for its landscapes, wine and mild climate

Natural Heritage	Home to the largest surviving *laurel forests (Laurus nobilis) in the world*, a *UNESCO World Heritage Site*

1.9 Minami-Torishima Island

Japanese researchers have recently discovered a trove of magnesium deposits essential for electric car batteries around the Minami-Torishima Island.

- **Minami-Torishima Island** – It is also known as ***Marcus Island***, is an *isolated Japanese coral atoll* in the north western Pacific Ocean.
- **Topography** – It's located on the ***Marcus-Necker Ridge***, and the only land of it in Japan on the Pacific Plate.
- The Island is relatively flat and low-lying, with its highest point being only a few meters above sea level.
- **Climate** – It has an oceanic climate with an average annual temperature of around 25.6°C.
- **Exclusive Economic Zone (EEZ)** – The exclusive economic zone based on the baseline of the Minami Torishima Island is larger than Japan's land area.
- **Current Status** – It is *administered by Japan* as part of the ***Tokyo Metropolis***.

Atoll *is a ring-shaped reef including rim which is present around a lagoon.*

EEZ *is an area of the ocean, generally extending 200 nautical miles (230 miles) beyond a nation's territorial sea, within which a coastal nation has jurisdiction over both living and nonliving resources.*

1.10 Chagos Archipelago

India has reiterated its support for Mauritius in its sovereignty dispute with the UK over the Chagos archipelago.

- **Chagos Archipelago** – A group of islands located in the *central Indian Ocean*, being situated approximately 1,600 kilometers (1,000 miles) south of *India and Sri Lanka.*
- **Physiography** – It consists of about *60 small islands*, with the largest and most significant being ***Diego Garcia***.
- **Climate** – They have a *tropical climate* with warm temperatures year-round, high humidity and seasonal rainfall.
- **Biodiversity** – It is known for its rich biodiversity, including coral reefs, various species of fish and seabirds.
- It is part of the *British Indian Ocean Territory Marine Protected Area*, which aims to conserve its unique marine environment.
- **Territorial dispute** – The dispute is *between Mauritius and the United Kingdom* (UK).

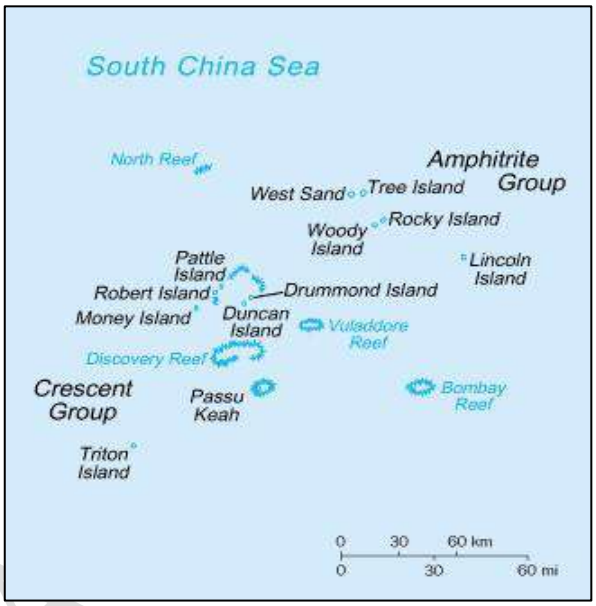
- **Historical background** – It was originally a part of the British colony of Mauritius.
- In 1965, the UK separated it from Mauritius and established it as the *British Indian Ocean Territory (BIOT)*.
- In 1966, Britain *leased Diego Garcia to the United States*, which was seeking a military base in the region.
- Mauritius, which gained independence from Britain in 1968, has consistently maintained its claim over the Chagos Islands

- **Current status** – In 2019, the *International Court of Justice* ruled that the *UK had no right to govern* the Chagos Islands and urged it to withdraw from the archipelago.

1.11 Triton Island

Recent satellite imagery reveals a significant military build-up on Triton Island, the closest landmass in the disputed Paracels archipelago to Vietnam.

- Triton Island is a small island in the ***South China Sea*** that is part of the ***Paracel Islands*** chain.
- It's located on the southwest corner of Triton Reef.
- The island is claimed by multiple countries, including China, Vietnam, and Taiwan.
- The island is administered by the People's Republic of China.
- Its location in a contested area increases tensions among these nations.
- The surrounding waters are believed to be rich in oil and natural gas reserves.
- The waters around Triton Island are also important fishing grounds.
- Due to its strategic position in the South China Sea, Triton Island can serve as a military outpost, impacting regional security dynamics.



- The South China Sea is a crucial shipping route for global trade, making control over islands and features in the area significant for maritime security.

1.12 Global Importance of Greenland

US President-elect Donald Trump has expressed interest in acquiring Greenland.

- **Greenland** – It is *world's largest island*.
- It is a *semi-autonomous territory of Denmark*, a longtime U.S. ally and a founding member of NATO.
- **Environmental importance** – It holds enough ice that if it all melts, the world's *seas would rise by 7.4 meters*.
- Melting of ice would reshape coastlines across the globe and potentially shift weather patterns.
- It plays a role in the dramatic freeze that two-thirds of the United States is currently experiencing.
- It also *changes patterns in the jet stream*, which brings storms across the globe and dictates daily weather.
- **Role in Atlantic Meridional Overturning Circulation (AMOC)** – It serves as the engine & on/off switch for AMOC that influences Earth's climate like hurricane and winter storms.

- **Economic importance** – It has valuable *rare earth minerals* needed for telecommunications, as well as uranium, billions of untapped barrels of *oil and a vast supply of natural gas*.
- **Concerns** – It is *warming 4 times faster* than the rest of the globe.
- Since 1992, Greenland has *lost about 182 billion tons of ice each year*, with losses hitting 489 billion tons a year in 2019.

*In 2012, weather patterns over Greenland helped steer **Super-storm Sandy** into New York and New Jersey in the United States.*

- *AMOC is slowing down* because more fresh water is being dumped into the ocean by melting ice in Greenland.
- It is *also changing color* as it melts from the white of ice, which reflects sunlight, heat and energy away from the planet, *to the blue and green* of the ocean and land, which absorb much more energy.

Greenland is also home to a large U.S. military base.

1.13 Naming of Cyclones

According to Indian Meteorological Department (IMD), Cyclone Remal will likely make landfall between West Bengal's Sagar Island and Bangladesh's Khepupara.

***Cyclone Remal**, the 1st pre-monsoon tropical cyclone in the Bay of Bengal in 2024, whose name means 'sand' in Arabic, was chosen Oman.*

- **PTC** – Panel of Tropical Cyclones, established *in 1972* by *World Meteorological Organisation, is the authority that names the cyclones*.
  - *They started naming cyclones in the region in 2004.*
- **13 member countries** – Bangladesh, India, Maldives, Myanmar, Pakistan, Sri Lanka, Oman & Thailand were the 8 original members.
- In 2018, *Iran, Qatar, Saudi Arabia, UAE and Yemen* were included.
- **Assigning name** – In *2000*, PTC agreed to assign names, each member to send its recommendations and finalised by PTC.
- **Coverage** – The tropical cyclones in Bay of Bengal and Arabian Sea.

***Lake District** of India, Nainital is India's very own Lake District. It houses Jim Corbett National Park, the oldest national park in India, established in 1936.*

Guidelines in naming Cyclone – The proposed name

- Is *neutral* to (a) politics and political figures (b) religious believes, (c) cultures and (d) gender;
- Does *not hurt the sentiments* of any group of population over the globe or is not very rude and cruel in nature;
- Is short, easy to pronounce, and not offensive to any PTC member;
- Is at most *8 letters long*;
- Is provided with its pronunciation and voice over; and
- Is *not repeated* (not before, not after).

- **Name list** – In 2020, a list of ***169 cyclone names*** were released, comprises *13 suggestions each from the 13 countries*.
- The *countries are arranged in alphabetical* order, all the names suggested by them are placed alongside in different columns with 1 name in each, *totally 13 columns*.
- **Name allocation** – The name in the *1st column is chosen.*
  - **For instance,** the *1st cyclone was named Nisarga* (by Bangladesh that hit Maharashtra, followed by Gati (India's choice, hit Somalia), Nivar (Iran's choice, hit Tamil Nadu).

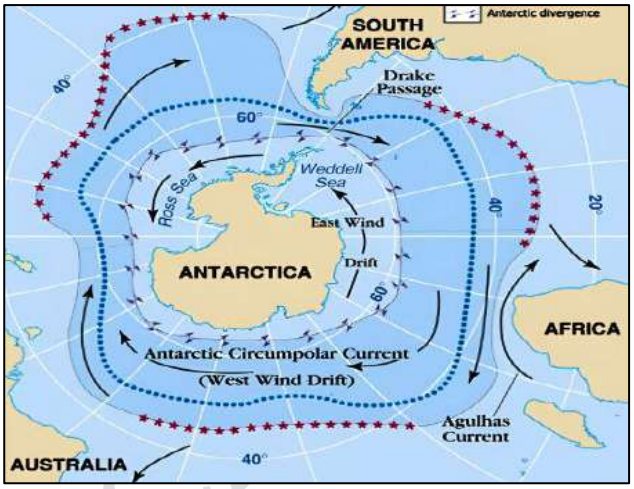
Cyclone Name List (169 names)		
Countries	**Column 1 - Used**	**Column 2 – Used till Ramal**
Bangladesh	Nisarga	Biparjoy
India	Gati	Tej
Iran	Nivar	Hamoon
Maldives	Burevi	Midhili
Myanmar	Tauktae	Michaung
Oman	Yaas	**Remal**
Pakistan	Gulab	Asna
Qatar	Shaheen	Dana
Saudi Arabia	Jawad	Fengal
Sri Lanka	Asani	Shakhti
Thailand	Sitrang	Montha
UAE	Mandous	Senyar
Yemen	Mocha	Ditwah

- After all the names of 1st column are exhausted, *names from the next column* are chosen, again starting from Bangladesh (for instance, after Mocha, the next cyclone was named Biparjoy).
- **New list** – After this current list is exhausted, a new list will be submitted by PTC members.
- **Significance of naming** – It is easy to identify individual cyclones, create awareness of its development, rapidly disseminate warnings for disaster mitigation and management.

1.14 Southern Ocean

Recently, a study on Southern ocean "Closing the loops on Southern Ocean dynamics: From the circumpolar current to ice shelves and from bottom mixing to surface waves "revealed more details on the dynamic nature of Southern Ocean.

- Southern Ocean is also known as the *Antarctic Ocean*, comprises the southernmost waters of the world ocean.
- It used to be part of the Pacific Ocean and it is separated from other Oceans by currents not Continents.
- **Location** – It is generally taken to be south of 60° S latitude and encircling Antarctica.
- **Size** – It is the second-smallest of the five oceans.
- **Characteristics** – It experiences *Earth's strongest winds and largest waves*.
- It is home to *city-sized icebergs*.
    - Antarctic Ice Sheet is the largest ice mass on Earth, equivalent to 58 metres of the global sea level.
    - The ice sheet flows onto the Southern Ocean surface in the form of giant ice shelves.



- It acts as an *ocean hub* as waters from the Atlantic, Pacific and Indian basins converge and mix in Southern ocean.
- It experiences *dramatic seasonal changes* and cold temperatures.
    - During winter, Southern Ocean freezes into a fringe of sea ice, almost doubling the size of Antarctica.
- It encompasses the *biggest ocean current* on the globe, as well as tiny turbulent flows that fit inside a teacup.
    - **Antarctic Circumpolar Current (ACC)** – It is the longest, strongest, deepest-reaching current on earth and circulates clockwise around the continent, carrying more water around the globe than any other current.
    - Antarctic Slope Current
    - Sub-polar gyres and
    - The meridional overturning circulation.

> ***Southern Ocean** acts as a **time capsule** as it takes hundred year for the ocean water from the surface to sink and return to surface. Water returning to the surface today reflects the cooler, pre-industrial climate when it first sank to the ocean depths*

1.15 Lake Erie

Algae bloom in western Lake Erie was moderate compared to previous years, getting rid of problem algae starts with giving it less food.

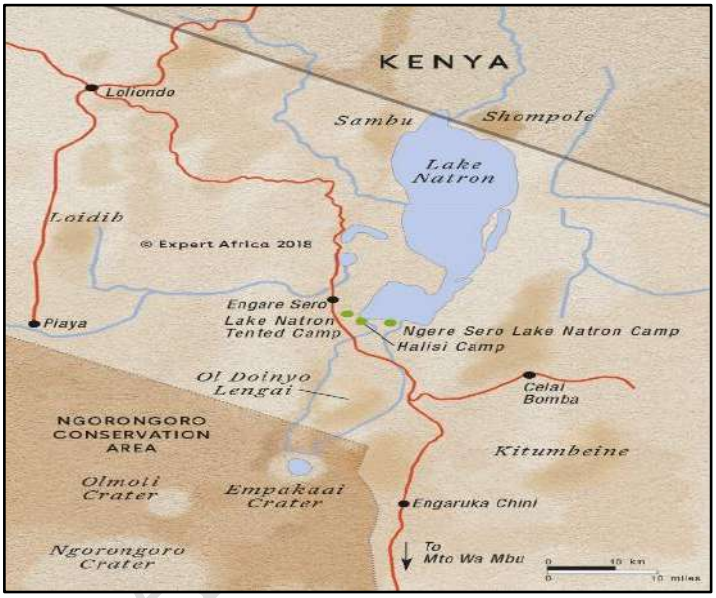
- Lake Erie is one of the ***5 Great Lakes of North America*** and the 4th largest by surface area.
- It is located on the border between ***Canada and the United States***.
- It is primarily bordered by the states of Ohio, Pennsylvania, and New York, as well as the Canadian province of Ontario.
- Lake Erie is the ***shallowest of the Great Lakes***, which contributes to its warmer temperatures and greater susceptibility to pollution and algal blooms compared to the other lakes.

- **Tributaries –** The Detroit, Huron, and Raisin rivers are the main tributaries to Lake Erie.
- **Discharge –** The Niagara River carries the water from Lake Erie to the east.

- It is a key part of the St. Lawrence Seaway.
- **Pollution –** The Great Lakes have been affected by pollution, and in the late 20th century, the U.S. and Canada investigated ways to reverse the damage.
- **Ice levels –** The Great Lakes have experienced historically low ice levels for two years in a row.

1.16 Lake Natron

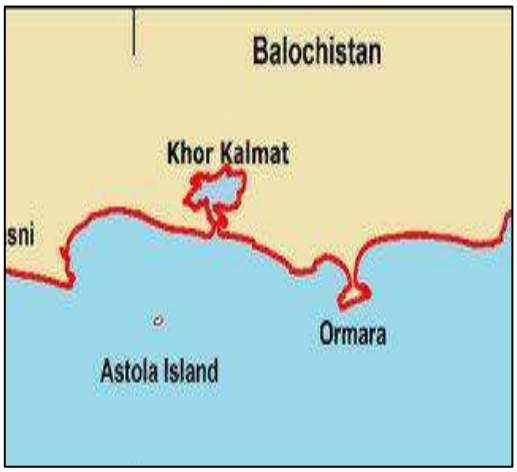
- Lake Natron is an *alkaline or saline lake*, situated at ***Arusha Region of Tanzania***.
- It is located in the ***Gregory Rift***, which is part of the East African Rift Valley.
- It is situated on the *border of Kenya and Tanzania*.
- It is a part of ***Lake Natron Basin***, a Ramsar Site wetland of international significance.
- The Southern Ewaso Ngiro River, which originates from central Kenya is the main source of water supply for the Lake.
- It is one of the most outstanding soda lakes in Africa because of the high PH of water which is always about 12.
- The lake is a regular feeding ground for the majority of the East Africa's lesser flamingos.



1.17 Khor Kalmat Lagoon

Recently, according to the U.S. Geological Survey, the aerial image of Khor Kalmat lagoon appear darker and more vibrant, like blue ink bleeding.

- **Khor Kalmat** – It is a ***tidal lagoon*** *that fully forms only at high tide*, when waters from the Arabian Sea run through a narrow channel carved into the coastline.
- At low tide, it almost completely empties, leaving behind exposed mudflats.
- **Location** – *Makran Coast in Pakistan's Balochistan province*, around 180 miles west of Karachi.
- It is cut off from the rest of the mainland by harsh desert mountains, known as the ***Makran Coast Ridge***, which run parallel to much of the country's coast.
- **Significance** – It is home to sizable *mangrove forests*, which are an important nursery for juvenile fish, as well as other marine organisms, such as crustaceans and mollusks.



- At low tide, it provides a hunting ground for wading birds that reside in ***Buzi Makola Wildlife Sanctuary***, which lies west of lagoon.
- **Supports livelihood** – It provides timber to the few local people who live alongside the lagoon.
- **Threats** – Overfishing, deforestation of mangroves and rising temperatures and climate change.
- Construction of a proposed *Pakistani Naval Base*.

1.18 Hurricane Beryl

Recently, the Indian cricket team is stranded in Barbados due to Hurricane Beryl.

- **Hurricane Beryl** – Is the ***Category 4 Atlantic hurricane*** which poses a severe threat to the ***Windward Islands.***

- The Windward Islands are a group of islands in the West Indies that make up the southern part of the Lesser Antilles, located in the eastern Caribbean Sea.

Tropical Cyclones

- Tropical cyclones are intense, rotating storms that form over warm tropical or subtropical waters.
- Tropical cyclones are the *second-most dangerous natural hazards*, after earthquakes.
- Tropical cyclones are referred to by different names depending on its origination around the world.

Hurricanes	Tropical cyclones that form over the *Atlantic Ocean or the eastern Pacific Ocean*.
Typhoons	Tropical cyclones that form in the *Northwest Pacific*.
Cyclones	Tropical storms that form in the *Bay of Bengal or the Arabian Sea*.

Characteristics of cyclones

- **Low pressure** – They are warm-core low pressure systems without fronts.
- **Organized circulation** – They are rotating systems of clouds and thunderstorms with closed, low-level circulation.
- **Favorable conditions** – They typically form when atmospheric conditions are favorable and the sea surface temperature is above 26.5 °C.
- **Spin** – They spin clockwise in the southern hemisphere and anticlockwise in the northern hemisphere due to the Coriolis Effect.

1.19 Typhoon Yagi

Super Typhoon Yagi, one of Vietnam's strongest storms in 30 years, struck northern and central regions of the country.

- **Journey –** After passing through ***Hainan Island in China*** as a tropical cyclone, it got intensified into a super typhoon and made landfall in Quang Ninh province and Hai Phong City, Vietnam.
- **Impact –** It has become the most ***powerful storm in Asia in 2024*** and severely impacted countries including the Philippines, China, Laos, Myanmar, Thailand, and especially Vietnam.

Typhoon yagi is the 2nd most powerful storm globally in 2024 after Hurricane Beryl.

Formation of Tropical Cyclones

- **Conditions** – They form over Warm Ocean waters near the ***equator,*** with sea temperatures of at least 27°C.
- **Process –** Warm, moist air rises, creating a low-pressure area.
- **Low pressure** – Areas of low-pressure form over the warm ocean waters, drawing in surrounding winds.
- **Converging winds** – Winds near the ocean surface converge, forcing air to rise and form storm clouds.
- **Low wind shear** – Winds do not vary greatly with height, allowing storm clouds to rise vertically.
- **Distance from the equator** – The cyclone is far enough from the equator for the Coriolis force to take effect and cause the cyclone to spin.
- Surrounding high-pressure air moves into this low-pressure zone, also becoming warm and moist, then rises to form clouds and thunderstorms.

*The **Saffir–Simpson hurricane** wind scale is based on the highest wind speed averaged over a one-minute interval 10 m above the surface.*

The strength of tropical cyclones is categorized using the Saffir-Simpson Hurricane Wind Scale into 5 categories based on sustained wind speeds.

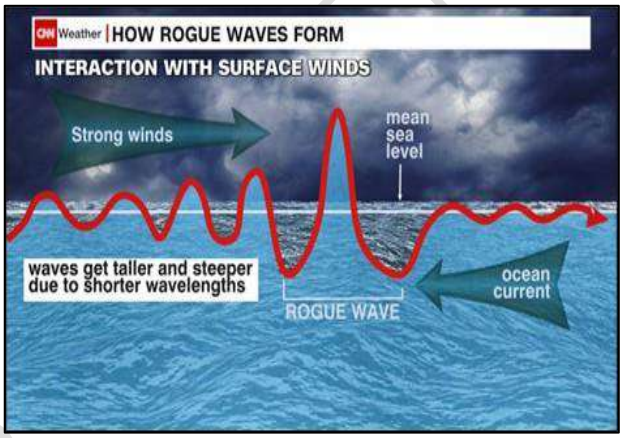
Climate Change and Tropical Cyclones

- **Impact –** There is a consensus that ***rising global temperatures*** are making tropical cyclones more intense.
- **Study findings –** Tropical cyclones in Southeast Asia are forming closer to coastlines, intensifying more rapidly, and lingering longer over land.
- **Sea surface temperature –** Global mean sea surface temperature has increased by 0.9°C since 1850 and by 0.6°C in the ***last four decades***.
- **Effect –** Higher sea surface temperatures cause marine heat waves, escalating the intensity of storms with stronger winds, heavier rainfall, and increased flooding.

1.20 Rogue waves

Researchers have recently developed a new tool that uses AI to predict rogue waves.

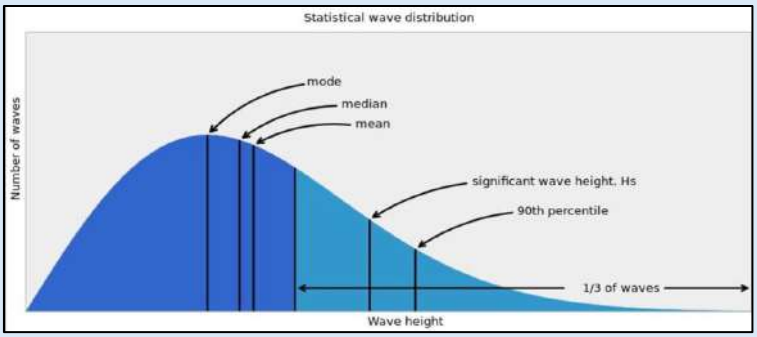
- **Rogue wave** – A large, unexpected, and dangerous ocean wave that can be more than twice the size of the surrounding waves.
- These waves are also called as ***freak, extreme storm waves or killer*** waves.
- **Caused by** – A ***combination of waves and currents*** or by multiple wind-driven wave crests stacking up at a single point.
- They can also be caused by constructive interference or gale-force winds.
- **Appearance** – They are often steep-sided with deep troughs and can look like walls of water.
- **Height** – They can reach heights of up to ***30 meters*** and can come from unexpected directions, even opposite to the prevailing wind and waves.
- **Threats** – Rogue waves can pose a threat to ships, coastal infrastructure, and human lives.
- **New tool** – This program *uses AI* that can predict about **75%** rogue waves 1 minute in advance.
- Roughly **73%** of rogue waves could be predicted 5 minutes in advance.



*The **Draupner wave** is the highest confirmed rogue wave known. However, the most extreme rogue wave occurred in the Pacific Ocean in 2020 was more than 3 times higher than the surrounding waves.*

Quick facts

- **Significant Wave Height** – It is the average of the highest one-third of waves that occur over a given period.
- It is defined traditionally as the mean wave height (trough to crest) of the highest third of the waves.
- It should be noted that some individual waves might be much larger than this.

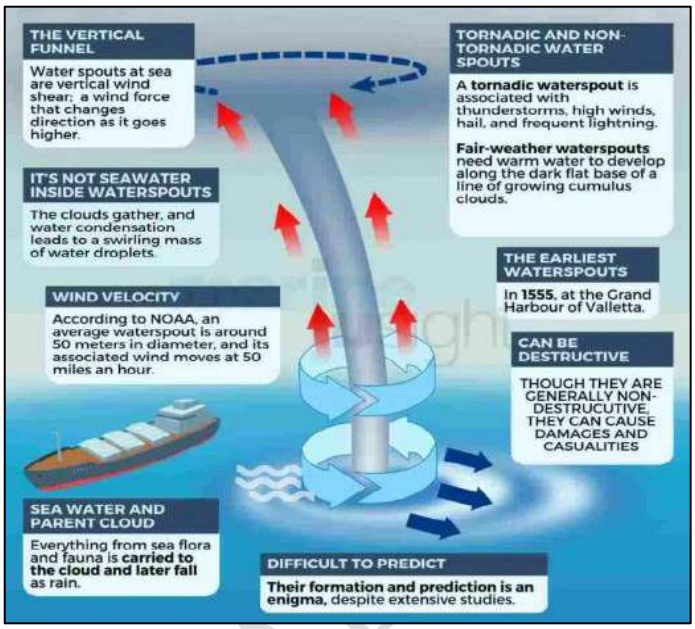


1.21 Waterspout

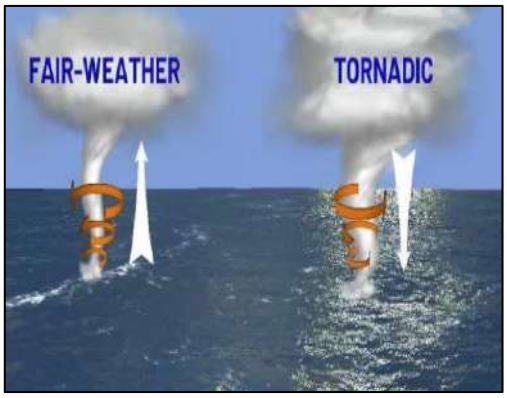
A luxury yacht in Mediterranean Sea was hit & sank by a violent storm, could be a waterspout off the coast of Sicily, Italy.

- **Waterspout** – A whirling column of air and water mist.

- **Favorable Condition** – They occur when there are *high levels of humidity and relatively warm water* temperatures compared to the overlying air.
- **Size & Physical characteristics –** The average waterspout can be around 165 feet in diameter, with wind speeds of 100 kilometres per hour.
- **Duration** – It typically *lasts for around 5 minutes* and occasionally it can last up to 10 minutes.
- **Occurrence** – Although waterspouts are *more common in tropical waters*, they can appear anywhere.
- **2 categories** – Tornadic waterspouts and Fair-weather waterspouts.
- **Tornadic Waterspouts** – They are actual tornadoes that form ***over water or move from land to water.***



    - They are accompanied by severe thunderstorms, high winds and seas, large hail, and frequent dangerous lightning.
    - Tornadic waterspouts ***develop downward in a thunderstorm***.
- **Fair-weather waterspouts** – They *form over only water* usually along the dark flat base of a line of developing cumulus clouds.
    - It develops on the surface of the water and works its way upward.
    - This type of waterspout is generally not associated with thunderstorms.
    - **Favorable conditio**n – They are formed during fair weather.
    - **Movement** – Fair weather waterspouts form in light wind conditions so they normally move very little.
    - Typically, fair weather waterspouts dissipate rapidly when they make landfall and rarely penetrate far inland.
    - They are *less dangerous and usually small.*



- **Increased frequency of occurrence** – With increase in sea surface temperature, the frequency of waterspouts is increasing.
- **Prevention** – The best way to avoid a waterspout is to move at a 90-degree angle to its apparent movement.

1.22 Project Waterworth

Meta introduced its internet subsea cable Project Waterworth recently.

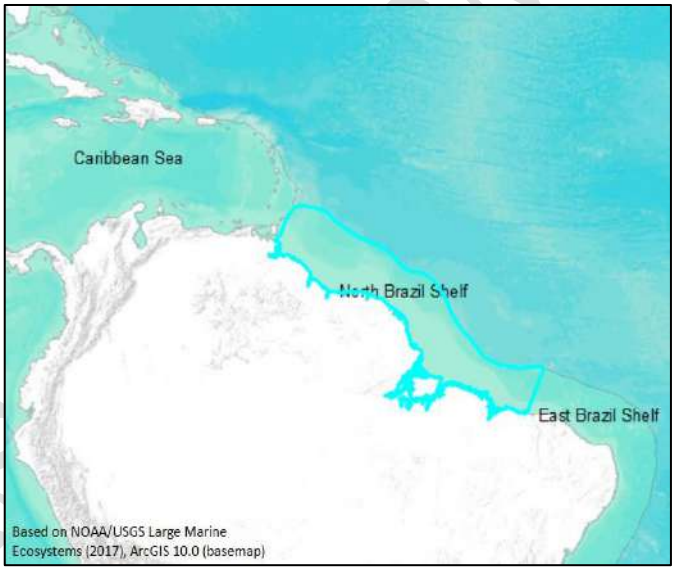
- It is the ***world's longest undersea cable system*** Project that stretches over ***50,000 km.***
- **Aim –** To predict and mitigate potential disruptions, enhancing the resilience of subsea networks.
- The cable will reach depths of ***up to 7,000 meters*** in deep waters.
- **Introduced by –** Meta, American multinational technology conglomerate.
- **Operational by –** 2030.
- **Connecting Regions –** The initiative will bring industry-leading connectivity to the US, India, Brazil, South Africa, and other key regions.
- **Features** – It will facilitate greater economic cooperation, digital inclusion, and open opportunities for technological development.

- It leverages advanced machine learning models like AI.
- It provides internet connectivity, linking countries and enabling local telecom operators to provide services to customers.
- It will deploy advanced routing techniques and innovative cable burial strategies to protect against damage in high-risk zones, such as shallow coastal waters.

1.23 Ocean Coordination Mechanism (OCM)

Caribbean and North Brazil shelves (Large Marine Ecosystem) are recently brought under the initiative, Ocean Coordination Mechanism (OCM).

- **About** – It is a collaborative framework to ensure a more inclusive and sustainable approach to ***ocean conservation*** in the ***wider Caribbean region.***
- **Announced by** – The Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization (UNESCO).
- It was conceived under the 10-year Caribbean Large Marine Ecosystem (CLME)+ Strategic Action Program (CLME+ SAP), endorsed by countries in the Wider Caribbean in 2014.
- **Implemented by** – IOC Sub commission for the Caribbean and Adjacent Regions (IOCARIBE), a UNESCO's agency.
- **Covered areas** – Caribbean Sea and North Brazil shelves.
- **Purpose –** Foster collaboration among countries, intergovernmental organizations (IGOs), and key stakeholders.



- Promotes blue carbon projects, which use coastal ecosystems for carbon storage, benefiting both the environment and local communities.
- Coordinate and streamline actions such as sustainable fisheries, ecosystem restoration, pollution control, blue carbon development, marine spatial planning, and establishing marine protected areas.
- **Funding –** It has secured an initial $15 million investment from the Global Environment Facility through the UNDP/GEF PROCARIBE+ Project for the period 2024–2028.
- The initiative has also benefited from a substantial co-financing total of $126.02 million facilitated by the GEF.

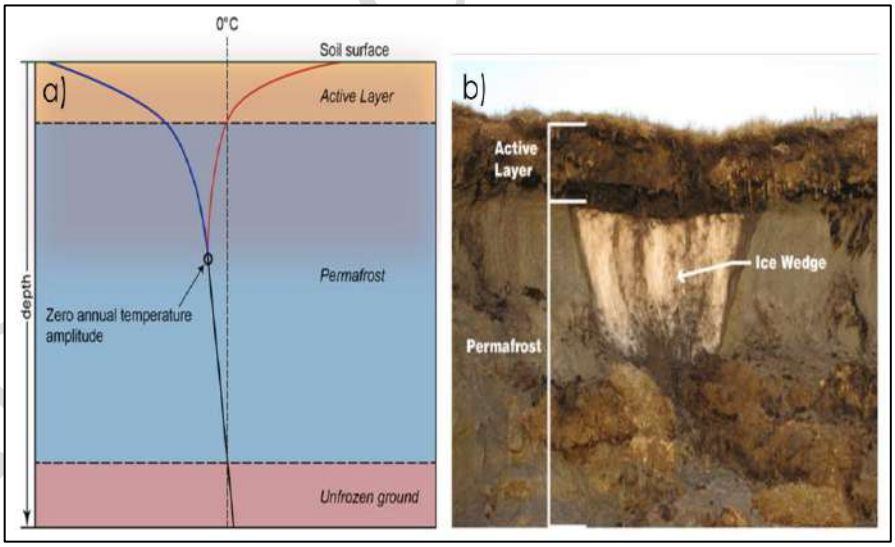
Carribean Sea	North Brazil Shelf
• The Caribbean Sea is a body of water adjacent to the Atlantic Ocean, southeast of the Gulf of Mexico.	• The "North Brazil Shelf" refers to a large marine ecosystem (LME) located off the north-eastern coast of South America.
• **Bordered by -** Venezuela, Colombia and Panama to the south, • Central American countries (Costa Rica, Nicaragua, Guatemala, Honduras and Belize) on the west, • Greater Antilles (Cuba, Jamaica, the Dominican Republic and Puerto Rico) on the north and	• Extending from the Caribbean Sea boundary near Venezuela to the Parnaiba River estuary in Brazil.

• Lesser Antilles on the east.	
• The deepest site in this sea is the Cayman Trench between Cuba and Jamaica	• It's characterized by a wide continental shelf significantly influenced by the Amazon River's discharge and the North Brazil Current.
• The Wider Caribbean Region includes 35 states and territories that border 2 interconnected watersheds- the ***Gulf of Mexico and the Caribbean Sea.***	• It includes 6 countries, highly productive region with diverse marine life including numerous fish species and shrimp populations.

1.24 Toxic mercury in Arctic's permafrost

As the Arctic's permafrost thaws in a warming climate, an enormous amount of toxic mercury is being released into the environment.

- **Permafrost** – An area that *remains completely frozen* 32°F (0°C) or colder—for at *least two years straight*.
- **Composition** – It is made of a combination of soil, rocks and sand that are held together by ice.
- **Occurrence** – Most common in regions with high mountains and in Earth's higher latitudes near the North and South Poles.
- **Active layer** – It is the top layer of the permafrost that *does not stay frozen all year*.
- It thaws during the warm summer months and freezes again in the fall.
- **Permafrost Thawing** – As Earth's climate warms, the ice inside the permafrost melts, leaving behind water and soil.
- **Mercury Bomb** – A significant amount of total *mercury (THg) is liberated from permafrost* during glacial erosion in Arctic.
- Abrupt thawing events can rapidly mobilise metres-thick deposits of sediment, potentially releasing large mercury.
- The mercury content was generally higher in sediment, with finer rather than coarser grains.



- **Thaw slumps** – It is a *type of landslide* that occurs in the terrestrial Arctic's permafrost region.
- Thaw slumps adjacent rivers around the arctic region such as Mackenzie River, Yukon and Koyukuk Rivers, elevate suspended particulate mercury contents downstream.
- Most mercury eroded from the banks during river migration is redeposited with sediments.
- **Arctic Mercury** – Mercury is a global environmental contaminant with both natural sources and sources associated with human activities.
- Much of the mercury contaminating the Arctic is a result of transport *by air and ocean pathways* from sources outside of the Arctic.
- Over ***98%*** of atmospheric mercury is emitted outside the region and is transported to the Arctic via long-range air and ocean transport.
- **Impact** – People and wildlife living in the Arctic are *highly exposed to mercury*.
- Mercury is a *neurotoxin* that can cause serious harm to the brain and nervous system, particularly when it accumulates in the food chain.

- Many indigenous communities, including Alaskan communities, rely on subsistence fishing and have disproportionately elevated blood mercury levels linked to dietary exposure.

1.25 Antarctic Peninsula

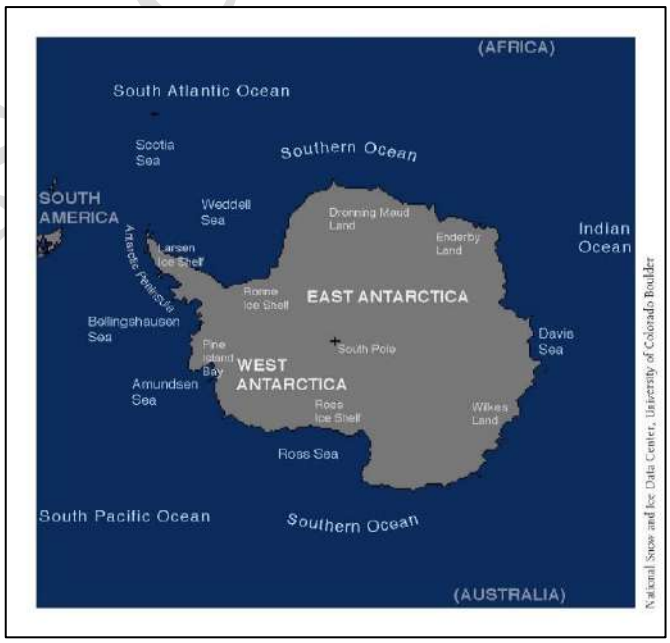
Antarctic Peninsula showed 10-fold greening since 1986 according to the archive study of National Aeronautics and Space Administration's (NASA) Landsat satellite mission between 1986 and 2021.

Recent Findings

- Vegetation cover likely *increased from less than one square km in 1986 to almost 12km in 2021*.
- The Antarctic Peninsula is *heating up 5 times faster than the global average*.
- More than 90% of the glaciers have been losing mass since the 1940s.
- *Vascular plants native to the Peninsula* have extended their range. However, scientists are particularly concerned about moss ecosystems.
- Mosses play a crucial role in changing the extent of vegetated ground cover, organic soil formation, and higher plant colonization.
- Mosses are capable of colonizing bare rock surfaces and helping future soil development to enable moss-dominated ecosystems and higher plants to take over.
- This raises the *risk of non-native and invasive species arriving*, possibly carried by eco-tourists, scientists or other visitors to the continent.

Antarctic Peninsula

- The Antarctic Peninsula is the northernmost part of mainland Antarctica.
- It is known as:
  - O'Higgins Land in Chile,
  - Tierra de San Martín in Argentina,
  - Originally as Graham Land in the United Kingdom and
  - The Palmer Peninsula in the United States.
- This peninsula is notable for its unique ecosystems and is considered one of the most accessible regions in Antarctica for scientific research.
- Mount Jackson is the highest peak at 3,184 metres but there are many other equally as impressive mountains.
- Marguerite Bay indents the west coast, and ***Bransfield Strait*** separates the peninsula from the South Shetland Islands to the north.



1.26 Korean Peninsula

North Korea has adopted a renewed aggressive stance in the face of tensions with its neighbour, South Korea.

- The Korean Peninsula is a peninsula in ***East Asia*** that is made up of the Korean mainland and more than 3,960 nearby islands.
- It's located between ***China and Japan***.
- **Bordered by** – The Yellow Sea to the west, the East China Sea and Korea Strait to the south and the East Sea to the east.
- The Yalu and Tumen rivers form the border between North Korea and China.
- Japan is located just east of the Korean Peninsula across the Korean Strait.
- The Korean Peninsula is *politically divided into North Korea and South Korea*, with each country claiming sovereignty over the entire region.

- **North Korea** – Also known as the Democratic People's Republic of Korea (DPRK) with its capital **Pyongyang**.
- **South Korea** – Also known as the Republic of Korea (ROK) with its capital **Seoul**.

- The two countries fought the Korean War from 1950 to 1953. These countries have been separated by the ***Korean demilitarized zone (DMZ)*** since 1953.
- *Approximately 70% of the Korean Peninsula is mountainous.*
- **Dolmens** – Are significant features of Korean Peninsula. Dolmens are large rocks that were erected over thousands of years.
- Many dolmens can be found across the Korean Peninsula, and some have been designated as UNESCO World Heritage sites.

1.27 DANA, Weather pattern

Millions have been affected in southern and eastern Spain due to torrential rain, which began recently because of the annual weather pattern, cold drop.

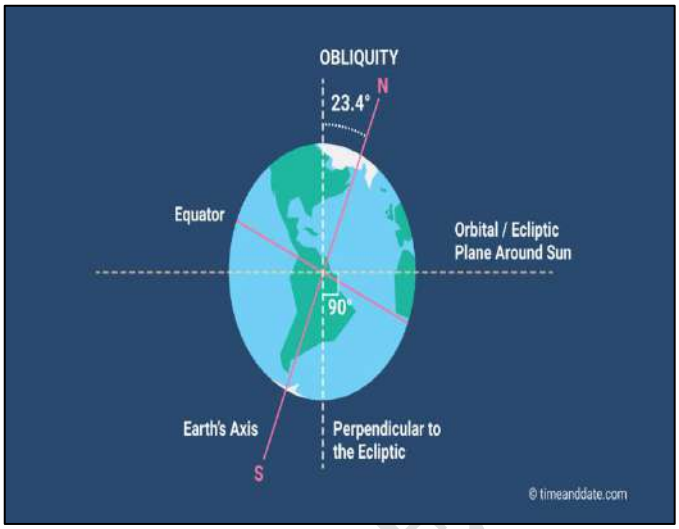
- DANA (*Depresion Aislada en Niveles Altos* or isolated depression at high altitudes) is an annual weather pattern that causes torrential rainfall in the Spain.
- It is also known as "gota fria," or cold drop.
- **Formation** – DANA takes place when cold air descends over the warm waters of the ***Mediterranean Sea***.
- This results in atmospheric instability, causing hotter, moist air on the surface of the sea to rise quickly, leading to the formation of dense, towering ***cumulonimbus clouds*** in a matter of hours.
- These clouds then dump heavy rain.
- Its occurrence is related to the polar jet stream, a fast-moving wind current at high levels of the troposphere which circulates from west to east and separates the cold polar air from the warm tropical air.
- Often, a pocket of cold air gets separated from the polar jet stream and collides with the warmer air over the Mediterranean Sea, which results in DANA.
- The phenomenon usually coincides with the onset of autumn and spring in the western Mediterranean.
- It can occur in Spain, Portugal, France, Italy and other Mediterranean countries.
- However, experts suggest that cold drops have become more frequent and intense in recent years. Also, the phenomenon has also become more geographically spread.
- This is happening partly because of soaring global temperatures warmer air can retain more moisture which, in turn, results in more intense rainfall.
- The rise in sea surface temperatures of the Mediterranean Sea has also exacerbated the situation.

1.28 Changes in Tilt of Earth's Axis

Researchers recently discovered that Earth's axis has tilted by 31.5 inches due to excessive groundwater extraction.

- **Axial tilt** – It is the ***angle between the planet's rotational axis and its orbital axis.***
- A planet's orbital axis is perpendicular to the ecliptic or orbital plane, the thin disk surrounding the sun and extending to the edge of the solar system.
- **Earth's axial tilt –** It is about ***23.5 degrees***.
- Due to this axial tilt, the sun shines on different latitudes at different angles throughout the year which causes the seasons.
- It is also known as the ***obliquity of the ecliptic***.

- **Axial Precession** – Its axis appears stable but wobbles very slowly, like a spinning top.
- It takes *Earth's axis about 26,000 years to complete a circular "wobble."*
- It is also known as axial precession which is influenced by the distribution of mass across the planet.



Recent Findings

- **Groundwater extraction –** The study reveals that excessive groundwater extraction has caused a significant shift in Earth's rotational pole.
- It is estimated that humans have *pumped out around 2,150 gigatons of groundwater* largely for irrigation and for their use.
- Between 1993 and 2010, the Earth's pole drifted approximately 80 centimeters eastward due to groundwater depletion.
- It has contributed to a sea level rise of about 0.24 inches and altered the distribution of Earth's mass, leading to the drift of the rotational pole at a rate of 4.36 centimeters per year.
- The redistribution of groundwater from aquifers to oceans has affected the polar motion.
- It has a larger impact on polar drift than climate-related factors such as ice sheet melting.

Polar Motion is the movement of Earth's rotational axis relative to its crust. When Earth rotates on its spin axis an imaginary line that passes through the North and South Poles, it drifts and wobbles.

- **Regional Impact –** Western North America and northwestern India have significant groundwater extraction.
- These mid-latitude areas influence polar drift due to their geographical location and the volume of water extracted.
- **Current Shift –** Earth's tilt is *not enough to affect weather patterns or seasons immediately.*
- The continued groundwater depletion could have long-term climatic impacts.

1.29 Baltic Sea

Recently, the Baltic Sea is at a high-risk zone after a suspected sabotage attack on undersea cables.

- It is the 15th largest sea of Atlantic Ocean and ***one of the world's largest brackish waters***.
- **Location –** ***Semi-enclosed*** inland sea in ***Northern Europe*.**
- It is the arm of the North Atlantic Ocean and connects it through the Danish Straits.
- **Origin –** It is the ***youngest sea on Earth***, emerging some 10,000-15,000 years ago as the glaciers retreated at the end of the last Ice Age.
- **Bordering Countries** – Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland, Russia, and Sweden.
- **Features** – *Danish Straits connects it to the Atlantic Ocean*.
- The Baltic Sea is connected to the White Sea via the White Sea Canal and to the North Sea's German Bight via Kiel Canal.
- **Rivers** – Neva is the largest river that drains into the Baltic Sea. Its longest rivers are the Vistula and the Oder.
- The highest salinity is recorded in the western Baltic.

World Wide Fund for Nature (WWF) doing a Baltic Programme with an aim at marine protected areas covering 30% of the sea, with 10% of the strictly protected area by 2030.

- **Major Gulfs –** The Gulf of Bothnia to the north, the Gulf of Finland to the east, and the Gulf of Riga slightly to the south.
- **Gotland** – Located off the coast of Sweden, is the largest island in the Baltic Sea.
- It is often cited as the *world's largest brackish inland water body.*

1.30 Caspian Sea

The Caspian Sea, planet's largest lake has been shrinking since the mid-1990s, but the rate it's disappearing has sped up since 2005.

- The Caspian Sea is the ***planet's largest inland sea*** located between Europe and Asia.
- It is classified as a lake, despite being referred to as a "sea."
- **Topography** – It lies to the east of the Caucasus Mountains and to the west of the vast steppe of Central Asia.
- **Coastline** – Its looping coastline stretches more than 4,000 miles.
- **Bordering countries (5)** – Kazakhstan, Iran, Azerbaijan, Russia and Turkmenistan.
- **Rivers –** The Caspian is fed by 130 rivers, although around 80% of the water comes from the ***Volga, Europe's longest river***, which winds through central and southern Russia.
- The Caspian Sea is endorheic, meaning it has no natural outlets.
- **Significance** – Bordered countries rely on it for fishing, farming, tourism and drinking water, as well as its coveted oil and gas reserves.
- The Caspian also helps regulate this arid region's climate, providing rainfall and moisture to Central Asia.

- **Important Species** – It is home to Caspian seals, an endangered marine mammal and critically endangered Beluga sturgeon.
- **Threats** – Damming, over-extraction, pollution and, increasingly, the human-caused climate crisis are driving its decline.

1.31 Deep Sea Metals and its Mining

Recently International Sea Bed authority elected new chief and held discussion on international moratorium on extraction of deep sea metals until clear research on their impacts.

What are deep sea metals?

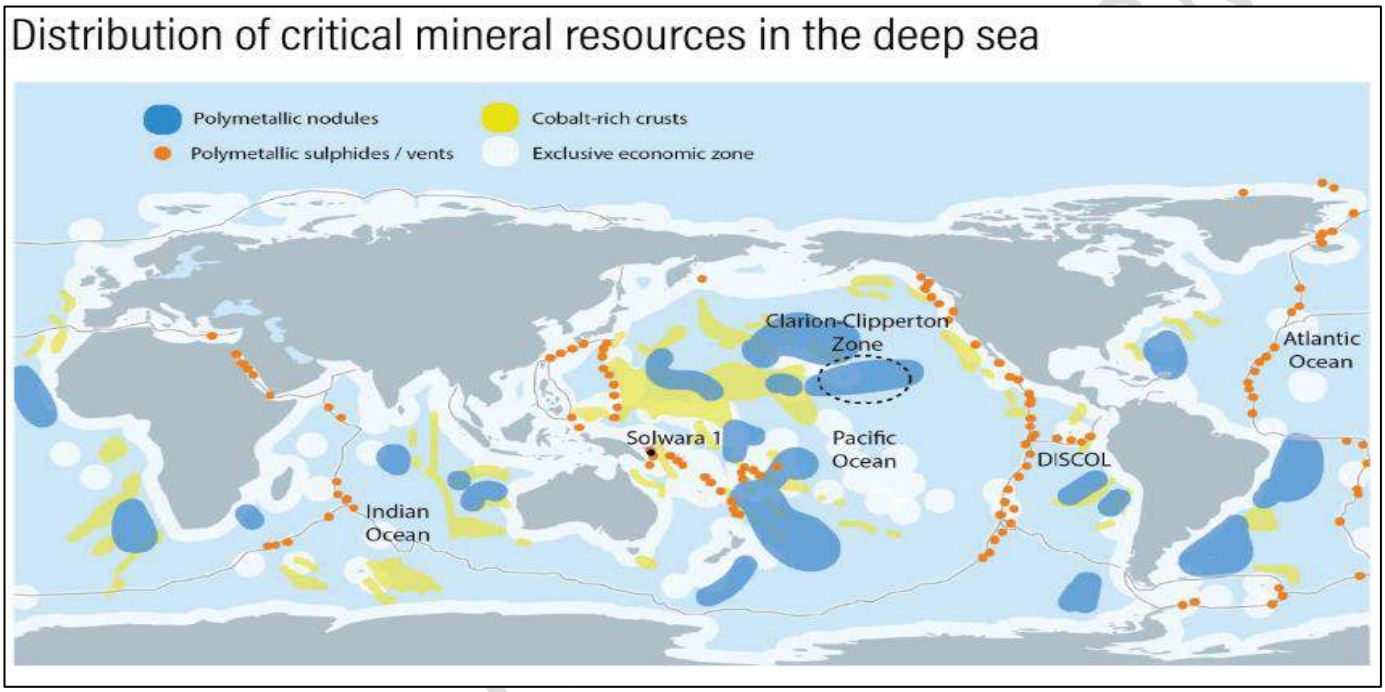
> *The high seas are defined by international law as all parts of the ocean that aren't included in the exclusive economic zone, the territorial sea, or the internal waters of a country, or in the archipelagic waters of an archipelagic country.*

- It refers to the metallic and non-metallic ores present in Deep sea ocean floor.
- **Occurrences** – Deep sea minerals are found at high seas that accounts for more than 50% of the world's oceans.
- They occur in different forms in different parts of the ocean.
- **Polymetallic nodules** – These are potato-sized lumps formed over millions of years from sediment deposits and are composed mainly of manganese, cobalt, copper and nickel.
- They are found at depths of 4–6 km in all major oceans.
    - **Example** - Clarion-Clipperton Zone between Hawaii and Mexico holds vast amounts of manganese nodules.
    - India is trying to explore Carlsberg Ridge & Afanasy-Nikitin Seamount for polymetallic nodules.
- **Polymetallic sulfides** – It contains large amounts of copper, zinc, lead, iron, silver and gold.

- **Cobalt-rich crusts (CRCs) –** CRCs form on sediment-free rock surfaces around oceanic seamounts, ocean plateaus, and other elevated features.

Deep Sea Mining

- Deep sea mining includes 3 stages that include:
  - **Prospecting** – Searching for minerals and estimating their size, shape and value.
  - **Exploration** – Analysing the resources, testing potential recovery and potential economic/environmental extraction impacts.
  - **Exploitation** – Recovering of these resources.
- **Countries opposing the mining** – Germany, Brazil and the Pacific island nation of Palau.
- **Countries supporting the mining** – China, Norway, Japan and the microstate Nauru in the Central Pacific.



1.32 Other Important Topics

Republic of Estonia

- **Located in** – North-Eastern ***Europe***.
- **Capital** – Tallinn.
- **Bounded by** – Russia to the east and Latvia to the south.
- It is the *most northerly of the 3 Baltic States* and has linguistic ties with Finland.
- Indian Prime Minister met President of the Republic of Estonia and it was the *1st meeting between the 2 leaders*.
- **Landscape** – The Estonian landscape is largely the product of ***glacial activity***.
- **Minerals** – The country's most important mineral is ***oil shale***, of which Estonia is a significant world producer.

Democratic Republic of Congo (DRC)

- It is the 2nd largest country in the African continent.
- **Capital** – Kinshasa.
- **Situated** – Astride the equator, West-Central Africa.
- **Coastline** – 25-mile (40-km) on the Atlantic Ocean.
- **Border countries:**
  - **North** – Central African Republic and South Sudan.
  - **East** – Uganda, Rwanda, Burundi, and Tanzania.
  - **Southeast** – Zambia Angola.
- **M23 rebellion** – It is an *armed conflict in DRC's North Kivu.*

- Rwanda-backed M23 rebels has recently captured eastern DRC's 2nd largest city, Bukavu.

Medvedev–Sponheuer–Karnik scale

- It is a *macro seismic intensity scale* used to determine the intensity of the earthquake.
- **Intensity of earthquake** – A value that represents the degree of oscillation of the Earth's surface during an earthquake.
- It is *greater* when the earthquake *closer to the surface* of the earth.
- **Intensity depends on:**
  - Degree of destruction of standard buildings.
  - Witnesses sensations.
  - Changes in topography of the earth's surface.
  - Depth and magnitude of the earthquake source.
- It is known as the *MSK or MSK-64*.

Sea Ice, Iceberg, Glacier, Ice Sheet, Ice Shelves

- **Sea ice** – It refers to the *free-floating ice* in the Polar Regions.
- **Iceberg** – It is a *large piece of floating ice* that has broken off from a glacier or ice shelf.
- **Glacier** – It is an *accumulation of ice and snow* that slowly flows over land.
- **Ice sheet** – It is a *mass of glacial ice* more than 50,000 square kilometres (19,000 square miles).
- **Ice shelves** – They are *large floating platforms of ice* that extend from the land to the ocean.

Iraq's Sinking North

- **Northern Iraq** - Near the Zagros Mountains, is slowly sinking.
- **Tectonic Pull** - A subducting oceanic slab is pulling the region down, a result of long-term tectonic activity.
- **Plate Interactions** - This is driven by the Arabian and Eurasian plates colliding, a core concept of plate tectonics.
- **Plate movement** - Causes earthquakes, volcanoes, and mountain building, also impacting Iraq's geology.

Dukono Eruption

- **Located in**- Halmahera Island in North Maluku, Indonesia.
- **Nature of Volcano** – Active.
- **Indonesia –** Has 130 active volcanoes, Situated on the Ring of Fire, faces frequent eruptions & earthquakes.
- **Active volcanoes** – Mount Merapi and Kelut, both located on Java Island of Indonesia.
- **Pacific Ring of Fire:** This 40,000km zone, with tectonic plate interactions, causes 90% of global earthquakes.

Mount Fentale

Scientists recently observed extraordinary methane emissions from Mount Fentale, Ethiopia.

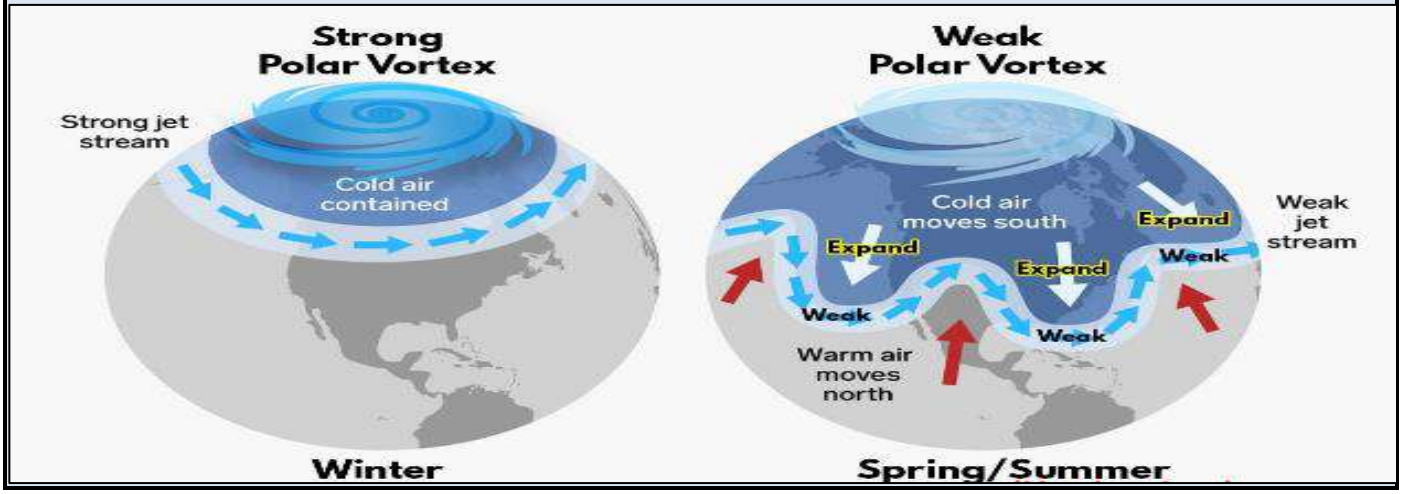
- **Volcano type** – Stratovolcano.
- **Emissions peaked at** – 58 metric tonnes per hour. This is significantly higher than typical volcanic emissions, dominated by carbon dioxide Methane & sulphur dioxide.
- **Methane** – A Potent greenhouse gas, 28 times more effective at trapping heat than carbon dioxide.
- **Features of Stratovolcano type –** Known for its steep, cone-shaped structure built up from layers of lava, ash and rock.
    - **Summit Caldera** – A large, bowl-shaped depression at the top, formed by past eruptions.

Zagros Mountains

- **Located In** – Iraq was pulled into the Earth.
- **Highest Peak** – Mount Dena.
- **Ancient city** – Susa.
- **Formation of Mountain –**Tectonic in Origin formed during Miocene and Pliocene orogenic episodes.
- This resulted in Arabian Plate's subduction under the Eurasian Plate, creating a 1,500km natural barrier.
- **Geographic Extension –** Stretching from Turkey to Iran, ending at the Strait of Hormuz.

Polar vortex

- Polar vortex is the band of cold air and low pressure systems that spins around the poles of the Earth in the stratosphere.
- The vortex that usually remains strong and stable during winter in the southern hemisphere keeps the cold air trapped over Antarctica and not letting hot air come in.

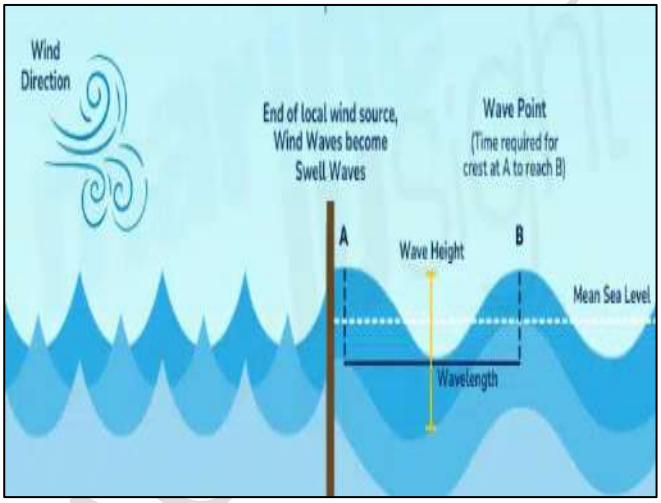


2. INDIAN GEOGRAPHY

2.1 Swell Waves

The Indian National Centre for Ocean Information Services (INCOIS) had forecasted Swell waves likely to hit several coastal areas in India over the weekend.

- **Swell Waves** – It is a *series of Ocean surface waves* that propagate along the interface *between water and air* and are often referred to as ***surface gravity waves***.
- They are formed by an ocean swell, hence the name swell surge.
- **Formation** – Swells (series of waves) are generated over the open ocean ***by a distant storms*** like hurricanes or even long periods of fierce gale winds and *not by any local wind*.
- During such storms, huge *energy transfer takes place from the air into the water*, leading to the formation of very high waves.
- Many ocean swells originate in the oceans around Antarctica where there is high winds with nearly infinite duration and fetch.



- **Impacts over India** – Usually, states like *Kerala witness swell waves as a result of strong winds in the southern part of the Indian Ocean*, where an ocean swell is generated, and the waves then travel north to reach the coast in 2 or 3 days.
- **2024 swell waves of Kerala** – They were generated after a low atmospheric pressure system moved over the region from the South Atlantic Ocean 10,000 kilometres off the Indian coast.
- It resulted in strong winds, forms swell waves.

*The swell waves flooding events are called **Kallakkadal** in Kerala.*

*To forecast swell waves, INCOIS launched the **Swell Surge Forecast System** in 2020 which can give forewarning seven days in advance.*

Wind Waves	Swell Waves
• Generated by *local wind*. • It tend to be *irregular*. • They are *not self-sustaining* and will die out when the wind stops. • Relatively *lesser speed* and cover *lesser distances*.	• Generated by *distant storms*. • *Regular* series of waves. • They are *self-sustaining*. • Larger wavelength and period. • *Travels faster* than small waves and travels *greater distances*.

Features of Tsunamis in comparison with Swell Waves

- Unlike Swell waves, it is *created by an underwater disturbance* like earthquakes occurring below or near the ocean.
- They are around *10 times faster than swell waves*.
- Although both swell waves and tsunamis slow down near the coast, the latter *hit land at 30–50 km/h*.

2.2 Thangjing Hills

Manipur police registered a zero FIR over pictures of a banner placed in the culturally-disputed areas of the Thangjing Hills

- **Located in** – Manipur.
- **Status** – It falls within the *Churachandpur-Protected Forest*, notified in 1966 under Section 29 of the Indian Forest Act, 1927.
- **Historical importance** – A *protected site*, under Section 4 of the Manipur Ancient and Historical Monuments and Archaeological Sites and Remains Act, 1976.

*In police regulations, information recorded under Section 154 of Code of Criminal Procedure (CrPC) is known as **First Information Report (FIR).***

- **Cultural & Religious significance** – It is considered sacred to both the *Meitei community* and the *Kuki-Zo community*.
- **Dispute** – Contests over the *right to pray and worship* on the hill range have only escalated since the ethnic conflict of 2023.
- **Dispute over nomenclature**
  - **Kuki-Zo people** – 'Thangting Hills'.
  - **Meitei people** – 'Thangjing Ching or Thangjing Hills'.

***A Zero FIR** can be filed in any Police Station by the victim, irrespective of their residence or the place of occurrence of crime, to provide speedy redressal to the victim.*

2.3 Kumaon Himalayas

Supreme Court halts 90-acre project in Kumaon Himalayas on a plea challenging 'single window' clearances.

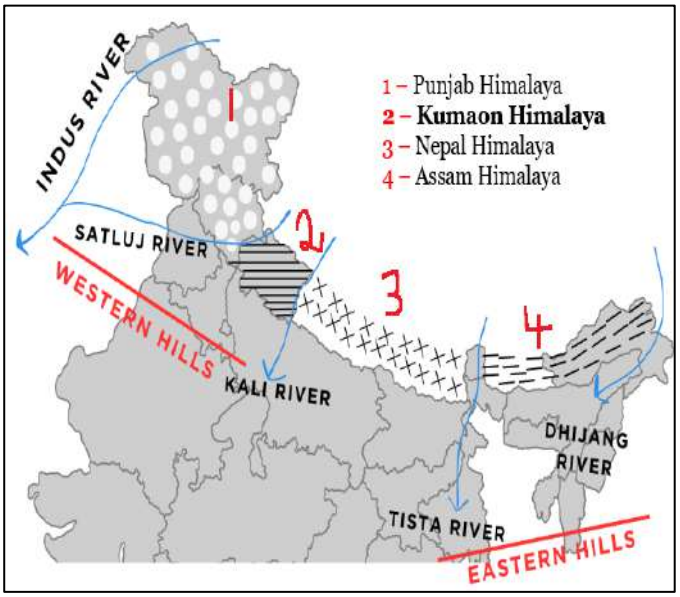
- **Kumaon Himalayas** – A *mountain range*, a part of *Western Himalayas*.
- **Himalayan features**
  - *Greater Himalayas* in the North
  - *Siwalik Range* in the South

***3 major entities of Himalayas** - The Himadri (greater), Himachal (lesser) and the Shivalik's (outer Himalaya).*

- **Located at** – *Uttarakhand*, which has 2 major divisions Kumaon hills and Garhwal area.
- **Geographical boundaries** – It extends from the *River Sutlej in west to the River Kali in the East*.
- It has Tibet on the north, Nepal on the east, Uttar Pradesh on the south and Garhwal are on the West.

Uttarakhand is home to 2 UNESCO World Heritage Sites, the Valley of Flowers and Nanda Devi National Park.

- Moving westwards, one comes across the Panchchuli Massif, the Gori Valley, and the Pindari and Sunderdungha valleys.
- **Peaks** – It ascends to *7817m at Nanda Devi* and 7756m at Kamet, close to China.
- **3 hill districts** – Nainital, Almorah and Pithoragarh
- **Melting pot of indigenous people** – Tharus, Bhutiyas, Jaunsaris, Buksas and Rajiswhose.
  - Tharus – Matrilineal.
  - Jaunsaris – A Polyandric society.
  - Bhotiyas – Tibeto-Mongoloid features & are expert weavers.
- **Concerns** – Ecologically fragile and seismic-prone lower Himalayan ranges.



2.4 Chug Valley

Chug valley, once blanketed by Cosmos flowers, has begun to shrink, and the meadows are no longer as dense as they used to be due to excessive human interference.

- The Chug Valley is in the Dirang region of ***Arunachal Pradesh***, with sprawling green grasslands.
- **Vegetation** – It encompasses green hills, vast meadows, and towering pine trees amidst majestic Himalayan peaks.
- **Duhumbi Monpa community** – Resides in the Chug village.
- **River –** The *Dihing River*, flows through the region.
- **Awards -** In 2024, Chung Valley was awarded
    - The 2nd Best Tourism Village Award and
    - Dammu's Heritage Dine of Chug Village was awarded the Responsible Tourism Award by the Government of Arunachal Pradesh.

Cosmos flowers

- Cosmos flowers showcases an enchanting beauty with a sea of pink and white Cosmos flowers during September and October months.
- They act as *pests repellent* and repel the corn earworm (Helicoverpa zea), which is a threat to food crops.
- They are *native to Southern and Central America* with Asteraceae family.
- These flowers attract butterflies, bees and other pollinators that are essential for a healthy environment besides offering food to birds, freshwater fish and other wildlife.
- They are grown easily from seeds and will even survive in poor soil conditions.
- Cosmos are also *tolerant to most soil pH levels* but grow best in neutral to alkaline soils (pH of 7.0-7.5).

2.5 Varkala cliff

The National Green Tribunal (NGT) sought a reply from the Geological Survey of India (GSI) and others regarding the declining state of Varkala cliff in Kerala.

- Varkala cliff is located in the varkala, a coastal town in ***Thiruvananthapuram, Kerala***.
- It rising from the shoreline of Varkala Papanasam beach.
- It formed during the Tertiary Period (around 2.58 million years ago), is divided into 3 sections –the North, South and Edava cliffs.
- It elevated up to 80 feet above the sea level and *made of high red laterite soil*.
- The cliff isn't made of hard, consolidated rocks and its basement rock is around 40 m under the form.
- It stands out as the *only region in southern Kerala where cliffs line the Arabian Sea*.

*A **geo-heritage site** is a location with geological, geomorphological, paleontological, or stratigraphic significance.*

- It is known as the *North Cliff and Warkallai formation*.
- Its unique Cenozoic sedimentary formation have designated them as a national geological monument.
- In 2015, the Ministry of Mines and the Geological Survey of India declared the Varkala Cliffs a geo-heritage site.
- The process to make it a UNESCO World Heritage Site Geo Park is also in progress.
- **Evidence of Mio-Pliocene Age** – It is the only place where sediments of the Mio-Pliocene Age have been founded.

2.6 Jiribam

Jiribam has emerged as the newest hotspot of ethnic violence in Manipur.

To know the history of Insurgency in Manipur Click Here

- Jiribam district is situated on the ***western most side of Manipur***.
- It is surrounded on the east and south by the Tamenglong and Churachandpur districts, respectively, and on the west and north by the Cachar district of Assam.
- NH-37 passes through Jiribam, connects Silchar in Assam and Imphal in Manipur, and is important for transporting essentials to the valley areas of the State.
- **Ethnic communities –** The Kuki-Zo-Hmar and Meitei are 2 ethnic communities primarily in the state of Manipur.
- **Soil –** It varies from sandy to loam and clay to loam having variety of colors from yellowish to bluish grey.
- **Drainage – *Jiri River*** flows from the north to the south.
- Jiri River forms the *boundary* between ***Assam and Manipur*** from its source to its termination in the Barak.

- The confluence point of Jiri and Barak Rivers is known as Jirimukh.
- **Flora –** It is covered by green vegetation, include bamboo, cane, teak, orchids, rubber, tea, agar, cashew nut, litchi, jack fruit, betel nut, pineapple, Eiranthus procerus etc.
- **Fauna –** There are various wild lives found in the area including *wild dog, wild pig, barking deer, sabu, moirang sathibi, samarak ngamarak,* etc.

The Kuki Inpi Manipur is the apex body of the Kuki tribes.

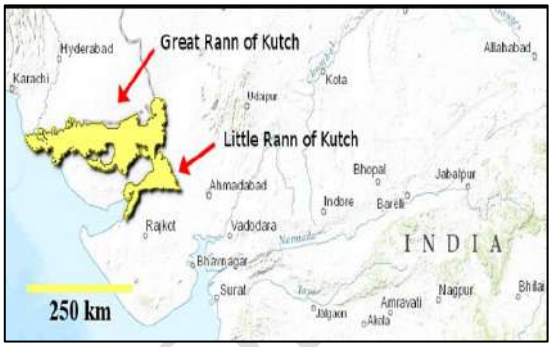
2.7 Cholanaikkan Tribes

Education department recently prepares exclusive talking texts for bed-ridden tribal girl in Kerala under the Samagra Shiksha Kerala' program.

- They are one of the most isolated tribes inhabits the forests in the ***Nilambur Valley*** of Malappuram district of ***Kerala.***
- **Nomenclature** – They call themselves as Malanaikan or Sholanaikan. Shola or chola means deep thicket in the forest and naikan means king.
- Cholanaikkans (coolanaaykkan) are called the Cavemen of Kerala and they are the ***only cave dwelling community in India***.
- **Population –** Small tribe with a total population of *less than 400 persons*, they ***are diminishing*** recently.
- **Jenmam –** They are divided into smaller groups called Jenmam and they have no fixed dwellings but prefer to live close to water sources.
- They are found in groups consisting of ***2 to 7*** primary families. Each group is called a ***Chemmam***.
- **Diet –** The community lives essentially by scavenging the forest. They do not cultivate due to the problem of elephants trampling over their produce.
- **Habitat –** A fraction of whom live in caves, the rest in temporary self-built structures.
- Their forest area is completely protected and outsiders are not even allowed to scavenge for forest produce or contact the tribal communities.
- They live in a protected forest with elephants and other wild animals including occasional sighting of tigers. Antelopes are very common.
- **Language –** They speak a language which is weakly called Dravidian but it is not directly related to any of the modern Dravidian languages.
- **Classification Status –** They are classified as ***Particularly Vulnerable Tribal Groups (PVTGs)***.

2.8 The Rann of Kutch

The Rann of Kutch can be considered a large ecotone, a transitional area between marine and terrestrial ecosystems.



- It is reputed to be *one of the largest salt deserts* in the world.
- **Location** – It lies at the end of the Gulf of Kutch in Gujarat.
- **Size** – It is about 7500 km² in area.
- **Evolution** – It evolved when *waters of the Arabian Sea* made incursions into this region 150-200 million years ago.
- Geological upheavals led to the *rise of a landmass* that cut off the Kutch basin from the sea.
- **Types** – Divided into the ***Little Rann and the Big Rann***.
- **Landscape** – Most of the year, it consists of vast, barren desiccated, *unbroken bare surface of dark silt*.
- It is also known for ecologically important *Banni grasslands*.
- **Landscape changes** – A striking alteration occurs when the monsoon sets in, and the Rann turns *into a shallow wetland*.
- **Bets** – 75 elevated pieces of land turn into islands, called as bets by *Agariya and Maldhari, local communities*.
- **Largest plateau** – P*ung*.
- **Economic significance** – 30% of India's salt comes from the Little Rann.

2.9 Ghataprabha River

Recently 9 people who fell into the Ghataprabha River were rescued.

- **About –** It is an important ***right-bank tributary*** *of the Krishna River* that flows in ***Karnataka***.
- **Origin –** It originates in the Western Ghats and flows eastward before its confluence with the Krishna River.
- **River basin –** It is wide and stretches across *Maharashtra and Karnataka states.*
- **Tributaries –** Markandeya and Hiranyakeshi rivers are tributaries of the Ghataprabha.
- **Bridges –** The River is crossed by a **suspension bridge** near the Gokak Falls.
- **Dams- *Hidkal Dam*** *also known as Raja Lakhamagouda Dam, is an earthen gravity dam* built across the river in Belagavi district.

Krishna River *is the 2nd largest river in peninsular India which rises in the Western Ghats near Mahabaleshwar in Maharashtra.*

2.10 Pennaiyar River

Recently, the Supreme Court directed the Union government to submit the report on Tamil Nadu and Karnataka's dispute between Pennaiyar river water.

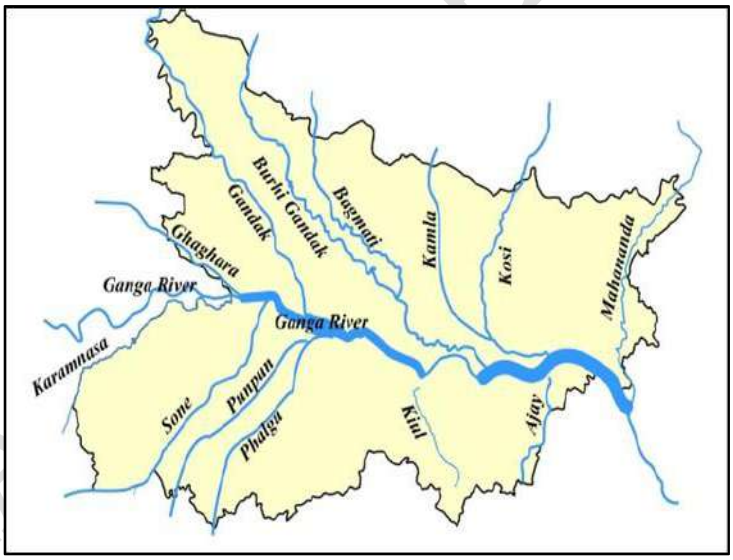
- It is the ***2nd largest interstate East flowing river*** basin among the 12 basins lying between Pennar and Cauvery basins.
- It is also known as *Thenpennai, Ponnaiyar, or Dakshina Pinakini.*
- **Origin** – It originates on the ***eastern slope of Nandi Hills*** in Karnataka and flows through Tamil Nadu into the Bay of Bengal.
- **Area –** It covers a large area in the State of Tamil Nadu besides the areas covered in the states of Karnataka and Andhra Pradesh, **77%** of the drainage basin lies in ***Tamil Nadu***.
- **Length** – 497 km.

- **Bounded by –** Velikonda, Nagari, Javadu, Shevaroy, Chitteri and Kalrayan hills of the Eastern Ghats.
- **Tributaries –** Chinnar West, Chinnar East, Markandanadhi, Kambainallur, Pambar, Vaniyar, Kottaipatti, Kallar, Valayar Odai, Ramakkal, Pambanar, Aliyar, Musukundanadhi and Thurinjalar.
- It *flows in monsoon seasons and dry in remaining parts of the year* and the river is mentioned in sangam literature.
- **Irrigation** – It is extensively dammed for irrigation, especially in Tamil Nadu.
- It's rich in abundance of soil such as non-calcareous red & brown and calcareous black soil, Red sandy loam and clay loam, and got coastal alluvium soil.

2.11 Bagmati river

The Chief Minister of Bihar has repeatedly raised concerns about the Bagmati River's annual flooding with multiple leaders from Nepal.

- Bagmati River is a *transboundary river* between the ***Nepal and India border.***
- The Bagmati flows from Nepal and *crosses the Bihar* before meeting the river Kamala in Samastipur and flows southward through the Shivalik Range (southernmost range of the Himalayas).
- **Origin –** ***Shivapuri Hills*** to the north of Kathmandu, Nepal.
- **Mouth of the River** – It ultimately joins the Narayani River.
- The merged waters of the Bagmati and Narayani eventually make their way southward and into the Ganges.
- **Tributaries –** Bishnumati River, Manohara River, Dhobi Khola River.
- The river is currently swollen, is a major cross-border river flowing through Bihar's plains, carrying significant water from Nepal's Himalayas.

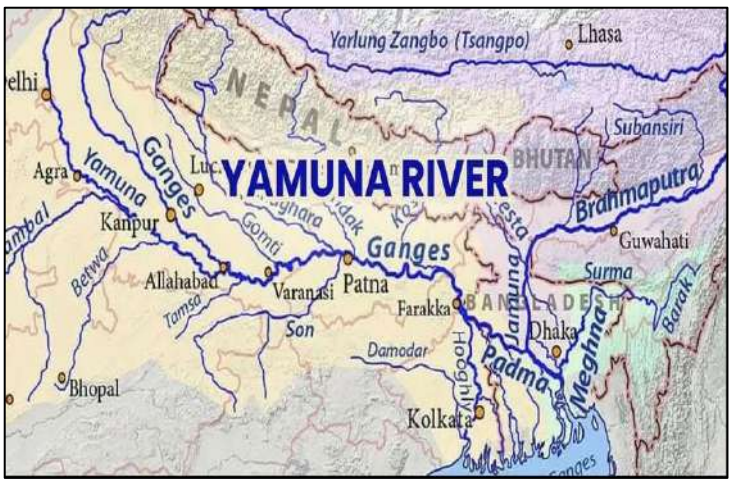


- **Hindu pilgrimage –** Located on the river's edge, the ***Pashupatinath Temple, UNESCO world heritage site*** is an important Hindu pilgrimage site dedicated to Shiva.
- **New course –** The River had a different course, draining directly into the Ganga, but it is the new course that has created the flooding issue.

2.12 Yamuna River

Delhi Lieutenant Governor VK Saxena, setting an ambitious four-pronged strategy to clean the Yamuna River.

- It is a major tributary of ***River Ganges*** and one of the ***longest river (1,376 kilometers) in India*** which does not directly flow to the sea.
- It is the ***largest tributary of the Ganga*** in the northern plains.
- **Origin** – It originates from the ***Yamunotri glacier*** in the Garhwal Himalayas of ***Uttarakhand***.
- **States –** The River flows across Uttarakhand, Himachal Pradesh, Haryana, Delhi, Uttar



Pradesh and Rajasthan (not a riparian zone) before it merges with the Triveni Sangam, Ganges River in Allahabad.

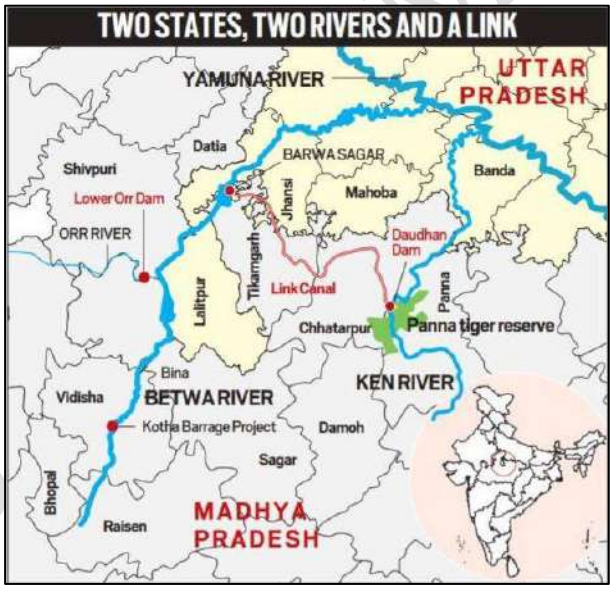
- **Tributaries in Himalayas –** Rishi Ganga, Kunta, Hanuman Ganga, Tons (largest) and Giri.
- **Tributaries in the plains -** Hindon, Chambal, Sind, Betwa and Ken.
- **Historical Cities-** Delhi (the national capital), Mathura (associated with Lord Krishna), Agra (home to the Taj Mahal), and Vrindavan (a revered pilgrimage site).

Gobind Pashu Vihar Sanctuary, Rupin valley is situated on the Tons River.

2.13 Ken-Betwa River linking project

Recently, Foundation for Ken-Betwa river-linking project has been laid.

- **Ken-Betwa Link Project (KBLP)** – It involves transferring surplus water from the *Ken River in Madhya Pradesh* to the *Betwa River in Uttar Pradesh*, both the river are tributaries of Yamuna.
- It is the *first project* under the National Perspective Plan for interlinking of rivers.
- **Phases** – The project has two phases, with four components.
- **Phase I** – It involves construction of Daudhan Dam, Ken-Betwa Link Canal and power houses.
- **Ken-Betwa Link Canal** – It will be 221 km in length, including a 2-km tunnel.
- **Daudhan dam irrigation project** – The project involves building a 77-metre tall and a 2-km wide Dhaudhan dam.
- It will be constructed inside the **Penna Tiger Reserve.**
- **Phase-II** – It consists of Lower Orr Dam, Bina Complex Project and Kotha Barrage.
- **Ken-Betwa Link Project Authority (KBLPA)** – A Special Purpose Vehicle (SPV) will be set up to implement the project.
- **Time period** – KBLP project is proposed to be implemented in ***8 years***.
- **Benefits** – The project is expected to provide ***annual irrigation to 10.62 lakh hectares*** (8.11 lakh ha in MP and 2.51 lakh ha in UP) of land in Bundelkhand region.
    - Supply drinking water to about 62 lakh people.
    - Generate 103 MW of hydropower and 27 MW of solar power.
- **Issue** – Submergence of around 98 sq. km of Panna national park.
- Felling of about two to three million trees.



Bundelkhand region *spreads across 13 districts of Uttar Pradesh and Madhya Pradesh.*

In 2021, ***memorandum of agreement*** *was signed among the Ministry of Jal Shakti and the Governments of Madhya Pradesh and Uttar Pradesh to implement the Ken-Betwa Link Project.*

National Perspective Plan for interlinking of rivers

- National River Linking Project was conceived in 1980 to transfer water from surplus basins to deficit basins.
- **Objectives:**
    - Increase water availability for drinking and industrial use,
    - Reduce flood risks in water-surplus regions,
    - Improve regional connectivity through waterways,

- Promote balanced regional development and
- Generate hydro power.

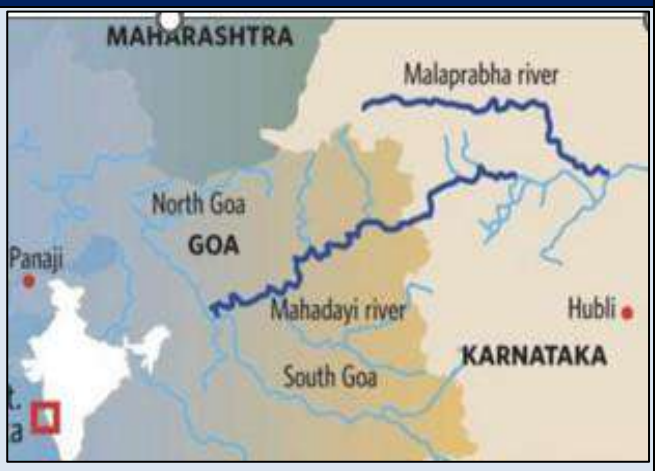
- **2 components**:
  - Peninsular component - 16 projects.
  - Himalayan rivers - 14 links.
- **Ministry** – Ministry of Jal Shakti.

2.14 Kalasa-Banduri project

A team from the Progressive River Authority for Water and Harmony (PRAWAH) recently visited Belagavi district, reigniting the dispute between Karnataka and Goa over the Mahadayi River.

- **Background** – The Kalasa-Banduri Project is a Karnataka government initiative first proposed in the 1980s.
- It aims to *divert water from the Mahadayi River to the Malaprabha River* to improve drinking water supplies to the districts of Belagavi, Bagalkote, Dharwad, and Gadag.
- The Kalasa nala project, part of the Kalasa-Banduri Project, involves building barrages to store and lift water from the stream and divert it into the Malaprabha.
- The entire project aims to construct a total of 11 dams on the river Mahadayi.
- The project would also involve diverting around 27 hectares of land, including 11 hectares in a tiger corridor between Karnataka and Goa.
- **The Dispute –** It is delayed due to *inter-state water dispute* between *Karnataka, Goa, and Maharashtra*.
- **Argument of Goa** – The project would reduce the flow of water into the Mahadayi, damaging its natural flow and ecology.
- It would also impact tiger conservation and concerns over ecological damage.
- **Tribunal –** The Mahadayi Water Dispute Tribunal was *set up in 2010* to look into the issue.
- The Tribunal in 2018 awarded 13.42 TMC water from Mahadayi river basin to Karnataka, 1.33 TMC to Maharashtra and 24 TMC to Goa.

Mahadayi River



- Mahadayi originates inside the *Bhimgad Wildlife Sanctuary* in the Belagavi district of Karnataka.
- It *flows through Karnataka, Goa, and Maharashtra*.
- It is called as *Mandovi River in Goa*.
- *Salim Ali Bird Sanctuary in Chorao Island, Goa* is located on the Mandovi River.
- **Tributaries –** Kalasa Nala, Surla Nala, Haltar Nala, Poti Nala, Mahadayi Nala, Pansheer Nala, Bail Nala, Andher Nala.

2.15 Roopkund Lake

Roopkund Lake is shrinking because of climate change.

- It is a ***high-altitude glacial lake*** located at the base of Mt Trishul in the Garhwal Himalayas in ***Uttarakhand.***
- It is also known as Skeleton Lake and part of ***Nanda Devi National Park***.
- It is famous for the skeletal remains found in and around the lake.
- There are hundreds of skeletons preserved in the ice around the region and they become visible when the ice melts and many experts believe that this is not from one catastrophic event.
- Studies have found that the skeletons are genetically diverse and many are even aged to have a difference of 1,000 years.
- **Recent Findings** – Instead of snow flurries that the area usually witnesses, it has started getting more rain.
- This is disrupting the natural balance of the region.
- Owing to the rain, loose moraine slides into the lake and causes it to shrink.
    - Moraine is soil, rocks and debris that a glacier carries with it and leaves behind.
- The lake is shrinking by ***0.1 to 0.5%*** every year.

2.16 The Sada

The land-use patterns Sada region are changing and they are increasingly being converted to orchards or residential areas.

- **Sada** – They *are lateritic flat tops region on the konkan region of Western Ghats*, locally called sada, meaning a large flat area.
- **Formed by** – Centuries of erosion.
- **Characteristics** – The sada are barren most of the year but become transformed during the monsoons.
- They are similar to the plateaux, locally called pathar, in the Satara district of Maharashtra, of which the Kaas Plateau is a well-known example.
- They are rocky and harbour unique endemic flora that cover it in the monsoon season.
- **Biodiversity** – 459 plant species, of which 105 are endemic to the Konkan region.
- 31 species of reptiles, 13 species of amphibians, 169 species of birds, and 41 species of mammals in the region.
- **Farming** – During the monsoons, the locals use small patches of sada to grow *rice and millets* (like nanchani, Eleusine coracana) with traditional practices that *don't require the use of pesticides and chemical fertilizers*.
- **Water catchment** – The highly weathered lateritic soil layer on the top acts as a catchment for the rainwater and recharges the groundwater, enabling the villages in the sada to have access to fresh water all year round.

- **Geoglyphs** – The area is also host to works of art called geoglyphs, dated to roughly 10,000 years ago.
- **Wasteland** – The fact that sada is also classified as a 'wasteland' in the Wasteland Atlas makes matters worse.

2.17 Great Nicobar Island

Recently, the Congress party demanded an immediate suspension of all clearances granted to NITI Aayog's mega project on Great Nicobar Island.

- Great Nicobar Island is the largest (in India) and southern-most island in the ***Nicobar Islands archipelago***, located in the Bay of Bengal.
- **Headquarters –** Campbell bay.
- **Vegetation –** It is a hilly island mostly covered in tropical rainforest, with mangroves and Pandan forests along the coast.
- The island's main hill range runs from north to south, and its *highest peak is Mount Thullier*.
- **Rainfall –** Great Nicobar also receives an annual rainfall of around 3,500 mm.
- **Rivers –** Galathea, Alexandra and Dagmar are the major rivers.

- **Species –** It is known for its diverse wildlife, including many endangered and endemic species, such as the
  - Giant leatherback turtle,
  - Nicobar megapode, and
  - Nicobar crab-eating macaque.

Andaman Padauk *is a tall deciduous tree found only in Andaman.*

- **Great Nicobar Biosphere Reserve** – Is included in the World Network of Biosphere Reserves of the MAB Programme.
- **Indigenous communities –** The Shompen and the Nicobarese.

2.18 Heatwaves in India

The Indian Meteorological Department (IMD) issued a red alert for heatwaves in Delhi, Punjab, Haryana, and most parts of Western Rajasthan.

- **About –** According to IMD, *heatwave is a period of abnormally high temperatures*, more than the normal maximum temperature that occurs during the summer season in the North-Western parts of India.
- **Occurrence –** Heatwaves typically occur between March and June, and in some rare cases extend till July.
- **Impact –** The extreme temperatures and resultant atmospheric conditions adversely affect people living in these regions as they cause physiological stress, sometimes resulting in death.
- **Qualitatively** – Heat wave is a condition of air temperature which becomes fatal to human body when exposed.
- **Quantitatively –** Heatwave is defined based on the temperature thresholds over a region in terms of actual temperature or its departure from normal.

Region	Temperature range to declare as a heatwave
Plains	Maximum temperature of at least 40°C or more
Hilly regions	Maximum temperature of at least 30°C or more.
Coastal region	Maximum temperature departure of 37°C or more from normal.
For a heatwave to be declared, these conditions must be met in at least two weather stations in a meteorological sub-division for at least two consecutive days. The heatwave is officially declared on the second day.	

- **Heatwave –** If the prevalent temperature is 4.5°C to 6.4°C more than normal, it is classified as a heatwave.
- **Severe heatwave –** A rise of more than 6.4°C is considered a severe heatwave. May is the peak month for heatwaves in India.
- **For coastal areas** – When maximum temperature departure is 4.5 °C or more from normal, heat wave may be described provided actual maximum temperature is 37°C or more.

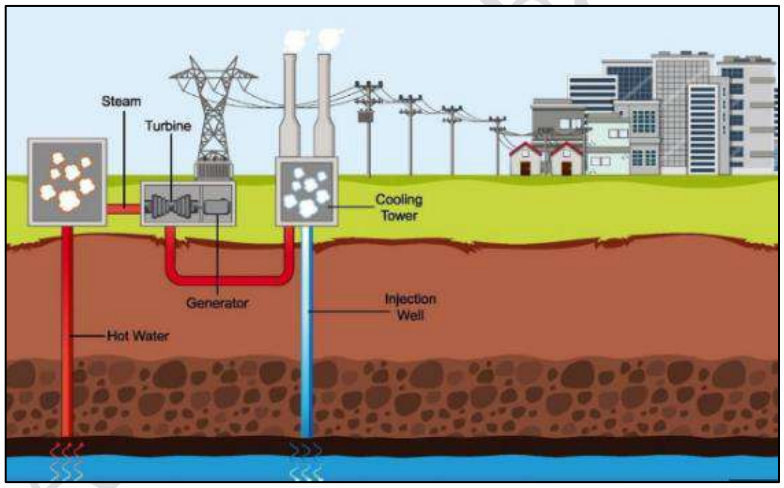
- **Vulnerable** – The States frequently affected include Punjab, Haryana, Delhi, Uttar Pradesh and Bihar.
- **Red alert** – A red alert refers to an extreme heat warning. It means that a severe heatwave has persisted for more than 2 days or the total number of heat/severe heatwave days has been more than 6 days.

2.19 Geothermal Energy

Recently, Minister of New and Renewable Energy has highlighted that Indian government is working on extensive exploration of potential geothermal site in India and in developing pilot plants.

- **Geothermal energy** – It is the energy that is stored in the form of heat beneath the earth's surface.
- **Usage** – To generate electricity and for other heating applications.
- **Source** – Energy from the formation of the planet and the decay of radioactive isotopes inside earth's core, such as potassium-40 and thorium-232.

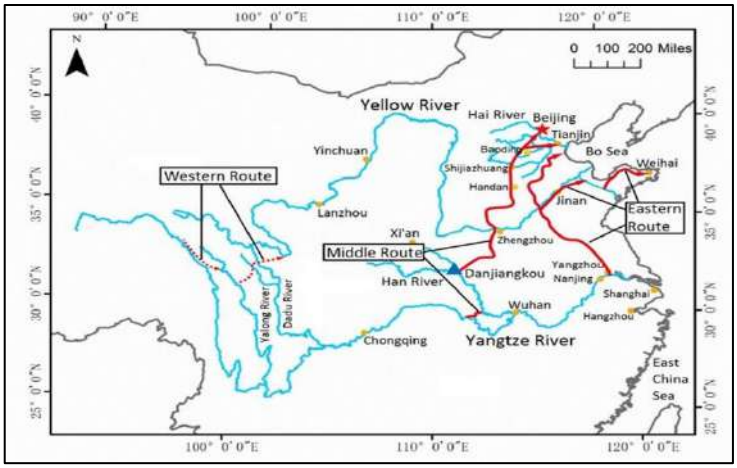
> ***Molten rocks*** *formed in the deeper hot regions of earth's crust are pushed upward and trapped in certain regions called 'hot spots'.*



- **Extraction** – From the underground pools of steam and hot water trapped in hot spot region in earth crust.
- There are 3 primary methods of geothermal energy production based on geological conditions and resource characteristics.
- **Dry Steam Power Plants** – *Steam from underground reservoirs* is directly used to fuel turbines, generating electricity with remarkable efficiency.
- It is ideal for areas with naturally occurring steam reservoirs.
- **Flash Steam Power Plants** – It is applied in geothermal reservoirs containing water at higher *temperatures greater than 182°C*.
- As this superheated water flows upward through wells under its own pressure, the decrease in pressure causes some of the water to flash into steam which is then separated & used to power turbines.
- **Binary Cycle Power Plants** – It is used in regions with *lower temperature geothermal resources* (between 107-182°C).
- Heat from hot water is used to *boil a secondary working fluid*, typically an organic compound with a low boiling point and the vaporized working fluid drives the turbines.

2.20 Upper Siang Hydroelectric project

The government authorities have detained two anti-dam activists' protests against the Upper Siang Hydroelectric project.



- **About** – The Upper Siang project is a significant hydropower project on the ***Siang River*** in the Upper Siang district of Arunachal Pradesh.
- **Type** – ***Run-of-the-river*** hydroelectric project with a dam.
- **Capacity** – Initially proposed at around ***10,000 MW***, making it one of the largest hydroelectric projects in India.
- **Project Developer** – National Hydroelectric Power Corporation (NHPC)

(public sector Hydropower Company), North Eastern Electric Power.

- **Components –** Includes a large dam, underground ***powerhouses, and extensive tunnelling systems.***
- **Objectives** – To boost India's hydroelectric capacity and providing a substantial amount of renewable energy.
- To foster economic development in the northeastern region of India, including ***improved infrastructure and job creation.***
- **Geographical Importance-** The project is situated in a remote, mountainous region, known for its challenging terrain and rich biodiversity.

Siang River
• The Siang River, also known as the *Dihang River*, is a major river in the Indian state of *Arunachal Pradesh*. • It is part of the Brahmaputra River system and plays a crucial role in the hydrology and ecology of the region. • The Siang River originates in the glaciers of the Himalayas in Tibet, where it is known as the Yarlung Tsangpo.

2.21 Extreme Weather Events in India

India has recently experienced extreme weather conditions, including heavy rain, floods, droughts and cyclones, which some experts attribute to climate change.

Extreme weather events

- It refers to significant variations in weather that can lead to severe and often destructive conditions.
- Examples include heatwaves, cold waves, heavy precipitation, tornadoes, tropical cyclones and droughts.
- These events are often short-lived but can have devastating impacts on communities and ecosystems.
- **Causes of Extreme Events**
    - Climate Change and Natural Climate Variability
    - Atmospheric Conditions and Seasonal Changes
    - Geographical Factors and Human Activities

Extreme weather events in India

Events	Location	Impacts
Heatwave and Floods, 2023	**New Delhi**	Casualties
Storms and Floods, 2023	**Mumbai**	Casualties
Flooding and Landslides, 2023	**Assam**	Animal population decreased including rare one-horned rhinoceroses, drowned in ***Kaziranga National Park***.
Cyclone, 2023	**Southern India**	Casualties
Himalayan Glacial Lake Outburst, 2023	**Sikkim**	High Casualties
Landslide, 2021	**Uttarakhand**	Destroyed 2 Hydro-electric projects
Landslide, 2023	**Near Mumbai**	Casualties
Floods, 2018	**Kerala**	40% more rainfall than usual with Heavy casualties

2.22 Indian Ocean Biodiversity Ocean Information System (IndOBIS)

Recently Centre for Marine Living Resources and Ecology (CMLRE) organized a national-level workshop on IndOBIS.

- **IndOBIS** – It is the Indian regional node of the global Ocean Biodiversity Information System (OBIS).
- **Developed by** – Centre for Marine Living Resources and Ecology (CMLRE).
- **Function –** It collects data of taxonomically resolved marine species occurrence records from the Indian Ocean.
- It accepts several categories of marine biodiversity data types, including literature and occurrence, abundance records, DNA-derived or genomic profiles, etc.
- **Uses** – Tracking species distribution, identifying biodiversity hotspots, and accessing climate change impacts.

Centre for Marine Living Resources and Ecology (CMLRE) is a premier research institution under the Ministry of Earth Sciences, established in 1998 at Kochi.

Ocean Biodiversity Information System (OBIS)

- **OBIS** – It is *one of the largest global repositories* of information on marine species, marine science, conservation, and education.
- It emanated from the Census of Marine Life (2000-2010).
- **Established by** – Intergovernmental Oceanographic Commission (IOC) of UNESCO.
- **Integral component of** – The International Oceanographic Data and Information Exchange (IODE) of IOC.
- **Features** – It is *supported by a network of nearly 30 regional nodes contributing data*.
- It contains millions of records from thousands of datasets contributed by researchers, governments, and organizations worldwide.
- It provides detailed information on ***species distribution across the world's oceans***, including data on their occurrence, habitats, and environmental parameters.
- It provides free and open access to, and application of, biodiversity and biogeographic data on marine life.
- It offers tools and services that allow users to search, visualize and download biodiversity data.

Ocean Eyes

- It is a *citizen-centric mobile app for community-engagement* approach to data collection, sharing, and analysis in marine biodiversity monitoring and research.
- **Developed by** – Centre for Marine Living Resources and Ecology.
- Citizens and users can record sightings of marine species, log environmental conditions, and upload geotagged photos directly through the mobile.

2.23 Landfall of a cyclone

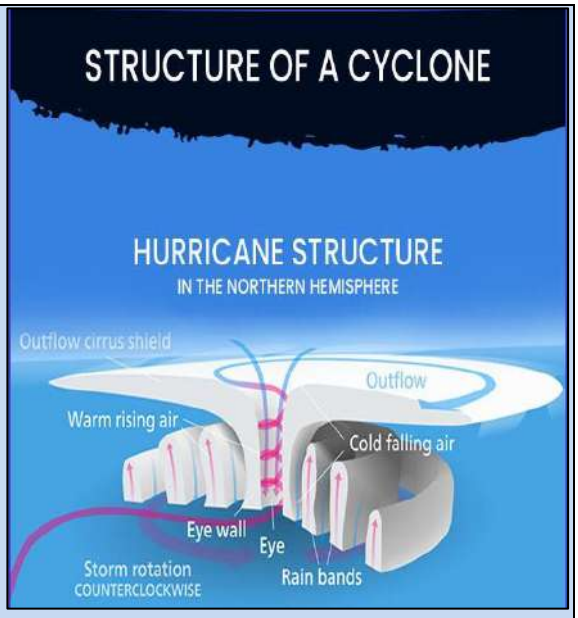
The India Meteorological Department (IMD) recently reported that Cyclone Fengal, tropical cyclone made landfall over Puducherry.

- **Landfall –** It is the event of a ***tropical cyclone coming onto land*** after being over water.
- It is said to have made landfall when the ***center of the storm or its eye moves*** over the coast.
- **Duration of landfall** – It can last for a few hours, with their exact duration ***depending on the speed of the winds and the size of the storm*** system.
- It is possible for a cyclone's strongest winds to be experienced over land even if landfall does not occur, because the strongest winds in a tropical cyclone may not located precisely at the center.

Cyclone

- **Formation–** They are large storms that form when water evaporates from the surface of a sea into the air.

- As it rises, the air cools and becomes saturated with vapor, eventually forming clouds.
- These clouds and the air circulation around them eventually start to rotate.
- The power of the cyclone depends on the warmness of the sea.
- **Eye and the eyewall** – Are the *2 features* of the cyclone.
- **Eye –** It is the small center around which the cyclone rotates.
- It consists of cold air descending from the cyclone's top with warm air rising in a spiral around it.



- **Eyewall –** Consists of high thunderstorms that bring rain, lightning, and powerful winds.
- These storms may also have large cloud tops called a *central dense* overcast that obscure a view of the eye as seen from above.
- As long as the cyclone moves over water, it can draw more moisture from below to produce new clouds and rain events around it.
- But when the storm crosses over onto land, its ***moisture supply declines drastically*** and the cyclone weakens.

2.24 Onset of monsoon

India Meteorological Department (IMD) says that the southwest monsoon is progressing normally, and conditions are suitable for its onset on the Kerala coast in the next 5 days.

- **Onset of Monsoon in India** – Here, the monsoon refers to the *South West Monsoon*.
  - **In Andaman and Nicobar Islands** – Monsoonal rainfall Between *May 15 & May 20 every year*.
  - **Kerala coast** – Rain in the *last week of May*.
- Rain over the Kerala coast marks the beginning of the 4-month, June-September southwest monsoon season over India.
- **Official declaration** – It is announced only after certain defined and measurable parameters, *adopted in 2016 by IMD* are met.
- **Determining factors** – The consistency of rainfall over a defined geography, its intensity, and wind speed.
- **Rainfall** – At least 60% of 14 designated meteorological stations in Kerala & Lakshadweep record *at least 2.5 mm of rain for 2 consecutive days* at any time after May 10.
- In such a situation, the onset over Kerala is declared on the 2nd day.
- **Wind field** – The westerlies are prevailing winds that blow from the west at mid-latitudes.

Outgoing Longwave Radiation *(OLR) is a measure of the energy emitted to space by the Earth's surface, oceans, and atmosphere.*

- The depth of *westerlies, should be up to 600 hectopascal* (1 hPa is equal to 1 millibar of pressure) in the area bound by the equator to 10°N latitude, and from longitude 55°E to 80°E.
- **Zonal Wind speed** – It should be of the *order of 15-20 knots* (28-37 kph) at 925 hPa over the area bound by 5-10°N latitude and 70-80°E longitude.
- **Heat** – According to IMD, the INSAT-derived *Outgoing Longwave Radiation (OLR) value should be below 200 watt per sq m* (wm2) in the box confined by 5-10°N latitude and 70-75°E latitude.
- **Significance** – It brings more than 70% of India's annual rainfall.

According to the IMD, the onset of the monsoon marks a crucial transition in the large-scale atmospheric and ocean circulations in the Indo-Pacific region.

2.25 Monsoonal Rainfall across India

Currently, multiple favourable weather systems have kept the monsoon either active or vigorous (with respect to rainfall events) over southern peninsular, east, northeast, and central India regions.

- **Monsoon** – A seasonal change in the direction of the prevailing, or strong, winds of a region.
- **Features** – It causes wet and dry seasons throughout much of the tropics.
- It always blow from cold to warm regions.
- The summer monsoon and the winter monsoon determine the climate for most of India and Southeast Asia.
- **In India** – There are three prominent seasons influencing rainfall which are:
    - **Southwest Monsoon** – June to September
    - **Northeast Monsoon** – October to December
    - **Summer Monsoon** – March to May
- **Rainfall in India** – India experienced on an average 1,257 millimetres (125 cm) of rainfall in 2022.

Rainfall Distribution in India

Annual Precipitation Levels	Regions
Extreme (>400cm)	Northeastern India and windward side of Western Ghats.
Heavy (200-300 cm)	Eastern Areas and Sub-Himalayan belts
Moderate (100-200 cm)	Leeward side of Western Ghats and Parts of Central and Eastern India
Scanty (50-100 cm)	Parts of Gujarat, Maharashtra, Punjab, Haryana, Western UP, TamilNadu, Andhra Pradesh
Very less (<50 cm)	Majorly in Rajasthan, Gujarat, some parts of Jammu & Kashmir

- **Southwest monsoon** – It brings *about 70-90% of India's annual* precipitation.
- Regions like the Western Ghats and north-eastern areas receive heavy rainfall during this season.
- **Northeast monsoon** – It is also known as the *retreating monsoon* and affects peninsular India.
- It isn't as intense as the southwest monsoon.

2.26 Mission Mausam

The Union Cabinet recently approved Mission Mausam with a budget outlay of 2,000 crores over two years.

- **Aim** – To make India ***'Weather Ready' and 'Climate Smart'***.
- **Mission** – To enhance the country's weather & climate observations, understanding, modelling and forecasting.
- **Mission Period** – 2024-26.
- **Nodal Ministry** – ***Ministry of Earth*** Sciences.
- **Implementing Agencies**

- India Meteorological Department (IMD), Mausam Bhavan, New Delhi.
- National Centre for Medium Range Weather Forecasting (NCMRWF), Noida.
- Indian Institute of Tropical Meteorology, Pune.

- **Objectives**
  - Develop Cutting Edge Weather Surveillance Technologies & Systems.
  - Implement higher resolution atmospheric observations.
  - Implement Next-generation radars, and satellites with advanced instrument payloads.
  - Implement High-Performance Computers (HPC).
  - Improve understanding of weather and climate processes and prediction capabilities.
  - Develop improved earth system models, and data-driven methods (use of AI/ML).
  - Develop state-of-art dissemination system for last mile connectivity.
- **Features** – The mission will establish the following:
  - 50 Doppler Weather Radars (DWR)
  - 60 Radio Sonde/Radio Wind (RS/RW) stations
  - 10 Wind Profilers
  - 100 disdrometers
  - 25 radiometers
  - 1 Ocean Research station
  - 10 Marine Automatic Weather Stations with upper air observation.

*A **disdrometer** is a device that measures the size and velocity of falling raindrops, snowflakes, and hail. It can also differentiate between different types of precipitation.*

- **Benefits** – It will *improve forecasts on both spatial and temporal scales* and air quality data and help strategize weather management/intervention in the long run.

2.27 Earthquakes

Recently the National Capital Region, Delhi and adjoining regions faces a shallow earthquake of 4.0 magnitude with a focal depth of five kilometres.

- An earthquake is a phenomenon that occurs without warning and involves ***violent shaking of the ground*** and everything over it.
- It results from the release of accumulated stress of the moving lithospheric or crustal plates.
- An earthquake is the sudden movement of Earth's crust at a fault line.
- It is also called as quakes, tremors, or temblors.
- **Epicentre –** The location where an earthquake begins is called the epicentre. An earthquake's most intense shaking is often felt near the epicentre.
- However, the vibrations from an earthquake can still be felt and detected hundreds, or even thousands of miles away from the epicentre.
- The energy from an earthquake travels through Earth in vibrations called seismic waves, measured by seismometer.

P waves or primary waves	• These 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	• These are the second waves to be detected. • These waves move *only through rock.* • They move up and down or side to side, perpendicular to the direction in which the wave is moving.

Surface waves	• It follows P and S waves. • They travel along the surface of the earth and thus cause the most damage. • Surface waves can be characterized as Love waves, which are faster and move the ground from side to side.

- **Types Of Earthquake –** Along with the tectonic earthquakes, there are also 3 types of earthquakes.
  - **Volcanic –** Earthquakes that occur in conjunction with volcanic activity
  - **Collapse –** Smaller-scale earthquakes that result from the subterranean collapse of caverns or mines
  - **Explosion –** Earthquakes caused by underground explosions of nuclear or chemical devices.
- **Depth**
  - **Shallow earthquakes** – 0 to 70 km deep.
  - **Intermediate earthquakes** – 70 to 300 km deep.
  - **Deep earthquakes** – 300 to 700 km deep.
- **Scenario in Delhi –** Delhi lies in the ***Aravalli-Delhi Fold Belt***, a seismically-active geological belt extending from southern and eastern Rajasthan to Haryana and Delhi.
- Over the years, the tectonic activity in the region has slowed down considerably, leading to greater geological stability. But some faults still remain, which give rise to occasional mild earthquakes.
- **Medvedev-Sponheuer-Karnik scale –** It is a ***measure of intensity***, rather than strength, or energy released, which is described by magnitude.
- Delhi is classified in ***Zone 4***, the 2nd highest classification of areas based on their susceptibility to shaking experienced during an earthquake.

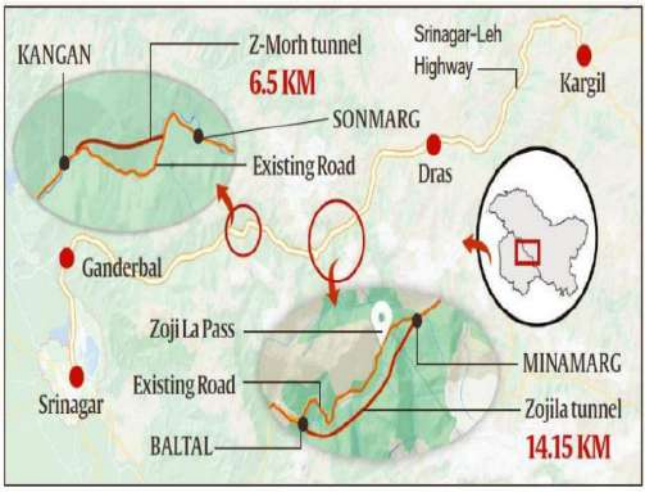
2.28 Z-Morh tunnel

- The tunnel has acquired its name for the Z-shaped road stretch at the place where the tunnel is being constructed.
- The Z-Morh tunnel is an ***all-weather connectivity tunnel***.
- **Connect –** Sonamarg town with Kangan town in central Kashmir's Ganderbal district.
- **Altitude –** The stretch where the tunnel is under construction is situated at an altitude of over 8,500 feet, and is prone to snow avalanches in the winter.
- **Constructed by –** The tunnel project was originally conceived by the Border Roads Organisation in 2012.
- However, the project was later taken over by APCO Infratech.
- **Managed by** – National Highways & Infrastructure Development Corporation Limited (NHIDCL).
- **Significance** – It will promote tourism by transforming Sonamarg into a year-round destination, boosting winter tourism, adventure sports, and local livelihoods.
- **Zojila tunnel project –** The Z-Morh tunnel is ***part of the Zojila tunnel project,*** which will connect Sonamarg in Kashmir with Drass in Ladakh, is ongoing and expected to finish by December 2026.
- Thus providing all-weather access to Sonamarg, the tunnel is vital for ensuring year-round connectivity to Ladakh.
- This is particularly important for the movement of military personnel to border areas.

- The Z-Morh tunnel is also important for the success of the Zojila tunnel project, which is situated at an altitude of approximately 12,000 ft.

2.29 Sonamarg tunnel

Recently Sonamarg tunnel has been inaugurated by the Prime Minister.

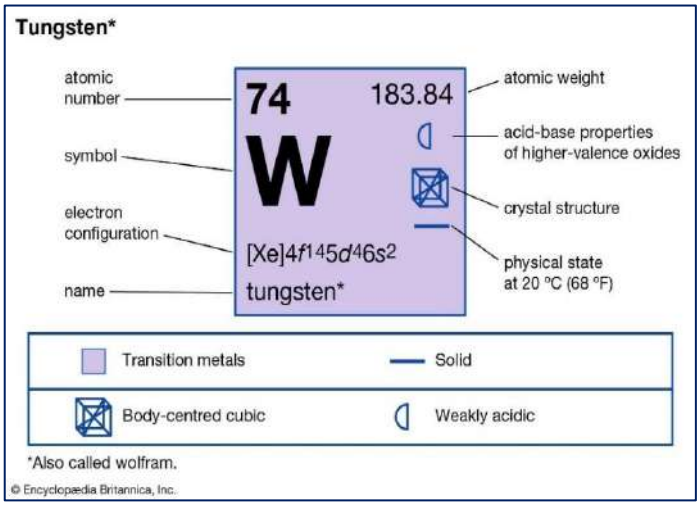


- **Sonamarg Tunnel project** – It is around 12 km long, has been constructed at a cost of over Rs 2,700 crore.
- **Components** - It comprises the Sonamarg main tunnel of 6.4 km length, an egress tunnel and approach roads.
- **Sonamarg tunnel** - Previously known as Z-Morh Tunnel, is a 6.5 km long 2-lane road tunnel between Gagangair and Sonamarg in the Ganderbal district of Jammu and Kashmir in northern India.
- It is situated at an altitude of over 8,650 feet above sea level.
- **Leh Connectivity** - it will enhance all-weather connectivity between Srinagar and Sonamarg enroute to Leh.
- **Ladakh Connectivity** – It ensures safer and uninterrupted access to the strategically critical Ladakh region.
- **NH 1** – Along with Zojila tunnel, it will ensure seamless NH-1 connectivity between Srinagar Valley and Ladakh.
- **Tourism promotion** - It will also promote tourism by transforming Sonamarg into a year-round destination, boosting winter tourism, adventure sports, and local livelihoods.

2.30 Tungsten

The tamil nadu Chief minister has requested Prime Minister to cancel the tungsten mining rights granted to a private company in Madurai.

- Tungsten (W) is a rare, refractory metal found *naturally on Earth*.
- It is a ***chemical element***, and an ***exceptionally strong metal*** of Group 6 (VIb) of the periodic table.
- **Discovered on –** 1783.
- **Discovered by** – Mineralogists Juan and Fausto Elhuyar.
- Pure tungsten is a ***silver-white metal*** and when made into a fine powder can be combustible and can spontaneously ignite.
- Natural tungsten contains 5 stable isotopes and 21 other unstable isotopes.
- Tungsten is used in many different ways because it is very strong and durable.
- Its strength comes when it is made into compounds, though pure tungsten is very soft.
- **Occurrence** – The amount of tungsten in Earth's crust is estimated to be 1.5 parts per million.
- Most tungsten resources are found in China, South Korea, Bolivia, Great Britain, Russia and Portugal, as well as in California and Colorado.
- It *doesn't occur as a free metal*.
- It is harvested from the minerals by reducing tungsten oxide with hydrogen or carbon.



- **Properties –** It has ***the highest melting point of all metals***.
- At temperatures over 1650°C has the highest tensile strength and it can be alloyed with other metals to strengthen them.

- The metal oxidizes in air must be protected at elevated temperatures.
- It is very resistant to corrosion and has the highest melting point and highest tensile strength of any element.
- **Uses** – It is used in:
  - Electric lamps, Electron and television tubes, Metal evaporation work,
  - Automobile distributors, X-ray targets,
  - Windings and heating elements, Numerous spacecraft and
  - High-temperature applications.

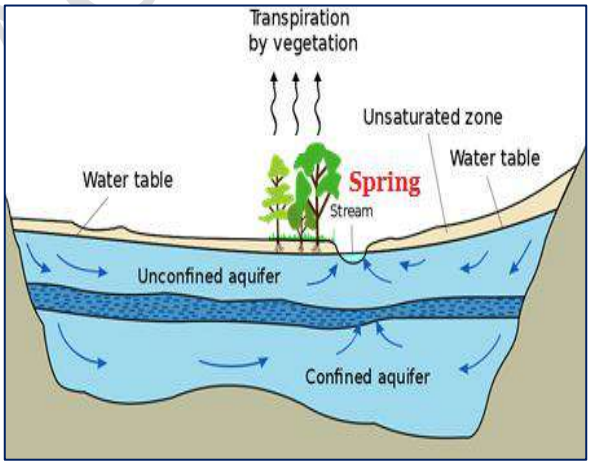
*In 2016, China produced over 80% of total tungsten mined, and it contained **nearly 2/3rd** of the world's reserves.*

- **Compounds –** The most important tungsten compound is ***Tungsten Carbide (WC).***
- It is relatively inert and noted for its hardness.
- It is used in combination with other metals to impart wear-resistance to cast iron and the cutting edges of saws and drills.

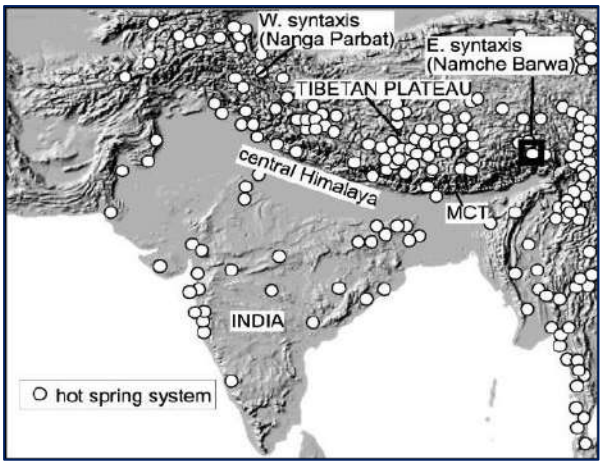
2.31 Reduction of springs in Himalayas

A Recent study showed that the spring system in Himalayan region, especially in Himachal Pradesh witnessed a drop due to climate change.

- **Springs –** It occurs when *water pressure causes a natural flow of groundwater* onto the earth's surface.
- **Mechanism** – As rainwater enters or "recharges" the aquifer, pressure is placed on the water already present.
- This *pressure moves water through the cracks and tunnels* within the aquifer, and this water flows out naturally to the surface at places called springs.
- **Hot springs** are springs with *water at temperatures substantially higher than the air temperature* of the surrounding region.
- **Causes of heating:**
  - **Volcanic activity** – By shallow intrusion of magma.
  - **Convective circulation** – Percolation of groundwater deep reaching hotter rocks.
- **Hot springs of the Himalaya** – They are located in the ***zones of deep faults*** that define tectonic boundaries.
  - **Indus Tsangpo Suture** – Between the Himalayan province and mainland Asia.
  - **Main Central Thrust** – Between the Great Himalaya and Lesser Himalaya.
  - **Main Boundary Thrust** – Between the Siwalik domain and the Lesser Himalaya.
- **Importance of springs** – Natural springs acts as a source of water for both *drinking and irrigation*.
  - **In Himalayan region** – It serves 64% of the cultivable land for irrigation.
- **Reduction in springs** – In the western Himalayas, over ***45% have completely dried up*** in the past 4 decades.
- Over ***26% have become semi-active***, transitioning from perennial springs which depend on the monsoon.
- **Cause of decline of Spring:**



*In the Eastern Himalayas **Meghalaya** has the most villages with springs, while Sikkim with the highest density. In the Western Himalayas, Jammu & Kashmir leads in both the number of villages and spring density.*



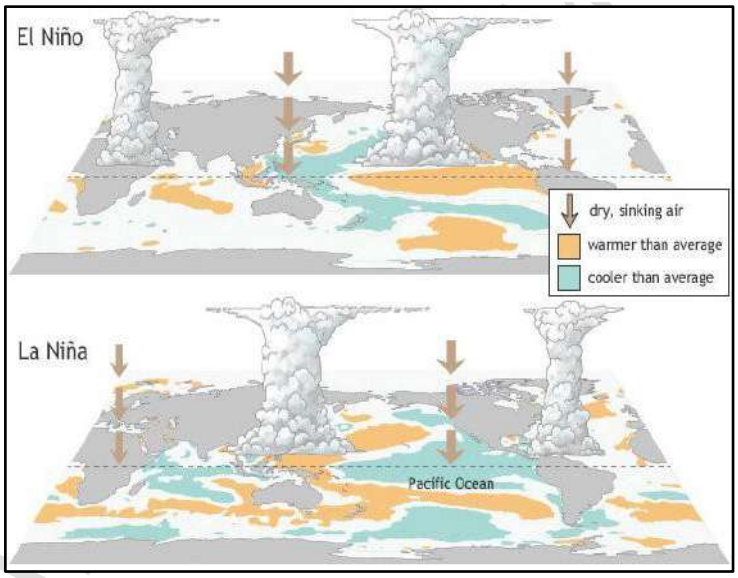
- Rising temperatures,
- Altered precipitation patterns and
- Decreasing snowfall and rainfall.

- **Impacts** – The rural communities will face shortages in drinking water, agriculture, and daily household needs.

2.32 Bayesian Convolutional Neural Network (BCNN)

Recently, Indian National Centre for Ocean Information Services (INCOIS) has created a Bayesian Convolutional Neural Network (BCNN).

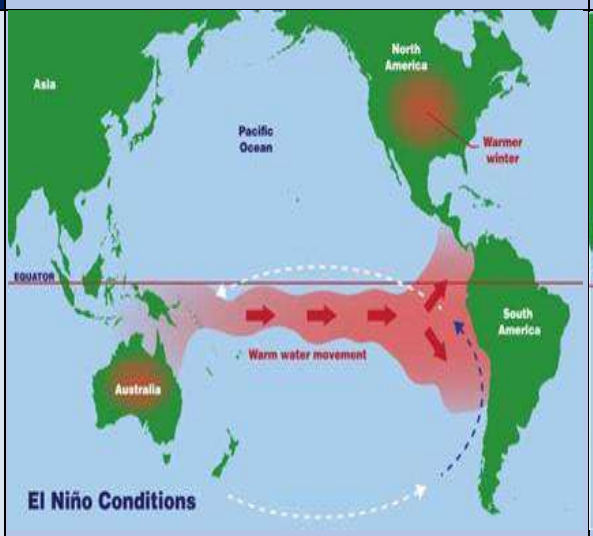
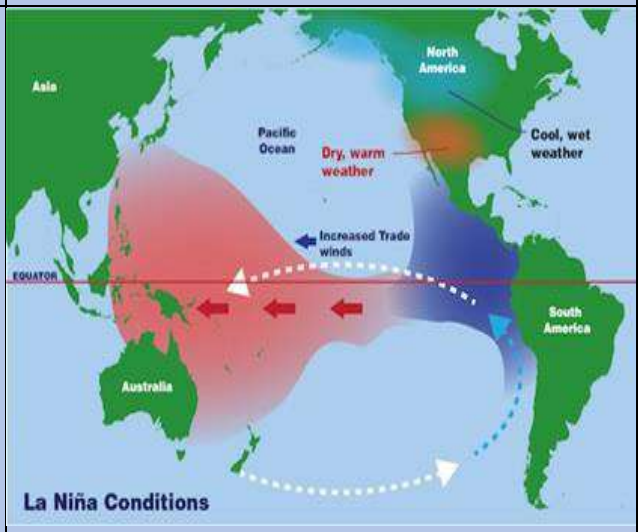
- **About –** BCNN is new product that integrates cutting-edge technology to enhance forecasts associated with ENSO phases.
- It is to forecast ***El Nino and La Nina conditions*** up to 15 months ahead, due to its ability to account for the slow oceanic variations and their atmospheric coupling.
- It computes the ***Nino 3.4 Index*** by averaging sea surface temperature anomalies across the central equatorial Pacific, enhancing ENSO phase prediction accuracy.
- **Developed by** – Indian National Centre for Ocean Information Services (INCOIS).



ENSO, El Nino and La Nina

- **ENSO –** Is short for *El Niño-Southern Oscillation*, affects global weather by changing sea temperatures in the *tropical Pacific Ocean and altering atmospheric circulation.*
- It can alter the global atmospheric circulation, which, in turn, influences weather across the world.
- ENSO occurs in irregular cycles of *2-7 years and has three different phases warm (El Niño), cool (La Niña), and neutral.*
- **El Nino** – A condition which is warmer than average sea surface temperatures in the central and eastern Pacific.
- **La Nina –** A condition which is cooler than average sea surface temperatures in the central and eastern Pacific.
- **Neutral –** Conditions when sea surface temperatures are close to average.

Key aspects	El Nino	La Nina
Meaning	• It is a loose translation of "little boy" or "Christ child" in Spanish.	• It is called as "Little girl" in Spanish which is the opposite of El Niño.
About	• It is the warming of sea waters in Central-east Equatorial Pacific that occurs every few years (Warm phase off the coast of Peru).	• It sees cooler than average sea surface temperatures in the equatorial Pacific region (Cool phase).
Trade winds	• It weakens in the western Pacific which cause warmer waters in the East.	• It becomes stronger than normal and cause warmer waters in the west.
Sea surface temperature	• It increases across the Eastern Pacific by 6-8°C.	• It reduces across the Eastern Pacific by 3-5°C.
Impact	• It *disrupts normal upwelling*, reducing the rise of cold, nutrient-rich water from the ocean depths.	• It *enhances upwelling*, bringing cold, and nutrient-rich water to the surface near South America.

Impact on India	• It has the impact of suppressing monsoon rainfall, can cause **droughts**, adversely affecting agriculture and water supply.	• It is associated with *good rainfall* during the monsoon season.
Frequency	• It occurs every 3-7 years	• It occurs half the amount of time El Nino events do.
Fish population	• Reduced upwelling of deep nutrient rich waters leads to reduction in fish populations along South America coast.	• Enhanced upwelling of nutrient rich waters increasing fish populations along South American coast.
		

Indian National Centre for Ocean Information Services (INCOIS)

- It is an *autonomous organization* established in *1999*.
- **Location –** Hyderabad.
- **Ministry –** Ministry of Earth Sciences.
- It is a unit of the Earth System Science Organization, New Delhi.
- **Objective –** Its primary mandate is to provide ocean information and advisory services to various stakeholders including government agencies, research institutions, industry, and the public.
- It is being the central repository for marine data in the country, receives large oceanographic data in real time, from a variety of in-situ and remote sensing observing systems.

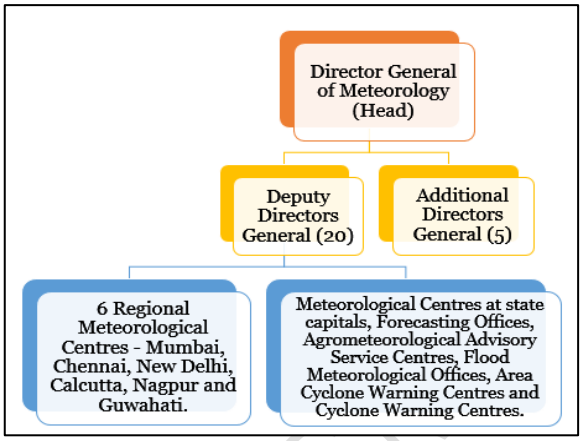
2.33 India Meteorological Department (IMD)

The India Meteorological Department (IMD) has completed 150 years of service as of January 15, 2025.

- **IMD** – It is the *National Meteorological Service* of India and the principal government agency in all matters relating to meteorology and allied subjects.
- **Historical background** – Science and Meteorology in India commenced with the establishment of the *1st Meteorological and Astronomical Observatory in (then) Madras in 1793*.
- The ***Sanitation Committee*** was formed in *1860* and the Meteorological Committee at provincial level was set up.
- **Establishment of IMD** – in ***1875*** with H.F. Blanford as the Meteorological Reporter.
- **Headquarters** – New Delhi.

*Between 2014 and 2023, there was rapid enhancement of weather and climate services and the **forecast accuracy** improved by 40-50%.*

- **Nodal Ministry** – Ministry of Earth Sciences.
- **Objectives –** To take *meteorological observations* and to provide current and forecast meteorological information.
- To *warn against severe weather phenomena* which cause destruction of life and property and to conduct and *promote research* in meteorology and allied disciplines.
- **Networks** – It has *6 Regional Meteorological Centres* (RMCs) catering to 6 regions of the country, which are further assisted by *26 Meteorological Centres (MCs) at the State level*.
- **Achievements:**
    - Preparation of 1st chart in 1877.
    - Preparation of 1st Daily Weather Report in 1878.
    - Radar age and flood meteorological services between 1947-1959.
    - Global monitoring and better forecasting up to 24 hours in 1971-1983.



2.34 Rat-Hole Mining

Recently, several workers have been trapped for more than 12 hours in a rat-hole mine after it was flooded with water in Dima Hasao district, Assam.

- **Rat-hole mining** – It is a method of ***extracting coal from narrow and horizontal seams.***
- The term "rat hole" refers to the narrow pits dug into the ground, typically just large enough for 1 person to descend and extract coal.
- It is prevalent in ***Meghalaya***.
- **Process** – Once the pits are dug, miners use ropes or bamboo ladders to reach the coal seams.
- The coal is then manually extracted using primitive tools such as pickaxes, shovels and baskets.
- **Issues** – The mines are *typically unregulated and lacking safety measures* such as proper ventilation, structural support or safety gear for the workers.
- The mining process cause land degradation, deforestation and water pollution.
- Unregulated mining led to water with high concentrations of sulphates, iron and toxic heavy metals, low dissolved oxygen and high biochemical oxygen demand.
- Its hazardous working conditions, environmental damage and numerous accidents leading to injuries and fatalities.
- **Ban** – The ***National Green Tribunal (NGT)*** banned the practice in 2014 and retained the ban in 2015.

Types of Rat-Hole mining	
Side cutting	**Box cutting**
Narrow tunnels are dug on the hill slopes and workers go inside until they find the coal seam.	A rectangular opening is made.
Size – Very thin, less than 2m in most cases.	**Size** – Varying from 10-100 sqm and through that a vertical pit is dug, 100-400 feet deep.

*The two rivers, Lukha and Myntdu, became too acidic to sustain aquatic life because of **unregulated mining** in Meghalaya.*

2.35 Illegal Coal Mining in India

Recently, three workers died of asphyxiation inside an illegal coal mine in Gujarat's Surendranagar district.

- **Coal mining** – Extracting coal from open cast mines or underground mines.

- **NCDC –** National Coal Development Corporation (NCDC), was ***formed in 1956*** for *exploring new coalfields* & expediting development of new coal mines.
- **MMDR Act 1957 –** Mines and Minerals (Development and Regulation) Act *regulates mining* sector *except minor minerals and atomic* minerals in India.
- **Nationalisation of coal mines –** It was done in 2 phases.
    - In 1971-72 - Coking coal mines
    - In 1973 - Non-coking coal mines
- **Coal Mines (Nationalisation) Act, 1973** – All coal mines were nationalized through this Act.
- It determines eligibility for coal mining in India.
    - *1993 amendment* enabled the *entry of the private sector* to mine coal for captive use.

***Coal** is a sedimentary deposit composed predominantly of carbon that is readily combustible. Anthracite, Bituminous, Lignite and Peat are different types of coal.*

***Illegal mining** is defined under Minerals (Other than Atomic and Hydro Carbons Energy Minerals) Concession Rules, 2016 as "any exploration or mining operation undertaken in any area without holding a mineral license." It is often carried out using techniques like surface mining and rat-hole mining without safety equipment.*

2.36 Gold nuggets in orogenic quartz veins

A study explored why gold nuggets accumulate in orogenic quartz veins found in mountainous areas.

- **Gold Nuggets** – They are *naturally occurring* pieces of gold which contains 75 to 97 % gold.
- **Formation –** Most nuggets originate from the quartz veins formed in orogenic gold systems found around the world.
- **Quartz** – Is a piezoelectric crystal that develops a voltage when squeezed or mechanically distorted.
- **Piezo catalytic chemical reactions –** Piezoelectric field distorts the electronic properties of the crystal.
- It makes the charged particles, like electrons, flow from the crystal to an aqueous solution on its surface or vice versa.
- This drives electrochemical reactions at the material-solution interface and causes *gold to be deposited from the solution* to the slabs' surface.
- **Earthquake** – Is a seismic activity that can repeatedly squeeze quartz crystals, leading to piezo catalytic reactions and the gradual accumulation of gold in quartz veins.
- Over time, this process results in large gold nuggets.

***Orogenic** refers to mountain formation driven by tectonic plate convergence and deformation.*

2.37 Other Important Topics

Indo- Bangladesh Border

- India and Bangladesh have a border that spans 4,096.7 km, making it the longest land border India has with any neighbouring country.
- **Bordering States** – West Bengal, Assam, Meghalaya, Tripura and Mizoram.
- **Fencing** – A total of 3,141 kilometres has been fenced along the India-Bangladesh border, which encompasses all eastern states, from the total 4,156.
- Over 800 km of the India- Bangladesh border still needs fencing.

Dabhol

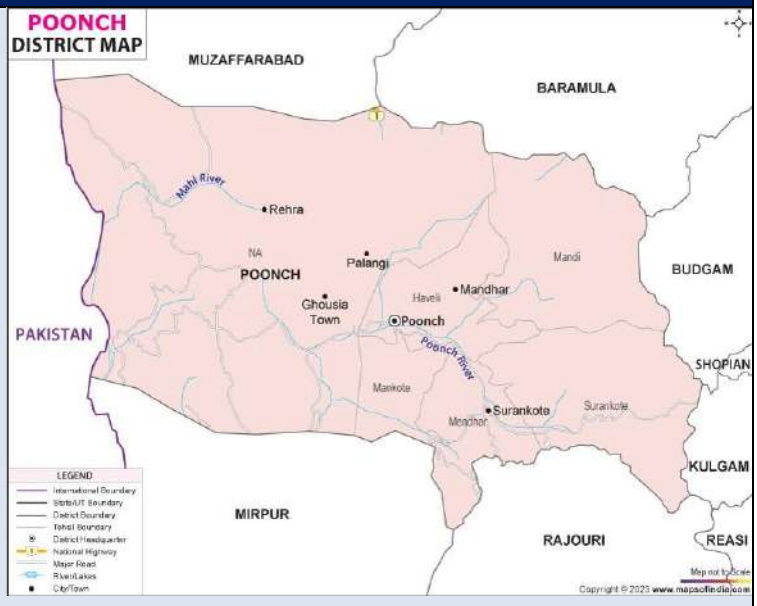
- **Located in** – A *small seaport town* located in Ratnagiri District of ***Maharashtra***.
- **Dabhol LNG Terminal** – Commissioned in early 2013, it consists of three 160,000 cubic meter storage tanks and a receiving capacity of 5 Million Tonnes Per Annum (MTPA).
- It provides access to *natural gas to India's southern and western states.*
- Gas Authority of India Ltd (GAIL) plans to increase its capacity to *12 mtpa by 2030* to meet rising gas demand.

Sedongpu Gully

- **Location** – It is located in the catchment of the Sedongpu glacier on the ***Tibetan Plateau***.
- Its valley, is 11 km long and covers 66.8 sq. km.
- **Gully** – It is a landform created by erosion from running water, mass movement or both.
- **Great Bend** – Sedongpu river drains into the Yarlung Zangbo, or the Tsangpo River by taking a sharp turn called as great bend.
- It is *close to Tibet's border with Arunachal Pradesh*, where the River Tsangpo flows as the Siang River.
- **Gorges** – It creates a gorge 505 km long and 6,009 metres deep while flowing around Mt. Namcha Barwa (altitude 7,782 metres) and Mt. Gyala Peri (7,294 metres).
- It is one of the deepest gorges on the earth.

Poonch District

- It is a *border district of J &K* situated on the Line of Control (LoC).
- **Located in** – West of State bordering Punjab and Himachal Pradesh.
- **Major part** – Occupied by *Pakistan* which is a part of Azad Kashmir territory.
- **Separated from** – Kashmir Valley by gigantic Pir Panjal range.
- **Trade** – Poonch holds a prominent place on the world map for trade along the LoC, particularly at the Chakka-Da-Bagh crossing.
- It is popularly known as *Mini Kashmir.*



Varanasi-Ranchi-Kolkata Expressway Project

- **Started on** – *2024*.
- **Umbrella scheme –** Bharat Mala Yojana.
- **Nodal Ministry** – Ministry of Road Transport and Highways.
- It is an approved 710 km long, *6 lane and Greenfield access*-controlled expressway.
- **Objective** – To boost trade and freight movement, particularly benefiting industries reliant on the *Kolkata and Haldia* ports.
- **Sates covered** – Uttar Pradesh, Bihar, Jharkhand and West Bengal.
- It is known as *Varanasi–Kolkata Expressway (NH-319B)*.

Earthquake recorded in Bay of Bengal (BOB)

- **Epi-centre –** Near *Puri, Odisha*, in BOB.
- **Occurred at** – Depth of *91 km*.
- **Tremor recorded areas** – Across Odisha, including, Paradip, Puri & Berhampur.
    - **Paradip** – *Natural & Deep-water Port,* highest cargo-handling major port in financial year 2023-24.
    - **Puri –** Known for Jagannath Temple.
    - **Berhampur –** Known as Silk City of India.

Water Source of Delhi

- **Water dependency –** Delhi *depends on neighboring states* to meet around 50% of drinking water demand of its residents.
- **Semi-arid zone** – The city, being *located in a semi-arid zone*, depends to a great extent on raw waters from the Ganga basin, Yamuna sub-basin, Indus-basin, in addition to its own internal aquifers and its groundwater resources.
- **Major rivers** – Delhi gets most of its water from the ***Yamuna, Ravi-Beas, and Ganga*** rivers.
- **Ganga –** Through Upper Ganga Canal in UP, Delhi receives 470 cusecs (roughly 254 MGD) of water.
- **River channels –** Two channels entering Delhi from Haryana the ***Carrier Lined Channel (CLC) and the Delhi Sub Branch (DSB)*** supply Delhi with water from the Yamuna and Ravi-Beas rivers.
- **Water capacity** – Delhi receives 719 cusecs of water through CLC, a lined channel meant to reduce seepage-induced water loss, and 330 cusecs through the DSB.
- **Delhi Jal Board** – It takes water directly from Yamuna to try and meet demand.
    - It supplements its river- water supply with ground water around 135 MGD of which are drawn from Delhi's tubewells and ranney wells.
- ***Delhi is not allotted*** any specific amount of water it can draw directly from the river.

Impacts of Changing Rainfall Patterns in India
• Extreme *rainfall events increased the frequency* of flash floods. • *Uneven distribution of rainfall* give rise to pest attacks and diseases. • Changing rainfall pattern makes it difficult for forecasting the monsoon pattern. • Heavy rainfall in growing and harvesting season can reduce the yield of crops. • Irregular rainfall can affect the supply of drinking water and also can have implication in electricity production.

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