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CONCISE

GEOGRAPHY

Current Affairs for Prelims 2025
(April 2024- November 2024)

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PREFACE

Concise Prelims Current Affairs 2025

Current Affairs-Sine QuaNon of UPSC Preparation

Proficiency in Current affairs is sine non qua for UPSC preparation. It is the basic foundation of any aspirant 's preparation. Knowledge and skill to relate current news with UPSC syllabus is quintessential part of the preparation.

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CONCISE
GEOGRAPHY
APRIL 2024 - NOVEMBER 2024

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Universe, Solar System & Evolution of Earth.

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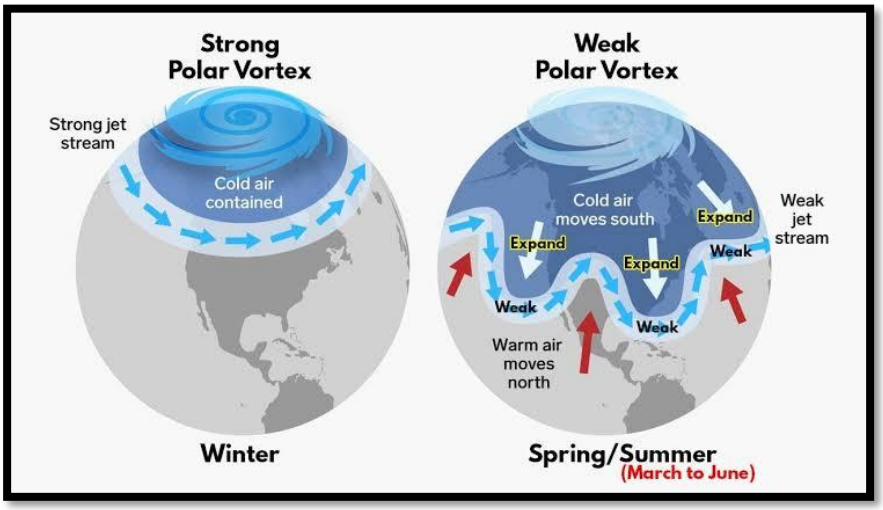
Earth's Polar Vortex

Context:
Recently, the atmospheric scientists have noticed the development of the polar vortex and characterized it as one of the biggest events in the last four decades.

Polar Vortex Overview:

- **Geographical Definition:** A large area of low pressure and cold air around both poles.
- **Seasonal Variations:** Present year-round; weakens in summer, strengthens in winter.
- **Location:** Located in the polar stratosphere, above the troposphere where weather occurs.
- **Formation & Winter Hemisphere:** Develops in the winter hemisphere when the Earth's pole is tilted away from the Sun.
- **Vortex Characteristics:** Air flows counterclockwise, concentrating cold air near the poles.



Impact on Weather Patterns:

- **Strong Vortex Effects:** Polar jet stream stays north, resulting in colder Arctic and milder mid-latitudes.
- **Weak/Shifted Vortex Effects:** Jet stream becomes wavy, allowing warm air into the Arctic and pushing cold air into the mid-latitudes.
- **Resulting Weather Events:** Can cause extreme cold snaps, snowstorms, and harsh winter conditions in regions like North America, Europe, and Asia.

Climate change is Slowing Earth's Rotation

Context:
A study published in Nature found that Global warming has slightly slowed the Earth's rotation.

Impact of Human-Induced Global Warming on Earth's Rotation:

- **Polar Ice Melting:** Global warming leads to polar ice melt, altering Earth's dynamics.
- **Effect on Spin:** Melting ice causes Earth to spin more slowly than normal.
- **Shape Changes:** Water movement from poles to equator flattens Earth slightly.
- **Moment of Inertia Increase:** Earth's mass redistribution increases its moment of inertia.
- **Angular Momentum Conservation:** Earth's spin rate decreases to conserve angular momentum, unless external forces act.

Other Factors:

- **Moon's Gravitational Pull:** Over millions of years, the Moon's gravity has slowed Earth's rotation.
- **Historical Rotational Speed:** 1.4 billion years ago, a day was 19 hours; 70 million years ago, it was about 23.5 hours.

Leap Second:

- **Definition:** A leap second is a one-second adjustment to Coordinated Universal Time (UTC) to align with Earth's slowing rotation.
- Earth's rotation slows by about 2 thousandths of a second per day due to tidal friction.
- The last leap second was added on December 31, 2016.
- **Recent Changes:** Earth's rotational speed has slightly increased since 1970 due to outer core fluid movements, potentially canceling out the slowing effect of the Moon's gravity.
- **Future Adjustments:** A leap second subtraction may occur around 2025-2026, delayed by human-induced slowing.

Catatumbo Lightning

Context:
Lake Maracaibo's status as the world's most lightning-struck location is a testament to the intricate interplay of geographical, meteorological, and environmental factors.

Catatumbo Lightning:

- **Location:** Occurs over the Catatumbo River, where it meets Lake Maracaibo in Venezuela.
- **Frequency & Duration:** Happens for up to 160 nights per year, with up to 28 strikes per minute at its peak.
- **Title:** Known as "the lightning capital of the world."

Reasons for Catatumbo Lightning:

Converging Factors:

- Warm, moist air from the Caribbean Sea meets cooler air from the Andes mountains.
- This causes the warm air to cool, forming towering cumulonimbus clouds.

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- **Electrical Charge Generation:** Strong winds and temperature differences create electrical charges in these clouds.
- **Lightning Formation:** When the electrical potential in the clouds becomes too high, it discharges as lightning.

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Earth's Core is Rotating in Reverse Direction.

Context:
A research by scientists has revealed that the rotation speed of Earth's core is slowing down and has even reversed, a phenomenon called 'backtracking'.

Earth's Structure and Core:

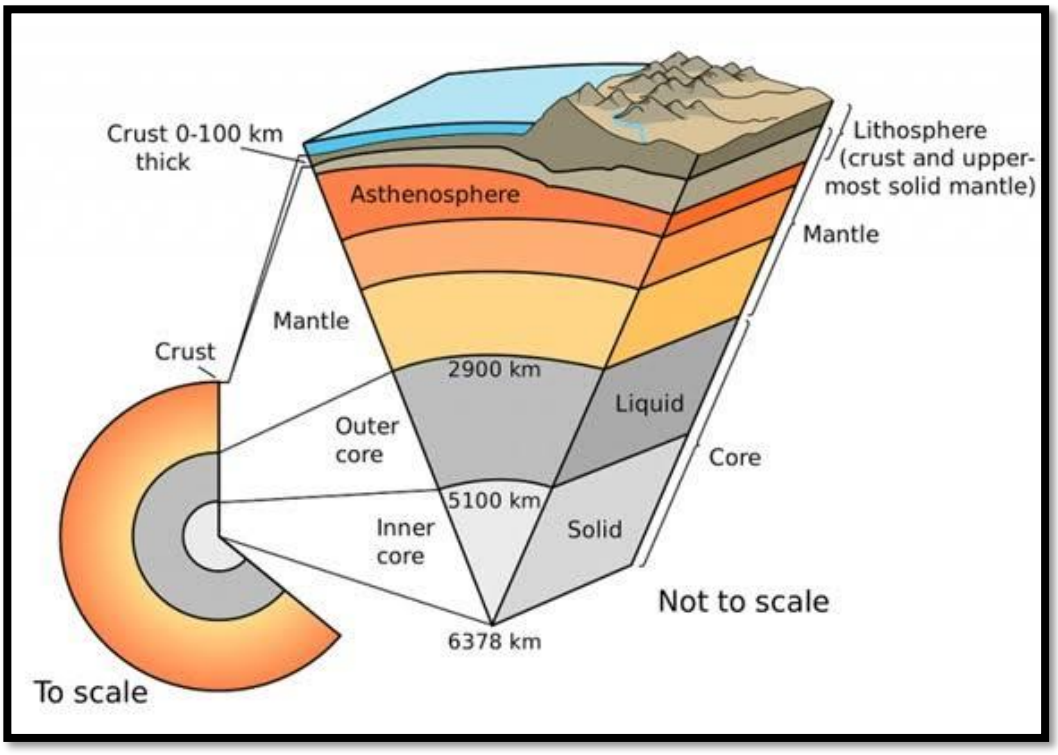
- Earth's interior is made up of three layers: crust, mantle, and core.
- The core is the hottest part of the planet, located about 5,180 kilometers deep.
- It consists mainly of iron and nickel.
- The inner core is surrounded by a liquid outer core, which acts as a barrier, allowing the inner core to spin independently of the rest of Earth.

Rotation of Inner Core:

- Earth's magnetic field pulls on the solid inner core, causing it to spin.
- The gravity and fluid flow in the outer core and mantle exert drag on the inner core, affecting its rotational speed.
- These forces result in variations in the inner core's spin.

Impact:

- When the core slows down, the mantle speeds up, causing Earth to rotate faster and shortening the length of a day.
- However, these shifts in rotation only affect the day length by thousandths of a second.



Aphelion

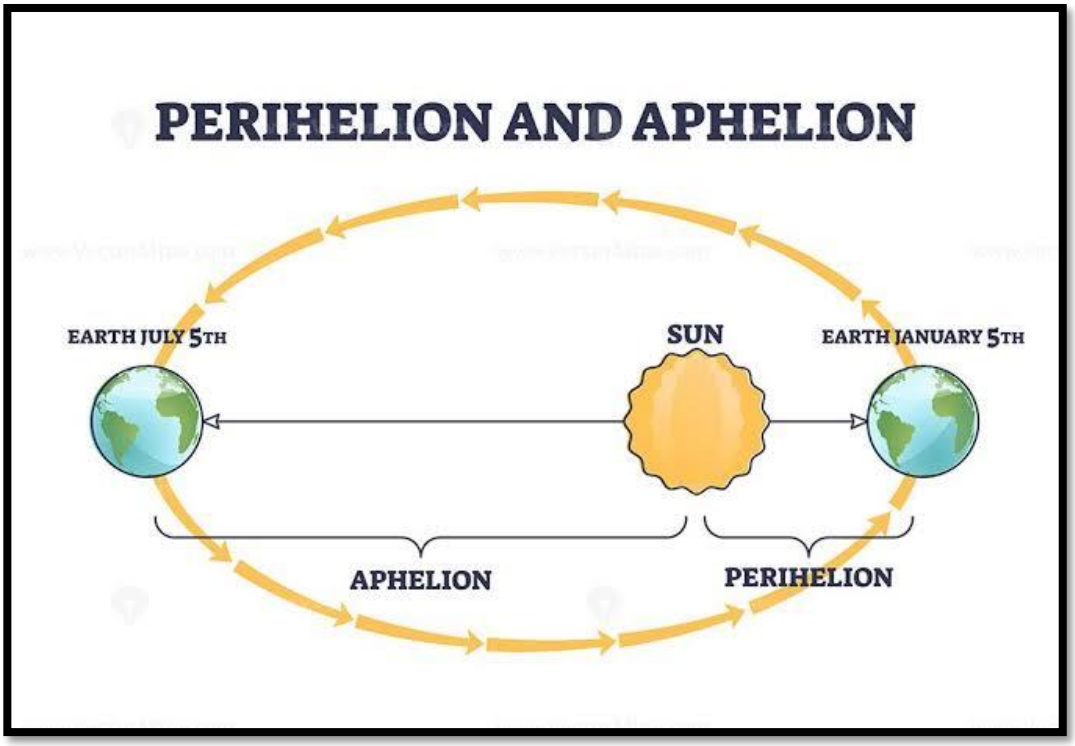
Context:
The Earth reaches the Aphelion in July every year. This year it reached Aphelion on July 05.

Aphelion:

- Earth's orbit is elliptical, so distance from the Sun varies.
- Aphelion is the point where Earth is farthest from the Sun (~152.1 million km), occurring in early July.
- Perihelion is the closest point (~147.1 million km), occurring in early January.
- Distance changes by about 5 million kilometers.

Impact on Seasons:

- Earth's axis tilt causes seasons, depending on which hemisphere faces the Sun.
- At aphelion, Earth receives 7% less sunlight than at perihelion.
- If orbit were circular, seasons would be of equal length.
- Spring and summer are slightly longer than fall and winter in the Northern Hemisphere.
- More elliptical orbits could lead to extreme seasons (hotter summers, colder winters), harmful to life.



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Climatology

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Impact of Tonga Volcanic Eruption on Climate

Context:
A study published in the Journal of Climate investigated the climatic effects caused by the eruption of Hunga Tonga-Hunga Ha'apai volcano. It had erupted in January 2022, in Tonga.

Findings of the Study:

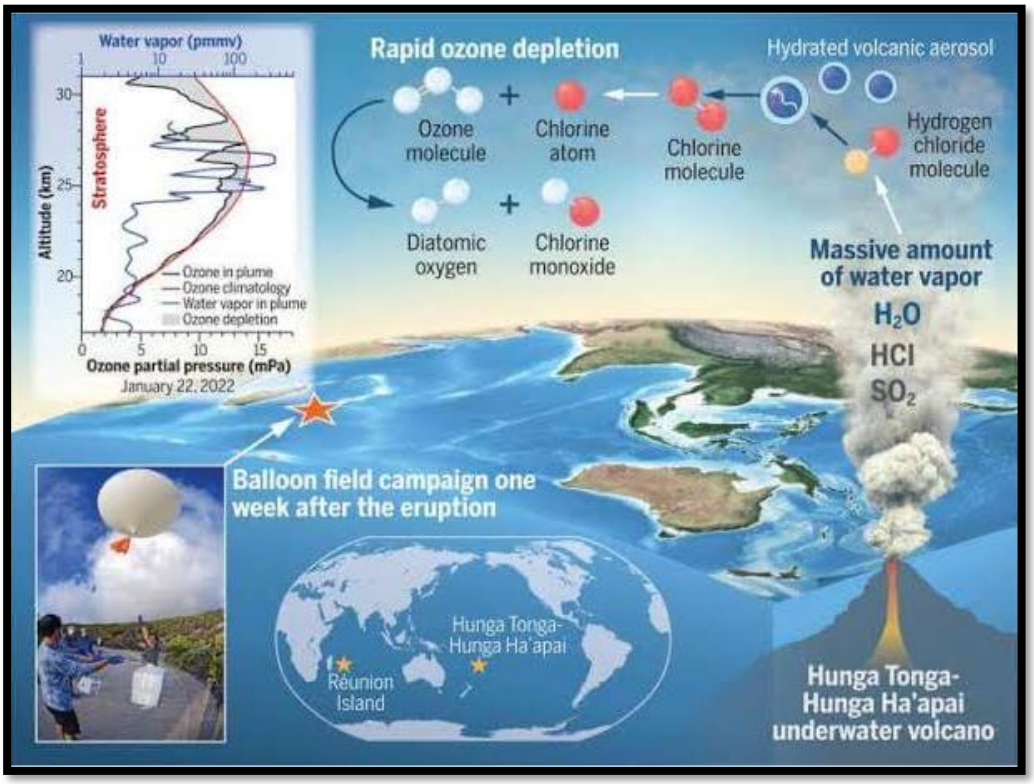
- **Effect on Ozone Layer:** A large hole in the ozone layer occurred from August to December 2023, partly due to the Hunga Tonga eruption, but this was a short-term effect expected to dissipate by the end of 2023.

Weather Changes:

- Australia had a wetter summer in 2024, unusual for an El Niño year.
- Global temperature increased slightly by about 0.015°C.

Regional Climate Effects:

- Northern Australia may experience colder, wetted winters until 2029.
- North America could see warmer winters during the same period.
- Scandinavia might face colder winters.
- **Atmospheric Changes:** The eruption altered atmospheric circulation, potentially affecting weather patterns.



Uniqueness of the Tonga Eruption:

- **Eruption Details:** On January 15, 2022, the Hunga Tonga-Hunga Ha'apai underwater volcano erupted, releasing 100-150 million tonnes of water vapor into the stratosphere (~15-40 km above Earth).

- **Unusual Impact:** Unlike typical volcanic eruptions that release smoke and sulfur dioxide, Hunga Tonga primarily emitted water vapor, which can damage the ozone layer and act as a greenhouse gas, possibly warming the Earth.

About Hunga Tonga-Hunga Ha'apai Volcano:

- Located in the western South Pacific Ocean, near Tonga.
- A submarine volcano in the Tofua Arc, part of the larger Tonga-Kermadec volcanic arc formed by the subduction of the Pacific Plate beneath the Indo-Australian Plate.
- Includes two small, uninhabited islands: Hunga-Tonga and Hunga-Ha'apai.

Impact of La Nina on Indian monsoon and Agriculture

Context:
The Asia-Pacific Economic Cooperation (APEC) Climate Center, has forecast the return of the La Nina phenomenon in India.

Monsoon Forecast for India:

- India is expected to experience above-normal rains, according to global weather agencies.
- The forecast includes regions spanning eastern Africa, Arabian Sea, India, Bay of Bengal, Indonesia, Caribbean Sea, tropical North Atlantic, southern Australia, and the southern South Pacific.

Ocean-Atmosphere System:

Normal Conditions:

- Trade winds blow west along the equator, pushing warm water from South America to Asia.
- Cold water rises from the depths (upwelling) to replace the warm water.
- This creates low-pressure areas near Indonesia, leading to rising air, cloud formation, and heavy rainfall.
- The airflow supports the monsoon system, bringing rainfall to India.

Abnormal Conditions:

- El Niño and La Niña phases typically develop from March to June, peak in winter, and dissipate post-winter.
- These phases last about a year, with La Niña typically lasting longer.
- El Niño and La Niña alternate in cycles of two to seven years, with neutral phases in between.

About El Niño:

- **Definition:** El Niño is the warming of seawater in the central-east Equatorial Pacific, occurring every few years.

Impact:

- Surface temperatures in the equatorial Pacific rise, and trade winds weaken.
- El Niño brings dry, warm winters to the Northern U.S. and Canada.
- It increases the risk of flooding in the U.S. Gulf Coast and southeastern U.S.
- It causes drought in Indonesia and Australia.

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Honeycomb Clouds and Clean Air of Southern Ocean the Earth

Context:
Recently, scientists have found the honeycomb-shaped clouds are the reason for having the cleanest air on Earth.

Honeycomb Clouds:

- Nature of Clouds: Known as 'open-cell clouds,' these are low, flat formations resembling a quilt with patches of open air surrounded by cloud walls.
- Appearance and Occurrence: Honeycomb patterns typically form in mid-latitudes, often linked to low-pressure systems or cyclones.
- Formation: Result from convection, where warm air rises and cold air descends, creating vertical movements (updrafts and downdrafts) that form vertical "walls."
- Hexagonal Formation: Uniform heating creates hexagonal cells; though irregular ocean heating leads to open-cell clouds with non-perfect shapes.
- **Role of Aerosols:** Aerosols, tiny particles like dust and dirt, provide surfaces for water to form droplets, influencing cloud formation and rain production.
- **Southern Ocean's Clean Air:** The Southern Ocean has low aerosol levels, contributing to clean air, with natural sources like sea salt and wind-blown dust.

Role of Honeycomb Clouds in Climate Regulation:

- MCC Clouds: Honeycomb-like clouds, called Mesoscale Cellular Convection (MCC) clouds, help regulate climate by reflecting sunlight (when closed) or allowing it in (when open).
- Rainfall and Clean Air: Days with open honeycomb clouds are linked to the cleanest air, as intense, sporadic rain showers remove aerosol particles from the atmosphere.

Nor'westers (Kalbaisakhi)

Context:
India aims to launch its first research testbed dedicated to studying Nor'westers (aka Kalbaisakhi).

Research Testbed Facility:

- **Collaboration:** Joint effort by the India Meteorological Department (IMD), Indian Institute of Tropical Meteorology (Pune), and National Centre for Medium-Range Weather Forecasting (Delhi).
- **Coverage Area:** Focuses on West Bengal, Odisha, and Jharkhand, with the control center at Chandbali, Odisha.
- **Equipment:** Drones, mobile vans, and advanced instruments will be used.
- **Purpose:** Aims to improve thunderstorm predictions, issue timely nowcast warnings, and save lives through better data.

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Nor'westers (Kalbaisakhi):

- **Origin and Direction:** Severe thunderstorms in Eastern India, southern Nepal, Bhutan, and Bangladesh during the pre-monsoon season. They generally move northwest to southeast or sometimes southwest to northeast.
- **Triggering Factors:** Daytime heating in early summer leads to convection in regions like Bihar, Jharkhand, Chhattisgarh, Odisha, and sub-Himalayan West Bengal.

Impact and Effects of Nor'westers:

- Weather Phenomena: Heavy rain, lightning, thunder, hailstorms, dust storms, squalls, downbursts, and sometimes tornadoes.
- **Agricultural Benefits:** Help with the growth of Kharif crops such as tea, jute, and rice.
- **Local Names:** Known as 'Bardoli Chheerha' in Assam.

Famous Local Storms:

- **Mango Shower:** Pre-monsoon showers in Kerala and coastal Karnataka that aid early mango ripening.
- **Blossom Shower:** Occurs in Kerala, helping coffee flowers bloom.
- **Loo:** Hot, dry winds blowing across Northern India, particularly between Delhi and Patna.

Heat Dome

Context:
Recently, the intense heat experienced in northeast India has been linked to a phenomenon called the heat dome effect.

Heat Dome:

- **Definition:** A high-pressure system traps hot air, preventing it from rising, creating extreme heat and dry conditions for days or weeks.
- **Process:** Hot air becomes compressed, intensifying heat and keeping it near the ground, with stagnant air getting hotter daily.

Contributing Factors:

- **Clear Skies & Solar Radiation:** High-pressure systems bring clear skies, allowing more sunlight to heat the ground and prevent natural cooling at night.
- **Land Characteristics:** Dry, large land masses, like plains or deserts, heat up quickly, creating ideal conditions for heat domes.
- **Weak Monsoon Circulation:** The absence of monsoon winds and moisture has allowed high-pressure systems to settle, especially over Assam.
- **Poor Soil Moisture:** Lack of soil moisture exacerbates heat, contributing to high nighttime temperatures.
- **Deforestation:** Loss of forests has created urban heat islands, worsening climate conditions in Assam.
- **Climate Change & Air Currents:** Disruptions in global air currents, driven by climate change, reduce the cooling impact of the monsoon.

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Impacts:

- **Health Risks:** Increased heat-related illnesses, like heatstroke and dehydration, especially for the elderly and children.
- **Agricultural Stress:** Damaged crops, reduced yields, and soil moisture depletion, leading to food insecurity.
- **Water Shortages:** Accelerated evaporation leads to drought conditions and reduces water availability.
- **Wildfires:** Increased heat and dryness heighten wildfire risk, damaging forests and worsening air quality.

Heat Dome vs. Heat Wave:

Heat Dome:

- A high-pressure system that traps hot air over a large area, creating extreme temperatures.
- Acts as a causative factor for heat waves.
- Causes prolonged hot conditions, but can also occur due to tropical weather systems.

Heat Wave:

- A prolonged period of excessively hot weather, often lasting several days.
- Can be caused by various factors, including heat domes or warm air masses lingering over a region.

Relationship:

- Heat domes create conditions for heat waves, but heat waves can also occur due to other factors, like stagnating warm air masses.

Western Disturbance and Heatwaves

Context:
Recently, India Meteorological Department (IMD) forecast a heatwave in North India due to an approaching western disturbance towards northwest India.

Western Disturbances (WDs) and Heatwaves:

Origin & Movement:

- WDs are extratropical weather systems that originate over the Mediterranean Sea and move eastward, influencing the Indian subcontinent, especially in winter.

Role in Heatwaves:

- Temperature Contrast: WDs bring cold air from the Mediterranean, which, when meeting warm air over India, creates a sharp temperature contrast, potentially triggering heatwaves.
- Pre-Heatwave Conditions: WDs can precede heatwaves by disrupting weather patterns, leading to rising temperatures and intensifying warm air.

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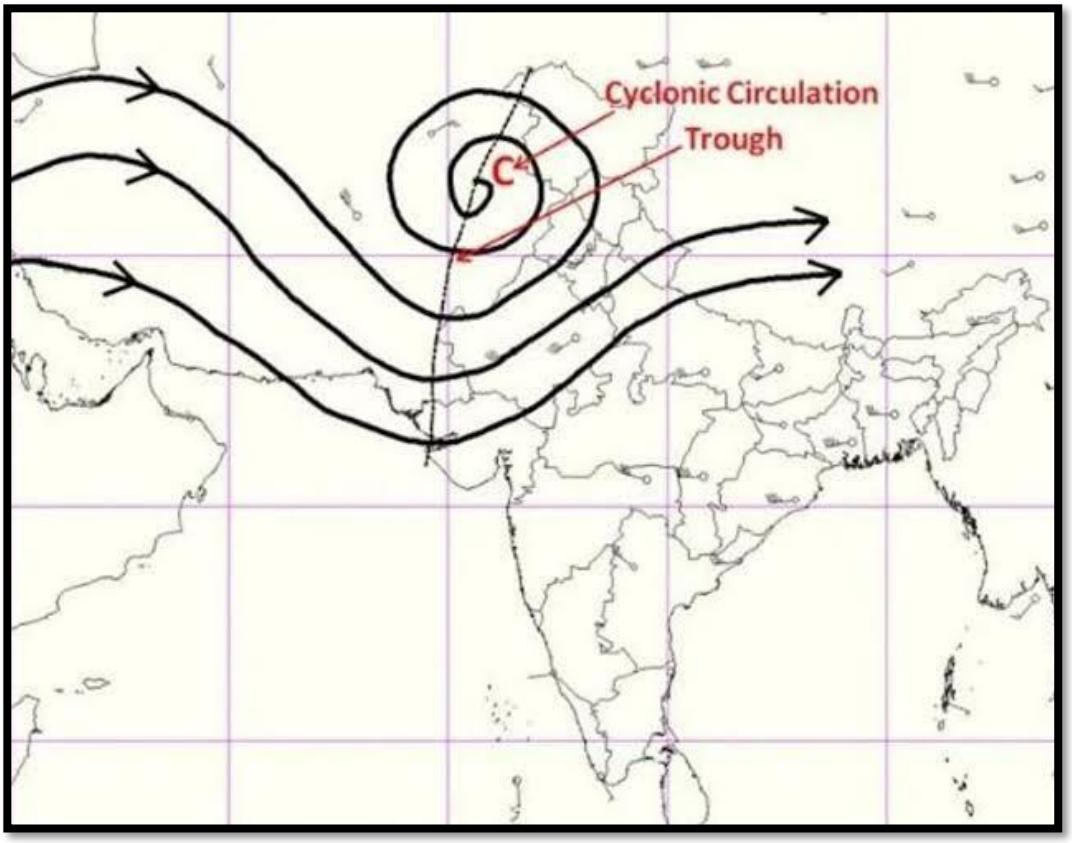
Heatwave Amplification: WDs contribute to heatwaves by:

- Reducing cloud cover (allowing more sunlight to heat the surface).
- Suppressing moisture (hindering monsoon winds and reducing humidity).
- Intensifying dry winds (bringing dry continental air, worsening heat stress).



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Pyro cumulonimbus Clouds

Context:
Wildfires in the U.S. and Canada have become so intense that they are generating 'pyro cumulonimbus' clouds, which can produce thunderstorms and ignite additional fires.

Formation:

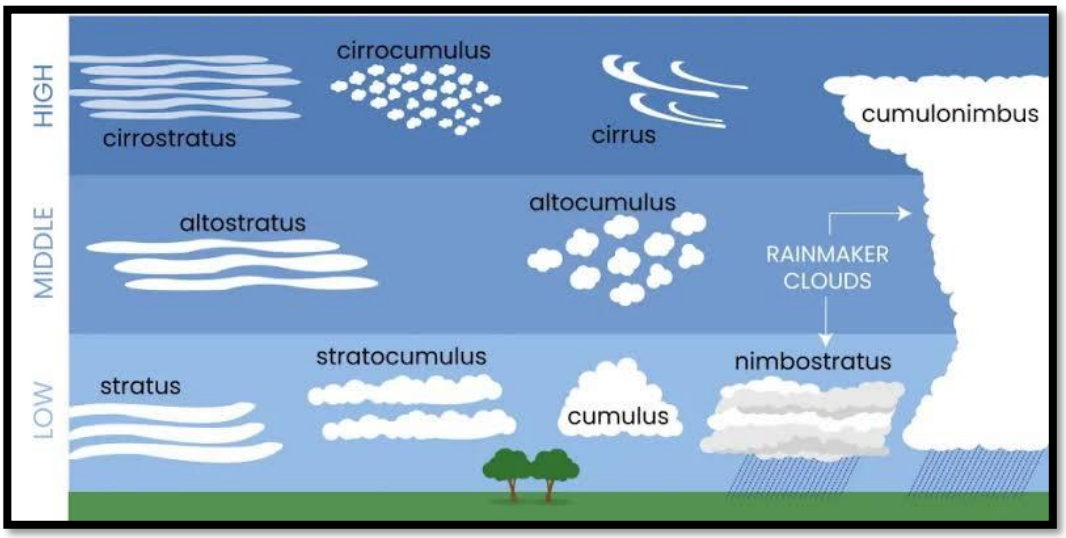
- Created by intense heat from wildfires or volcanic eruptions.
- Rising global temperatures may increase their frequency.
- Warmed air rises, cooling and condensing on ash to form pyro cumulus clouds.
- Can develop into pyro cumulonimbus clouds up to 50,000 feet, creating thunderstorms.

Impact:

- Produces lightning but little rain.
- Can spark new wildfires and trigger strong winds that spread fires.

Data:

- 102 pyro cumulonimbus clouds were recorded globally per year before 2023, with 50 in Canada.
- In 2023, 140 pyro cumulonimbus clouds were recorded in Canada alone.



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More Frequent Cyclones in Arabian Sea

Context:
Recently, the Arabian Sea experienced an unusual cyclone named Asna, which attracted significant attention because of its atypical timing and origin.

Cyclone Activity in the North Indian Ocean:

Moisture Source:

- The North Indian Ocean provides moisture crucial for the Indian summer monsoon, generating about 200 lakh crore buckets of water.
- Warm temperatures in the Arabian Sea and Bay of Bengal are key for evaporation, fueling monsoon rainfall and cyclogenesis.

Cyclone Frequency:

- Despite favorable conditions, the North Indian Ocean has low cyclone frequency compared to other regions due to vertical wind shear and other atmospheric conditions.
- **Vertical Wind Shear:** Variation in wind speed and direction disrupts cyclone formation and intensification.
- **Proximity to Landmasses:** Cyclones encounter friction when moving over land, losing energy and intensity rapidly.

Unique Characteristics of the Indian Ocean:

- **Oceanic Tunnels:** Linked to the Pacific and Southern Oceans via 'oceanic tunnels', impacting water temperatures.
- The Pacific tunnel supplies warm water, while the Southern Ocean provides cooler waters.
- **Temperature and Convection:** The Arabian Sea warms rapidly in the pre-monsoon, while the Bay of Bengal produces more convection and rainfall, leading to monsoon onset in Kerala by mid-May.
- **Post-Monsoon Season:** The northeast monsoon brings significant rainfall to several Indian states.

Cyclogenesis and Climate Change:

Cyclogenesis Patterns:

- The North Indian Ocean has two cyclone seasons: pre-monsoon and post-monsoon.
- Vertical wind shear limits cyclone development in the Bay of Bengal.

Climate Change Impact:

- Warming trends in the Indian Ocean due to heat input from the Pacific and Southern Oceans are changing cyclone frequency and intensity.
- The Arabian Sea shows increasing cyclone numbers in recent years.
- **Unusual Cyclone Events:** Cyclone 'Asna': Developed from a land-born depression that intensified unusually over the warm Arabian Sea, fueled by soil moisture.

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Permafrost Region:

Context:
A new study has found that the northern permafrost region is emitting more greenhouse gases into the atmosphere than it is capturing.

Permafrost and Global Warming:

- **Definition:** Permafrost, or permanently frozen ground, covers a quarter of the northern hemisphere.
- Carbon and Nitrogen Storage: The top 3 meters of permafrost store 1 trillion tons of organic carbon and 55 billion tons of nitrogen.
- **Impact of Warming:** Global warming is causing permafrost to thaw, releasing these stored greenhouse gases into the atmosphere.
- **Northern Permafrost Region:** Historically one of the largest carbon and nitrogen pools, the northern permafrost region is shifting from a carbon sink to a carbon source due to warming temperatures.

Shift from Sink to Source:

Study Findings (2000-2020):

- Emitted 38 million tonnes of methane, 670,000 tonnes of nitrous oxide, and 12 million tonnes of CO_2.
- The region became a net source of 144 million tonnes of CO_2 and methane, and 3 million tonnes of nitrogen.

Impact of Thawing Permafrost:

- Thawing permafrost could significantly impact the global carbon cycle, accelerating global warming through the "permafrost carbon feedback."

Regional Emissions Breakdown:

- The study categorized the region into five ecosystems: Boreal Forests, Wetlands, Dry Tundra, Tundra Wetlands, and Permafrost Bogs.
- Wetlands were the largest methane emitters (83%).
- Dry Tundra was the largest driver of nitrous oxide release, followed by permafrost bogs.
- All ecosystems except boreal forests were net methane emitters.

Oceanography

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Discovery of Hidden Ocean Inside the Earth

Context:
Scientists have recently discovered a hidden ocean which is 700 km below the Earth's surface. The ocean is located within a mineral called ringwoodite.

About Ringwoodite:

- It is a mineral that exists in the Earth's transition zone.
- It is a rare type of mineral that forms from olivine under very high pressures and temperatures.
- The heavy weight of rocks (100s of kilometres thick) and extremely high temperatures above 1,000oC (1,832o Fahrenheit) break down water into its components.
- This mineral has a special crystal structure that can soak up water and hydrogen, like a sponge. It can hold a lot of water.
- When these water-containing minerals reach specific depths, they break down through dehydration, releasing the water to create magmas. Such "dehydration melting" is common in the shallow mantle and forms the source for magmas in many volcanoes.

Significance of the Discovery

- This ocean is much larger than all the surface oceans combined. Its size raises questions about current theories on the source of earth's water and suggests new inquiries into Earth's formation.
- This finding strongly suggests that Earth's water might have come from deep within the planet. With the passage of time, it slowly leaked out from the core, explaining why earth has so much water.
- This internal water source could also play a role in volcanic activity and the formation of new crust.

Swell Waves

Context:
Swell waves inundated coastal areas in central and southern districts of Kerala.

Swell Waves (Kallakkadal):

- **Local Term:** 'Kallakkadal' is a term used by Kerala fishermen for freak flooding episodes caused by swell waves. In 2012, UNESCO officially accepted this term for scientific use.
- **Impact:** During 'Kallakkadal' events, the sea surges onto the land, causing inundation.

Swell Wave Characteristics:

- **Origin:** Swell waves are low-frequency waves that travel long distances from the storm that created them, with reduced height and increased length.

- **Appearance:** They organize into smooth, regular groups.
- **Travel Distance:** Swell waves can travel thousands of miles without changing in height or period.
- **Speed:** The longer the wave, the faster it travels.
- **Sorting:** As they move away from the storm, longer waves lead shorter ones, and the energy is spread over a larger area.

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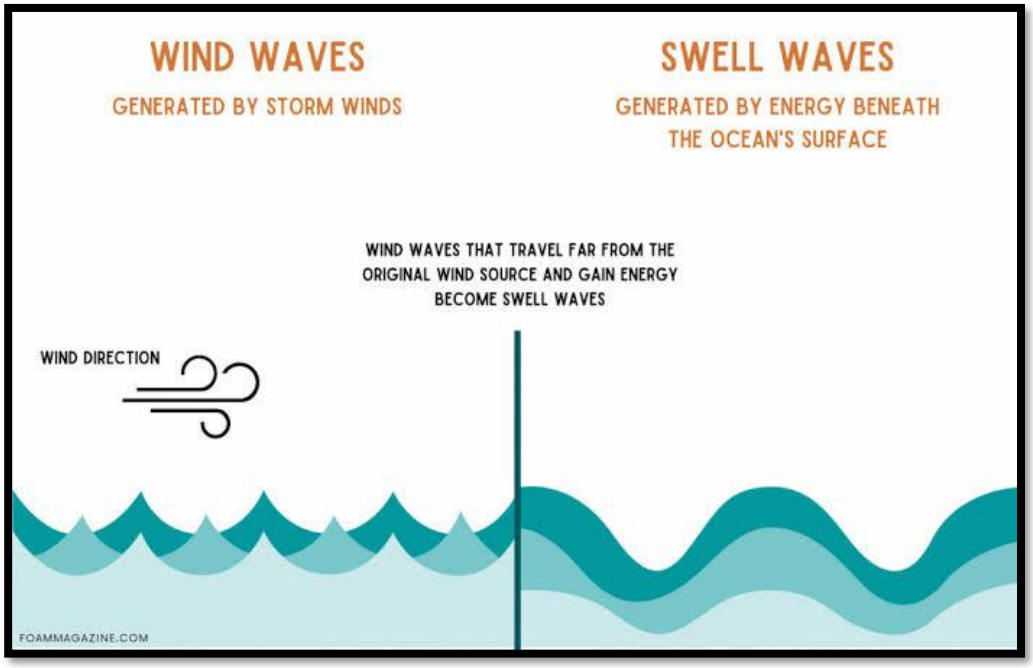

Integrated Ocean Energy Atlas

Context:
Recently, the Indian National Centre for Ocean Information Services (INCOIS) announced the creation of an 'Integrated Ocean Energy Atlas' for the Indian Exclusive Economic Zone.

Indian EEZ and Ocean Energy Potential:

- **Ocean Energy Resources:** India's Exclusive Economic Zone (EEZ) holds significant potential for marine and hydrological energy, including solar, wind, wave, tide, currents, ocean thermal, and salinity gradient energy.
- **Energy Estimates:** The Indian EEZ can generate about 9.2 lakh terawatt hours (TWh) of energy from various ocean energy sources.
- **Ocean Energy Atlas:** This newly created atlas identifies high-potential areas for ocean energy within India's EEZ and serves as a reference tool for policymakers, researchers, and industries.

Scope and Mapping:

- **Resolution & Coverage:** The mapping was conducted at a 5 km x 5 km resolution, covering India's EEZ up to 220 km from the coast.
- **Coastline & Ocean Economy:** With over 7,000 km of coastline, India has significant opportunities for ocean energy generation. The Ocean Energy Atlas supports India's efforts to strengthen its ocean economy sustainably.

World's First Integrated Ocean Energy Atlas:

- **Global First:** This atlas is the first integrated assessment of ocean energy reserves across India's EEZ.
- **Considerations:** It factors in fishing zones, shipping lines, cyclone-prone areas, eco-sensitive regions, and existing ports, important for infrastructure planning.

Significance:

- Energy Potential Identification: The atlas helps identify energy-rich areas for increased ocean energy production.
- **Support for Net Zero:** It plays a key role in helping India meet its net-zero emissions goal through sustainable ocean energy.
- **Policy & Research Utility:** Provides vital data for policymakers and researchers to design effective strategies for harnessing ocean energy.

Regional Insights:

- **Tidal Wave Energy:** Coastal areas of West Bengal and Gujarat are ideal for tidal wave energy.
- **Salinity Gradient Energy:** The coasts of Andhra Pradesh and West Bengal show promise for salinity gradient energy.

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Atlantic Meridional Overturning Circulation

Context:
The Atlantic Meridional Overturning Circulation (AMOC) is at risk of imminent collapse, with recent studies indicating that anthropogenic emissions could expedite this between 2025 and 2095.

Atlantic Meridional Overturning Circulation (AMOC):

What is AMOC?

- A large-scale ocean circulation system.
- Transports warm surface waters from the tropics to northern latitudes and cold, deep waters back to the equator.
- Crucial for redistributing heat and influencing regional and global climates, e.g., moderating temperatures in Europe and North America.

Mechanism:

- Warm Water Transport: AMOC moves warm, salty water from the tropics to northern regions, warming areas like Europe.
- Cooling & Density Increase: Water cools as it moves north; fresh, cold water from Arctic ice melts into the ocean.
- **Down welling:** Cold, dense water sinks in the North Atlantic, starting its southward flow.
- **Southward Flow:** Cold water moves along the ocean floor, redistributing heat and nutrients.
- **Cycle Completion:** Water resurfaces, warms, and returns to complete the circulation.

Current Concern:

- AMOC could collapse between 2025 and 2095 due to anthropogenic emissions.
- Potential climate disruptions, including regional cooling, altered weather patterns, and rising sea levels.

Indian Ocean & AMOC: Key Facts

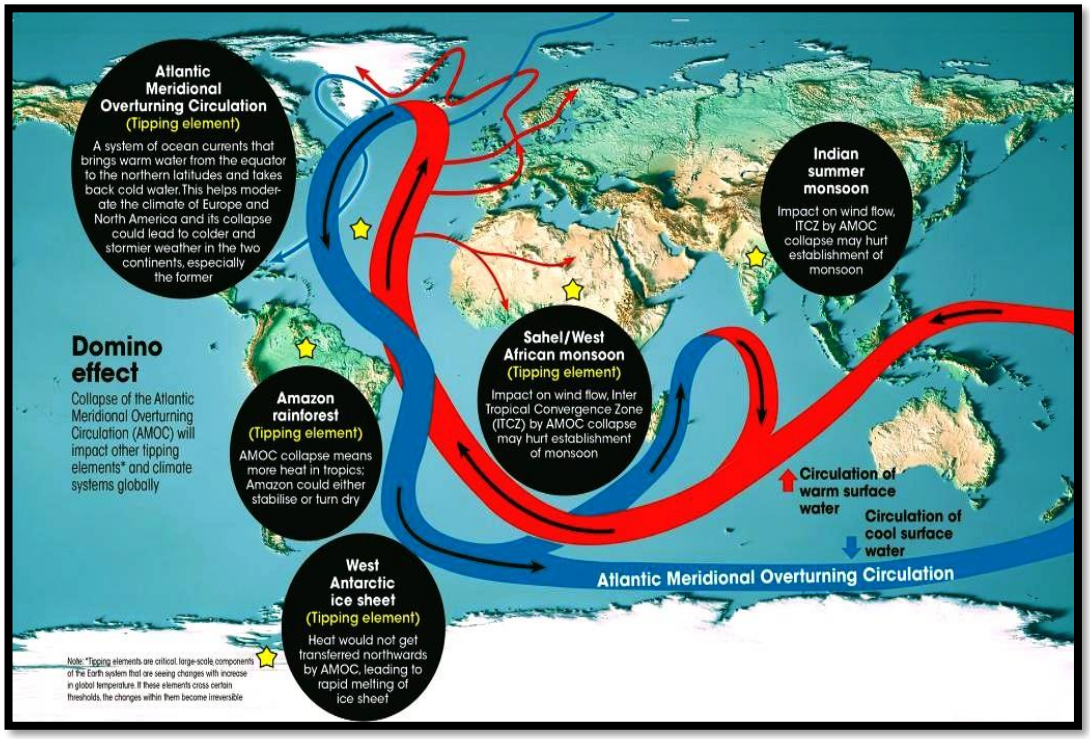
- **Indian Ocean's Role:** Warming Indian Ocean generates more precipitation, drawing air from other parts, including the Atlantic.
- Increased precipitation in the Indian Ocean reduces rainfall in the Atlantic, raising its salinity.
- Saltier water in the Atlantic cools faster and sinks quicker, intensifying the AMOC circulation.
- **Contribution to Global Climate:** AMOC acts as a heat conveyor belt, warming northern latitudes and cooling southern latitudes, stabilizing global climate.

Threats to AMOC:

- Increased precipitation and melting Greenland ice sheet add cold freshwater to the North Atlantic, lowering salinity and density, slowing down AMOC.
- Greenhouse gas emissions disrupt ocean temperatures and circulation.

Potential Cascading Effects:

- AMOC collapse could destabilize the southern Amazon, turning it into a savannah-like ecosystem.
- Increased ocean heat could accelerate West Antarctic ice sheet melting, raising sea levels.
- Weakening monsoon circulation in South Asia and Africa could affect agriculture, water resources, and regional climates.



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World Geography - Physical

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Afar Depression

Context:
Geologists predict that the African continent's rift in the Afar Triangle could lead to the formation of a new ocean in 5 to 10 million years.

Afar Triangle (Afar Depression) Overview:

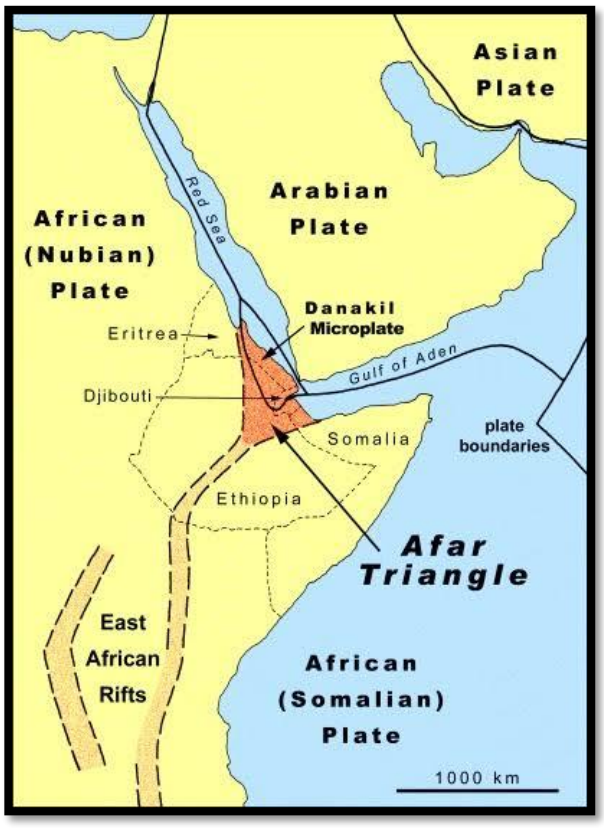
- **Location:** Located in the Horn of Africa.
- **Geological Significance:** A depression where the Nubian, Somali, and Arabian tectonic plates converge, part of the East African Rift system.
- **Continental Rifting:** The convergence causes a continuous rifting process over millions of years, characterized by slow movement and separation.

Rifting Activity:

- **Recent Rift:** In 2005, a significant rift, 35 miles long, appeared in the Ethiopian desert, marking the ongoing separation of the African continent.
- **Tectonic Forces:** The Somali plate moves away from the Nubian plate, stretching and thinning the Earth's crust.

Future Predictions:

- **Continental Division:** In 5-10 million years, the tectonic activity is expected to split the African continent, creating a new ocean basin.
- **Formation of a New Ocean:** Water from the Red Sea and Gulf of Aden will flood into the East African Rift Valley, forming a new body of water and potentially creating a new continent in the Afar region.



Geo-physical Phenomenon

Space for Notes:

Growth of Glacial Lakes in the Himalayas

Context:
According to ISRO, the size of the Glacial Lakes in the Himalayas is increasing. This poses significant risks especially related to Glacial Lake Outburst Floods.

ISRO's Recent Findings on Glacial Lakes:

- **Satellite Data Analysis:** ISRO scientists studied satellite data from 1984 to 2023, focusing on Indian Himalayan river basins.
- **Lake Expansion:** Out of 2,431 glacial lakes larger than 10 hectares, 676 have significantly expanded, with 601 of them doubling in size.
- **Indian Lakes:** 130 of these expanded lakes are in India, located in the Indus (65), Ganga (7), and Brahmaputra (58) river basins.
- **Increased Risk:** The expansion of these lakes due to glacial retreat poses a higher risk of Glacial Lake Outburst Floods (GLOFs), threatening downstream communities.

Formation of Glacial Lakes:

- **How They Form:** Glacial lakes are formed when glaciers move and melt, creating depressions that fill with meltwater.

Types of Glacial Lakes:

- **Moraine-dammed:** Created by debris left by glaciers.
- **Ice-dammed:** Formed when ice traps water.
- **Erosion-based:** Created by depressions formed through erosion.

Risks of Glacial Lakes:

- **GLOFs:** Glacial lakes are risky because natural dams (moraine or ice) can fail, leading to sudden and severe floods, which can endanger downstream communities.

Mitigating Risks:

- **Lowering Lake Levels:** Reducing water levels by 10-30 meters, as suggested for Ghepan Gath lake, can reduce flood risks but doesn't eliminate them completely.
- **Using HDPE Pipes:** In 2016, HDPE pipes were used successfully in Sikkim to lower water levels in South Lhonak Lake, reducing flood risks.
- **Early Warning Systems:** Installing motion detection cameras, water level sensors, and discharge meters at critical lake sites to detect potential GLOFs.
- **Satellite Monitoring:** Ongoing satellite remote-sensing helps track glacial lake changes and aids in planning for timely interventions.

Glacial Lake Floods

Context:
The Uttarakhand government has constituted two teams of experts to evaluate the risk posed by five potentially hazardous glacial lakes in the region. These lakes are prone to Glacial Lake Outburst Floods (GLOFs).

About GLOFs (Glacial Lake Outburst Floods):

- GLOFs are caused by the sudden discharge of water from glacial lakes formed by melting glaciers.
- As glaciers recede, they create depressions that fill with meltwater, forming larger and more dangerous lakes.

Reasons for GLOFs:

- **Glacial Calving:** Large ice chunks detach from glaciers, causing water displacement.
- **Avalanches/Landslides:** Can destabilize lake boundaries, triggering water discharge.
- **Climate Change:** Rising global temperatures increase glacier melting and GLOF risk.
- **Infrastructure Development:** Rapid development in vulnerable areas worsens the risk.

Impacts of GLOFs:

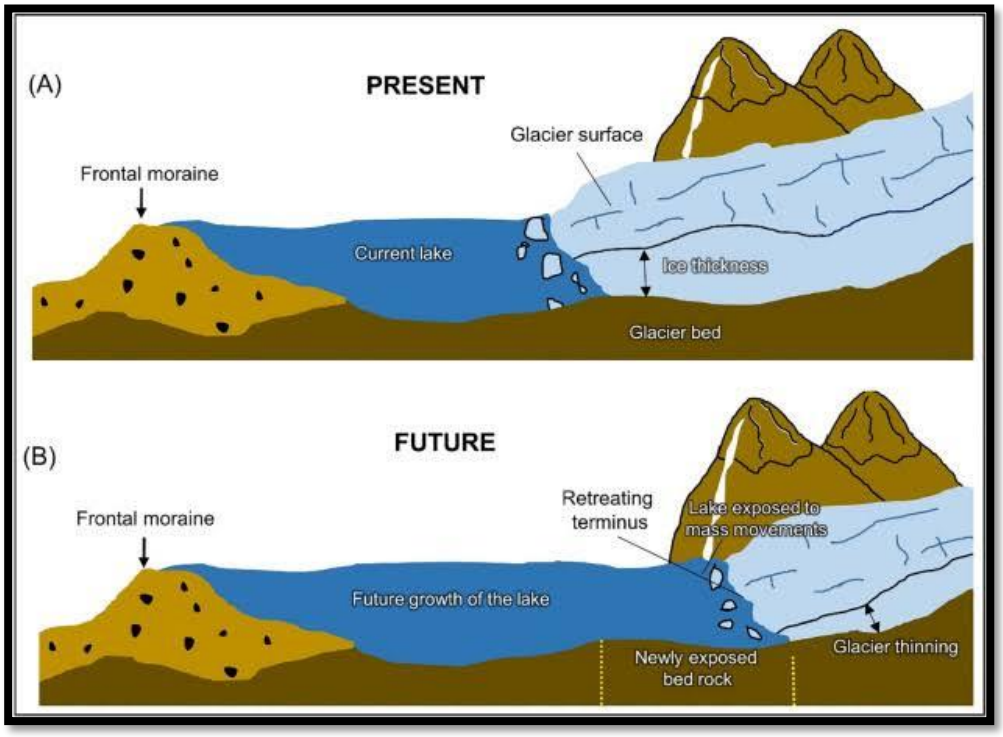
- Unleash large volumes of water, sediment, and debris downstream.
- Can submerge valleys, destroy infrastructure, and cause loss of life and livelihoods.
- Recent disasters in the Himalayan region highlight the severity.

Geographical Distribution:

- GLOFs occur in glacial regions, such as the Himalayas, Andes, and Alps.
- Increased frequency in the Himalayan region (especially southeastern Tibet and China-Nepal border) since 1980.
- NDMA identified 188 vulnerable glacial lakes in Himalayan states, 13 in Uttarakhand.

Suggestions for Mitigation:

- Study glacier and glacial lake dynamics to assess GLOF risk and improve planning.
- Use satellite imagery and remote sensing to monitor glacial lake changes.
- Develop and communicate emergency preparedness plans for at-risk communities.



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Volcanic Vortex Rings

Context:
Recently, Mount Etna, one of the most active volcanoes in the world, has been sending up almost perfect rings of smoke into the air, termed as 'volcanic vortex rings'.

Volcanic Vortex Rings:

- **Nature:** Formed when gas (mainly water vapor) is rapidly released through a circular vent during volcanic eruptions.
- **Formation Mechanism:** Similar to smoke rings, created by forceful gas expulsion through a circular opening, leading to spinning motion that forms coherent rings.

Historical Observations:

- First documented at Mount Etna and Mount Vesuvius (Italy) in 1724.
- Observed at various volcanoes worldwide, including Redoubt (Alaska), Tungurahua (Ecuador), Pacaya (Guatemala), and others.

Global Occurrence:

- Not restricted to specific regions; volcanic vortex rings have been observed at volcanoes around the world.

Significance:

- Vortex rings provide valuable data on volcanic activity.
- Studying these rings helps scientists understand gas emissions and predict potential eruptions.

Mass Wasting of Sedongpu Gully of Tibetan Plateau

Context:
Environmental scientists have raised concerns in a recent study regarding the high frequency of mass wasting events occurring in the Sedongpu Gully of the Tibetan Plateau since 2017.

Mass Wasting:

Definition: The downward and outward movement of materials (ranging from fine clay to massive rocks) under the influence of gravity, contributing to landform formation. It can lead to minor events or large-scale disasters.

Causes:

- **Passive Causes:**
  - Lithogenic (unconsolidated, weak materials)
  - Stratigraphic (thin-bedded formations)
  - Structural (faults, dense joints)
  - Topographic (steep slopes)
  - Climatic (freeze-thaw, heavy rainfall)
  - Organic (lack of vegetation)
- **Active Causes:**
  - Removal of support (erosion or human activity)
  - Oversteepening of slope (due to surface runoff)
  - Overloading of regolith (snow, ice, or structures)

Types of Mass Wasting:

- **Solifluction:** Water-saturated soil moves downslope, common in warm and cold climates (e.g., permafrost in cold regions).
- **Soil Creep:** Slow, widespread movement, requires minimal slope and no moisture, can happen in any climate.
- **Mud Flow:** Rapid, channelized movement of water and debris, especially in arid regions due to intense rainfall.
- **Earth Flow:** Localized, less channelized, can happen in various climates.

Sedongpu Gully:

- **Location:** In the Sedongpu Glacier catchment, Tibet.
- **Gully:** Landform shaped by erosion from water and mass movement.

Drainage:

- Drains into the Yarlung Zangbo (Tsangpo) River, which turns sharply at the Great Bend near the Tibet-Arunachal Pradesh border.
- Tsangpo becomes the Siang River in Arunachal Pradesh, merging with the Dibang and Lohit rivers to form the Brahmaputra.

Geological Features:

- **Great Bend Gorge:** 505 km long, 6,009 meters deep, one of the deepest on Earth.
- **Sedongpu Basin:** Composed of Proterozoic marble, with land temperatures ranging from –5° to –15°C, rarely exceeding 0°C until 2012.

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Resources - World and India

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Ringwoodite

Context:
Scientists have recently discovered a hidden ocean which is 700 km below the Earth's surface. The ocean is located within a mineral called ringwoodite.

- Ringwoodite is a rare mineral found in Earth's transition zone, formed from olivine under extreme pressure and temperatures above 1,000°C.
- It has a unique crystal structure that absorbs water and hydrogen, holding large amounts like a sponge.
- When Ringwoodite reaches certain depths, it undergoes dehydration, releasing water and forming magmas, contributing to volcanic activity.
- The discovery suggests an internal "ocean" larger than surface oceans, challenging current theories on Earth's water origin.
- This finding implies Earth's water might have come from deep within the planet, slowly leaking out over time, playing a role in volcanic activity and new crust formation.

Blood Minerals

Context:
Recently, the Democratic Republic of the Congo (DRC) has accused Apple of using 'blood minerals' (illegally exploited minerals) extracted from the eastern region of the country.

- Blood minerals (conflict minerals) include tin, tantalum, tungsten, and gold (3T or 3TG), mined under armed conflict and human rights abuses.
- These minerals are vital for products like smartphones, laptops, cars, and aircraft.
- Heart of the issue: The Democratic Republic of the Congo (DRC), rich in 3TG minerals, has been marred by violence for decades.
- Minerals are extracted under harsh conditions, leading to significant human rights violations.
- Vulnerable groups, especially women and children, suffer from displacement, sexual violence, and forced labor in the mines.

Stromatolites

Context:
Living stromatolites have been discovered on Sheybarah Island, on the northeastern shelf of the Red Sea in Saudi Arabia.

Stromatolites Overview:

- **Definition:** Layered structures formed by microorganisms, primarily cyanobacteria (blue-green algae), also known as stromatoliths.

- **Formation:** Cyanobacteria trap and bind sedimentary grains in shallow waters, building layers over time to form mound-like structures.
- **Appearance:** Typically display alternating light and dark layers, with shapes varying from flat to rounded (hummocky) or dome-shaped.

Historical Significance:

- **Ancient Structures:** Common during the Precambrian era, over 542 million years ago.
- **Location:** Primarily marine but some ancient stromatolites from over 2.5 billion years ago are found in intertidal zones and freshwater lakes.
- **Present-Day Occurrence:** Living stromatolites are rare, found in places like Shark Bay in Western Australia.

Importance of Stromatolites:

- **Fossil Records:** Stromatolites are key evidence of early life on Earth, with fossils dating back over 3.5 billion years.
- **Oxygen Production:** Cyanobacteria in stromatolites are photosynthetic and produce oxygen, contributing to Earth's early atmosphere.
- **Evolution of Earth:** Around 2.5 billion years ago, stromatolites played a major role in increasing atmospheric oxygen, which helped shift Earth's atmosphere from carbon dioxide-rich to oxygen-rich. This paved the way for the evolution of eukaryotic cells (cells with a nucleus) and more complex life forms.

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