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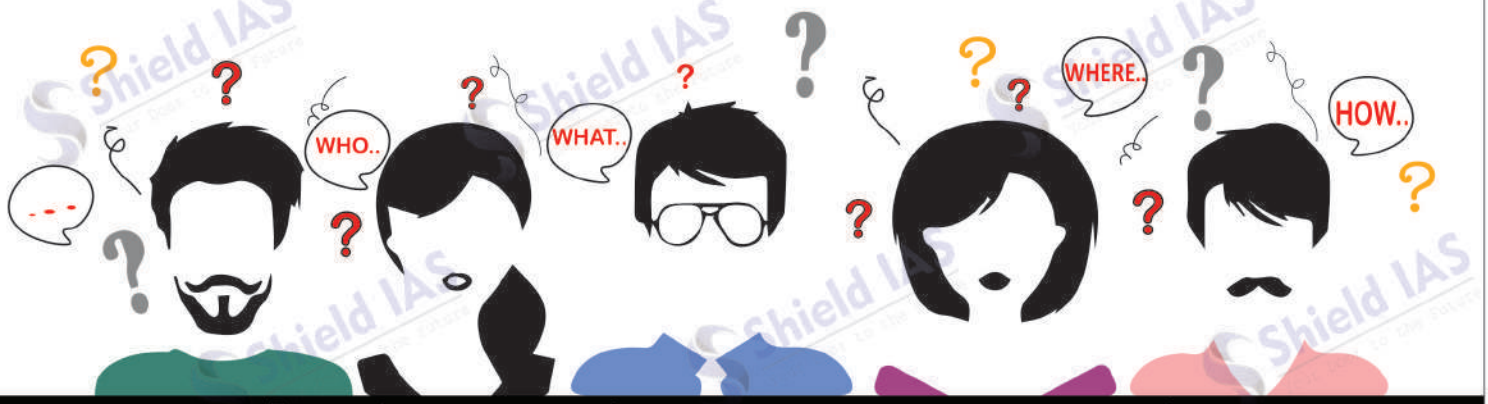

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NOTE FOR STUDENTS

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With respect to the scheduled **Civil Services (Preliminary) Examination, 2023**, which is to be conducted on **28th May, 2023**, the time is ripe for **targeted revision**.

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RAPID REVISION BOOK-5
GEOGRAPHY AND ENVIRONMENT

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Note: Additional booklet **number 9** on important topics of current affairs will be released in **April, 2023.**

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I suggest UPSC civil services aspirants to refer to the standardised, precise and aptly curated SHIELD IAS Rapid Revision Books for targeted preparation of UPSC CSE Preliminary examination.

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AMOL SRIVASTAVA
AIR-83 UPSC CSE 2017

I would recommend the study material provided by Shield IAS for the UPSC Civil Services preparation to cover the General Studies syllabus. The Rapid Revision Books would help the aspirants for speedy revision for the Civil Services (Preliminary) examination. The books have been prepared by my mentors who helped me in clearing my Civil Services Exam in 2015-16.

HARSH KUMAR
IFS – 2016

I, Nidhin K Biju, IRS of 2020 batch, want to suggest the aspirants preparing for UPSC civil services Examination to read SHIELD IAS Rapid Revision books for swift coverage of syllabus for the UPSC Civil Services (Preliminary) exams. These books will help in targeted revision for confident attempt in the examination. I would also recommend reading the SHIELD IAS UPSC study material as a set of standard books for covering the entire General Studies syllabus (Prelims and Main Examination).

- Nidhin

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GEOGRAPHY AND ENVIRONMENT

GEOGRAPHY AND ENVIRONMENT

(SPECIAL EDITION FOR PRELIMS 2023)

GEOGRAPHICAL FEATURES

➡ INDIA: BASIC FACTS

- India has a unique culture and is one of the oldest and greatest civilizations of the world.
- It stretches from the snow-capped Himalayas in the north to sun drenched coastal villages of the south and the humid tropical forests on the south-west coast, from the fertile Brahmaputra valley on its east to the Thar desert in the west.
- It covers an area of 32,87,263 sq.km.
- India is the seventh largest country in the world and ranks second in population.
- The country stands apart from the rest of Asia, marked off as it is by mountains and the sea, which give her a distinct geographical entity.
- Bounded by the Great Himalayas in the north, it stretches southwards and at the Tropic of Cancer tapers off into the Indian Ocean between the Bay of Bengal on the east and the Arabian Sea on the west. Lying entirely in the northern hemisphere, the mainland extends between latitudes 8°4' and 37°6' north, longitudes 68°7' and 97°25' east and measures about 3,214 km from north to south between the extreme latitudes and about 2,933 km from east to west between the extreme longitudes.

Physical features

- The mainland comprises four regions, namely, **the great mountain zone, plains of the Ganga and the Indus, the desert region and the southern peninsula.**
- The Himalayas comprise three almost parallel ranges interspersed with large plateaus and valleys, some of which, like the Kashmir and Kullu valleys, are fertile, extensive and of great scenic beauty. Some of the highest peaks in the world are found in these ranges.
- The high altitudes allow travel only through a few passes, notably the Jelep La and Nathu La on the main Indo-Tibet trade route through the Chumbi valley, north-east of Darjeeling and Shipki La in the Satluj valley, north-east of Kalpa (Kinnaur).
- The plains of the Ganga and the Indus are formed by basins of three distinct river systems—the Indus, the Ganga and the Brahmaputra. They are one of the world's greatest stretches of flat alluvium and also one of the most densely populated areas on the earth. The desert region can be divided into two parts—the 'great desert' and the 'little desert'. The great desert extends from the edge of the Rann of Kutch beyond the Luni river northward. The whole of the Rajasthan-Sind frontier runs through this. The little desert extends from the Luni between Jaisalmer and Jodhpur up to the northern west.
- The Peninsular Plateau is marked off from the plains of the Ganga and the Indus by a mass of mountain and hill. Prominent among these are the Aravali, Vindhya, Satpura, Maikala and Ajanta. The Peninsula is flanked on the one side by the Eastern Ghats and on the other by the Western. Between the Western Ghats and the Arabian Sea lies a narrow coastal strip, while between Eastern Ghats and the Bay of Bengal, there is a broader coastal area. The southern point of the plateau is formed by the Nilgiri Hills where the Eastern and the Western Ghats meet. The Cardamom Hills lying beyond may be regarded as a continuation of the Western Ghats.

Geological structure

- The geological regions broadly follow the physical features and may be grouped into three regions: **the Himalayas and their associated group of mountains, the Indo-Gangetic Plain and the Peninsular Shield.** The Himalayan mountain belt to the north and the Naga-Lushai Mountain in the east, are the regions of mountain-building movement.

- The weathering and erosive elements worked on these to produce the relief seen today. The Indo-Ganga plains are a great alluvial tract that separates the Himalayas in the north from the Peninsula in the south.
- The Peninsula is a **region of relative stability** and **occasional seismic disturbances**. Highly metamorphosed rocks of the earliest periods occur in this area; the rest being covered by the Gondwana formations, lava flows belonging to the Deccan Trap formation and younger sediments.

River systems

- The river systems of India can be classified into four groups viz., **(i) Himalayan rivers, (ii) Deccan rivers, (iii) Coastal rivers and (iv) Rivers of the inland drainage basin.** The Himalayan rivers are formed by melting snow and glaciers and therefore, continuously flow throughout the year. During the monsoon months, Himalayas receive very heavy rainfall and rivers swell, causing frequent floods.
- The Deccan rivers on the other hand are rainfed and therefore fluctuate in volume. Many of these are non-perennial. The Coastal streams, especially on the west coast are short in length and have limited catchment areas. Most of them are non-perennial. The streams of inland drainage basin of western Rajasthan are few and far apart. Most of them are of an ephemeral character. The main Himalayan river systems are those of the Indus and the Ganga-Brahmaputra-Meghna system.
- The Indus, which is one of the great rivers of the world, rises near Mansarovar in Tibet and flows through India and thereafter through Pakistan and finally falls into the Arabian sea near Karachi. Its important tributaries flowing in Indian territory are the Sutlej (originating in Tibet), the Beas, the Ravi, the Chenab and the Jhelum.
- The **Ganga-Brahmaputra-Meghna** is another important system of which the principal sub-basins are those of Bhagirathi and the Alaknanda, which join at Dev Prayag to form the Ganga. It traverses through Uttarakhand, Uttar Pradesh, Bihar and West Bengal. Below Rajmahal Hills, the Bhagirathi, which used to be the main course in the past, takes off, while the Padma continues eastward and enters Bangladesh.
- The Yamuna, the Ramganga, the Ghaghra, the Gandak, the Kosi, the Mahananda and the Sone are the important tributaries of the Ganga. Rivers Chambal and Betwa are the important sub-tributaries, which join the Yamuna before it meets the Ganga. The Padma and the Brahmaputra join at Bangladesh and continue to flow as the Padma or Ganga.
- The Brahmaputra rises in Tibet, where it is known as Tsangpo and runs a long distance till it crosses over into India in Arunachal Pradesh under the name of Dihang. Near Passighat, the Debang and Lohit join the river Brahmaputra and the combined river runs all along the Assam valley. It crosses into Bangladesh downstream of Dhubri. The principal tributaries of Brahmaputra in India are the Subansiri, Jia Bhareli, Dhansiri, Puthimari, Pagladiya and the Manas. The Brahmaputra in Bangladesh fed by Teesta, etc. finally falls into the Ganga.
- The Barak river, the head stream of Meghna, rises in the hills in Manipur. The important tributaries of the river are Makku, Trang, Tuivai, Jiri, Sonai, Rukni, Katakhal, Dhaleswari, Langachini, Maduva and Jatinga. Barak continues in Bangladesh till the combined Ganga-Brahmaputra joins it near Bhairab Bazar.
- In the Deccan region, most of the major river systems flowing generally in the east fall into Bay of Bengal. The major east flowing rivers are Godavari, Krishna, Cauvery and Mahanadi. Narmada and Tapti are major west flowing rivers. The Godavari in the southern Peninsula has the second largest river basin covering 10 per cent of the area of India. Next to it is the

Krishna basin in the region and the Mahanadi is another large basin of the region. The basin of the Narmada in the uplands of the Deccan, flowing to the Arabian Sea and of the Cauvery in the south, falling into the Bay of Bengal are about the same size, though with different character and shape. A few rivers in Rajasthan do not drain into the sea. They drain into salt lakes and get lost in sand with no outlet to sea. Besides these, there are the desert rivers which flow for some distance and are lost in the desert. These are Luni, Machhu, Rupen, Saraswati, Banas, Ghaggar and others.

Climate/seasons

- India's climate is affected by two seasonal winds—**the north-east monsoon and the south-west monsoon.**
- The north-east monsoon commonly known as winter monsoon blows from land to sea whereas south-west monsoon known as summer monsoon blows from sea to land after crossing the Indian ocean, the Arabian sea and the Bay of Bengal.
- The south-west monsoon brings most of the rainfall during the year in the country.

Flora

- India is rich in flora. Available data place India in the tenth position in the world and fourth in Asia in plant diversity. With a wide range of climatic conditions from the torrid to the arctic, India has rich and varied vegetation, which only a few countries of comparable size possess. India can be divided into eight distinct floristic regions, namely, the western Himalayas, the eastern Himalayas, Assam, the Indus plain, the Ganga plain, the Deccan, the Malabar and the Andamans.
- The **western Himalayan region extends from Kashmir to Kumaon**. Its temperate zone is rich in forests of chir, pine, other conifers and broadleaved temperate trees. Higher up, forests of deodar, blue pine, spruce and silver fir occur.
- The characteristic trees of this zone are high-level silver fir, silver birch and junipers. The eastern Himalayan region extends from Sikkim eastwards and embraces Darjeeling, Kurseong and the adjacent tracts. The temperate zone has forests of oaks, laurels, maples, rhododendrons, alder and birch. Many conifers, junipers and dwarf willows also grow here.
- The Indus plain region comprises the plains of Punjab, western Rajasthan and northern Gujarat. It is dry, hot and supports natural vegetation. The Ganga plain region covers the area which is alluvial plain and is under cultivation for wheat, sugarcane and rice. Only small areas support forests of widely differing types.
- The Deccan region comprises the entire table land of the Indian Peninsula and supports vegetation of various kinds from shrub jungles to mixed deciduous forests. The Malabar region covers the excessively humid belt of mountain country parallel to the west coast of the Peninsula.

Faunal resources

- India is very rich in terms of biological diversity due to its unique bio-geographical location, diversified climate conditions and enormous eco-diversity and geo-diversity. India's immense biological diversity encompasses ecosystems, populations, species and their genetic make-up. This diversity can be attributed to the vast variety in physiography and climatic situations resulting in a diversity of ecological habitats ranging from tropical, sub-tropical, temperate, alpine to desert.

- According to world bio-geographic classification, India represents two of the major realms (the Palearctic and Indo-Malayan) and three biomes (Tropical Humid Forests, Tropical Dry/Deciduous Forests and Warm Deserts/Semi-Deserts).
- In the light of Biodiversity Convention, India holds a unique position with the priority of conservation of natural resources and sustainable development. In fact, within only about 2 per cent of world's total land surface, India is known to have over 7.50 per cent of the species of animals that the world holds.

➡ ICEBERG

- Icebergs are pieces of ice that formed on land and float in an ocean or lake. Icebergs come in all shapes and sizes, from ice-cube-sized chunks to ice islands the size of a small country.
- The term "**iceberg" refers to chunks of ice larger than 5 meters (16 feet) across**.
- **Smaller icebergs, known as bergy bits and growlers**, can be especially dangerous for ships because they are harder to spot.
- The North Atlantic and the cold waters surrounding Antarctica are home to most of the icebergs on Earth.

How do icebergs form, and where do they go?

- Icebergs form when chunks of ice calve, or break off, from glaciers, ice shelves, or a larger iceberg.
- Icebergs **travel with ocean currents,** sometimes smashing up against the shore or getting caught in shallow waters.
- When an iceberg reaches warm waters, the new climate attacks it from all sides.
- On the iceberg surface, warm air melts snow and ice into pools called **melt ponds** that can trickle through the iceberg and widen cracks. At the same time, warm water laps at the iceberg edges, melting the ice and causing chunks of ice to break off. On the underside, warmer waters melt the iceberg from the bottom up.

Why are icebergs important?

- Icebergs pose a danger to ships traversing the North Atlantic and the waters around Antarctica. After the Titanic sank near Newfoundland in 1912, the United States and twelve other countries formed the **International Ice Patrol** to warn ships of icebergs in the North Atlantic.
- The International Ice Patrol uses airplanes and radars to track icebergs that float into major shipping lanes. The **U.S. National Ice Center** uses satellite data to monitor icebergs near Antarctica. However, it only tracks icebergs larger than 500 square meters (5,400 square feet).
- Icebergs can also serve as tools for scientists, who study them to learn more about climate and ocean processes.

Why do scientists study icebergs?

- Climate scientists study icebergs as they break up for clues to the processes that cause ice shelf collapse. Scientists have noticed that the way icebergs break up when they reach warmer waters mirrors the disintegration of Antarctic ice shelves. By studying the factors that cause icebergs to break up, researchers hope to better understand the influences that lead to ice shelf breakup, and to better predict how ice shelves will respond to a warming climate.
- Oceanographers follow icebergs because the cold freshwater they contribute to the sea can influence currents and ocean circulation far away from their origins.
- Biologists study icebergs to find out how they influence ocean life. As icebergs melt, they leak nutrients into the ocean around them. Recent studies have shown that the water surrounding icebergs teems with plankton, fish, and other sea life.

➡ ARCTIC REGION

- The Arctic region, or the Arctic, is a geographic region spreading around the North Pole. There is no single correct definition of the region as the southern boundary varies.

Key ways to define the Arctic:

- The **Arctic Circle (66 ° 33'N) delimits the Arctic in terms of solar radiation**.
- In theory, areas north of the Arctic Circle have at least one day without daylight in the winter and at least one nightless night in the summer. In practice, this does not happen everywhere because the surface of the earth is uneven, and the light refracts in the atmosphere.
- Based on temperature, the **monthly average temperature in the Arctic is below + 10 ° C throughout the year**, even in summer.
- The forest line follows a **temperature-defined area**. The forest line is not a narrow line but a zone tens of kilometres wide between the northern coniferous forest and the tundra. In this demarcation, the Arctic is predominantly wooded tundra and glaciers.
- **Permafrost increases the area of Russian Arctic** compared to the other delimitations. Permafrost is soil that stays frozen for at least two consecutive years.
- The ice cover determines the Arctic nature of marine areas.
- **Sea ice is highest in February-March** and **lowest in September**. The surface of the Arctic ice is monitored almost in real time by satellites.
- **Culturally defined**, the Arctic covers the **homelands of northern indigenous peoples**.

- **Political delimitations** vary according to how they serve, for example, the interests of states or international cooperation.
- As the climate warms, the Arctic shrinks if defined by temperature, forest line, permafrost, or ice cover. Cultural and political boundaries also vary. The Arctic Circle is the most permanent of the delimitations, although also the polar circle moves very slowly due to the variation of the Earth's axial tilt.

Interesting facts and figures about the Arctic

1. The Arctic is regarded as containing some of the last physically undisturbed marine spaces on earth.
2. Shipping (unique ships) within the Arctic Polar Code area has increased by 25% over 6 years from 2013-2019. A majority of these vessels are fishing vessels.
3. The central feature of the Arctic is the Arctic Ocean. The **Arctic Ocean has the widest continental shelf of all the oceans.**
4. The Arctic sea ice has **diminished from 6,1 million sq.km. in 1999 to 4,3 million sq.km. in 2019.**
5. Boreal forests of the Arctic cover about 17% of the global land area, representing the largest natural forests in the world.
6. Together with the Antarctic, the Arctic contains the largest freshwater resource on Earth.
7. **Seven of the world's ten largest wilderness** areas are located in the Arctic region.
8. The total catch of wild fish in the Arctic mounted to 10% of the world catch .
9. The Arctic as an area is essentially an ocean surrounded by the land north of the Arctic circle (66032' N) that covers a region of 33 million Km2 , larger than Africa or Asia.
10. The United States Geological Survey (USGS) estimates that 30 per cent of the world's undiscovered natural gas is in the Arctic, mostly on the continental shelves beneath the Arctic Ocean.
11. More than 70 per cent of the undiscovered oil resources are estimated to occur in northern Alaska, the Amerasian Basin, the eastern side of Greenland, the eastern Barents Sea region, and the Davis Strait of Greenland and Canada.
12. An estimated 84 per cent of the undiscovered oil and gas in the Arctic occurs offshore.
13. The Arctic region is characterized by some of the largest continuous intact ecosystems on the planet, but is facing increasingly larger threat.

➡ GLACIERS

- Ice acts like a protective cover over the Earth and our oceans. These bright white spots **reflect excess heat back into space and keep the planet cooler**. In theory, the Arctic remains colder than the equator because more of the heat from the sun is reflected off the ice, back into space.
- Glaciers around the world can range from ice that is several hundred to several thousand years old and provide a scientific record of how climate has changed over time.
- Through their study, we gain valuable information about the extent to which the planet is rapidly warming. They provide scientists a record of how climate has changed over time.
- Today, about **10% of land area on Earth is covered with glacial ice**. Almost **90% is in Antarctica, while the remaining 10% is in the Greenland ice cap.**
- **Rapid glacial melt in Antarctica and Greenland also influences ocean currents**, as massive amounts of very cold glacial-melt water entering warmer ocean waters is slowing ocean currents. And as ice on land melts, sea levels will continue to rise.

Difference between sea ice and glaciers

- Sea ice forms and melts strictly in the ocean whereas glaciers are formed on land. Icebergs are chunks of glacial ice that break off glaciers and fall into the ocean.
- When glaciers melt, because that water is stored on land, the runoff **significantly increases the amount of water** in the ocean, contributing to global sea level rise.
- Sea ice, on the other hand, is often compared to **ice cubes in a glass of water: when it melts, it does not directly change the level of water** in the glass. Instead, depleting Arctic sea ice triggers a host of other devastating consequences—from depleting available ice on which walrus can haul out or polar bears hunt to changing weather systems around the world by altering the pattern of the Jet stream.

Why are glaciers melting?

- Since the early 1900s, many glaciers around the world have been rapidly melting. Human activities are at the root of this phenomenon. Specifically, since the industrial revolution, carbon dioxide and other greenhouse gas emissions have raised temperatures, even higher in the poles, and as a result, glaciers are rapidly melting, calving off into the sea and retreating on land.
- Even if we significantly curb emissions in the coming decades, more than a third of the world's remaining glaciers will melt before the year 2100. When it comes to sea ice, 95% of the oldest and thickest ice in the Arctic is already gone.
- Scientists project that if emissions continue to rise unchecked, the Arctic could be ice free in the summer as soon as the year 2040 as ocean and air temperatures continue to rise rapidly.

Glacier in Antarctica	Sea ice in Finland
	

Effects of melting glaciers on sea level rise

- Melting glaciers add to **rising sea levels**, which in turn **increases coastal erosion and elevates storm surge** as warming air and ocean temperatures create more frequent and intense coastal storms like hurricanes and typhoons. Specifically, the Greenland and Antarctic ice sheets are the largest contributors of global sea level rise. Right now, the Greenland ice sheet is disappearing four times faster than in 2003 and already contributes 20% of current sea level rise.
- How much and how quickly these Greenland and Antarctic ice sheets melt in the future will largely determine how much ocean levels rise in the future. If emissions continue to rise, the current rate of melting on the Greenland ice sheet is expected to double by the end of the century. Alarmingly, if all the ice on Greenland melted, it would raise global sea levels by 20 feet.

How do melting sea ice and glaciers affect weather patterns?

- Today, the **Arctic is warming twice as fast as anywhere on earth**, and the sea ice there is declining by more than 10% every 10 years. As this ice melts, darker patches of ocean start to emerge, eliminating the effect that previously cooled the poles, creating warmer air temperatures and in turn disrupting normal patterns of ocean circulation. Research shows the polar vortex is appearing outside of the Arctic more frequently because of changes to the jet stream, caused by a combination of warming air and ocean temperatures in the Arctic and the tropics.
- The glacial melt we are witnessing today in Antarctic and Greenland is **changing the circulation of the Atlantic Ocean and has been linked to collapse of fisheries** in the Gulf of Maine and more destructive storms and hurricanes around the planet.

Effects of melting glaciers and sea ice loss on humans and wildlife

- What happens in these places has consequences across the entire globe. As sea ice and glaciers melt and oceans warm, ocean currents will continue to disrupt weather patterns worldwide.

- Industries that thrive on vibrant fisheries will be affected as warmer waters change where and when fish spawn. Coastal communities will continue to face billion-dollar disaster recovery bills as flooding becomes more frequent and storms become more intense.
- People are not the only ones impacted. In the Arctic, as sea ice melts, wildlife like walrus are losing their home and polar bears are spending more time on land, causing higher rates of conflict between people and bears.

➡ AVALANCHE

- An avalanche is a **mass of snow that slides rapidly down an inclined slope**, such as a mountainside or the roof of a building. Avalanches are **triggered by either natural forces** (e.g. precipitation, wind drifting snow, rapid temperature changes) or **human activity**. In mountainous terrain, they are among the most serious hazards to human life and property. Avalanches are sometimes called **snowslides.**
- An avalanche occurs when **stress from the pull of gravity and/or applied load (such as a skier) exceeds the strength of the snow cover**.
- **Strength is derived from bonds between snow grains**. A slab (a cohesive layer within the snowpack) avalanche can occur when the following three conditions are present: – **A snow-covered slope – A slab of snow resting on top of a weak layer of snow – A triggering mechanism.**
- About 90% of all avalanches begin on slopes of **30-45 degrees**, and about 98% occur on slopes of 25-50 degrees. Avalanches strike most often on slopes above timberline that face away from prevailing winds (leeward slopes tend to collect snow blowing from the windward sides of ridges). However, it is possible for avalanches to run on small slopes well below timberline, such as in gullies, road cuts, and small openings in the trees.
- Very dense trees can help anchor the snow to steep slopes and prevent avalanches from starting; however, avalanches can release and travel through a moderately dense forest.
-

Loose Snow Avalanche: They are common on steep slopes and are seen after a fresh snowfall. Since the snow does not have time to settle down fully or has been made loose by sunlight, the snow-pack is not very solid. Such avalanches have a single point of origin, from where they widen as they travel down the slope.	

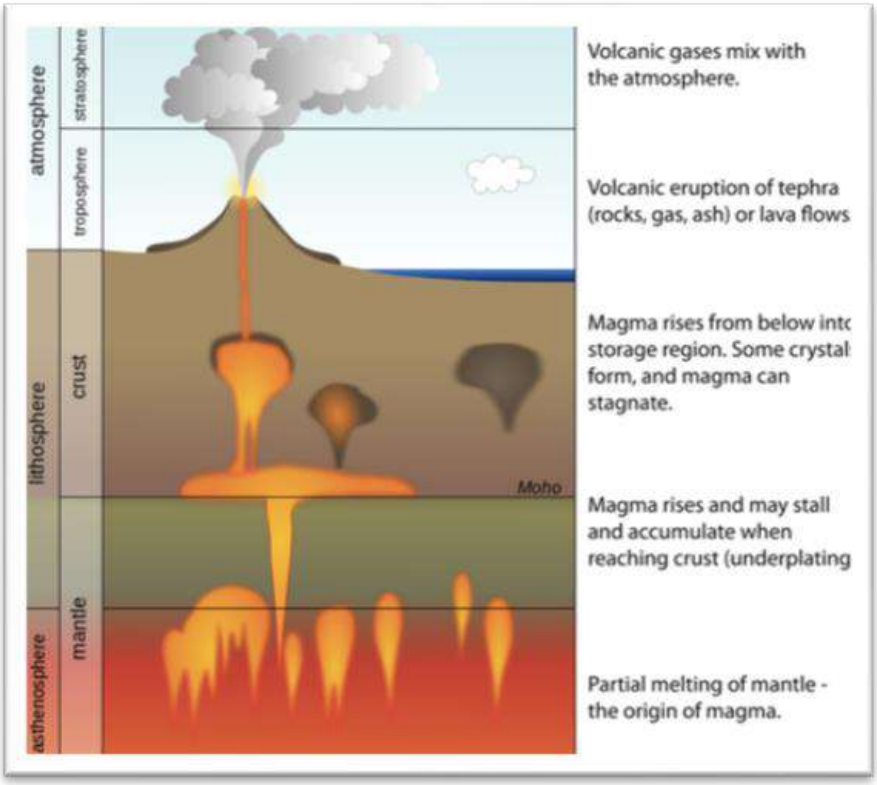
Slab Avalanche: Loose Snow Avalanches in turn could cause a Slab Avalanche, which are characterized by a the fall of a large block of ice down the slopes. Thin slabs cause fairly small amounts of damage, while the thick ones are responsible for MANY FATALITIES.	
Powder Snow Avalanche: A mix of the other forms, Loose Snow and Slab. The bottom half of this avalanche consists of a slab or a dense concentration of snow, ice and air. Above this is a cloud of powdered snow, which can snowball into a larger avalanche as it progresses down the slope. The speed attained by this avalanche can cross 190 miles per hour and they can cross large distances.	
Wet Snow Avalanche: These are quite dangerous as they travel slowly due to friction, which collects debris from the path fairly easily. The avalanche comprises of water and snow at the beginning, but understanding of avalanches has showed us that it can pick up speed with ease.	

➡ VOLCANO

- Volcanoes are **openings, or vents** where lava, tephra (small rocks), and steam erupt on to the Earth's surface. Many mountains form by folding, faulting, uplift, and erosion of the Earth's crust.
- **Volcanic terrain, however, is built by the slow accumulation of erupted lava**.
- The vent may be visible as a small bowl shaped depression at the summit of a cone or shield-shaped mountain. Through a series of cracks within and beneath the volcano, the vent connects to one or more linked storage areas of molten or partially molten rock (magma). This connection to fresh magma allows the volcano to erupt over and over again in the same location. In this way, the volcano grows ever larger, until it is no longer stable. Pieces of the volcano collapse as rock falls or as landslides.

How do volcanoes erupt?

- Molten rock below the surface of the Earth that rises in volcanic vents is known as **magma,** but after it erupts from a volcano it is called **lava.**
- Magma is made of molten rock, crystals, and dissolved gas. The molten rock is made of the chemicals oxygen, silicon, aluminum, iron, magnesium, calcium, sodium, potassium, titanium, and manganese. After cooling, liquid magma may form crystals of various minerals until it becomes completely solid and forms an igneous or magmatic rock.



- Originating many tens of miles beneath the ground, magma is lighter than surrounding solid rock. It is driven towards Earth's surface by buoyancy, it is lighter than the surrounding rock, and by pressure from gas within it. Magma forces its way upward and may ultimately break though weak areas in the Earth's crust. If so, an eruption begins.
- Magma can be erupted in a variety of ways. Sometimes molten rock simply pours from the vent as fluid lava flows. It can also **shoot violently** into the air as dense clouds of rock shards (tephra) and gas. Larger fragments fall back around the vent, and clouds of tephra may move down the slope of the volcano under the force of gravity. Ash, tiny pieces of tephra the thickness of a strand of hair, may be carried by the wind only to fall to the ground many miles away. The smallest ash particles may be erupted miles into the sky and carried many times around the world by winds high in the atmosphere before they fall to the ground.

What are the main types of volcanoes?

- **Cinder cones** are the simplest type of volcano. They are made of **small pieces of solid lava, called cinder**, that are erupted from a vent.
- The ground shakes as magma rises from within the Earth. Then, a powerful blast throws molten rocks, ash, and gas into the air. The rocks cool quickly in the air and fall to the earth to break into small pieces of bubbly cinder that pile up around the vent.
- They accumulate as a small cinder cone that can be as high as a thousand feet above the surrounding ground. If the wind is blowing during the eruption, cinder is carried downwind before its deposited into an oval shape. Eruptions that form cinder cones also feed lava flows

that spread outward from the eruptive vent. When you climb a cinder cone you can usually find the bowl-shaped crater marking the location of the vent.

- If eruptions of cinder and lava flows happen repeatedly from the same vent, the overlapping layers can form a **composite volcano (stratovolcano).**
- Thousands of cinder cones exist in western North America and in other volcanic areas of the world.

Composite Volcano (Stratovolcano)

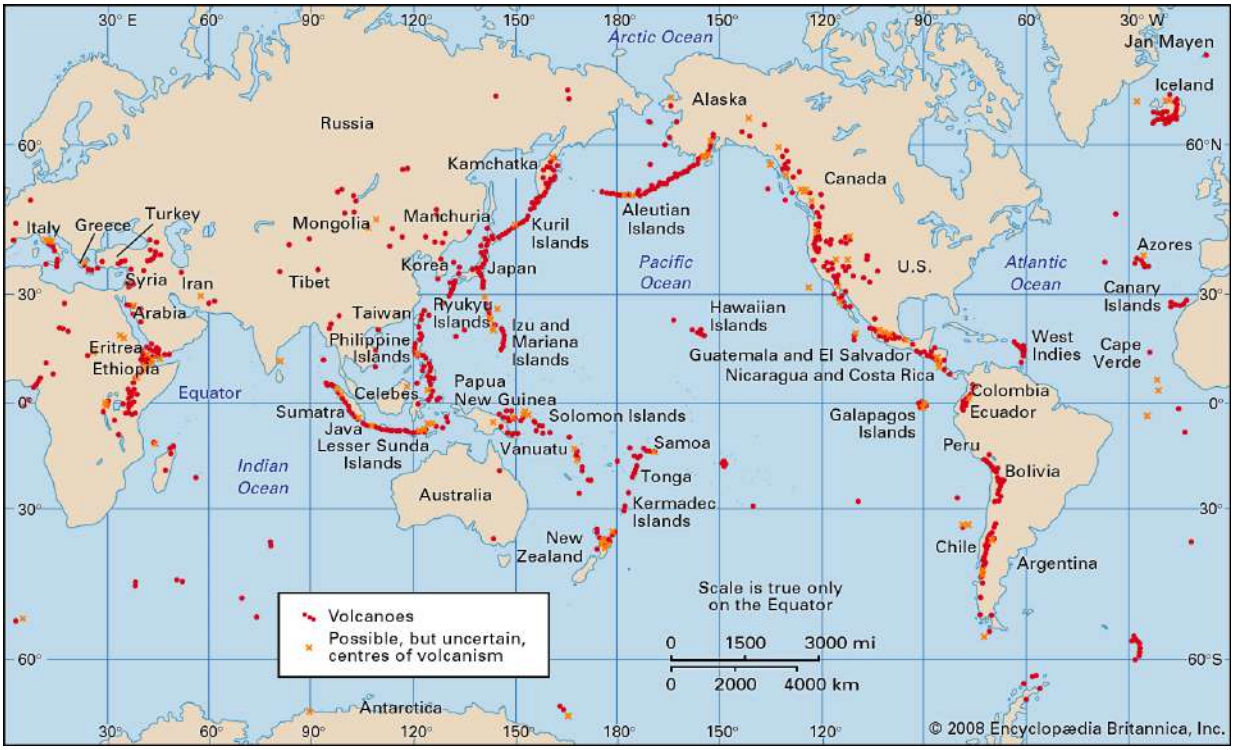
- Some of the Earth's grandest mountains are composite volcanoes—sometimes called **stratovolcanoes**.
- They are usually tall with steep even sides and are made out of repeating layers of lava flows, volcanic ash, cinders, blocks, and volcanic bombs. Some composite volcanoes rise over 8,000 feet above their surroundings, but they reach much higher elevations when compared to the level of the sea (called above sea level).
- **Ojos del Salado** in Chile is the tallest composite volcano on Earth with a summit elevation (height above sea level) of 22,615 feet; the tallest in the U.S. is **Mount Rainier** in Washington State with a summit elevation of 14,410 feet. Some of the most famous and beautiful mountains in the world are composite volcanoes, including Mount Fuji in Japan, Mount Cotopaxi in Ecuador, Mount Shasta in California, Mount Hood in Oregon, and Mount St. Helens in Washington.
- **Stratovolcanoes can erupt with great violence**. Stratovolcanoes are considered the most violent.

Other volcanic landforms

- Besides well-known symmetrical volcanoes such as Mount Fuji in Japan and Kilimanjaro in Tanzania, volcanic activity is responsible for several other distinctive landforms.
- **Calderas:** A caldera is a bowl-shaped depression formed when a **volcano collapses into the void** left when its magma chamber is emptied. There are three types:
  - The first type is a **crater lake caldera**. This is the result of a stratovolcano collapsing into its magma chamber during a violent eruption.
  - **Basaltic calderas** have a concentric ring pattern resulting from a series of gradual collapses rather than a single event. They are often found at the summit of shield volcanoes such as the craters at the tops of Mauna Loa and Kilauea.
  - **Resurgent calderas** are the **largest volcanic structures** on Earth. They are the result of catastrophic eruptions that dwarf any eruptions ever recorded. Yellowstone caldera, sometimes called a "super volcano," is one example.
- **Volcanic plugs:** When magma solidifies in the fissure of a volcano the hard dense rock may form a "neck" that remains when softer surrounding rock has been eroded away.
- **Tuff cones:** also known as **maars,** tuff cones are shallow, flat-floored craters that scientists think formed as a result of a violent expansion of magmatic gas or steam. Maars occur geologically young volcanic regions of the world such as the western United States and the Eifel region of Germany.
- **Lava plateaus:** Shield volcanoes may erupt along lines of fissures rather than a central vent spilling liquid lava in successive layers. Over time, these layers form broad plateaus such as

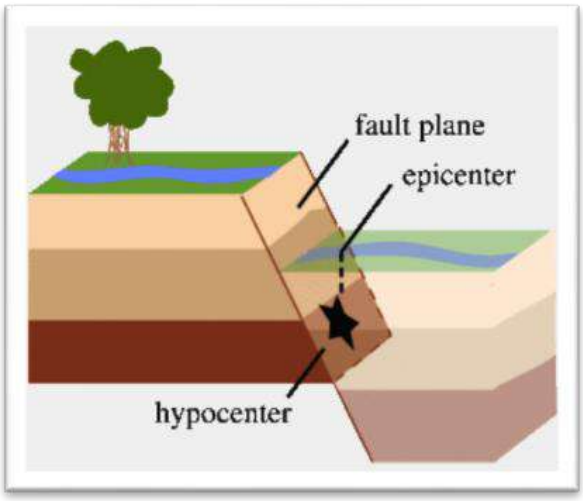
the Columbia Plateau. These plateaus are often cut by deep canyons that expose the layers of rock.

➡ VOLCANO DISTRIBUTION MAP



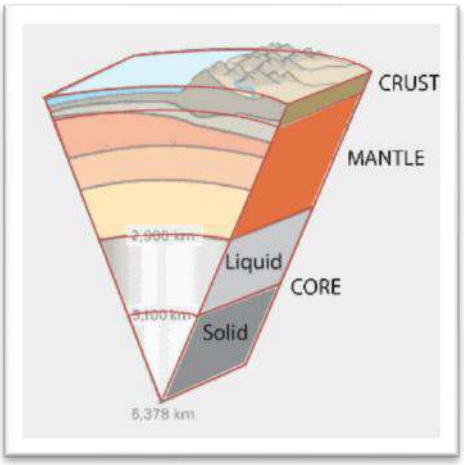
➡ EARTHQUAKE

- An earthquake happens when **two blocks of the earth suddenly slip past one another.**
- The surface where they slip is called the **fault or fault plane.**
- The location below the earth's surface where the earthquake **starts is called the hypocenter**, and the location directly above it on the surface of the earth is called the **epicenter.**
- Sometimes an earthquake has **foreshocks.** These are smaller earthquakes that happen in the same place as the larger earthquake that follows. Scientists can't tell that an earthquake is a foreshock until the larger earthquake happens. The largest, main earthquake is called the **mainshock**.



- Mainshocks always have **aftershocks** that follow. These are smaller earthquakes that occur afterwards in the same place as the mainshock. Depending on the size of the mainshock, aftershocks can continue for weeks, months, and even years after the mainshock.

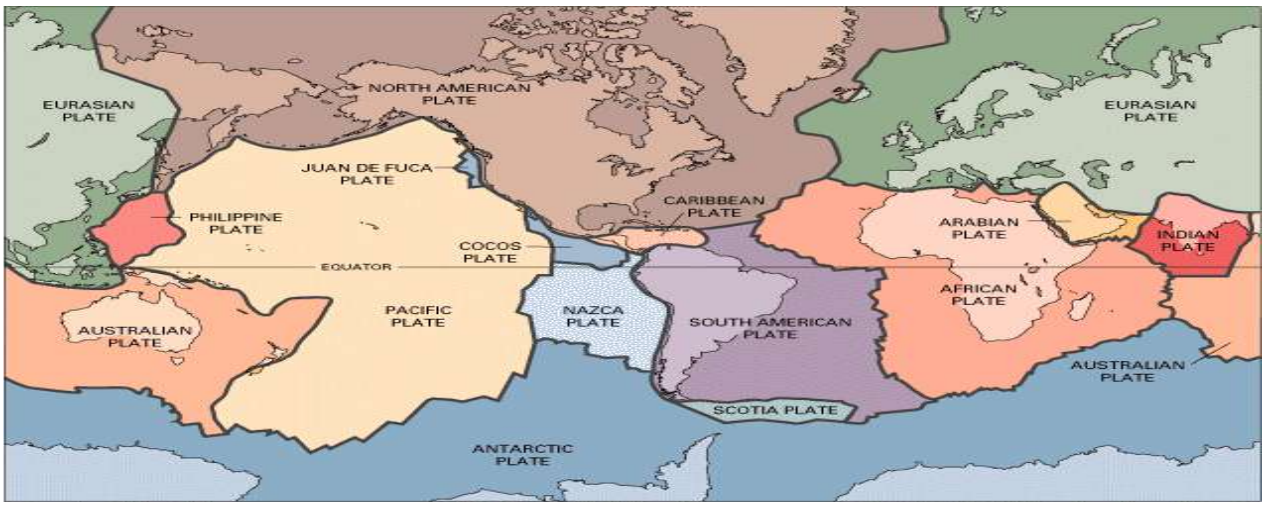
What causes earthquakes and where do they happen?



- The earth has **four major layers: the inner core, outer core, mantle and crust.** The crust and the top of the mantle make up a thin skin on the surface of our planet.
- But this skin is not all in one piece – it is made up of many pieces like a puzzle covering the surface of the earth. Not only that, but these puzzle pieces keep slowly moving around, sliding past one another and bumping into each other.
- These pieces are called **tectonic plates**, and the edges of the plates are called the **plate boundaries**.
- The plate boundaries are made up of many **faults,** and most of the earthquakes around the world occur on these faults.
- Since the edges of the plates are rough, they get stuck while the rest of the plate keeps moving. Finally, when the plate has moved far enough, the edges unstick on one of the faults and there is an earthquake.

Why does the earth shake when there is an earthquake?

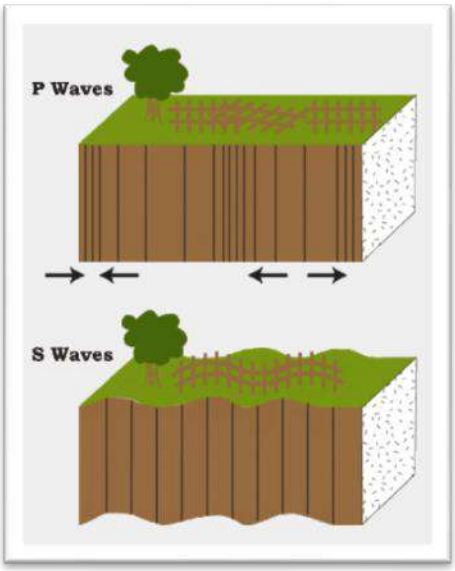
- While the edges of faults are stuck together, and the rest of the block is moving, the energy that would normally cause the blocks to slide past one another is being stored up. When the force of the moving blocks finally overcomes the friction of the jagged edges of the fault and it unsticks, all that stored up energy is released.
- The **energy radiates outward from the fault in all directions in the form of seismic waves** like ripples on a pond. The seismic waves shake the earth as they move through it, and when the waves reach the earth's surface, they shake the ground and anything on it, like our houses and us!



How are earthquakes recorded?

- Earthquakes are recorded by instruments called seismographs.
- The recording they make is called a **seismogram.** The seismograph has a base that sets firmly in the ground, and a heavy weight that hangs free. When an earthquake causes the ground to shake, the base of the seismograph shakes too, but the hanging weight does not. Instead the spring or string that it is hanging from absorbs all the movement.
- The **difference in position** between the shaking part of the seismograph and the motionless part is what is recorded.

How can scientists tell where the earthquake happened?



- Seismograms come in handy for locating earthquakes too, and being able to see the **P wave and the S wave** is important.
- P waves are also faster than S waves, and this fact is what allows us to tell where an earthquake was. To understand how this works, let's compare P and S waves to lightning and thunder. Light travels faster than sound, so during a thunderstorm you will first see the lightning and then you will hear the thunder. If you are close to the lightning, the thunder will boom right after the lightning, but if you are far away from the lightning, you can count several seconds before you hear the thunder. The further you are from the storm, the longer it will take between the lightning and the thunder.
- **P waves are like the lightning, and S waves are like the thunder**. The P waves travel faster and shake the ground where you are first. Then the S waves follow and shake the ground also. If you are close to the earthquake, the P and S wave will come one right after the other, but if you are far away, there will be more time between the two.
- **P Waves alternately compress and stretch the crustal material parallel to the direction they are propagating**.
- **S Waves cause the crustal material to move back and forth perpendicular to the direction they are travelling.**
- By looking at the amount of time between the P and S wave on a seismogram recorded on a seismograph, scientists can tell how far away the earthquake was from that location. However, they can't tell in what direction from the seismograph the earthquake was, only how far away it was. If they draw a circle on a map around the station where the radius of the circle is the determined distance to the earthquake, they know the earthquake lies somewhere on the circle.

But where?

- Scientists then use a method called **triangulation** to determine exactly where the earthquake was.

- It is called triangulation because a triangle has three sides, and it takes **three seismographs to locate an earthquake.** If you draw a circle on a map around three different seismographs where the radius of each is the distance from that station to the earthquake, the intersection of those three circles is the epicenter.

➡ CYCLONES

About Tropical Cyclone

- Tropical cyclones are one of the biggest threats to life and property even in the formative stages of their development.
- They include a **number of different hazards** that can individually cause significant impacts on life and property, such as **storm surge, flooding, extreme winds, tornadoes and lighting**. Combined, these hazards interact with one another and substantially increase the potential for loss of life and material damage.

Characteristics of tropical cyclones

- A tropical cyclone is a **rapid rotating storm originating over tropical oceans** from where it draws the energy to develop.
- It has a **low pressure centre and clouds spiraling towards the eyewall surrounding the "eye",** the central part of the system where the weather is normally calm and free of clouds. Its diameter is typically around 200 to 500 km, but can reach 1000 km.
- A tropical cyclone brings **very violent winds, torrential rain, high waves** and, in some cases, very destructive storm surges and coastal flooding.
- The winds blow **counterclockwise in the Northern Hemisphere** and **clockwise in the Southern Hemisphere**. Tropical cyclones above a certain strength are given names in the interests of public safety.
- About 85 tropical storms form annually over the warm tropical oceans of the globe. Among these, a little more than half (45) become tropical cyclone/hurricane/typhoon.
- Out of the 85 tropical storms, 72% form in the northern hemisphere, and 28% in the southern hemisphere.

The different terminologies

- In the Caribbean Sea, the Gulf of Mexico, the North Atlantic Ocean and the eastern and central North Pacific Ocean, it is called "hurricane"
- In the western North Pacific, it is called "typhoon"
- In the Bay of Bengal and Arabian Sea, it is called "cyclone"
- In western South Pacific and southeast Indian Ocean, it is called “severe tropical cyclone”
- In the southwest Indian Ocean, it is called “tropical cyclone”

Classification of tropical cyclones

- **Tropical depression** is when the maximum sustained wind speed is less than 63 km/h.
- **Tropical storm** is when the maximum sustained wind speed is more than 63 km/h. It is then also given a name.

- **Hurricane, typhoon, tropical cyclone**, very severe cyclonic storm - depending on the basin - when the maximum sustained wind speed **exceeds 116 km/h or 63 knots**.

Naming of cyclones

The **WMO/ Economic and Social Commission for Asia and the Pacific (ESCAP) Panel** on Tropical Cyclones at its twenty-seventh Session held in 2000 in Muscat, agreed in principal to assign names to the tropical cyclones in the Bay of Bengal and Arabian Sea. The naming of the tropical cyclones over north Indian Ocean commenced from September 2004, with names provided by eight Members. Since then, five countries have joined the Panel.

- The Panel Member's names are **listed alphabetically** country wise.
- The names will be **used sequentially column wise**.
- The **first name will start from the first row of column one** and continue sequentially to the last row in the column thirteen.
- The **names of tropical cyclones over the north Indian Ocean will not be repeated**, once used it will cease to be used again. The name should be new. It should not be there in the already existing list of any of the RSMCs worldwide including RSMC New Delhi.
- The name of a tropical cyclone from south China Sea which crosses Thailand and emerge into the Bay of Bengal as a Tropical cyclone will not be changed.

Annexure-I

New list of tropical cyclone names adopted by WMO/ESCAP Panel Member Countries in April 2020 for naming of tropical cyclones over North Indian Ocean including Bay of Bengal and Arabian Sea

(To be used after the name 'Amphan' from the previous list is utilised)

WMO/ESCAP Panel Member countries	Column 1		Column 2		Column 3		Column 4	
	Name	Pron'	Name	Pron'	Name	Pron'	Name	Pron'
Bangladesh	Nisarga	Nisarga	Biparjoy	Biporjoy	Arnab	Ornab	Upakul	Upokul
India	Gati	Gati	Tej	Tej	Murasu	Murasu	Aag	Aag
Iran	Nivar	Nivar	Hamoon	Hamoon	Akvan	Akvan	Sepand	Sepand
Maldives	Burevi	Burevi	Midhili	Midhili	Kaani	Kaani	Odi	Odi
Myanmar	Tauktae	Tau'Te	Michaung	Migjaum	Ngamann	Ngaman	Kyarthit	Kjathi
Oman	Yaas	Yass	Remal	Re-Mal	Sail	Sail	Naseem	Naseem
Pakistan	Gulab	Gul-Aab	Asna	As-Na	Sahab	Sa-Hab	Afshan	Af-Shan
Qatar	Shaheen	Shaheen	Dana	Dana	Lulu	Lulu	Mouj	Mouj
Saudi Arabia	Jawad	Jowad	Fengal	Feinjal	Ghazeer	Razeer	Asif	Aasif
Sri Lanka	Asani	Asani	Shakhti	Shakhti	Gigum	Gigum	Gagana	Gagana
Thailand	Sitrang	Si-Trang	Montha	Mon-Tha	Thianyot	Thian-Yot	Bulan	Bu-Lan
United Arab Emirates	Mandous	Man-Dous	Senyar	Sen-Yaar	Afoor	Aa-Foor	Nahhaam	Nah-Haam
Yemen	Mocha	Mokha	Ditwah	Ditwah	Diksam	Diksam	Sira	Sira

The **RSMC New Delhi Tropical Cyclone Center** is responsible to name the tropical cyclones that have formed over the Bay of Bengal and the Arabian Sea when they have reached the relevant intensity.

➡ TIDAL WAVES

- Tides are the daily rise and fall of sea level at any given place. The **pull of the Moon's gravity on Earth** is the primarily cause of tides and the pull of the Sun's gravity on Earth is the secondary cause.
- The Moon has a greater effect because, although it is much smaller than the Sun, it is much closer. The Moon's pull is about twice that of the Sun's.

Daily Tide Patterns

- To understand the tides it is easiest to start with the effect of the Moon on Earth. As the Moon revolves around our planet, its gravity pulls Earth toward it. The lithosphere is unable to move much but the water above it is pulled by the gravity and a bulge is created. This bulge is the high tide beneath the Moon.
- The Moon's gravity then pulls the Earth toward it, leaving the water on the opposite side of the planet behind. This creates a second high tide bulge on the opposite side of Earth from the Moon. These two water bulges on opposite sides of the Earth aligned with the Moon are the high tides.
- Since so much water is pulled into the **two high tides, low tides form between the two high tides**. As the Earth rotates beneath the Moon, a single spot will experience two high tides and two low tides every day.
- The tidal range is the difference between the ocean level at high tide and the ocean at low tide. The tidal range in a location depends on a number of factors, including the slope of the seafloor. Water appears to move a greater distance on a gentle slope than on a steep slope.

Monthly Tidal Patterns

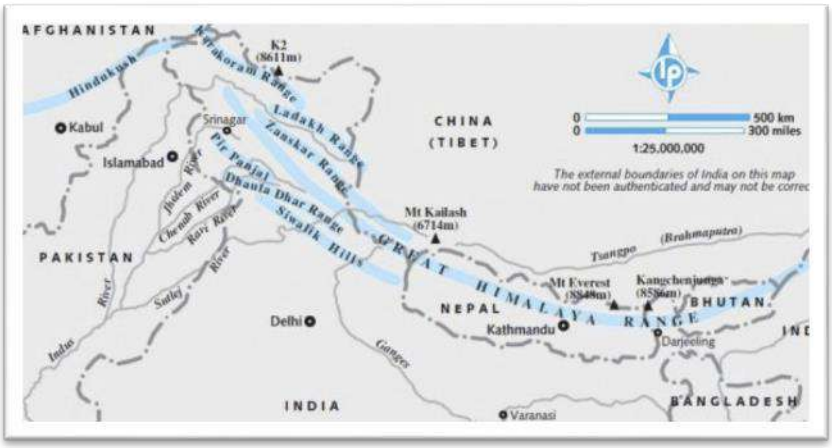
- Waves are additive so when the gravitational pull of the Sun and Moon are in the same direction, the **high tides add and the low tides add.**
- Highs are higher and lows are lower than at other times through the month. These more extreme tides, with a greater tidal range, are called **spring tides**.
- Spring tides don't just occur in the spring; they occur whenever the **Moon is in a new-moon or full-moon phase**, about every 14 days.
- **Neap tides** are tides that have the smallest tidal range, and they occur when the Earth, the Moon, and the Sun form a 90 degree angle. They occur exactly halfway between the spring tides, when the Moon is at first or last quarter.
- **How do the tides add up to create neap tides?** The Moon's high tide occurs in the same place as the Sun's low tide and the Moon's low tide in the same place as the Sun's high tide. At neap tides, **the tidal range relatively small**.
- High tides occur about twice a day, about every 12 hours and 25 minutes. The reason is that the Moon takes 24 hours and 50 minutes to rotate once around the Earth so the Moon is over the same location 24 hours and 50 minutes later. Since high tides occur twice a day, one arrives each 12 hours and 25 minutes.
  Note: Some coastal areas do not follow this pattern at all. These coastal areas may have one high and one low tide per day or a different amount of time between two high tides. These differences are often because of local conditions, such as the shape of the coastline that the tide is entering.

➡ HIMALAYAS

Geography

- The Himalayas stretch across the north-eastern portion of India. They cover approximately 1,500 mi (2,400 km) and pass through the nations of India, Pakistan, Afghanistan, China, Bhutan and Nepal.

- The Himalayan range is made up of three parallel ranges often referred to as the Greater Himalayas, the Lesser Himalayas, and the Outer Himalayas.



Ecology

- While intimidating mountains like Everest and K2 tend to dominate our perceptions of the region, the Himalayas are rich in biodiversity. Climates range from tropical at the base of the mountains to perennial snow and ice at the highest elevations.
- These complex and diverse eco-regions are interconnected: an ecological threat to one is ultimately a threat to many. Here are just a few examples of Himalayan ecology:

Montane Grasslands and Shrublands:

- Western alpine shrubs and meadows can be found between 9,850 and 16,400 ft.
- These areas tend to have cold winters and mild summers that allow for plant growth.
- Rhododendron plants cover the lower shrublands, while the alpine meadows, directly above, host a range of flora in the warmer months.
- Animals found in this region include the snow leopard, Himalayan tahr, musk deer, and pikas.

Temperate Coniferous Forest:

- In the northeast, temperate sub-alpine conifer forests are found at elevations of 8,200 to 13,800 ft.
- Located in the inner valley area, these forests are protected from harsh monsoon conditions by surrounding mountain ranges.
- The dominant tree types are pine, hemlock, spruce, and fir. Animals found in this region include red pandas, takins, and musk deer.

Temperate Broadleaf and Mixed Forests:

- Found in middle elevations of 6,600 to 9,800 ft. in the eastern region are broadleaf and coniferous forests.
- These forests receive almost 80 inches of annual rainfall, mostly during the monsoon season.
- In addition to indigenous oaks and maples, plants like orchids, lichen, and ferns also grow in the area.
- A huge range of wildlife, including over 500 species of birds, are found here during the cooler seasons before they migrate to higher elevations to escape the hot summers. This is also the primary home for golden langur monkeys.

Tropical and Sub-tropical Broadleaf Forests:

- Located at 1,650 to 3,300 ft. along a narrow strip of the outer Himalayan range are the Himalayan sub-tropical broadleaf forests.

- Here there is a wide range of plant life thanks to the areas varied topography, soil types, and rainfall levels.
- Forest types include subtropical dry evergreen, northern dry mixed deciduous forests, moist mixed deciduous forests, subtropical broadleaf forests, northern tropical semi-evergreen forests, and northern tropical wet evergreen forests. Wildlife includes many threatened species including tigers and Asian elephants. More than 340 different species of birds can be found in this region.

Important peaks:

- Mount Everest at 29,029 ft (8,848 m) is not only the highest peak in the Himalayas, but the highest peak on the entire planet.
- Other famous peaks include Karakora (K2), Kailash, Kanchenjunga, Nanga Parbat, Annapurna, and Manasklu.

Rivers:

- The Himalayas are the source for the Indus, the Yangtze and the Ganga-Brahmaputra. All three are major river systems for the continent of Asia.
- The main rivers sourced in Himalayas are the Ganges, Indus, Yarlung, Yangtze, Yellow, Mekong, and Nujiang.

Glaciers:

- The Himalayas are the third largest deposit of ice and snow in the world, after Antarctica and the Arctic. There are approximately 15,000 glaciers located throughout the range.
- At 48 miles (72 km) in length, the Himalayan Siachen glacier is the largest glacier outside the poles.
- Other notable glaciers located in the Himalayas include the Baltoro, Biafo, Nubra, and Hispur.

Additional Facts:

- The Himalayas are the result of **tectonic plate motions** that collided India into Tibet.
- Because of the great amount of tectonic motion still occurring at the site, the Himalayas have a proportionally high number of earthquakes and tremors.

- The Himalayas are **one of the youngest mountain ranges** on the planet.
- The range **affects air and water circulation systems**, impacting the weather conditions in the region.
- The Himalayas cover approximately 75% of Nepal.
- Serving as a natural barrier for tens of thousands of years, the range prevented early interactions between the people of India and the people of China and Mongolia.
- Mt. Everest was named after Colonel Sir George Everest, a British surveyor who was based in India during the early-to-mid-nineteenth century.
- The Nepalese call Mt. Everest "Samgarmatha" which can be translated as "Goddess of the Universe" or "Forehead of the Sky."
- Despite its name, the Snow Leopard – a Himalayan local – is actually most closely related to the Tiger.

➡ ARRAVALIS

Large chunks of forests and the Aravalis in Gurugram and Faridabad could lose protection from construction under the National Conservation Zone, if the provisions in the Draft Regional Plan-2041 are implemented, fear environmentalists, urban planners and analysts.

- According to the **DRP- 2041, the 'Natural Zone' (NZ)** "is a zone comprising any natural features such as mountains, hills, rivers, water bodies created by the action of nature."
- In the previous Plan, this was defined as the **Natural Conservation Zone (NCZ).** In the new draft, the definition of the natural features has been tweaked and restricted to only those that are notified under certain acts and recognised in land records.
- Environmentalists are worried that this new definition would expel large sections of the forest land in Gurugram and Faridabad out of the ambit of protected zonefor not meeting the criteria proposed in DRP.

About Arravalis

- Aravalli Range, also spelled Aravali Range is a hill system of northern India.
- The Aravalli Range is a mountain range in Northern-Western India, running approximately 670 km in a south-west direction, starting near **Delhi, passing through southern Haryana and Rajasthan, and ending in Gujarat.**
- The highest peak is **Guru Shikhar** at 1,722 metres.
- The series of peaks and ridges, with breadths varying from 6 to 60 miles (10 to 100 km), are generally between 1,000 and 3,000 feet (300 and 900 metres) in elevation.
- The system is divided into two sections: The Sambhar-Sirohi ranges, taller and including Guru Peak on Mount Abu, the highest peak in the Aravalli Range (5,650 feet [1,722 metres]); and the Sambhar-Khetri ranges, consisting of three ridges that are discontinuous.

- The Aravalli Range is rich in natural resources (including minerals) and serves as a check to the growth of the western desert.
- It gives rise to several rivers, including the **Banas, Luni, Sakhi, and Sabarmati**. Though heavily forested in the south, it is generally bare and thinly populated, consisting of large areas of sand and stone and of masses of rose-coloured quartzite.

➡ MONSOON

- Indian monsoon is the most prominent of the world's monsoon systems, which primarily affects India and its surrounding water bodies.
- It blows from the **northeast during cooler months and reverses direction to blow from the southwest** during the warmest months of the year. This process brings large amounts of rainfall to the region during June and July.
- At the Equator the area near India is unique in that dominant or frequent westerly winds occur at the surface almost constantly throughout the year; the surface easterlies reach only to latitudes near 20° N in February, and even then they have a very strong northerly component. They soon retreat northward, and drastic changes take place in the upper-air circulation (see climate: Jet streams). This is a time of transition between the end of one monsoon and the beginning of the next.
- Late in March the high-sun season reaches the Equator and moves farther north. With it go atmospheric instability, convectional (that is, rising and turbulent) clouds, and rain. The westerly subtropical jet stream still controls the flow of air across northern India, and the surface winds are northeasterlies.

Monsoon onset and early developments

- As the high-sun season (that is, the Northern Hemisphere summer) moves northward during April, India becomes particularly prone to rapid heating because the highlands to the north protect it from any incursions of cold air. There are three distinct areas of relative upper tropospheric warmth—namely, **(1) above the southern Bay of Bengal, (2) above the Plateau of Tibet, and (3) across the trunks of the various peninsulas** that are relatively dry during this time. These three areas combine to form a vast heat-source region.
- The relatively warm area above the southern Bay of Bengal occurs mostly at the 500–100-millibar level. (This atmospheric pressure region typically occurs at elevations between 5,500 and 16,100 metres [18,000 and 53,000 feet] but may vary according to changes in heating and cooling.) It does not appear at a lower level and is probably caused by the release of condensation heat (associated with the change from water vapour to liquid water) at the top of towering cumulonimbus clouds along the advancing intertropical convergence. In contrast, a heat sink appears over the southern Indian Ocean as the relatively cloud-free air cools by emitting long-wavelength radiation. Monsoon winds at the surface blow from heat sink to heat source. As a result, by May the southwest monsoon is well-established over Sri Lanka, an island off the southeastern tip of the Indian peninsula.
- Also in May, the **dry surface of Tibet** (above 4,000 metres [13,100 feet]) absorbs and radiates heat that is readily transmitted to the air immediately above. At about 6,000 metres (19,700 feet) an anticyclonic cell arises, causing a strong easterly flow in the upper troposphere above northern India. The subtropical jet stream suddenly changes its course to

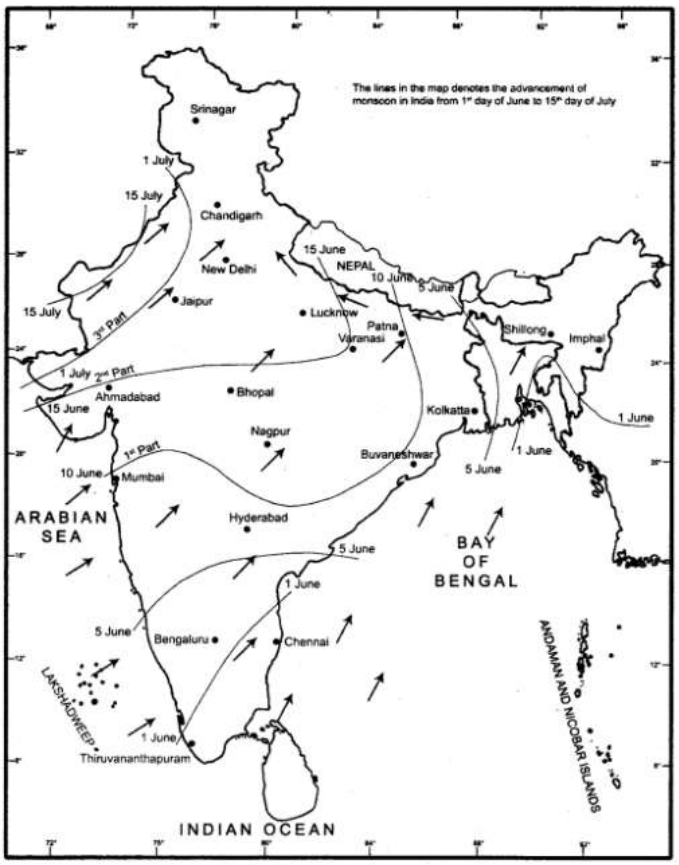
the north of the anticyclonic ridge and the highlands, though it may occasionally reappear southward of them for very brief periods. This change of the upper tropospheric circulation above northern India from westerly jet to easterly flow coincides with a reversal of the vertical temperature and pressure gradients between 600 and 300 millibars. On many occasions the easterly wind aloft assumes jet force. It anticipates by a few days the "burst," or onset, of the surface southwesterly monsoon some 1,500 km (900 miles) farther south, with a definite sequential relationship, although the exact cause is not known.

- Because of India's inverted triangular shape, the land is heated progressively as the sun moves northward. This accelerated spread of heating, combined with the general direction of heat being transported by winds, results in a greater initial monsoonal activity over the Arabian Sea (at late springtime), where a real frontal situation often occurs, than over the Bay of Bengal. The relative humidity of coastal districts in the Indian region rises above 70 percent, and some rain occurs. Above the heated land, the air below 1,500 metres (5,000 feet) becomes unstable, but it is held down by the overriding easterly flow. This does not prevent frequent thunderstorms from occurring in late May.

Peak period

- **During June the easterly jet becomes firmly established at 150 to 100 millibars**, an atmospheric pressure region typically occurring at elevations between 13,700 and 16,100 metres (45,000 and 53,000 feet). It reaches its greatest speed at its normal position to the south of the anticyclonic ridge, at about 15° N from China through India.
- In Arabia, it decelerates and descends to the middle troposphere (3,000 metres [9,800 feet]). A stratospheric belt of very cold air, analogous to the one normally found above the intertropical convergence near the Equator, occurs above the anticyclonic ridge, across southern Asia at 30°–40° N and above the 500-millibar level (6,000 metres [19,700 feet]). These upper-air features that arise so far away from the Equator are associated with the surface monsoon and are absent when there is no monsoonal flow. The position of the easterly jet controls the location of monsoonal rains, which occur ahead and to the left of the strongest winds and also behind them and to the right.
- The **surface flow**, however, is a strong, southwesterly, humid, and unstable wind that brings humidity of more than 80 percent and heavy squally showers that are the "burst" of the monsoon. The overall pattern of the advance follows a frontal alignment, but local episodes may differ considerably. The amount of rain is variable from year to year and place to place.
- Most spectacular clouds and rain occur against the **Western Ghats in India**, where the early monsoonal airstream piles up against the steep slopes, then recedes, and piles up again to a greater height. Each time it pushes thicker clouds upward until wind and clouds roll over the barrier and, after a few brief spells of absorption by the dry inland air, cascade toward the interior. The windward slopes receive 2,000 to 5,000 mm (80 to 200 inches) of rain in the monsoon season.
- Various factors, especially topography, combine to make up a complex regional pattern. Oceanic air flowing toward India below 6,000 metres (19,700 feet) is deflected in accordance with the **Coriolis effect.** The converging moist oncoming stream becomes unstable over the hot land and is subject to rapid convection. Towering cumulonimbus clouds rise thousands of metres, producing violent thunderstorms and releasing latent heat in the surrounding air. As

a result, the upper tropospheric warm belt migrates northwestward from the ocean to the land. The main body of air above 9,000 metres (29,500 feet) maintains a strong easterly flow.



***Map 12:** India - South West Monsoon*

- Later, in **June and July**, the monsoon is strong and well-established to a height of 6,000 metres (less in the far north), with occasional thickening to 9,000 metres. Weather conditions are cloudy, warm, and moist all over India. Rainfall varies between 400 and 500 mm (16 and 20 inches), but topography introduces some extraordinary differences. On the southern slopes of the Khasi Hills at only 1,300 metres (4,300 feet), where the moist airstreams are lifted and overturned, the village of Cherrapunji in Meghalaya state receives an average rainfall of 2,730 mm (107 inches) in July, with record totals of 897 mm (35 inches) in 24 hours in July 1915, more than 9,000 mm (354 inches) in July 1861, and 16,305 mm (642 inches) in the monsoon season of 1899. Over the Ganges valley the monsoon, deflected by the Himalayan barrier, becomes a southeasterly airflow. By then the upper tropospheric belt of warmth from condensation has moved above northern India, with an oblique bias. The lowest pressures prevail at the surface.
- It is mainly in **July and August** that waves of low pressure appear in the body of monsoonal air. Fully developed depressions appear once or twice per month. They travel from east to west more or less concurrently with high-level easterly waves and bursts of speed from the easterly jet, causing a local strengthening of the low-level monsoonal flow. The rainfall consequently increases and is much more evenly distributed than it was in June. Some of the deeper depressions become tropical cyclones before they reach the land, and these bring torrential rains and disastrous floods.
- A totally different development arises when the easterly jet moves farther north than usual. The monsoonal wind rising over the southern slopes of the Himalayas brings heavy rains and local floods. The weather over the central and southern districts, however, becomes suddenly drier and remains so for as long as the abnormal shift lasts. The opposite shift is also possible, with midlatitude upper air flowing along the south face of the Himalayas and bringing drought to the northern districts. Such dry spells are known as “breaks” of the monsoon. Those affecting the south of India are similar to those experienced on the Guinea Coast during extreme northward shifts of the wind belts (see West African monsoon), whereas those affecting the north are due to an interaction of the middle and low latitudes. The southwest monsoon over the lower Indus plain is only 500 metres (about 1,600 feet)

thick and does not hold enough moisture to bring rain. On the other hand, the upper tropospheric easterlies become stronger and constitute a true easterly jet stream. Western Pakistan, Iran, and Arabia remain dry (probably because of the divergence in this jet) and thus become the new source of surface heat.

Monsoon withdrawal

- By **August** the intensity and duration of sunshine have decreased, temperatures begin to fall, and the surge of southwesterly air diminishes spasmodically almost to a standstill in the northwest. Cherrapunji still receives over 2,000 mm (79 inches) of rainfall at this time, however. In September, dry, cool, northerly air begins to circle the west side of the highlands and spread over northwestern India. The easterly jet weakens, and the upper tropospheric easterlies move much farther south. Because the moist southwesterlies at lower levels are much weaker and variable, they are soon pushed back. The rainfall becomes extremely variable over most of the region, but showers are still frequent in the southeastern areas and over the Bay of Bengal.
- By early **October,** variable winds are very frequent everywhere. At the end of the month, the entire Indian region is covered by northerly air and the winter monsoon takes shape. The surface flow is deflected by the Coriolis force and becomes a northeasterly flow. This causes an October–December rainy season for the extreme southeast of the Deccan (including the Madras coast) and eastern Sri Lanka, which cannot be explained by topography alone because it extends well out over the sea. Tropical depressions and cyclones are important contributing factors.
- Most of India thus begins a sunny, dry, and dusty season. The driest period comes in November in the Punjab; December in central India, Bengal, and Assam; January in the northern Deccan; and February in the southern Deccan. Conversely, the western slopes of the Karakoram Range and Himalayas are then reached by the midlatitude frontal depressions that come from the Atlantic and the Mediterranean. The winter rains they receive, moderate as they are, place them clearly outside the monsoonal realm.
- Because crops and water supplies depend entirely on monsoonal rains, it became imperative that quantitative long-range weather forecasts be available. Embedded in the weather patterns of other parts of the world are clues to the summer conditions in South Asia. These clues often appear in the months leading up to monsoon onset. For a forecast to be released at the beginning of June, South American pressure and Indian upper-wind data for the month of April are examined. These data, though widely separated from one another, are positively correlated and may be used as predictors of June conditions. Forecasts may be further refined in May by comparing rainfall patterns in both Zimbabwe and Java with the easterly winds above the city of Kolkata (Calcutta) in West Bengal state. In this situation the correlation between rainfall and easterly winds is negative.

➡ WESTERN DISTURBANCE

- A western disturbance is an **extratropical storm** originating in the Mediterranean region that brings sudden winter rain to the north western parts of the Indian subcontinent. It is a non-monsoonal precipitation pattern driven by the westerlies.

- The moisture in these storms usually originates over the **Mediterranean Sea, the Caspian Sea and the Black Sea**.

Formation

- Western disturbances originate in the **Mediterranean region**.
- A **high-pressure area over Ukraine and neighbourhood** consolidates, causing the intrusion of cold air from polar regions towards an area of relatively warmer air with high moisture.
- This generates **favourable conditions for cyclogenesis** in the upper atmosphere, which promotes the formation of an eastward-moving extratropical depression.
- Traveling at speeds up to 12 m/s (43 km/h; 27 mph), the disturbance moves towards the Indian subcontinent until the Himalayas inhibits its development, upon which the depression rapidly weakens.
- The western disturbances are embedded in the mid-latitude subtropical westerly jet stream.

Impact of Western Disturbances on Indian climate

- Western disturbances are usually associated with cloudy sky, higher night temperatures and unusual rain.
- Western disturbances, specifically the ones in winter, bring moderate to heavy rain in low-lying areas and heavy snow to mountainous areas of the Indian Subcontinent.
- They are the cause of most winter and pre-monsoon season rainfall across northwest India.
- Precipitation during the winter season has great importance in agriculture, particularly for the rabi crops.
- Wheat among them is one of the most important crops, which helps to meet India's food security.

Are there any ill-effects of Western Disturbances?

- Excessive precipitation due to western disturbances can cause crop damage, landslides, floods and avalanches.
- Over the Indo-Gangetic plains, they occasionally bring cold wave conditions and dense fog. These conditions remain stable until disturbed by another western disturbance.
- When western disturbances move across northwest India before the onset of monsoon, a temporary advancement of monsoon current appears over the region.

CLIMATE PROTECTION

➡ CLIMATE CHANGE

- The Earth's average temperature is about **15C** but has been much higher and lower in the past.
- There are natural fluctuations in the climate but scientists say temperatures are now rising faster than at many other times.
- This is linked to the **greenhouse effect**, which describes how the Earth's atmosphere traps some of the Sun's energy.

- Solar energy radiating back to space from the Earth's surface is absorbed by greenhouse gases and re-emitted in all directions.
- This heats both the lower atmosphere and the surface of the planet. Without this effect, the Earth would be about 30C colder and hostile to life.
- Scientists believe we are adding to the natural greenhouse effect, with gases released from industry and agriculture trapping more energy and increasing the temperature.
- This is known as **climate change or global warming.**

What are greenhouse gases?

- The greenhouse gas with the greatest impact on warming is **water vapour**. But it remains in the atmosphere for only a few days.
- **Carbon dioxide (CO2), however, persists** for much longer. It would take hundreds of years for a return to pre-industrial levels and only so much can be soaked up by natural reservoirs such as the oceans.
- Most man-made emissions of CO2 come from burning fossil fuels. When carbon-absorbing forests are cut down and left to rot, or burned, that stored carbon is released, contributing to global warming.
- Since the Industrial Revolution began in about 1750, CO2 levels have risen more than 30%. The concentration of CO2 in the atmosphere is higher than at any time in at least 800,000 years.
- Other greenhouse gases such as **methane and nitrous oxide** are also released through human activities but they are less abundant than carbon dioxide.

What is the evidence for warming?

- The world is about **one degree Celsius warmer** than before widespread industrialisation, according to the World Meteorological Organization (WMO).
- It says the past five years, 2015–2019, were the warmest on record.
- Across the globe, the **average sea level increased by 3.6mm per year** between 2005 and 2015.
- Most of this change was because water increases in volume as it heats up.
- However, melting ice is now thought to be the main reason for rising sea levels. Most glaciers in temperate regions of the world are retreating.
- And satellite records show a dramatic **decline in Arctic sea-ice since 1979**. The Greenland Ice Sheet has experienced record melting in recent years.
- Satellite data also shows the **West Antarctic Ice Sheet is losing mass**. A recent study indicated East Antarctica may also have started to lose mass.
- The effects of a changing climate can also be seen in vegetation and land animals. These include earlier flowering and fruiting times for plants and changes in the territories of animals.

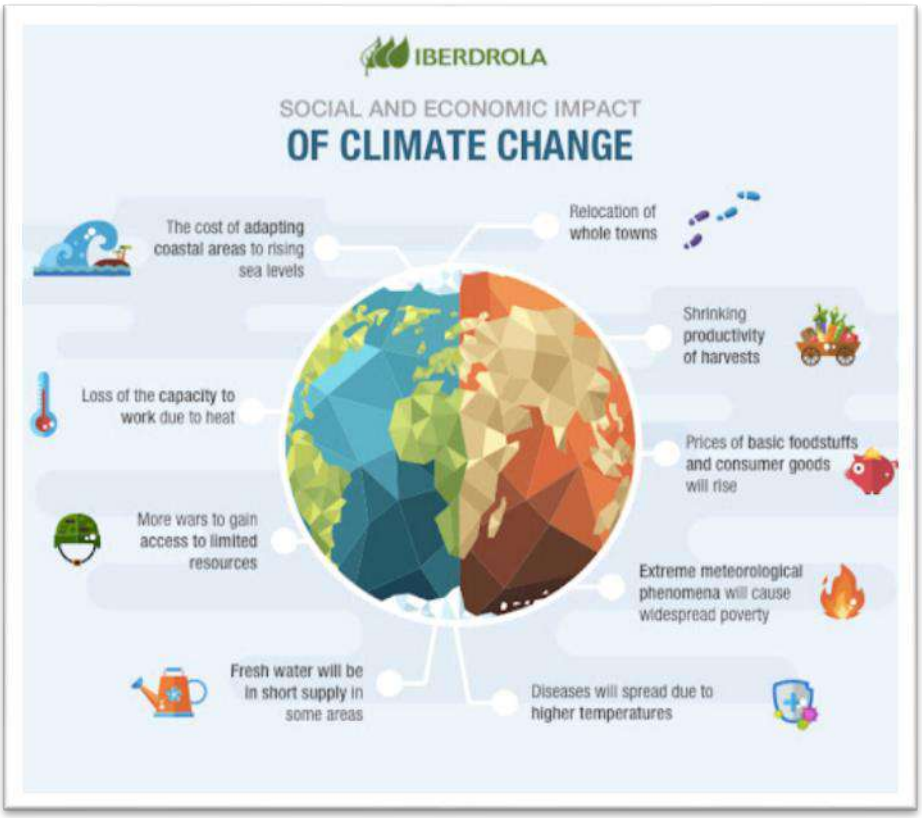
How much will temperatures rise in future?

- The change in the global surface temperature **between 1850 and the end of the 21st Century is likely to exceed 1.5C**, most simulations suggest.
- The WMO says that if the current warming trend continues, temperatures could rise 3-5C by the end of this century.

- Temperature rises of 2C had long been regarded as the gateway to dangerous warming. More recently, scientists and policymakers have argued that limiting temperature rises to 1.5C is safer.
- An Intergovernmental Panel on Climate Change (IPCC) report in 2018 suggested that keeping to the 1.5C target would require "rapid, far-reaching and unprecedented changes in all aspects of society".
- The UN is leading a political effort to stabilise greenhouse-gas emissions. China emits more CO_2 than any other country. It is followed by the US and the European Union member states, although emissions per person are much greater there.
- But even if we now cut greenhouse-gas emissions dramatically, scientists say the effects will continue. Large bodies of water and ice can take hundreds of years to respond to changes in temperature. And it takes CO_2 decades to be removed from the atmosphere.

How will climate change affect us?

- There is uncertainty about how great the impact of a changing climate will be.
- It could cause **fresh water shortages**, dramatically **alter our ability to produce food**, and **increase the number of deaths** from floods, storms and heatwaves. This is because climate change is expected to **increase the frequency of extreme weather events** - though linking any single event to global warming is complicated.



- As the world warms, more water evaporates, leading to more moisture in the air. This means many areas will experience **more intense rainfall** - and in some places snowfall. But the **risk of drought** in inland areas during hot summers will increase. **More flooding** is expected from storms and rising sea levels. But there are likely to be very strong regional variations in these patterns.
- Poorer countries, which are least equipped to deal with rapid change, could suffer the most.
- Plant and animal extinctions are predicted as habitats change faster than species can adapt. And the World Health Organization (WHO) has warned that the health of millions could be threatened by increases in malaria, water-borne disease and malnutrition.

➡ IPCC

- The Intergovernmental Panel on Climate Change (IPCC) is the leading **international body for assessment of climate change.**
- It is a key source of scientific information and technical guidance to the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol and Paris Agreement. The IPCC provides governments at all levels with scientific information they can use to develop climate policies.
- The IPCC is an **organisation of governments that are members of the United Nations or the World Meteorological Organization (WMO). The IPCC currently has 195 members**.
- The **IPCC Plenary is the main body** of IPCC members. Representatives of IPCC member governments meet one or more times a year in Plenary Sessions of the Panel. They **elect a Bureau of scientists** for the duration of an assessment cycle. Governments and Observer Organisations nominate, and Bureau members select, experts to prepare IPCC reports.

IPCC's main activities are to prepare:

- comprehensive **Assessment Reports** on climate change, its causes, impacts and response options.
- **Methodology Reports** which provide practical guidance to Parties to help them prepare national greenhouse gas inventories.
- **Special Reports** on topics that inform the Assessment Reports.
- The IPCC **does not undertake new research but synthesises** published and peer-reviewed literature to develop a comprehensive assessment of scientific understanding, published in IPCC Assessment Reports.
- The IPCC's work is guided by a set of principles and procedures that govern all the main activities of the organisation. IPCC member governments and observer organisations nominate experts and the IPCC Bureau selects authors and editors, with expertise in a range of scientific, technical and socio-economic fields. IPCC reports are the product of multiple drafting and review processes to promote an objective, comprehensive and transparent assessment of current knowledge.
- The IPCC was created in **1988 by the World Meteorological Organization (WMO)** and the **United Nations Environment Programme (UNEP).**

Sixth Assessment Report

- The IPCC is now in its sixth assessment cycle, in which the IPCC is producing the Sixth Assessment Report (AR6). It will provide an update on the scientific, technical and socio-economic aspects of climate change, its causes, potential impacts and response strategies. It is divided into three main topics with each prepared by a separate Working Group:

- Physical Sciences
- Impacts, Adaption and Vulnerability
- Mitigation of Climate Change

Special Reports:

The IPCC delivered three Special Reports between 2018 and 2019:

1. **Global warming of 1.5°C** assesses literature relevant to global warming of 1.5°C and for the comparison between global warming of 1.5°C and 2°C above pre-industrial levels. It was requested by the Parties to the Paris Agreement to inform key aspects of climate policy and strengthening the global response to climate change.
2. The **Ocean and the Cryosphere in a Changing Climate assesses** how the ocean and cryosphere have and are expected to change with ongoing global warming. It also assesses the risks and opportunities these changes bring to ecosystems and people, and options for reducing future risks.
3. **Climate Change and Land** provides information on the impacts of climate change on land systems and opportunities for action. The report covers climate change and its relevance to land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems.

➡ GREEN HOUSE EFFECT AND GREEN HOUSE GASES

Concentration of carbon dioxide (CO2), the most significant greenhouse gas, reached 413.2 parts per million in 2020 and is 149% of the pre-industrial level. Methane (CH4) is 262% and nitrous oxide (N2O) is 123% of the levels in 1,750 when human activities started disrupting earth's natural equilibrium.

About GHGs

- Greenhouse gases (GHGs) are a group of gases that are able to absorb heat in the atmosphere keeping the earth's surface warm. This absorbed heat/thermal radiation by the greenhouse gases is re-radiated back to earth's surface in all directions. This ability of gases to trap heat in thermal form and spread evenly at earth's surface is known as Greenhouse effect.
- The spreading of these greenhouse gases is responsible for the heat required to sustain life on earth. But the presence of these GHGs in excess enhances the Greenhouse effect which is creating global warming and consequently climate change.
- Water vapour (H2O), carbon dioxide (CO2), nitrous oxide (N2O) and methane (CH4) are the primary greenhouse gases in the Earth's atmosphere.
- Along with the rapid industrialisation in the 19th and 20th centuries human activities such as burning of fossil fuels and deforestation have increased the level of the presence of these gases within the earth's atmosphere.

UNFCCC's (United Nations Framework Convention on Climate Change) **Kyoto Protocol** has recognised six main greenhouse gases primarily responsible for global warming. They are:

- *Carbon dioxide (CO_2), Methane (CH_4), Nitrous oxide (N_2O), Hydro fluorocarbons (HFCs), Per fluorocarbons (PFCs), Sulphur hexafluoride (SF_6).*

- The most dominant greenhouse gas overall is water vapour, but it has a very short atmospheric lifetime (about 10 days) and is very nearly in a dynamic equilibrium in the atmosphere, so it is not a forcing gas in the context of global warming.
- CO2 is identified as the dominant greenhouse gas followed by methane and nitrous oxide as the major forcing contributors to global warming.

- Maximum anthropogenic GHG emissions is from Power stations followed by Industries, Transportation fuels, Agriculture by-products, Land use and burning, etc.

Green House Gas	Sources and Causes
Carbon dioxide (CO_2)	Burning of fossil fuels, deforestation
Methane (CH_4)	Growing paddy, excreta of cattle and other livestock, termites, burning of fossil fuel, wood, landfills, wetlands, fertilizer factories.
Nitrous oxides (N_2O)	Burning of fossil fuels, fertilizers; burning of wood and crop residue.
Hydro fluorocarbons (HFCs)	Used as refrigerants, aerosol propellants, solvents and fire retardants.
Per fluorocarbons (PFCs)	Produced as a by-product in aluminium production and manufacturing of semi-conductors.
Sulphur hexafluoride (SF6)	Used as tracer gas for leak detection, used in electrical transmission equipment

➡ CARBON CREDIT

- A carbon credit is a tradable permit or certificate that provides the holder of the credit **the right to emit one ton of carbon dioxide or an equivalent of another greenhouse gas** – it's essentially an offset for producers of such gases.
- The **main goal for the creation of carbon credits is the reduction of emissions of carbon dioxide** and other greenhouse gases from industrial activities to reduce the effects of global warming.
- Carbon credits are **market mechanisms** for the minimization of greenhouse gases emission.
- Governments or regulatory authorities set the caps on greenhouse gas emissions.
- For some companies, the immediate reduction of the emission is not economically viable. Therefore, they can purchase carbon credits to comply with the emission cap.
- Companies that achieve the carbon offsets (reducing the emissions of greenhouse gases) are usually rewarded with additional carbon credits. The **sale of credit surpluses may be used to subsidize future projects** for the reduction of emissions.

The introduction of such credits was ratified in the **Kyoto Protocol.** The Paris Agreement validates the application of carbon credits and sets the provisions for the further facilitation of the carbon credits markets.

Types of Carbon Credits

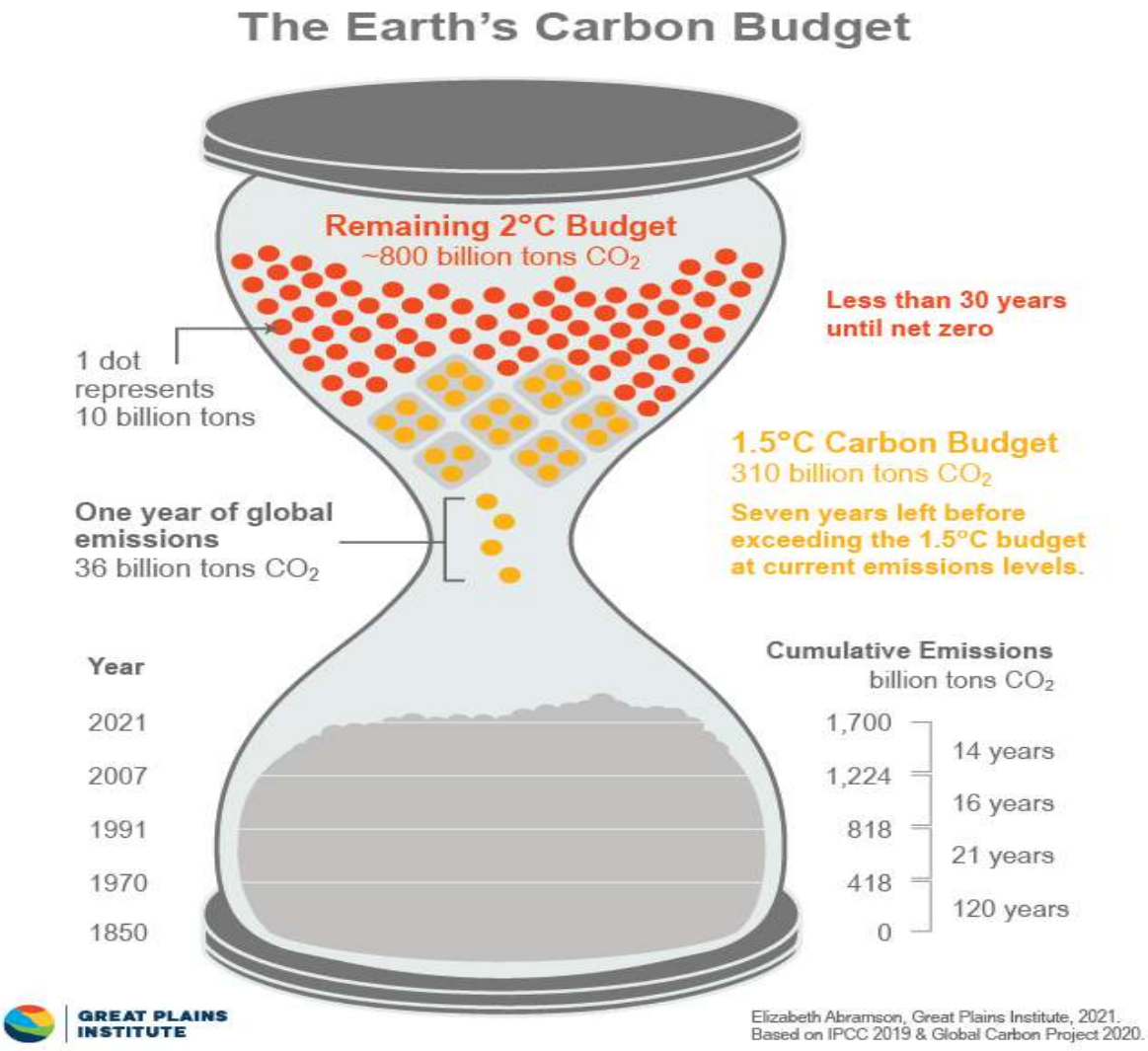
There are two types of credits:

- **Voluntary emissions reduction (VER):** A carbon offset that is exchanged in the over-the-counter or voluntary market for credits.
- **Certified emissions reduction (CER):** Emission units (or credits) created through a regulatory framework with the purpose of offsetting a project's emissions. The main difference between the two is that there is a third-party certifying body that regulates the CER as opposed to the VER.

Trading Credits

- Carbon credits can be traded on both private and public markets. Current rules of trading allow the international transfer of credits.
- The prices of credits are primarily driven by the levels of supply and demand in the markets. Due to the differences in the supply and demand in different countries, the prices of the credits fluctuate.
- Although carbon credits are beneficial to society, it is not easy for an average investor to start using them as investment vehicles. The certified emissions reductions (CERs) are the only product that can be used as investments in the credits.
- However, CERs are sold by special carbon funds established by large financial institutions. The carbon funds provide small investors with the opportunity to enter the market.
- There are special exchanges that specialize in the trading of the credits, including the European Climate Exchange, the NASDAQ OMX Commodities Europe exchange, and the European Energy Exchange.

➡ CO_2 BUDGET



- A CO_2 budget determines how much CO_2 a country or person is allowed to emit in order to achieve the global climate protection goal of limiting global warming to 1.5 °C.
- In Germany, German citizens cause an average of 10 tonnes of CO_2 per capita and year.
- In terms of the climate protection target, however, **only 1 tonne of CO_2 per person and year is acceptable**.

➡ METHANE

- **Methane (CH_4)** is a hydrocarbon that is a primary component of natural gas.
- Methane is also a **greenhouse gas (GHG),** so its presence in the atmosphere affects the earth's temperature and climate system. Methane is emitted from a variety of anthropogenic (human-influenced) and natural sources. Anthropogenic emission sources include landfills, oil and natural gas systems, agricultural activities, coal mining, stationary and mobile combustion, wastewater treatment, and certain industrial processes.
- Methane is the **second most abundant anthropogenic GHG after carbon dioxide (CO_2),** accounting for about 20 percent of global emissions.
- Methane is **more than 25 times as potent as carbon dioxide at trapping heat in the atmosphere**. Over the last two centuries, methane concentrations in the atmosphere have more than doubled, largely due to human-related activities. Because methane is both a powerful greenhouse gas and short-lived compared to carbon dioxide, achieving significant reductions would have a rapid and significant effect on atmospheric warming potential.

Who are the biggest methane emitters?

- China, the United States, Russia, India, Brazil, Indonesia, Nigeria, and Mexico are estimated to be responsible for nearly half of all anthropogenic methane emissions.
- The major methane emission sources for these countries vary greatly. For example, a key source of methane emissions in China is coal production, whereas Russia emits most of its methane from natural gas and oil systems.
- The largest sources of methane emissions from human activities in the United States are oil and gas systems, livestock enteric fermentation, and landfills.

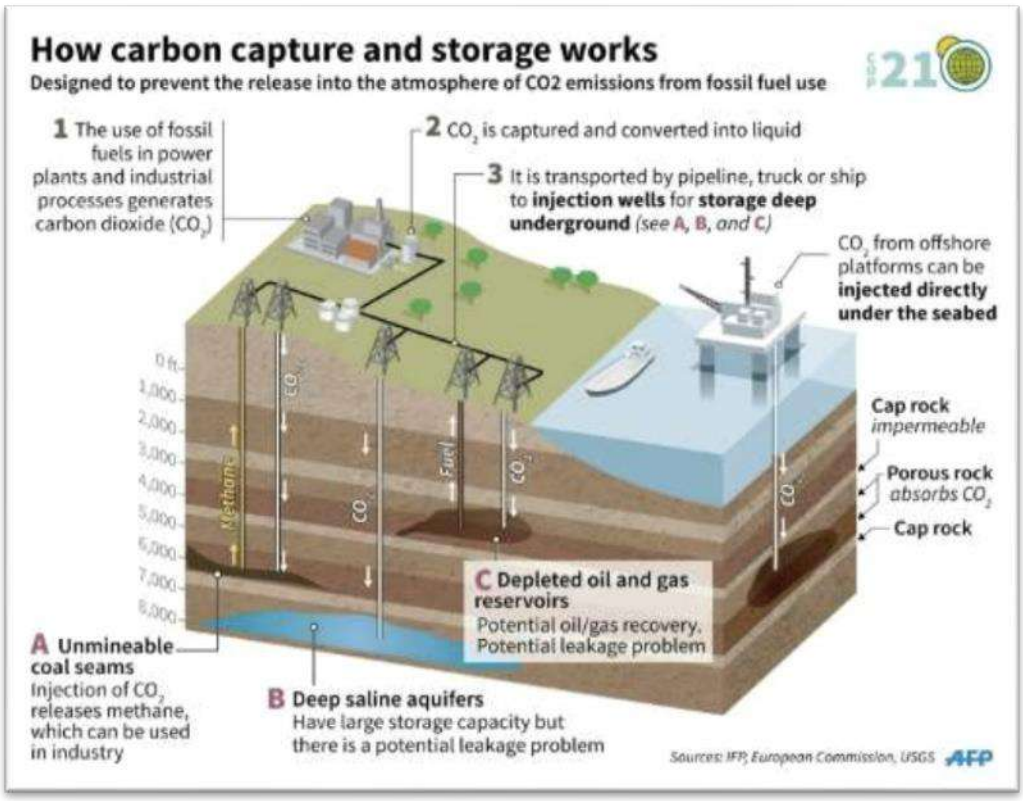
➡ CARBON CAPTURE AND STORAGE TECHNOLOGY

- Carbon capture and storage technology (CCS) has been hailed as a key component in the **world's shift towards renewable energy.**
- With global CO_2 emissions hitting a historic high, growing by more than 1.3% to a record of more than 33 billion tonnes, the need for tools that can help limit pollution has never been greater.
- The Global CCS Institute claims CO_2 emissions from fossil fuel combustion in the energy sector contribute roughly 30% to the amount of the pollutant present in the EU, specifically.
- Renewable energy presents a possible solution to this, but its ability to cater the world's power demand, which is expected to rise by 50% by 2030, according to the UK's Carbon Capture and Storage Association (CCSA), is up for debate – this is where CCS comes in.

- The International Energy Agency recently concluded that, to meet the goals of the Paris Agreement, CCS will need to contribute 32% of the extra effort to move from a 2C scenario to well below 2C.
- The Intergovernmental Panel on Climate Change (IPCC) has estimated that without CCS, the cost of trying to meet global climate change goals will increase by almost 140%.
  Here we take a closer look at CCS and how it works.

What is carbon capture and storage technology?

- CCS is a technology reportedly capable of **capturing up to 90% of the CO2 emissions produced by the burning of fossil fuels** to generate electricity, as well as those used in industrial processes, and prevent it from polluting the atmosphere.



- Fossil fuel power plants can be built with the **technology already integrated** or it can also be **combined with renewable biomass to create a "carbon-negative"** mode the goes one step further by actually removing CO2 from the planet.
- The Global CCS Institute says there are 18 large-scale CCS facilities currently in operation, with an additional five under construction.
- Some carbon storage facilities date back multiple decades, such as the Sleipner project in the North Sea, while others remain under construction, like the Gorgon project in Western Australia.
- **First,** CCS involves capturing CO2, before transporting it to be stored in geological rock formations thousands of metres below the Earth's surface.
- The initial part of the process involves separating CO2 from the gasses produced in power generation and industrial processes, such as manufacturing cement or steel, by pre-combustion capture, post-combustion capture or oxy-fuel combustion.

- The pollutant is then transporting using either a pipeline or a ship in much the same way the millions of tonnes of CO_2 are transported each year for various commercial purposes, chiefly by countries such as the US.
- It is then stored in depleted oil and gas fields or deep saline aquifer formations, which the Intergovernmental Panel on Climate Change (IPCC) says can retain 99% of the pollutant over a 1000-year period.
- At every point in the CCS chain, from production to storage, industry has at its disposal a number of process technologies that are well understood and have excellent health and safety records
- The commercial deployment of CCS will involve the widespread adoption of these techniques, combined with robust monitoring techniques and government regulation.

Capturing CO_2

Pre-combustion capture

- Pre-combustion systems, as provided by manufacturing companies such as British engineering firm **Costain**, convert solid, liquid or gaseous fuel into a blend of hydrogen and CO_2 using processes like "**gasification" or "reforming".**
- This can then be used to fuel electricity production, and the CCSA claims it will be able to power vehicles and provide heating, with extremely low emissions, in the future.

Post-combustion capture

- Post-combustion capture involves capturing the CO_2 from the exhaust of a combustion system and absorbing it into a solvent, before removing and compressing the pollutant elements.
- CO_2 can also be separated using high-pressure membrane filtration, as well as cryogenic separation processes.

Oxy-fuel combustion

- Using oxy-fuel combustion, oxygen is separated from the air before combustion, with the fuel then being combusted in oxygen using recycled flue-gas.
- This creates an atmosphere full of oxygen and nitrogen with flue-gases comprising CO_2 and water, allowing for easier purification of the former.

Transporting CO_2

- Transporting captured CO_2 involves many of the same techniques as used for oil and natural gas, including road tankers, ships and pipelines.
- Many of the networks in use today have been operational for more than 30 years, providing safe and regulation-consistent methods of getting the pollutant from A to B.
- The CCSA says: "There is significant potential for the development of local and regional CCS pipeline infrastructure, leading to CCS 'clusters' where CO_2-intensive industries could locate".
- Developing clusters, where infrastructure can be shared by a number of industrial sources of carbon dioxide emissions, will result in the most cost-effective way to deliver CCS infrastructure development and ultimately lower costs to consumers.

Storing CO2

- Storage sites for captured CO2 range from **defunct oil and gas fields to underground saline formations, porous rocks filled with salt water, while it can also injected into depleting oil fields** to increase their output.
- After being injected into such a formation, the CO2 is trapped by a layer of impermeable rock, known as the cap rock, preventing it from entering and polluting the atmosphere above in a process referred to as "structural storage."
- Deep saline aquifers offer the greatest storage capacity over the long term, according to the CCSA, but remain a relative unknown in many areas.

➡ UNFCCC

United Nation Framework Convention on Climate Change (UNFCCC) is an international environment treaty opened for signature in 1992. It came into force from 1994. Secretariat is located in Bonn, Germany. The convention is legally non-binding, but makes provisions for meeting called protocols where negotiating countries can set legally binding limits.

- It **aims** to **stabilize greenhouse gas concentrations** in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. The framework set no binding limits on greenhouse gas emissions for individual countries and contains no enforcement mechanisms. Instead, the framework outlines how specific international treaties (called "protocols" or "Agreements") may be negotiated to set binding limits on greenhouse gases. Kyoto Protocol was negotiated under this framework.
- One of the first tasks set by the UNFCCC was for signatory nations to establish national greenhouse inventories of greenhouse gas (GHG) emissions and removals, which were used to create the 1990 benchmark levels for accession of Annex I countries to the Kyoto Protocol and for the commitment of those countries to GHG reductions. Updated inventories must be regularly submitted by Annex I countries. Annex I, Annex II countries and developing countries.

Parties to UNFCCC are classified as:

- **Annex I countries:** Industrialized countries and economies in transition.
- **Annex II countries:** Developed countries which pay for costs of developing countries. Annex II countries are a sub-group of the Annex I countries.
- **Non-Annex I countries:** Developing countries are not required to reduce emission levels unless developed countries supply enough funding and technology.
- **Setting no immediate restrictions under UNFCCC serves three purposes: i.** It avoids restrictions on their development, because emissions are strongly linked to industrial capacity; **ii.** They can sell emissions credits to nations whose operators have difficulty meeting their emissions targets; **iii.** they get money and technologies for low-carbon investments from Annex II countries; **iv.** Developing countries may volunteer to become Annex I countries when they are sufficiently developed; **v.** India is Non Annex party to UNFCCC.

➡ REDD and REDD+

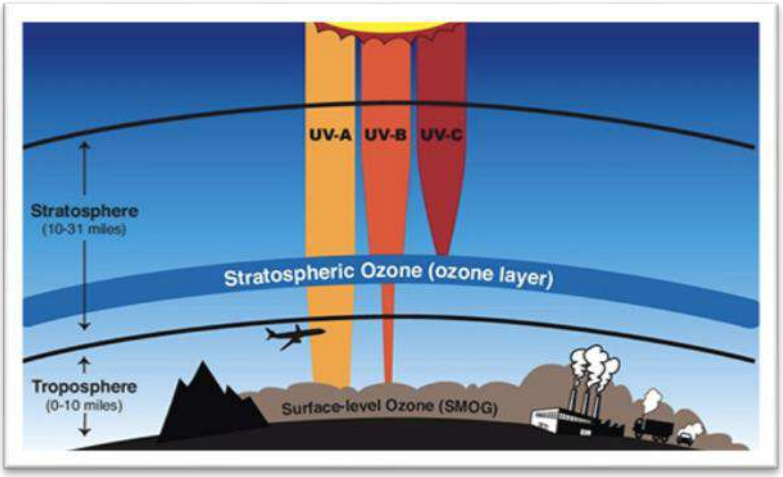
- It is a mechanism negotiated under UNFCC since 2005.
- Its objective is to mitigate climate change through reducing net emissions of greenhouse gases through enhanced forest management in developing countries.
- Inclusion of reducing emissions from land use change is considered essential to achieve the objectives of the UNFCCC.
- During the negotiations for the Kyoto Protocol the inclusion of tropical forest management was debated but eventually dropped due to anticipated methodological difficulties in establishing – in particular – additionality and leakage (detrimental effects outside of the project area attributable to project activities).
- India did not participate in UN-REDD.
- **REDD+ (Defined in Bali Action Plan, 2007, CoP13)**
- **What constitutes** "+": 1. sustainable management of forests, 2. conservation of forest carbon stocks and 3. enhancement of forest carbon stocks.

What is the difference between REDD and REDD+?

- REDD = "reducing emissions from deforestation in developing countries"
- REDD+ (or REDD-plus) = to "reducing emissions from deforestation and forest degradation in developing countries, and the role of conservation, sustainable management of forests, and enhancement of forest carbon stocks in developing countries"
- REDD+ is essentially **a vehicle to financially reward developing countries** for their verified efforts to reduce emissions and enhance removals of greenhouse gases through a variety of forest management option.
- **India favours REDD+**

➡ OZONE LAYER

Two facets of Ozone: Near the ground, ozone is an air pollutant that causes lung damage and asthma attacks. But 10 to 30 miles above the Earth's surface (16-48 km), ozone molecules protect life on Earth. They help shield our planet from harmful solar radiation.

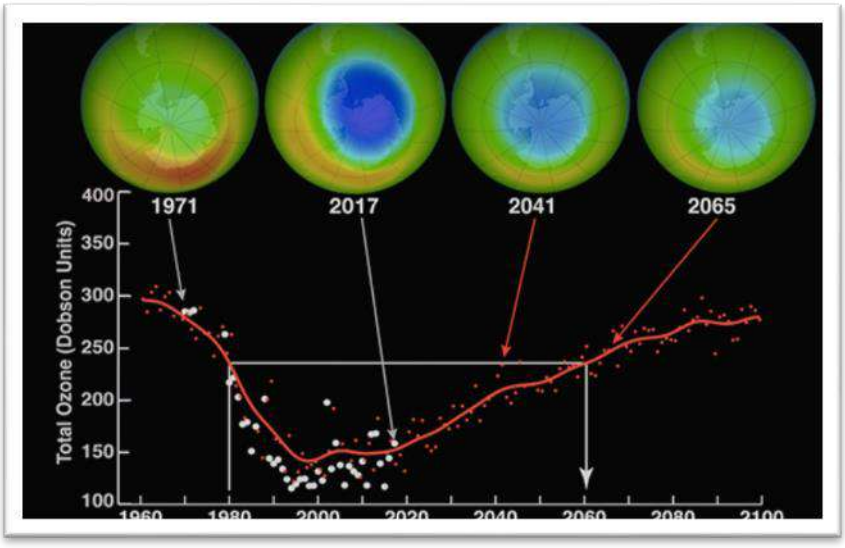


- The ozone layer, in the stratosphere, is where about **90% of the ozone in the Earth system is found**. But ozone makes up only one to ten out of every million molecules in the ozone layer. (*The rest of the molecules are mostly nitrogen and oxygen, like the air we breathe.)* There isn't much of it, but ozone is powerful, able to block the most harmful radiation.

- Ozone **absorbs the most energetic wavelengths** of ultraviolet light, known as **UV-C and UV-B,** wavelengths that harm living things. Oxygen molecules absorb other forms of ultraviolet light, too.
- Together, ozone and oxygen molecules are able to absorb 95 to 99.9% of the ultraviolet radiation that gets to our planet. When UV light is absorbed by oxygen and ozone, heat is generated, which is why the stratosphere gets warmer with altitude.
- **Ozone and oxygen molecules are constantly being formed, destroyed, and reformed in the ozone layer** as they are bombarded by ultraviolet radiation (UV), which breaks the bonds between atoms, creating free oxygen atoms.
- Free oxygen atoms are highly reactive, meaning that they bond easily with other molecules. If a free oxygen atom bumps into an oxygen molecule (O_2), it will form ozone (O_3). If a free oxygen atom bumps into another oxygen atom, it will form an oxygen molecule (O_2).

Ozone Holes

- British scientists at Halley Bay, Antarctica have detected a 10% drop in ozone levels during September, October, and November—the Antarctic spring. Since ozone concentrations over this region often vary from season to season, the researchers weren't concerned, but record low ozone levels kept occurring nearly every spring. No one knew why.
- They were the first to find an ozone hole and it would later be identified as the world's largest ozone hole. An ozone hole is really not a hole but **rather a thinning of the ozone layer in the stratosphere that changes seasonally**. At some times of year, the "hole" is larger. At other times, it's smaller.
- It wasn't until 1985 that scientists were certain that this was a major problem and it was human-caused. The **culprits were chemical compounds called chlorofluorocarbons (CFCs),** which started to be used in the 1960s in air conditioners, aerosol spray cans, and industrial cleaning products. They were also used to make Styrofoam. And they were capable of breaking apart ozone molecules, causing the breakdown of ozone in the stratosphere to happen faster than it could be built back up.
- **UV radiation breaks a chlorine atom off a CFC molecule**. The chlorine atom breaks an ozone molecule apart **into an oxygen molecule (O_2)** and a **chlorine monoxide molecule (ClO).** A free oxygen atom bumps the chlorine atom out, forming an oxygen molecule. This leaves the chlorine atom free to attack and destroy another ozone molecule.



- Once in the atmosphere, CFCs drift slowly upward to the stratosphere, where they are broken up by ultraviolet radiation, releasing chlorine atoms, which are able to destroy ozone molecules.
- The seasons have an impact on the Antarctic ozone hole. During the dark winter, air swirls in a vortex with very low temperatures that cause icy clouds to form. Reactions on the surface of icy cloud particles release chlorine from chemical compounds like CFCs, into a form that reacts with ozone. When sunlight returns in the spring, the chlorine begins to destroy ozone.
- There isn't much ozone depletion in the Arctic because icy clouds are less common and the vortex normally breaks down several weeks before sunlight returns in the spring.

Solving the Problem of Ozone Destruction

- The **Montreal Protocol,** an international agreement to address the global problem of ozone destruction, was signed by more than 70 countries in 1986. It set goals of reducing CFC production 20% by 1993 and 50% by 1998. Since the agreement was signed, these targets have been strengthened to call for the elimination of the most dangerous CFCs by 1996 and for regulation of other ozone-depleting chemicals.
- Scientists detected the problem and identified the cause of the problem. Their evidence convinced governments around the world to take action to help stop the problem. The global elimination of ozone-depleting chemicals from the atmosphere will take decades, but we have made progress on filling in the hole. It was the first time in history that we tackled a global-scale environmental issue with worldwide cooperation.

➡ CLIMATE FINANCE

- Climate finance refers to **local, national or transnational financing**—drawn from public, private and alternative sources of financing—that seeks to support mitigation and adaptation actions that will address climate change.
- The Convention, **the Kyoto Protocol and the Paris Agreement** call for financial assistance from Parties with more financial resources to those that are less endowed and more vulnerable. This recognizes that the contribution of countries to climate change and their capacity to prevent it and cope with its consequences vary enormously.
- Climate finance is **needed for mitigation, because large-scale investments** are required to significantly reduce emissions. Climate finance is equally important for adaptation, as significant financial resources are needed to adapt to the adverse effects and reduce the impacts of a changing climate.
- In accordance with the principle of **"common but differentiated responsibility and respective capabilities"** set out in the Convention, developed country Parties are to provide financial resources to assist developing country Parties in implementing the objectives of the UNFCCC. The Paris Agreement reaffirms the obligations of developed countries, while for the first time also encouraging voluntary contributions by other Parties. Developed country Parties should also continue to take the lead in mobilizing climate finance from a wide variety of sources, instruments and channels, noting the significant role of public funds, through a variety of actions, including supporting country-driven strategies, and taking into account the needs and priorities of developing country Parties. Such mobilization of climate finance should represent a progression beyond previous efforts.

- It is important for all governments and stakeholders to understand and assess the financial needs of developing countries, as well as to understand how these financial resources can be mobilized. Provision of resources should also aim to achieve a balance between adaptation and mitigation.
- Overall, efforts under the Paris Agreement are guided by its aim of making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development. Assessing progress in provision and mobilization of support is also part of the global stocktake under the Agreement. The Paris Agreement also places emphasis on the transparency and enhanced predictability of financial support.

What is the financial mechanism? What are the other funds?

- To facilitate the provision of climate finance, the Convention established a financial mechanism to provide financial resources to developing country Parties. The financial mechanism also serves the Kyoto Protocol and the Paris Agreement.
- The Convention states that the operation of the financial mechanism can be entrusted to one or more existing international entities. The **Global Environment Facility (GEF)** has served as an operating entity of the financial mechanism since the Convention's entry into force in 1994.
- At **COP 16, in 2010, Parties** established the **Green Climate Fund (GCF) and in 2011** also designated it as an operating entity of the financial mechanism. The financial mechanism is accountable to the COP, which decides on its policies, programme priorities and eligibility criteria for funding.
- In addition to providing guidance to the GEF and the GCF, Parties have established two special funds—the **Special Climate Change Fund (SCCF)** and the **Least Developed Countries Fund (LDCF),** both managed by the GEF—and the **Adaptation Fund (AF)** established under the Kyoto Protocol in 2001.
- At the Paris Climate Change Conference in 2015, the Parties agreed that the operating entities of the financial mechanism – GCD and GEF – as well as the SCCF and the LDCF shall serve the Paris Agreement. Regarding the Adaptation Fund serving the Paris Agreement negotiations are underway in the Ad hoc Working Group on the Paris Agreement (APA).

Standing Committee on Finance

- At COP 16 in 2010, Parties decided to establish the Standing Committee on Finance (SCF) to assist the COP in exercising its functions in relation to the financial mechanism of the Convention.
- Currently, the SCF has **four specific functions**:

1. assisting the COP in improving coherence and coordination in the delivery of climate change financing;
2. assisting the COP in rationalization of the financial mechanism of the UNFCCC;
3. supporting the COP in the mobilization of financial resources for climate financing; and
4. supporting the COP in the measurement, reporting and verification of support provided to developing country Parties.

- The Committee is also tasked to organize an annual forum on climate finance, provide the COP with draft guidance for the operating entities, provide expert input into the conduct of the periodic reviews of the financial mechanism and prepare a biennial assessment and

overview of climate finance flows. Furthermore, the SCF is designed to improve the linkages and to promote the coordination with climate finance related actors and initiatives both within and outside of the Convention. At the Paris Conference in 2015, Parties decided that the SCF shall also serve the Paris Agreement.

Long-term climate finance

- The long-term finance process is aimed at progressing on the mobilization and scaling up of climate finance of resources originating from a wide variety of sources, public and private, bilateral and multilateral, including alternative sources. The COP decided on the following activities through to 2020: organization, by the secretariat, of annual in-session workshops; developed countries providing, on a biennial basis, information on strategies and approaches for scaling up climate finance; and convening of biennial high-level ministerial dialogue on climate finance.
- Through the **Cancun Agreements in 2010** developed country Parties committed, in the context of meaningful mitigation actions and transparency on implementation, to a goal of mobilizing jointly USD 100 billion per year by 2020 to address the needs of developing countries. When adopting the Paris Agreement Parties confirmed this goal, called for a concrete road map to achieve the goal by 2020, and agreed that prior to 2025 the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement (CMA) shall set a new collective quantified goal from a floor of USD 100 billion per year.

What is the finance portal?

- The UNFCCC website includes climate finance data portal with helpful explanations, graphics and figures for better understanding the climate finance process and as a gateway to information on activities funded in developing countries to implement climate action. The finance portal comprises three modules, each of which includes information made available by Parties and the operating entities of the financial mechanism.

1. The **first module**, the **National Communications Module**, presents information communicated by contributing countries on the provision of financial resources, in the context of regular reporting to the Convention.
2. The **second module**, the **Fast-start Finance Module**, includes information on resources provided by developed countries in the context of their commitment to provide approximately USD 30 billion over the period 2010–2012.
3. The **third module**, on Funds Managed by the GEF, is a joint effort between the secretariat of the UNFCCC and the GEF and contains information on climate finance flows of the GEF in its role as one of the operating entities of the financial mechanism to the Convention.

- Additionally, information on projects and programmes of the Adaptation Fund can be found in the finance portal. This fund was established under the Kyoto Protocol to finance concrete adaptation projects and programmes in developing countries that are Parties to the Kyoto Protocol.

➡ GRADED RESPONSE ACTION PLAN (GRAP)

The air quality crisis of Delhi has become an annual affair for the past several years. Around the onset of the winter season, the government implements its Graded Response Action Plan (GRAP) for immediate relief from the dropping air quality. However, official data suggested that Delhi's Air Quality Index (AQI) deteriorates even when the GRAP is in place.

About GRAP

- Approved by the Supreme Court in 2016.
- **GRAP works only as an emergency measure**. As such, the plan does not include action by various state governments to be taken throughout the year to tackle industrial, vehicular and combustion emissions.
- The plan is incremental in nature — therefore, **when the air quality moves from 'Poor' to 'Very Poor',** the measures listed under both sections have to be followed.
- If air quality reaches the '**Severe+' stage**, the response under GRAP includes extreme measures such as shutting down schools and implementing the odd-even road-space rationing scheme.
- GRAP has been successful in doing two things that had not been done before — creating a step-by-step plan for the entire Delhi-NCR region, and getting on board several agencies: all pollution control boards, industrial area authorities, municipal corporations, regional officials of the India Meteorological Department, and others.
- The plan requires action and coordination among 13 different agencies in Delhi, Uttar Pradesh, Haryana and Rajasthan (NCR areas). At the head of the table is the EPCA, mandated by the Supreme Court.
- GRAP was **notified in 2017** by the Centre and draws its authority from this notification. Before the imposition of any measures, EPCA holds a meeting with representatives from all NCR states, and a call is taken on which actions have to be made applicable in which town.
- A blanket ban on the DG sets for Delhi-NCR towns from October 15 onward was announced last year as well. However, issues were raised by the Haryana power secretary at the time about deficiencies in the electrical infrastructure in commercial and residential areas developed by builders in Gurgaon.

Has GRAP helped?

- The biggest success of GRAP has been in **fixing accountability and deadlines**. For each action to be taken under a particular air quality category, executing agencies are clearly marked. In a territory like Delhi, where a multiplicity of authorities has been a long-standing impediment to effective governance, this step made a crucial difference. Also, coordination among as many as 13 agencies from four states is simplified to a degree because of the clear demarcation of responsibilities.
- Three major policy decisions that can be credited to EPCA and GRAP are the closure of the thermal power plant at Badarpur, bringing BS-VI fuel to Delhi before the deadline set initially, and the ban on Pet coke as a fuel in Delhi-NCR.
- The initial mandate of the body was to ensure that Delhi's bus and auto fleet moves entirely to CNG — a mammoth task that played a crucial role in cleaning Delhi's air in the late 2000s.

- The body continues to monitor pollution, and assists the Supreme Court in several pollution-related matters.

ACTIONS UNDER GRAP

Severe+ or Emergency (PM 2.5 over 300 µg/cubic metre or PM10 over 500 µg/cu. m. for 48+ hours)	○ Stop entry of trucks into Delhi (except essential commodities) ○ Stop construction work ○ Introduce odd/even scheme for private vehicles and minimise exemptions ○ Task Force to decide any additional steps including shutting of schools
Severe (PM 2.5 over 250 µg/cu. m. or PM10 over 430 µg/cu. m.)	○ Close brick kilns, hot mix plants, stone crushers ○ Maximise power generation from natural gas to reduce generation from coal ○ Encourage public transport, with differential rates ○ More frequent mechanised cleaning of road and sprinkling of water
Very Poor (PM2.5 121-250 µg/cu. m. or PM10 351-430 µg/cu. m.)	○ Stop use of diesel generator sets ○ Enhance parking fee by 3-4 times ○ Increase bus and Metro services ○ Apartment owners to discourage burning fires in winter by providing electric heaters during winter ○ Advisories to people with respiratory and cardiac conditions to restrict outdoor movement
Moderate to poor (PM2.5 61-120 µg/cu. m. or PM10 101-350 µg/cu. m.)	○ Heavy fines for garbage burning ○ Close/enforce pollution control regulations in brick kilns and industries ○ Mechanised sweeping on roads with heavy traffic and water sprinkling ○ Strictly enforce ban on firecrackers

➡ GREEN ENERGY

- Green energy is any energy type that is **generated from natural resources**, such as sunlight, wind or water. It often comes from renewable energy sources although there are some differences between renewable and green energy, which we will explore, below.
- The key with these energy resources are that they don't harm the environment through factors such as releasing greenhouse gases into the atmosphere.
- As a source of energy, green energy often comes from renewable energy technologies such as solar energy, wind power, geothermal energy, biomass and hydroelectric power. Each of these technologies works in different ways, whether that is by taking power from the sun, as with solar panels, or using wind turbines or the flow of water to generate energy.

What Does it Mean?

- In order to be deemed green energy, a **resource cannot produce pollution**, such as is found with fossil fuels. This means that not all sources used by the renewable energy industry are green. For example, power generation that burns organic material from sustainable forests may be renewable, but it is not necessarily green, due to the CO_2 produced by the burning process itself.
- Green energy sources are **usually naturally replenished**, as opposed to fossil fuel sources like natural gas or coal, which can take millions of years to develop. Green sources also often avoid mining or drilling operations that can be damaging to eco-systems.

Types: The main sources are wind energy, solar power and hydroelectric power (including tidal energy, which uses ocean energy from the tides in the sea). Solar and wind power are able to be produced on a small scale at people's homes or alternatively, they can be generated on a larger, industrial scale. The six most common forms are as follows:

1. **Solar Power:** This common renewable, green energy source is usually produced using **photovoltaic cells** that capture sunlight and turn it into electricity. Solar power is also used to heat buildings and for hot water as well as for cooking and lighting. Solar power has now become affordable enough to be used for domestic purposes including garden lighting, although it is also used on a larger scale to power entire neighbourhoods.
2. **Wind Power:** Particularly suited to offshore and higher altitude sites, wind energy uses the power of the flow of air around the world to push turbines that then generate electricity.
3. **Hydropower:** Also known as hydroelectric power, this type of green energy uses the flow of water in rivers, streams, dams or elsewhere to produce energy. Hydropower can even work on a small scale using the flow of water through pipes in the home or can come from evaporation, rainfall or the tides in the oceans.
4. **Geothermal Energy:** This type of green power uses thermal energy that has been stored just under the earth's crust. While this resource requires drilling to access, thereby calling the environmental impact into question, it is a huge resource once tapped into. Geothermal energy has been used for bathing in hot springs for thousands of years and this same resource can be used for steam to turn turbines and generate electricity. The energy stored under the United States alone is enough to produce 10 times as much electricity as coal currently can. While some nations, such as Iceland, have easy-to-access geothermal resources, it is a resource that is reliant on location for ease of use, and to be fully 'green' the drilling procedures need to be closely monitored.
5. **Biomass:** This renewable resource also needs to be carefully managed in order to be truly labelled as a 'green energy' source. Biomass power plants use wood waste, sawdust and combustible organic agricultural waste to create energy. While the burning of these materials releases greenhouse gas these emissions are still far lower than those from petroleum-based fuels.
6. **Biofuels:** Rather than burning biomass as mentioned above, these organic materials can be transformed into fuel such as ethanol and biodiesel. Having supplied just 2.7% of the world's fuel for transport in 2010, the biofuels are estimated to have the capacity to meet over 25% of global transportation fuel demand by 2050.

Why is it Important?

- Green energy is important for the environment as it **replaces the negative effects of fossil fuels** with more environmentally-friendly alternatives.
- Derived from natural resources, **green energy is also often renewable and clean**, meaning that they emit no or few greenhouse gases and are often readily available.
- Even when the full life cycle of a green energy source is taken into consideration, they **release far less greenhouse gases** than fossil fuels, as well as few or low levels of air pollutants. This is not just good for the planet but is also better for the health of people and animals that have to breathe the air.
- Green energy can also **lead to stable energy prices as these sources are often produced locally and are not as affected by geopolitical crisis, price spikes or supply chain disruptions**. The economic benefits also include job creation in building the facilities that often serve the communities where the workers are employed. Renewable energy saw the creation of 11 million jobs worldwide in 2018, with this number set to grow as we strive to meet targets such as net zero.
- Due to the local nature of energy production through sources like solar and wind power, the energy infrastructure is **more flexible and less dependent on centralised sources** that can lead to disruption as well as being less resilient to weather related climate change.
- Green energy also represents a **low cost solution for the energy needs** of many parts of the world. This will only improve as costs continue to fall, further increasing the accessibility of green energy, especially in the developing world.

Which Type Is the Most Efficient?

- Renewable energy sources are currently ranked as follows in efficiency (although this may change as developments continue):

  - Wind Power
  - Geothermal
  - Hydropower
  - Nuclear
  - Solar Power

Green Energy vs Clean Energy vs Renewable Energy – What is the Difference?

- Green energy is that which comes from natural sources, such as the sun. Clean energy are those types which do not release pollutants into the air, and renewable energy comes from sources that are constantly being replenished, such as hydropower, wind power or solar energy.
- Renewable energy is often seen as being the same, but there is still some debate around this. For example, can a hydroelectric dam which may divert waterways and impact the local environment really be called 'green?'
- However, a source such as wind power is renewable, green and clean – since it comes from an environmentally-friendly, self-replenishing and non-polluting source.

➡ OCEAN RENEWABLE ENERGY

Ocean renewable energy refers to all forms of renewable energy derived from the sea including wave energy, tidal energy, ocean current energy, salinity gradient energy and ocean thermal gradient energy.

- **Wave Energy**: It is generated from the power of waves near their surface. It can be captured through oscillating water columns, which trap waves in a column and change the air pressure in the upper portion which drives a turbine.
- **Tidal Energy**: The Tides in the oceans are caused by the combined effects of gravitational forces exerted by the Moon, the Sun, and the rotation of the Earth. Tidal Energy converts the natural rise and fall of the tides into Electricity.
- **Ocean Current Energy:** It refers to harnessing the energy of the ocean currents to generate electricity.
- **Salinity gradient energy**: Salinity gradient power is the energy created from the difference in salt concentration between fresh and salt water, e.g., when a river flows into the sea. Hence, Salinity gradient power plants are based on the natural mixing of fresh and salt water.
- **Ocean thermal gradient energy**: It is a technology for producing energy by harnessing the temperature differences (thermal gradients) between ocean surface waters and deep ocean waters.

- India has **wave energy potential of 40,000 MW**, **tidal energy potential of 9000 MW** and **Ocean thermal gradient** energy potential of around **180,000 MW.**
- **Tidal Energy**: To capture sufficient power from the tidal energy potential, the **height of high tide must be at least five meters more than the low tide**. The Gulf of Cambay and the Gulf of Kutch in Gujarat with higher tidal ranges are considered to be suitable places for harnessing tidal energy.

Benefits of harnessing ocean energy

- **Optimum utilisation of Potential**: India has a long coastline with estuaries and gulfs where waves and tides are strong enough to move turbines for electrical power generation.
- **Reliable and Predictable Power:** As tides follow monthly cycle, which are more predictable in nature, the dependence of tidal energy on rise and fall of tides makes tidal energy a more uniform, reliable and predictable energy source. Similarly, wave energy is reliable because of perpetual motion of ocean waves.
- **Easier Grid Integration**: The power generated from renewable sources such as wind and solar is dependent on random weather patterns. Hence, the power generated may face grid integration challenges due to their unpredictable nature. However, ocean energy, being uniform and reliable does not pose grid integration challenges.
- **Seashore protection**: The Offshore breakwaters are used along beaches for providing protection against coastal erosion by the waves. These structures can be combined with tidal and wave energy projects to reap the dual benefits of sea shore protection and harnessing tidal / wave energy.
- **Higher Energy Density**: Water has higher energy density than air i.e. it can store a larger amount of energy per unit volume as compared to other forms of renewable energy, such as the wind. Hence, for a given electricity output, tidal turbines can be much smaller than equivalent wind turbines. Further, it is possible to harness energy at low speeds from wave and tidal sources as compared to wind which require comparatively higher speeds.

- **Less Visual and Noise Impact:** Tidal and wave power systems have less prominent visual impact as compared to wind and solar systems. They require less space as compared to wind turbine or solar projects. Furthermore, they produce less amount of noise, unlike wind turbines, which produce aerodynamic noise, thereby avoiding disturbance to the marine surroundings.
- **Socio-economic Impact**: Ocean Energy projects provide a number of socio-economic benefits for the coastal population ranging from local electricity production and consumption, creation of job opportunities, creation of industrial clusters etc.

➡ SDG GOAL 7: AFFORDABLE AND CLEAN ENERGY

- Lack of access to energy supplies and transformation systems is a constraint to human and economic development. The environment provides a series of renewable and non-renewable energy sources i.e. solar, wind, hydropower, geothermal, biofuels, natural gas, coal, petroleum, uranium.
- Increased use of fossil fuels without actions to mitigate greenhouse gases will have global climate change implications. Energy efficiency and increase use of renewables contribute to climate change mitigation and disaster risk reduction. Maintaining and protecting ecosystems allow using and further developing hydropower sources of electricity and bioenergy.

Facts:

- 3 billion people rely on wood, coal, charcoal or animal waste for cooking and heating.
- Energy is the dominant contributor to climate change, accounting for around **60 per cent of total global greenhouse gas emissions**
- Since 1990, global emissions of CO_2 have increased by more than 46 per cent.
- Hydropower is the largest single renewable electricity source today, providing 16% of world electricity at competitive prices. It dominates the electricity mix in several countries, developed, emerging or developing.
- Bioenergy is the single largest renewable energy source today, providing 10% of world primary energy supply.

Targets linked to the environment:

1. **Target 7.1**: By 2030, ensure universal access to affordable, reliable and modern energy services.
2. **Target 7.2:** By 2030, increase substantially the share of renewable energy in the global energy mix.
3. **Target 7.3**: By 2030, double the global rate of improvement in energy efficiency.
4. **Target 7.a:** By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology
5. **Target 7.b**: By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States, and land-locked developing countries, in accordance with their respective programmes of support.

➡ NET-ZERO

India has promised to cut its emissions to net zero by 2070.

About Net Zero

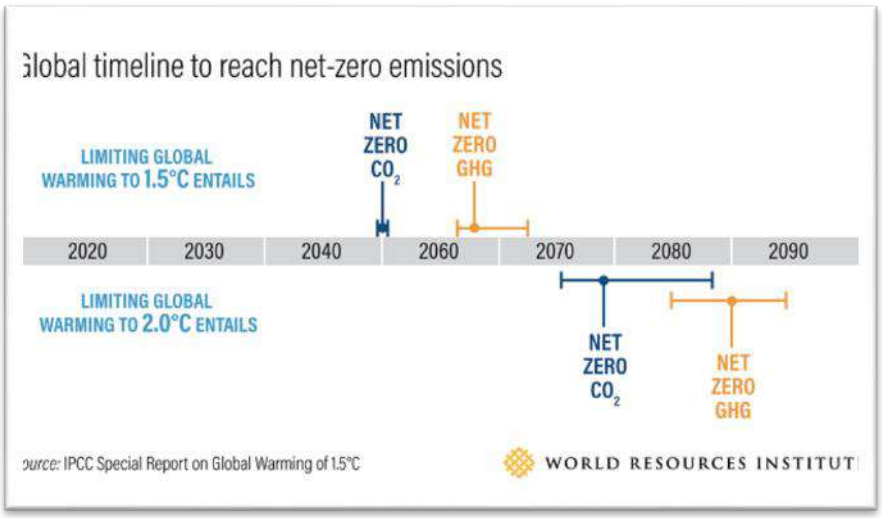
- Net-zero, which is also referred to as carbon-neutrality, does not mean that a country would bring down its emissions to zero. Rather, net-zero is a state in which a **country's emissions are compensated by absorption and removal of greenhouse gases from the atmosphere.**
- Absorption of the emissions can be increased by creating more carbon sinks such as forests, while removal of gases from the atmosphere requires futuristic technologies such as carbon capture and storage.
- This way, it is even possible for a country to have negative emissions, if the absorption and removal exceed the actual emissions. A good example is **Bhutan which is often described as carbon-negative** because it absorbs more than it emits.
- A very active campaign has been going on for the last two years to get every country to sign on to a **net-zero goal for 2050**. It is being argued that global carbon neutrality by 2050 is the only way to achieve the Paris Agreement target of keeping the planet's temperature from rising beyond 2°C compared to pre-industrial times.

What Does It Mean to Reach Net-Zero Emissions?

- We will achieve net-zero emissions when any remaining human-caused GHG emissions are balanced out by removing GHGs from the atmosphere in a process known as **carbon removal**.
- **First and foremost**, human-caused emissions — like those from fossil-fueled vehicles and factories — should be reduced as close to zero as possible. Any remaining GHGs would be balanced with an equivalent amount of carbon removal, for example by restoring forests or through **direct air capture and storage (DACS)** technology.
- The concept of net-zero emissions is akin to **"climate neutrality."**

When Does the World Need to Reach Net-Zero Emissions?

- Under the Paris Agreement, countries agreed to limit warming well below 2 degrees C (3.6 degrees F) and ideally 1.5 degrees C (2.7 degrees F). Climate impacts that are already unfolding around the world, even with only 1.1 degrees C (2 degrees F) of warming — from melting ice to devastating heat waves and more intense storms — show the urgency of minimizing temperature increase to no more than 1.5 degrees C. The latest science suggests that to meet



the Paris Agreement's temperature goals, the world will need to reach net-zero emissions on the following timelines as given in image below:

- In scenarios that limit warming to 1.5 degrees C, carbon dioxide (CO_2) reaches net-zero on average by 2050 (in scenarios with low or no overshoot) to 2052 (in scenarios that have high overshoot, in which temperature rise surpasses 1.5 degrees C for some time before being brought down). Total GHG emissions reach net-zero between 2063 and 2068.
- In 2 degrees C scenarios, CO_2 reaches net-zero on average by 2070 (in scenarios with a greater than 66% likelihood of limiting warming to 2 degrees C) to 2085 (50–66% likelihood). Total GHG emissions reach net-zero by the end of the century.
- The Special Report on Global Warming of 1.5˚C, from the Intergovernmental Panel on Climate Change (IPCC), finds that if the world reaches net-zero emissions one-decade sooner, by 2040, the chance of limiting warming to 1.5 degrees C is considerably higher. The sooner emissions peak, and the lower they are at that point, the more realistic it is that we achieve net-zero in time. We would also need to rely less on carbon removal in the second half of the century.

Do All Countries Need to Reach Net-Zero at the Same Time?

- The timelines above are global averages. Because countries' economies and stages of development vary widely, there is no one-size-fits-all timeline for individual countries.
- There are, however, hard physical limits to the total emissions the atmosphere can support while limiting global temperature increase to the agreed goals of the Paris Agreement.
- At the very least, major emitters (such as the United States, the European Union and China) should reach net-zero GHG emissions by 2050, or it will be hard for the math to work regardless of what other countries do. Ideally, major emitters will reach net-zero much earlier, given that the largest economies play an outsize role in determining the trajectory of global emissions.

How Do We Achieve Net-Zero Emissions?

- Policy, technology and behavior need to shift across the board. For example, in pathways to 1.5 degrees C, **renewables are projected to supply 70-85% of electricity** by 2050.
- **Energy efficiency** and **fuel-switching measures** are critical for transportation.
- Improving the **efficiency of food production**, **changing dietary choices**, **halting deforestation**, **restoring degraded lands**, and **reducing food loss** and **waste** also have significant potential to reduce emissions.
- It is critical that the structural and economic transition necessary to limit warming to 1.5 degrees C is approached in a just manner, especially for workers tied to high-carbon industries.
- The good news is that most of the technologies we need are available and they are increasingly cost-competitive with high-carbon alternatives. Solar and wind now provide the cheapest power for 67% of the world. Markets are waking up to these opportunities and to the risks of a high-carbon economy, and shifting accordingly.
- Additionally, **investments will need to be made in carbon removal**. The different pathways assessed by the IPCC to achieve 1.5 degrees C rely on different levels of carbon removal, but all rely on it to some extent. Removing CO_2 from the atmosphere will be necessary to compensate for emissions from sectors in which reaching zero emissions is more difficult, such as aviation. Carbon removal can be achieved by several means, including land-based approaches (**such as restoring forests and boosting soil uptake of carbon**)

and technological approaches (**such as direct air capture and storage, or mineralization**).

Does the Paris Agreement Commit Countries to Achieving Net-Zero Emissions?

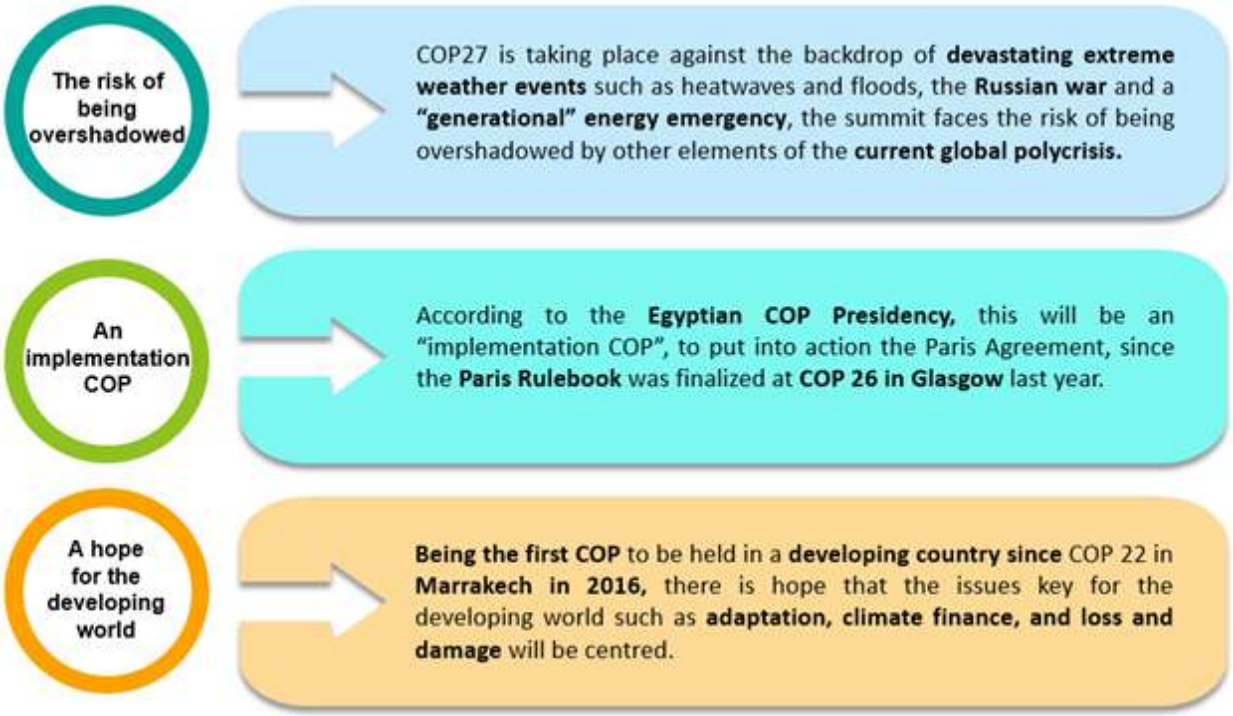
- In short, yes.
  The Paris Agreement has a long-term goal of achieving "a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century , on the basis of equity, and in the context of sustainable development and efforts to eradicate poverty." The concept of balancing emissions and removals is akin to reaching net-zero emissions.
- Coupled with the ultimate goal to limit warming well below 2 degrees C, and aiming for 1.5 degrees C, the Paris Agreement commits governments to sharply reduce emissions and ramp up efforts to reach net-zero emissions in time to avoid the worst consequences of climate change. The Paris Agreement framework also invites countries to submit long-term, low-emissions development strategies by 2020. These strategies can be a vehicle for setting net-zero targets and chart how countries aim to make such transitions.
- Commitments to create bold short- and long-term targets that align with a net-zero emissions future would send important signals to all levels of government, to the private sector, and to the public that leaders are betting on a safe and prosperous future, rather than one devastated by climate impacts.

➡ COP 27

Egypt's coastal city of Sharm el-Sheikh hosted the 27th session of the Conference of Parties (COP27) of the United Nations Framework Convention on Climate Change (UNFCCC).

Highlights of the meeting

- United Nations Secretary-General exclaimed that humanity faces a stark choice: **work together now to cut emissions or condemn future generations to climate catastrophe.**
- He also called for a pact between the richest and poorest countries of the world to accelerate the transition from fossil fuels and funding to ensure poorer countries can reduce emissions and cope with the impacts that have already occurred.
- It was reiterated that the planet is fast approaching tipping points that will certainly make the climate chaos irreversible.



COP 27 Agenda

- The Sharm-El-Sheikh Adaptation Agenda outlines 30 Adaptation Outcomes to build resilience for four billion people that are most vulnerable to climate, by 2030.
- Each outcome provides a global solution that can be adopted at a local level in response to local climate risks like rising climate hazards in the form of floods, heatwaves, droughts, etc.
- These outcomes together present the first comprehensive global plan for both State and non-State actors on a shared set of adaptation actions that are required to be adopted by the end of this decade across major impact systems: ***food and agriculture, water and nature, coastal and oceans, human settlements, and infrastructure, and including enabling solutions for planning and finance.***

Food Security and Agriculture Systems	○ Climate-resilient, sustainable agriculture increases yields by 17% and reduces farm-level GHG emissions by 21%, without expansion of the agricultural frontier. ○ Halve the share of food production lost, and per capita food waste (with respect to 2019). ○ Healthy alternative proteins capture 15% of the global meat and seafood market. ○ The global consumption of fruits, vegetables, seeds, nuts, and legumes increase by 1.5 times.
Water and Nature Systems	○ Protection of 45 million hectares (lands and inland waters), 2 billion hectares sustainable management, and 350 million hectares restoration of land securing legal indigenous and local communities with the use of

	nature-based solutions to improve water security and livelihoods. o By 2025: financial institutions contribute to halting land conversion by eliminating commodity-driven deforestation from portfolios and tap into nature-based solutions investment opportunities of USD 354 billion/year needed by 2030. o Water systems are smart, efficient, and robust with a reduction in water loss through leakage. o Wastewater systems maximize recycling and reuse alongside natural wetland filtration with zero environmental spillage. o Sustainable irrigation systems are implemented across 20% of global croplands to preserve water availability whilst supporting yield growth.
Human Settlements Systems	o 1 billion people have better design, construction, and access to finance to live in decent, safe homes. o Smart and early warning systems reach 3 billion people. o USD 1 trillion investment in nature-based solutions for communities in urban areas. o Harden social infrastructure to ensure access to basic and essential community services. o Increased use of waste as a secondary resource boosts the livelihoods of informal workers and reduces open waste burning by 60%, lowering pollution levels and improving the health of local communities.
Ocean and Coastal Systems	o Invest USD 4 billion to secure the future of 15 million hectares of mangroves globally through collective action on halting mangrove loss, restoring half of the recent losses, doubling the protection of mangroves globally, and ensuring sustainable long-term finance for all existing mangroves. o Halt loss, protect and restore coral reefs to support people in tropical communities. o Halt loss, protect, and restore seagrass, marshes, and kelp forests to support people in temperate communities. o The urban coastline is protected by grey and hybrid solutions.
Infrastructure Systems	o A diverse set of energy generation sources enable affordable access to electricity for 679 million unconnected people and higher quality access for 1 billion underserved people through climate-resilient energy systems. o 4 billion people with access to clean cooking through at least USD 10

	billion/year in innovative finance for clean cooking action worldwide. o 585 GW of battery storage capacity and extension of transmission and distribution networks enable decentralized generation and consumption. o 2 billion people access low-cost, clean vehicles and mobility solutions through the expansion of affordable public and private transport services. o Transport infrastructure is resilient to climate hazards through the adoption of new technology, design, and materials.
Planning	o 10,000 cities and 100 regional governments have evidence-based, actionable adaptation plans. o 2,000 of the world's largest companies develop actionable adaptation plans. o Universal access to the tools and information required to integrate climate risks into decision-making from local to global levels. o Operationalization of National Adaptation Plans and Locally-Led Principles, enabling adaptation in a country-driven localized, and consultative manner.
Finance	o The private sector integrates physical climate risks into investment decisions and continues to innovate mechanisms for financing adaptation and resilience so as to enable the mobilization of the USD 140 to USD 300 billion that will be needed across both public and private sources. o Public finance actors increase the provision of climate finance and allocate 50% of climate funds to adaptation and resilience. o The global property and casualty insurance sector has an industry capabilities framework, actively supports project implementation, and institutionalizes a longer-term industry approach to climate adaptation.

Major initiatives announced in the COP 27 meeting:

International Climate Change University

- The President of Sri Lanka Ranil Wickremesinghe has proposed to set up an **international climate change university in Sri Lanka,** with an ancillary institution in the Maldives.
- It was reiterated that Sri Lanka and Maldives as island nations are vulnerable to the adverse impacts of climate change.

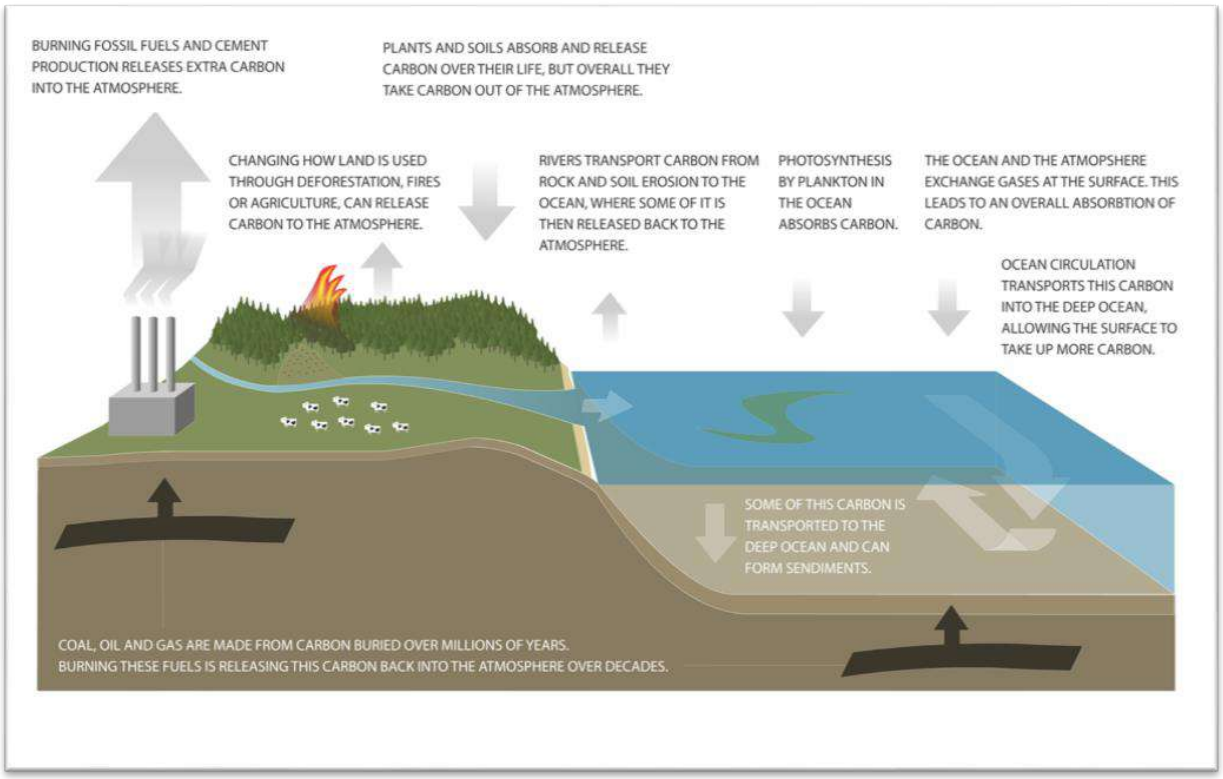
UAE-Egypt Deal

- The United Arab Emirates (UAE) and Egypt have struck a deal on the sidelines of the summit to develop one of the world's largest wind farms.

- Once completed, the 10 GW onshore wind project in Egypt will produce approximately 47,790 GWh of clean energy annually. This would offset nearly 9% (23.8 million tonnes) of Egypt's current carbon dioxide emissions.

➡ CARBON SINK

A carbon sink is anything that absorbs more carbon from the atmosphere than it releases – for example, plants, the ocean and soil. In contrast, a carbon source is anything that releases more carbon into the atmosphere than it absorbs – for example, the burning of fossil fuels or volcanic eruptions.



- **Carbon is an element that is essential to all life on Earth**. Carbon makes up the fats and carbohydrates of our food and is part of the molecules, like DNA and protein, that make up our bodies. Carbon, in the form of carbon dioxide, is even a part of the air we breathe. It is also stored in places like the ocean, rocks, fossil fuels, and plants.
- The **carbon cycle describes the flow of carbon between each of these places**. For example, carbon continually flows in and out of the atmosphere and also living things. As plants photosynthesize, they absorb carbon dioxide from the atmosphere. When plants die, the carbon goes into the soil, and microbes can release the carbon back into the atmosphere through decomposition.
- **Forests are typically carbon sinks,** places that absorb more carbon than they release. They continually take carbon out of the atmosphere **through the process of photosynthesis**.
- The **ocean is another example of a carbon sink**, absorbing a large amount of carbon dioxide from the atmosphere.

- Some processes release more carbon dioxide into the atmosphere than they absorb. Any process that uses **fossil fuels—such as burning coal to make electricity—releases a lot of carbon into the atmosphere.**
- Raising **cattle for food also releases a lot of carbon into the atmosphere**. These processes that release carbon into the atmosphere are known as carbon sources.
- Ideally, the carbon cycle would keep Earth's carbon concentrations in balance, moving the carbon from place to place and keeping atmospheric carbon dioxide levels steady. However, the carbon cycle is changing because of human activity.

Protecting our carbon sinks

The ocean, atmosphere, soil and forests are the world's largest carbon sinks. Protecting these vital ecosystems is essential for tackling climate change and keeping our climate stable. But they're increasingly under threat.

- **Forests:** The world's forests absorb 2.6bn tonnes of carbon dioxide every year. Yet despite their vital importance, an area the size of a football pitch is destroyed every second. There are three important strands to this effort: improving laws, empowering forest communities and fighting illegal logging and trade.
- **Soil:** The Earth's soil absorbs roughly a quarter of all human emissions each year, with a large portion of this stored in peatland or permafrost. But it's under threat from increasing global demand for food production, chemical pollution and climate change. Need to push for a **reformed agricultural model.**
- **The Ocean:** The ocean has sucked up about a quarter of the carbon dioxide released into the atmosphere since we began burning fossil fuels for energy during the Industrial Revolution. Phytoplankton are the main reason the ocean is one of the biggest carbon sinks.

These microscopic marine algae and bacteria play a huge role in the world's carbon cycle - absorbing about as much carbon as all the plants and trees on land combined.

But plastic pollution in our ocean means plankton are eating micro plastics which is impacting the rate at which they are trapping carbon in our ocean.

➡ NATIONAL HYDROGEN MISSION

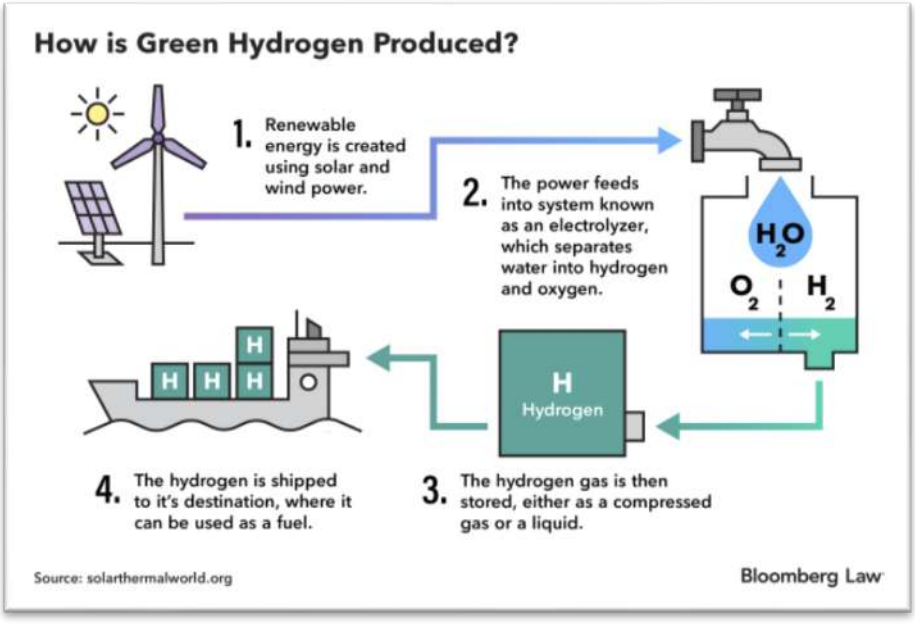
- National Hydrogen Mission **aims to cut down carbon emissions and increase the use of renewable sources of energy** while aligning India's efforts with global best practices in technology, policy and regulation.
- The Government of India has allotted Rs 25 crore in the Union Budget 2021–22 for the research and development in hydrogen energy and intends to produce three-fourths of its hydrogen from renewable resources by 2050.
- Similarly, the GCC countries have invested heavily in hydrogen energy and are looking at it as the holy-grail to a cleaner future. This is an opportune time for **India and the GCC countries to strengthen partnership in R&D, production, storage and transportation of hydrogen energy**.
- India should look at enhancing hydrogen cooperation with GCC countries, especially the front runners, i.e., Saudi Arabia, the UAE and Oman.

Draft Paper

- The NHM, according to a draft paper prepared by the **Ministry of New and Renewable Energy (MNRE),** has identified pilot projects, infrastructure and supply chain, research and development, regulations and public outreach as broad activities for investment with a proposed financial outlay of Rs 800 crores for the next three years.
- It **aims to leverage the country's landmass and low solar and wind tariffs** to produce low-cost green hydrogen and ammonia for export to Japan, South Korea and Europe.
- In this regard, there are immense possibilities for India to collaborate with the Gulf Cooperation Council (GCC) countries that have also invested significantly in developing hydrogen as a future source of energy.
- Geographical proximity and robust trade ties in conventional energy calls for proactive measures to collaborate with GCC countries especially Saudi Arabia, UAE and Oman for research and development pertaining to hydrogen energy.

Hydrogen Energy

- Hydrogen is emerging as an important source of energy since it has **zero carbon content** and is a non-polluting source of energy in contrast to hydrocarbons that have net carbon content in the range of 75–85 per cent.
- Hydrogen energy is **expected to reduce carbon emissions** that are set to jump by 1.5 billion tons in 2021.
- It has the **highest energy content by weight and lowest energy content by volume**.
- As per **International Renewable Energy Agency (IRENA)**, Hydrogen shall make up 6 per cent of total energy consumption by 2050.
- The **Hydrogen Council Report, 2021** also mentions that, global investments on hydrogen will constitute around 1.4 per cent of the total global energy funding by 2030.
- Hydrogen energy is currently at a nascent stage of development, but has considerable potential for aiding the process of energy transition from hydrocarbons to renewables. Though it is the most abundantly available element on earth, commercially viable Hydrogen can be produced from hydrocarbons including natural gas, oil and coal through processes like steam methane reforming, partial oxidation and coal gasification; as well as from renewables like



water, sunlight and wind through electrolysis and photolysis and other thermo-chemical processes.

- The current global demand for hydrogen is 70 million metric tons per year, more than 76 per cent of which is being produced from natural gas, 23 per cent comes from coal and the remaining is produced from electrolysis of water.
- Hydrogen can be stored in **cryo-compressed tanks** in gaseous form apart from being kept in liquefied and solid state. Presently, **Hydrogen is mostly used in industry sector** including those dealing with oil refining, ammonia production, methanol production and steel production. It has huge potential in transportation sector as a direct replacement to fossil fuels.
- Shipping and aviation have limited low-carbon fuel options available and represent an opportunity for hydrogen-based fuels.

Hydrogen Energy in India

- Hydrogen is at an early stage of entering the energy sector in India. Government as well as non-government funding agencies are engaged in R&D projects pertaining to hydrogen production, storage, utilisation, power generation and for transport applications.
- As early as in **2003, National Hydrogen Energy Board** was formed and in **2006** the Ministry of New and Renewable Energy laid out the **National Hydrogen Energy Road Map** identifying transport and power generation as two major green energy initiatives.
- India is participating in **Mission Innovation Challenge** for clean hydrogen and shares the objective to accelerate the development of a global hydrogen market by identifying and overcoming key technology barriers to the production, distribution, storage and use of hydrogen at gigawatt scale.
- By 2050 India intends to produce three-fourths of its hydrogen from renewable resources.
- Presently, more than 100 research groups are focusing on fuel cell technology. There are a number of foreign and Indian companies that are involved in hydrogen production, storage or delivery in India, including Praxair (USA), Linde (global-member of hydrogen council), Inox (Indo-US joint venture), Air Liquide (France), SAGIM (France), Air Products (USA), Fuel Cell Energy (USA), H2Scan (USA), ITM Power (UK), Heliocentris (Germany), Aditya Birla, Bhoruka Gases Ltd, Gujarat Alkalies and Chemicals Limited, Gujarat Heavy Chemicals Ltd, Air Science Technologies and Sukan Engineering Private Limited.

Hydrogen Energy and GCC

- Rich in hydrocarbon resources, currently the GCC countries consume around 7 per cent of the grey hydrogen sourced from the natural gas. **Qatar is the largest consumer of hydrogen** in the region followed by Saudi Arabia, Kuwait, Oman, the UAE and Bahrain.
- UAE and Saudi Arabia, and more recently Oman, have embraced the concept of a hydrogen economy. They are keen to use it domestically as part of decarbonisation effort as well as intend to use it as an alternative export commodity. Besides, there are other motivating factors including energy security and economic diversification.
- GCC countries are at the forefront of cost reductions in renewables and in shaping the energy transformation within as well as outside the region. According to an IRENA analysis, the accelerated deployment of renewable energy in the GCC region can reduce emissions of CO_2 by 136 million tons.

- Apart from that, there are facilitating factors that make it convenient for the GCC countries to invest in renewable energy. These countries have the potential to become hydrogen producers as well as exporters as they have existing **industrial capacity and required capital to invest** in the initial infrastructure.
- Second, GCC has **abundance of inexpensive land and water along with solar and wind resources that can help in production of Green Hydrogen**.
- Third, the countries are situated in **geographical proximity to the emerging and future markets** for cleaner fuel.
- Lastly, the GCC countries can easily be producers of **Blue Hydrogen due to availability of hydrocarbons and the carbon capture, utilisation and storage (CCUS) capacity.**

India–GCC Cooperation

- India and GCC countries share robust energy cooperation. In 2017–18 India imported nearly 53 per cent of its energy from the Persian Gulf, and UAE and Saudi Arabia were third and fourth largest trading partners of India.
- India and the GCC are natural energy partners and have huge potential for extending cooperation in cleaner fuels like hydrogen. India has signed MoUs on renewable energy with most of the GCC countries.
- India's largest pure-play solar platform Acme Solar Holdings Ltd plans to invest US$ 2.5 billion to manufacture **green ammonia and green hydrogen in Duqm** and signed an MoU with the Oman Company for the Development of the Special Economic Zone. The manufacturing facility will supply green ammonia to Europe, America and Asia region and will produce 2,200 metric tonnes (mt) of green ammonia per day.
- India is looking at developing Hydrogen collaboration with Bahrain and even invited Bahrain to participate in the **Hydrogen Roundtable** in April 2021. The two countries agreed to engage more in renewable energy capacity-building and focus on cooperation between their governments as well as the private sector, particularly in the field of solar, wind and clean hydrogen.
- In 2019, **India signed an agreement with Saudi Arabia** about cooperation in renewable energy including hydrogen. The two countries are collaboratively exploring Hydrogen Energy as a future source of energy. Saudi companies like Alfanar and Aljomaih that have invested in India's wind and solar energy projects may be roped in for collaboration on production of Green Hydrogen.
- Similarly GCC leaders too have stated the importance of clean fuel and their willingness to collaborate on the hydrogen energy.
- Major prospects of hydrogen collaboration between India and GCC countries are in terms of investment and technology sharing. One of the major challenges faced by GCC countries in production of hydrogen fuel is the incompatibility of electrolysers with salt water. **Sea water needs to be desalinised before it becomes feasible** for electrolysis. There is a potential for collaboration between India and these countries on this issue.
- A number of Indian research groups are working on **hydrogen generation from sea water**. For instance, **Central Electrochemical Research Institute, Karaikudi** is conducting research on design of electrodes and electrolytes for hydrogen generation using sea water and Centre for Fuel Cell Technology at the International Advanced Research Centre

for Powder Metallurgy and New Materials, Chennai is conducting research on sea water electrolysis.

➡ ARCTIC COUNCIL

- The establishment of the Arctic Council was considered an important milestone enhancing cooperation in the circumpolar North.
- In the **Ottawa Declaration**, the eight Arctic States established the Council as a high-level forum to provide means for promoting cooperation, coordination and interaction among the Arctic States – including the full consultation and full involvement of Arctic Indigenous communities and other Arctic inhabitants.
- The **Arctic Council is the leading intergovernmental forum promoting cooperation, coordination and interaction among the Arctic states, Arctic Indigenous communities and other Arctic inhabitants** on common Arctic issues, in particular, on issues of sustainable development and environmental protection in the Arctic.

The work of the Council is primarily carried out in six Working Groups:

1. The **Arctic Contaminants Action Program (ACAP)** acts as a strengthening and supporting mechanism to encourage national actions to reduce emissions and other releases of pollutants.
2. The **Arctic Monitoring and Assessment Programme (AMAP)** monitors the Arctic environment, ecosystems and human populations, and provides scientific advice to support governments as they tackle pollution and adverse effects of climate change.
3. The **Conservation of Arctic Flora and Fauna Working Group (CAFF)** addresses the conservation of Arctic biodiversity, working to ensure the sustainability of the Arctic's living resources.
4. The **Emergency Prevention, Preparedness and Response Working Group (EPPR)** works to protect the Arctic environment from the threat or impact of an accidental release of pollutants or radionuclides.
5. The **Protection of the Arctic Marine Environment (PAME)** Working Group is the focal point of the Arctic Council's activities related to the protection and sustainable use of the Arctic marine environment.
6. The **Sustainable Development Working Group (SDWG)** works to advance sustainable development in the Arctic and to improve the conditions of Arctic communities as a whole.
7. The Council may also establish Task Forces or Expert Groups to carry out specific work.

Member States

Canada, the Kingdom of Denmark, Finland, Iceland, Norway, the Russian Federation, Sweden and the United States

Permanent Participants

Aleut International Association (AIA), Arctic Athabaskan Council (AAC), Gwich'in Council International (GCI), Inuit Circumpolar Council (ICC), Russian Association of Indigenous Peoples of the North (RAIPON), Saami Council (SC)

Observers

- **States:** France, Germany, the Netherlands, Poland, Spain, United Kingdom, People's Republic of China, Italian Republic, Republic of Korea, Republic of Singapore, Republic of India
- **Non-Govermental Organizations:** Advisory Committee on Protection of the Seas (ACOPS), Arctic Institute of North America (AINA)—Formerly Arctic Cultural Gateway (ACG), Association of World Reindeer Herders (AWRH), Circumpolar Conservation Union (CCU), International Arctic Science Committee (IASC), International Arctic Social Sciences Association (IASSA), International Union for Circumpolar Health (IUCH), International Work Group for Indigenous Affairs (IWGIA), Northern Forum (NF), University of the Arctic (UArctic), World Wide Fund for Nature-Global Arctic Program (WWF)

Chairmanship

- The chairmanship of the Council rotates among the eight member states, each state holding the position for two years at a time.
- **Iceland** is currently holding the Arctic Council Chairmanship (2019-2021).

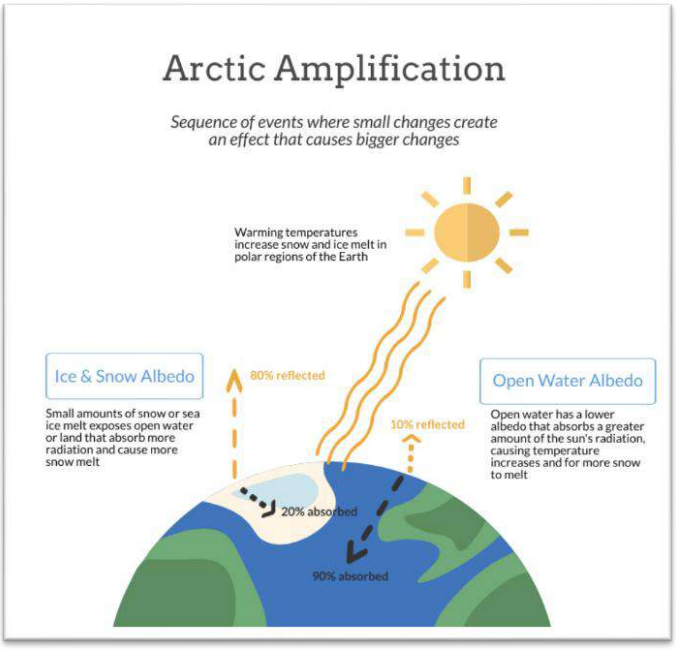
➡ ARCTIC AMPLICATION

#News: *Finnish Meteorological Institute published their study in the Communications Earth & Environment journal, concluding that the Arctic is heating four times faster than the rest of the planet.*

The warming is more concentrated in the Eurasian part of the Arctic, where the Barents Sea north of Russia and Norway is warming at an alarming rate — seven times faster than the global average.

What is Arctic amplification? What causes it?

- Global warming, the long-term heating of the earth's surface, expedited due to anthropogenic forces or human activities since pre-industrial times and has increased the planet's average temperature by 1.1 degrees Celsius.
- While changes are witnessed across the planet, any change in the surface air temperature and the net radiation balance tend to produce larger changes at the north and south poles. This phenomenon is known as **polar amplification**; these changes are more pronounced at the northern latitudes and are known as the **Arctic amplification**.
- Among the many global warming-



driven causes for this amplification, the **ice-albedo feedback**, **lapse rate feedback**, **water vapour feedback** and **ocean heat transport** are the primary causes.

- **Sea ice and snow have high albedo** (measure of reflectivity of the surface), implying that they are capable of reflecting most of the solar radiation as opposed to water and land. In the Arctic's case, global warming is resulting in diminishing sea ice.
- As the sea ice melts, the Arctic Ocean will be more capable of absorbing solar radiation, thereby driving the amplification. The lapse rate or the rate at which the temperature drops with elevation decreases with warming.
- Studies show that the ice-albedo feedback and the lapse rate feedback are responsible for 40% and 15% of polar amplification respectively.
- **Thawing Permafrost** also contributes to Arctic Amplification
- **Permafrost is frozen ground** that is composed largely of decayed plants. It is full of carbon because, as part of the photosynthesis process, living plants continuously extract CO_2 from the air.
- Scientists once thought that the carbon in permafrost binds tightly with iron and is therefore safely sequestered from the atmosphere.
- However, in a study published in a journal demonstrated that iron doesn't permanently trap CO_2.
- This is because, as permafrost melts, bacteria frozen inside the soil activate. They use the iron as a food source. When they consume it, once-captive carbon is released.
- In a process called **photomineralization**, sunlight oxidizes the released carbon into CO_2.

Wildfires and Arctic Amplification

- As temperatures rise and permafrost thaws and dries out, grasslands become tinderboxes.
- When they burn, the CO_2 and CH_4 in the vegetation combust. Airborne in smoke, they add to the atmosphere greenhouse gas load.

Impact on India

- A study found that the **reduced sea ice in the Barents-Kara Sea region** can lead to extreme rainfall events in India, in the latter half of the monsoons — in September and October.
- The study was titled - **'A possible relation between Arctic Sea ice and late season Indian Summer Monsoon Rainfall extremes'**
- The changes in the atmospheric circulation due to diminishing sea ice combined with the warm temperatures in the Arabian Sea contribute to enhanced moisture and drive extreme rainfall events.
- According to the World Meteorological Organization's report, 'State of Global Climate in 2021', sea level along the Indian coast is rising faster than the global average rate.
- One of the primary reasons for this rise is the melting of sea ice in the polar regions, especially the Arctic.

➡ LIGHTNING IN ARCTIC

- Meteorologists were stunned when three successive thunderstorms swept across the icy Arctic from Siberia to north of Alaska, unleashing lightning bolts in an unusual phenomenon that scientists say will become less rare with global warming.
- Typically, the air over the Arctic Ocean, especially when the water is covered with ice, lacks the convective heat needed to generate lightning storms. But as climate change warms the Arctic faster than the rest of the world, that's changing, scientists say.

Tripled in frequency

- Episodes of summer lightning within the Arctic Circle have tripled since 2010, a trend directly tied to climate change and increasing loss of sea ice in the far north, scientists reported in a study published in the journal Geophysical Research Letters. As sea ice vanishes, more water is able to evaporate, adding moisture to the warming atmosphere.
- These electrical storms threaten boreal forests fringing the Arctic, as they spark fires in remote regions already baking under the round-the-clock summer sun.
- The paper also documented more frequent lightning over the Arctic's treeless tundra regions, as well as above the Arctic Ocean and pack ice. In August 2019, lightning even struck within 100 kilometers of the North Pole, the researchers found.
- In Alaska alone, thunderstorm activity is on track to increase threefold by the end of the century if current climate trends continue.

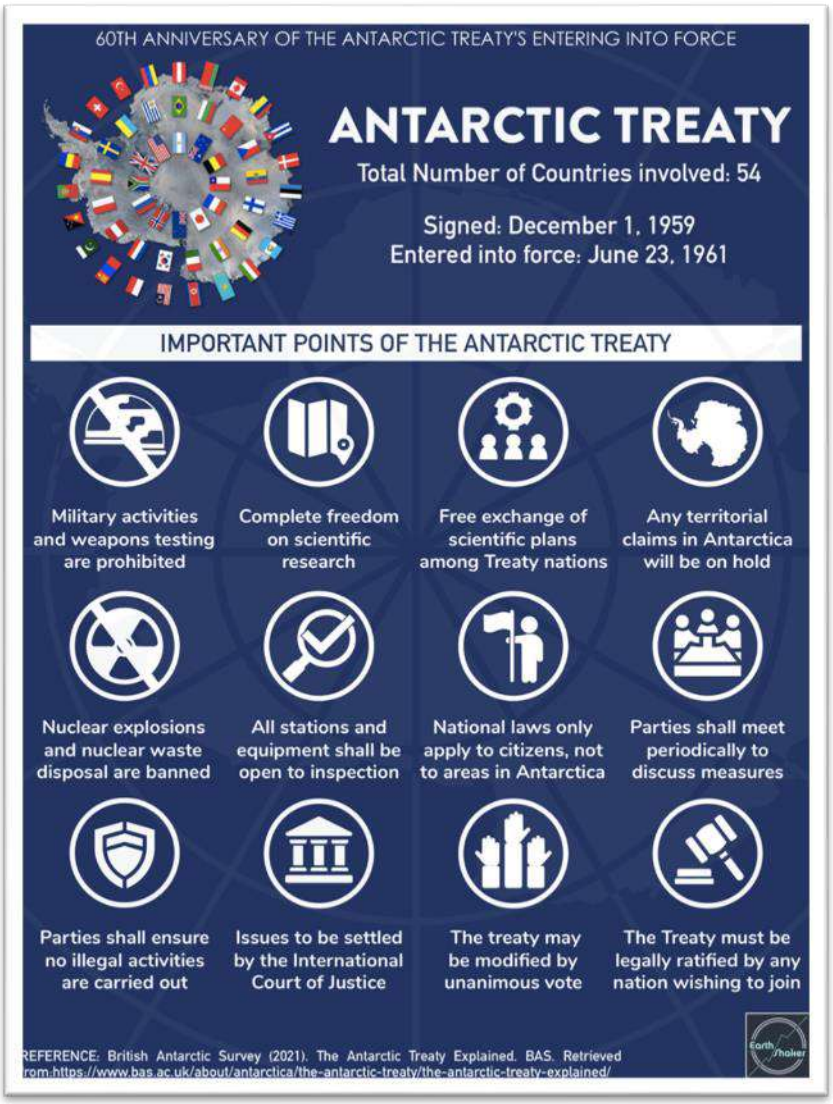
➡ ANTARCTIC TREATY

- The Antarctic Treaty was a treaty signed on **December 1, 1959**, during the Cold War by 12 countries that had vested interests in Antarctica.
- Those 12 countries were Argentina, Australia, Belgium, Chile, France, Japan, New Zealand, Norway, South Africa, the United Kingdom, the United States, and the Soviet Union.

- It entered into force in **1961.**
- The treaty provides a **framework for international relations concerning Antarctica**. It regulates an entire continent with no local population.

Overview of Antarctic Treaty

- The article aims to define the Antarctic Treaty and other relevant information related to it, such as the year it was signed, the 12 original countries that initially signed it, its expansion, function, purpose. It also shines a light on the issue of mining surrounding the continent as natural resources like oil deplete increasingly.
- It also briefly explains the Antarctic Treaty within the context of India, when India got involved, and what research investigations the country is focusing on.



Purpose of Antarctic Treaty

- The Antarctic Treaty of 1961 was written to ensure that Antarctica remained free of any international sovereignty or dispute by permitting its use strictly for humanitarian purposes only.
- The treaty states that Antarctica should be **used only for the benefit of mankind**.
- The main stipulations of this treaty were the **ban of military activities and intervention, nuclear trials, and the disposal of radioactive waste**.
- The treaty, however, **favours scientific investigations and data exchange** as long as they are conducted without violating any rules based on international order concerning Antarctica.
- All territorial **claims or sovereignty are suspended**. Though signed in 1959, the treaty came into effect on 23rd June 1961.

Antarctic Treaty System

- The Antarctic Treaty System (ATS) is the governing body that regulates international relations concerning Antarctica, the only continent without any human population in the world.
- The treaty designated Antarctica as a haven of scientific research with complete scientific autonomy and no military intervention.
- All human activities within the continent are regulated through this treaty to ensure safe and environmentally friendly visits by travellers.
- The treaty **applies to areas south of 60 degrees** south latitude, including land and ice shelves.

Conclusion

- The Antarctic Treaty was a paradigm shift and a significant step towards international relations concerning Antarctica, the continent with no human population.
- The treaty ensures that Antarctica remains free of territorial claim or sovereignty to minimise conflicts or disputes between nations.
- The treaty also ensured that the continent was demilitarised, and provisions were made for joint research and potential use.
- The ban on nuclear testing and dumping of radioactive wastes set a beautiful precedent for environmentally friendly practices. Nations are encouraged to display prudence and cooperation to prevent conflict from escalating.

➡ INDIAN ANTARCTIC BILL, 2022

*The Bill seeks to give effect to the **Antarctic Treaty**, the Convention on the Conservation of Antarctic Marine Living Resources, and the Protocol on Environmental Protection to the Antarctic Treaty.*

- It also seeks to protect the Antarctic environment and regulate activities in the region. Key features of the Bill include:

Applicability

- The provisions of the Bill will apply to any person, vessel or aircraft that is a part of an Indian expedition to Antarctica under a permit issued under the Bill.
- Areas comprising of Antarctica include:

  - the continent of Antarctica, including its ice-shelves, and all areas of the continental shelf adjacent to it, and
  - all islands (including their ice-shelves), seas, and air space south of 60°S latitude.

Central committee

- The central government will establish a Committee on Antarctic Governance and Environmental Protection.
- The Committee will be chaired by the **Secretary of the Ministry of Earth Sciences**.

- 10 members, not below the rank of joint secretary, will be nominated from various Ministries and organisations such as defence, external affairs, National Centre for Polar and Ocean Research, and National Security Council Secretariat.
- In addition, two experts from Antarctic environment and geo-political fields will be nominated by the central government.
- The functions of the Committee include:

  - granting permits for various activities,
  - implementing and ensuring compliance of relevant international laws for protection of Antarctic environment,
  - obtaining and reviewing relevant information provided by parties to the Treaty, Convention, and Protocol, and
  - negotiating fees/charges with other parties for activities in Antarctica.

Need for permit

A permit by the Committee or written authorisation from another party to the Protocol (other than India) will be required for various activities such as:

- an Indian expedition to enter or remain in Antarctica,
- a person to enter or remain in an Indian station in Antarctica,
- a vessel or aircraft registered in India to enter or remain in Antarctica,
- a person or vessel to drill, dredge or excavate for mineral resources, or collect samples of mineral resources,
- activities which may harm native species, and
- waste disposal by a person, vessel or aircraft in Antarctica.

- Before a permit is granted by the Committee, the applicant has to carry out an environmental impact assessment of the proposed activities.
- Moreover, a permit must not be granted unless a waste management plan has been prepared for the expedition by the Committee.

Prohibited activities

The Bill prohibits certain activities in Antarctica including:

- nuclear explosion or disposal of radioactive wastes,
- introduction of non-sterile soil, and
- discharge of garbage, plastic or other substance into the sea which is harmful to the marine environment.

Offences and penalties

The Bill specifies penalties for contravention of its provisions.

- For instance, conducting a nuclear explosion in Antarctica will be punishable with an imprisonment of 20 years which may extend to life imprisonment and a fine of at least Rs 50 crore.
- Drilling for mineral resources or introducing non-native animals or plants in Antarctica without a permit will be punishable with imprisonment up to seven years and a fine between Rs 10 lakh and Rs 50 lakh.

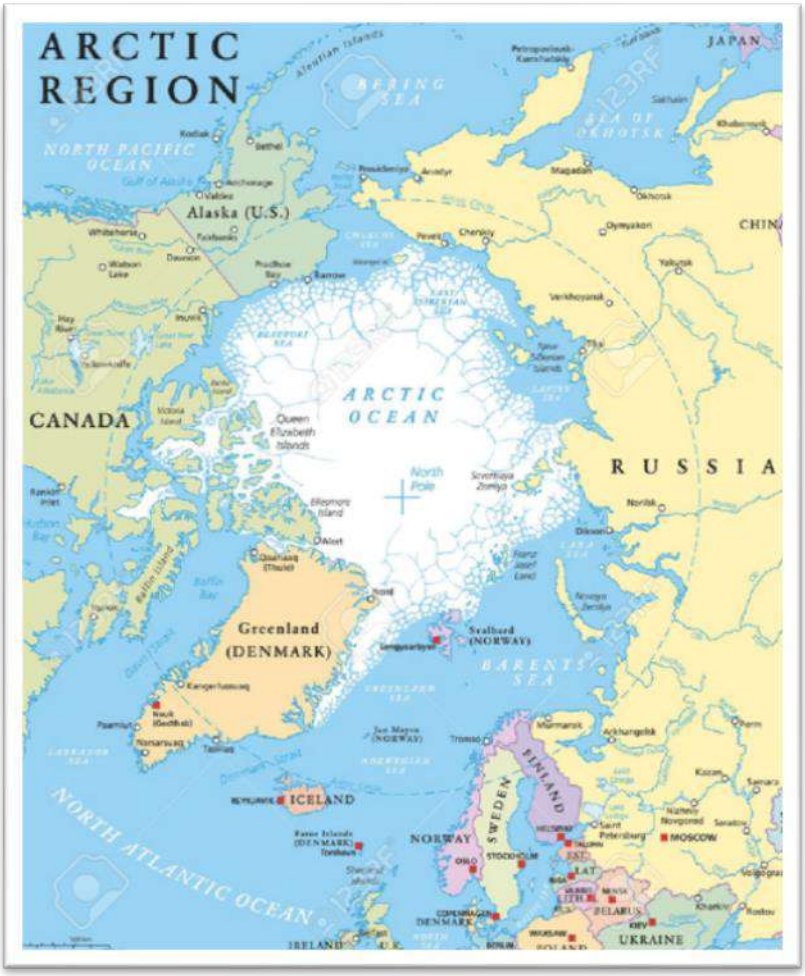
- The central government **may notify one or more Sessions Courts to be the Designated Court** under the Bill and specify its territorial jurisdiction to try offences punishable under the Bill.

➡ INDIA AND THE ARCTIC

- The Arctic region, or the Arctic, is a geographic region spreading around the North Pole. There is no single correct definition of the region as the southern boundary varies.

Key ways to define the Arctic:

- The **Arctic Circle (66 ° 33'N) delimits the Arctic in terms of solar radiation**.
- In theory, areas north of the Arctic Circle have at least one day without daylight in the winter and at least one nightless night in the summer. In practice, this does not happen everywhere because the surface of the earth is uneven, and the light refracts in the atmosphere.
- Based on temperature, the **monthly average temperature in the Arctic is below + 10 ° C throughout the year**, even in summer.
- The forest line follows a **temperature-defined area**. The forest line is not a narrow line but a zone tens of kilometres wide between the northern coniferous forest and the tundra. In this demarcation, the Arctic is predominantly wooded tundra and glaciers.
- **Permafrost increases the area of Russian Arctic** compared to the other delimitations. Permafrost is soil that stays frozen for at least two consecutive years.
- The ice cover determines the Arctic nature of marine areas.



- **Sea ice is highest in February-March** and **lowest in September**. The surface of the Arctic ice is monitored almost in real time by satellites.
- **Culturally defined**, the Arctic covers the **homelands of northern indigenous peoples**.

- **Political delimitations** vary according to how they serve, for example, the interests of states or international cooperation.
- As the climate warms, the Arctic shrinks if defined by temperature, forest line, permafrost, or ice cover. Cultural and political boundaries also vary. The Arctic Circle is the most permanent of the delimitations, although also the polar circle moves very slowly due to the variation of the Earth's axial tilt.

Interesting facts and figures about the Arctic

1. The Arctic is regarded as containing some of the last physically undisturbed marine spaces on earth.
2. Shipping (unique ships) within the Arctic Polar Code area has increased by 25% over 6 years from 2013-2019. A majority of these vessels are fishing vessels.
3. The central feature of the Arctic is the Arctic Ocean. The **Arctic Ocean has the widest continental shelf of all the oceans.**
4. The Arctic sea ice has **diminished from 6,1 million sq.km. in 1999 to 4,3 million sq.km. in 2019.**
5. Boreal forests of the Arctic cover about 17% of the global land area, representing the largest natural forests in the world.
6. Together with the Antarctic, the Arctic contains the largest freshwater resource on Earth.
7. **Seven of the world's ten largest wilderness** areas are located in the Arctic region.
8. The total catch of wild fish in the Arctic mounted to 10% of the world catch .
9. The Arctic as an area is essentially an ocean surrounded by the land north of the Arctic circle (66032' N) that covers a region of 33 million Km2 , larger than Africa or Asia.
10. The United States Geological Survey (USGS) estimates that 30 per cent of the world's undiscovered natural gas is in the Arctic, mostly on the continental shelves beneath the Arctic Ocean.
11. More than 70 per cent of the undiscovered oil resources are estimated to occur in northern Alaska, the Amerasian Basin, the eastern side of Greenland, the eastern Barents Sea region, and the Davis Strait of Greenland and Canada.
12. An estimated 84 per cent of the undiscovered oil and gas in the Arctic occurs offshore.The Arctic region is characterized by some of the largest continuous intact ecosystems on the planet, but is facing increasingly larger threat.

What is the Background?

- India's engagement with the Arctic began when it signed the **Svalbard Treaty in 1920** in Paris between Norway, the US, Denmark, France, Italy, Japan, the Netherlands, Great Britain, and Ireland, and the British overseas Dominions and Sweden concerning Spitsbergen.
- Spitsbergen is the **largest island of the Svalbard archipelago**, part of Norway, in the Arctic Ocean.
- Spitsbergen is the only permanently inhabited part of Svalbard. More than 50% of the land is covered in ice year-round. Together with the glaciers, it is mountains and fjords that define the landscape.
- Ever since then, India has been closely monitoring all the developments in the Arctic region.
- India initiated its **Arctic research program in 2007** with a focus on climate change in the region.

- The objectives included **studying teleconnections between Arctic climate and Indian monsoon**, to characterise sea ice in the Arctic using satellite data, to estimate the effect on global warming.
- India also focuses on conducting research on the dynamics and mass budget of Arctic glaciers and sea-level changes, carrying out an assessment of the flora and fauna of the Arctic.

Six Central Pillars of India's Arctic Policy

- Science and research.
- Environmental protection.
- Economic and human development.
- Transportation and connectivity.
- Governance and international cooperation.
- National capacity building.

Objectives

- It aims to strengthen national capabilities and competencies in science and exploration, climate and environmental protection, maritime and economic cooperation with the Arctic region.
- It seeks to strengthen institutional and human resource capacities within the government and academic, research and business institutions through inter-ministerial coordination in pursuit of India's interests in the Arctic.
- It seeks to **enhance understanding of the impact of climate change in the Arctic region on India's climate,** economic and energy security.
- It aims to promote better analysis, prediction and coordinated policymaking on the implications of ice melting in the Arctic on India's economic, military and strategic interests related to global shipping routes, energy security and exploitation of mineral wealth.
- It seeks to study the linkages between polar regions and the Himalayas and deepen the cooperation between India and the countries of the Arctic region under various Arctic forums, drawing expertise from scientific and traditional knowledge.
- The policy also seeks to increase India's participation in the Arctic Council and improve understanding of the complex governance structures in the Arctic, relevant international laws and geopolitics of the region.

Relevance of Arctic for India

- The Arctic region is significant due to the shipping routes that run through it.
- According to an analysis published by the Manohar Parrikar Institute for Defence Studies and Analyses, the adverse effects of the Arctic are not just impacting the availability of mineral and hydrocarbon resources, but also transforming global shipping routes.
- According to the Ministry of External Affairs, India can play a constructive role in securing a stable Arctic.
- The region holds immense geopolitical importance as the Arctic is projected to be ice-free by 2050 and world powers making a beeline to exploit the region rich in natural resources.

➡ HEAT FROM DATACENTRES

- A datacentre is a **physical facility that organisations use to store their critical applications and data, process data and disseminate them to users**.
- It is designed based on a network of computing and storage resources that enables delivery of shared applications and data.
- The **key components** of a datacentre are routers, switches, firewalls, storage systems, servers, and application-delivery controllers.
- Many large datacentres are located in dedicated buildings. Smaller datacentres may be situated in specially designed rooms within buildings constructed to serve multiple functions.
- Since datacentres consume large amounts of energy, it's important to ensure the physical structures that house them are well-designed and insulated to optimise temperature controls and energy efficiency.
- The temperatures recorded in the hot aisles of a datacentre hover **between 80 and 115 degrees Fahrenheit,** according to Lifeline datacentres, a provider of datacentre facilities and services.
- Global cybersecurity firm Kaspersky estimates over 75% of a datacentre's electricity becomes waste heat.
- It noted that in winter, a datacentre can provide heating up to 85 degrees Fahrenheit, similar to a gas boiler, with better energy efficiency than a heat pump in a new house.

What's the scale of their carbon footprint?

- On a global level, datacentres consume **around 200 terawatt-hours (TWh) of electricity**, which is **more than 1% of the world's total electricity**.
- They **contribute to 0.3% of all global CO2 emissions**, according to the International Energy Agency.
- Datacentre energy usage in some countries could increase to 15% to 30% of their total domestic electricity consumption by the end of the decade, according to predictive models by Eric Masanet and Nuoa Lei of Northwestern University.
- Ireland's energy regulator says datacentres could use almost 30% of the country's electricity by 2027, endangering climate goals.

What is Microsoft's plan to cut carbon emission in Finland?

- According to Microsoft, the recycled waste heat, along with other carbon reduction measures, can help the city of Espoo and its neighbouring communities to reach their CO2 emission reduction targets. It can also help decommission Fortum's last coal-fired heat unit in the city.
- The heat recycling system can **provide clean heat to homes, businesses and public buildings in Helsinki, and can reduce up to 400,000 tons of CO2 emissions annuall**y, according to estimates by Fortum.
- The company highlighted that once the new data centre region's waste heat capture is in operation, a total of about 60% of the area's heating will be generated by climate-friendly waste heat. Of this, 40% results from the datacentre region and the rest from other waste heat sources like purified waste water.

- Fortum will capture the excess heat generated by the new datacentre region and transfer the clean heat from the server cooling process to homes, services and business premises that are connected to the district heating system.
- **District heating** is the most popular method of heating premises in Finland. It is a system of generating heat in a centralised location by capturing heat and then distributing it to buildings for residential and commercial heating needs. The heat is transferred to customers as hot water which is pumped through insulated underground pipes.
- The new generation of district heating is based on replacing fossil fuels with flexible solutions like renewable electricity, heat pumps and waste heat utilisation. Artificial intelligence will help optimise operations of the entire system.

Which other countries recycle waste heat from datacentres?

- District heating is popular in the **Nordic and Baltic countries**, as well as in **Russia and China**, which have high heat demands during winters.
- Datacentres **thrive in cold climates**.
- Their location in **cold climates helps to cut down on the need to cool server rooms**.
- Cold weather is also an asset as technology companies shift to selling their heat which doesn't have a lot of demand in hot weather.

Which other companies are doing this?

- **Facebook** is putting its waste heat to use heating nearby homes in Odense, Denmark.
- **Apple** is building a datacentre in Denmark and plans to run it with renewable energy and use waste heat to warm up nearby office buildings.
- **Fast fashion retailer H&M** has been distributing waste heat to nearby homes in Denmark since 2013 and has plans to build a new, 1 MW datacentre that will be capable of heating up to 2,500 apartments at full load.
- An **IBM datacentre** in Switzerland is heating a nearby community pool.
- In Canada, communications company **Quebecor** donates its heat to the editorial office of a local newspaper.

➡ HEATWAVES

#News: *During peak of summer in 2022, the European Space Agency recorded land surface temperatures nearing 55°C over many parts of northwest India, crossing 60°C in some pockets.*

The five warmest years ever recorded in India have all been in the last decade.

Heatwave

- A heatwave is a period of abnormally high temperatures, a common phenomenon in India during the months of May-June and in some rare cases even extends till July.
- India Meteorological Department (IMD) classifies heat waves according to regions and their temperature ranges. As per IMD, the number of heatwave days in India has increased from **413 over 1981-1990 to 600 over 2011-2020.**
- This sharp rise in the number of heatwave days has resulted due to the increasing impact of climate change.

Criteria for declaring a heatwave

- The Heatwave is considered when the **maximum temperature of a station reaches at least 40°C** for Plains and **at least 30°C for Hilly regions**.
- If the normal maximum temperature of a station is less than or equal to 40°C, then an increase of 5°C to 6°C from the normal temperature is considered to be heat wave condition.
- Further, an **increase of 7°C or more from the normal temperature** is considered a severe heat wave condition.
- If the normal maximum temperature of a station is more than 40°C, then an increase of 4°C to 5°C from the normal temperature is considered to be heat wave condition. Further, an increase of 6°C or more is considered a severe heat wave condition.
- Additionally, if the actual **maximum temperature remains 45°C or** more irrespective of normal maximum temperature, a heat wave is declared.
- In **2016, the National Disaster Management Authority (NDMA)** issued comprehensive guidelines to prepare national level key strategies for mitigating the impact of heatwaves.

Impacts of Heat Waves In India

Economic Impacts	○ The frequent occurrence of heat waves also adversely affects different sectors of the economy. ○ For instance, the **livelihood of poor and marginal farmers** is negatively impacted due to the **loss of working days**. ○ Heatwaves also have an **adverse impact on daily wage workers' productivity**, impacting the economy. ○ **Crop yields suffer** when temperatures exceed the ideal range. ○ Farmers in Haryana, Punjab and Uttar Pradesh have reported losses in their wheat crop in the past rabi season. Across India, wheat production could be down 6-7% due to heat waves. ○ **Livestock is also vulnerable** to heatwaves.
Human Mortality	○ Mortality due to heat waves occurs because of rising temperature, lack of public awareness programmes, and inadequate long-term mitigation measures. ○ According to a **2019 report of the Tata Centre for Development** and the University of Chicago, by 2100, annually, more than 1.5 million people will be likely to die due to extreme heat caused by climate change. ○ The increased heat will lead to an increase in diseases like diabetes, circulatory and respiratory conditions, as well as mental health challenges.
Food Insecurity	○ The concurrence of heat and drought events are causing **crop production losses and tree mortality.** ○ The risks to health and food production will be made more severe from the sudden **food production losses** exacerbated by heat-induced labour productivity losses. ○ These interacting impacts will **increase food prices, reduce household incomes, and lead to malnutrition and climate-**

	related deaths, especially in tropical regions.
Impact on Workers	○ Workers in sectors like **agriculture and construction** will be severely impacted in 2030 because India's large population depends on these sectors for their livelihoods.
Weaker Sections to be Specifically Affected	○ The climate science community has reported overwhelming evidence that extreme events such as heatwaves are likely to become more intense, more frequent and of longer duration in future unless emissions of greenhouse gases and aerosols are significantly cut globally. ○ It is important to remember that heatwaves in India, such as in 2022, have the potential to influence thousands of vulnerable and poor people who contributed very little to the climate crisis.

Long-term strategies does India need to adopt to mitigate the impacts

Heat Waves Action Plan	○ As deaths due to heatwaves are preventable, the government must prioritise preparing a long-term action plan to safeguard human lives, livestock, and wildlife. ○ Effective implementation of the **Sendai Framework for Disaster Risk Reduction 2015-30** with the State playing a leading role and sharing responsibility with other stakeholders is now the need of the hour.
Public Awareness and Early Warning Systems	○ **Disseminating public awareness** through print, electronic and social media, providing heat-proof shelter facilities in heatwave prone areas during summer, easing access to public drinking water, and afforestation programmes in urban and rural areas would help mitigate heat wave fatalities. ○ Death from heat waves can be prevented by **installing improved early warning systems** that communicate heatwave threats, recommend different preventative measures, and constrain disaster impacts.
Implementing Climate Action Plans	○ **National Action Plan for Climate Change (NAPCC)** should be implemented in true spirit for inclusive growth and ecological sustainability. ○ Nature-based solutions should be taken into account, not just for tackling climate change but also doing it in a way that is ethical and promoting intergenerational justice. ○ **Recognising heat waves as a major disaster** is long due. India still has a long way to go in building public awareness, particularly on how individuals and local communities can take care of themselves. ○ Declaring heat waves as a natural disaster would help the state and district administration prepare a heatwave action plan at the regional level. ○ Also, there needs to be clear guidelines regarding when to shut schools or how long one should stay outdoors if that's unavoidable.
Sustainable	○ **Passive cooling technology**, a widely-used strategy to create naturally

Cooling	ventilated buildings, can be a vital alternative to address the urban heat island for residential and commercial buildings. ○ The Intergovernmental Panel on Climate Change (IPCC) stated that ancient Indian building designs that have used this technology, can be adapted to modern facilities in the context of global warming.
Replacing Dark Roofs	○ A big reason that cities are hotter than rural areas is that they are covered by dark roofs, roads and parking lots that absorb and retain heat. ○ One of the long term solutions can be replacing the dark surfaces **with lighter and more reflective materials,** it will result in a comparatively cooler environment.
Climate-Resilient Crops	○ A dynamic understanding of risks is needed to evaluate whether the crops we have relied on so far will also be the ones to provide food and nutrition security in future. ○ Provisions will have to be made for insurance against crop loss and mixed cropping should be promoted.

➡ URBAN FLOODING

- Urban flooding is the **inundation of land or property in a built environment**, particularly in more densely populated areas (like cities), caused by rainfall overwhelming the capacity of drainage systems.
- Unlike rural floods (Heavy rain over a flat or low-lying area), urban flooding is not only caused by just higher precipitation but also unplanned urbanisation (catchments) that:

- increases the flood peaks from 1.8 to 8 times
- increases the flood volumes by up to 6 times.

Causes of urban flooding in India

Encroachments on Drainage Channels	○ In Indian cities and towns, due to increased land prices and less availability of land in the city centre. New developments are coming up in low-lying areas, usually as encroachments over lakes, wetlands and riverbeds. ○ Ideally, the natural drains should have been widened (similar to road widening for increased traffic) to accommodate the higher flows of stormwater. ○ But on the contrary, there have been large scale encroachments without widening the natural drains. Consequently, the capacity of the natural drains has decreased, resulting in flooding.
Climate Change	○ Exacerbated by changing climate, resulting in extreme events. The climate change has caused an **increase in the frequency of short duration heavy rainfall leading to higher water run-off.** ○ Whenever the **rain bearing clouds pass over the urban heat island**, the hot air pushes the clouds up, resulting in highly localised

	rainfall which may sometimes be of high intensity.
Unplanned Tourism Activities	○ Water bodies have been used as an attraction for tourism development for decades. Water plants that reduce the runoff speed are being removed from rivers and lakes for maintaining tourism activity. ○ Throwing **non-bio degradable matter into the rivers and lakes** during religious and cultural activities reduces the water quality. In the event of floods, the suspended particles and pollutants overflow into the cities posing health risks.
Uninformed Release of Water from Dams	○ Unplanned and sudden release of water from dams and lakes lead to floods in an urban area, without giving the public enough time to respond. ○ **Example:** Chennai Floods 2015 due to release of water from Chembarambakkam Lake.
Illegal Mining Activities	○ Illegal mining of river sand and quartzite for use in building construction deplete the natural bed of the rivers and lakes. ○ It causes soil erosion and reduces the water retention capacity of the waterbody increasing the speed and scale of water flow. ○ Example: Jaisamand Lake- Jodhpur, Cauvery river- Tamil Nadu.

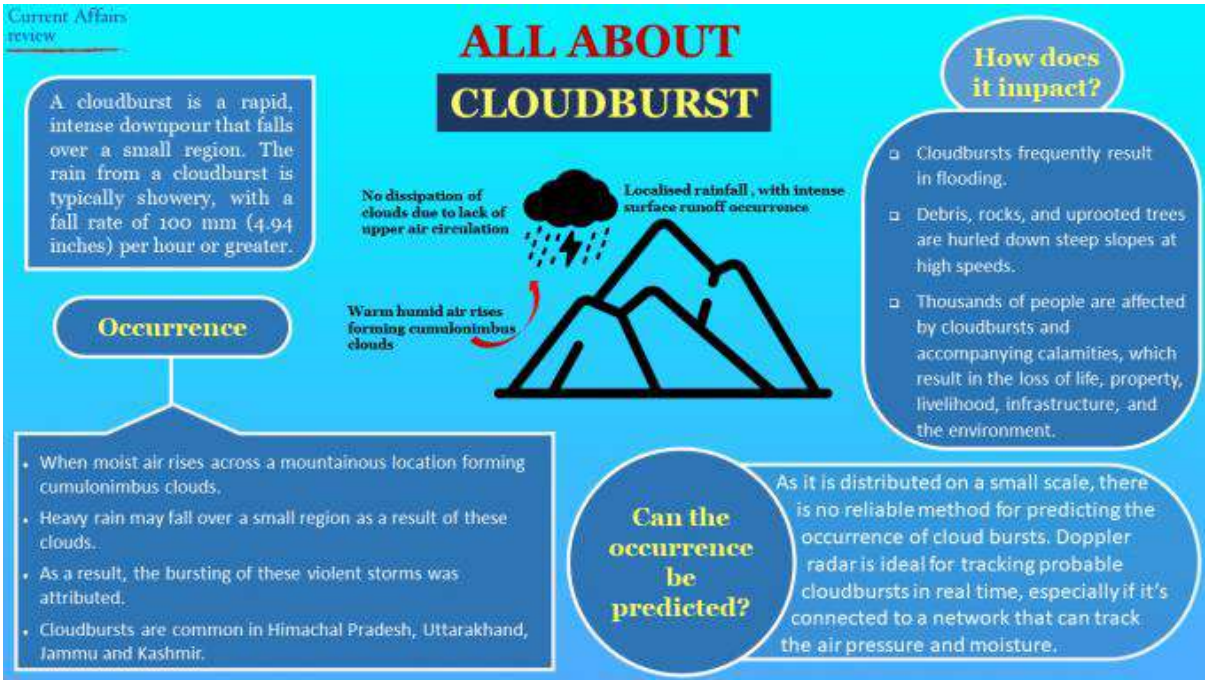
Steps taken to Mitigate Urban Flooding

- One of the best solutions to reduce the chances of flooding is to build away from floodplains and high flood hazard zones. It is a challenging task to identify such zones and water bodies but using geospatial analysis can lend crucial aid in identifying such areas.
- New construction in flood-prone areas must be strictly monitored and regulated and in areas where constructions had already finished or rather encroached upon. Structural flood control measures, like increasing stormwater drainage capacitors, must be taken into account.
- Government initiatives like the **Sponge Cities mission and Atal Mission for Rejuvenation and Urban Transformation (AMRUT)** can go a long way in helping civic authorities to plan cities keeping flood risks in mind. Further, residential and commercial stakeholders can be further motivated to install green infrastructure options like rain gardens, green roofs, and rainwater harvesting systems.
- In addition to reducing flood risks, these systems store water for drier seasons and help in recharging groundwater. It is only prudent to invest in making our cities resilient so that when disaster strikes, we can bounce back to normal with minimum loss of life and property.
- Along with the government taking these measures, the general public must also be educated about the dangers of buying houses in low lying areas or near floodplains. Such steps may not yield immediate results but the steps taken might lead to tangible results in the future.

➡ CLOUD BURST

- Cloudbursts are **short-duration, intense rainfall events** over a small area.
- It is a weather phenomenon with unexpected precipitation exceeding 100mm/h over a geographical region of approximately 20-30 square km.

- In the Indian Subcontinent, it generally occurs when a **monsoon cloud drifts northwards**, from the **Bay of Bengal or the Arabian Sea** across the plains then on to the Himalaya that sometimes brings 75 millimetres of rain per hour.



Occurrence

- The relative humidity and cloud cover is at the **maximum level with low temperature and slow winds** because of which a high amount of clouds may get condensed at a very rapid rate and result in a cloudburst.
- As temperatures increase, the atmosphere can hold more and more moisture and this moisture comes down as a short very intense rainfall for a short duration probably half an hour or one hour resulting in flash floods in the mountainous areas and urban floods in the cities.

Cloudburst are Different from Rainfall

- Rain is condensed water falling from a cloud while cloudburst is a sudden heavy rainstorm.
- Rain over 100mm per hour is categorised as a cloudburst.
- The cloudburst is a natural phenomenon, but occurs quite unexpectedly, very abruptly, and rather drenching.

Impact of Climate Change

- Several studies have shown that climate change will increase the frequency and intensity of cloudbursts in many cities across the globe.
- In May 2021, the World Meteorological Organization noted that there is about a 40% chance of the annual average global temperature temporarily reaching 1.5°C above the pre-industrial level in at least one of the next five years.
- It added that there is a 90% likelihood of at least one year between 2021 and 2025 becoming the warmest on record and dislodge 2016 from the top rank.

- It is seen that more cloudbursts are happening in Himalayan region because the decadal temperature rise in the Himalayan region is higher than the global rate of rising temperatures.
- **Consequences of Cloudbursts:** Flash floods, Landslides, Mudflows, Land caving.

Prediction

- There is no satisfactory technique for anticipating the occurrence of cloud bursts because they develop over a small period of time.
- A very fine network of radars is required to be able to detect the likelihood of a cloud burst and this would be expensive.
- Only the areas likely to receive heavy rainfall can be identified on a short range scale. Much of the damage can be avoided by way of identifying the areas and the meteorological situations that favour the occurrence of cloud bursts.

CONSERVATION- FLORA AND FAUNA

➡ UN DECADE ON ECOSYSTEM RESTORATION

- **2021-2030** was declared the Decade for Ecosystem Restoration.
- It called for a **biosphere restoration** equal to the total land area of China.
- In addition, more stringent efforts towards climate mitigation as well were needed to preserve the ecological makeup of the earth.
- It was first proposed by **El Salvador during the Bonn Challenge** meeting in March 2018. The proposal put forward by El Salvador called for restoration of about 350 million hectares of degraded ecosystems by 2030.
- About 71 countries supported the proposal during the 73rd session of the United Nations General Assembly in 2018.
- On 1 March 2019, the UN General Assembly officially adopted the resolution declaring **2021–2030 the UN Decade of Ecosystem Restoration.**

Rationale

- The aim of the Decade on Ecosystem Restoration is balancing **ecological, social and developmental priorities** with the aim of fostering long term resilience.
- Human activities are affecting the capacity of ecosystems to provide these goods and services. Drivers of biodiversity loss and decline in ecosystem functioning include climate change, deforestation, desertification and land degradation, freshwater decline, overexploitation, stratospheric ozone depletion, and pollution.
- It is therefore necessary to **preserve the ecosystem for future generations**.

Aim of UN Decade on Ecosystem Restoration

The UN Decade on Ecosystem Restoration was established in order to:

1. **Build a common vision**, prioritizing ecosystem restoration from the global to the local level to accelerate reversal of ecosystem degradation.

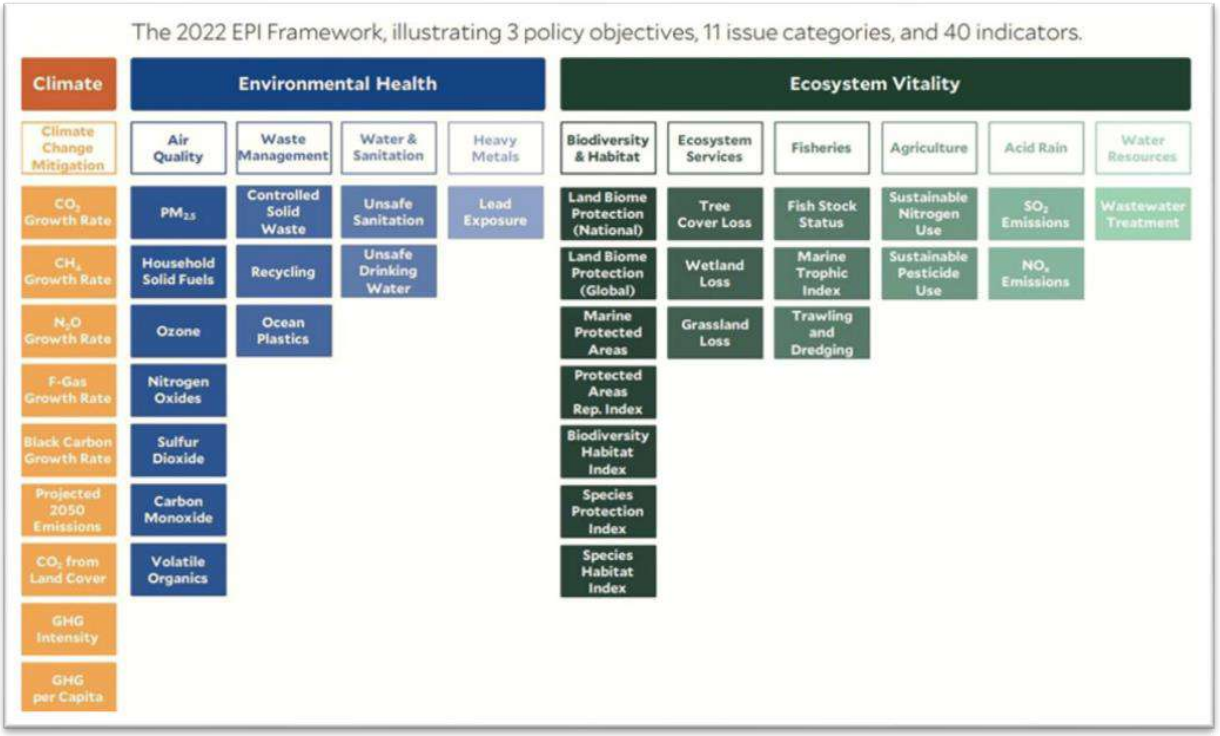
2. **Mainstream ecosystem restoration in policy and planning** to address current developmental challenges due to land degradation, biodiversity loss, and climate change vulnerability

3. **Foster a holistic approach** to achieving international commitments and national priorities through ecosystem and landscape restoration
4. **Enhance cooperation and resource mobilization** to increase the flow of financial resources, technologies, knowledge, and capacity building to countries and jurisdictions working to meet national goals and international commitments, including the Sustainable Development Goals, through ecosystem restoration
5. **Encourage partnerships and investments**, promoting a resilient economy by increasing support for smallholders' generation of value from land use products and potential to contribute to ecosystem restoration
6. **Promote cooperation between funds providers, governments, civil society, and the private sector** to help overcome barriers to scaling up resource-efficient productive systems in association with ecosystem restoration
7. **Raise awareness** of the importance of functional ecosystems for human well-being and productive activities, local development and the economic sustainability of society
8. The UN Decade aims to **promote a concerted and holistic landscape-focused approach** to the interdependence of ecosystems, human needs, and biodiversity, to accelerate the progress needed to maintain and restore ecosystems.

➡ ENVIRONMENT PERFORMANCE INDEX (EPI) 2022

EPI 2022 ranks India right at the bottom among 180 countries based on performance across parameters related to mitigating climate change, improving environmental health, and protecting ecosystem vitality.

The report is generally prepared by researchers from ***Yale and Columbia Universities*** *in the United States.* ***Denmark is ranked at the top*** *with a score of 77.90, while* ***India scored 18.90****.*



About the ranking

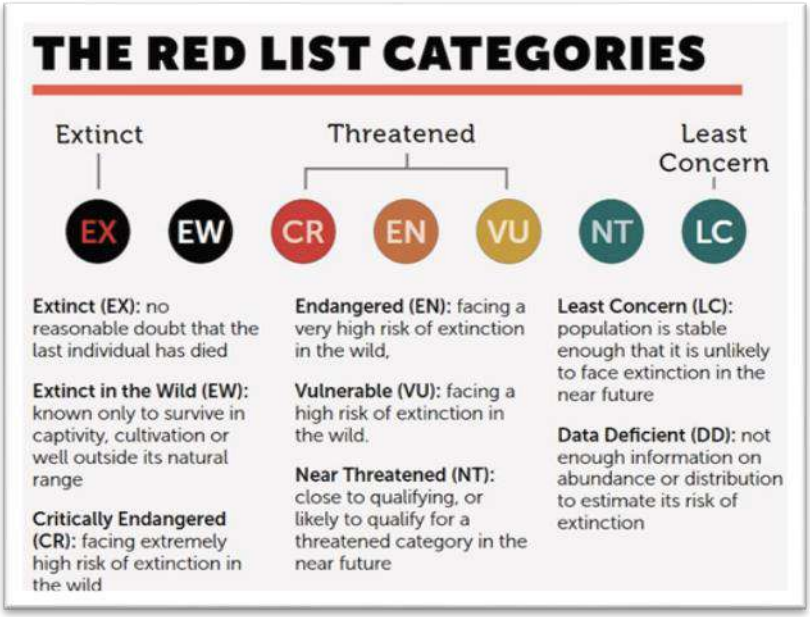
- The overall EPI rankings indicate **which countries are best addressing the environmental challenges** that every nation faces.
- It **provides a way** to spot problems, set targets, track trends, understand outcomes, and identify best policy practices.
- **Data and fact-based analysis can also help government officials** refine their policy agendas, facilitate communications with key stakeholders, and maximise the return on environmental investments.
- The **EPI also offers a powerful policy tool** in support of efforts to meet the targets of the UN Sustainable Development Goals and to move society toward a sustainable future.
- The 2022 EPI **supports evolving climate policy discussions** with a new that projects countries' progress towards net-zero emissions in 2050.
- **Most low-scoring countries** such as Myanmar and Vietnam, are those **that have prioritised economic growth over sustainability,** or those that are struggling with civil unrest and other crises. China and India are projected to be the largest and second-largest emitters of greenhouse gases in 2050, despite recently promising to curb emission growth rates.

- Many countries, including **India and China, rely heavily on coal to support economic growth** as their population grows. Large-scale fossil fuel combustion adds to the poor air quality.
- India is **home to 21 of the 30 most polluted cities** in the world and has an air quality rated one of the poorest in the world.
- **Seven indicators —** PM2.5 exposure, household solid fuels, ozone exposure, nitrogen oxides exposure, sulphur dioxide exposure, carbon monoxide exposure, and volatile organic compound exposure — are used to determine the air quality in the listed countries.
- **China, India, the U.S., and Russia** will account for over **50 per cent of residual global greenhouse gas emissions in 2050**.
- **Greenhouse gases (GHG)** include carbon dioxide, methane, fluorinated gases, and nitrous oxide. To project GHG emission levels in 2050, the study calculates the average rate of increase or decrease in emissions over ten years (2010 – 2019) and extrapolates this trend till 2050.
- **India and Indonesia** have been identified as the **top two generators of marine plastic waste** in the world, while China has managed to decrease its ocean plastic pollution.
- Ocean plastic pollution is measured as an **absolute quantity of the amount of plastic released by a country into the ocean annually**.
- **Indonesia, India, the U.S., Brazil and Thailand** are the top five producers of ocean plastic pollution and are responsible for 43 per cent of the global total.

➡ IUCN

- **International Union for Conservation of Nature** (IUCN), in full **International Union for Conservation of Nature and Natural Resources** was formerly called **World Conservation Union**.
- It is a network of environmental organizations founded as the **International Union for the Protection of Nature in October 1948 in Fontainebleau, France**, to promote nature conservation and the ecologically sustainable use of natural resources.
- It changed its name to the International Union for Conservation of Nature and Natural Resources (IUCN) in 1956 and was also known as the World Conservation Union (IUCN) from 1990 to 2008. The IUCN is the world's oldest global environmental organization.
- Its headquarters are in **Gland, Switz**.
- Through its member organizations, the IUCN supports and participates in environmental scientific research; promotes and helps implement national conservation legislation, policies, and practices; and operates or manages thousands of field projects worldwide.
- The IUCN's activities are organized into **several theme-based programs** ranging from business and biodiversity to forest preservation to water and wetlands conservation. In addition, a smaller number of special initiatives draw upon the work of different programs to address specific issues, such as climate change, conservation, and poverty reduction.
- The volunteer work of more than 10,000 scientists and other experts is coordinated through special commissions on education and communication; environmental, economic, and social policy; environmental law; ecosystem management; species survival; and protected areas.

- All of the IUCN's work is guided by a global program, which is adopted by member organizations every four years at the IUCN World Conservation Congress.
- The IUCN maintains the **IUCN Red List of Threatened Species**, a comprehensive assessment of the current risk of extinction of thousands of plant and animal species. The organization also publishes or coauthors hundreds of books, reports, and other documents each year.
- The IUCN has been **granted observer status at the United Nations General Assembly.**



- The IUCN's membership includes more than 1,000 governmental and nongovernmental organizations from more than 140 countries.
- It is governed by a **democratically elected council**, which is chosen by member organizations at each World Conservation Congress. The IUCN's funding comes from a number of governments, agencies, foundations, member organizations, and corporations.

➡ CITES

- The Convention on International Trade in Endangered Species of Wild Fauna and Flora, often referred to as CITES, is an agreement between governments that **regulates the international trade of wildlife and wildlife products**—everything from live animals and plants to food, leather goods, and trinkets.
- It **came into force in 1975** with the goal of ensuring that international trade does not threaten the survival of wild plants and animals.
- There are about 5,800 species of animals and 30,000 species of plants protected by CITES currently. They're categorized into one of three appendices, depending on how at risk from trade they are.
- As of June 2019, CITES had 183 party governments, which must abide by CITES regulations by implementing legislation within their own borders to enforce those regulations.
- CITES was **first conceived of at a 1963 meeting** of the International Union for the Conservation of Nature (IUCN), the global authority on the conservation status of wild animals and plants.

What are CITES appendices?

There are three appendices: Appendix I, II, and III. Each denotes a different level of protection from trade.

- **Appendix I** includes species that are in **danger of extinction because of international trade**. Permits are required for import and export, and trade for commercial purposes is prohibited.

Trade may be allowed for research or law enforcement purposes, among a few other limited reasons, but first the source country must confirm that taking that plant or animal won't hurt the species' chance of survival. (This is known as a **"non-detriment finding."**)
The **Asiatic lion** and **tigers** are two species listed as Appendix I.

- **Appendix II** includes species that **aren't facing imminent extinction but need monitoring to ensure that trade doesn't become a threat**.

Export is allowed if the plant, animal, or related product was obtained legally and if harvesting it won't hurt the species' chance of survival.
American alligators are listed on Appendix II, for example. They were overhunted through the 1960s for their skin, but their numbers are now on the rise.
CITES Appendix II listing helps ensure the alligator skin trade doesn't become a threat again.

- **Appendix III** includes **species that are protected in at least one country**, **when that country asks others for help in regulating the trade**.

  Regulations for these species vary, but typically the country that requested the listing can issue export permits, and export from other countries requires a certificate of origin.

➡ CONVENTION ON BIOLOGICAL DIVERSITY

- The Convention on Biological Diversity (CBD), known informally as the Biodiversity Convention, is a **multilateral treaty**.
- The Convention on Biological Diversity (CBD) was adopted at the Earth Summit, in Rio de Janeiro, in 1992.
- It has three main objectives:

a. To conserve biological diversity;
b. To use its components in a sustainable way;
c. To share fairly and equitably the benefits arising from the use of genetic resources.

- The CBD was negotiated under the guidance of the United Nations. It was signed by more than 150 government leaders at the Rio Earth Summit (which official denomination is the 'United Nations Conference on Environment and Development').
- The convention is now one of the most widely ratified international treaties on environmental issues, with 194 member countries.
- Unlike other international agreements that set compulsory targets and obligations, the CBD takes a flexible approach to implementation.
- It identifies general goals and policies, and countries are free to determine how they want to implement them.

The Convention on Biological Diversity has adopted two supplementary protocols they are:

1. **The Cartagena Protocol on Bio-safety -** The Cartagena Protocol on Bio-safety to the Convention on Biological Diversity is an international treaty governing the movements of living modified organisms (LMOs) resulting from modern biotechnology from one country to another. It was adopted in 2000 as a supplementary agreement to the Convention on Biological Diversity and entered into force in 2003.
2. **Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization -** The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity is a supplementary agreement to the Convention on Biological Diversity.

- It provides a transparent legal framework for the effective implementation of one of the three objectives of the CBD: **the fair and equitable sharing of benefits arising out of the utilization of genetic resources.** The Protocol was adopted in 2010 in Nagoya, Aichi Province, Japan, and entered into force in 2014.
- Its objective is the fair and equitable sharing of benefits arising from the utilization of genetic resources, thereby contributing to the conservation and sustainable use of biodiversity. The Strategic Plan consists of 20 new biodiversity targets, termed the **'Aichi Biodiversity Targets'**

- **Aichi Biodiversity Targets**

The 20 Aichi Targets are divided into 5 sections

- **Strategic Goal A:** Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society
- **Strategic Goal B:** Reduce the direct pressures on biodiversity and promote sustainable use.
- **Strategic Goal C:** To improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity.
- **Strategic Goal D:** Enhance the benefits to all from biodiversity and ecosystem services.
- **Strategic Goal E:** Enhance implementation through participatory planning, knowledge management and capacity building.

➡ PROTECTED AREA

- Protected areas are those in which human occupation or at least the exploitation of resources is limited.
- The definition has been provided by IUCN in its categorization guidelines for protected areas.
- The term "**protected area"** also includes Marine Protected Areas, the boundaries of which will include some area of ocean, and Transboundary Protected Areas that overlap multiple countries which remove the borders inside the area for conservation and economic purposes.

National Parks	• An area, whether within a sanctuary or not, can be **notified by the state government** to be constituted as a National Park, by reason of its ecological, faunal, floral, geomorphological, or zoological association or importance, needed to for the purpose of protecting & propagating or developing wildlife therein or its environment. • The state government can fix and alter boundaries of the National Parks with prior consultation and approval with **National Board of Wildlife.** • There is no need to pass an act for alternation of boundaries of National Parks. • **No human activity is permitted inside the national park** except for the ones permitted by the Chief Wildlife Warden of the state under the conditions given in the Wildlife Protection Act 1972.
Wildlife Sanctuaries	• Any area other than area comprised with any reserve forest or the territorial waters can be notified by the State Government to constitute as a sanctuary if such area is of adequate ecological, faunal, floral, geomorphological, natural or zoological significance, for the purpose of protecting, propagating or developing wildlife or its environment. • There is no need to pass legislation (act) by the state assembly to declare a wildlife sanctuary. Fixation and alternation of boundary can be done by state legislature via resolution. • No need to pass an act for alternation of boundaries. No alternation of boundaries in wildlife sanctuaries can be done without approval of the NBWL (National Board of Wildlife). • **Some restricted human activities** are allowed inside the Sanctuary area details of which are given in wildlife protection Act 1972.
Conservation reserves and community reserves	• These are terms denoting protected areas of India which typically act as **buffer zones to or connectors and migration corridors** between established national parks, wildlife sanctuaries and reserved and protected forests of India. • Such areas are designated as conservation areas if they are uninhabited and **completely owned by the Government of India** but used for subsistence by communities and community areas if part of the lands is privately owned. • These categories were added because of reduced protection in and around existing or proposed protected areas due to private ownership of land, and land use.

Marine Protected Areas	• A marine protected area (MPA) is essentially a space in the ocean where human activities are more strictly regulated than the surrounding waters - similar to parks we have on land. • These places are given special protections for natural or historic marine resources by local, state, territorial, native, regional, or national authorities.

➡ SPECIES AND GENUS

SPECIES	GENUS
• Organisms having **similar set of DNA** and **similar physical and morphological attributes** are said to be of the same species. • They have the **same number of chromosomes** and thus possess similar morphological characteristics. • The **male and female of the same species can interbreed to** produce a fertile offspring of the same species. • There may be **many species under the same genus.**	• At times it is not possible to identify all organisms up to the level of the species, especially the fossilized and extinct ones. In such case identifying the genus of the organism is enough to label it. • **Organisms of different species of the same genus cannot produce a fertile offspring** if interbred together. • **Mule is a product of a donkey and a horse which are two different species** belonging to the same genus. • A **genus can have many species**.

➡ TYPES OF SPECIES

Flagship species	Indicator species	Keystone species
• A flagship species is a species **chosen to represent an environmental cause**, such as an ecosystem in need of conservation. • Chosen species could be either vulnerable or attractive or distinct. **Example:** Indian Tiger, African Elephant, Giant Panda of China, etc.	• It is a species whose presence **indicates the presence of a set of other species** and whose absence indicates the lack of that entire set of species. • For example, a species might indicate presence of environmental pollution or arrival of monsoon and so on. **Example:** Lichens (air quality), most amphibians, fishes, etc.	• It is a species **whose addition or loss to an ecosystem will lead to major changes** in the ecosystem. • This is because certain species are considered more important in determining the presence of other species. **Example**: All top predators are considered Keystone Species (tiger, lion, crocodile, elephant) as their addition or removal will distort the existing food chain in the ecosystem.

➡ TRAFFIC

- The Wildlife Trade Monitoring Network (TRAFFIC)
- Found in **1976,** TRAFFIC is a **non-governmental organization** working globally on trade in wild animals and plants in the context of both biodiversity conservation and sustainable development.
- TRAFFIC is a **joint programme of World Wide Fund for Nature (WWF) and IUCN.**
- Traffic is complementary to Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).
- TRAFFIC's mission is to ensure that trade in wild plants and animals is not a threat to the conservation of nature.
- It investigates and analyses wildlife trade trends, patterns, impacts and drivers to provide the leading knowledge base on trade in wild animals and plants.

➡ WILDLIFE (PROTECTION ACT), 1972

- The Government of India enacted **Wild Life (Protection) Act 1972** with the objective of **effectively protecting the wild life** of this country and to control poaching, smuggling and illegal trade in wildlife and its derivatives.
- The act has **six schedules** which cover the entire gamut of wild life.

Schedules

- **Schedule I and part II of schedule II** are the most important sections of the act. These sections cover animals which are in the **category of endangered species**. The sections in this schedule give absolute protection to certain species and these cannot be infringed on any account.
- **Schedule III and IV** - These also have roughly the same provisions of Section I and II, but cover animals that are not in danger of becoming extinct. The penalties under this section are also less than Schedule I and II.
- **Schedule V** delineates animals **that can be hunted** like ducks and deers with the prior permission of chief wildlife warden.
- **Schedule VI** concerns cultivation and plant life and gives teeth to setting up more protected animal parks.

Provisions

- It defines the wildlife related terminology.
- It provides for the appointment of wildlife advisory Board, Wildlife warden, their powers, duties etc.
- Becoming a party to the Convention of International Trade in Endangered Species of Fauna and Flora (CITES, 1976).
- Launching a "**national component of UNESCO's 'Man and Biosphere Programme' (1971).**
- Under the Act, comprehensive listing of endangered wildlife species was done for the first time and prohibition of hunting of the endangered species was mentioned.
- Protection to some endangered plants.

- The act provides for:-
  - ✓ Central government to appoint Director of Wildlife Preservation
  - ✓ State Governments to appoint Chief Wildlife Warden, Wildlife Wardens
  - ✓ Central Zoo Authority
  - ✓ National Board of Wildlife to be headed by Prime Minister, Vice Chairperson to be Minister of MOEFCC
  - ✓ Standing Committee of the National Board of Wildlife to be headed by Minister of MOEFCC
  - ✓ State Board of Wildlife to be headed by Chief Minister of the State and Minister of Forests and Wildlife as Vice Chairperson
  - ✓ Prohibition of hunting of animals provided in Schedule I, II, III and IV except by the process laid down in the act such as danger to human life, property, or the animal being so disabled or diseased as to be beyond recovery or killing or wounding in good faith of any animal in defence of oneself or of any other person, or for education, scientific research etc. However, usually a permission has to be granted by Chief Wildlife Warden of the state before such killing takes place.
  - ✓ National Tiger Conservation Authority to be headed by Minister of MOEFCC
  - ✓ Tiger conservation foundation to be established by each state for the conservation of tiger.
  - ✓ Statutory status to Wildlife Crime Control Bureau to be headed by Director of Wildlife Preservation to deal with wildlife related crimes.
- The Act provides for setting up of National Parks, Wildlife Sanctuaries etc.
- There is provision for trade and commerce in some wildlife species with license for sale, possession, transfer etc.
- The act bans collection of trophies, taxidermy etc.
- The act imposes a ban on the trade or commerce in scheduled animals.
- It provides for legal powers to officers and punishment to offenders.
- It provides for captive breeding programme for endangered species. Several Conservation Projects for individual endangered species like Lion (1972), Tiger (1973), Crocodile (1974) and Brown antlered Deer (1981) were stated under this Act.
- The Act is adopted by all states in India except J & K, which has its own Act.

Vermin

- Vermin means wild mammals and birds **which are harmful to crops, farm animals or which carry disease.**
- In India, wild animals can be declared as vermin if they have become
- Dangerous to human life or property (including standing crops on any land).
- Become disabled or diseased as to be beyond recovery.
- Using these provisions, any animal listed in Schedule I to IV of WPA can be declared vermin by listing it in Schedule V for a specific period.

➡ WETLANDS

- Wetlands are **transition zones between terrestrial and aquatic ecosystems**. E.g. **Mangroves, lake littorals** (marginal areas between highest and lowest water level of the lakes), **floodplains (areas** lying adjacent to the river channels beyond the natural levees

and periodically flooded during high discharge in the river) and other marshy or swampy areas.

- These habitats experience periodic flooding from adjacent deep water habitats and therefore support plants and animals specifically adapted to such shallow flooding or water logging.
- Waterlogged soil **adapted plant life (hydrophytes)** and **hydric soils (not enough O2)** are the chief characteristics of wetlands.
- Among the most productive life support, wetlands have immense socio-economic and ecological importance for mankind. They are crucial to the survival of natural biodiversity. They provide suitable habitats for endangered and rare species of birds and animals, endemic plants, insects besides sustaining migratory birds.

Importance

1. Wetlands are indispensable for the countless benefits or "ecosystem services" that they provide humanity, ranging from freshwater supply, food and building materials, and biodiversity, to flood control, groundwater recharge, and climate change mitigation.
2. Habitat to aquatic flora and fauna, numerous species of native and migratory birds.
3. Important resource for sustainable tourism.
4. Carry out water purification, filtration of sediments and nutrients from surface water.
5. Help in nutrients recycling, ground water recharging and stabilization of local climate.
6. Important role in flood mitigation by controlling rate of runoff.
7. Buffer shorelines against erosion and pollutants.
8. Act as genetic reservoir for various species of plants (especially rice).

RAMSAR CONVENTION

- The Convention on Wetlands, **signed in Ramsar, Iran, in 1971**, is an intergovernmental treaty which provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources.
- Ramsar Convention is the only global environment treaty dealing with a particular ecosystem.
- The Convention uses a broad definition of the types of wetlands covered in its mission, including lakes and rivers, swamps and marshes, wet grasslands and peatlands, oases, estuaries, deltas and tidal flats, near-shore marine areas, mangroves and coral reefs, and human-made sites such as fish ponds, rice paddies, reservoirs, and salt pans.
- At the centre of the Ramsar philosophy is the **"wise use" of wetlands**. - Wise use: maintenance of ecological character within the context of sustainable development.
- At the time of joining the Convention, each Contracting Party undertakes to designate at least one wetland site for inclusion in the List of Wetlands of International Importance.
- The inclusion of a "Ramsar Site" in the List embodies the government's commitment to take the steps necessary to ensure that its ecological character is maintained.
- The country with the highest number of sites is the **United Kingdom**.
- The country with the greatest area of listed wetlands is **Bolivia**.

MONTREUX RECORD

- The Montreux Record is a register of wetland sites on the List of Wetlands of international importance where changes in ecological character have occurred, are occurring, or are likely

to occur as a result of technological developments, pollution or other human interference and therefore in need of priority conservation attention.

- It is maintained as part of the Ramsar List.
- The two Montreux Record Sites in India are:

✓ **Loktak Lake (Manipur):** Due to deforestation in the catchment area, infestation of water hyacinth and pollution. The construction of a hydroelectric power plant has caused the local extinction of several native fish species.

✓ **Keoladeo National Park**: Water shortage and unbalanced grazing regime around it. The invasive growth of the grass and reducing its suitability for certain water-bird species, notably the Siberian Crane.

WETLANDS INTERNATIONAL

- Wetlands International is a non-profit organization established in 1937 as 'International Wildfowl Inquiry' and HQ in Netherlands.
- It is an independent, not-for-profit organization, supported by government and NGO membership from around the world.

ASIAN WATERBIRD CENSUS

- Asian Waterbird Census is an **annual event across Asia and Australasia** for counting waterbirds in the wetlands.
- This event happens every **January.** This event is coordinated by Wetlands International and forms part of global waterbird monitoring programme called the **International Waterbird Census (IWC).**
- In India, the AWC is annually coordinated by the Bombay Natural History Society (BNHS) and Wetlands International.

NATIONAL WETLAND CONSERVATION PROGRAMME

- The Government operationalized National Wetland Conservation Programme (NWCP) in closed collaboration with concerned State Government during the year 1986.
- The scheme aims at Conservation and wise use of wetlands in the country so as to prevent their further degradation.
- The scheme was initiated to lay down policy guidelines for conservation and management of wetlands in the country; to undertake intensive conservation measures in priority wetlands; to monitor implementation of the programme and to prepare an inventory of Indian wetlands.

WETLAND (CONSERVATION AND MANAGEMENT) RULES

- The rules are applicable to three types of wetlands:

✓ Wetlands of international importance under Ramsar Convention.
✓ Wetlands notified by central govt based in Union Territories.
✓ Wetlands notified by State govts located in their respective states.

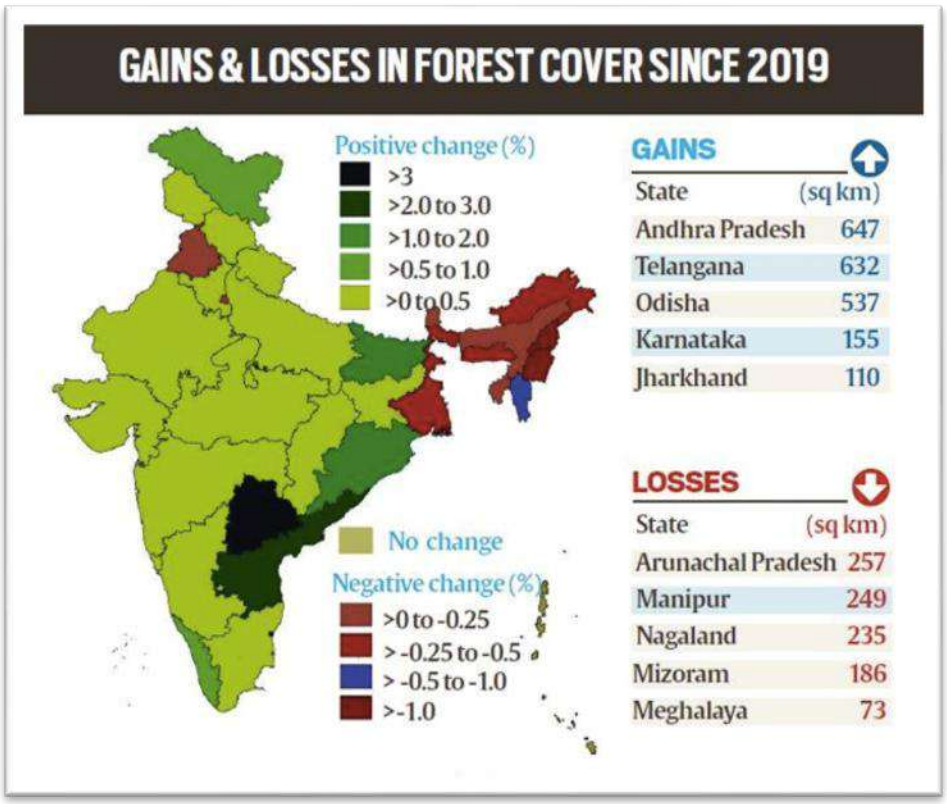
- The wetland rules follow the "wise use" philosophy of the Ramsar Convention and accord emphasis on maintaining ecological character and integrity of wetlands in their conservation and use. Accordingly, the following activities have been prohibited in wetlands:

✓ 12 activities including fishing, boating, dredging, etc. are restricted without prior permission from the state government.

- ✓ Activities prohibited in wetlands include reclamation, constructing permanent structures within 50 m, setting up or expanding industries, throwing waste, etc.
- An Environment Impact Assessment (EIA) is compulsory before undertaking any activity in a wetland area.

➡ INDIA STATE OF FOREST REPORT (ISFR) 2021

The report showed a continuing increase in forest cover across the country, but a decline in moderate dense forest and an increase in forest fires.



- The IFSR is an overall assessment of the country's forests and is published every two years by the Forest Survey of India.
- It was published in 1987 for the first time and recently, the 17th ISFR was released.
- The ISFR-2021 provides information on **forest cover, tree cover, mangrove cover, growing stock, carbon stock in India's forests, forest fire monitoring, forest cover in tiger reserve areas**, above ground estimates of biomass using SAR data and climate change hotspots in Indian forests.
- It is the 17th biennial assessment of India's forests by the Forest Survey of India, an organisation under the Ministry of Environment, Forest and Climate Change (MoEFCC).
- The ISFR 2021 presents the latest status of the **'Forest cover'** and **'Tree cover'** of the country.
- In addition to the regular chapters, this time round, a special chapter on **"Forest Cover assessment in Tiger reserves and Tiger corridor areas of the country and decadal change in Forest Cover"** has also been included.
- Results of the two special studies namely **Above Ground Biomass Estimation using Synthetic Aperture Radar data (carried out in collaboration with ISRO)** and **Climate hot spots in forest areas studies (carried out in collaboration with BITS Pilani, Goa campus)** are also being presented in this report.

- India's progress towards achieving the Nationally Determined Contribution commitments are also included as part of the chapter on Forest carbon assessment.

Key findings of ISFR 2021

- The biennial forest report has found that there is an increase of **2,261 sq km in the total forest and tree cover** of the country, as compared to 2019.
- The total forest and tree cover of the country is 80.9 million hectares which is 24.62 per cent of the geographical area of the country. As compared to the assessment of 2019, there is an increase of 2,261 sq km in the total forest and tree cover of the country.
- The increase in the forest cover has been observed as 1,540 sq km and that in tree cover is 721 sq km.
- **Top three states** showing increase in forest cover are Andhra Pradesh (647 sq km) followed by Telangana (632 sq km) and Odisha (537 sq km).
- **Area-wise** Madhya Pradesh has the largest forest cover in the country followed by Arunachal Pradesh, Chhattisgarh, Odisha and Maharashtra.
- In terms of forest cover as **percentage of total geographical area**, the top five states are Mizoram (84.53 per cent), Arunachal Pradesh (79.33 per cent), Meghalaya (76.00 per cent), Manipur (74.34 per cent) and Nagaland (73.90 per cent).
- **A total of 17 states/union territories' have above 33 percent of the geographical area under forest cover**. Out of these states and union territories, five namely Lakshadweep, Mizoram, Andaman & Nicobar Islands, Arunachal Pradesh and Meghalaya have more than 75 per cent forest cover.
- **Twelve states and union territories** namely Manipur, Nagaland, Tripura, Goa, Kerala, Sikkim, Uttarakhand, Chhattisgarh, Dadra & Nagar Haveli and Daman & Diu, Assam, Odisha, **have forest cover between 33 per cent to 75 per cent.**
- Total **mangrove cover** in the country is 4,992 sq km. An increase of 17 sq km in mangrove cover has been observed as compared to the previous assessment of 2019. Top three states showing mangrove cover increase are Odisha (8 sq km) followed by Maharashtra (4 sq km) and Karnataka (3 sq km).
- **Bamboo forests** have grown from 13,882 million culms (stems) in 2019 to 53,336 million culms in 2021.
- Total **carbon stock** in the country's forest is estimated to be 7,204 million tonnes and there is an increase of 79.4 million tonnes in the carbon stock of the country as compared to the last assessment of 2019. The annual increase in the carbon stock is 39.7 million tonnes.

Causes of concern

Forest fires:

- Over 3.98 lakh forest fires were reported in India in the fire season from 2020-2021, more than double the number of blazes compared to the previous year.
- Among states, the maximum number of fires were observed in Odisha at 51,968, followed by Madhya Pradesh at 47,795 and Chhattisgarh at 38,106.
- Among districts, the maximum number of such incidents were observed in Gadchiroli in Maharashtra at 10,577, followed by Kandhamal in Odisha at 6,156 and Bijapur in Chhattisgarh at 5,499 incidents.

- According to the long-term trend analysis performed by the FSI, nearly **10.66 per cent area of forest cover in India is under extremely to very highly fire-prone zones**.

Decline in natural forests:

- Even though 'very dense forests' (with canopy density over 70 per cent) have increased by 501 sq km, 'moderately dense forests' or 'natural forests' (with 40-70 per cent canopy density) have declined by 1,582 sq km.
- When compared with an increase of 2,621 sq km in open forest areas (10-40 per cent density), the decline of moderately dense forests suggests a degradation of forests in the country as natural forests are degrading to less dense open forest areas.

Decline in North-eastern forest cover: Even though Mizoram, Arunachal Pradesh, Meghalaya, Manipur and Nagaland top the charts in terms of forest cover as percentage of total geographical area, the five north-eastern states have all shown a loss in forest cover. The forest cover in the region has shown an overall decline of 1,020 sq km in forest cover.

Other findings

- The report for the first time has assessed forest cover in tiger reserves, tiger corridors and the Gir forest and found that it has increased by 37.15 sq km (0.32 per cent) in tiger corridors between 2011-2021, but tiger reserves recorded a decline of 22.6 sq km (0.04 per cent).
- The report has found that forest cover has increased in 20 tiger reserves, and decreased in 32 in the last 10 years.

Impact of climate change

- The ISFR 2021 estimates that by 2030, 45-64 per cent of Indian forests will be affected by climate change and rising temperatures, and forests in all states (except Assam, Meghalaya, Tripura and Nagaland) will be highly vulnerable climate hot spots.
- The report suggests that **Ladakh** (forest cover 0.1-0.2 per cent) is likely to be the most affected by climate change.

➡ NEW RAMSAR SITES

TAMPARA LAKE

- Tampara Lake is among the most prominent freshwater lakes in the **State of Odisha** situated in Ganjam district.
- The depression on the ground gradually filled with rainwater from catchment flow and was called **"Tamp"** by the British and subsequently termed **"Tampra"** by the locals.
- The wetland supports at least 60 species of birds, 46 species of fishes, at least 48 species of phytoplanktons, and more than seven species of terrestrial plants and macrophytes.
- The wetland is an important habitat for **vulnerable species such as Cyprinus carpio**, **common pochard (Aythya ferina),** and **river tern (Sterna aurantia).**
- With an estimated average fish yield of 12 tonnes per year, the wetland is an important source of livelihood for the local communities. Along with fishes the wetland also provides provisioning services like water for agriculture, and domestic use and is a well-known tourism and recreation site.

HIRAKUD RESERVOIR

- Hirakud Reservoir, the largest earthen dam in Odisha started operating in 1957.
- The reservoir to support a range of floral and faunal species, including several of high conservation significance.
- Out of the known 54 species of fish from the reservoir, one has been classed as being endangered, six near threatened and 21 fish species of economic importance.
- Fisheries presently yield a catch of around 480 MT of fish annually and is the mainstay of livelihoods of 7,000 fisher households. Similarly, over 130 bird species have been recorded at this site, out of which 20 species are of high conservation significance.
- The reservoir is a source of water for producing around 300 MW of hydropower and irrigating 436,000 ha of cultural command area.
- The wetland also provides important hydrological services by moderating floods in the **Mahanadi delta,** the ecological and socio-economic hub of the east coast of India. Hirakud reservoir supports abundant tourism, and forms an integral part of the high touristic value sites located around Sambalpur with over 30,000 tourists annually visiting the site.

ANSUPA LAKE

- Ansupa Lake is **the largest freshwater lake of Odisha** situated in Banki sub-division of Cuttack district and has its fame from time immemorial for its scenic beauty, biodiversity, and natural resources.
- The wetland is **an oxbow lake** formed by **River Mahanadi** and is spread over an area of 231 ha. The wetland is home to at least 194 species of birds, 61 species of fishes and 26 species of mammals in addition to 244 species of macrophytes.
- The wetland provides a safe habitat to at least **three threatened bird species**- Rynchops albicollis (EN), Sterna acuticauda (EN) and Sterna aurantia (VU) and three threatened fish species- Clarias magur (Clariidae) (EN), Cyprinus carpio (Cyprinidae) (VU) and Wallago attu (VU).
- Ansupa lake sustains the freshwater demands of the surrounding areas and also supports the livelihood of the local communities through fisheries and agriculture. The wetland has immense recreational and tourism potential as it is a major wintering ground for migratory birds and is also known for its scenic beauty.

YASHWANT SAGAR

- Yashwant Sagar is one of the two **Important Bird Areas (IBA) in the Indore region** as well as one of the most important birding sites in Malwa region of Madhya Pradesh.
- Presently, it is mainly used for water supply to the city of Indore and is also being used for fish culture on a commercial scale.
- Yashwant Sagar reservoir comes under the jurisdiction of Indore City Municipal Corporation.
- Indore which has bagged the title of one of the cleanest cities in India is also often known as center of economic growth of Madhya Pradesh.
- The catchment area of this wetland is predominantly agriculture. Yashwant Sagar is considered to be a stronghold of the **vulnerable Sarus Crane** in central India.
- The lake backwaters have plenty of shallow areas, conducive for waders and other waterfowl. As the water level recedes, many islands serve as roosting sites for waterfowl. Due to its vast

shallow reed beds, the wetland is considered heaven to a large number of winter migratory birds.

CHITRANGUDI BIRD SANCTUARY

- Chitrangudi Bird Sanctuary, locally known as **"Chitrangudi Kanmoli"** is located in Ramanathapuram district in Tamil Nadu.
- The wetland is a protected area since 1989 and declared as Bird Sanctuary, coming under the jurisdiction of Tamil Nadu Forest Department, Ramanathapuram division.
- Chitrangudi Bird Sanctuary is an ideal habitat for winter migratory birds. Around 50 birds belonging to 30 families have been reported from the site. Out of these 47 are water birds and 3 terrestrial birds. Notable waterbirds spotted from the site area spot-billed pelican, little egret, grey heron, large egret, open billed stork, purple, and pond herons.
- Chitrangudi is surrounded by agricultural fields, where different crops are grown throughout the year. The wetland also supports a number of fishes, amphibians, molluscs, aquatic insects, and their larvae forming good food sources for arriving waterbirds. Groundwater is extracted for irrigation around and within the wetland for agricultural purposes.

SUCHINDRAM THEROOR WETLAND COMPLEX

- Suchindrum Theroor Wetland complex is part of the Suchindrum-Theroor Manakudi Conservation Reserve. It is declared an Important Bird Area and lies at the southern tip of the **Central Asian flyway of migratory birds.** It was formed for birds' nesting purposes and it attracts thousands of birds every year. The total population dependent upon Theroor is about 10,500 and 75% of the population's livelihood hinges on agriculture which in turn is dependent upon the water released from the Theroor tank.
- This is **a man-made, inland Tank** and is perennial. Copper plate inscriptions from the 9th century mention Pasumkulam, Venchikulam, Nedumarthukulam, Perumkulam, Elemchikulam and Konadunkulam. Around 250 species of birds have been recorded in the area, of which 53 are migratory, 12 endemic, and 4 threatened.

VADUVUR BIRD SANCTUARY

- Vaduvur bird sanctuary spreads over an area of 112.638 ha, is a large **human-made irrigation tank** and shelter for migratory birds as it provides a suitable environment for food, shelter, and breeding ground.
- While these irrigation tanks have socio-economic and cultural significance, very little is known of their ecological importance. These tanks have the potential to harbor good populations of resident and wintering water birds but no studies have been done to confirm this.
- Indian Pond Heron Ardeola grayii occurred in most of the surveyed tanks.
- Large concentrations of wintering waterfowl such as **Eurasian Wigeon Anas penelope, Northern Pintail Anas acuta, Garganey Anas querquedula** were recorded in tanks.
- Vaduvur Bird Sanctuary has a diverse habitat including a number of inlets and surrounding irrigated agricultural fields which provides good nesting and foraging habitats for birds. Thus, the site provides support to the species listed above during critical stages of their life-cycle.

KANJIRANKULAM BIRD SANCTUARY

- Kanjirankulam Bird Sanctuary is a Protected area near **Mudukulathur Ramanathapuram District, Tamil Nadu.** India, declared in 1989.
- It is notable as a nesting site for several migratory heron species that roost in the prominent growth of babul trees there. The breeding population of migratory waterbirds arrive here between October and February and include: painted stork, white ibis, black ibis, little egret, great egret.
- The site qualifies as an IBA as the **threatened Spot-billed Pelican** Pelecanus philippensis breeds here. The wetland exhibits rich biodiversity including many globally near-threatened species like Spot-billed Pelican, Oriental Darter, Oriental white Ibis and Painted Stork and also commonly occurring shore and water birds like greenshank, plovers, stilts and forest birds like bee-eaters, bulbuls, cuckoos, starlings, barbets, etc.
- They act as breeding, nesting, roosting, foraging, and stopover sites for the birdsThe wetland supports IUCN RedList vulnerable avian species like Sterna aurantia (River Tern).

THANE CREEK

- Thane Creek is located in Maharashtra, India. There are several sources of fresh water to the creek, of which Ulhas River is the largest, followed by many drainage channels from various suburban areas of Mumbai, Navi Mumbai & Thane.
- It has been declared as **Thane Creek Flamingo Sanctuary**. Thane creek is fringed by mangroves on both banks & comprises around 20% of the total Indian mangrove species.
- The mangrove forest acts as a natural shelter belt & protects the land from cyclones, tidal surges, seawater seepage & intrusions. The mangrove serves as a nursery for several fishes & sustains the local fishery.
- The area is an important part of the wetland complex of the Central Asian Flyway of the birds and has been categorized as an Important Bird Area (IBA). Other than 202 avifaunal species, the creek also houses 18 species of fishes, crustaceans & molluscs, 59 species of butterflies, 67 species of Insects, and 35 species of phytoplankton, and 24 species of zooplankton & 23 species of Benthos.

HYGAM WETLAND CONSERVATION RESERVE

- Hygam Wetland falls within the River Jhelum basin and plays a significant role as a flood absorption basin, biodiversity conservation site, eco-tourism site, and livelihood security for the local communities.
- The wetland is located in the Baramulla district. It serves as an abode to many residents and migratory bird species. It is also recognized as an Important Bird Area (IBA).
- Consequent to the high rate of siltation, Hygam Wetland has lost its wetland characteristics to a large extent and in many places changed its profile into a landmass. This has resulted in further loss of habitat conditions to offer a suitable site for visiting migratory birds (Winter/ Summer migrants) and for resident birds as well.
- Hygam Wetland provides a plethora of ecosystem services, these include fish and fiber, water supply, water purification, climate regulation, flood regulation, and recreational opportunities. The livelihoods of people living in, and adjoining the fringes of wetlands depend partially or entirely on wetland ecosystem services.

SHALLBUGH WETLAND CONSERVATION RESERVE

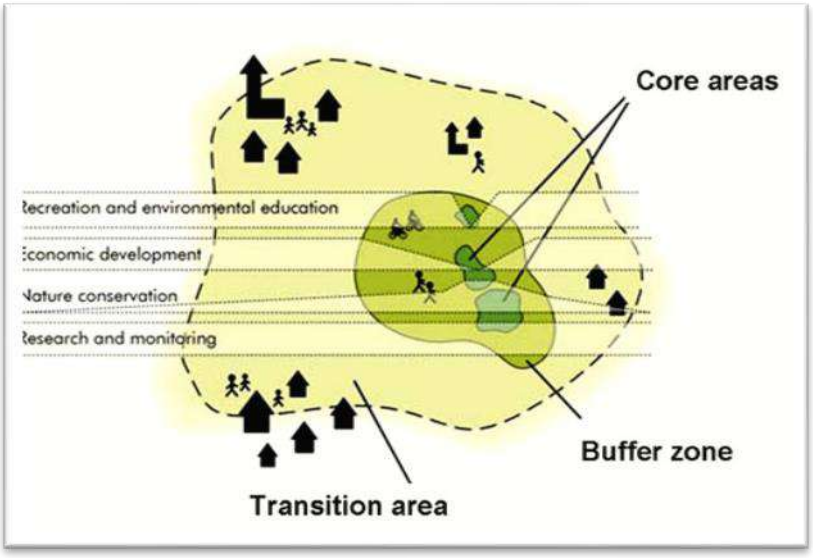
- Shallabug Wetland Conservation Reserve is located in the **District Srinagar, UT of J&K**. Large areas of the wetland dry up between September and March.
- The area has extensive reedbeds of Phragmites communis and Typha angustata, and rich growth of Nymphaea candida and N. stellata on open water. It serves as an abode to more than four lakh resident and migratory birds of at least 21 species.
- Shallabugh Wetland plays a major role in the natural control, amelioration or prevention of flooding, It is also important for seasonal water retention for wetlands or other areas of conservation importance downstream.
- The wetland is important for the recharge of aquifers. A major natural floodplain system. Shallabugh Wetland provides plethora of ecosystem services, these include fish and fiber, water supply, water purification, climate regulation, flood regulation, recreational opportunities. The wetland serves as an important breeding ground for many species of waterbirds

➡ PROJECT TIGER

- India is now home to almost 75% of the world's Wild Tigers. The relative transparency in the estimation process and the dedication to the project in India of Saving the Tiger is unparalleled.
- A previous estimation by the data collected, and number of Tigers shot for sport – it was estimated that, at the beginning of the 20th Century, there likely could have been upwards of 50,000 Tigers in India alone. The continued hunting, poaching and habitat destruction has decimated their populations and by the 1960's, wildlife in India had hit rock bottom. They were treated like vermin, and nearly exterminated.
- It was around 1970, that, a group of conservationists and researchers applied sustained pressure on the Indian Government. Notable Conservationist **Dr.Kailash Sankhla** made a personal appeal to then Prime Minister Mrs. Indira Gandhi, who turned out to be empathetic and understanding towards the need to protect India's Natural Heritage – the oldest heritage of India.
- **Wildlife Protection Act was drawn up in 1972** as a result, and it ended legally, all hunting in India – and protected individual species by Law.
- Project Tiger was launched subsequently, in 1973, and **Dr.Kailash Sankhla** was appointed the 1st Director of Project Tiger in India.
- **Jim Corbett Tiger Reserve in Uttarakhand was the 1st Tiger Reserve in India**. A further 8 Tiger Reserves were established with around 9115 sq.km of forests under the wing of Project Tiger.
- This figure stands today at 71,000 sq.km – a stark improvement from its initial days but nearly not enough forest cover for a burgeoning country such as India with a beautiful and rich Natural Heritage.
- Today, there are **53 Tiger Reserves** established in India.

Each Tiger Reserve is divided into 02 areas: **Core Area and Buffer Area**

Core Area /Critical Tiger Habitat



- This is the critical habitat of surviving Tigers and prey species which can support or already support Tiger populations in the landscape due to favourable ecological conditions having potential for improving existing habitat to ensure long-term success of the species.
- No human activity save for conservation-related or Park-management related activities are permitted here. Everyday tasks of wood collection, grazing and utilisation of forest produce is banned.
- Tourism is permitted, however **according to NTCA guidelines, only upto 20% of the Core Area** is available for Wildlife Tourism.
- These areas usually have a legal status of National Park or Wildlife Sanctuary.

Buffer Area

- Demarcated areas adjoining or surrounding the Core Area have been given the status of the Buffer Area.
- These are peripheral areas of the Core or newly created habitat for wildlife which inevitably spills over from the declared Core Area.
- However, activities such as livestock grazing, controlled collection of firewood and minimal use of forest produce for the sake of livelihood by the locals are permitted.
- Forest Check-Posts and Patrolling Camps have been strategically established across Tiger Reserves in the Core and Buffer Areas to mitigate poaching threats and ensure management of the reserve and swift action in case of emergency situations.

Village Relocation

- One of the most difficult and herculean of all tasks has been the ongoing Village Relocation Programmes in Tiger Reserves, ongoing since 1973.
- Voluntary relocation of people and settlements has been one of the major tasks and a massive challenge ineffective establishment and management of Tiger Reserves across India in addition to reducing poaching threats and preserving the habitat.
- Many villages were/are situated in the identified Critical Tiger Habitats in India, as well as in the newly identified Critical Tiger Habitats for the future establishment of Tiger Reserves. The need to educate the local people of the benefits of relocating/moving away from their present homes in the Tiger Reserve. Compensatory land or money is provided as aid from the government along with logistical assistance.
- The challenge of Human Rights, Political pressure and vested interest groups has definitely ensured that this task be a Herculean effort – however, relatively good governance practices

and diligence of the various Forest Departments has resulted in various positive breakthroughs for Project Tiger.

Tiger Task Force

- In light of heavy poaching and formation of strong poaching networks by smugglers within India, a need for greater monitoring and an additional layer of protection was included in the year 2005.
- Following the exposure by the media and ground-level conservationists on the sudden disappearance of Tigers in the notable plight of Sariska Tiger Reserve in Rajasthan, the then Prime Minister of India Dr. Manmohan Singh set up the **Tiger Task Force** to strengthen the conservation of the National Animal of India.
- The guiding principles for all the Tiger Reserves in the country by the Tiger Task Force include : –

- Looking into the various problems of Tiger Conservation and suggesting methods for its improvement.
- Improving methods to check-poaching of tigers and illegal practices followed in the wildlife sanctuaries.
- To improve the method of counting and forecasting Tigers.
- To educate the local indigenous population inhabitant in the Reserves towards the conservation of tigers and preservation of habitat.

➡ NTCA

The National Tiger Conservation Authority (NTCA) is the Apex body that administers Project Tiger.

Powers and functions of the National Tiger Conservation Authority as prescribed under Section 38 of the Wildlife (Protection) Act, 1972 are as under:-

- To **approve the Tiger Conservation Plan** prepared by the Individual State Governments.
- To **evaluate and assess the various aspects of sustainable ecology**.
- **Disallowing unsustainable land use** for projects such as Mining, Industry and other such projects within Tiger Reserves.
- Establishment of **Standards for Tourism Guidelines** within the Tiger Reserves has to be set by the NTCA. It encapsulates those in the Core as well as the Buffer Area of the Tiger Reserve.
- To focus on **addressing inevitable Human-Animal Conflict scenarios**. To ensure due processes are established on the areas surrounding the National Park, Sanctuaries or Tiger Reserve to enable co-existence around forest areas.
- To provide **information on Protection Measures** including the Future Conservation Plan, Estimation of Tiger Population and its Natural Prey Species, Status of Habitats, Disease Surveillance, Mortality Survey, Patrolling, reports on any Untoward Happenings and such Management Aspects as deemed fit in the Future Conservation Plan.
- To **approve and co-ordinate Research and Monitoring** on ecological aspects of the Tiger, Prey, Habitat as well as related ecological and socio-economic parameters and their evaluation.

- To **ensure that Tiger Reserves and areas linking a protected area with another, are not diverted** for ecologically unsustainable use, except in absolute public interest; with approval from the National Board for Wildlife and the advice of the NTCA.
- To **facilitate Eco-development and People's Participation in Biodiversity Conservation** Initiatives as per the approved management plans. Additionally, to support similar initiatives in adjoining areas consistent with State and Central Laws.
- To **ensure critical support** including Scientific, Information Technology and Legal Support for ideal implementation of the Future Conservation Plan.
- To ensure **Training and Development of Officers and Staff** of Tiger Reserves through Capacity – building Programs.
- To perform any such other functions to carry out purposes of the Project with regards to protecting the Tiger and its Habitat.

➡ SIMILIPAL TIGER RESERVE

- Similipal, which derives its name from **'Simul' (Silk Cotton) tree**, is a national park and a Tiger Reserve situated in the northern part of Orissa's Mayurbhanj district.
- The tiger reserve is spread over 2750 sq km and has some beautiful waterfalls like Joranda and Barehipani. The park is surrounded by high plateaus and hills, the highest peak being the **twin peaks of Khairiburu and Meghashini** (1515m above mean sea level).
- At least twelve rivers cut across the plain area, all of which drain into the Bay of Bengal. The prominent among them are Burhabalanga, Palpala Bandan, Salandi, Kahairi and Deo.
- An astounding 1078 species of plants including 94 species of orchids find their home in the park. The vegetation is a mix of different forest types and habitats, with **Northern tropical moist deciduous** dominating some semi-evergreen patches. **Sal is the dominant tree species** here. The park also has extensive **grasslands** that are grazing grounds for many of the herbivores. These forests boast of many plants that have medicinal and aromatic properties.
- The park is known for the **tiger, elephant and hill mynah**. It holds the highest tiger population in the state of Orissa. 55 species of mammals, 304 species of birds, 60 species of reptiles, 21 species of frogs, 38 species of fish and 164 species of butterflies have been recorded from the Park.
- Apart from the tiger, the major mammals are leopard, sambar, barking deer, gaur, jungle cat, wild boar, four-horned antelope, giant squirrel and common langur. Grey hornbill, Indian pied hornbill and Malabar pied hornbill are also found here. The park also has a sizeable population of reptiles, which includes the longest venomous snake, the King cobra and the Tricarinate hill turtle. The **Mugger Management Programme** at Ramatirtha has helped the mugger crocodile to flourish on the banks of the Khairi and Deo Rivers.

History and current status:

- The Tiger Reserve originated as a hunting ground for the surrounding royalty. It was formally designated a tiger reserve under Project Tiger in May 1973. The Government of Orissa declared **Similipal as a wildlife sanctuary in 1979** with an area of 2750 sq. km.
- Later in 1980, Government of Orissa proposed 303 sq. km of the sanctuary as National Park. Further in 1986, the area of the National Park was increased to 845.70 sq. km.

- The Government of India declared it as a biosphere reserve in 1994. UNESCO added this National Park to its list of Biosphere Reserves in May 2009.
- This tiger reserve also comes under **Mayurbhanj Elephant Reserve** that includes the adjacent Hadgarh and Kuldiha Wildlife Sanctuaries.
- Apart from its biodiversity, the region around Similipal forests is home to a variety of tribes. Prominent among these are **Kolha, Santhala, Bhumija, Bhatudi, Gondas, Khadia, Mankadia and Sahara**. Most of them are settled agriculturists, supplementing their income by collecting firewood and timber except for the last three who are indigenous hunter-gatherer communities living primarily off the forest, collecting forest produce. While the tribes earlier followed a number of traditional conservation practices like closed seasons, hunting taboos on specific species, maintenance of sacred groves (Jharia) etc., of late, these practices have been on the decline due to the increasing influence of modern civilization, increasing human population and decreasing wildlife availability.

➡ SARISKA TIGER RESERVE

The measures for habitat management for tigers launched about six months ago at the famous Sariska Tiger Reserve in Rajasthan's Alwar district have started bearing fruit.

The tiger population in the wildlife sanctuary has gone up to 25, while the resources are being provided to create water holes and develop grasslands for ungulates as a prey base.

- Sariska Tiger Reserve is **well nestled in the Aravali Hills** covering 800 sq km area divided into the **grasslands, dry deciduous forests, sheer cliffs and rocky landscape**.
- Nearly 90% of the area in the sanctuary is covered with **dhok trees** accommodating various wildlife species.
- A variety of other wild animals like the leopard, sambhar, chital, nilgai, four-horned antelope, wild boar, rhesus macaque, langur, hyena and jungle cats are found in the Sariska Tiger Reserve apart from the tiger.
- The Sariska National Park is **home to India's largest population of peafowl**, and harbours quail, sand grouse, golden- backed woodpeckers and crested serpent eagles, among other species.
- Also the **Siliserh Lake** on the edge of the park has a large number of crocodiles.
- The Sariska Wildlife Sanctuary houses the ruins of **medieval temples of Garh-Rajor** that date back to the 10th and 11th centuries.
- The Sariska was **declared a sanctuary in 1955** and attained the **status of a National Park in 1979**.

➡ SATKOSIA TIGER RESERVE

- Fifteen years after declaration as a tiger reserve and failure of revival of big cat population through **India's first inter-State tiger relocation programme**, the **Satkosia Tiger Reserve (STR) in Odisha has started making efforts afresh to re-establish it** as a tiger habitat.

- The State and Forest department are attempting to relocate inhabitants of three villages from its core area to create 500 sq km area of inviolate zone for tigers.
- **Satkosia Tiger Reserve** is a tiger reserve located in the **Angul district of Odisha**, India covering an area of 988.30 km²
- The STR was declared as tiger reserve in 2007.
- In 2017, the National Board for Wildlife (NBWL) tried to rationalise STR boundary by excluding 104 villages from its STR's jurisdiction. The STR had 963.87 sq km where it was declared as a tiger reserve. Later, forest patches of 172 sq km were proposed to be added to the STR.

➡ TIGER COUNT IN KARNATAKA

Bandipur and Nagarahole lead in tiger numbers in the State followed by BRT Tiger Sanctuary, Bhadra and Kali tiger reserves, as per the 'Status of Tigers, Co-predators, and Prey in India' report.

- In terms of density, Nagarahole has 11.82 tigers per 100 sq.km, while Bandipur has 7.7 tigers per 100 sq.km.
- BRT has 4.96 tigers per 100 sq.km and Bhadra has a relatively low tiger density pegged at 2.86 in the same area.
- Other forests and sanctuaries where tiger presence has been found in significant numbers include M.M. Hills Wildlife Sanctuary, Madikeri Wildlife Division, Madikeri Territorial Division, Virajpet Territorial Division, Koppa Wildlife Division, and Haliyal Forest Division which is part of Joida taluk of Uttara Karnataka district, among others.

BANDIPUR NATIONAL PARK

- Bandipur National Park is a national park covering 868.63 km2 (335.38 sq mi) in **Chamarajnagar district** of Karnataka.
- It was established as a tiger reserve under Project Tiger in 1973.
- It is part of the **Nilgiri Biosphere Reserve since 1986**
- Bandipur National Park is located where the **Deccan Plateau meets the Western Ghats**, and the altitude of the park ranges from 680 meters (2,230 ft) to 1,454 meters (4,770 ft).
- As a result, the park has a v**ariety of biomes including dry deciduous forests, moist deciduous forests and shrublands**.
- The park is flanked by the **Kabini river in the north and the Moyar river in the south**.
- The **Nugu river runs through the park**.
- Bandipur has **typical tropical climate with distinct wet and dry seasons**. The dry and hot period usually begins in early March and can last till the arrival of the monsoon rains in June.
- Bandipur supports a **wide range of timber trees** including: teak (Tectona grandis), rosewood (Dalbergia latifolia), sandalwood (Santalum album V), Indian-laurel (Terminalia tomentosa), Indian kino tree (Pterocarpus marsupium), giant clumping bamboo (Dendrocalamus strictus), clumping bamboo (Bambusa arundinacea) and Grewia tiliaefolia.

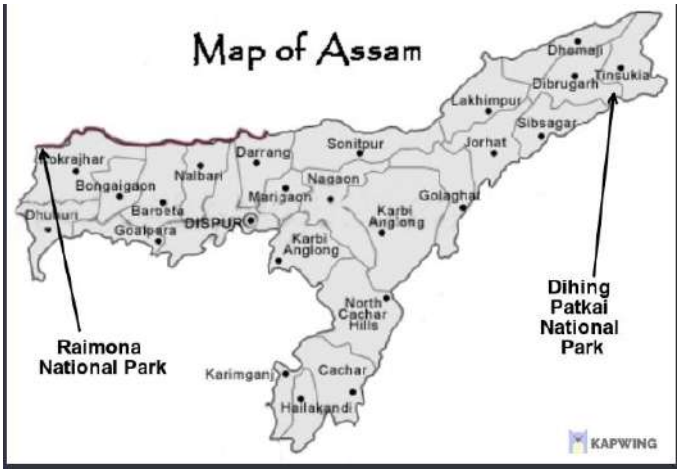
- Bandipur National Park **harbours** Indian elephant, gaur, Bengal tiger, sloth bear, mugger crocodile, Indian rock python, four-horned antelope, golden jackal and dhole.
- **Peafowl** are among the most commonly seen birds in Bandipur along with grey junglefowl, crows and drongos.

NAGARAHOLE TIGER RESERVE

- "Nagarahole Tiger Reserve" previously known as Rajiv Gandhi National Park is named after the stream 'Nagarahole' which literally means serpent stream (Nagara – serpent, hole – stream) in Kannada language.
- The protected area is located in both the **districts of Mysuru and Kodagu** with an area of 847.981 sq.km
- This park was declared the **37th Tiger Reserve of India** in 1999.
- It is **part of the Nilgiri Biosphere Reserve**.
- The Western Ghats Nilgiri Sub-Cluster of 6,000 km2 (2,300 sq mi), including all of Nagarhole National Park, is under consideration by the UNESCO World Heritage Committee for selection as a World Heritage Site.
- The **Kabini and Taraka reservoirs are large waterbodies** located towards the west and south eastern parts of the park respectively.
- Nagarahole is **contiguous with Wayanad wildlife sanctuary (Kerala)** to the south and **Bandipur Tiger Reserve** to its south eastern parts.
- These forests of Malenad landscape in the western ghats support large assembles of carnivores and herbivores: Tiger (Panthera tigris), Leopard (Panthera pardus), Asiatic Wild Dog (Cuon alpinus), Sloth Bear (Melursus ursinus), Asiatic Elephant (Elephas maximus), Gaur (Bos gaurus), Sambar (Rusa unicolor), Chital (Axis axis), Muntjac(Muntiacus muntjak) , Four Horned Antelope (Tetracerus quadricornis), Wild Pig (Sus scrofa), Mouse Deer (Moschiola indica) and South-western langur (Semnopithecus hypoleucos).

➡ RAIMONA NATIONAL PARK

- Raimona in **Kokrajhar district** has become **Assam's sixth national park.**
- The five national parks that existed prior to the 422 sq. km Raimona are **Kaziranga, Manas, Nameri, Orang and Dibru-Saikhowa**.
- The Raimona National Park is within the **Bodoland Territorial Region**. The area of the park includes the northern part of the notified **Ripu Reserve Forest** (508.62 sq. km), which forms the western-most buffer to the Manas National Park that straddles the India-Bhutan border.



- Raimona was bounded on the west by the **Sonkosh river** along the Assam-West Bengal border running southward from the India-Bhutan border and the **Saralbhanga river** on

the east till it touched the India-Bhutan border on the north and the southern part of the Ripu Reserve Forest.

- The Pekua river defines Raimona's southern boundary.
- Raimona also shares contiguous forest patches of the **Phipsoo Wildlife Sanctuary** and the **Jigme Singye Wangchuk National Park** in Bhutan (total area of 1,999 sq. km) creating a transboundary conservation landscape of more than 2,400 sq. km.
- Raimona is an integral part of the 2,837 sq. km Manas Biosphere Reserve and the Chirang-Ripu Elephant Reserve.

➡ DIHING PATKAI NATIONAL PARK

- Dihing Patkai has been created as the **seventh National Park in Assam.**
- It was declared a **wildlife sanctuary in 2004**.
- The 234.26-sq. km Dihing Patkai straddling eastern Assam's **Dibrugarh and Tinsukia districts** is a major **elephant habitat** and 310 species of butterflies have been recorded there.
- The Dehing Patkai Wildlife Sanctuary was declared as **Dehing-Patkai Elephant Reserve under Project Elephant**.
- The park has 47 species each of reptiles and mammals, including the tiger and clouded leopard.

- Dihing Patkai, in focus a year ago for **illegal coal mining** in the vicinity, encompasses the erstwhile Dehing Patkai Wildlife Sanctuary, the Jeypore Reserve Forest and the western block of the Upper Dihing Reserve Forest.
- Short stretches of the **Dirak and Buri Dihing rivers** have been included in the park.
- The newly-notified national park will be administered by the Soraipung Range of Digboi Forest Division and Jeypore Range of Dibrugarh Forest Division. Additional anti-poaching camps and manpower are being provided for intensive patrolling and conservation of the new park.

➡ PAKKE TIGER RESERVE

- The 862 km2 (333 sq mi) reserve is protected by the Department of Environment and Forest of Arunachal Pradesh.
- Pakke Tiger Reserve (declared in 1999 - 2000) lies in the foothills of the eastern Himalaya in Arunachal Pradesh's **Pakke Kessang District.**
- It is also known as **Pakhui Tiger Reserve**.
- It falls within the **Eastern Himalaya Biodiversity Hotspot.**

- It is home to over 2000 species of plants, 300 species of birds, 40 species of mammals, 30 species of amphibians and 36 species of reptiles. Many species of the flora and fauna are globally threatened, and PTR is one of the last remaining strongholds left for these species.
- It is known for its amazing sightings of four resident **hornbill species**.
- This Tiger Reserve has won **India Biodiversity Award 2016** in the category of **'Conservation of threatened species'** for its **Hornbill Nest Adoption Programme.**
- Towards the south and south-east, the sanctuary adjoins reserve forests and Assam's **Nameri National Par**k. To the west, it is bounded by **Doimara Reserve Forest** with an area of 216 km2 (83 sq mi) and **Eaglenest Wildlife Sanctuary**; and to the north by **Shergaon Forest Division**.
- The main perennial streams in the area are the Nameri, Khari and Upper Dikorai.

➡ MANAS NATIONAL PARK

Captive-bred pygmy hogs, the world's rarest and smallest wild pigs, were released in the Manas National Park of western Assam. This is the second batch to have been reintroduced into the wild under the ***Pygmy Hog Conservation Programme (PHCP)*** *in a year.*

The PHCP is a collaboration among ***Durrell Wildlife Conservation Trust of UK, Assam Forest Department, Wild Pig Specialist Group of International Union for Conservation of Nature*** *and* ***Union Environment Ministry*** *and is currently being implemented by* ***NGOs Aaranyak and EcoSystems India.***

- Manas, at the base of **foot hills of the Bhutan-Himalayas** in the state of Assam, with unique biodiversity and landscape is one of the first reserves included in the network of tiger reserve under Project tiger in 1973.
- In **1985, the Manas Wildlife Sanctuary was inscribed as World Heritage Site.**
- In **1989, Manas acquired the status of a Biosphere reserve**.
- It extends over an area of 2837 Sq. Km from **Sankosh river in the west to Dhansiri river** in the east, with a core area of 500 Sq. Km. of the National park, which declared in 1990. The average elevation of the area is 85 m above mean sea level. The river Manas flows into the national Park from the gorges of Bhutan and split into two major streams of which the main water course comes out of the National Park about 30 km downstream is known as 'Beki".
- About the half of the Park is covered by Grasslands of Terai and Bhabar type, the riparian areas have colonizing grasslands and woodlands of several species. The thick woodlands are called Eastern Moist Deciduous Forests of various types. The undergrowths are very thick. There are more than 650 species of Angiosperms alone. The commonly seen trees are the Simul, Oxi, Sissoo, Khaie, Gamari, etc.

- Manas is the **only landscape in the world where pristine Terai Grasslands are seen merging with the Bhabar grasslands** interspersed with diverse habitats ascending to Semi-Evergreen forests and then to Bhutan Himalayas. The Biodiversity is very rich here. The last population of the Pygmy Hog survive in the wilds of Manas and nowhere else in the world.

➡ OPERATION OLIVIA

- Operation Olivia was started by the Indian Coast Guard (ICG), first in early 1980s. This operation helps in **protecting Olive Ridley turtles** every year when they start nesting along Odisha coast for breeding in months of November to December. Under it, round-the-clock surveillance is conducted from November till May through Coast Guard assets like Fast patrol vessels, Interceptor craft, Air cushion vessels and Dornier aircraft.
- These laws and operation are enforced by the Coast Guard which gets power under Orissa Marine Fisheries Act. Efforts are made at various levels such as:
  - Enforcement of use of Turtle Excluder Devices (TED) by trawlers in waters surrounding nesting areas.
  - Prohibition of using gill nets as turtle approaches to the shore to curtail turtle poaching.

About Olive Ridley

- Olive Ridley turtles are listed as **vulnerable under International Union for Conservation of Nature (IUCN) Red List**.
- Sea turtles found in India have been included in **Schedule I of Indian Wildlife Protection Act, 1972**.
- They are also listed in **Appendix I of Convention of International Trade in Endangered Species (CITES)** of Wild Fauna and Flora.
- Their mass nesting is called as **arribada.**
- Gahirmatha, Astaranga coast, mouth of Devi river and Rushikulya are four arribadas sites off the Odisha Coast in India. Apart from that, Hope Island of Coringa Wildlife Sanctuary in Andhra Pradesh is also preferred for mass nesting.

➡ KAZIRANGA NATIONAL PARK

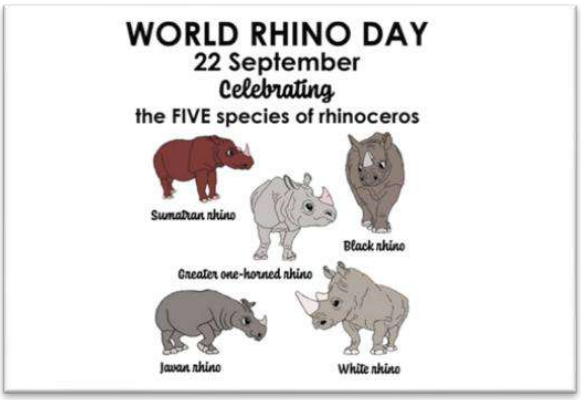
- Kaziranga National Park is a national park in the **Golaghat, Karbi Anglong and Nagaon districts** of the state of Assam, India.
- The sanctuary hosts **two-thirds of the world's great one-horned rhinoceroses.**
- In the year **1985,** the park was declared as a **World Heritage Site** by UNESCO.
- Kaziranga is home to large density of tigers.

- The park is home to large breeding populations of elephants, wild water buffalo, and swamp deer.
- Kaziranga is recognized as an **Important Bird Area by BirdLife International** for conservation of avifaunal species. When compared with other protected areas in India, Kaziranga has achieved notable success in wildlife conservation. Located on the edge of the Eastern Himalaya biodiversity hotspot, the park combines high species diversity and visibility.
- Kaziranga is a **vast expanse of tall elephant grass**, marshland, and dense tropical moist broadleaf forests, criss-crossed by four major rivers, including the Brahmaputra, and the park includes numerous small bodies of water. Kaziranga has been the theme of several books, songs, and documentaries. The park celebrated its centennial in 2005 after its establishment in 1905 as a reserve forest.
- It was formed on the recommendation of **Mary Curzon**, the wife of the Viceroy of India – Lord Curzon.

- **Flora:** Due to the difference in altitude between the eastern and western areas of the park, here one can see mainly four types of vegetation' like **alluvial inundated grasslands**, **alluvial savanna woodlands**, **tropical moist mixed deciduous forests**, and **tropical semi-evergreen forests**.
- Kumbhi, Indian gooseberry, the cotton tree, and elephant Apple are amongst the famous trees that can be seen in the park. Also, a good variety of aquatic flora can be seen in lakes, ponds, and along the river shores.
- **Fauna:** The forest region of Kaziranga Park is home to world's largest population of Indian Rhinoceros. Other animals that can be seen are Hoolock Gibbon, Tiger, Leopard, Indian Elephant, Sloth Bear, Wild water buffalo, swamp deer, etc. With increase in tiger population every year, the government authorities declared Kaziranga as a Tiger Reserve in the year 2006. Also here one can find good number of migratory bird species from Central Asia.

➡ WORLD RHINO DAY

- Assam marked World Rhino Day — **September 22** — with a special ceremony by burning a stockpile of nearly 2,500 horns of the one-horned rhinoceros.
- Rhino horn is used in traditional Chinese medicine to cure a range of ailments, from cancer to hangovers, and also as an aphrodisiac. In Vietnam, possessing a rhino horn is considered a status symbol.
- Due to demand in these countries, poaching pressure on rhinos is ever persistent.



What is the purpose of the ceremony?

- The public ceremony at Bokakhat in Kaziranga National Park (KNP) with Chief Minister Himanta Biswa Sarma as the chief guest has been publicised as a "milestone towards rhino

conservation" aimed at "busting myths about rhino horns". It's a loud and clear message to the poachers and smugglers that such items have no value.

- Thus the case for the destruction of horns — a process that is in compliance with **Section 39(3)(c) of the Wildlife (Protection) Act of 1972.**

How serious a threat is poaching?

- Several cases of rhino poaching were reported in the years leading up to 2013 and 2014. These two years witnessed the highest number of incidents in a decade, at 27 in each year. This has since decreased to 17 in 2015, 18 in 2016, 6 each in 2017 and 2018, and 3 in 2019.
- The one-horned rhino, which was earlier "endangered" as per the IUCN Red List, is now listed as **"Vulnerable."**
- In 2019, the Assam government constituted a dedicated **"Special Rhino Protection Force"** to keep a check on rhino poaching and related activities at KNP.
- A March 2018 rhino census pegged the rhino population at 2,413 in KNP, 101 in Orang National Park, and 102 in Pobitora Wildlife Sanctuary, and a more recent count said there were 43 in the Manas National Park.

➡ WORLD ELEPHANT DAY

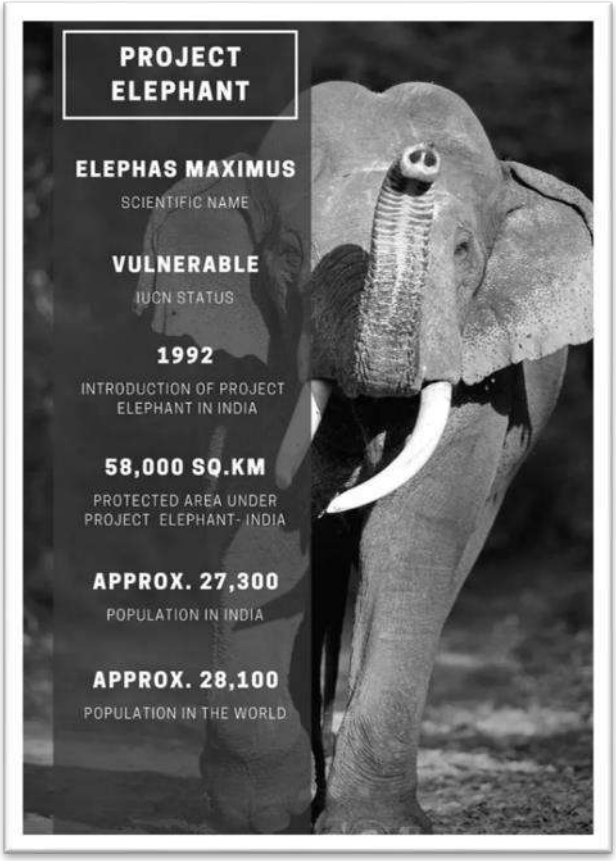
- On **12 August, 2012**, the first international Elephant Day was celebrated. Since then, it is observed annually and this day is dedicated to **huge animal protection and preservation**.
- World Elephant Day was conceived by the **Elephant Reintroduction Foundation** and filmmakers **Patricia Sims** and **Michael Clark**.
- This day makes people understand the need for better protection for wild animals, elephants, and also to improve the illegal poaching and trade of ivory, better treatment of captive elephants.
- In the IUCN Red List of threatened species, **African elephants are listed as Vulnerable** and **Asian elephants as Endangered.**
- The goal of World Elephant Day is to create awareness of the urgent plight of African and Asian elephants, and to share knowledge and positive solutions for the better care and management of captive and wild elephants.

➡ PROJECT ELEPHANT

- Project Elephant was launched by the Government of India in the year **1992** as a Centrally Sponsored Scheme.
- The Ministry of Environment, Forest and Climate Change provides the financial and technical support to major elephant range states in the country through Project Elephant.
- The Project is being implemented in **16 States / UTs** , viz. Andhra Pradesh, Arunachal Pradesh, Assam, Chhattisgarh, Jharkhand, Karnataka, Kerala, Maharashtra, Meghalaya, Nagaland, Orissa, Tamil Nadu, Tripura, Uttarakhand, Uttar Pradesh, West Bengal.

Project Elephant - Objectives

- To protect elephants, their habitat & corridors.
- To address issues of man-animal conflict.
- Welfare of captive elephants.



Project Elephant - Activities

- Main activities under Project Elephant are as follows:
  - Research on Elephant management related issues;
  - Public education and awareness programmes;
  - Eco-development;
  - Veterinary care;
  - **Elephant Rehabilitation/Rescue Centers**;
  - **Ecological restoration** of existing natural habitats and migratory routes of elephants;
  - **Development of scientific and planned management** for conservation of elephant habitats and viable population of Wild Asiatic elephants in India;
  - Promotion of **measures for mitigation of man-elephant conflict** in crucial habitats and moderating pressures of human and domestic stock activities in crucial elephant habitats;
  - Strengthening of measures for the protection of Wild elephants from poachers and unnatural causes of death.

➡ MIKE: GLOBAL EFFORTS

- The **Monitoring the Illegal Killing of Elephants (MIKE) programme is an international collaboration** that measures the levels, trends and causes of elephant mortality, thereby providing an information base to support international decision-making related to conservation of elephants in Asia and Africa.
- The MIKE Programme was established by the **Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) by Resolution 10.10** adopted at the tenth Conference of the Parties in 1997.
- There are currently **28 sites participating in the MIKE programme in Asia**, distributed across 13 countries: India has 10 sites, followed by two sites each in Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar and Thailand, and one site each in Bangladesh, Bhutan, China, Nepal, Sri Lanka and Viet Nam.
- In 2017, IUCN was engaged by CITES to implement the MIKE Asia programme in two sub-regions: **South Asia** (via the IUCN India Country Office in New Delhi); and **Southeast**

Asia (through the IUCN Asia Regional Office in Bangkok). This forms part of the wider Asia Wildlife Law Enforcement and Demand Reduction Management Project funded by the European Union.

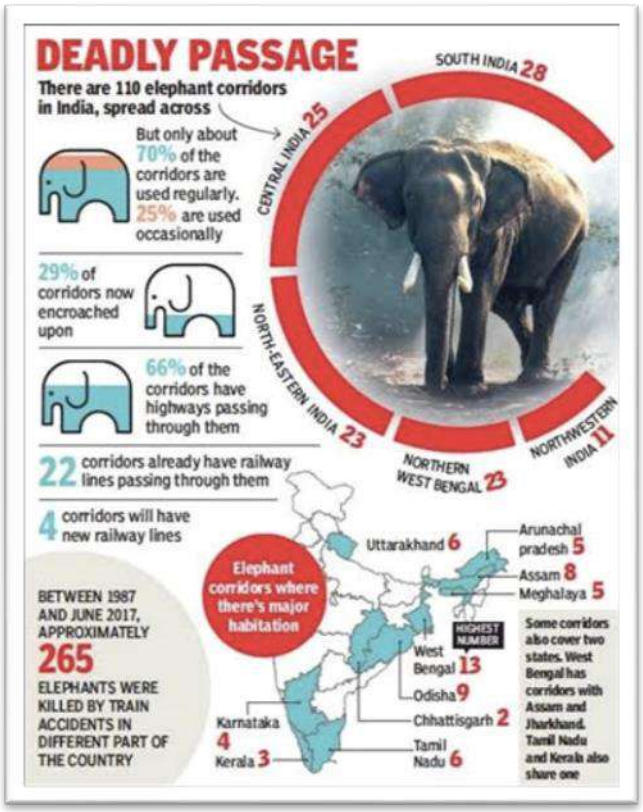
- The main objective of the **MIKE Asia programme** is to identify spatial, temporal and other trends in elephant mortalities by collating and analysing data on elephant carcasses (which are collected by management agencies). Other objectives include support for law enforcement activities, capacity-building for front-line field staff and limited provision of field equipment to sites. The program's analytical outputs and field activities support international decision-making related to elephant conservation in Asia.

Expected outputs:

- Collation and quality control of annual records of elephant carcasses from MIKE sites in Asia.
- Data analysis to identify patterns at the level of site, local region and country.

➡ ELEPHANT CORRIDORS

- Elephant corridor is a **thin strip of land that allows elephants to move freely from one habitat patch to another.**
- More than 100 elephant corridors have been identified by the wildlife trust of India under National elephant Corridor project.



Importance of elephant corridors

- To address the development vs. environment issue which causes habitat loss to animals.
- **To reduce man-animal conflict**: Expanding economic aspirations have given way to the conversion of many wetlands into urban centres, roads and railway projects, infrastructure for tourism. It has caused reduction of space available for animals to roam freely. It arises from man-animal conflict if space for roaming is not provided for them.
- These corridors/projects are win-win for both the people and the animal because farming produce in those get destroyed whenever a herd of animals passes from those areas.
- It can **address the poaching issue** because now the corridors can be technologically monitored.
- WLT(world land trust) and other foreign elephant conservation organisations are funding wildlife trust of India in some corridor formation.

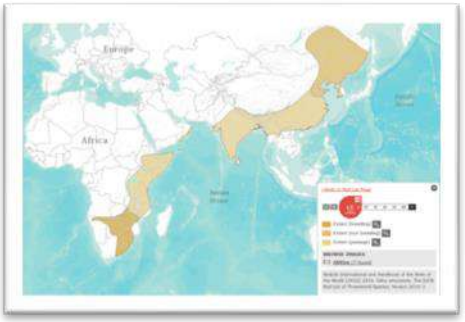
Latest Man-elephant Conflict Examples

- Elephant corridor identified by WWF-India in Wayana for restoration stuck due to non-cooperation among various government agencies.
- Due to quarrying which has come up on hills adjacent to the 566-hectare Basavanatara forest, there is very loud noise pollution which causes elephants to stray from their groups
- Parsa East and Kanta Basan' open cast mine, which consists of a coal washery, involves 1,871 hectares of forest and an elephant corridor.
- Lands owned by the Isha foundation based at the foothills of Velliangiri Mountains are located in the elephant corridor-Case is under litigation in high court and NGT(National Green Tribunal).
- Numaligarh Refinery Ltd (NRL) in Assam created a golf course and fenced it with a barbed wire and wall resulting in deaths of many elephants since then. It is present in elephant corridor region and also it is a No-development zone.
- Dhanagur elephant corridor, where a farmer was killed and another seriously injured in separate elephant attacks.

Some Initiative on domestic front

- To swiftly address the man-animal conflict issue, West Bengal government has come up with **Rapid Response Force (RRP) plan** which is response team that would be equipped with forest official, personnel with animal rescue training and equipment, veterinary surgeons and a smart vehicle with rotating searchlights fitted atop it.
- Another initiative by WB government is **Airavat (mythical war elephant and the pet of Lord Indra),** dedicated to reducing man-elephant conflict.
- **Radio collar and technological devices** for real-time monitoring in Assam and west Bengal elephant corridors.

➡ AMUR FALCON



With the arrival of the migratory Amur falcons to Tamenglong district of Manipur for the annual stopover, State Forest and Environment Minister appealed to the people not to hunt the seasonal visitors.

These falcons visit the district every year from breeding grounds in China and Russia before beginning their onward voyage to Africa for the winter — a journey of more than 30,000 km.

Key Facts

- The Amur Falcon is a fascinating migratory raptor. Every year, the small, resilient birds make the daring voyage from breeding grounds in Russia and China to winter in southern Africa. It

is supposed that the falcons cross the Arabian Sea during their migration, but much is still unknown about the patterns of their migration.

- Breeds in South-east Russia and northern China.
- Migrates west through India and across the Arabian Sea to Southern Africa.
- Feeds on dragonflies that follow a similar migration path over Arabian Sea.
- 22,000 km journey (longest sea crossing of any raptor)
- Flyway: East-Asian Australasian and African Eurasian
- IUCN Red List Status: **Least Concern**

➡ BEHLER AWARD

- Indian biologist Shailendra Singh has been awarded the **Behler Turtle Conservation Award** for bringing three critically endangered turtle conservation species back from the brink of extinction.
- These are **Red-crowned Roofed Turtle (Batagur kachuga), Northern River Terrapin (Batagur baska),** and **Black Softshell Turtle (Nilssonia nigricans)**

RED-CROWNED ROOFED TURTLE (BATAGUR KACHUGA)

- Red Crowned Roofed Turtle is one of the 24 species endemic to India, is characterised by the bright colours such as red, yellow, white and blue on the faces and necks of the males.
- **Common Names:** Bengal roof turtle, Red-crowned roofed turtle.

Distribution:

- It is a freshwater turtle species found in **deep flowing rivers** with terrestrial nesting sites.
- The Red-crowned roofed turtle is **native to India, Bangladesh and Nepal**.
- Historically, the species was widespread in the Ganga River, both in India and Bangladesh. It also occurs in the Brahmaputra basin.
- Currently in India, the National Chambal River Gharial Sanctuary is the only area with substantial population of the species, but even this Protected Area and habitat are under threat.

NORTHERN RIVER TERRAPIN (BATAGUR BASKA)

- The northern river terrapin (Batagur baska), is a species of riverine turtle. It is one of the most critically endangered turtle species according to IUCN.
- **Habitat:** Terrestrial & highly aquatic (freshwater & brackish); lives in tidal areas of the estuaries of medium and large rivers and also in mangrove habitat.

Habit

- Amphibian. Little known about the natural ecology and behavior of Batagurs, partly because the highly silted rivers of their habitat make observations particularly difficult.

- Mainly prefers freshwater habitats and go up to brackish river mouths or estuaries in the breeding season. After laying eggs they return to the freshwater. Individuals known to undertake massive seasonal migrations of 50 to 60 miles to the sand banks that constitutes their breeding grounds.
- **Diet:** Omnivorous- Takes waterside plants and small animals such as clams.

BLACK SOFTSHELL TURTLE (NILSSONIA NIGRICANS)

- **Scientific Name:** Nilssonia nigricans
- **Features:** They look almost the same as the Indian peacock softshell turtle (Nilssonia hurum).

Habitat:

- A freshwater species and there are 29 species of freshwater turtles and tortoises found in India.
- They are found in ponds of temples in north-eastern India and Bangladesh. Its distribution range also includes the Brahmaputra River and its tributaries.
- **Protection Status:** IUCN Red List: Critically Endangered; CITES: Appendix I; Wildlife (Protection) Act, 1972: No legal protection
- Threats: Consumption of turtle meat and eggs, silt mining, encroachment of wetlands and change in flooding pattern.

➡ MANDA BUFFALO

- The Manda buffalo found in the **Eastern Ghat and Koraput plateau in Odisha** has been tagged as the 19th unique breed of buffaloes found in the country by the **National Bureau of Animal Genetic Resources (NBAGR).**
- The **NBAGR is affiliated with the Indian Council of Agriculture Research (ICAR).** It gave the indigenous recognition to this breed after assessing a survey report submitted by Odisha's Animal Resource Development (ARD) and Odisha University of Agriculture and Technology (OUAT).
- The ARD and OUAT had first identified the germ-plasm of this unique breed through a survey.
- There are around one lakh Manda buffaloes, which mostly contribute to nutrition needs of households and also assist in agricultural operations in the hilly terrains of Koraput, Malkangir and Nabarangpur districts. Besides, these buffaloes are **resistant to parasitic infections and less prone to diseases**.

- The average single milk yield of these buffaloes is 2-2.5 litres with more than 8% fat. However, some of the yield goes up to 4 litres.
- The Manda buffaloes get matured in three years and give birth to the first calf in the fourth year. During their 20-year life span, they give birth to a calf every 1.5 to 2 years.

➡ GECKO

- *A team of herpetologists have recorded a new species of bent-toed gecko from a wooded part of the **Umroi Military Station in Meghalaya**.*
- *Its scientific name is **Crytodactylus exercitus** and English name is Indian Army's bent-toed gecko.*
- *Exercitus in Latin means army.*

What are Geckos?

- Geckos are reptiles and are **found on all the continents** except Antarctica.
- These colorful lizards have **adapted to habitats** from rainforests, to deserts, to cold mountain slopes.
- Over a long period of time, geckos have developed special physical features to help them survive and avoid predators.
- Gecko tails serve many purposes. They help balance their weight as they climb branches, they act as fuel tanks to store fat, and as camouflage to help them disappear into their environment.
- Geckos are also able to shed their tails if a predator grabs them.
- **Most geckos are nocturnal**, which means they are active at night, but day geckos are active during the day and nibble on insects, fruits, and flower nectar.
- Most geckos make noises such as chirping, barking, and clicking when they are defending their territory or attracting a mate.
- There are many species of geckos. Depending on the species, their endangered status can range from least concern to critically endangered.

➡ CRIMSON ROSE

- *The pristine beach of Dhanushkodi at the southern-most tip of the **Rameswaram island** in the Indian peninsula has witnessed a rare phenomenon.*
- *Thousands of Crimson Rose butterflies swarmed all available flowering plants along the beach. It was their stopover for nectaring, before the butterflies undertook their ultimate flight towards Sri Lanka, which is around 25 km away from the tip of Dhanushkodi.*

About Crimson Rose

- It is a large butterfly with a mix of black, white and crimson colours on its wings and body.
- It is known for crossing the sea to migrate to Sri Lanka.
- Certain other butterfly species found in Tamil Nadu are also known for their migration in response to the climate and food availability.

➡ BLACK PERCHER

- *Black Percher or Black Ground Skimmer (Diplacodes lefebvrii), a species of dragon fly, was sighted for the first time in the Seshachalam Hill ranges.*
- *It belongs to the **phylum arthropoda**, class insecta and order odonata.*

About Black Percher or Black Ground Skimmer (Diplacodes lefebvrii):

- It is a **species of dragon fly**.
- It is labelled as of **'least concern'** the International Union for Conservation of Nature and Natural Resources (IUCN) Red List of threatened species.
- **Habitat and distribution**: It is a *common* species native of Africa and southern Eurasia. It can be found in almost any type of freshwater habitat.

The Seshachalam Hills

- These are hilly ranges part of the **Eastern Ghats in southern Andhra Pradesh state**, in *southeastern* India.
- The ranges are **bounded by the Rayalaseema uplands** to the west and northwest, and **the Nandyal Valley to the north.**
- **Tirupati,** a major Hindu *pilgrimage* town is located in the hills.
- **Protected reserve forest**: In 2010, it was designated as a Biosphere Reserve. It has large reserves of red sandalwood, which is used in medicines, soaps, spiritual rituals, etc.

➡ PYROSTRIA LALLJI

- A 15-meter-tall tree that belongs to the genus of the coffee family has recently been discovered from the Andaman Islands.
- The new species, Pyrostria laljii, is also the **first record of the genus Pyrostria** in India.
- Plants belonging to genus Pyrostria are usually found in Madagascar but the recently discovered species is new to science.

- The tree is distinguished by a long stem with a whitish coating on the trunk, and oblong-obovate leaves with a cuneate base, and was first reported from **South Andaman's Wandoor forest**. The other places in the Andaman and Nicobar Islands where the tree could be located are the **Tirur forest near the Jarawa Rerserve Forest** and the Chidia Tapu (Munda Pahar) forest.
- Pyrostria laljii has been assessed as **'Critically Endangered'** based on the International Union for Conservation of Nature's (IUCN) Red List criteria.
- While the genus Pyrostria is not found in India, there are several genera from the family Rubiaceae that are common in India. These plants, including cinchona, coffee, adina, hamelia, ixora, galium, gardenia, mussaenda, rubia, morinda, have high potential for economic value.

➡ POKEWOOD SPECIES

- A new species of pokeweed named **Rivina andamanensis** was discovered recently A&N Islands.
- Pokeweed is a species of open or edge habitats, especially those where birds are able to roost. It is found at forest edge
- It was found growing under large trees, shaded and rocky areas, along with herbs and shrubby plants. This discovery of new species, representing the first record of the pokeweed family Petiveriaceae in the Andaman and Nicobar Islands, adds one more family to the islands' flora.
- The A&N Islands is a group of 572 islands and islets that are rich and unique in terms of plant diversity in India. The total number of listed flora on the islands is approximately 3,410 plant species under 1,281 genera and 303 families belonging to Angiosperms, Gymnosperms, Pteridophytes, Bryophytes, and Lichens.

➡ WHITEFLIES

- Whiteflies are soft-bodied, winged insects closely related to **aphids and mealybugs**. Despite their name, whiteflies are not a type of fly, though they do have wings and are capable of flying.
- Whiteflies can be as small as **1/12 of an inch**, are somewhat **triangular in shape**, and are often **found in clusters on the undersides of leaves.** They are active during the day and will scatter when disturbed, so they can be easier to spot than some nocturnal insect pests.

- There are hundreds of species of whiteflies, but most affect only a small number of host plants. However, there are a few whitefly species that affect a wider range of plants, which make them the most problematic in horticulture.
- These whitefly species include the **greenhouse whitefly, bandedwinged whitefly, giant whitefly,** and **silverleaf whitefly**, among others.
- Whiteflies can be found on a wide variety of plants, from ornamental flowers to warm-weather vegetables, including tomatoes, eggplant, peppers, and okra. Some species may attack sweet potatoes, plants from the cabbage family, and citrus trees. Indoors, they will feed on most common houseplants, especially those with soft, smooth leaves.
- Like aphids, whiteflies use their piercing mouthparts to suck up plant juices and, in turn, produce a sticky substance known as **honeydew.**
- Honeydew left on its own can cause fungal diseases such as sooty mold to form on leaves.
- With heavy whitefly feeding, plants will quickly become extremely weak and may be unable to carry out photosynthesis. Leaves will wilt, turn pale or yellow, growth will be stunted, and eventually leaves may shrivel and drop off the plant.

Where to find whiteflies on plants

- Whiteflies tend to **prefer to feed on new growth**, so check around any newly unfurled leaves first.
- Check the **undersides of leaves—especially around the veins**—for white insects, even if they aren't immediately visible, and feel leaf surfaces for sticky honeydew. If the whiteflies are feeding, they'll suddenly all fly off the leaves in a swarm.
- Eggs are laid on the undersides of leaves. This is the beginning of a new generation! When the eggs hatch, the larvae will look like teeny white ovals without legs; they don't move but they immediately start sucking the plant juice. This is why gardeners often miss whiteflies until it's too late.

➡ GIANT AFRICAN SNAIL

- The giant African land snail is a **highly invasive agricultural pest**, known to feed on over 500 varieties of plants.
- They also **pose a risk to humans and animals by carrying rat lung worm**, a parasite that can cause **meningitis in humans**.
- The species is **native to East Africa**, but it has been widely introduced to other parts of the world through the pet trade, as a food resource, and by accidental introduction.
- Nonetheless, the species has established itself in some temperate climates and its habitat now

includes most regions of the humid tropics, including many Pacific islands, southern and eastern Asia, and the Caribbean.

- The giant snail **can now be found in agricultural areas, coastland, natural forest, planted forests, riparian zones, scrub and shrublands, urban areas, and wetlands.**
- The giant African snail is a **macrophytophagous herbivore**; it eats a wide range of plant material, fruit, vegetables, lichens, fungi, paper, and cardboard.
- It sometimes eats sand, very small stones, bones from carcasses, and even concrete as calcium sources for its shell.
- In rare instances, the snails consume each other, snail eggs, and other deceased small animals such as mice and birds.

➡ ACUTE BLADDER SNAIL

A tiny snail with a striking, pellucid golden-yellow shell found in the Edappally canal in Kochi has been flagged as an invasive species that could play havoc with native ecosystems.This is the first time that this snail has been reported in the State.

- ACUTE BLADDER SNAIL (Physella acuta) is considered **native to North America** but is now found in all continents except Antarctica.
- The snail was first reported in India in the early 1990s. It is believed to have reached Kerala through the **aquarium trade, a major vector for invasive species.**
- In the Edappally canal, the snail had made its home in a highly polluted reach plagued by high sedimentation, untreated sewage, commercial effluents, construction wastes and a thick growth of invasive aquatic weeds.
- Small in size, the snail can grow to 16 mm in height and 9 mm in width.
- The **dead, vacant shell is brownish-yellow** while that of the **live individuals are translucent golden-yellow with a mottled appearance**.
- Physella acuta is easily **identified by its sinistral (left-opening aperture) shell**.
- Threat posed by invasive species to global biodiversity can be drastic due to their ability to quickly dominate new environments, endanger native species, even causing serious economic loss.

➡ RISE IN BUTTERFLY SPECIES

The four-day butterfly survey was conducted by the Kerala Forest Department and Travancore Nature History Society (TNHS) Thiruvananthapuram.

- The survey was done in **Peechi-Vazhany**, **Chimmony**, and **Chulannur Wildlife Sanctuaries**.

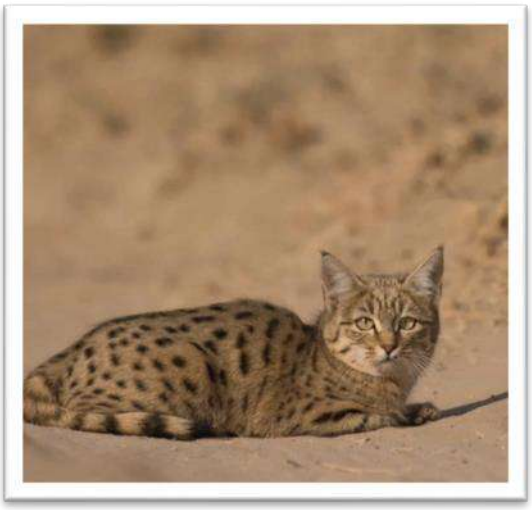
- Peechi-Vazhany Wildlife sanctuary had 132 species of butterflies, Chimmony had 116 species, while Chulannur recorded 41 species.
- The survey added 80 species, almost double, to the older record of Peechi-Vazhany, 33 to Chimmony, and 41 species to Chulannur.

Butterfly species

- **Southern Birdwing**, the largest butterfly in India, and **Grass Jewel**, the smallest, were found during the survey.
- **Buddha Peacock**, the State butterfly of Kerala, was also recorded.
- Other notable species are Nilgiri Grass Yellow, Travancore Evening Brown, Malabar Flash, Orange Tailed Awl, Southern Spotted Ace and Common Onyx.
- The report of Common Tinsel at Chulannur was another highlight.

➡ INDIAN DESERT CAT

An Indian desert cat has been spotted for the first time in Madhya ***Pradesh's Panna Tiger Reserve (PTR).***



About the cat

- It is usually a creature of the **Thar desert in Rajasthan**, and inhabits scrub desert areas.
- The cat occurs in **arid and semi-arid zones** of **western India** which includes Gujarat, Rajasthan, Madhya Pradesh and Maharashtra up to Pune and Nagpur.
- This cat is found in deserts and can survive without water.
- The **toes of the species have cushion-like hair** which help it balance the fluctuating desert temperatures.
- It can be found mostly in scrub deserts, up to 2,000-3,000 m elevation, mountainous areas with sufficient vegetation, as well as temperate forests.
- The Asiatic wildcat usually occurs close to water sources but can also live in low-water areas. It does not seem to avoid cultivated areas and human settlements.

- **IUCN Red List: Least Concern**
- **CITES: Appendix-II**

- **Wildlife protection Act's: Schedule-I.**

PANNA TIGER RESERVE

- It was **established in 1981** and is situated in the **Vindhya mountain range** in the northern part of Madhya Pradesh.
- **Ken river (a tributary of the Yamuna River)** flows through the reserve.
- The region is also famous for Panna diamond mining.
- Ken-Betwa river interlinking project will be located within the tiger reserve.
- The United Nations Educational, Scientific and Cultural Organization (UNESCO) designated the **Panna Tiger Reserve as a Biosphere Reserve in 2011**.
- In 2021, it was awarded the **Conservation Assured Tiger Standards (CAITS) certificate** by the National Tiger Conservation Authority for meeting the established international standards for tiger conservation and management.

➡ GHARIAL

*Gharial have been successfully reintroduced in the **Beas River of Punjab** where it had become extinct half a century ago.*

- The **Beas Conservation Reserve is a 185-kilometre stretch** of the Beas River located primarily in the north-west of the State of Punjab.
- The gharial reintroduction in the Beas Conservation Reserve is an ambitious programme of the Punjab government.

About Gharials

- Gharials, sometimes called **gavials,** are a type of Asian crocodilian distinguished by their long, thin snouts.
- **Population of Gharials are a good indicator of clean river water**.
- Gharials are a type of Crocodilians that also includes crocodiles, alligators, caimans, etc.
- India has three species of Crocodilians namely:
  - **Gharial** (Gavialis gangeticus): International Union for Conservation of Nature (IUCN)- Critically Endangered.
  - **Mugger crocodile** (Crocodylus palustris): IUCN- Vulnerable
  - **Saltwater crocodile** (Crocodylus porosus): IUCN- Least Concern
- In comparison to Crocodiles, Gharials are very shy and unharmful species

Beas River

- The Beas originates near the Rohtang Pass, at a height of 4,062 m above sea level, on the southern end of the **Pir Panjal Range**, close to the source of the Ravi.
- It is a **tributary of Indus river**.
- It **meets the Satluj river at Harike** in Punjab.
- It is a comparatively small river which is only 460 km long but lies entirely within the Indian territory.
- The river flows through **Kullu Valley.**
- It **forms a gorge at Kati and Largi** in the Dhauladhar range.

➡ INDIAN PANGOLIN

- India is home to **two species of pangolin**.
- While the **Chinese Pangolin** (Manis pentadactyla) is found in **north-eastern India**, the **Indian Pangolin** is distributed in other parts of the country as well as Sri Lanka, Bangladesh and Pakistan.

- Both these species are protected and are listed under **Schedule I Part I of the Wild Life (Protection) Act, 1972** and under **Appendix I of the Convention on International Trade in Endangered Species (CITES).**
- Commonly known **as 'scaly anteaters'**, the toothless animals are unique, a result of millions of years of evolution.
- Pangolins evolved scales as a means of protection. When threatened by big carnivores like lions or tigers they usually curl into a ball.
- The scales defend them against dental attacks from predators.
- **IUCN status: Endangered**

➡ HORNBILL FESTIVAL

- This is a very popular festival of Nagaland. Often cited as **"festival of all festivals",** the Hornbill Festival is a grand celebration that is brought to life each year in Nagaland.

- The festival is **conducted to encourage inter-tribal interaction and to promote cultural heritage of Nagaland.**
- The festival gets its name from the Indian Hornbill. The **Hornbill is a common bird among the folklores and tribes of Nagaland** and can be commonly seen prancing around in the forests of Nagaland.
- The Hornbill festival is **celebrated annually**. The festival

opens in the first week of December each year. The government of Nagaland organizes the cultural event.

- The festival is lush with various food fair, games, songs, musical concerts and entertainment to keep the lively spirits of the celebration going.
- Traditional art work, wood crafts, handy crafts, sculptures, paintings, and wood carvings are displayed. Sales and exhibition of these art pieces are held. There are also herbal medicine stalls and display of flower shows.
- There are various food stalls that serve different varieties of food, including the traditional Naga food which is deliciously indulging.
- People indulge in traditional archery, Naga wrestling, indigenous games, other athletic sports and other activities.

➡ LESSER FLORICAN

In a major discovery, the longest in-country migration route of lesser floricans, the endangered birds of the bustard group, has been tracked for the first time from Rajasthan to Maharashtra's Ahmednagar district.

- The exercise was undertaken in the **Shokaliya landscape of Ajmer district** to trace the journey of lesser floricans from their breeding grounds to their places of origin.
- The scientific experiment has succeeded in locating a bird which travelled a distance of 1,000 km after breeding during the monsoon.
- **Lesser florican (Sypheotides indicus),** is a small and slender bird species belonging to the bustard group, found in tall grasslands.
- For its conservation, Dehradun-based Wildlife Institute of India (WII) has launched a recovery programme.
- The endangered bird is observed in Rajasthan, Madhya Pradesh, Gujarat and some other regions during the monsoon season, when it breeds and later disappears with its chicks to unknown places.
- **IUCN status: critically endangered**.

➡ CHILIKA LAKE

- The vast **Chilika Lagoon** is situated on the east-coast of India.
- It is the **largest brackish Water Lagoon** with **estuarine character** that sprawls along the east coast.
- It is the **largest wintering ground for migratory waterfowl** found anywhere on the Indian sub-continent.

- It is one of the hotspot of biodiversity in the country, and some rare, vulnerable and endangered species listed in the IUCN Red List of threatened Animals inhabit in the lagoon for atleast part of their life cycle.
- Chilika supports some of the largest congregation of migratory birds in the country, particularly during the winter.
- Flocks of migratory waterfowl arrive from as far as the Caspian Sea, Lake Baikal, Aral Sea, remote parts of Russia, Kirghiz steppes of Mongolia, Central and South East Asia, Ladakh and the Himalayas, to feed and breed in its fertile waters. In 1989-90 an estimated two million birds visited the Lake.
- **Chilika is an integral part of the culture of coastal Odisha**.

➡ SPOT-BILLED PELICAN

- The **spot-billed pelican** (Pelecanus philippensis) belongs to the **family Pelecanidae**.
- The Spot-billed pelican species is distributed in India, Sri Lanka, Nepal, Myanmar, Thailand, Vietnam and Cambodia.
- The **adult pelican has a dull white head** and neck.
- The **feathers on the hind neck are curly and form a greyish nape crest**. The tail is brownish. The pouch is pinkish with speckles. The upper mandible carries speckles. The tip of the bill is orange. The base of the bill is dark grey and the orbital patch is pink.

- **Habitat:** These spot-billed pelican species roost in trees near water bodies such as ponds, village tanks, lakes, streams and rivers.
- **Feeding habits:** These spot-billed pelican species feed mainly on fish. They also feed on crustaceans and small birds.
- **Breeding:** The breeding season of these pelican species varies between October to May.
  - In South India, it coincides with the Northeast monsoon.
  - They build nest on low trees. The nest may contain a clutch of three to four white eggs.
- **Distribution:** The breeding population of these pelican species is limited to India, Sri Lanka and Cambodia. In the non-breeding season they are recorded in Nepal, Myanmar, Thailand, Laos and Vietnam.
- **Movement Patterns:** The pelican species in South India are considered to be sedentary. Not much is known about their migratory movement. They may locally move for selecting feeding grounds.

Status and conservation

- These species are threatened by habitat loss, fishing activity in the feeding grounds, poaching of chicks and eggs, agricultural pollutants and silting up of water bodies.

- The IUCN has listed them as **"Near Threatened".**

➡ SEPTEMERANTHUS PARASITIC PLANT

- A new genus of a parasitic flowering plant has recently been discovered from the Nicobar group of islands.
- The genus **Septemeranthus grows** on the plant species Horsfieldia glabra(Blume) Warb.
- The parasitic flowering plants have a modified root structure spread on the stem of the tree and are anchored inside the bark of the host tree.
- The plant was found on the periphery of the tropical forest in one of the biodiversity hotspots, the Nicobar group of islands.
- The genus Septemeran thus has a distinct vegetative morphology, inflorescence architecture and floral characters.
- The leaves of the plant are **heart-shaped** with a very long tip and the ovary, fruit and seeds are 'urceolate' (earthen pot-shaped).
- The flowers have five persistent bracts having conspicuous margins.
- The name Septemeranthusis derived from the Latin word 'septem' meaning 'seven', referring to the arrangement of flowers.

➡ DENISON BARB

Denison barb (Miss Kerala), a fish species, has been included in Schedule I of the Wild Life (Protection) Amendment Bill, 2021. However, aquarists and ornamental fish breeders have issues with this inclusion.

- **Denison barb (Miss Kerala)** is also known as red-line torpedo barb, or roseline shark.
- It is a native **freshwater fish species**, commonly found in parts of Karnataka and Kerala.
- The fish is featured with red and black stripes on its body.
- **IUCN Status: Endangered**

- Threats: The fish species is being exploited for the aquarium trade.

What are the issues with the inclusion of Denison barb under Schedule I of the Wild Life (Protection) Amendment Bill, 2021?

- Firstly, the scientific name given to the Denison barb is Puntius denisonii. This is wrong. It should have been named Sahyadria denisonii.
- Secondly, the inclusion of Denison barb in Schedule I is incorrect as it is commonly found.
  - This fish species is found in rivers of Kerala and Karnataka with some of the highest endemic aquatic fauna in the country.
  - The income from the collection of Denison barb for the fish trade acts as an incentive for fishermen to protect habitats.
  - Hence, it would have been preferable to better regulate the trade by including the species in Schedule IV instead of Schedule I.

➡ EASTERN SWAMP DEER

The population of the vulnerable eastern swamp deer, extinct elsewhere in South Asia, has dipped in the Kaziranga National Park and Tiger Reserve.

About Swamp Deer

- The **barasingha, also called swamp deer**, is a deer species distributed in the Indian subcontinent.
- It differs from all other Indian deer species in that the antlers carry more than three tines.
- Threats: Poaching for antlers and meat, habitat loss.
- Barasingha is the state animal of the Indian states of Madhya Pradesh and Uttar Pradesh.

Three subspecies of swamp deer are:

- **Western swamp deer** is adapted to the flooded tall grassland habitat in the Indo-Gangetic plain and are found in the Sukla Phanta Wildlife Reserve of Nepal.
- **Southern swamp deer** has hard hooves and is adapted to hard ground in open sal forest with a grass understorey survives only in the Kanha National Park. It was reintroduced into Satpura Tiger Reserve.
- **Eastern swamp deer** is only found in Assam i.e. it is endemic to Assam.

Protection Status

- It is listed as **Vulnerable in the IUCN Red list**.
- It is listed on **CITES Appendix I**.

- In India, it is included under **Schedule I** of the Wildlife Protection Act of 1972.

➡ ROOT BRIDGES

UNESCO tag sought for living root bridges.

- The Living Root Bridges are made from rubber tree roots also known as **Ficus elastica tree**.
- These wonderful structures have meticulously grown over a period of time and are among the biggest attractions in Meghalaya.
- Such a bridge is locally called **jingkieng jri**.
- The ever evolving Meghalaya bridges are made up of tangled thick roots that provide formidability to the structure and make it good enough to hold 50 or more people in one go.
- They are grown by trained **Khasi and Jaintia tribes** who have mastered the art of growing root bridges across raised banks of streams running through the dense woods of Meghalaya.
- The whole idea of Meghalaya's living bridges came into the picture some two centuries ago (180 years precisely) when veterans of Khasi clan living in Meghalaya **put rubber tree roots into hollow canes of Areca nut palm that met halfway across the stream.**
- The roots were nurtured and cared properly until they grew enough to reach the opposite bank, get completely entwined with each other, and make themselves capable enough to carry heavy weight.
- Once fully grown, these roots last for as long as 500 years. While some of the roots decay because of their continuous association of water, others grow and make up for the decayed, thus providing the required stability to the bridge.
- Of all the Living Root Bridges in Meghalaya, the double-decker root bridge in Cherrapunji and the single-decker root bridge in Shillong are the unique bridges in the world and make for prime attraction in the Northeast.

➡ NEW PLANT SPECIES

Researchers have reported two new plant species from the biodiversity-rich Western Ghats regions in Thiruvananthapuram and Wayanad districts.

They have been christened Fimbristylis sunilii and Neanotis prabhuii.

Fimbristylis sunilii	Neanotis prabhuii
○ Fimbristylis sunilii has been provisionally assessed as data deficient (DD) under the IUCN Red List 	 ○ Neanotis prabhuii is a **prostrate perennial herb**. ○ Discovered in the Chembra Peak grasslands of Wayanad, it hails from the family Rubiaceae and grows on high-altitude grasslands. ○ Neanotis prabhuii grows up to 70 cm in length and is many-flowered with the petals pale pink in colour ○ Neanotis prabhuii has been categorised data deficient (DD) in the absence of any detailed observations and data on populations

➡ BHUNGLOTI CREEPER

A creeper that once gave a monk's robe its saffron colour has made a Buddhist village in eastern Assam's Charaideo district adopt a forest.

- **Bhugloti is a creeper that in combination with the pith of the roots of a jackfruit tree** yields a saffron dye.
- Five years ago, the bhikkhus of a Buddhist monastery in the 152-year-old Chalapather Shyamgaon had bemoaned the near-extinction of bhungloti, a creeper that in combination with the pith of the roots of a jackfruit tree yielded a saffron dye for their robes.
- The concern of the monks triggered a movement for conserving the adjoining **Chala Reserve Forest.**
- In 2018, the people of ten villages in the vicinity converged to form Chala Village Sanctuary Conservation Society and 683 hectare reserve forest under the Sivasagar Forest Division was declared as the Chala Village Sanctuary.
- The Chala Reserve Forest is about 100 metres above sea level, but it houses a few orchids that are usually found in higher altitudes.

➡ TEMPLE TURTLE

- **Hayagriva Madhava Temple temple** in Assam has signed a memorandum of understanding with two green NGOs, the Assam State Zoo cum Botanical Garden and the Kamrup district administration for long-term conservation of the rare freshwater black softshell turtle (Nilssonia nigricans).
- A **vision document 2030** was also launched after **Turtle Survival Alliance India and Help Earth** signed the pact involving the Hayagriva Madhava Temple Committee. The temple, revered by both Hindus and Buddhists, is at Hajo, about 30 km northwest of Guwahati.
- Until sightings along the Brahmaputra River's drainage in Assam, the black softshell turtle was thought to be 'extinct in the wild' and confined only to ponds of temples in northeastern India and Bangladesh.

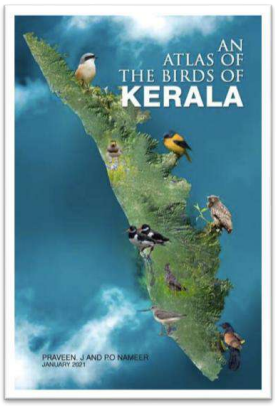
Critically endangered

- The International Union for Conservation of Nature had in 2021 listed the turtle as 'critically endangered'. But it does not enjoy legal protection under the Indian Wildlife (Protection) Act of 1972 although it has traditionally been hunted for its meat and cartilage, traded in regional and international markets.

- Various temple ponds in Assam such as that of the Hayagriva Madhava Temple harbour various threatened species of turtles. Since the turtles are conserved in these ponds only based on religious grounds, many biological requirements for building a sustainable wild population have since long been overlooked.
- This multi-stakeholder association (conservation pact) aims to restock the wild with viable, self-sufficient and genetically pure threatened turtle populations in the region.

➡ BIRD ATLAS OF KERALA

The Kerala Bird Atlas (KBA), the first-of-its-kind state-level bird atlas in India, has created solid baseline data about the distribution and abundance of various bird species across all major habitats giving an impetus for futuristic studies.



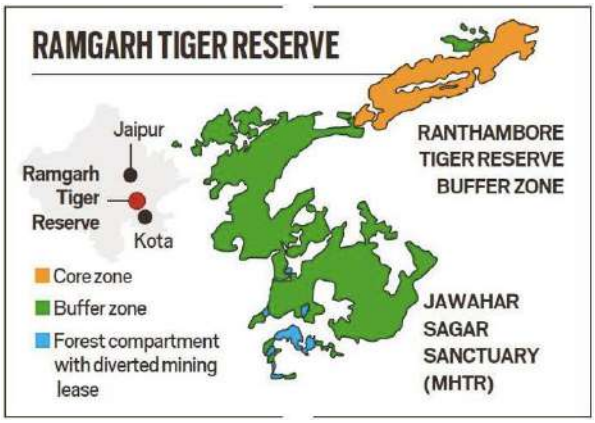
- It was conducted as a citizen science-driven exercise with the participation of volunteers of the bird watching community.
- KBA was prepared based on systematic surveys held twice over 60 days a year during the wet (July to September) and dry (January to March) seasons between 2015 and 2020.
- It is arguably **Asia's largest bird atlas** in terms of geographical extent, sampling effort and species coverage derived from the

aggregation of 25,000 checklists.

- It was found that the species count was higher during the dry season than in the wet season while species richness and evenness were higher in the northern and central districts than in the southern districts.
- Most of the endemics were concentrated in the Western Ghats while the threatened species were mostly along the coasts. The KBA is considered to be a valuable resource for testing various ecological hypotheses and suggesting science-backed conservation measures.
- Among the species, **White-cheeked Barbet and House Crow** topped the chart.
- The survey, however, ignored the very short duration passage of migrant species like Eurasian Cuckoo, Amur Falcon etc.

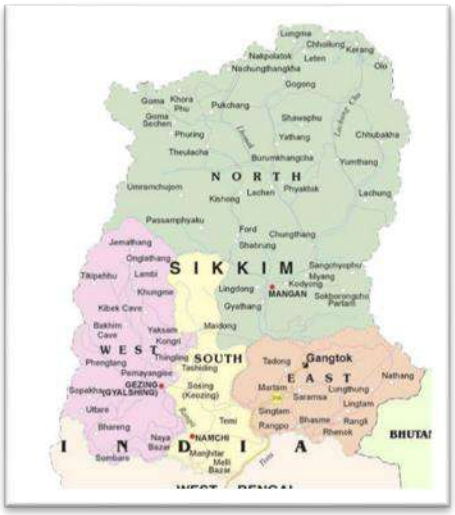
➡ RAMGARH VISHDHARI SANCTUARY

- After the Centre's nod for creation of the Ramgarh Vishdhari sanctuary, the Rajasthan government is hoping to develop a tiger corridor connecting three tiger reserves passing through districts including Sawai Madhopur, Kota and Bundi.
- Tiger corridor connecting **Ranthambore, Ramgarh Vishdhari** and **Mukundra.**



➡ SIKKIM: FLORA CAPITAL

- Sikkim, the smallest State with less than 1% of India's landmass, is home to 27% of all flowering plants found in the country as per the recent publication by the Botanical Survey of India (BSI).
- Flora of Sikkim – A Pictorial Guide, lists 4,912 naturally occurring flowering plants in the tiny Himalayan State.
- The total number of naturally occurring flowering plants in the country is about 18,004 species, and with 4,912 species, the diversity of flowering plants in Sikkim is very unique.
- Scientists and researchers behind the publication said that the State, which is a part of the **Kanchenjunga biosphere landscape,** has different altitudinal ecosystems, which provide opportunity for herbs and

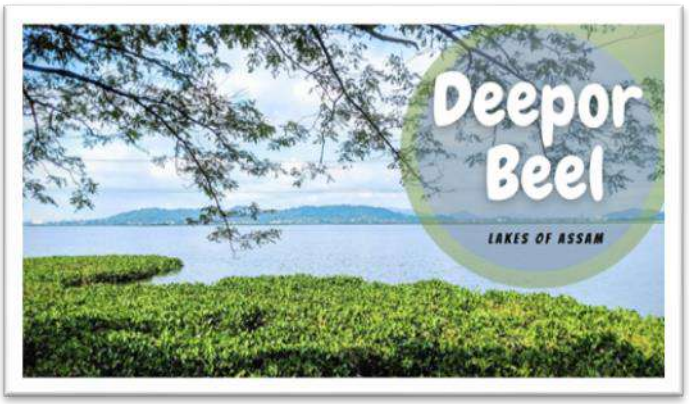


trees to grow and thrive. The State also borders **China, Bhutan and Nepal**, and the **Darjeeling hills of West Bengal.**

- **Landscape:** From subalpine vegetation to the temperate to the tropical, the State has different kinds of vegetation, and that is the reason for such a diversity of flora. The elevation also varies between 300 to 8,598 metres above mean sea level, the apex being the top of Mt. Kanchenjunga (8,586 metres).

➡ DEEPER BEEL

- The Ministry of Environment, Forest and Climate Change notified the eco-sensitive zone of the Deepar Beel Wildlife Sanctuary on the south-western edge of Guwahati.
- Deepor Beel (**Beel means wetland or large aquatic body in Assamese)** located about 10 km Southwest of Guwahati city is considered one of the large and important riverine wetlands in the Brahmaputra Valley of lower Assam, India.

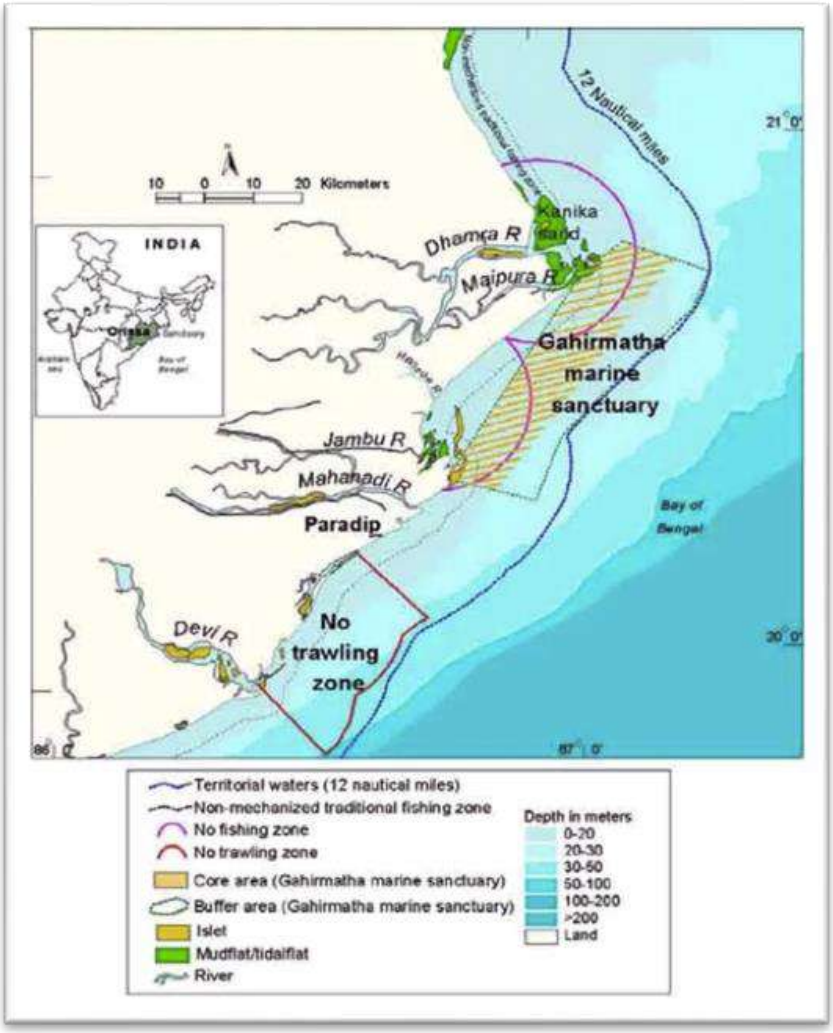


- Deepor Beel is an **open lake basin** connected with a set of inflow and outflow channels.
- Deepor Beel has both biological and environmental importance besides being the only major storm-water storage basin for Guwahati city. It is considered one of the staging sites for migratory birds in India; and some of the large congregations of aquatic birds in Assam during winter.
- Because of the richness of avian fauna it enjoyed, **Deepor Beel has been selected as one of the Important Bird Area (IBA) sites by Birdlife International**.
- Deepor Beel has also been designated as a **Ramsar Site in November 2002**.
- The wetland expands up to 30 sq. km in summer and reduces to about 10 sq. km in the winter. The wildlife sanctuary measures 4.1 sq. km within this wetland.

➡ OLIVE RIDLEY AND ARRIBADA

- The Olive Ridley Sea Turtle (Lepidochelys olivacea), also known as the **Pacific ridley sea turtle**, is a medium-sized species of sea turtle **found in warm and tropical waters**, primarily in the Pacific and Indian Oceans.
- In the Indian Ocean, the majority of olive ridleys nest in two or three large groups at **Rushikulya rookery near Gahirmatha** in Odisha.
- The coast of Odisha in India is the largest mass nesting site for the olive ridley, followed by the coasts of Mexico and Costa Rica.
- The species is listed as **Vulnerable** in the **IUCN Red List, Appendix 1 in CITES, and Schedule 1 in Wildlife Protection Act, 1972.**

- The Odisha's Gahirmatha Marine Sanctuary is known as the world's largest rookery (colony of breeding animals) of sea turtles.



Arribada (Mass Nesting):

- They are best known for their unique mass nesting called Arribada, where **thousands of females come together on the same beach to lay eggs.**
- They lay their eggs over a period of five to seven days in conical nests about one and a half feet deep which they dig with their hind flippers.

Threats

- Marine pollution and waste
- Human Consumption: They are extensively poached for their meat, shell and leather, and eggs.
- Plastic Garbage: An ever-increasing debris of plastics, fishing nets, discarded nets, polythene and other garbage dumped by tourists and fishing workers.
- Fishing Trawlers: Overexploitation of marine resources by use of trawlers often violates the rule to not fish 20 kilometres within a marine sanctuary.
- There were injury marks on many dead turtles indicating they could have been trapped under trawls or gill nets.

Gahirmatha Marine Sanctuary

- Gahirmatha is the **mass nesting spot in Indian Ocean region** and the only turtle sanctuary in Odisha.
- It is the world's **largest nesting beach of Olive Ridley Sea Turtles**.
- Gahirmatha was declared a turtle sanctuary in 1997 by the Odisha government after considering its ecological importance and as part of efforts to save the sea turtles.

- **Gahirmatha Marine Sanctuary** is one of the three parts of the Bhitarkanika National Park. The other two includes the area of Bhitarkanika National Park and the Bhitarkanika Wildlife Sanctuary.

➡ SUNDERBANS

- The Sundarbans is the **biggest delta, back water** and **tidal phenomenon of the region** and thus provides diverse habitats for several hundreds of aquatic, terrestrial and amphibian species.
- The site includes the entire landscape of **mangrove habitats with an adequate surrounding area of aquatic (both marine and freshwater) and terrestrial habitats**, and thus all the areas essential for the long term conservation of the Sundarbans and its rich and distinct biodiversity.
- The Sundarbans mangrove forest, one of the largest such forests in the world (140,000 ha), lies on the delta of the **Ganges, Brahmaputra and Meghna rivers** on the Bay of Bengal.
- It is adjacent to the border of **India's Sundarbans World Heritage site** inscribed in 1987. The site is intersected by a complex network of tidal waterways, mudflats and small islands of salt-tolerant mangrove forests, and presents an excellent example of ongoing ecological processes. The area is known for its wide range of fauna, including 260 bird species, the Bengal tiger and other threatened species such as the estuarine crocodile and the Indian python.
- The **Sundarbans Reserve Forest (SRF),** located in the south-west of Bangladesh between the river Baleswar in the East and the Harinbanga in the West, adjoining to the Bay of Bengal, is the largest contiguous mangrove forest in the world. The land area, including exposed sandbars, occupies 414,259 ha (70%) with water bodies covering 187,413 ha (30%).
- The three wildlife sanctuaries in the south cover an area of 139,700 ha and are considered core breeding areas for a number of endangered species. Situated in a unique bioclimatic zone within a typical geographical situation in the coastal region of the Bay of Bengal, it is a landmark of ancient heritage of mythological and historical events. Bestowed with magnificent scenic beauty and natural resources, it is internationally recognized for its high biodiversity of mangrove flora and fauna both on land and water.
- The Sundarbans is of universal importance for globally endangered species including the **Royal Bengal Tiger, Ganges and Irawadi dolphins, estuarine crocodiles** and the

critically endangered endemic **river terrapin (Batagur baska).** It is the only mangrove habitat in the world for Panthera tigris species.

- The Sundarbans provides a significant example of on-going ecological processes as it represents the process of delta formation and the subsequent colonization of the newly formed deltaic islands and associated mangrove communities. These processes include monsoon rains, flooding, delta formation, tidal influence and plant colonization. As part of the world's largest delta, formed from sediments deposited by three great rivers; the Ganges, Brahmaputra and Meghna, and covering the Bengal Basin, the land has been moulded by tidal action, resulting in a distinctive physiology.
- Natural calamities such as cyclones, have always posed threats on the values of the property and along with saline water intrusion and siltation, remain potential threats to the attributes.
- Cyclones and tidal waves cause some damage to the forest along the sea-land interface and have previously caused occasional considerable mortality among some species of fauna such as the spotted deer.
- Over exploitation of both timber resources and fauna, illegal hunting and trapping, and agricultural encroachment also pose serious threats to the values of the property and its overall integrity.

➡ CORALS

- Corals are **sessile,** which means that they **permanently attach themselves to the ocean floor,** essentially "taking root" like most plants do. We certainly cannot recognize them by their faces or other distinct body parts, as we can most other animals.
- Corals are **invertebrate animals** belonging to a large group of **colourful and fascinating animals called Cnidaria**. Other animals in this group that you may have seen in rock pools or on the beach include jelly fish and sea anemones. Although Cnidarians exhibit a wide variety of colours, shapes and sizes, they all share the same distinguishing characteristics; a simple stomach with a single mouth opening surrounded by stinging tentacles.
- Each **individual coral animal is called a polyp**, and most live in groups of hundreds to thousands of genetically identical polyps that form a 'colony'. The colony is formed by a process called budding, which is where the original polyp literally grows copies of itself.
- Coral are generally classified as either **"hard coral" or "soft coral".** There are around 800 known species of hard coral, also known as the 'reef building' corals. Soft corals, which include seas fans, sea feathers and sea whips, don't have the rock-like calcareous skeleton like the others, instead they grow wood-like cores for support and fleshy rinds for protection.
- Soft corals also live in colonies, that often resemble brightly coloured plants or trees, and are easy to tell apart from hard corals as their polyps have tentacles that occur in numerals of 8, and have a distinctive feathery appearance. Soft corals are found in oceans from the equator to the north and south poles, generally in caves or ledges. Here, they hang down in order to capture food floating by in the currents that are usually typical of these places.

More about coral reefs

- **Hard corals extract abundant calcium** from surrounding seawater and use this to create a hardened structure for protection and growth. Coral reefs are therefore **created by millions of tiny polyps forming large carbonate structures**, and are the basis of a

framework and home for hundreds of thousands, if not millions, of other species. Coral reefs are the largest living structure on the planet, and the only living structure to be visible from space.

- Coral reefs have evolved on earth over the past 200 to 300 million years, and over this evolutionary history, perhaps the most unique feature of corals is the highly evolved form of **symbiosis.** Coral polyps have developed this relationship with **tiny single-celled plants, known as zooxanthellae.** Inside the tissues of each coral polyp live these microscopic, single-celled algae, sharing space, gas exchange and nutrients to survive.
- This symbiosis between plant and animal also contributes to the brilliant colors of coral that can be seen while diving on a reef. It is the importance of light that drives corals to compete for space on the sea floor, and so constantly pushes the limits of their physiological tolerances in a competitive environment among so many different species. However, it also makes corals highly susceptible to environmental stress.
- **Coral reefs are part of a larger ecosystem that also includes mangroves and seagrass beds**. Mangroves are salt tolerant trees with submerged roots that provide nursery and breeding grounds for marine life, that then migrate to the reef. Mangroves also trap and produce nutrients for food, stabilise the shoreline, protect the coastal zone from storms, and help filter land based pollutants from run off. Seagrasses are flowering marine plants that are a key primary producer in the food web. They provide food and habitat for turtles, seahorses, manatees, fish and foraging sea life such as urchins and sea cucumbers, and are also a nursery for many juvenile species of sea animals. Seagrass beds are like fields that sit in shallow waters off the beach, filtering sediments out of the water, releasing oxygen and stabilising the bottom.
- **Location-**Coral reefs are **found throughout the oceans, from deep, cold waters to shallow, tropical waters.** Temperate and tropical reefs however are formed only in a zone extending at most from 30°N to 30°S of the equator; the reef-building corals prefering to grow at depths shallower than 30 m (100 ft), or where the temperature range is between 16-32oc, and light levels are high.

What does a coral reef look like?

It was Charles Darwin who originally classified coral reefs as to their structure and morphology, and described them as follows:

- **Fringing reefs** lie near emergent land. They are fairly shallow, narrow and recently formed. They can be separated form the coast by a navigable channel (which is sometimes incorrectly termed a “lagoon”).
- **Barrier reefs** are broader and lie farther away from the coast. They are separated from the coast by a stretch of water which can be up to several miles wide and several tens of metres deep. Sandy islands covered with a characteristic pattern of vegetation have sometimes formed on top of a barrier reef. The coastline of these islands is broken by passes, which have occupied the beds of former rivers.
- **Atolls are large, ring-shaped reefs lying off the coast,**

with a lagoon in their middle. The emergent part of the reef is often covered with accumulated sediments and the most characteristic vegetation growing on these reefs consists of coconut trees. Atolls develop near the sea surface on underwater islands or on islands that sink, or subside.

THINGS TO KNOW

➡ GEO-TOURISM SITES

The Geological Survey of India (GSI) has identified certain geological sites across the Northeast for promotion of geo-tourism.

- Of the 12 sites in the Northeast, three are in Meghalaya, two each in Assam and Tripura, and one each in Arunachal Pradesh, Manipur, Mizoram, Nagaland and Sikkim.

MEGHALAYA

Mawmluh Cave: Near Cherrapunjee in the East Khasi Hills district, this cave led scientists to the **Meghalayan Age** associated with a major climatic event – very abrupt, critical and significant drought and cooling – 4,200 years ago.

A stage of the **Meghalayan Age is defined from a specific level in a stalagmite from this cave.** According to geologists, speleothems from the cave provide important records of Holocene paleo-climate and paleo-monsoon.

The cave is about 55 km from the State capital Shillong.

Mawblei or God's Rock: Situated near Syntung village in East Khasi Hills district, it is a huge balancing rock slanting at an angle of about 45 degrees in the south-southeast direction on a hill slope at 1,303 metres above mean sea level overlooking the Wahrashi River valley.

The rock is composed of the **reddish-purple Mahadek sandstone** belonging to the Khasi group of cretaceous age. Thin partings of shale are also observed in the boulder.

Mawblei in the Khasi language means **God's Rock** and is a sacred place for the local populace.

The rock is about 63 km from Shillong.

Therriaghat: Also in East Khasi Hills district, it is probably one of the best-preserved and most complete Cretaceous-Paleogene boundary sections in India.

Most of the large vertebrates, planktons and many tropical invertebrates suddenly became extinct at the end of the Cretaceous period.

A new assemblage of ammonites recorded recently probably represent a few of the last representatives just before the mass extinction in which the complete sub-class Ammonidea vanished from the face of the earth.

ASSAM

Umananda: One of the smallest inhabited islands in the Brahmaputra, Umananda is off the administrative hub of Guwahati and sports an old Shiva temple. The island is actually an inselberg, composed of the rocks of the Assam-Meghalaya gneissic complex.

Majuli: A river "island", among the world's largest, Majuli is a district at the mercy of the Brahmaputra. The river erodes the island every year but also deposits soil to ensure a constant change in its shape.
The island is also the hub of spiritualism in Assam because of a number of 'satras' or Vaishnav monasteries established by the 15th-16th century saint-reformer **Srimanta Sankaradeva** and his disciples.
The island is about 330 km east of Guwahati.

TRIPURA

Chabimura: In Gomati district, this site is known for its panels of rock carving on a steep hill wall on the bank of river Gomati.
The huge images of **Shiva, Vishnu, Karthikeya, Durga** and other gods and goddesses date back to the 15th-16th century and the biggest carved deity is about 20 ft.
The hill range is covered with thick jungles and one can reach this abode of gods after trekking through the foliage but rafting or boating on the river is the only option for a view of the rock-face carvings. The site is about 82 km from the State capital Agartala.

Unakoti: This site in the Unakoti district has numerous rock-cut sculptures and temples made between the 7th and 9th centuries. The hilly environs and waterfalls are an added attraction at Unakoti, which means "one less than a crore". The place is a historic Shaiva pilgrimage 172 km from Agartala. The central Shiva head, known as 'Unakotiswara Kal Bhairava' is about 30 feet high, including an embroidered headdress that is 10 feet high.

ARUNACHAL PRADESH

Sangetsar Tso: Popularly known as **Madhuri Lake**, this waterbody in Tawang district is close to the border with Tibet and was formed due to the damming of a river during a major earthquake in 1950.
The lake is surrounded by a lush valley and snow-capped mountains.

MIZORAM

Reiek Tlang: About 29 km from State capital Aizawl, this hill is a **cuesta formed due to erosion of the tertiary sand shale alternations**.

Cuesta means a ridge with a gentle slope or dip on one side and a steep slope or scarp on the other. The local authorities host the annual anthurium festival at a heritage village near the Reiek peak.

NAGALAND

Naga Hill Ophiolite: Geologically referred to as NHO, it is in the Pungro region of Kiphire district and about 240 km from State capital Kohima.

It refers to the **ophiolitic rocks of mantle and oceanic crust percentage at the continental plate margin** with vast potential for intensive research and economic growth.

The NHO consists of a variety of Mesozoic and the subsequently Cenozoic rocks – magmatic, metamorphic and sedimentary – that originated at the India-Myanmar convergent plate boundary. It has been assigned ages ranging from Cretaceous to Paleocene.

SIKKIM

Stromatolite Park: At Mamley, about 80 km from State capital Gangtok, this site comprising stromatolitic (algal) development – boulder outcrops with circular structures – hosted in the limestone of **Buxa Formation** was discovered a little over a decade ago.

It provides one of the rare examples of early life on earth in the Sikkim Himalayas. The age of the Buxa Formation is tentatively assigned as Meso-Neoproterozoic based on the available evidence of stromatolites and organic-walled microfossils.

MANIPUR

Loktak Lake: About 40 km from State capital Imphal, this lake in the Bishnupur district is the largest freshwater lake in the Northeast.

The attractions of this lake are the **' phumdis'** or floating biomass and the 'phumsangs' or huts of fishermen on them.

The **Keibul Lamjao National Park**, the only floating wildlife habitat on earth, is on the southwestern part of the lake and is the last natural habitat of the sangai or brow-antlered dancing deer.

➡ TRADITIONAL RAINWATER HARVESTING

Jhalara:

are typically rectangular-shaped stepwells that have tiered steps on three or four sides. These stepwells collect the subterranean seepage of an upstream reservoir or a lake.

Jhalaras were built to ensure easy and regular supply of water for religious rites, royal ceremonies and community use. The **city of Jodhpur** has eight jhalaras, the oldest being the Mahamandir Jhalara that dates back to 1660 AD.

Talab /Bandhi:

Talabs are reservoirs that store water for household consumption and drinking purposes. They may be natural, such as the **pokhariyan ponds** at Tikamgarh in the Bundelkhand region or man-made, such as the lakes of Udaipur.

A reservoir with an area less than five bighas is called a talai, a medium sized lake is called a bandhi and bigger lakes are called sagar or samand.

Bawari:

Bawaris are unique stepwells that were once a part of the ancient networks of water storage in the cities of Rajasthan. The little rain that the region received would be diverted to man-made tanks through canals built on the hilly outskirts of cities.

The water would then percolate into the ground, raising the water table and recharging a deep and intricate network of aquifers. To minimise water loss through evaporation, a series of layered steps were built around the reservoirs to narrow and deepen the wells.

Taanka:

Taanka is a traditional rainwater harvesting technique indigenous to the Thar desert region of Rajasthan. A Taanka is a cylindrical paved underground pit into which rainwater from rooftops, courtyards or artificially prepared catchments flows.

Once completely filled, the water stored in a taanka can last throughout the dry season and is sufficient for a family of 5-6 members. An important element of water security in these arid regions, taankas can save families from the everyday drudgery of fetching water from distant sources.

Ahar Pynes:

Ahar Pynes are traditional floodwater harvesting systems indigenous to South Bihar.

Ahars are reservoirs with embankments on three sides that are built at the end of diversion channels like pynes.

Pynes are artificial rivulets led off from rivers to collect water in the ahars for irrigation in the dry months. Paddy cultivation in this relatively low rainfall area depends mostly on ahar pynes.

Johads:

Johads, one of the oldest systems used to conserve and recharge ground water, are small earthen check dams that capture and store rainwater. Constructed in an area with naturally high elevation on three sides, a storage pit is made by excavating the area, and excavated soil is used to create a wall on the fourth side.

Sometimes, several johads are interconnected through deep channels, with a single outlet opening into a river or stream nearby. This prevents structural damage to the water pits that are also called madakas in Karnataka and pemghara in Odisha.

Panam Keni:

The Kuruma tribe (a native tribe of Wayanad) uses a special type of well, called the panam keni, to store water. Wooden cylinders are made by soaking the stems of toddy palms in water for a long time so that the core rots away until only the hard outer layer remains. These cylinders, four feet in diameter as well as depth, are then immersed in groundwater springs located in fields and forests. This is the secret behind how these wells have abundant water even in the hottest summer months.

Khadin:

Khadins are ingenious constructions designed to harvest surface runoff water for agriculture. The main feature of a khadin, also called dhora, is a long earthen embankment that is built across the hill slopes of gravelly uplands.

Sluices and spillways allow the excess water to drain off and the water-saturated land is then used for crop production. First designed by the Paliwal Brahmins of Jaisalmer in the 15th century, this system is very similar to the irrigation methods of the people of ancient Ur (present Iraq).

Kund:

A kund is a saucer-shaped catchment area that gently slope towards the central circular underground well. Its main purpose is to harvest rainwater for drinking.

Kunds dot the sandier tracts of western Rajasthan and Gujarat. Traditionally, these well-pits were covered in disinfectant lime and ash, though many modern kunds have been constructed simply with cement. Raja Sur Singh is said to have built the earliest known kunds in the village of Vadi Ka Melan in the year 1607 AD.

Baoli:

Built by the nobility for civic, strategic or philanthropic reasons, baolis were secular structures from which everyone could draw water. These beautiful stepwells typically have beautiful arches, carved motifs and sometimes, rooms on their sides.

The locations of baolis often suggest the way in which they were used. Baolis within villages were mainly used for utilitarian purposes and social gatherings. Baolis on trade routes were often frequented as resting places. Stepwells used exclusively for agriculture had drainage systems that channelled water into the fields.

Nadi:

Found near Jodhpur in Rajasthan, nadis are village ponds that store rainwater collected from adjoining natural catchment areas. The location of a nadi has a strong bearing on its storage capacity and hence the site of a nadi is chosen after careful deliberation of its catchment and runoff characteristics.

Since nadis received their water supply from erratic, torrential rainfall, large amounts of sandy sediments were regularly deposited in them, resulting in quick siltation. A local voluntary organisation, the Mewar Krishak Vikas Samiti (MKVS) has been adding systems like **spillways and silt traps to old nadis** and **promoting afforestation** of their drainage basin to prevent siltation.

Bhandara Phad:

Phad, a community-managed irrigation system, probably came into existence a few centuries ago. The system starts with a **bhandhara (check dam)** built across a river, from which kalvas (canals) branch out to carry water into the fields in the phad (agricultural block).

Sandams (escapes outlets) ensure that the excess water is removed from the canals by charis (distributaries) and sarangs (field channels). The Phad system is operated on three rivers in the Tapi basin – Panjhra, Mosam and Aram – in the Dhule and Nasik districts of Maharashtra.

Zing:

Zings, found in Ladakh, are small tanks that collect melting glacier water. A network of guiding channels brings water from the glacier to the tank. A trickle in the morning, the melting waters of the glacier turn into a flowing stream by the afternoon. The water, collected by evening, is used in the fields on the following day.

A water official called a **Chirpun** is responsible for the equitable distribution of water in this dry region that relies on melting glacial water to meet its farming needs.

Kuhls:

Kuhls are surface water channels found in the mountainous regions of Himachal Pradesh. The channels carry glacial waters from rivers and streams into the fields. The Kangra Valley system has an estimated 715 major kuhls and 2,500 minor kuhls that irrigate more than 30,000 hectares in the valley.

An important cultural tradition, the kuhls were built either through public donations or by royal rulers. A kohli would be designated as the master of the kuhl and he would be responsible for the maintenance of the kuhl.

Zabo:

The Zabo (meaning 'impounding run-off') system combines water conservation with forestry, agriculture and animal care.

Practised in **Nagaland**, Zabo is also known as the **Ruza system**. Rainwater that falls on forested hilltops is collected by channels that deposit the run-off water in pond-like structures created on the terraced hillsides. The channels also pass through cattle yards, collecting the dung and urine of animals, before ultimately meandering into paddy fields at the foot of the hill. Ponds created in the paddy field are then used to rear fish and foster the growth of medicinal plants..

Bamboo Drip Irrigation:

Bamboo Drip irrigation System is an ingenious system of efficient water management that has been practised for over two centuries in northeast India. The tribal farmers of the region have developed a system for irrigation in which water from perennial springs is diverted to the terrace fields using varying sizes and shapes of bamboo pipes. Best suited for crops requiring less water, the system ensures that small drops of water are delivered directly to the roots of the plants. This ancient system is used by the farmers of Khasi and Jaintia hills to drip-irrigate their black pepper cultivation..

Jackwell:

The Shompen tribe of the Great Nicobar Islands lives in a region of rugged topography that they make full use of to harvest water. In this system, the low-lying region of the island is covered with jackwells (pits encircled by bunds made from logs of hard wood). A full-length bamboo is cut longitudinally and placed on a gentle slope with the lower end leading the water into the jackwell. Often, these split bamboos are placed under trees to collect the runoff water from leaves. Big jackwells are interconnected with more bamboos so that the overflow from one jackwell leads to the other, ultimately leading to the biggest jackwell.

Ramtek model:

The Ramtek model has been named after the water harvesting structures in the town of Ramtek in Maharashtra. An intricate network of groundwater and surface water bodies, this system was constructed and maintained mostly by the malguzars (landowners) of the region.

In this system, tanks connected by underground and surface canals form a chain that **extends from the foothills to the plains.** Once tanks located in the hills are filled to capacity, the water flows down to fill successive tanks, generally ending in a small waterhole. This system conserves about 60 to 70 % of the total runoff in the region!

Pat system:

The Pat system, in which the peculiarities of the terrain are used to divert water from hill streams into irrigation channels, was developed in the Bhitada village in Jhabua district of Madhya Pradesh. Diversion bunds are made across a stream near the village by piling up stones and then lining them with teak leaves and mud to make them leak-proof. The Pat channel then passes through deep ditches and stone aqueducts that are skilfully cut info stone cliffs to create an irrigation system that the villagers use in turn..

Eri:

The Eri (tank) system of Tamil Nadu is one of the oldest water management systems in India. Still widely used in the state, eris act as flood-control systems, prevent soil erosion and wastage of runoff during periods of heavy rainfall, and also recharge the groundwater.

Eris can either be a **system eri**, which is fed by channels that divert river water, or a non-system eri, that is fed solely by rain. The tanks are interconnected in order to enable access to the farthest village and to balance the water level in case of excess supply. The eri system enables the complete use of river water for irrigation and without them, paddy cultivation would have been impossible in Tamil Nadu.

There are several other hyperlocal versions of the traditional method of tank irrigation in India. From **Keres in Central Karnataka** and **Cheruvus in Andhra Pradesh** to **Dongs in Assam**, tanks are among the most common traditional irrigation systems in our country.

➡ BIO-DECOMPOSER

- Bio-decomposer generally, an activator or accelerator is a substance that activates, accelerates or increases the total output of the process.

- Microbial cultures added to organic materials or residues to hasten their decomposition act as biological accelerators. **Decomposers produce enzymes**, which lower the activation energy **necessary to break chemical bonds in organic materials.**
- It is formulation of **fast decomposing fungus, which converts biomass** its includes grass windrows/clippings, animal wastes, fields straw after crop harvest and weeds, etc. in fertile humus gradually.
- It will take 60-90 days for conversion of agricultural wastes in powder form.

➡ CIRCULAR ECONOMY

- A circular economy is **restorative and regenerative by design**. This means materials **constantly flow around a 'closed loop' system,** rather than being used once and then discarded.
- In the case of plastic, this means **simultaneously keeping the value of plastics in the economy**, **without leakage into the natural environment.**
- In short, the circular economy is an economic system in which **materials are designed to be used, not used up**. From the outset, products and the systems they sit within should be designed to ensure no materials are lost, no toxins are leaked, and the maximum use is achieved from every process, material, and component. If applied correctly, the circular economy benefits society, the environment, and the economy.

Eliminate the plastics we don't need.

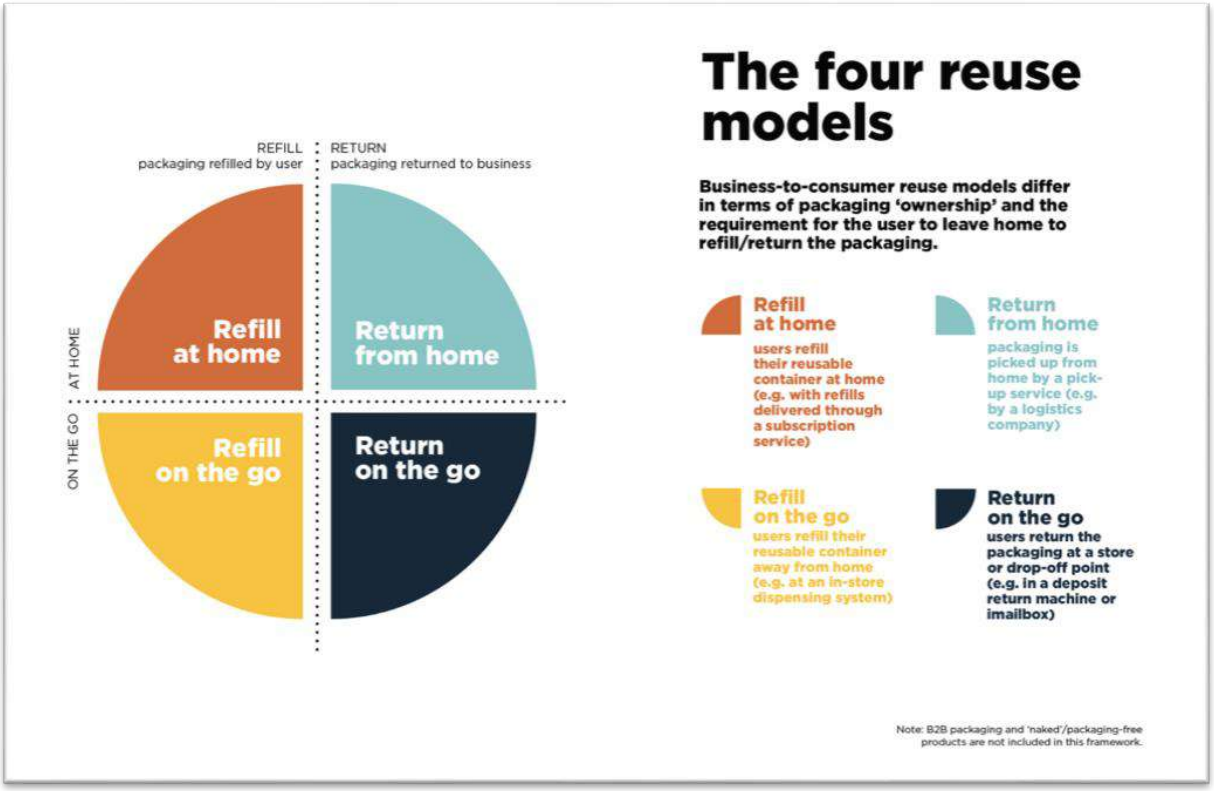
- Plastic brings many benefits. At the same time, there are some problematic items on the market that need to be eliminated to achieve a circular economy, and sometimes, plastic packaging can be avoided altogether while maintaining utility.

- While improving recycling is crucial, we cannot recycle our way out of the plastic issues we currently face. Wherever relevant, **reuse business models should be explored as a preferred solution** (or 'inner loop' in circular economy terms), reducing the need for single-use plastic packaging.

Reuse models, which provide an economically attractive opportunity for at least 20% of plastic packaging, need to be implemented in practice and at scale.

- **Innovate** to ensure that the plastics we do need are reusable, recyclable, or compostable. This requires a combination of redesign and innovation in business models, materials, packaging design, and reprocessing technologies.
- **Compostable plastic packaging** is not a blanket solution, but rather one for specific, targeted applications, because an effective collection and composting infrastructure is essential but often not in place.
- Circulate all the plastic items we use to keep them in the economy and out of the environment.
- No plastic should end up in the environment. Landfill, incineration, and waste-to-energy are not long term solutions that support a circular economy.
- Governments are essential in setting up effective collection infrastructure, facilitating the establishment of related self-sustaining funding mechanisms, and providing an enabling regulatory and policy landscape.
- Businesses producing and/or selling packaging have a responsibility beyond the design and use of their packaging, which includes contributing towards it being collected and reused, recycled, or composted in practice.
- In a new plastics economy, plastic never becomes waste or pollution. Three actions are required to achieve this vision and create a circular economy for plastic. **Eliminate** all problematic and unnecessary plastic items. **Innovate** to ensure that the plastics we do need are reusable, recyclable, or compostable. **Circulate** all the plastic items we use to keep them in the economy and out of the environment.

REUSE

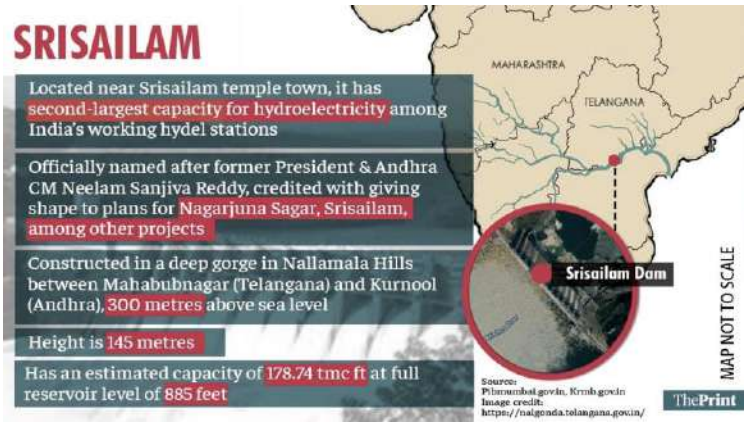


➡ INDIA PLASTIC PACT

- The India Plastics Pact is an ambitious, collaborative initiative that aims to bring together **businesses, governments and NGOs** to reduce, reuse, and recycle plastics in their value chain.
- Launched on 3 September, the Pact aims to **tackle plastic pollution** in the country, bringing together businesses from across the Indian plastics value chain to **move towards a circular plastics system** that aims to keep the material in the economy, and out of the environment.
- India generates 9.47 million tonnes of plastic waste annually, of which 40 per cent goes uncollected. 43 per cent of all plastics produced in the country are used for packaging, most of which is single-use.
- The India Plastics Pact will set out to address this through direct actions across four 2030 targets – define a list of unnecessary or problematic plastic and take measures to address them through redesign and innovation; 100 per cent of plastic packaging to be reusable or recyclable; 50 per cent of plastic packaging to be effectively recycled, and 25 per cent average recycled content across all plastic packaging.
- A total of 27 businesses and supporting organisations have joined the Pact as founding members, including major FMCG brands, manufacturers, retailers and recyclers such as Tata Consumer Products, Amazon, Hindustan Unilever, Coca Cola India, Mondelez, Godrej, Marico and ITC.
- The Pact has been developed as a **collaboration between WRAP, WWF India, and the CII.** The development received funding from **UK Research and Innovation (UKRI),** with further capital to support delivery being secured from Stewart Investors.
- Following the launch of the Pact in India, collaboration is set to continue between WRAP, the CII and WWF-India on four key actions – draw up a delivery roadmap; initiate 'Action Groups' to support the targets; scope out the reporting process to develop a baseline; drive recruitment.
- The India Plastics Pact is the latest to join a growing list of Pacts, including initiatives in Europe, the US, Canada, South Africa and Chile.

➡ SRISAILAM DAM

- The inflows into Srisailam Reservoir have touched 5 lakh cusecs and the Dam Maintenance engineers are discharging 5,50,149 cusecs and the quantum of discharge from the dam is inching closer to the highest reached last year 597,440 cusecs on September 27, 2020.
- The Srisailam Dam is constructed across the **Krishna River in**

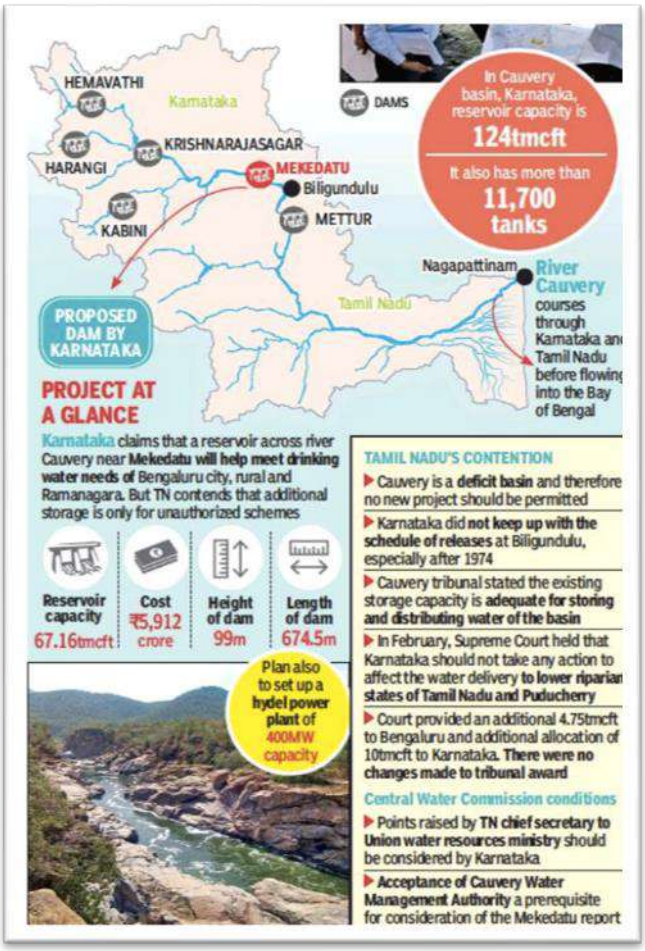


Kurnool district, Andhra Pradesh near Srisailam temple town and is the 2nd largest capacity working hydroelectric station in the country.

- The dam was constructed in a deep gorge in the **Nallamala Hills** in between Kurnool and Mahabubnagar districts.

➡ MEKEDATU PROJECT

- Mekedatu, meaning **goat's leap**, is a deep gorge situated at the confluence of the **rivers Cauvery and its tributary Arkavathi.**
- The Rs. 9,000 crore project aims to store and supply water for drinking purposes for the Bengaluru city. Around 400 megawatts (MW) of power is also proposed to be generated through the project.
- It was first approved by the Karnataka state government in 2017.
- It received approval from the erstwhile Ministry of Water Resources for the detailed project report and is awaiting approval from the Ministry of Environment, Forest and Climate Change (MoEFCC).
- The approval from MoEFCC is crucial because 63% of the forest area of the Cauvery Wildlife Sanctuary will be submerged.
- In 2018, Tamil Nadu approached the Supreme Court (SC) against the project even if Karnataka had held that it would not affect the flow of water to Tamil Nadu.



- In June 2020, during the Cauvery Water Management Authority's meeting, Tamil Nadu reiterated its opposition to the project.

Reasons for Opposition by Tamil Nadu:

- Tamil Nadu is opposed to any project being proposed in the upper riparian unless it was approved by the SC.
- Karnataka has no right to construct any reservoir on an inter-state river without the consent of the lower riparian state i.e. Tamil Nadu in this case.
- The project is against the final order of the Cauvery Water Disputes Tribunal (CWDT) in which the SC held that no state can claim exclusive ownership or assert rights to deprive other states of the waters of inter-state rivers.

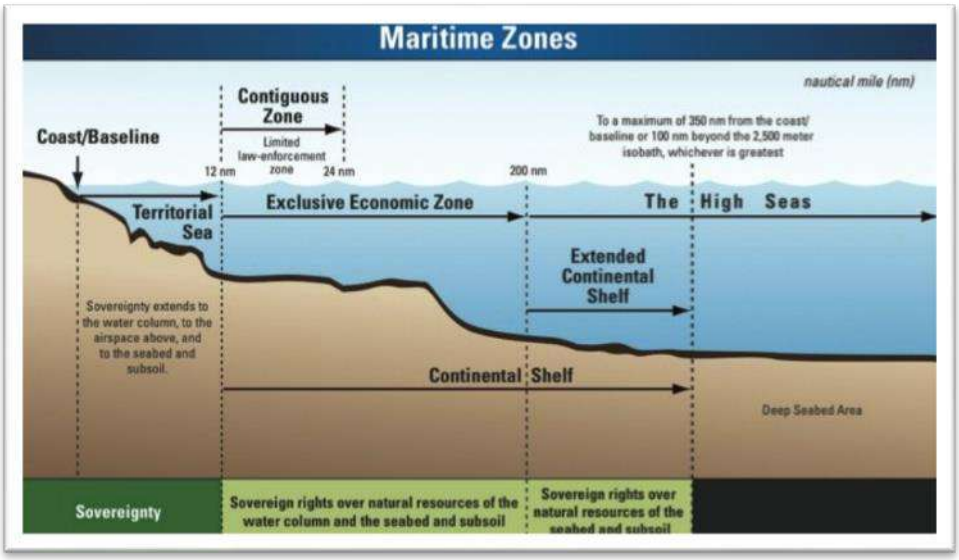
- The CWDT and the SC have found that the existing storage facilities available in the Cauvery basin were adequate for storing and distributing water so Karnataka's proposal is ex-facie (on the face of it) untenable and should be rejected outright.
- It has also held that the reservoir is not just for drinking water alone, but to increase the extent of irrigation, which is in clear violation of the Cauvery Water Disputes Award.

➡ UNCLOS

- United Nations Convention on the Law of the Sea (UNCLOS) 1982, also known as **Law of the Sea** divides marine areas into **five main zones namely**- *Internal Waters, Territorial Sea, Contiguous Zone, Exclusive Economic Zone (EEZ) and the High Seas.*
- UNCLOS is the only international convention which stipulates a framework for state jurisdiction in maritime spaces. It provides a different legal status to different maritime zones.
- It provides the backbone for offshore governance by coastal states and those navigating the oceans. It not only zones coastal states' offshore areas but also provides specific guidance for states' rights and responsibilities in the five concentric zones.

Maritime Zones

Baseline: It is the low-water line along the coast as officially recognized by the coastal state.



Internal Waters:

- Internal waters are waters on the landward side of the baseline from which the breadth of the territorial sea is measured.
- Each coastal state has full sovereignty over its internal waters as like its land territory. Examples of internal waters include bays, ports, inlets, rivers and even lakes that are connected to the sea.
- There is no right of innocent passage through internal waters.
- The innocent passage refers to the passing through the waters which are not prejudicial to peace and security. However, the nations have the right to suspend the same.

Territorial Sea:

- The territorial sea extends seaward up to 12 nautical miles (nm) from its baselines.

- A nautical mile is based on the circumference of the earth and is equal to one minute of latitude. It is slightly more than a land measured mile (1 nautical mile = 1.1508 land miles or 1.85 km).
- The coastal states have sovereignty and jurisdiction over the territorial sea. These rights extend not only on the surface but also to the seabed, subsoil, and even airspace.
- But the coastal states' rights are limited by the innocent passage through the territorial sea.

Contiguous Zone:

- The contiguous zone extends seaward up to 24 nm from its baselines.
- It is an **intermediary zone between the territorial sea and the high seas**.
- The coastal state has the right to both prevent and punish infringement of fiscal, immigration, sanitary, and customs laws within its territory and territorial sea.
- Unlike the territorial sea, the contiguous zone only gives jurisdiction to a state on the ocean's surface and floor. It does not provide air and space rights.

Exclusive Economic Zone (EEZ):

- Each coastal State may claim an EEZ beyond and adjacent to its territorial sea that extends seaward up to 200 nm from its baselines.
  Within its EEZ, a coastal state has:
- Sovereign rights for the purpose of exploring, exploiting, conserving and managing natural resources, whether living or nonliving, of the seabed and subsoil.
- Rights to carry out activities like the production of energy from the water, currents and wind.
- Unlike the territorial sea and the contiguous zone, the EEZ only allows for the above-mentioned resource rights. It does not give a coastal state the right to prohibit or limit freedom of navigation or overflight, subject to very limited exceptions.

High Seas:

- The ocean surface and the water column beyond the EEZ are referred to as the high seas.
- It is considered as "the common heritage of all mankind" and is beyond any national jurisdiction.
- States can conduct activities in these areas as long as they are for peaceful purposes, such as transit, marine science, and undersea exploration.

➡ ETHANOL

- Ethanol is a renewable fuel made from various plant materials collectively known as "biomass." More than 98% of U.S. gasoline contains ethanol, typically E10 (10% ethanol, 90% gasoline), to oxygenate the fuel, which reduces air pollution.
- Ethanol is also available as E85 (or flex fuel), which can be used in flexible fuel vehicles, designed to operate on any blend of gasoline and ethanol up to 83%. Another blend, E15, is approved for use in model year 2001 and newer light-duty vehicles.

There are several steps involved in making ethanol available as a vehicle fuel:

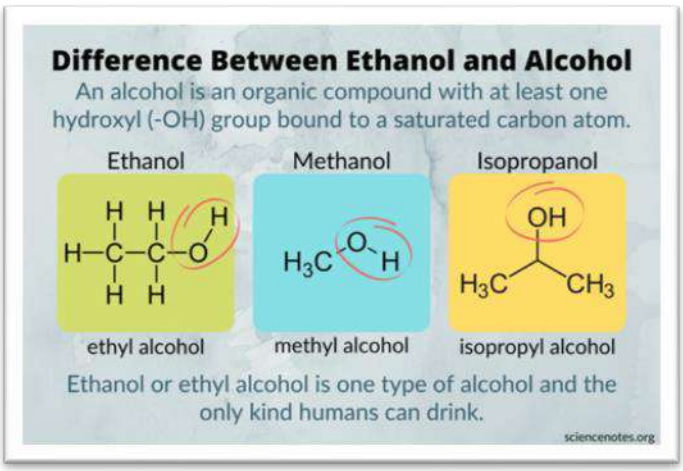
- Biomass feedstocks are grown, collected, and transported to an ethanol production facility.

- Feedstocks are converted to ethanol at a production facility and then transported to a fuel terminal or end-user by rail, truck, or barge.
- Ethanol is blended with gasoline at the fuel terminal to make E10, E15, or E85, and then distributed by truck to fueling stations. E15 is either sourced directly from a terminal or via a blender pump from the E10 and E85 tanks at a station.

Fuel Properties

- **Ethanol (CH_3CH_2OH)** is a **clear, colorless liquid**. It is also known as ethyl alcohol, grain alcohol, and EtOH (see Fuel Properties search.)
- Ethanol has the same chemical formula regardless of whether it is produced from starch- or sugar-based feedstocks, such as corn grain (as it primarily is in the United States), sugar cane (as it primarily is in Brazil), or from cellulosic feedstocks (such as wood chips or crop residues).
- Ethanol has a **higher octane number than gasoline**, providing premium blending properties. Minimum octane number requirements for gasoline prevent engine knocking and ensure drivability. Lower-octane gasoline is blended with 10% ethanol to attain the standard 87 octane.
- Ethanol contains less energy per gallon than gasoline, to varying degrees, depending on the volume percentage of ethanol in the blend. Denatured ethanol (98% ethanol) contains about 30% less energy than gasoline per gallon. Ethanol's impact on fuel economy is dependent on the ethanol content in the fuel and whether an engine is optimized to run on gasoline or ethanol.

Ethanol Energy Balance



- In the United States, 94% of ethanol is produced from the starch in corn grain. Energy is required to turn any raw feedstock into ethanol. Ethanol produced from corn demonstrates a positive energy balance, meaning that the process of producing ethanol fuel does not require more energy than the amount of energy contained in the fuel itself.
- Cellulosic ethanol improves the energy balance of ethanol because the feedstocks are either waste, co-products of another industry (wood, crop residues), or are dedicated crops—such as switchgrass and miscanthus—with low water and fertilizer requirements compared to corn.
- When biomass is used to power the process of converting non-food-based feedstocks into cellulosic ethanol, the amount of fossil fuel energy used in production is reduced even further. Another benefit of cellulosic ethanol is that it results in lower levels of life cycle greenhouse gas emissions.

➡ OIL PALM

- A plan cleared by the Union Cabinet to expand domestic palm oil output in ecologically-sensitive regions could be environmentally dangerous unless backed by a set of strong safeguards, experts said, citing disastrous impacts in growers such as Malaysia and Indonesia.
- Palm oil is the **cheapest edible oil**, used in most foods items, from bread to pizzas. In recent months, global prices have surged to multi-year peaks, forcing the government to cut import duties to make the fats affordable.
- To cut India's growing reliance on import of edible oils, the government approved the **"National Mission on Edible Oils – Oil Palm (NMEO-OP)"**, allocating ₹11,040 crore for it. The programme seeks to promote plantations in the northeastern regions, besides the Andaman and Nicobar Islands.
- **Problem:** Edible oil plantations, as opposed to oilseeds crops, tend to replace natural tropical forests, depleting biodiversity. Environmental case studies in forested belts of Sumatra, Borneo and the Malay Peninsula -- which produce 90% of global palm oil – have found commercial cultivation had decimated swathes of pristine forests, wiping out wildlife, from orangutans to birds.
- A top expert on sustainable agriculture said it was possible to grow sustainable palm oil, but certain strict criteria will need to be followed, which he said he hoped to see in the government's plan.
- India has become the world's largest importer of vegetable oils, a base ingredient for cooking most common dishes. The country meets up to two-thirds of its domestic demand through imports. In 2020-21, India imported both crude and refined palm oil worth $5.8 billion. Edible oil is the country's **third most high-value import,** after petroleum crude and gold.
- **Palm oil, a perennial crop, yields more oil per acre, than say, coconut, but it requires three times the water.** So, it must be grown in rainy areas to avoid groundwater extraction.
- The new scheme seeks to bring additional 0.65 million hectare under oil palm by 2025-26 to reach a targeted one million hectare, up from 0.3 million hectare at present. This would result in an increase in crude palm oil output to o 1.1 million tonne by 2025-26 and up to 2.8 million tonne by 2029-30.
- The scheme also provides for viability gap funding to shield growers from international price volatility by paying directly to the farmers' accounts in the form of direct benefit transfer.

Know more

- Oil palm, (Elaeis guineensis) is an African tree in the palm family (Arecaceae), cultivated as a source of oil.

- The oil palm is **grown extensively in its native West and Central Africa**, as well as in **Malaysia and Indonesia**. Palm oil, obtained from the fruits, is used in making soaps, cosmetics, candles, biofuels, and lubricating greases and in processing tinplate and coating iron plates.
- Palm kernel oil, from the seeds, is used in manufacturing such edible products as margarine, ice cream, chocolate confections, cookies, and bread, as well as many pharmaceuticals. The cake residue after kernel oil is extracted is a cattle feed.
- The plant is also grown as an ornamental in many subtropical areas.
- For commercial oil production, the outer fleshy portion of the fruit is steamed to destroy the lipolytic enzymes and then pressed; the resulting palm oil is highly coloured because of the presence of carotenes. The kernels of the fruit are pressed in mechanical screw presses to recover palm kernel oil, which is chemically quite different from the oil from the flesh of the fruit.
- The commercial palm oil industry rapidly expanded in the late 20th century and led to the deforestation of significant swaths of Indonesia and Malaysia as well as large areas in Africa.
- New plantations are often formed using **slash-and-burn agricultural methods**, and the resulting fragmentation of natural forests and loss of habitat threatens native plants and animals. Bornean and Sumatran orangutans are especially iconic species threatened by the expansion of oil palm farming in Indonesia.
- In addition to driving biodiversity loss, the slash-and-burn practices of oil palm cultivation have contributed significantly to poor seasonal air quality in parts of Southeast Asia. Although attempts have been made to certify sustainably grown palm oil, corporate buyers have been slow to support those endeavours; some environmental groups have urged individuals to avoid products with palm oil altogether.

Additional

- The American oil palm (Elaeis oleifera) is native to Central and South America and is sometimes cultivated under the erroneous name Elaeis melanococca. Unlike the African oil palm, the trunk of the American oil palm creeps along the ground and bears flat leaves. Both the American oil palm and the maripa palm (Attalea maripa) are used to obtain palm oil in some areas.
- The oil of the American oil palm was probably used for making candles by the early American colonizers.

➡ INDIAN ENVIRONMENT SERVICE

The Supreme Court has asked the Government if it will create an Indian Environmental Service (IES) as recommended by a committee headed by former Cabinet secretary T.S.R Subramanian in 2014.

TSR Subramanian Committee Report on Environment

- The Subramanian committee was set up in August 2014 to review the country's green laws and the procedures followed by the Ministry of Environment, Forest and Climate Change (MoEF&CC).

- It suggested several amendments to align with the Government's economic development agenda.
- The report had suggested amendments to almost all green laws, including those relating to the environment, forest, wildlife and coastal zone clearances.
- The committee suggested that another committee, with more expertise and time, be constituted to review the environmental laws.

Key recommendations

Establishment of Environment Management Authorities

- The report proposed an **'Environmental Laws (Management) Act' (ELMA),** that envisioned full-time expert bodies to be constituted at the Central and State levels respectively:
  - National Environmental Management Authority (NEMA)
  - State Environmental Management Authority (SEMA)

Project clearances

- These authorities evaluate project clearance (using technology and expertise), in a time bound manner, providing for single-window clearance.
- It suggested a "fast track" procedure for "linear" projects (roads, railways and transmission lines), power and mining projects and for "projects of national importance."
- It also suggested an appellate mechanism against the decisions of NEMA/SEMA or MoEF&CC, in respect of project clearance, prescribing a three-month deadline to dispose appeals.

Expanding Environment Protection Act

- The Air Act and the Water Act is to be subsumed within the EP Act.
- The existing Central Pollution Control Board and the State PCBs, which monitor and regulate the conditions imposed on the industries to safeguard environment be integrated into NEMA and SEMA.

Evaluating Environmental Reconstruction Cost (ERC)

- The report also recommends that an "ERC" should be assessed for each project on the basis of the damage caused by it to the environment and this should be added into the cost of the project.
- This cost has to be recovered as a cess or duty from the project proponent during the life of the project.

Research and Development

- It proposed the establishment of a National Environment Research institute "on the lines of the Indian Council of Forestry Research and Education".
- It would bring in the application of high-end technology in environment governance.

Establishment of Indian Environment Service (IES)

- Finally, an Indian Environment Service should be established to recruit qualified and skilled human resource in the environment sector.

How were the recommendations received?

- The Centre never formally accepted this report and neither constituted a new committee as recommended by the Parliamentary Standing Committee.

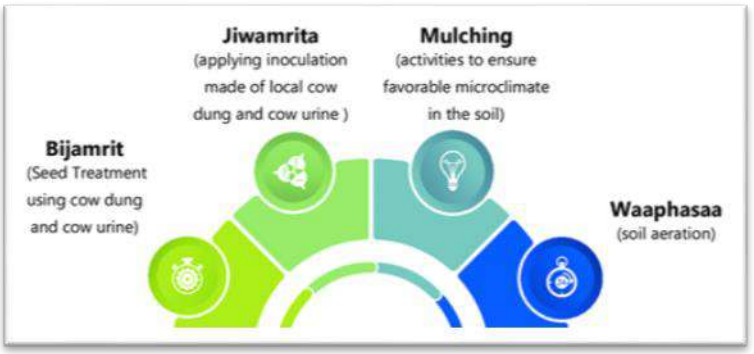
- The Parliamentary rejected the report on the grounds that it ended up diluting key aspects of environmental legislation designed to protect the environment.
- However, many of these recommendations are implicitly making their way into the process of environmental regulation.

➡ ZERO BUDGET NATURAL FARMING

- Zero budget natural farming is a type of farming that **promotes chemical-free agricultural practices.**
- It was originally **introduced by agriculturist Subhash Palekar in the mid-1990s** as an alternative to the Green Revolution methods such as the adoption of high yield variety seeds and use of inorganic fertilisers and pesticides.
- While current farming practices are driven by using chemicals, zero budget natural farming promotes low-cost inputs such as the use of **cow dung, aged cow urine, jaggery, pulse flour** and other **plant-based extracts**.

Palekar has argued that the cost of external inputs such as pesticides and fertilisers were the leading cause of indebtedness and suicides among farmers in the country. By implementing traditional methods, he said that production costs and interest rates for credit could be significantly reduced. Similarly, according to the Food and Agriculture Organisation of the United Nations, a zero budget promises to end reliance on loans which in turn could help in ending the debt cycle for farmers.

- According to Palekar's website, natural farming is based on four pillars:



- **"Jeevamrit"** (nectar of life),
- **"Beejamrit"** (seed treatment),
- **"Acchadana"** (mulching) and **"Waaphasa"** (soir aeration),
- **"Jiwamrita",** a fermented microbial culture containing ingredients such water, cow dung, cow urine, jaggery or sugarcane juice, ripen fruit pulp, flour of any pulses (Beans, Black gram, Cowpea, Bengal gram, Red gram, Pigeon pea) and a handful of soil from bund of a farm or forest.

- About 200 litres of this mixture should be sprayed twice a month per acre.
- Further, zero budget natural farming also promotes soil aeration and mulching (spreading a layer of material to the surface of the soil for moisture retention).

Research in progress

- The Indian Council of Agriculture Research initiated an experiment on "Evaluation of zero budget farming practices in basmati rice-wheat system" at Modipuram (Uttar Pradesh), Ludhiana (Punjab), Pantnagar (Uttarakhand) and Kurukshetra (Haryana) from Rabi 2017 to study the impact of zero budget natural farming on productivity, economics and soil health including soil organic carbon and soil fertility.

- The study is still in progress. However, the **National Academy of Agricultural Sciences**, a think-tank of agriculture scientists in India, said, in a policy brief, that zero budget natural farming is an **"unproven technology" because of insufficient data.**
- In 2019, the National Academy of Agricultural Sciences had e**xpressed concern over the possible effects of zero budget natural farming** on the income of farmers and food security.

➡ HOGENAKKAL WATER PROJECT

- Hogenakkal Integrated Drinking Water Project is a **fluorosis mitigation drinking water project being undertaken at Hogenakkal, Dharmapuri district**, state of Tamil Nadu, India.
- It is scheduled to be executed by Tamil Nadu Water Supply and Drainage Board (TWAD), with funding from Japan Bank for International Cooperation (JBIC) using Tamil Nadu's share of Cauvery river water.
- The project aims to supply safe drinking water to drought prone and fluorosis affected Dharmapuri and Krishnagiri districts of Tamil Nadu.

Opposition by Karnataka

- Karnataka government would legally oppose the proposed project by Tamil Nadu as it falls within the **geographical jurisdictions of both Karnataka and Tamil Nadu**.
- The Survey of India has not finalised the Karnataka-Tamil Nadu border at Hogenakkal.
- Any project that Tamil Nadu wants to implement in the Cauvery basin should be in line with the allocation of water made by the Cauvery Water Disputes Tribunal and Supreme Court orders.
- Tamil Nadu has not placed the proposed project before the Tribunal or the Supreme Court.
- As per Section 13 of the Cauvery Tribunal's order, the Hogenakkal project should be taken up through the Central Water Commission.

➡ MICROPLASTICS

- Delhi-based NGO Toxics Link released a study titled, **"Quantitative analysis of Microplastics along River Ganga"**, which has found that the river – which flows through five states covering about 2,500 km before flowing into the Bay of Bengal – is heavily polluted with microplastics.

What are microplastics?

- Among the range of plastic debris that is found in water bodies, microplastics are the most notorious because of their small size, on average microplastics are **less than 5 mm in length or roughly equal to five pinheads**.
- Apart from humans, microplastics are harmful to marine species as well. More than 663 marine species are affected by marine debris and 11 percent of them are said to be related to microplastic ingestion, the study says.

- Because microplastics are so small, they are ingested by marine habitants including fish, corals, planktons and sea mammals and are then carried further into the food chain. In the case of humans, most of the microplastics can be found in food, water and food containers and their ingestion can cause health problems.

What does the recent study about the levels of pollution in river Ganga tell us?

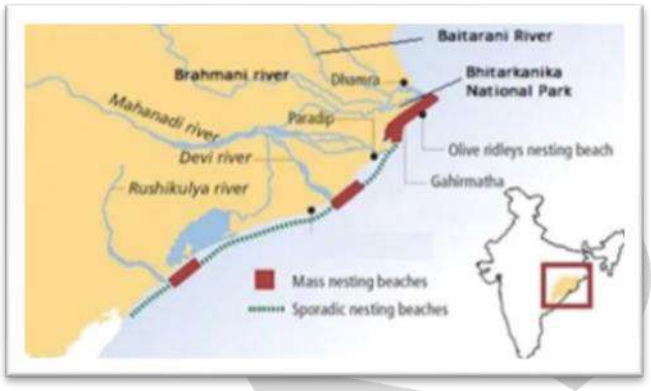
- For the study, samples of Ganga's water were collected from Haridwar, Kanpur and Varanasi and microplastics were found in all of them. Apart from microplastics, there were other kinds of plastics as well such as single-use plastic and secondary plastic products. Of the samples, those taken at Varanasi had the highest concentration of plastic pollution.
- Further, the study notes that untreated sewage from densely populated cities across the river's course, along with industrial waste and religious offerings that are wrapped in non-degradable plastic add a significant amount of pollutants into the river. As the river flows, these waste and plastic materials break down further and are eventually carried into the Bay of Bengal and then into the ocean which is the "ultimate sink" of all plastics that are used by humans.
- Essentially all along microplastics are flowing into the river system. It does reflect or suggest a direct linkage between the poor state of both solid and liquid waste management; hence it is critically important to initiate steps to remediate it.

What are the efforts being made to clean the Ganga?

- Ganga has the largest river basin in terms of catchment area in the country and constitutes about 26 percent of India's landmass spread across 11 states, which supports 43 percent of the population.
- That the holy river Ganga is polluted is not a recent discovery, in fact, efforts to clean it have been ongoing for over 40 years. Most of them have focussed on creating sewage treatment capacities in the major urban centres along the river.
- In May 2015, the government approved the Namami Gange (which receives a 100 percent funding from the central government) programme to clean and protect the river. Programmes launched before this include the Ganga Action Plan (GAP) in 1985, the IIT Consortium (2011) for water diversion and effective treatment, and the National Mission for Clean Ganga in 2011.
- However, the Toxics Link study says that not only do none of these plans address pollution caused by microplastics but even otherwise these programs and schemes launched over the past decades on which millions of rupees have been spent so far, have yielded "little success".

➡ BRAHMANI RIVER

- Environmentalists expressed concern over the massive diversion of fresh water from the Brahmani river basin, which could pose a grave threat to the famous mangrove vegetation in Odisha.
- Bh**itarkanika** — a notified Ramsar wetland — is spread over 195 sq. km and is home to 62 mangrove species. Besides, 1,600 salt water crocodiles crawl on the mudflats of the Bhitarkanika mangrove forest.



- Mangroves grow in brackish water. Proportionate fresh water flow from the Brahmani river basin and the **Kharasrota river** keep the salinity level of the water along the shore down. The brackish water becomes ideal for the mangroves to grow and stay healthy.
- The Wildlife Society of Orissa (WSO), an environmental pressure group, had drawn public attention on the excess water allocation for industries, which is likely to reduce fresh water discharge to the sea.
- The Talcher-Angul coal mines, steel and power plants as well as the Kalinganagar steel and power hub are drawing enormous quantities of fresh water from the Brahmani river.

Brahmani River

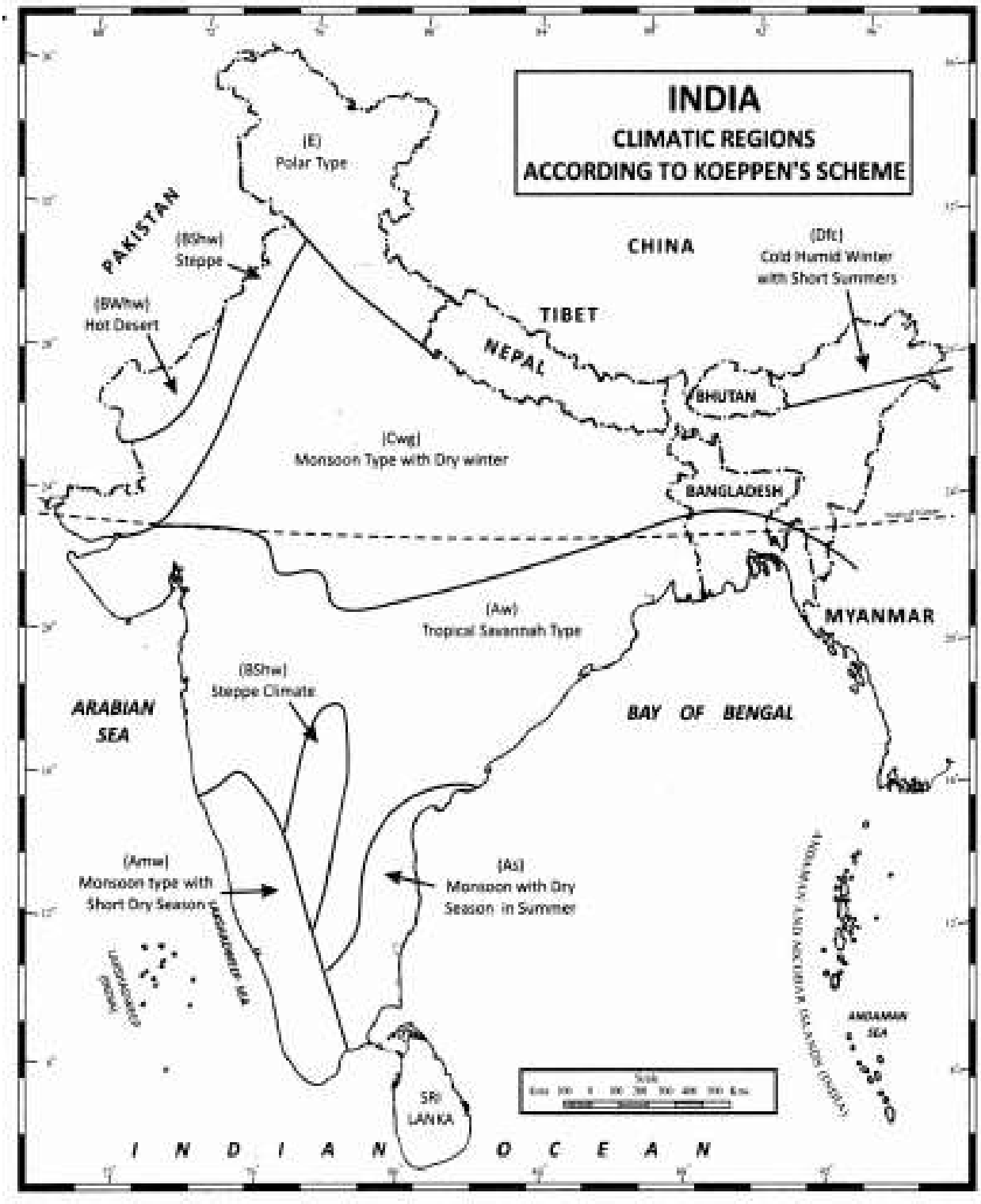
- Brahmani River is in northeastern Odisha state.
- Formed by the confluence of the **Sankh and South Koel rivers**, the Brahmani flows for 300 miles (480 km).
- It winds generally south-southeast past Bonaigarh and Talcher and then turns east to join northern branches of the Mahanadi River, which then empties into the Bay of Bengal at **Palmyras Point**.
- It is one of the few rivers that cut across the Eastern Ghats, and it has formed a **minor gorge at Rengali**, where a dam has been built.

IMPORTANT MAPS

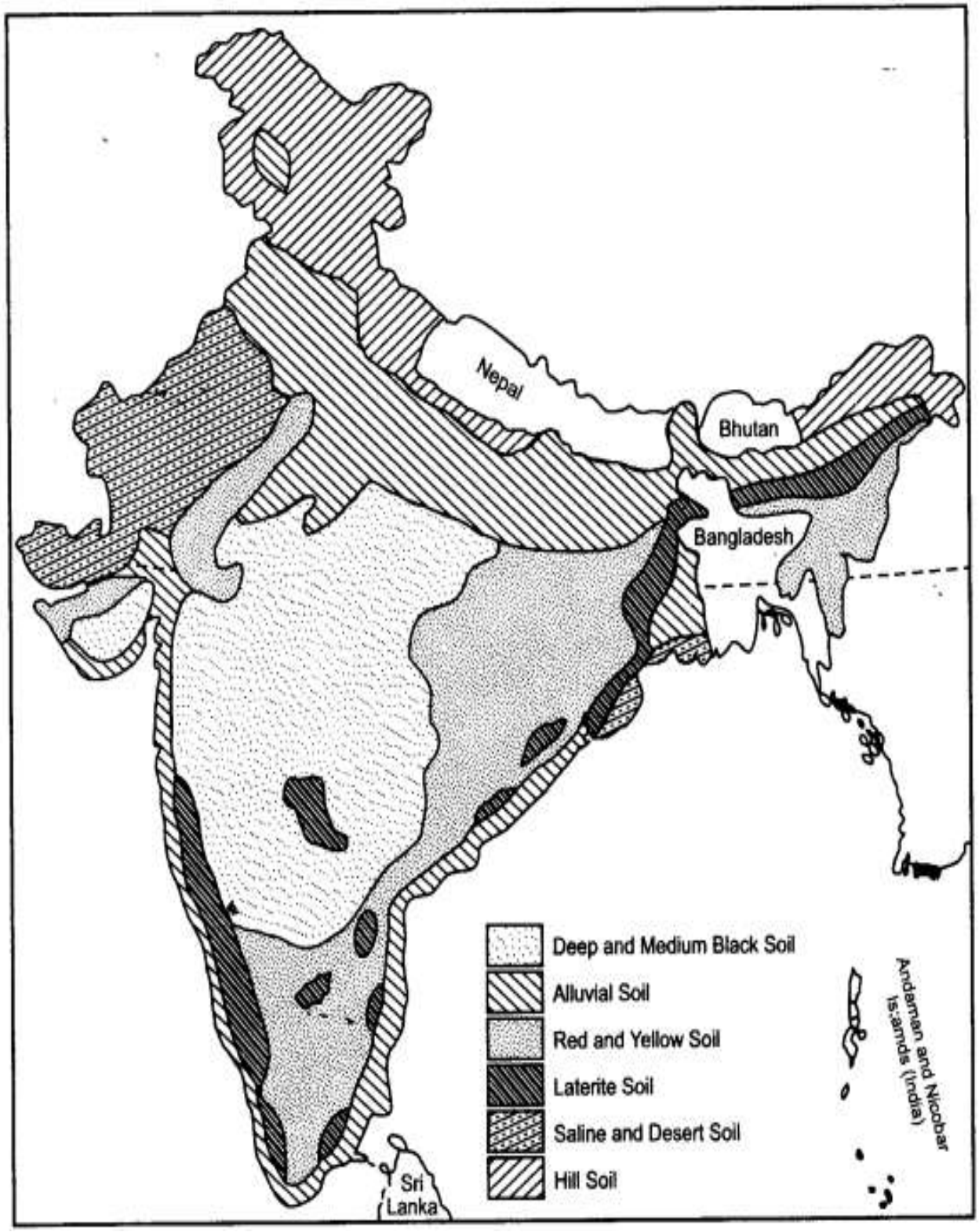
➡ MOUNTAINS MAP OF INDIA

➡ RIVERS MAP OF INDIA

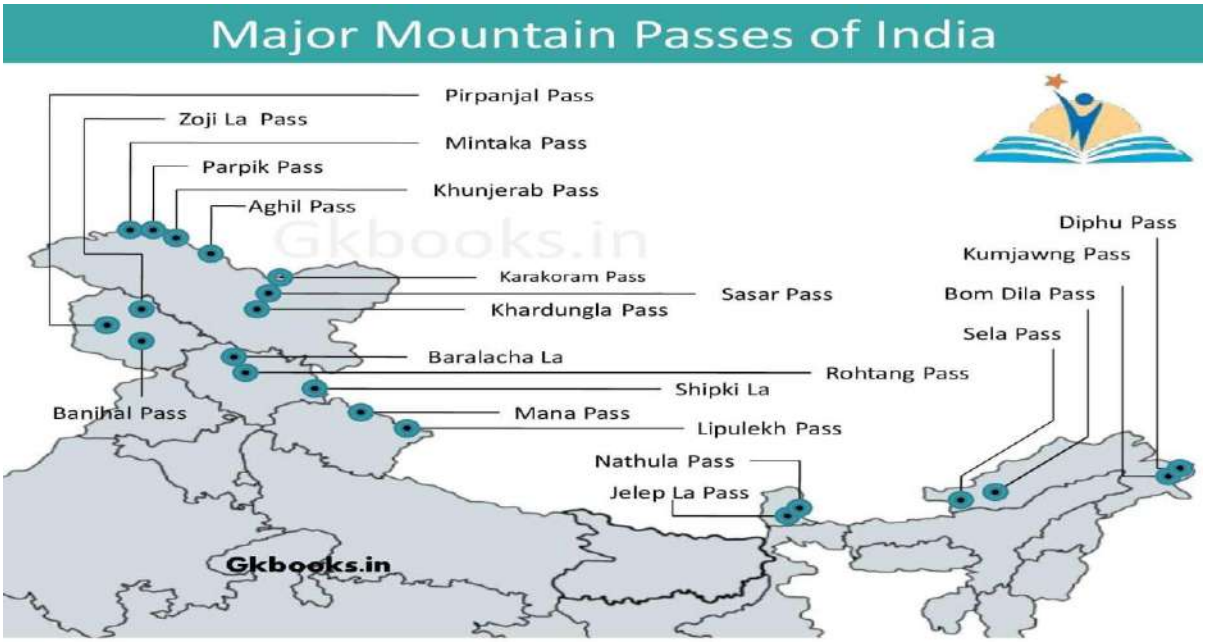
➡ CLIMATE MAP OF INDIA



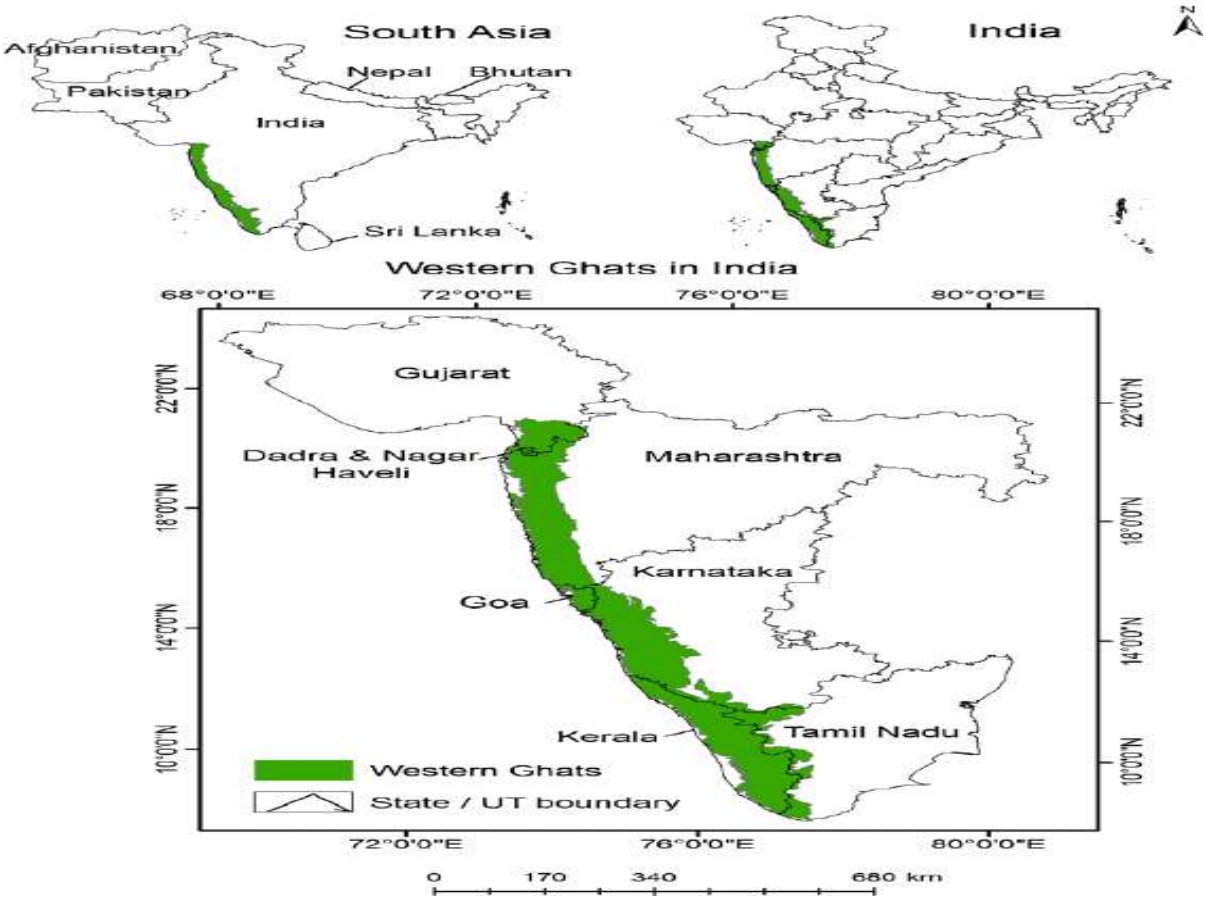
➡ SOIL MAP OF INDIA



➡ MAJOR MOUNTAIN PASSES



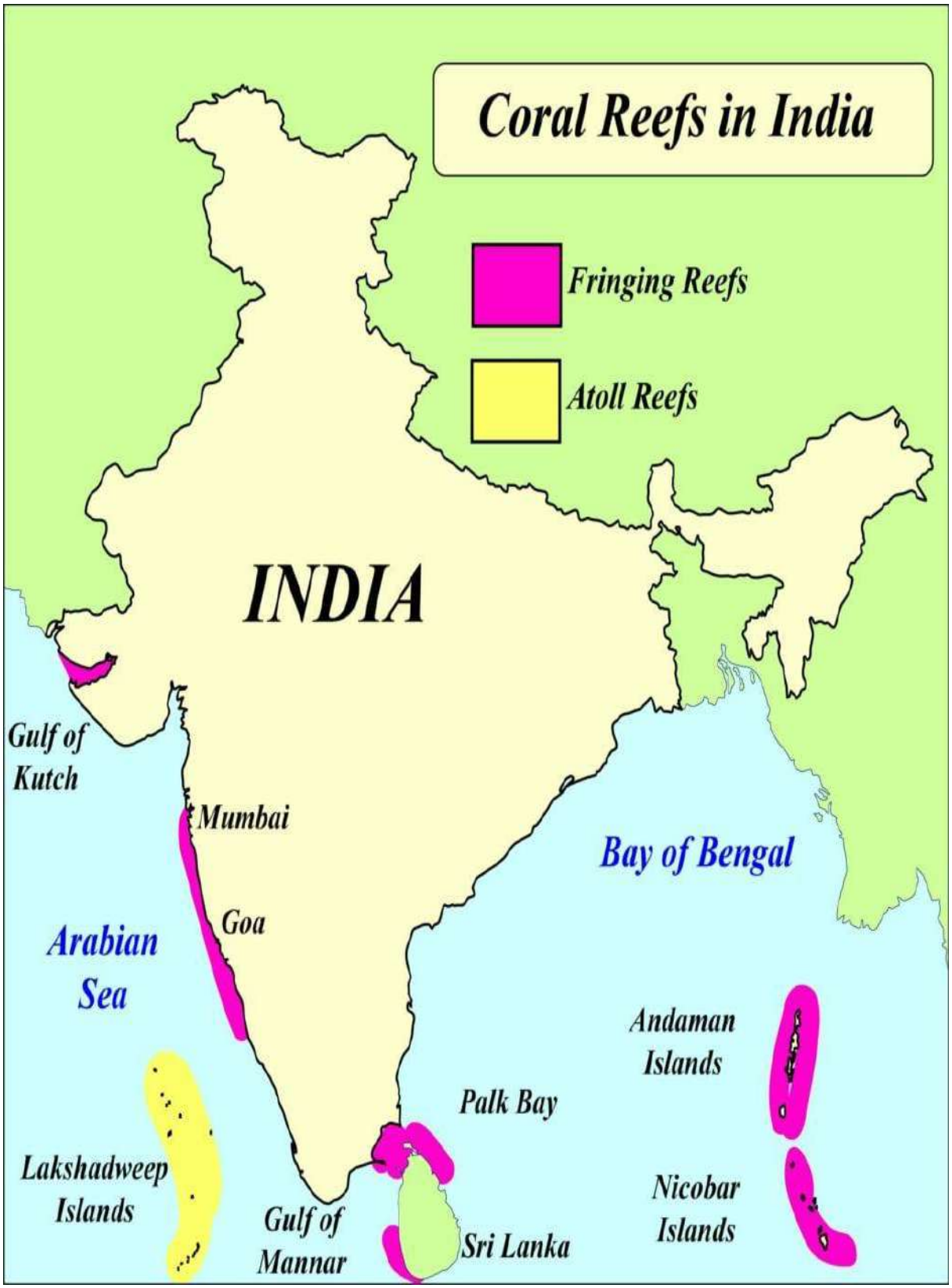
➡ WESTERN GHATS MAP



➡ TIGER RESERVES MAP

➡ BIOSPHERE RESERVES MAP

➡ CORAL MAP OF INDIA



➡ TOP TEN NATIONAL PARKS

PREVIOUS YEARS QUESTION

Q. Which one of the following is the process involved in photosynthesis?

(a) Potential energy is released to form free energy

(b) Free energy is converted into potential energy and stored

(c) Food is oxidized to release carbon dioxide and water

(d) Oxygen is taken, and carbon dioxide and water vapour are given out

Q. Which of the following adds/add carbon dioxide to the carbon cycle on the planet Earth?

1. Volcanic action
2. Respiration
3. Photosynthesis
4. Decay of organic matter

Select the correct answer using the code given below.

(a) 1 and 3 only (b) 2 only

(c) 1, 2 and 4 only (d) 1, 2, 3 and 4

Q. In India, the problem of soil erosion is associated with which of the following?

1. Terrace cultivation
2. Deforestation
3. Tropical climate

Select the correct answer using the code given below.

(a) 1 and 2 only (b) 2 only

(c) 1 and 3 only (d) 1, 2 and 3

Q. Lichens, which are capable of initiating ecological succession even

on a bare rock, are actually a symbiotic association of

(a) algae and bacteria
(b) algae and fungi
(c) bacteria and fungi
(d) fungi and mosses

Q. The most important strategy for the conservation of biodiversity together with traditional human life is the establishment of

(a) biosphere reserves
(b) botanical gardens
(c) national parks
(d) wildlife sanctuaries

Q. With reference to 'Eco-Sensitive Zones', which of the following statements is/are correct?

1. Eco-Sensitive Zones are the areas that are declared under the Wildlife (Protection) Act, 1972.
2. The purpose of the declaration of Eco-Sensitive Zones is to prohibit all kinds of human activities, in those zones except agriculture.

Select the correct answer using the code given below.

(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

Q. Consider the following pairs:

1. Dampa Tiger Reserve : Mizoram
2. Gumti Wildlife Sanctuary : Sikkim
3. Saramati Peak : Nagaland

Which of the above pairs is /are correctly matched?

(a) 1 only (b) 2 and 3 only
(c) 1 and 3 only (d) 1, 2 and 3

Q. Which of the following have coral reefs?

1. Andaman and Nicobar Islands
2. Gulf of Kutch
3. Gulf of Mannar
4. Sunderbans

Select the correct answer using the code given below.

(a) 1, 2 and 3 only (b) 2 and 4 only
(c) 1 and 3 only (d) 1, 2, 3 and 4

Q. Consider the following:

1. Bats
2. Bears
3. Rodents

The phenomenon of hibernation can be observed in which of the above kinds of animals?

(a) 1 and 2 only
(b) 2 only
(c) 1, 2 and 3
(d) Hibernation cannot be observed in any of the above

Q. Among the following organisms, which one does not belong to the class of other three?

(a) Crab (b) Mite
(c) Scorpion (d) Spider

Q. Which one of the following is the correct sequence of a food chain?

(a) Diatoms-Crustaceans-Herrings
(b) Crustaceans-Diatoms-Herrings
(c) Diatoms-Herrings-Crustaceans
(d) Crustaceans-Herrings-Diatoms

Q. If you travel through the Himalayas, you are Likely to see which of the following plants naturally growing there?

1. Oak
2. Rhododendron
3. Sandalwood

Select the correct answer using the code given below

(a) 1 and 2 only (b) 3 only
(c) 1 and 3 only (d) 1, 2 and 3

Q. If you walk through countryside, you are likely to see some birds stalking alongside the cattle to seize the

insects, disturbed by their movement through grasses, Which of the following is/are such bird/birds?

1. Painted Stork
2. Common Myna
3. Black-necked Crane

Select the correct answer using the code given below.

(a) 1 and 2 (b) 2 only
(c) 2 and 3 (d) 3 only

Q. Other than poaching, what are the possible reasons for the decline in the population of Ganges River Dolphins?

1. Construction of dams and barrages on rivers
2. Increase in the population of crocodiles in rivers
3. Getting trapped in fishing nets accidentally
4. Use of synthetic fertilizers and other agricultural chemicals in crop-fields in the vicinity of rivers

Select the correct answer using the code given below.

(a) 1 and 2 only (b) 2 and 3 only
(c) 1, 3 and 4 only (d) 1, 2, 3 and 4

Q. With reference to two non-conventional energy sources called 'coal bed methane' and 'shale gas', consider the following 'statements:

1. Coal bed methane is the pure methane gas extracted from coal seams, while shale gas is a mixture of propane and butane only that can be extracted from fine-grained sedimentary rocks.
2. In India abundant coal bed methane sources exist, but so far no shale gas sources have been found.

Which of the statements given above is/are correct?

(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

Q. In India, cluster bean (Guar) is traditionally used as a vegetable or animal feed, but recently the cultivation of this has assumed significance. Which one of the following statements is correct in this context?

(a) The oil extracted from seeds is used in the manufacture of biodegradable plastics
(b) The gum made from its seeds is used in the extraction of shale gas
(c) The leaf extract of this plant has the properties of anti-histamines
(d) It is a source of high quality biodiesel

Q. With reference to technologies for solar power production, consider the following statements:

1. 'Photovoltaics' is a technology that generates electricity by direct conversion of light into electricity, while 'Solar Thermal' is a technology that utilizes the Sun's rays to generate heat which is further used in electricity generation process.
2. Photovoltaics generates Alternating Current (A(C), while Solar Thermal generates Direct Current (D(C).
3. India has manufacturing base for Solar Thermal technology, but not for Photovoltaics.

Which of the statements given above is / are correct?

(a) 1 only (b) 2 and 3 only
(c) 1, 2 and 3 (d) None

Q. There is some concern regarding the nanoparticles of some chemical elements that are used by the industry in the manufacture of various products. Why?

1. They can accumulate in the environment, and contaminate water and soil.
2. They can enter the food chains.

3. They can trigger the production of free radicals.

Select the correct answer using the code given below.

(a) 1 and 2 only (b) 3 only
(c) 1 and 3 only (d) 1, 2 and 3

Q. Which of the following are some important pollutants released by steel industry in India?

1. Oxides of sulphur
2. Oxides of nitrogen
3. Carbon monoxide
4. Carbon dioxide

Select the correct answer using the code given below.

(a) 1, 3 and 4 only (b) 2 and 3 only
(c) 1 and 4 only (d) 1,2, 3 and 4

Q. Brominated flame retardants are used in many household products like mattresses and upholstery. Why is there some concern about their use?

1. They are highly resistant to degradation in the environment.
2. They are able to accumulate in humans and animals.

Select the correct answer using the code given below.

(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

Q. Consider the following countries:

1. Denmark
2. Japan
3. Russian Federation
4. United Kingdom
5. United States of America

Which of the above are the members of the 'Arctic Council '?

(a) 1, 2 and 3 (b) 2, 3 and 4
(c) 1, 4 and 5 (d) 1, 3 and 5

Q. If a wetland of international importance is brought under the 'Montreux Record', what does it imply?

1. Changes in ecological character have occurred, are occurring or are likely to occur in the wetland as a result of human interference.
2. The country in which the wetland is located should enact a law to prohibit any human activity within five kilo meters from the edge of the wetland
3. The survival of the wetland depends on the cultural practices and traditions of certain communities living in its vicinity and therefore the cultural diversity therein should not be destroyed.
4. It is given the status of 'World Heritage Site'

Q. With reference to a conservation organization called Wetlands International', which of the following statements is/are correct?

1. It is an intergovernmental organization formed by the countries which are signatories to Ramsar Convention.
2. It works at the field level to develop and mobilize knowledge, and use the practical experience to advocate for better policies.

Select the correct answer using the code given below.

(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

Q. Consider the following international agreements:

1. The International Treaty on Plant Genetic Resources for Food and Agriculture
2. The United Nations Convention to Combat Desertification
3. The World Heritage Convention

Which of the above has / have a bearing on the biodiversity?

(a) 1 and 2 only (b) 3 only,

(c) 1 and 3 only (d) 1, 2. and 3

Q. The scientific view is that the increase in global temperature should not exceed 2 °C above pre-industrial level. If the global temperature increases beyond 3°C above the pre-industrial level, what can be its possible impact/impacts on the world?

1. Terrestrial biosphere tends toward a net carbon source
2. Widespread coral mortality will occur.
3. All the global wetlands will permanently disappear.
4. Cultivation of cereals will not be possible anywhere in the world.

Select the correct answer using the code given below.

(a) 1 only (b) 1 and 2 only
(c) 2, 3 and 4 only (d) 1, 2, 3 and 4

Q. Consider the following statements:

1. Animal Welfare Board of India is established under the Environment (Protection) Act, 1986.
2. National Tiger Conservation Authority is a statutory body.
3. National Ganga River Basin Authority is chaired by the Prime Minister.

Which of the statements given above is/ are correct?

(a) 1 only (b) 2 and 3 only
(c) 2 only (d) 1, 2 and 3

Q. With reference to Bombay Natural History Society (BNHS), consider the following statements

1. It is an autonomous organization under the Ministry of Environment and Forests.
2. It strives to conserve nature through action-based research, education and public awareness.
3. It organizes and conducts nature trails and camps for the general public.

Which of the statements given above is/are correct?

(a) 1 and 3 only (b) 2 only
(c) 2 and 3 only (d) 1, 2 and 3

Q. Consider the following statements regarding 'Earth Hour'

1. It is an initiative of UNEP and UNESCO.
2. It is a movement in which the participants switch off the lights for one hour on a certain day every year.
3. It is a movement to raise the awareness about the climate change and the need to save the planet.

Which of the statements given above is / are correct?

(a) 1 and 3 only (b) 2 only
(c) 2 and 3 only (d) 1, 2 and 3

Q. Every year, a month long ecologically important campaign/festival is held during which certain communities/ tribes plant saplings of fruit-bearing trees. Which of the following are such communities/tribes?

(a) Bhutia and Lepcha
(b) Gond and Korku
(c) Irula and Toda
(d) Sahariya and Agariya

Notes

PRACTICE QUESTIONS

1. Which of the following countries does not border Russia?

(a) Armenia (b) Georgia (c) Belarus (d) Kazakhstan

2. Consider the following statements:

1. Chindwin River is the tributary of Yangtse River.
2. Irrawaddy River empties into Gulf of Thailand.

Which of the above statement/s is/are correct?

(a) 1 only (b) 2 only (c) Both 1 and 2 (d) Neither 1 nor 2

3. Consider the following statements:

1. These are formed in the areas of high temperature and high rainfall.
2. Lime and Silica are leached away in soils and iron oxide and aluminium compound are left behind.
3. They are poor in organic matter, nitrogen, phosphate and calcium.
4. They are widely cut as bricks for use in house construction.

Which of the soils type is well characterized by the above said statements?

(a) Red and Yellow soils (b) Arid and Semi-arid soils
(c) Saline and Alkaline soils (d) Laterite soils

4. Consider the following statements:

1. Moderate rainfall of 100-200 cm per annum.
2. Mean annual Temperature of about 27°C.
3. Average annual relative humidity of 60-70 percent.
4. Trees drop their leaves for about 6-8 weeks during the spring and early summer.
5. Heavily buttressed trees and fairly complete shrubby undergrowth with patches of bamboos, climbers and cane.

The above said characteristics are well represented in which of the following forests types in India.

(a) Tropical wet Evergreen (b) Tropical Moist deciduous
(c) Montane Sub-Tropical (d) Littoral and Swamp

5. Which of following statements is/are correct?

1. The Pamir Mountains are a mountain range between Central Asia, South Asia, and East Asia.
2. Much of the Pamir Mountains lie in Turkmenistan.

Choose the correct code:

(a) 1 only (b) 2 only (c) Both 1 and 2 (d) Neither 1 nor 2

6. Consider the following statements:

1. In bhabar region soil is very porous and all streams reappear in this zone.
2. Terai region is more marked in the western part than the eastern part.
3. The khadar represents the uplands formed by the deposition of the older alluvium and lie above the flood limit of the plains.
4. The younger alluvium of the flood plains of the numerous rivers is called the bhangar.

Which of the above statements are correct?

(a) 1, 2 and 3 (b) 2, 3 and 4 (c) All of the above (d) None of the above

7. In which one of the following Union Territories, do the people of the Onge tribe live?

(a) Andaman and Nicobar Islands (b) Dadra and Nagar Haveli
(c) Daman and Diu (d) Lakshadweep

8. Mon and Peren districts lie in which of the following states?

(a) Mizoram (b) Nagaland (c) Manipur (d) Tripura

9. Aravalli mountain crosses which of the following states in India?

1. Punjab 2. Delhi 3. Haryana 4. Rajasthan 5. Gujarat

Choose the correct code:

(a) 2, 4 and 5 only (b) 2, 3 and 4 only
(c) 1, 3 and 5 only (d) 2, 3, 4 and 5

Q10. Consider the following statements:

1. Gulf of Aqaba lies between Syria and Turkey.
2. Gulf of Suez lies between Egypt and Saudi Arabia.

Which of the above statement/s is/are correct?

(a) 1 only (b) 2 only (c) Both 1 and 2 (d) Neither 1 nor 2

Q11. Consider the following statements:

1. Latakia is a sea port in Syria.
2. Jordan is a landlocked country.

Which of the above statement/s is/are correct?

(a) 1 only (b) 2 only (c) Both 1 and 2 (d) Neither 1 nor 2

Q12. Bishnupur and Chandel districts lie in which of the following states?

(a) Manipur (b) Jharkhand (c) West Bengal (d) Tripura

13. Which of the following passes lies on the Laddakh range?

(a) Zoji La (b) Banihal (c) Photu La (d) Khardung La

14. Which of the following coast has got certain distinguishing features in the form of 'Kayals' (backwaters), which are used for fishing, inland navigation and are special attraction for tourists?

(a) Kathiawar coast (b) Konkan coast (c) Goan coast (d) Malabar Coast

15. Consider the following statements:

1. The highest general elevation in the mid-western part of Chhotanagpur plateau is known as pat lands.
2. The Shillong peak is the highest elevation in the Garo Hills while Nokrek is the highest peak in the Meghalaya plateau.

3. The Mikir Hills are characterized by the rectangular drainage with Dhansiri and Jamuna being the main rivers.

Which among the above statements is/are correct?

(a) 1 only (b) 2 only (c) 3 only (d) Neither of the above

16. Which among the following statements is not correct?

(a) In north-western regions of the subcontinent winter precipitation is caused by the depressions that are associated with the westerly disturbances from the Mediterranean sea.

(b) The hot winds (Loo) in western India, the Norwesters (Kalbaisakh) of West Bengal are the characteristics of summer season.

(c) The temperature during the season of retreating monsoon is uniformly high in the beginning of October in Northern India.

(d) The highest variability of rainfall is found in the areas where the average annual rainfall is the highest.

17. Match List-I (Minerals) with List-II (Mining are(a) and select the correct answer using the code given below the lists.

List - I	List - II
A. Iron-ore	1. Malanjkhand
B. Copper	2. Ratnagiri
C. Uranium	3. Dalli-Rajhara
D. Manganese	4. Bhatin

Code:

	A	B	C	D
(a)	2	3	4	1
(b)	3	1	4	2
(c)	1	2	3	4
(d)	2	1	4	3

18. Which among the following statements is not correct?

(a) The deepest point is the challenger deep in Mariana Trench which plunges 10,990m into the Earth's crust.

(b) Less than 3% of the Earth's water is fresh of which 2.24% is frozen in ice sheets and about 0.6% is stored underground as groundwater.

(c) Europe is the only continent which lies entirely in the Northern Hemisphere.

(d) December 21 is the longest day in the Southern Hemisphere.

19. Consider the following countries:

1. Ecuador 2. Somalia 3. Ethiopia 4. Surinam

Equator passes through which of the above countries?

(a) 1 and 2 (b) 1, 2 and 3 (c) 2 and 3 (d) All of the above

20. Which of the following countries are landlocked countries?

1. Kyrgyzstan 2. Tajikistan 3. Uzbekistan 4. Bhutan

Choose the correct code:

(a) 1 and 4 (b) 1 and 3 (c) 3 and 4 (d) All of the above

21. Australasia includes:

1. Australia 2. Asia 3. New Zealand 4. India
5. Tasmania 6. New Guinea 7. Indonesia

Code:

(a) 1 and 2 only (b) 1 and 4 only
(c) 1, 3, 5 and 6 only (d) All of these

22. Which of the statements are incorrect?

1. Westerlies and Polar winds are permanent winds that blow throughout the year.
2. Winds blowing from subtropical high pressure belt to sub-polar low pressure belt are called Trade winds.
3. The Westerlies blow from sub-tropical high pressure belts towards Equatorial low Pressure belt.
4. The Monsoons are the winds which reverse their direction with the change in season.

Code:

(a) 1 only (b) 2 only (c) 2 and 3 (d) 2, 3 and 4

23. Consider the following statements:

1. Titan is the largest satellite of Jupiter and the Solar System's second largest moon.
2. Titan is larger than the planet Mercury.
3. It is the only natural satellite in the Solar System to retain a substantial atmosphere.

Choose the correct statements:

(a) 1 and 2 (b) 2 and 3 (c) 1 and 3 (d) All of the above

24. Which among the following are responsible for variation in insolation at the earth's surface?

1. Rotation of earth on its axis. 2. Angle of inclination of sun's rays.
3. Transparency of the atmosphere. 4. Revolution of earth on its orbit.

Code:

(a) 1, 2, 3 and 4 (b) 1, 2 and 3 (c) 2, 3 and 4 (d) 1, 2 and 4

25. Which of the following tribes are inhabitants of the North Eastern states?

1. Kuki 2. Moplahs 3. Khasis 4. Jaintias 5. Jarawas

Choose the correct code:

(a) 1, 3 and 4 (b) 3 and 4 only (c) 2 and 5 only (d) All of the above

26. Which of following statements is/are correct?

1. Union Territory of Ladakh is predominantly a tribal region in the country.
2. Apatani and Aka are the major tribes in Ladakh.

Choose the correct code:

(a) 1 only (b) 2 only (c) Both 1 and 2 (d) Neither 1 nor 2

27. Match the following shifting cultivation with regions where they are known so-

List-I	List-II
1. Jhumming	A. Mexico
2. Milpa	B. Brazil
3. Roca	C. Malaysia
4. Ladang	D. India

Code:

	1	2	3	4
(a)	D	C	A	B
(b)	A	D	C	B
(c)	D	A	B	C
(d)	A	C	B	D

28. Match the following:

List-I	List-II
1. Open Cast Mining	A. Deep bores to reach minerals at great depth.
2. Shaft mining	B. Digging out of minerals near the surface.
3. Drilling	C. Minerals at shallow depth taken out by removing the surface layer.
4. Quarrying	D. Boring deep wells to take out minerals from far below the earth's crust.

Code:

	1	2	3	4
(a)	B	A	C	D
(b)	C	B	A	D
(c)	B	A	D	C
(d)	C	A	D	B

29. Which of the following is/are the native tribes of North America?

1. Apache 2. Blackfoot 3. Cheyenne

Choose the correct code:

(a) 1 only (b) 1 and 2 only (c) 2 and 3 only (d) All of the above

30. Cloud is a mass of minute water droplets or tiny crystals of ice formed by the condensation of the water vapour in free air at considerable elevations. Consider the following observations in context of different types of clouds:

1. Cirrus clouds are formed at high altitudes and they are always white in colour while Cumulus clouds look like cotton wool with a flat base.
2. Stratus clouds cover large portions of the sky and they are formed due to loss of heat or the mixing of air masses with different temperatures.
3. Nimbus clouds are black in colour and very near to the surface of the earth having shapeless masses of thick vapour.

Which of the above statements is/are correct?

(a) 1 only (b) 2 and 3 only (c) 1, 2 and 3 (d) None of them

31. The Great Lakes are a series of interconnected freshwater lakes located in northeastern part of North America on the border between Canada and the United States. Consider the following Lakes located in this region:

1. Lake Erie 2. Lake Hudson 3. Lake Ontario 4. Lake Superior
5. Lake Michigan

The Great Lakes consist of which of the above Lakes?

(a) 1 and 2 only (b) 1, 3 and 4 only (c) 1, 3, 4 and 5 only (d) 1, 2, 3, 4 and 5

32. Consider the statements.

1. The process in which sedimentary fragments becomes compact to form rocks in called lithification.
2. The process of metamorphism in which rocks, grains or minerals get arranged in layers is called foliation.
3. The arrangement of different minerals into alternating thin to thick layers is called banding.

Which if the above statement/s is/are incorrect?

(a) 1 only (b) 2 and 3 only (c) All the above (d) None of the above

Q33. Which of the following countries does not border Myanmar?

(a) China (b) Thailand (c) Laos (d) Cambodia

34. Drumlins form due to dumping of rock debris beneath heavily loaded ice through fissures in the glacier. Choose the correct statements.

1. Drumlins are smooth oval shaped ridge like features composed mainly of glacial till.
2. The stoss end of a drumlin is blunt due to pushing by moving ice.
3. The long axes of drumlins are perpendicular to the direction of ice movement.

Code:

(a) 1 and 2 (b) 1 and 3 (c) 2 and 3 (d) All the above

35. Consider the following statements:

1. Alluvial fans are formed when streams flowing from higher levels break into foot slope plains of low gradient.
2. Alluvial fans in humid areas show normally high cones with steep slopes.

3. Arid and semi-arid areas develop low cones with gentle slopes.

Choose the correct statement(s):

(a) 1 only (b) 2 and 3 only (c) All the above (d) None of the above

36. The theory of plate tectonics proposes that the earth's lithosphere is divided into seven major and some minor plates and young Fold Mountain ridges, trenches, or faults surround these major plates. Match the following plates with its boundaries.

1. Cocos plate: Between Central America and Pacific plate.
2. Nazca plate: Between South America and Pacific plate.
3. Caroline plate: Between the Philippine and Indian plate.
4. Philippine plate: Between the Asiatic and Pacific plate.

Which of the above are correctly matched?

(a) 1 and 2 only (b) 3 and 4 only (c) 1, 2 and 3 only (d) 1, 2, 3 and 4

37. Consider the following statements in the context of an aftermath of an earthquake:

1. While body waves travel through the interior of the Earth, the surface waves travel across the surface of the earth.
2. Surface waves decay faster with distance than do body waves and body waves travel in three dimensions.
3. Particle motion of surface waves is larger than that of body waves and surface waves tend to cause more damage

Which of the above statements are correct?

(a) 1 and 2 only (b) 1 only (c) 1 and 3 only (d) 1, 2 and 3

38. Which among the following statement is not correct?

(a) Kolleru is the largest fresh water lake of India located between the deltas of Godavari and Mahanadi.

(b) Loktak lake is the largest fresh water lake in north-east India.

(c) Vambanad lake is the largest lake in Kerala

(d) The Tulbul project is a 'navigation Lock-cum-control structure' at the mouth of the Wular lake.

Q39. The Kiel Canal is a freshwater canal in which of the following countries?

(a) Netherlands (b) Denmark (c) Germany (d) Belgium

40. Consider the following statements:

1. Most of the red soils have come into existence due to weathering of ancient crystalline and metamorphic rocks.
2. Red soils are poor in lime, magnesia, phosphatic nitrogen and humus, but are fairly rich in potash.
3. Regur are formed in the areas of high temperature and high rainfall with alternate wet & dry period.

4. Rajasthan has largest area under the saline soil.

The correct statements are:

(a) 1 and 2 (b) 2 and 3 (c) 3 and 4 (d) 1 and 4

41. Gaza Strip is located

(a) at the eastern coast of the Mediterranean Sea
(b) at the western coast of the Dead Sea
(c) in Sinai Peninsula
(d) at the western border of Golan Heights

42. Which of the following ethnic groups does Uighurs belong?

(a) Uzbek (b) Turk (c) Kyrgyz (d) Mongol

43. Which of the following tiger reserves is not in Arunachal Pradesh?

(a) Namdhapa (b) Kamlang (c) Pakke (d) Nameri

44. Which of the following elephant reserves is not in Odisha?

(a) Singhbhum (b) Mayurbhanj (c) Mahanadi (d) Sambhalpur

45. Consider the following statements:

1. The Kalahari Desert is situated between the Orange and Limpopo river.
2. Harmattan is a hot local wind which blows from Sahara to Mediterranean.
3. Masai is a pastoral tribe of Kenya and Tanzania.

Which among the above is/are correct?

(a) 1 and 2 (b) 2 only (c) 3 only (d) 2 and 3

46. Consider the following statements:

1. The Boulder Dam and the Grand Coulee Dam generate power for Eastern USA.
2. The Grand Banks of Newfoundland is at the meeting place of warm Labrador and the cold Gulf Stream.
3. Tuna is the chief fish in the Grand Bank region.
4. Malaysia is the leading producer of nickel in the world.

The correct statements are:

(a) 1, 2 and 3 (b) 2, 3 and 4 (c) All of the above (d) None of the above

47. Consider the following statements:

1. The glowing surface of Sun, that we see, is called the photosphere.
2. Venus has the maximum diurnal range of temperature and the shortest year.
3. Ganymede is the largest and heaviest of all satellites in the solar system.
4. Blue moon is a rare celestial phenomenon marked by the occurrence of the second full moon within one month.

The correct statements are:

(a) 1 and 2 (b) 1, 2 and 3 (c) 1, 3 and 4 (d) 2, 3 and 4

48. What is true about the China type of climate?

(1) Summer rainfall (2) Year round rainfall

(3) Mid latitude location (4) Coniferous forests

Code :

(a) All the four (b) 1, 2 and 3 (c) 2 and 3 (d) 3 and 4

49. Match List I (Rivers) with List II (Countries) and select the correct answer using the code given below the list

List I	List II
A. Salween	1) Vietnam
B. Chao Phraya	2) Myanmar
C. Mekong	3) Thailand
D. Ma	4) Laos

Code :

	A	B	C	D
(a)	2	3	4	1
(b)	3	2	4	1
(c)	3	2	1	4
(d)	2	3	1	4

50. Consider the following about the Tropical Marine type of Climate:

1. This type of climate is experienced along the eastern coasts of tropical lands.
2. The Trade Winds brings the rainfall.
3. There is no month without rainfall.

Which of the above statements is/are true?

(a) 1 and 3 (b) 2 and 3 (c) 1 and 2 (d) All of the above

Notes

PRACTICE QUESTIONS (ANSWER KEY)

1	2	3	4	5	6	7	8	9	10
a	d	d	b	a	d	a	b	d	d
11	12	13	14	15	16	17	18	19	20

a	a	d	d	a	d	b	c	a	d
21	22	23	24	25	26	27	28	29	30
c	c	b	a	a	a	c	d	d	c
31	32	33	34	35	36	37	38	39	40
c	c	d	a	a	d	c	a	c	a
41	42	43	44	45	46	47	48	49	50
a	b	d	c	a	c	c	c	d	d

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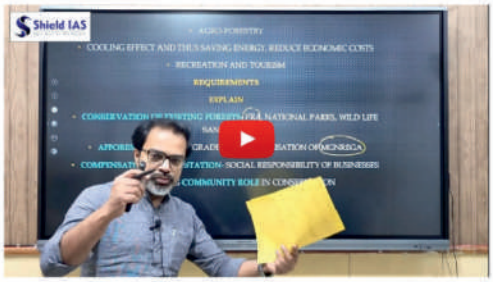

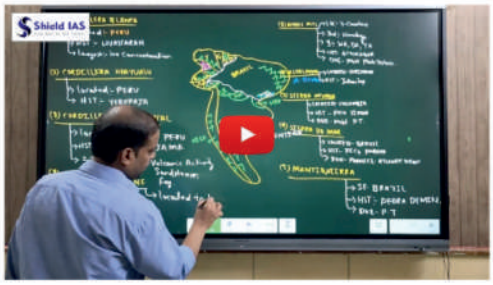
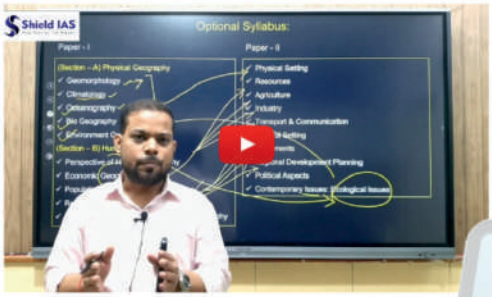

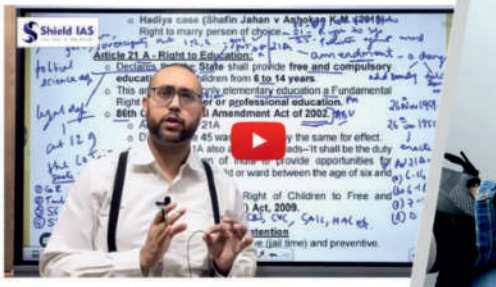

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First Floor 1/26, Lalita Park, Vikas Marg, Near Metro Station,
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Inquiry Contact:
011-46512150, 7037272363

Email: shieldias@gmail.com
Log on to: Shieldias.in

For Business Enquires: 9540411855