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{EG – Energy Resources – 20/04} Indian Strategic Petroleum Reserve (ISPRL)

TH | FE | ISPRL | Economic Geography > Mineral Resources > Energy Resources > Petroleum and Mineral Oil

- **Context:** Taking advantage of the low oil prices, ISPRL have been filling caverns at Mangalore & Padur.
- The **Oil Industry Development Board** was formed following steep increase in the prices of crude oil since early 1973, when self-reliance and petroleum based industrial raw materials assumed importance.
- India continued to be impacted by the volatility of oil prices and depleting foreign exchange reserves.
- It faced the worst economic crisis during the **Gulf War in 1990 (forced LPG reforms of 1991)**.
- In 1998, GOI proposed **ISPRL** as a long-term solution for managing oil markets & ensuring energy security.
- ISPRL is an Indian company responsible for maintaining the country's strategic petroleum reserves.
- ISPRL is a wholly owned subsidiary of the **Oil Industry Development Board (OIDB)**, which functions under the administrative control of the **Ministry of Petroleum and Natural Gas**.

ISPRL's strategic crude oil storage facilities

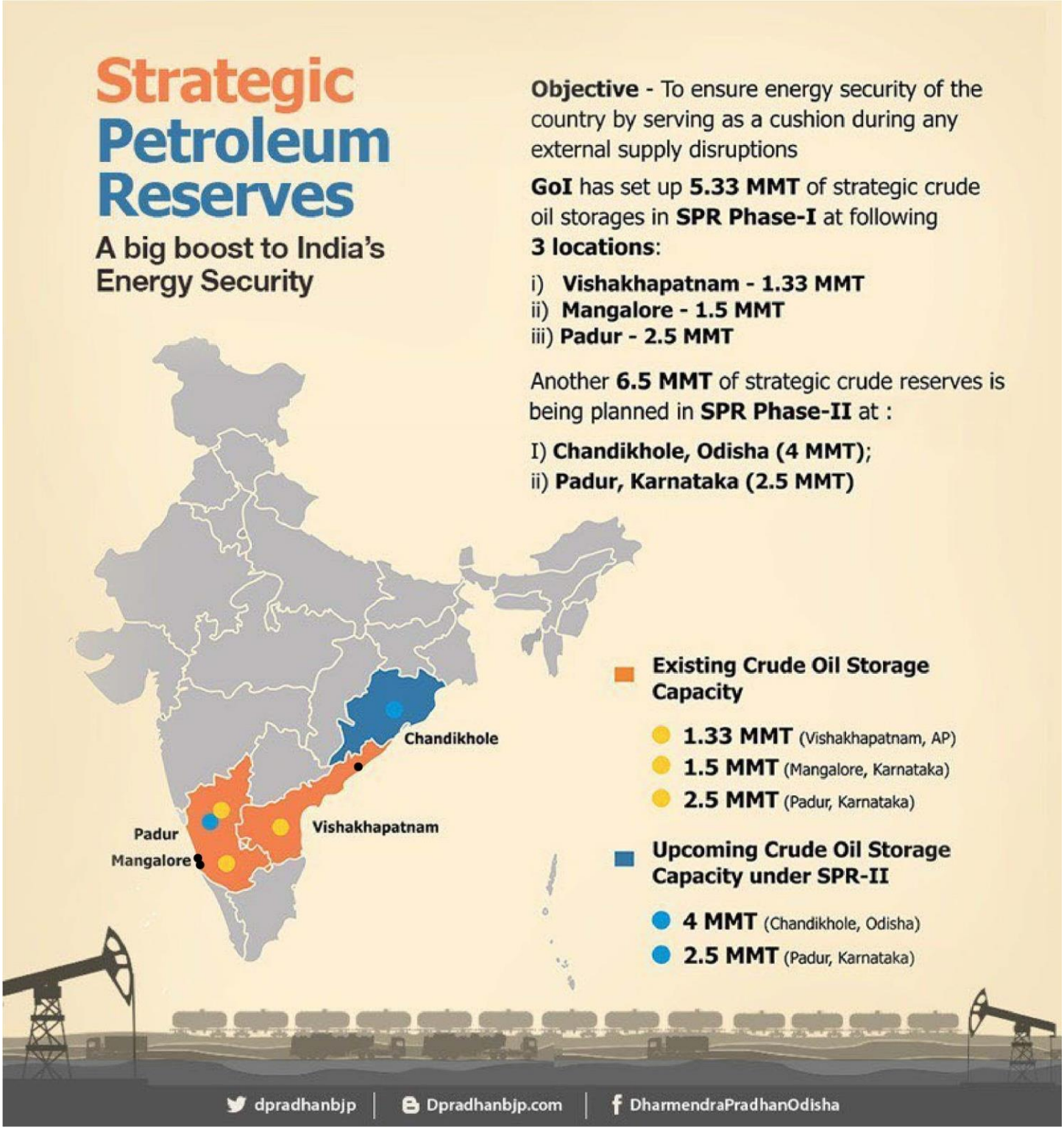
- ISPRL's strategic crude oil storage facilities are constructed at three underground rock caverns in:

Sl. No.	ISPRL's storage facility	Capacity in Million Metric Tonnes (MMT)
1	**Mangalore**	1.50
2	**Vishakhapatnam**	1.33
3	**Padur (Udupi district, Karnataka)**	2.50
Total		**5.33 MMT**

- All these are located on the coasts of India which are readily accessible to the refineries.
- ISPRL maintains an emergency fuel store of strategic crude oil enough to provide **10 days** of consumption.
- These strategic storages are in addition to the existing storages of crude oil and petroleum products with the oil companies and serve in response to external supply disruptions.
- Indian refiners maintain 65 days of crude storage, so India has **overall reserve oil storage of 87 days**.

Additional storage facilities

- In the 2017-18 budget, it was announced that two more rock caverns will be set up at **Chandikhole in Odisha** and **Bikaner in Rajasthan** as part of the second phase.
- In 2018, GOI approved the construction of storage facility in **Chandikhole** and doubling the capacity at Padur.
- This would raise India's strategic reserve capacity to 12.33 million tonnes.



Underground hydrocarbon storage

- **Underground rock caverns** are considered as the safest means of storing hydrocarbons.
- The success of underground hydrocarbon storage lies in its economic efficiency, its safety and, ultimately, its excellent environmental track record.
- To retrieve oil from a cavern, all you have to do is pump water into its bottom (oil is lighter than water).

{EG – Water Resources – 20/04} Cauvery Water Dispute

LM | TH | D2E | TNW | TH | IE | MOWR | Economic Geography > Water Resources

- **Context:** The centre has put out a notification to bring the **Cauvery Water Management Authority (CWMA)** under the administrative control of the **Union Ministry of Jal Shakti**.

Union Ministry of Jal Shakti was formed in 2019 by merging Ministry of Water Resources, River Development and Ganga Rejuvenation and Ministry of Drinking Water and Sanitation.

Concerns raised over centre's CWMA notification by TN farmers

- CWMA was created on the direction of the SC in 2018.
- The centre's move could dilute the autonomy of the CWMA and reduce CWMA to a "puppet" of the centre.
- CWMA was never designated as an organisation under the earlier Ministry of Water Resources.
- CWMA under Jal Shakti ministry might favour the construction of a dam across Cauvery river at **Mekedatu**, a project aggressively pursued by the Karnataka, and vehemently opposed by TN.

Centre's arguments to address the concerns raised

- There is no change in the functions and powers of the CWMA and the Cauvery Water Regulation Committee.
- The decisions taken by the CWMA are final and binding on the riparian States.
- Hence bringing it under Jal Shakti Ministry has no impact on its functional autonomy.
- Besides, there are eight inter-State river water boards functioning under the **Jal Shakti Ministry**.
- Several subjects like the Godavari and Krishna River Management Boards have been transferred to the new Ministry without compromising with their autonomy.

The Cauvery Basin

- The Cauvery basin extends over states of **TN, Karnataka, Kerala,** & **Puducherry (UT).**

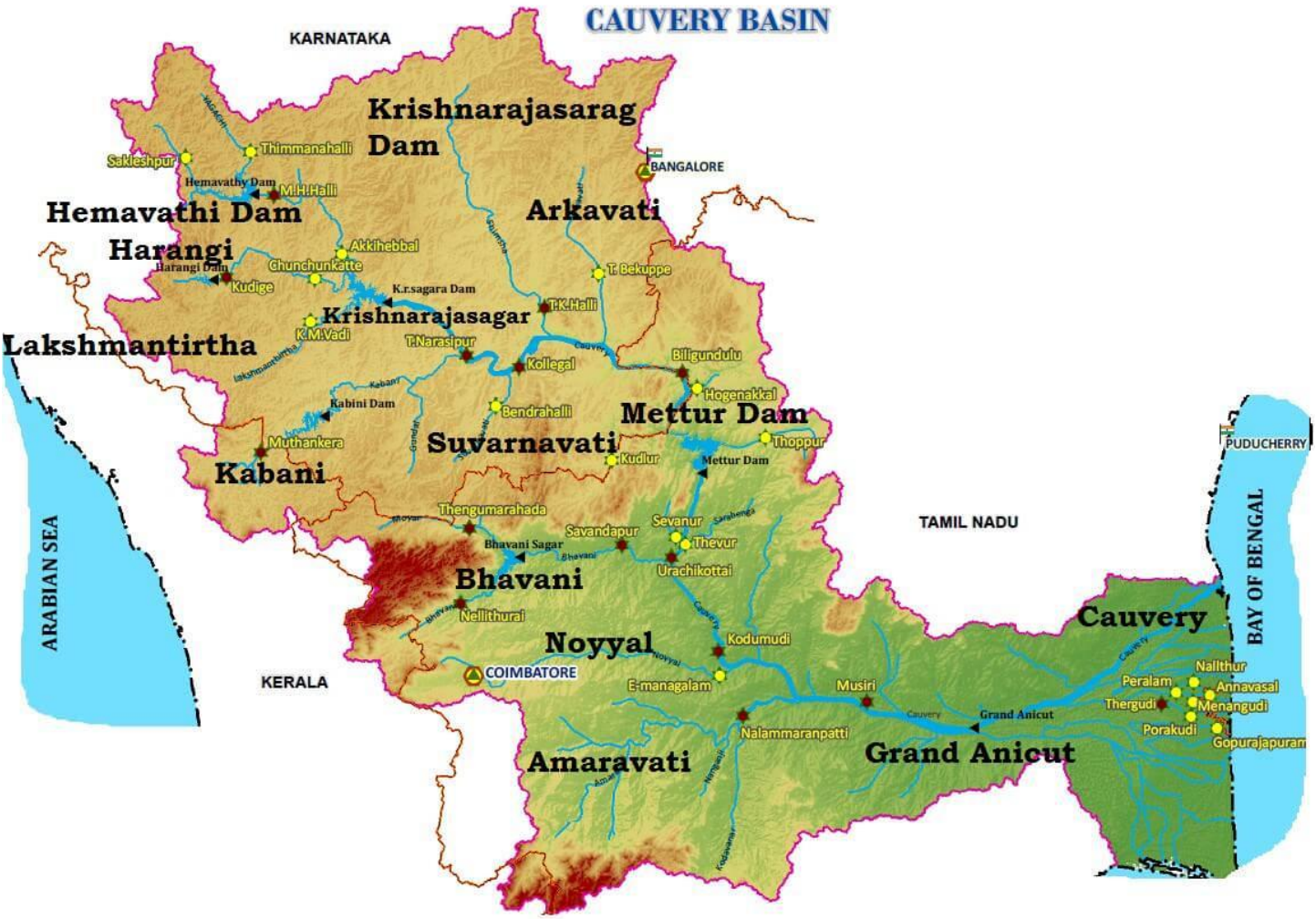
S.No.	State	Drainage area/catchment area (sq. km.)
1	**Tamil Nadu**	48,730 (55.4%)
2	**Karnataka**	36,240 (41.2%)
3	Kerala	2,930 (0.03%)
	Total	**87,900** (2.7% of the total geographical area of the country)

The Cauvery River Course

- The Cauvery River rises at an elevation of 1,341 m at **Talakaveri** on the **Brahmagiri range, Kodagu (Coorg) district of Karnataka.**
- The river descends from the South Karnataka Plateau to the Tamil Nadu Plains through the **Shivanasamudram waterfalls (101 m high)**.
- At Shivanasamudram, the river branches off into two parts and falls through a series of falls and rapids.
- The two branches of the river join after the fall and flow through a wide gorge which is known as **Mekedatu (Goats leap) (Mekedatu falls is here)**.
- At **Hogennekkal Falls**, it takes Southerly direction and enters the **Mettur Reservoir.**
- Below Mettur reservoir the river widens with sandy bed and flows as **Akhanda Cauvery.**
- In the last stage, the river divides into two parts, the Northern branch being called **'The Coleron'** and Southern branch remains as Cauvery, and from here the **Cauvery Delta** begins.
- After flowing for about 16 Kms, the two branches join again to form '**Srirangam Island**'.
- On the Cauvery, branch lies the **"Grand Anicut"** (constructed by a Chola King in 1st Century A.D).
- Below the Grand Anicut, the Cauvery branch splits into two — Cauvery and **Vennar**.

Tributaries of the Cauvery River

- Left Bank: the **Harangi**, the **Hemavati**, the **Shimsha** and the **Arkavati**.
- Right Bank: **Lakshmantirtha**, the **Kabbani**, the **Suvarnavati**, the **Bhavani**, the **Noyil** and the **Amaravati**.



Tributaries of the Cauvery River

Cauvery Water Dispute

Timeline

- 1892: Madras presidency disagrees to Mysore's proposal to build irrigation systems, arguing that it would impede water flow into Tamil Nadu.
- **1924:** Mysore & Madras reach an agreement under which Mysore is allowed to build **Krishnaraja Sagar dam** at Kannambadi (Mandya district, Karnataka).
- The agreement is to be valid for 50 years and reviewed thereafter.
- **Krishnaraja Sagar dam** becomes functional in 1931 and the **Mettur dam** in 1934.
- **1974:** The 1924 water sharing agreement lapses after expiration of its term of 50 years.
- 1986: Tamil Nadu approaches the centre for setting up a tribunal to settle arising disputes.
- **1990: Cauvery Water Disputes Tribunal (CWDT)** was set up under the centre after the SC's direction.
- 1991: CWDT passes an interim award asking Karnataka to release 205 TMC of water to Tamil Nadu every year.

- It also directed Karnataka not to increase its irrigated land area from the existing 11,20,000 acres.
- 1998: **Cauvery River Authority (CRA)** was constituted by the centre for implementation of the interim award.
- 2002: The CRA directs Karnataka to release 9,000 cusecs per day of Cauvery water to Tamil Nadu. The body was presided over by then prime minister Atal Bihari Vajpayee.
- **2007:** CWDT passed the final award.
- According to the CWDT, the total availability of water in the Cauvery basin is **740 TMC in a normal year**.
- Of the total 740 TMC, CWDT awarded:
  - ✓ **419 TMC was awarded to Tamil Nadu**
  - ✓ **270 TMC to Karnataka**
  - ✓ 30 TMC to Kerala
  - ✓ 7 TMC to Puducherry
  - ✓ The remaining 14 TMC was reserved for environmental protection.
- In case the yield was less in a **distress year**, the **allocated shares shall be proportionately reduced**.
- February 2013: The centre notifies the final award of the CWDT, on the direction of the Supreme Court.
- **March 2013:** Tamil Nadu moves the SC, seeking directions to the water ministry for constitution of the **Cauvery Management Board (CMB)**.
- 2016: SC asks Karnataka to release 15,000 cusecs a day till 20 September and protests flare-up in Karnataka.
- **2017:** SC declared Cauvery a "national asset". It upheld the principle of equitable apportionment of inter-State river water among riparian States.
- **2018:** SC's verdict has **reduced the allocation of Cauvery water from Karnataka to Tamil Nadu**.
- SC declared that the decision was taken considering that the CWDT had failed to consider groundwater held below the Cauvery basin in Tamil Nadu.
- The final allocation for a total of 740 TMC is
  - ✓ **Karnataka: 284.75 (270 + 14.75) TMC**
  - ✓ **Tamil Nadu: 404.25 (419 – 14.75) TMC**
  - ✓ 30 TMC to Kerala (unchanged)
  - ✓ 7 TMC to Puducherry (unchanged)
  - ✓ The remaining 14 TMC was reserved for environmental protection (unchanged)
- The water allocation arrangement will stand unchanged for the **next 15 years**.
- SC has also directed the formation of the **Cauvery Management Board (CMB)**.
- 2018: The dispute was settled with the **Cauvery Water Management Authority** being set up.
- 2020: Tamil Nadu and Puducherry have objected to Karnataka's bid to seek approval for the **Mekedatu dam** project at the fifth Cauvery Water Management Authority (CWMA) meeting.

Cauvery Water Disputes Tribunal

- GOI, in exercise of the powers conferred by the **Inter-State River Water Disputes Act, 1956** had constituted the Cauvery Water Disputes Tribunal (Autonomous) in 1990.
- It aims to adjudicate upon the water dispute regarding the Inter-State river Cauvery and the river valley thereof among the States of Karnataka, Kerala, Tamil Nadu, and Union territory of Puducherry.

Cauvery Management Board (CMB)

- CWDT recommended that the CMB be constituted on the lines of the Bhakra Beas Management Board.
- CWDT recommended that CMB be entrusted with the function of
  1. supervision of the operation of reservoirs and
  2. the regulation of water released with the assistance of the Cauvery Water Regulation Committee (CWRC).
- The CWRC is to be constituted by the CMB.
- Chief Engineer of the Central Water Commission will head the CWRC.

Cauvery Water Management Authority (CWMA)

- GOI notified the Cauvery Water Management Scheme on June 2018, in line with the SC's order.
- It constituted '**Cauvery Water Management Authority (CWMA)**' and the '**Cauvery Water Regulation Committee (CWRC)**' to give effect to the decision of the Cauvery Water Disputes Tribunal.

Composition of CMWA

- The authority will comprise a chairman, a secretary and eight members.
- Out of the eight members, two will be full time, while two will be part time members from centre's side.
- Rest four will be part time members from states.

Mandate

- The main mandate of the CMA will be to secure implementation and compliance of the Supreme Court's order in relation to "storage, apportionment, regulation and control of Cauvery waters".
- CMA will also advise the states to take suitable measures to improve water use efficiency.
- It will do so by promoting use of micro-irrigation, change in cropping patterns, improved farm practices, etc.

Issues

- Even two years after its formation, the Authority does not have a full-fledged chairman.

- In fact, the CWMA has had only a part-time head, the chairman of the Central Water Commission (CWC), attached to the Jal Shakti Ministry.

Mekedatu Project

- It is a proposed multi-purpose reservoir project over **Mekedatu** (it is a narrow and deep gorge at the confluence of Cauvery and Arkavathi rivers; Mekedatu means **Goat's leap** in Kannada) across the river Cauvery.
- It is aimed at solving the drinking water problems of Bengaluru and Ramnagar districts in Karnataka.
- 2018: TN has moved to the SC against the **approval given by the Central Water Commission (CWC)** to build Mekedatu project.
- Karnataka's argument: The proposed project intends to store excess water that would otherwise flow into the Bay of Bengal. It will by no means affect the mandatory allocation of water to TN and Puducherry.
- TN's argument: Cauvery was already a deficit basin and the construction or any new project "would drastically affect the lower riparian State in getting their due share of waters.

{Geo – Climatology – 20/04} Arctic's Ozone 'Healed Itself'

IE | Climatology > Polar Cyclone (Polar Vortex) and Ozone Depletion

Ozone hole

- 'Ozone hole' refers to a region in the **stratosphere** where the concentration of ozone becomes extremely low in certain months (winter months — when the polar vortex is the strongest).
- The unique cocktail of the powerful **polar vortex** and **low temperatures generates stratospheric clouds** that react with **CFCs** and **destroy the Ozone layer** in the process.

Ozone holes in the polar regions

- Ozone holes are most commonly found over the **Antarctic region** (experiences strong polar vortex).
- Here, they can reach sizes of around 20 to 25 million sq km.
- They are comparatively rare & small over the Arctic (because polar vortex here is comparatively weak and temperatures are relatively high).

Largest ever recorded ozone hole over the North Pole

- An ozone hole, **largest ever recorded over the North Pole**, was detected in February 2020.
- It had since reached a maximum extension of around 1 million sq km.
- It has now 'healed itself' and closed.

Why did it form?

- Arctic temperatures are usually not as low as in Antarctica.
- However, this year, cold air trapped within the polar vortex lead to stratospheric cooling.
- By the end of the winter, the first sunlight over the North Pole initiated unusually strong ozone depletion.

How did it heal?

- According to the scientists the closure is **not** due to the reduced pollution levels due to COVID-19 lock down.
- The closing was because of the **weak polar vortex**.
- The Polar Vortex split allowed the ozone-rich air into the Arctic.

Ozone and its significance

- Ozone (O_3) forms less than 0.00005% by volume of the atmosphere and is unevenly distributed.
- O_3 is formed at higher altitudes and transported downwards.
- It is between **20 km & 25 km altitude (in stratosphere)** that the greatest concentrations of ozone are found.
- Ozone plays a crucial role in **blocking the harmful ultraviolet radiation** from the sun.
- The lack of the Ozone layer can cause skin cancer and other possibly fatal skin diseases.

Polar Vortex

This topic is already explained in detail in Geography PDF > Climatology > Temperate Cyclones > Polar Vortex

Some additions are made here for better clarity.

- Polar vortex is a **polar cyclone** (an area of low pressure and very cold air) that can reach up to 2,000 km wide.
- It sometimes extends till the **lower stratosphere** (at poles, the troposphere extends only up to 8-9 km).
- It surrounds **polar highs** & lie within the **polar front** (boundary that separates temperate & polar air masses).
- A polar vortex **rotates counter-clockwise at the North Pole** and clockwise at the South Pole.
- Polar cyclones differ with others because they are not seasonal. They can occur at any time of the year.
- It is **formed mainly in winter** and gets **weaker in summer**.

Polar Vortex Cold Wave

Polar Vortex slipping into Mid-latitudes,

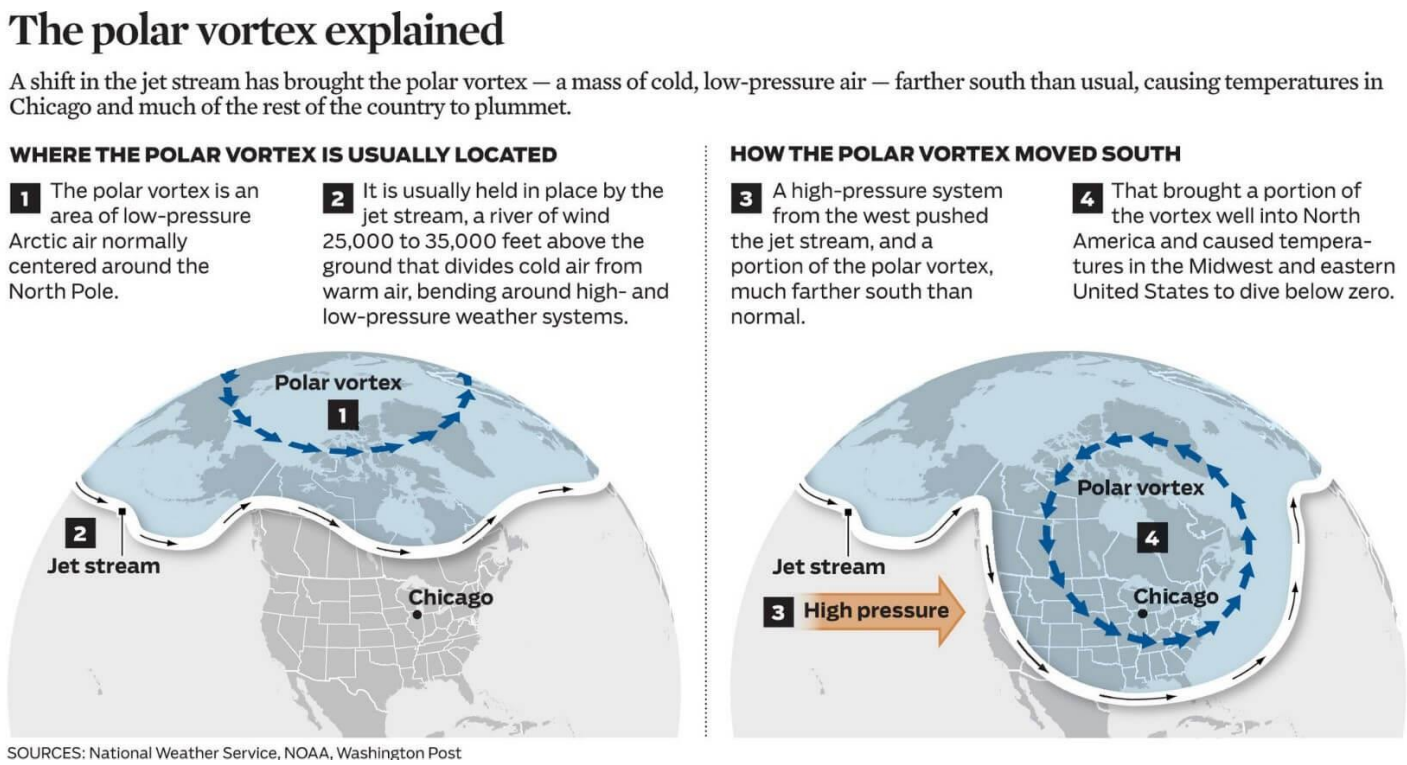
Breakdown of the polar vortex,

Sudden stratospheric warming (reduces Ozone Depletion),

Polar vortex event.

All the above terms mean the same — Polar Vortex Cold Wave **(reduces Ozone Depletion)**.

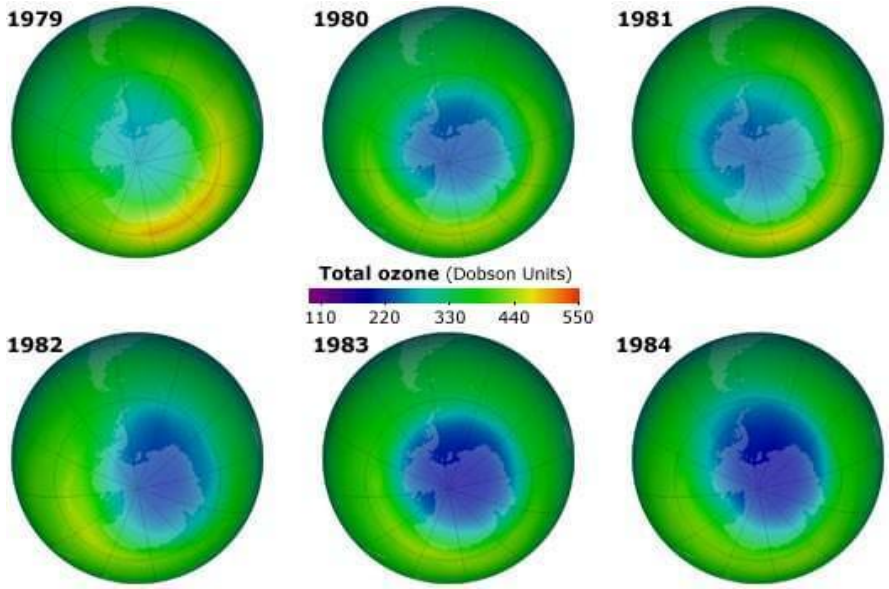
- The polar vortex will remain in its place when the westerlies along with the polar jet are strong (strong polar vortex means that there is **huge temperature contrast** between the temperate and polar regions).
- **When the polar vortex is weak**, it intrudes into the mid-latitude regions by buckling the general wind flow pattern (meandering jet streams or Rossby waves).



Polar Vortex slipping into temperate regions

Polar Vortex and Ozone Depletion at South Pole (and also at North Pole)

- Polar vortex and ozone depletion are two distinct but related phenomena.
- There is a steady decline of about 4% in the total volume of ozone in Earth's stratosphere.
- Much larger decrease in stratospheric ozone is observed around **Earth's polar regions**.
- Depletion of ozone is due to increase in **halocarbons** in the atmosphere.



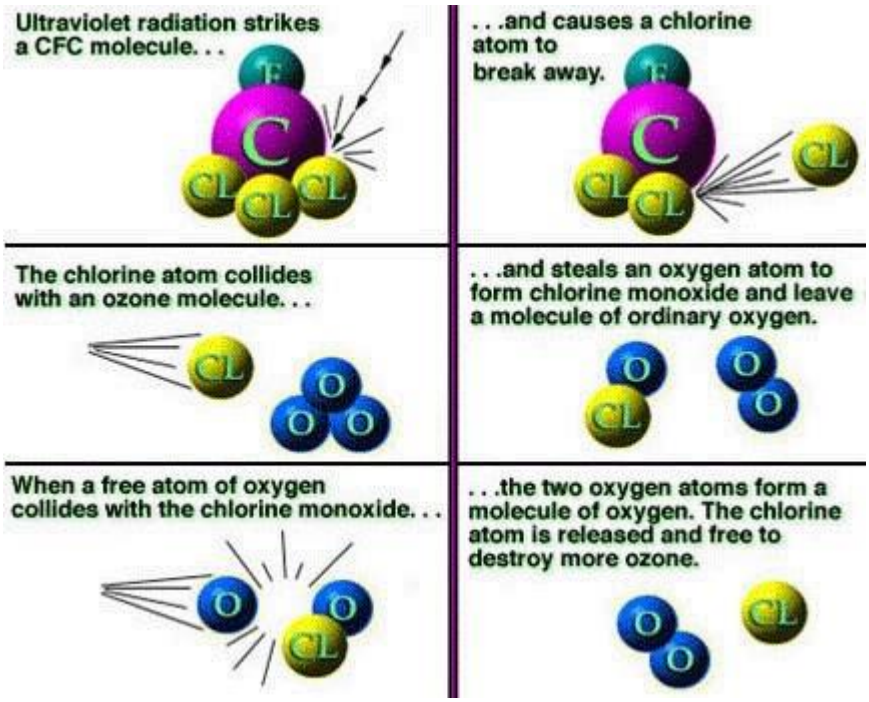
Ozone Hole at the South Pole

Halocarbon: a compound in which the hydrogen of a hydrocarbon is replaced by halogens like chlorine, bromine, iodine etc.

Halogen: group of reactive non-metallic elements like fluorine, chlorine, bromine, iodine, etc.

Ozone Depletion Mechanism: Halogen atoms like chlorine destroy ozone

- **Photodissociation (under the influence of sunlight)** of **ozone-depleting substances** (ODS) like **halocarbon refrigerants, solvents, propellants, and foam-blowing agents (CFCs, HCFCs, carbon tetrachloride and trichloroethane, freons, halons)** creates **free chlorine atoms** that destroy ozone.

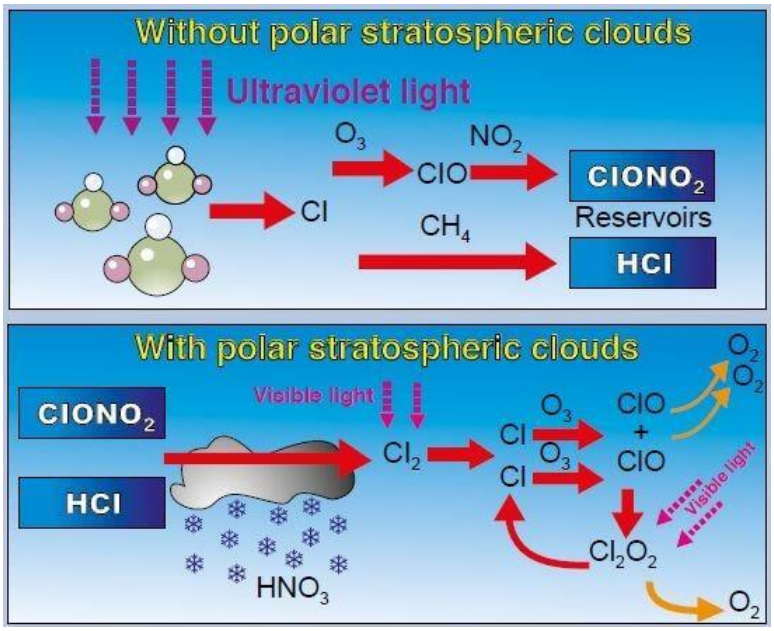


Photodissociation of ozone-depleting substances break O_3 into O_2

But how does a chlorine atom reach to such high levels of atmosphere?

Polar Stratospheric Clouds (PSCs – the link between Polar Vortex and Ozone Depletion)

- They are nacreous clouds that extend from 12-22 km above the surface.
- Nacreous clouds are rare clouds in frigid regions of the **lower stratosphere**.
- They are seen mostly during winter at high latitudes.
- PSCs or nacreous clouds contain water, **nitric acid and/or sulfuric acid**.
- They are **formed mainly during the event of polar vortex in winter**; **more intense at south pole** (because polar vortex here is stronger due to **high temperature contrast between the polar & temperate regions**).
- The **Cl-catalysed ozone depletion is enhanced in the presence of polar stratospheric clouds**.
- **PSCs convert reservoir compounds into reactive free radicals (Cl and ClO)** thereby significantly **increasing the reactive halogen radicals**. These **free radicals accelerate depletion of ozone**.
- **Thus, polar vortex, in the form of PSCs, accelerate ozone depletion**.



Ozone Depletion is Enhanced by PSCs

Prelims question: The formation of ozone hole in the Antarctic region has been a cause of concern. What could be the reason for ozone depletion at poles?

a) Presence of prominent tropospheric turbulence; and inflow of chlorofluorocarbons

b) Presence of prominent polar front and stratospheric Clouds and inflow of chlorofluorocarbons

c) Absence of polar front and stratospheric clouds; and inflow of methane and chlorofluorocarbons

d) Increased temperature at polar region due to global warming

Explanation:

- Ozonosphere lies at an altitude between 20 km and 55 km from the earth's surface and spans the stratosphere and lower mesosphere. But the highest concentration occurs between 20 km and 30 km.
- **To destroy ozone, ozone-depleting substances** (ODS) like **CFCs, HCFCs, etc. needs to be carried up to the lower levels of stratosphere**.
- **And the only weather phenomenon that can reach to this level are Polar Vortex and** towering tropical cumulus clouds.
- But **towering cumulus clouds (convectional thunderstorms) do not occur at the poles**.

Question: The formation of ozone hole in the Antarctic region has been a cause of concern. What could be the reason for ozone depletion at poles?

- Presence of prominent tropospheric turbulence: they do not reach the stratosphere **(flights prefer lower stratosphere as it is free of any significant weather phenomenon)**.
- Presence of prominent polar front: essential to keep polar vortex in its place. Polar vortex gives rise to stratospheric Clouds.
- **Presence of stratospheric Clouds:** they have the necessary ingredients (**nitric acid and/or sulfuric acid**) to amplify ozone depletion.
- Absence of polar front and stratospheric clouds: **polar vortex slips into the temperate region and this reduces ozone depletion**.
- Inflow of methane: **methane (CH_4) is not in the list of ozone-depleting substances**.
- It does not contain a halogen like chlorine, bromine, fluorine, etc. But it reacts with halogens to create **reservoir compounds**.
- Increased temperature at polar region due to global warming: this does not have any direct impact on ozone depletion (that occurs in the stratosphere) over the poles.

Answer: b) Presence of prominent polar front and stratospheric Clouds and inflow of chlorofluorocarbons

{Geo – Climatology – 20/04} IMD releases new list of cyclone names

IMD | PIB | Tropical Cyclones

- **UPSC CSE Mains 2013:** The recent cyclone on east coast of India was called 'Phailin'. How are the tropical cyclones named across the world? Elaborate.

Naming of tropical cyclones worldwide

- It is usual practice for a storm to be named when it reaches tropical storm strength (**winds of 34 knots**; **1 knot = speed equal to one nautical mile per hour; 1 nautical mile = 1.852 km**).
- World Meteorological Organisation has divided the world Oceans into Basins and assigned the responsibility of naming the Cyclones to the respective regional bodies — **six regional specialised meteorological centres (RSMCs)** and **five regional Tropical Cyclone Warning Centres (TCWCs)**.
- Each RSMC and TCWC has its own rules in naming cyclones.
- To avoid controversies and disagreements, the names chosen are meant to be neutral and acceptable.
- In most regions, pre-determined alphabetic lists of alternating male and female names are used.
- In the north-west Pacific, the majority of names used are the names of flowers, animals, birds, trees, etc.

Naming of tropical cyclones developing over the north Indian Ocean (NIO)

- **India Meteorological Department** (RSMC, New Delhi) is one of the six RSMCs to provide tropical cyclone and storm surge advisories to **13 member countries**.
- It is also mandated to name the Tropical Cyclones developing over the north Indian Ocean (NIO) — Bay of Bengal (BoB) and the Arabian Sea (AS) — following a standard procedure.
- IMD has a list of names contributed by each of 13 member countries.
- Every time a cyclone occurs, a name is picked in the order of the names that are already submitted.
- After all the countries get their turn, the next list of names is followed.

Contributed by	Name			
Bangladesh	Helen	Chapala	Ockhi	Fani
India	**Lehar(2013)**	**Megh**	**Sagar**	**Vayu**
Maldives	Madi	Roanu	Mekunu	Hikaa
Myanmar	Na-nauk	Kyant	Daye	Kyarr
Oman	**Hudhud**	Nada	Luban	Maha
Pakistan	**Nilofar**	Vardah	Titli	Bulbul
Sri Lanka	Priya	Asiri	Gigum	Soba
Thailand	Komen	Mora	Phethai	Amphan

Old Table of Names contributed by countries in the Northern Indian Ocean Region

- The cyclone that formed in the Bay of Bengal in the 3rd week of May is named **Amphan** **(the last name in the old table)**.

New table of names of tropical cyclones over north Indian Ocean

Place	List 1	List 2	List 3	List 4	List 5
Bangladesh	Nisarga	Biparjoy	Arnab	Upakul	Barshon
India	Gati	Tej	Murasu	Aag	Vyom
Iran	Nivar	Hamoon	Akvan	Sepand	Booran
Maldives	Burevi	Midhili	Kaani	Odi	Kenau
Myanmar	Tauktae	Michaung	Ngamann	Kyarthit	Sapakyee
Oman	Yaas	Remal	Sail	Naseem	Muzn
Pakistan	Gulab	Asna	Sahab	Afshan	Manahil
Qatar	Shaheen	Dana	Lulu	Mouj	Suhail
Saudi Arabia	Jawad	Fengal	Ghazeer	Asif	Sidrah
Sri Lanka	Asani	Shakhti	Gigum	Gagana	Verambha
Thailand	Sitrang	Montha	Thianyot	Bulan	Phutala
United Arab Emirates	Mandous	Senyar	Afoor	Nahhaam	Quffal
Yemen	Mocha	Ditwah	Diksam	Sira	Bakhur

- The first cyclone formed after cyclone Amphan will take the name **Nisarga** (the first name in the new table — contributed by **Bangladesh**).
- The second cyclone formed after cyclone Amphan will take the name **Gati** (the first name in the new list provided by India).
- There are a total of 13 lists (columns) in the new table (13 countries X 13 names = 169 names in total).

Why name tropical cyclones?

- Naming of TCs helps the scientific community, disaster managers, media, and general masses to
  - ✓ identify each individual cyclone.
  - ✓ create awareness of its development.
  - ✓ remove confusion in case of simultaneous occurrence of TCs over a region (storms can often last a week and more than one cyclone can be occurring in the same region at the same time).
  - ✓ remember a TC easily
  - ✓ rapidly and effectively disseminate warnings to much wider audience (naming them after a person/flower/animal etc. makes it easier for quick information exchange).

Following criteria of naming is adopted by IMD:

- The proposed name should be neutral to political figures, religious believes, cultures and gender.
- The maximum length of the name will be **eight letters**.

- The names of tropical cyclones over the north Indian Ocean **will not be repeated**.
- The finalised names may also be reviewed during the course of time of implementation.

{Geo – Climatology – 20/04} IMD's Monsoon Forecast

TH | Indian Climate > Monsoon Forecast

- Recently IMD has predicted that India will likely have a **normal monsoon in 2020**, with a chance of '**above normal**' rain in August and September.
- The IMD's confidence stems largely from global weather models pointing to negligible chances of El Nino.

Indian Meteorological Department (IMD) issues five kinds of weather forecasts

1. Nowcast is for less than 24 hours.
2. The short-range forecast is for up to three days.
3. The medium-range is from three to 10 days.
4. The extended-range is for 10-30 days.
5. The long-range is on a seasonal scale (e.g. monsoons).

- The IMD issues a two-stage monsoon forecast: the first in April, followed by a more detailed one in the last week of May, which will also illustrate how the monsoon will spread over the country.

Monsoon Rainfall distribution categories

- Long Period Average (LPA) is the averages of rainfall received over a 50-year period between 1951 and 2001, this average comes to **88 cm of rainfall** (according to recent change).
- This is the average rainfall recorded during the months from **June to September (it doesn't take into account the retreating monsoon)**.

IMD maintains five rainfall distribution categories on an all-India scale which are

1. **Normal:** When per cent departure of actual rainfall is +/-10% of LPA, that is, between 96-104% of LPA
2. **Below normal:** When departure of actual rainfall is less than 10% of LPA, that is 90-96% of LPA
3. **Above normal:** When actual rainfall is 104-110% of LPA
4. **Deficient:** When departure of actual rainfall is less than 90% of LPA
5. **Excess:** When departure of actual rainfall is more than 110% of LPA

Statistical models of monsoon prediction

- Since long, IMD employed statistical models to forecast the monsoon.
- Statistical models involved identifying climate parameters linked to the performance of the monsoon — for instance, the sea surface temperature gradient between North Atlantic and North Pacific, the volume of warm water in the equatorial Pacific, the Eurasian snow cover, etc.
- Their values are correlated to values of actual rainfall over a hundred years and then, using statistical techniques, extrapolated to forecast a particular year's monsoon.
- For example, historical data between the monsoons and El Niño shows that they have a negative relationship.
- This is how the IMD dispensed its long-range forecasts until recently.
- This has, however, proved wrong as the IMD missed its mark on forecasting major droughts and rain-deficits.

Digital System (dynamic model) since 2015

- IMD started to use the dynamic model along with the statistical model.
- The dynamical model or the Monsoon Mission Coupled Forecast System relies on supercomputers, mathematically simulating the physics of the ocean and the atmosphere.
- It simulates the weather at a chosen set of locations on a given set of variables and the computers calculate how these weather variables will change over days, weeks, months.
- Dynamical models need data about current weather conditions for accurate prediction.
- But IMD does not have enough data collection centres to collect weather data of the entire country.
- The dynamical model, while **better at forecasting the state of the weather a week or two in advance, is not reliable in forecasting longer term weather phenomenon like monsoon**.

High-resolution computer models

- The IMD and several private weather agencies are increasingly relying on more sophisticated and high-resolution computer models to give **localised forecasts** or warn farmers of changes in weather 10-15 days ahead.
- These **shorter forecasts are far more reliable** and help farmers make decisions about sowing.
- These models are also useful for anticipating heat-wave or a cold-wave and therefore useful to urban planners and government.

Why are monsoons difficult to predict?

- Indian monsoon is the most complex weather system in the world as it is influenced by multitude of factors such as:
  - ✓ El Nino, La Nina, Indian Ocean Dipole, etc. (El Nino | ENSO | La Nina Indian Ocean Dipole (IOD))
  - ✓ Sub-tropical Jet Stream, Somali Jet, etc.

- ✓ Atlantic Zonal Mode or Atlantic Nino ({Geo – IG – 19/06/04} Atlantic Ocean and Indian Summer Monsoon)
- ✓ Madden–Julian oscillation (given in May 2019 current affairs file), etc.

- There is no proper understanding of how pollution, aerosols and clouds influence the monsoon.
- IMD has shortage of resources, highly skilful software professionals and scientists.

{Geo – Geomorphology – 20/04} Earth's seismic noise

IE | Seismic waves

- Geologists in Britain have reported a change in the Earth's seismic noise amid the coronavirus lockdown.
- They have observed a 30-50 per cent fall in levels of ambient seismic noise since the lockdown.

What is seismic noise?

- In geology, seismic noise refers to the persistent vibration of the ground due to a multitude of causes.
- It is the **unwanted component** of signals recorded by a **seismometer** (instrument that records seismic waves or ground motions caused by earthquakes, volcanic eruptions, explosions, etc.).
- Seismic noise includes vibrations caused due to human activity, such as transport and manufacturing, and makes it difficult for scientists to study seismic data that is more valuable.
- Apart from geology, seismic noise is also studied in fields such as oil exploration & earthquake engineering.

How do the reduced seismic noise levels help scientists?

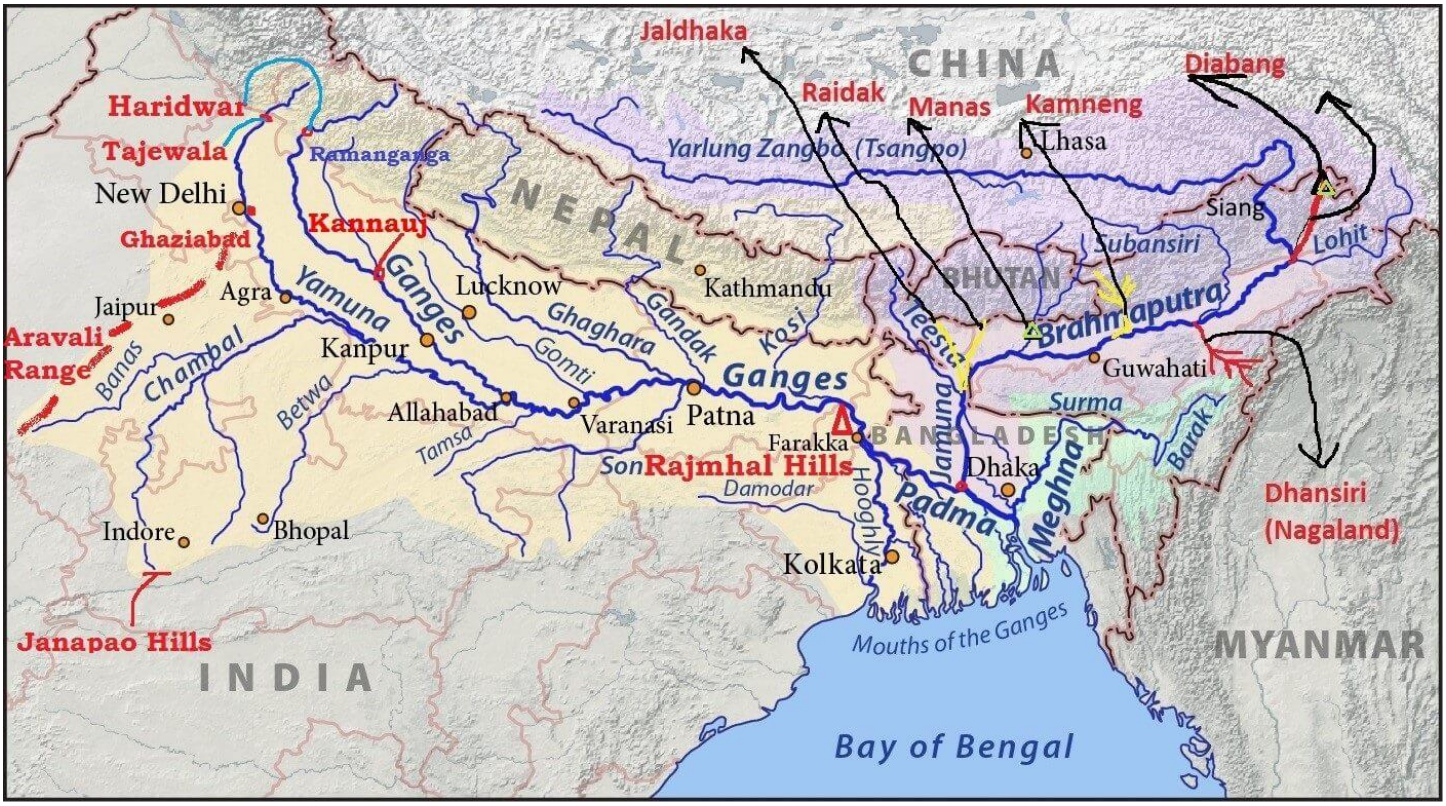
- The seismic noise vibrations caused by human activity are of high frequency (1-100 Hz), and travel through the Earth's surface layers.
- Usually, to measure seismic activity accurately and reduce the effect of seismic noise, geologists place their detectors 100 metres below the Earth's surface.
- However, since the lockdown, researchers have said that they were able to study natural vibrations even from surface readings, owing to lesser seismic noise.

{Geo LBT – India – 20/04} Daporijo Bridge

TH | Location Based Topics – India

- The Border Roads Organisation (BRO) has constructed the Daporijo bridge over **Subansiri river** in Arunachal Pradesh in a record span of just 27 days.
- The bridge links roads leading upto the Line of Actual Control (LAC) between India and China.

- The Subansiri River is a tributary of the Brahmaputra River in the Indian states of Assam and Arunachal Pradesh, and the Tibet Autonomous Region of China.
- It originates in the Tibet Plateau and enters India through Miri hills in Arunachal Pradesh.
- The Subansiri is the **largest tributary of the Brahmaputra**.

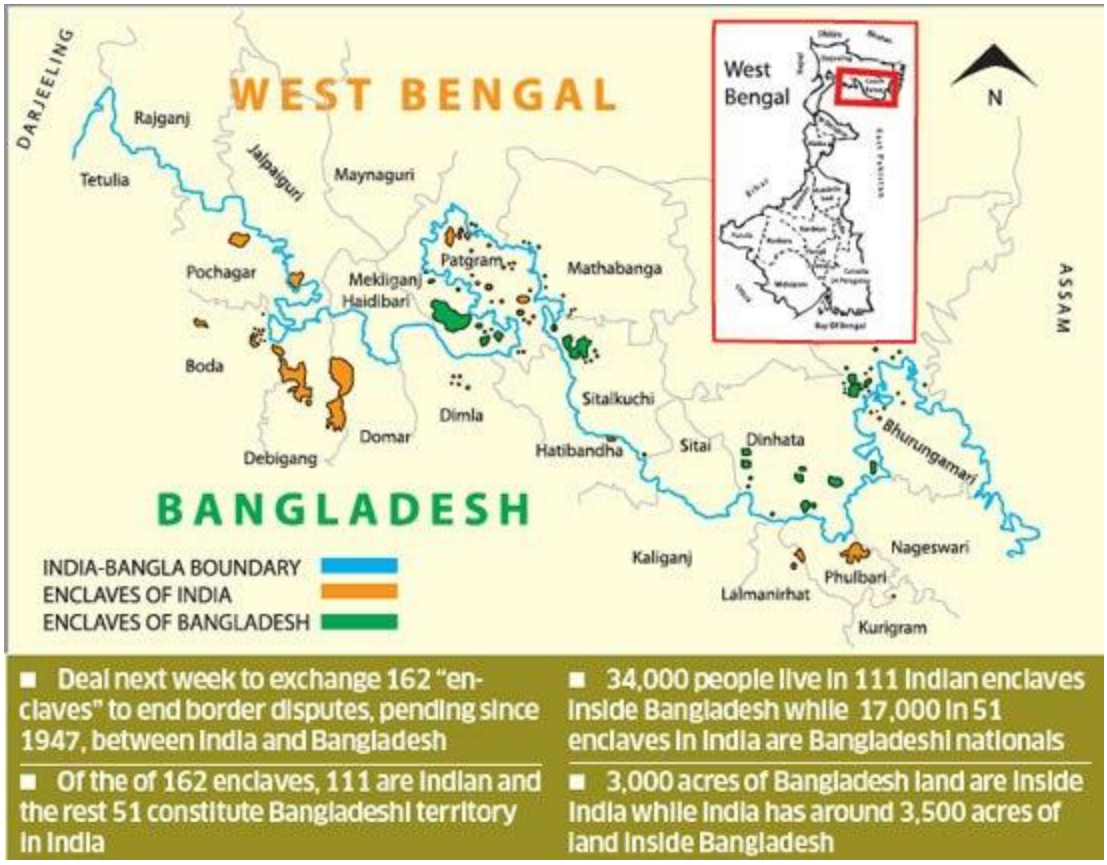


Ganga and Brahmaputra River System

{Geo LBT – India – 20/04} Kasowal Bridge

PIB | Location Based Topics – India

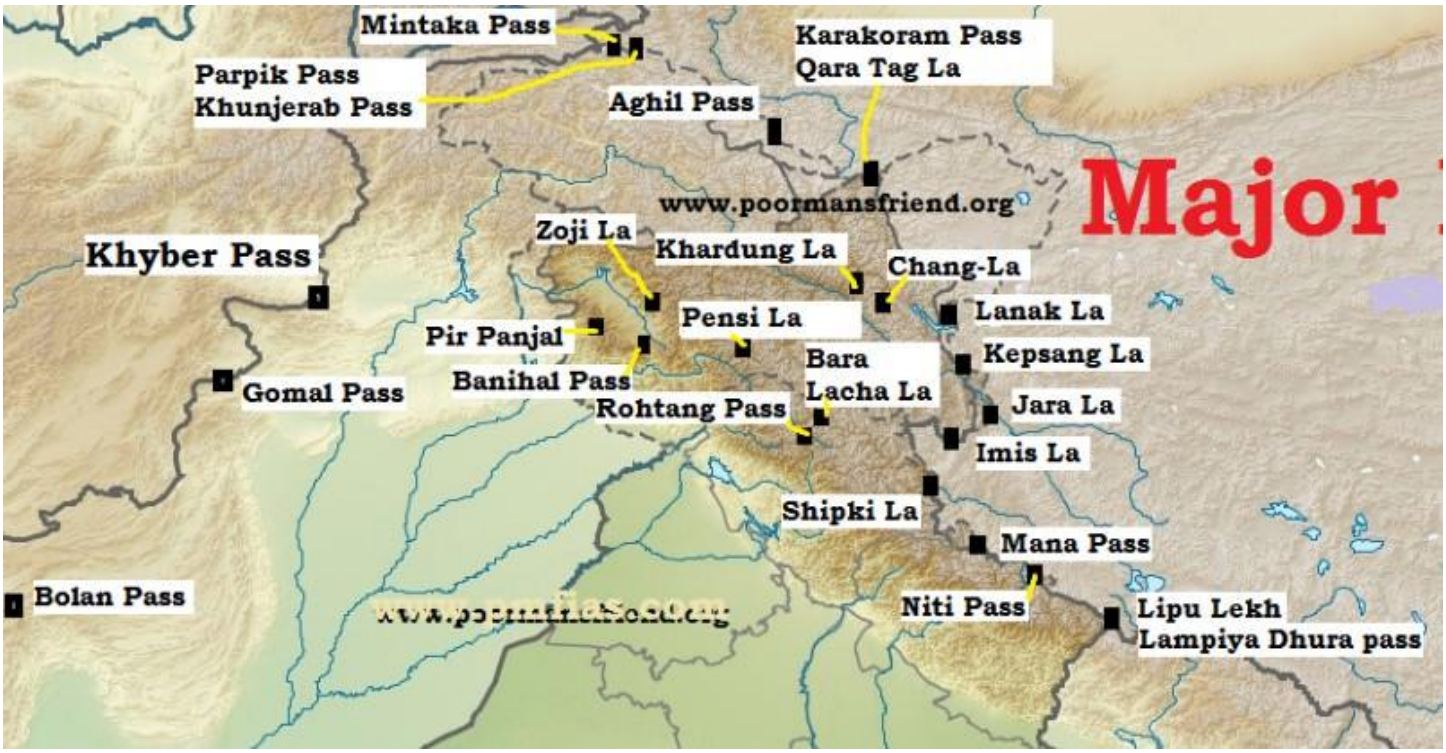
- It is a 484-metre long permanent bridge built by the Borders Roads Organization on the river Ravi to connect the Kasowal enclave of Punjab (along the Pakistan border) to the rest of the country.
- Kasowal enclave is around 35 square km.
- It was till now connected through a pontoon bridge of limited load capacity.
- The enclave was formed because it has the Ravi behind it and the International Border ahead of it.
- There are similar enclaves of Pakistani territory too, which lie ahead of Ravi and face Indian territory.
- These Pakistani enclaves — Dera Baba Nanak enclave and Jassar enclave — were occupied by the Indian Army in the 1965 and 1971 wars.
- There are similar enclaves along the India and Bangladesh border.



{Geo LBT – India – 20/04} Rohtang Pass

PIB | Location Based Topics – India

- Context: Border Roads Organization (BRO) opened the **Rohtang Pass**, three weeks in advance, for transporting essential supplies to **Lahaul and Spiti districts** of Himachal Pradesh amid the lockdown.
- Rohtang Pass is a high mountain pass on the eastern **Pir Panjal Range** of the Himalayas.
- It **connects the Kullu Valley with the Lahaul and Spiti Valleys** of Himachal Pradesh, India.
- **Manali-Leh Highway**, a part of NH 21, transverses Rohtang Pass.
- River Ravi rises west of the Rohtang pass in the Kullu Hills.



Suggested Reading: {Geo LBT – India – 19/12/25} Atal Tunnel (Rohtang Tunnel)

{Geo LBT – World – 20/04} Concerns over Chinese dams on Brahmaputra & Mekong

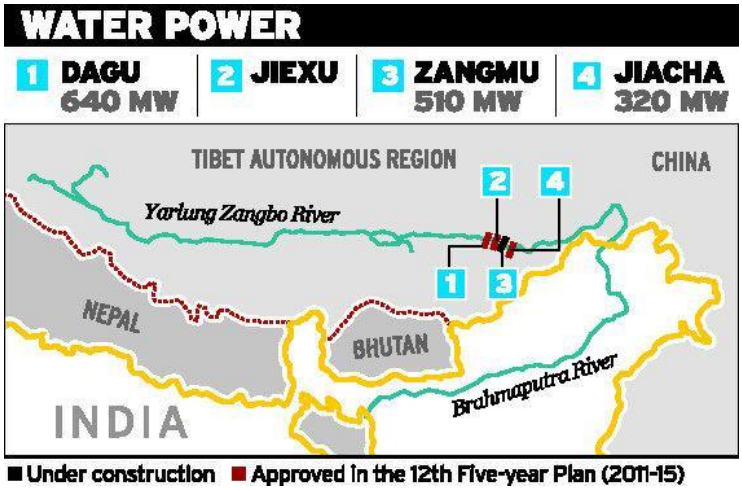
TH | Location Based Topics – World

- A new study funded by the U.S. highlighted the impact of China's dams on the Mekong River.
- According to the study, China's dams on Mekong River (Lancang in China) are causing droughts downstream.
- China has countered that the dams it is building on the river are "run of the river" dams for power generation.
- The study has raised fresh questions on whether dams being built on other rivers that originate in China, such as the **Brahmaputra** may similarly impact countries downstream.

Chinese dams on Brahmaputra (Yarlung Tsangpo)

- India has long expressed concerns over dam-building on the Brahmaputra.
- In 2015, China operationalized its first hydropower project at **Zangmu Dam**.
- Three other dams at **Dagu, Jiexu and Jiacha** are being developed.
- Indian officials have said the dams are not likely to impact the quantity of the Brahmaputra's flows because they are only storing water for power generation.
- Moreover, the Brahmaputra is not entirely dependent on upstream flows and an estimated 35% of its basin is in India.

- **India does not have a water-sharing agreement with China**, but both sides share hydrological data.



Mekong River (Lancang River in China)

- The Mekong, or Mekong River, is a trans-boundary river in Southeast Asia.
- It is the world's twelfth longest river and the seventh longest in Asia.
- Its estimated length is 4,350 km.
- From the Tibetan Plateau the river runs through **China, Myanmar, Laos, Thailand, Cambodia, and Vietnam**.
- The extreme seasonal variations in flow and the presence of rapids make navigation difficult.
- The river is a major trade route between western China and Southeast Asia.

{Geo LBT – World – 20/04} Matterhorn

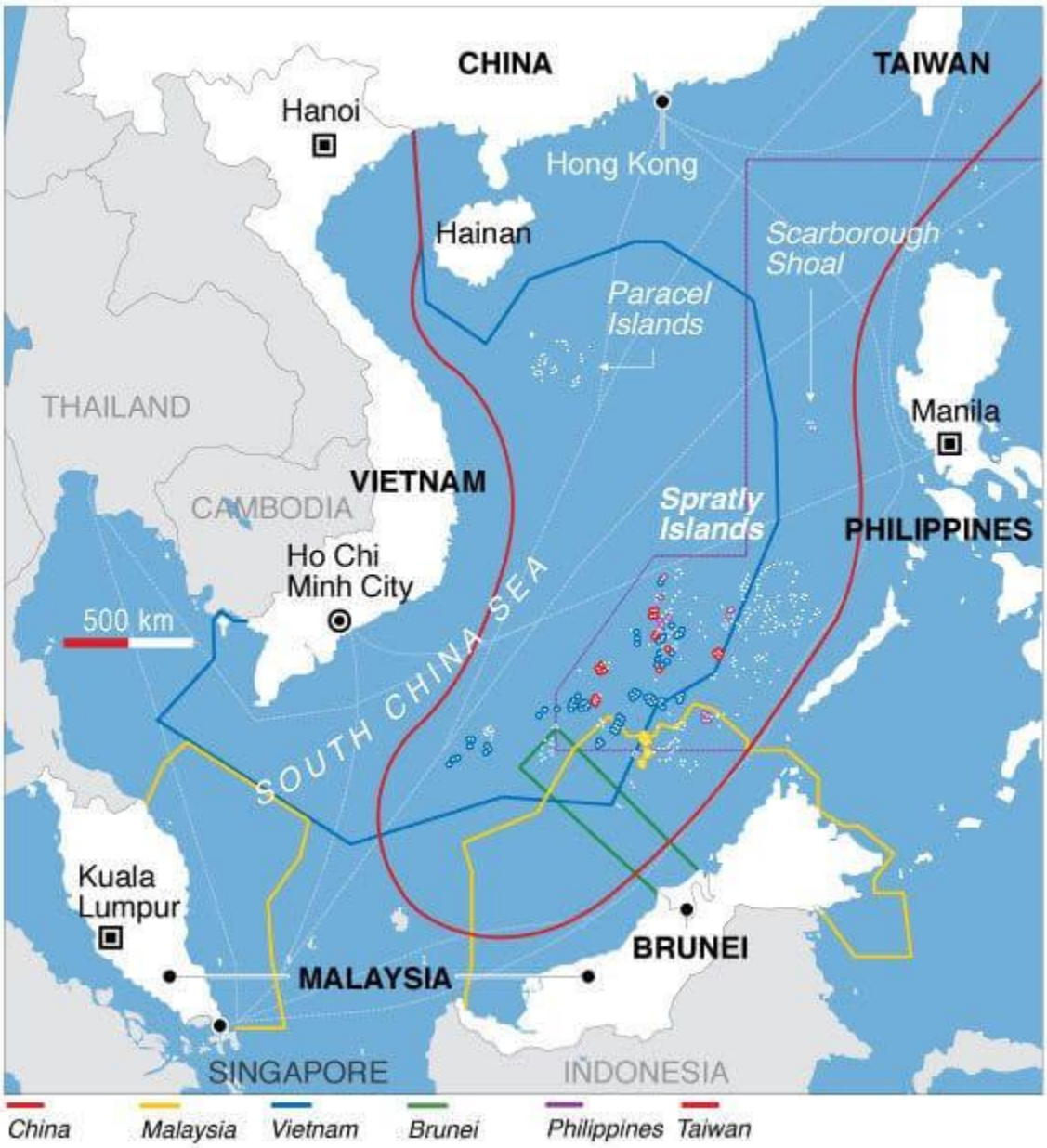
- **Context:** Indian Tricolour of more than 1,000 meters in size was projected on Matterhorn Mountain, Switzerland to express solidarity to all Indians in the fight against COVID-19.

- **Matterhorn is a mountain in the Swiss Alps**.
- It is situated in the Pennine Alps on the **border between Switzerland and Italy**.
- Its summit is 4,478 metres high, making it one of the highest summits in the Alps and Europe.

{Geo LBT – World – 20/04} South China Sea dispute

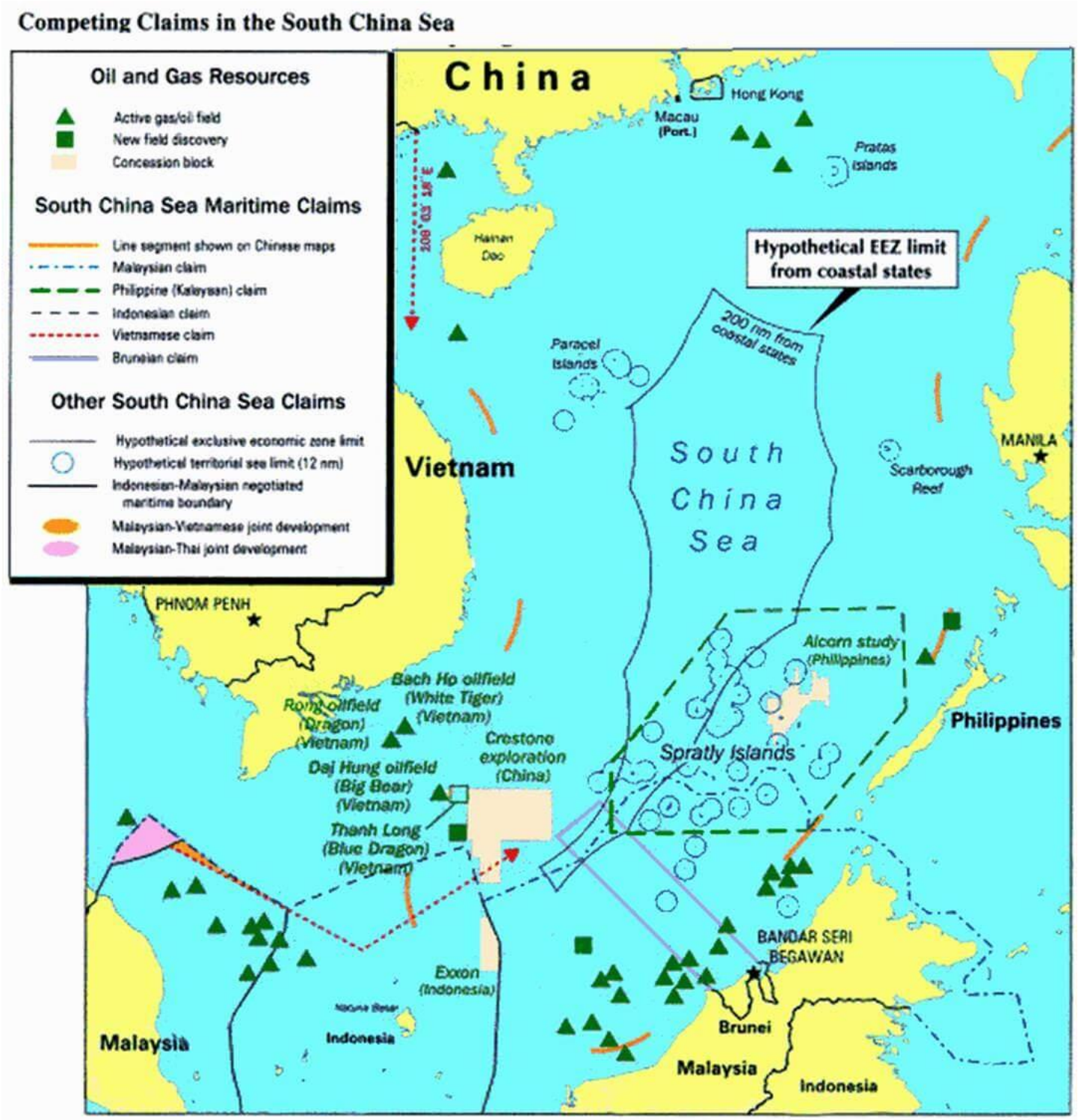
- In the middle of the COVID-19 pandemic, China is busy increasing its presence in the South China Sea.
- The focus this time is on two disputed archipelagos of the **Spratly Islands and the Paracel Islands**.
- Beijing unilaterally renamed 80 islands and other Geographical features in the area.

Land Disputes in South China Sea: Parcel Islands and Spratly Islands



Parcel Islands and Spratly Islands in South China Sea (Voice of America, Wikipedia)

- The **Spratly Islands and Paracel Islands** are two of the most contested areas in the South China Sea.
- However, unlike other parts of the South China Sea, they **do not** hold large resources of oil and natural gas.
- Most fields containing discovered oil and natural gas are clustered in uncontested parts of the South China Sea, close to shorelines of the coastal countries.
- The Paracel Islands, however, contain significant **natural gas hydrate** resources (given in Oceanography).
- Under the UNCLOS, ownership of habitable islands can, however, extend the exclusive access of a country to surrounding energy resources (**200 mile EEZ**).
- Hence, the country that wins the dispute would have the right to explore and develop whatever the resources that are available in the EEZ.

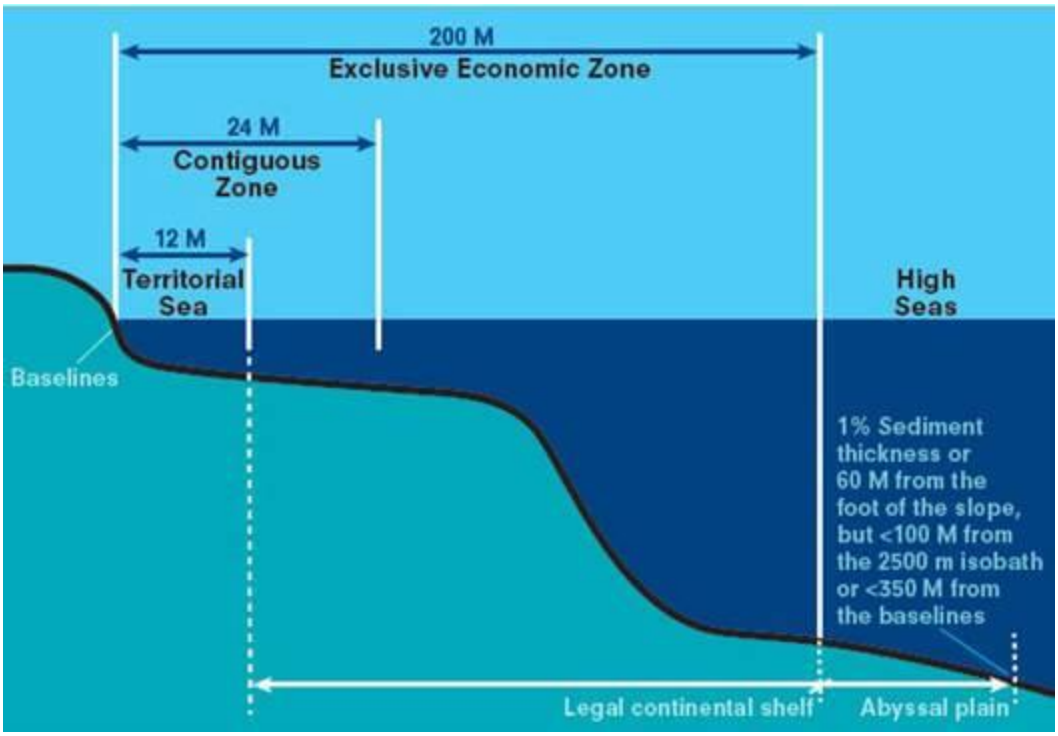


Oil and Gas reserves around Spratly Islands and Parcel Islands (Source)

United Nations International Conferences on the Law of the Sea (UNCLOS)

For full information on UNCLOS, go to Geography > Oceanography > Resources from the Ocean

- UNCLOS is an **international agreement** that defines the **rights and responsibilities of nations** where **use of the oceans' waters** by them is concerned.



UNCLOS Coastal Zones

Territorial waters

- Territorial waters are those waters over which a state has full sovereignty
- Territorial waters extend for **19 km (12 miles)** from the coast.
- Territorial waters include fjords, estuaries & land between the mainland & offshore islands in internal waters.

Contiguous Zone or Pursuit Zone

- A further contiguous zone of **19 km (24 miles)** is recognized in which the coastal state can act against those who break the law (smugglers, pirates, illegal immigrants etc.) within the true territorial waters.
- This, in other words, is a **pursuit zone**.

Exclusive Economic Zone (EEZ)

- Exclusive economic zone (EEZ) starts at the same baseline as the territorial waters.
- EEZ extend for **320-km (200-mile)** from the baseline.
- Within the EEZ the coastal state has the right to **exploit all economic resources** — fish, oil and gas, etc.
- The state may extend these rights to the edge of the shelf — as much as **1280 km (800 miles)** in some cases — though this does not include rights to the sea itself beyond the 320 km EEZ.
- Land-locked and geographically disadvantaged states can participate on an equitable basis in exploiting an appropriate part of the surplus of the living resources of the EEZs of coastal states.

- In the EEZ and on the continental shelf, all marine scientific research is subject to relevant coastal State's consent.
- The coastal states, in turn, are expected to grant consent for peaceful purposes to other States.

High Seas

- Beyond all the zones in which individual countries can claim control are the high seas.
- The high seas are **free for navigation** by vessels of all nations.
- The oceans and the airspace above may also be used freely.
- The oceans may also be freely fished by all nations.
- The States must share with the international community part of the revenue derived.