SIVARAJAVEL IAS ACADEMY
FOUNDER - DIRECTOR OF SMART LEADERS IAS

TOPICS & POINTERS

Exclusively For UPSC Mains 2022

GEOGRAPHY GS-1

MAINS WORK BOOK

METIS 2022

Mentoring and Enabling Through Intelligent Support System

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TOPICS AND POINTERS

2022- MAINS STUDY MODULE

TOPICS & POINTERS

ABOUT

The material aims to equip the aspirants with enough knowledge to attempt mains questions by incorporating various dimensions. This material will be provided every week as per the test module.

HOW TO READ THIS ?

1. Only key points will be provided .
2. Readers are advised to make a synopsis from topics and points given.
3. Make your own chart, diagrams and maps after reading the topics.
4. Understand the topics. Don't try to memorise them but link organically
5. Make sure to complete the module before the Test on Sunday.
6. Revise, Write, Practice- Repeat

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MAINS ANSWER WRITING CHALLENGE

Starting from 13th of June till the end of the test schedule every day two questions will be posted and answers may be provided in the evening.

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2022- MAINS STUDY MODULE

GEOGRAPHY

Geography Mains Important Themes & PYQ's (Part -I)

Salient features (World & India)

1. Continental drift & Plate tectonics
2. Distribution of Fold mountains, Earthquakes, Volcanoes & Archipelagoes – Causes & Impacts – Recent events and its impact on environment.
3. Geophysical characteristics of Circum-Pacific Zone
4. Climate concepts (Temperature inversion & Air mass) and its effects on climate change
5. Ocean currents, Salinity & Cryosphere – Causes and its effects on multidimensional aspects like climate change, fishing & resources etc.
6. Tropical cyclones – factors & confinement to specific geographical locations
7. Elnino, Lanina & IOD – causes and its impact on global climate
8. Distribution of hot deserts and its locational reasons
9. Deltas & Estuaries by Peninsular rivers
10. Important Space missions (JUNO/IRNSS) – objective & its uses

Critical features, fauna & flora

1. Specific cyclone – causes & its impact on Indian regions
2. Heat urban islands – causes & effects.
3. Urban flooding – Hyderabad and Pune – Causes and remedial measures.
4. Landslides in Himalayas and Western ghats
5. Monsoon – its features on provision of food security
6. Indian monsoon – changing behavior due to human aspects
7. Shrinking Himalayan glaciers – Linkages & impacts on climate change, mountain ecosystem, tourism & developments.
8. Melting of Himalayan Glaciers have a far-reaching impact on Water resources of India.
9. Melting of Arctic and Antarctic ice/glaciers and its impact on weather patterns.
10. Coastal ecosystem – Coral reefs & Mangroves – significance & destruction due to climate change
11. Ocean currents & Water mass – Impact on marine life & coastal ecosystem
12. Dead zones on marine ecosystem
13. Process of Desertification does not have climatic boundaries.

Urbanization

1. Urbanization – Social, economic & environmental impacts
2. Smart city & Smart Village – Significance & limitations
3. Affordable Urban Mass transport

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Previous Year Questions

1. What do you understand by the theory of continental drift? Discuss the prominent evidences in its support. 2013
2. Why are the world's fold mountain systems located along the margins of continents? Bring out the association between the global distribution of Fold Mountains and the earthquakes and volcanoes. 2014
3. Briefly mention the alignment of major mountain ranges of the world and explain their impact on local weather conditions, with examples. 2021
4. Explain the formation of thousands of islands in Indonesian and Philippines archipelagos. 2014
5. Define mantle plume and explain its role in plate tectonics. 2018
6. Discuss the geophysical characteristics of Circum-Pacific Zone. 2020
7. Mention the global occurrence of volcanic eruptions in 2021 and their impact on the regional environment. 2021
8. There is no formation of deltas by rivers of the Western Ghat. Why? 2013

1. Bring out the causes for more frequent landslides in the Himalayas than in Western Ghats. 2013
2. "The Himalayas are highly prone to landslides." Discuss the causes and suggest suitable measures of mitigation. 2016
3. Differentiate the causes of landslides in the Himalayan region and the Western Ghats. 2021
4. What do you understand by the phenomenon of temperature inversion in meteorology? How does it affect the weather and the habitants of the place? 2013
5. Bring out the causes for the formation of heat islands in the urban habitat of the world. 2013
6. Tropical cyclones are largely confined to South China Sea, Bay of Bengal and Gulf of Mexico. Why? 2014
7. The recent cyclone on the east coast of India was called "Phailin". How are the tropical cyclones named across the world? 2013
8. Discuss the concept of air mass and explain its role in macro-climatic changes. 2016
9. Major hot deserts in northern hemisphere are located between 20-30 degree north and on the western side of the continents. Why? 2013
10. The process of desertification does not have climatic boundaries. Justify with examples. 2020
11. Most of the unusual climatic happenings are explained as an outcome of the El-Nino effect. Do you agree? 2014
12. How far do you agree that the behaviour of the Indian monsoon has been changing due to humanizing landscapes? Discuss. 2015
13. What characteristics can be assigned to monsoon climate that succeeds in feeding more than 50 percent of the world population residing in Monsoon Asia? 2017

1. Explain the factors responsible for the origin of ocean currents. How do they influence regional climates, fishing and navigation? 2015
2. Account for variations in oceanic salinity and discuss its multi-dimensional effects. 2017
3. How does the cryosphere affect global climate? 2017

4. Bring out the relationship between the shrinking Himalayan glaciers and the symptoms of climate change in the Indian sub-continent. 2014
5. How will the melting of Himalayan glaciers have a far-reaching impact on the water resources of India? 2020
6. How does the melting of the Arctic ice and glaciers of the Antarctic differently affect the weather patterns and human activities on the Earth? Explain. 2021
7. What is water stress? How and why does it differ regionally in India? 2019
8. In what way can flood be converted into a sustainable source of irrigation and all-weather inland navigation in India? 2017
9. The interlinking of rivers can provide viable solutions to the multi-dimensional inter-related problems of droughts, floods and interrupted navigation. Critically examine. 2020
10. Account for the huge flooding of million cities in India including the smart ones like Hyderabad and Pune. Suggest lasting remedial measures. 2020
11. What are the environmental implications of the reclamation of the water bodies into urban land use? Explain with examples. 2021
12. What are the consequences of spreading of 'Dead Zones' on marine ecosystem? 2018
13. Assess the impact of global warming on coral life system with examples. 2019
14. Discuss the causes of depletion of mangroves and explain their importance in maintaining coastal ecology. 2019
15. How can the mountain ecosystem be restored from the negative impact of development initiatives and tourism? 2019
16. How do ocean currents and water masses differ in their impacts on marine life and the coastal environment? Give suitable examples? 2019

TOPICS AND POINTERS

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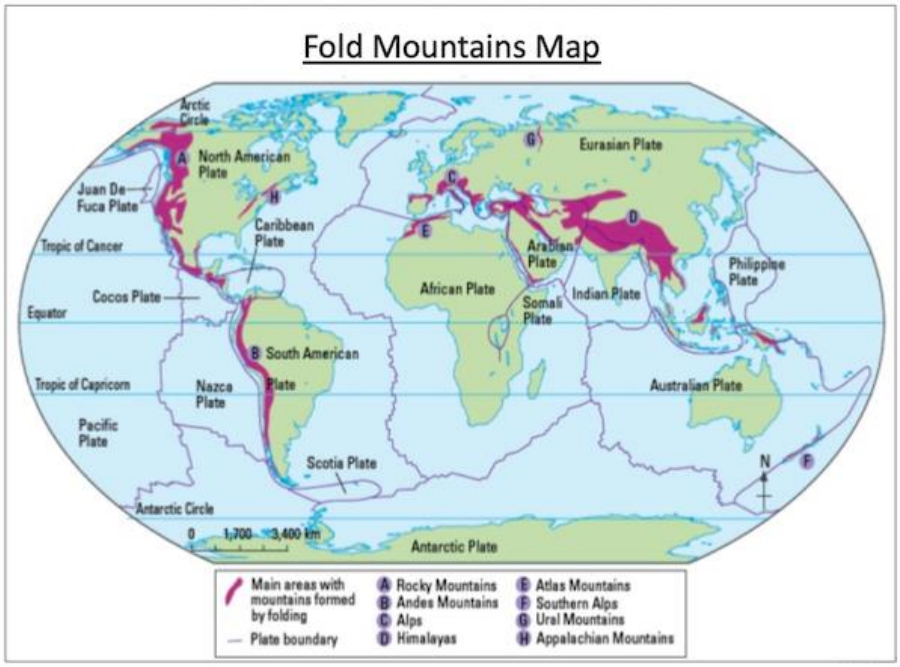
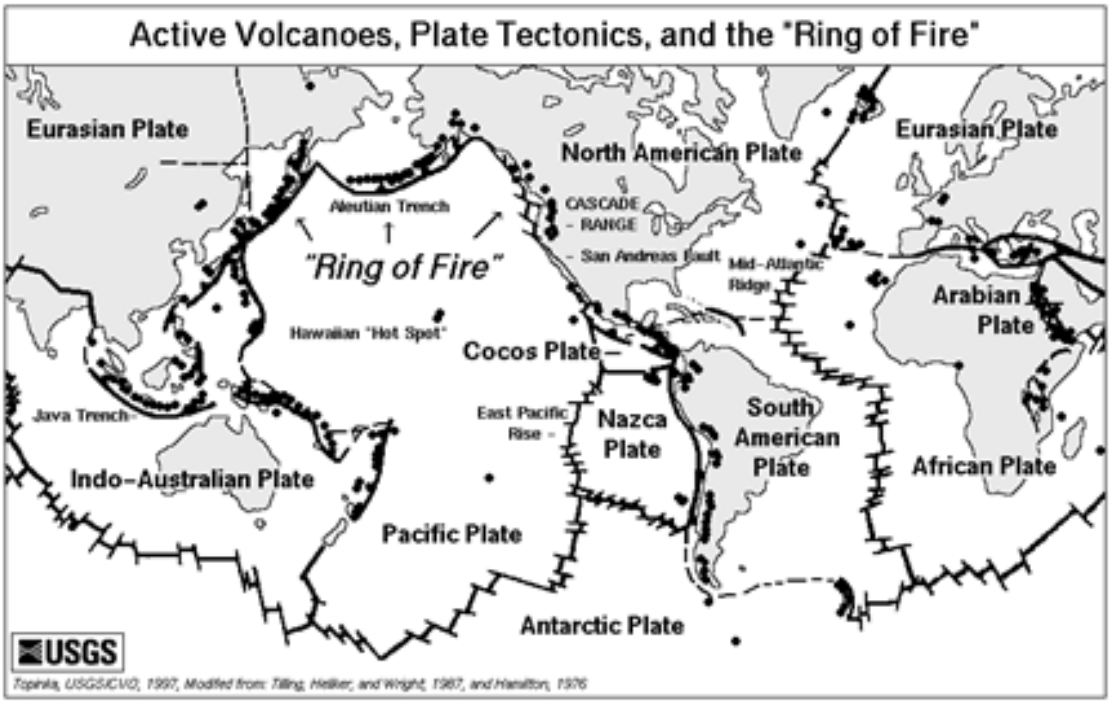
1.	**Fold Mountains**	
	Creation Plates converging (Continent – Continent & Ocean - Continent)– Folding over each other – Anticlines (Up folds) – Synclines (Down folds) **Distribution** Primarily on continental margins – due to sedimentary nature and less stability compared to interior region. **Characteristics** Lofty, Rugged – Greater length Less width. **Impact on climate/environment** Windward side gets more rain and aridity on the leeward side – effective climate barriers (e.g. Himalayas) – loftiness leading to glacial formations  	
2.	**Volcanoes, Earthquake and Tsunami**	
	Volcano A vent in the earth's crust – molten material erupts – Plates collide – subduction resulting in magma release **Distribution** Plate margins both convergent and divergent – also present in intra plate zones – Hotspot volcanism – Predominantly present in Pacific Ocean. **Pacific ring of fire (Circum pacific zone)** More than 75 percent of volcanoes – convergence on both the sides – also has a lot of hotspot volcanoes. **Positives** New landforms, fertile soil deposits **Negatives** Destructive in nature, crop damage, affects water quality **Earthquake** Release of energy in all directions – types – Wadati Benioff zone **Distribution**	

	Both plate margins and intra plate earthquakes occur – mostly occurs in plate margins (Circum pacific belt, Alpine belt, mid Atlantic ridge, African rift valley) **Tsunami** Long waves caused by sudden displacement – mostly caused by earthquakes – Other causes (Volcano, Meteor, Landslide, etc.) – imperceptible in deep sea – grows more higher on reaching shallow sea.  	
3.	**Recent events of Volcanic eruptions and earthquake**	
	• Hunga Tonga-Hunga Hapai – Pacific ring of fire – Undersea volcanic eruption • Taal volcano – Manila – Pacific ring of fire – Convergent boundary • Nyiragongo – Democratic republic of Congo – African rift valley – Divergence • Iceland Volcanic eruption – Mid Atlantic Ocean ridge – Divergent boundary • La-Palma – Canaries (spain) – Oceanic volcano • Mount Semeru – Indonesia – Pacific ring of fire • Haiti earthquake – Carribean – plate margin of the North American plate and the Caribbean plate. • Sulawesi earthquake – Indonesia – Pacific ring of fire • Balochistan earthquake – Makran subduction zone between Eurasian and arabian plate	
4.	**Mapping Seismic Hazard of Eastern Himalayas**	
	India – 4 seismic zones (II, III, IV and V – Low to very high) – Eastern Himalayas falls under Zone V (Very high risk) **Recent geological evidence** Arunachal Pradesh – Tuting Tidding Suture zone - Sadiya earthquake – helps to determine seismic potential and seismic hazard map.	

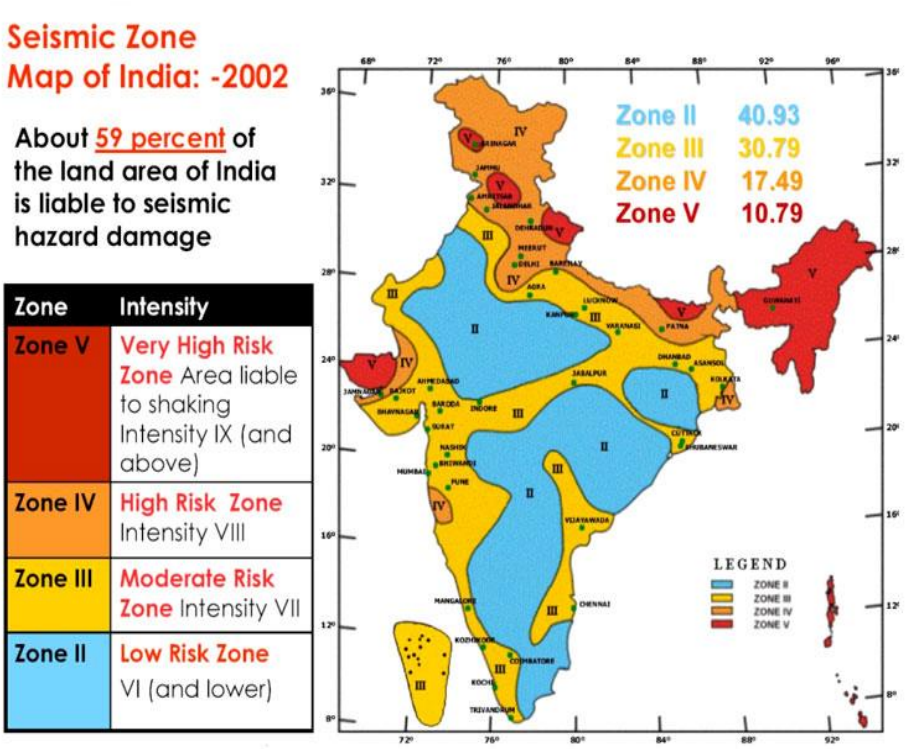


Fig. 1 Seismic zonation and intensity map of India

5. Earthquake Observatories

Indian sub-continent – world's most earthquake prone area – only 152 observatories -Plans to add 100 more by 2026.
Need: Prevention of loss – Timely action
National Centre for Seismology (NCS) – nodal agency for monitoring seismological activity

6. Volcano – pre-eruption warning signal

Every volcano – own features – scientists trying to find commonalities or pattern for warnings for eruptions
Recent research – Whakaari, Ruapehu and Tongariro in New Zealand could be driven to eruption by common processes – Displacement Seismic Amplitude Ratio (DSAR). DSAR – activity of fluids in the shallow and deeper crust

7. Tropical Cyclones

A rapidly rotating storm system -low-pressure center, strong winds and thunderstorms that produce heavy rain. D**evelops in the region between the Tropics of Capricorn and Cancer.**
Factors
Originate and intensify over warm tropical oceans
Favourable conditions

- Large sea surface with temperature higher than 27° C.
- Presence of the Coriolis force.
- Small variations in the vertical wind speed.
- A pre-existing weak low- pressure area or low-level-cyclonic circulation.
- Upper divergence above the sea level system.

Locational reason

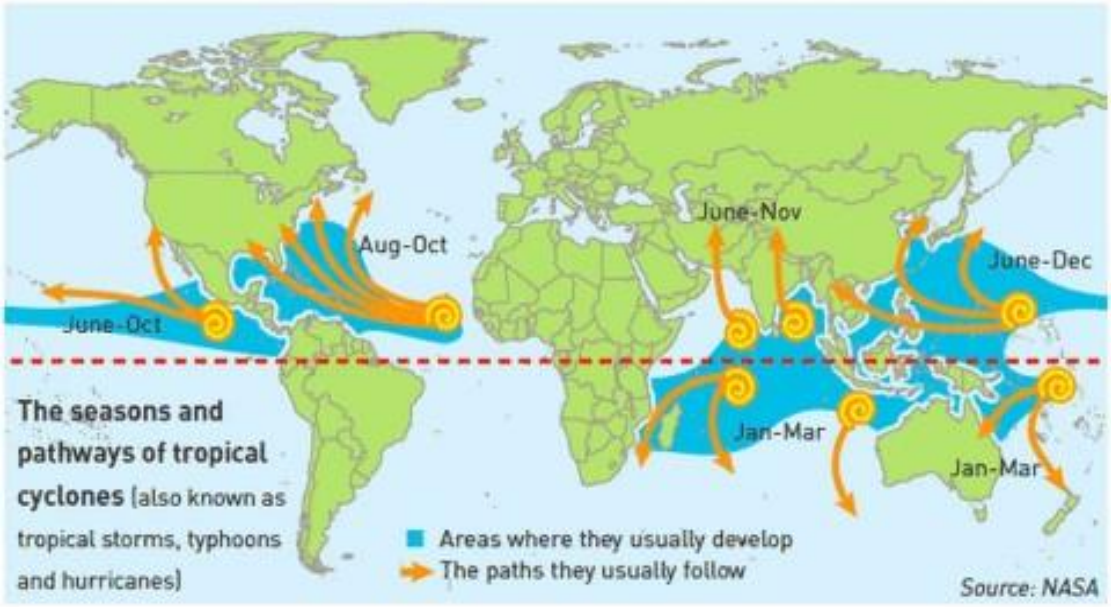
- Ocean waters (27° C or more) – condensation- **latent heat of condensation** to drive the storm
- Western margins of the oceans - Stratification of warm ocean water - because of warm ocean currents
- **Cold currents** lower the surface temperatures of the eastern parts of the tropical oceans
- Coriolis force at **5°** latitude -cyclonic vortex.
- About 65 per cent of cyclonic activity - 10° and 20° latitude.

Seasonal variation

- Cyclones occur mostly in late summers.
- Whirling motion is enhanced when the region within ITCZ) over oceans are farthest from the equator - during the autumnal equinox (August-September).
- At this time, there are two advantages—the air is overheated and the sun is exactly over the equator.

Impact on local environment

- The winds from a Category 1 cyclone cause minimal damage to shrubbery and trees, Category 5 cyclone – uproots trees and destroys vegetation
- Bring torrential rains - flooding.
- Surge in ocean waters – Sea level rise - Tidal waves – Damage to coastal ecosystem
- Soil erosion by storm surges from tropical cyclones.



8. Temperate Cyclone

The systems developing in the mid and high latitude (35° latitude and 65° latitude in both hemispheres), beyond the tropics. Also referred as mid-latitude depressions, temperate cyclones, frontal depressions and wave cyclones.

Factors

- Thermal contrast of the two types of air masses- development of the low-pressure centre
- Warm-humid air masses from the tropics meet the dry-cold air masses from the poles - Polar front

- Such conditions occur over **sub-tropical high, sub-polar low-pressure belts** and along the **Tropopause**
- The cold air pushes the warm air upwards from underneath
- The surrounding air rushed in to occupy this void and coupled with the earth's rotation, a cyclone is formed which advances with the westerlies

Locational reason

- USA and Canada – extend over Sierra Nevada, Colorado, Eastern Canadian Rockies and the Great Lakes region,
- the belt extending from Iceland to Barents Sea and continuing over Russia and Siberia,
- winter storms over Baltic Sea,
- Mediterranean basin extending up to Russia and even up to India in winters (called western disturbances) and the Antarctic frontal zone.

Seasonal variation

- Occur mostly in winter, late autumn and spring
- During summer, all the paths of temperate cyclones shift northwards
- There are only few temperate cyclone over sub-tropics and the warm temperate zone
- Although a high concentration of storms occurs over Bering Strait, USA and Russian Arctic and sub-Arctic zone.

Impact on local environment

- Temperate cyclones enter India from the Mediterranean Sea – Winter rainfall in India – Rabi Crops
- Flooding, damage to local vegetation
- Tornados, Water Spouts

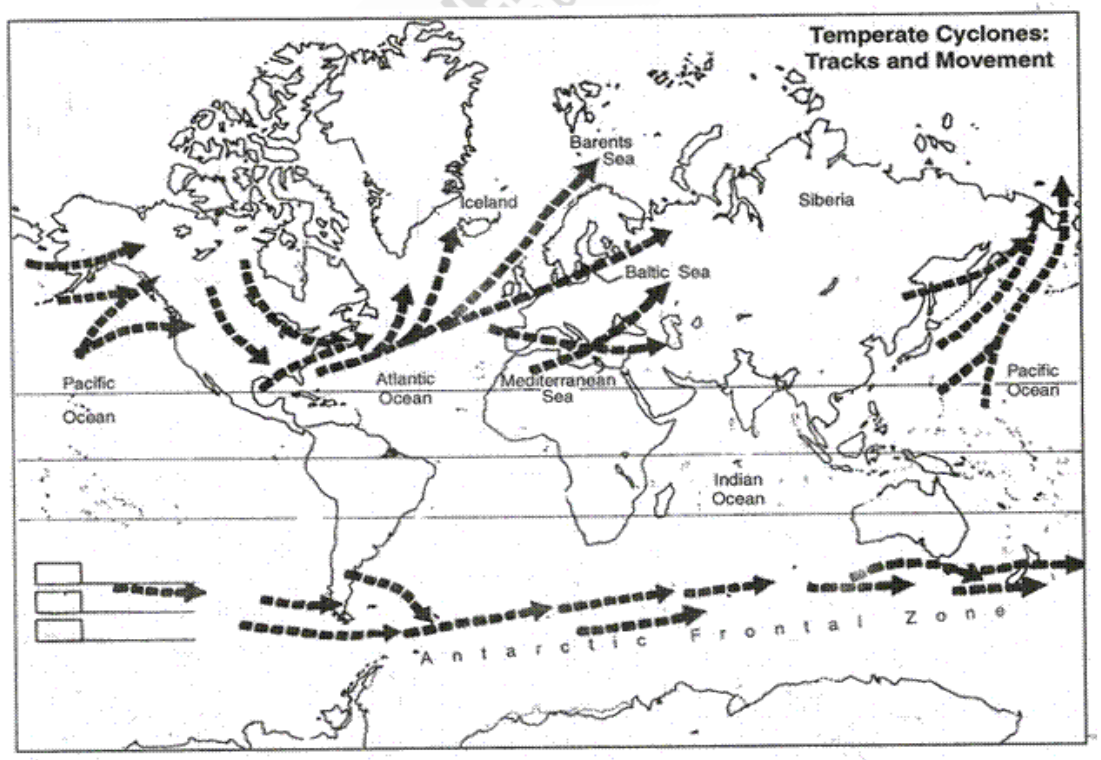
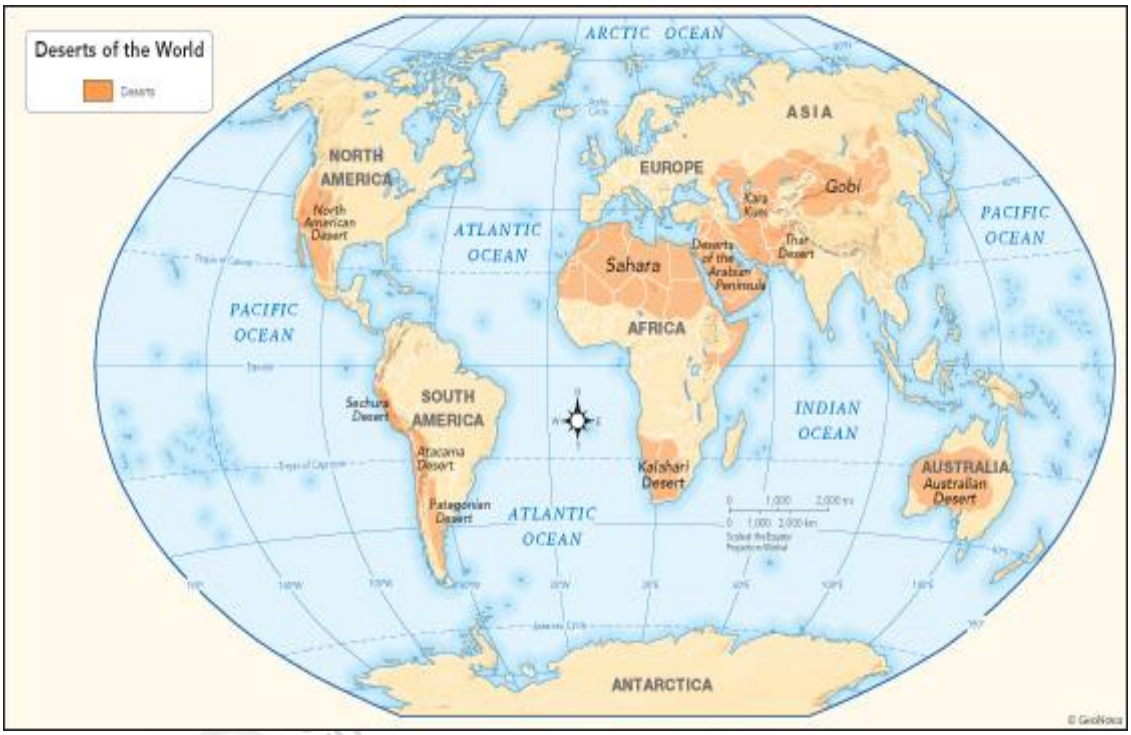
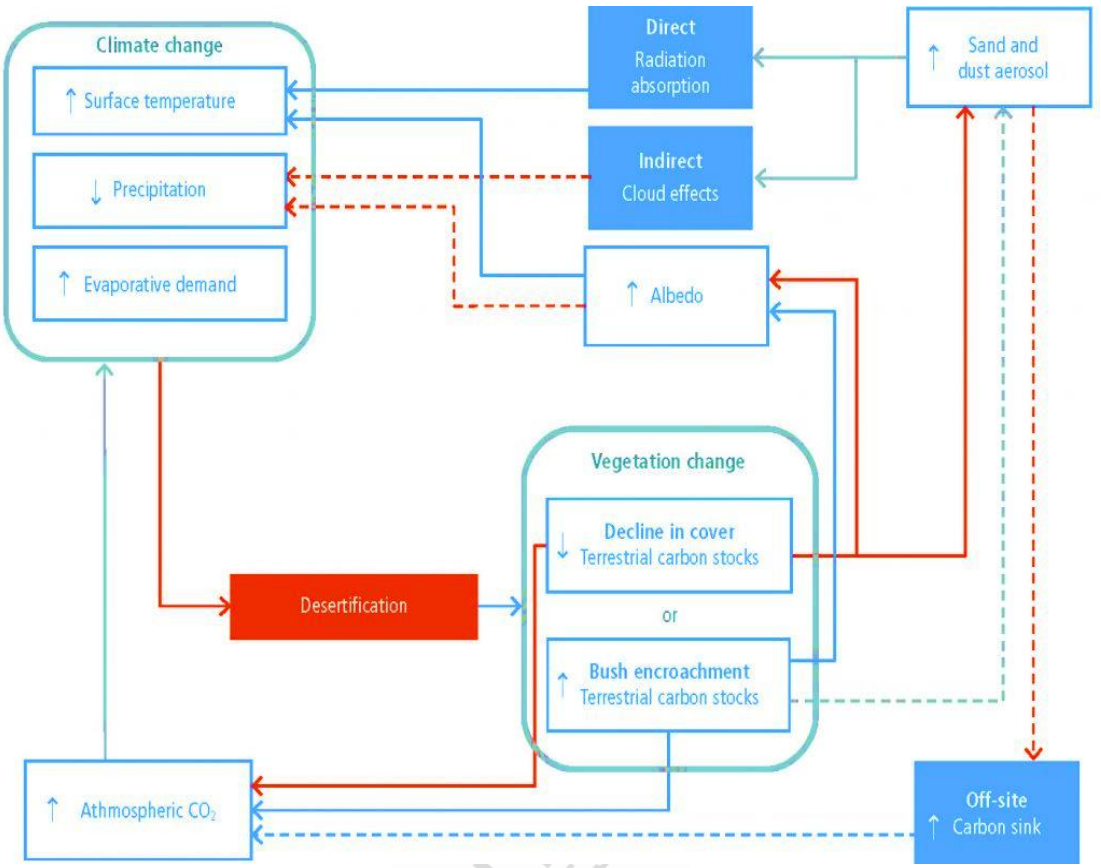


Fig. 2.26 Principal areas and tracks of temperate cyclones

9.	**Naming of Tropical Cyclone**	
	WMO maintains rotating lists of names - for each Tropical Cyclone basin. If a cyclone is particularly deadly or costly, then its name is retired and replaced by another one**.** Cyclones are named by the **Regional Specialised Meteorological Centres (RSMCs)** and **Tropical Cyclone Warning Centres (TCWCs).** There are six RSMCs in the world, including the India Meteorological Department (IMD). In 2000, a group of nations called **WMO/ESCAP (World Meteorological Organisation/United Nations Economic and Social Commission for Asia and the Pacific)**, which comprised Bangladesh, India, the Maldives, Myanmar, Oman, Pakistan, Sri Lanka and Thailand, decided to start naming cyclones in the region. It included five more countries in 2018 — Iran, Qatar, Saudi Arabia, United Arab Emirates and Yemen. **Guidelines to adopt names of cyclones** • The proposed name should be neutral to (a) politics and political figures (b) religious believes, (c) cultures and (d) gender • Name should be chosen in such a way that it does not hurt the sentiments of any group of population over the globe • It should not be very rude and cruel in nature etc., **Benefits of naming:** • Identify each individual cyclone. • Create awareness of its development. • Remove confusion in case of simultaneous occurrence of tropical cyclones over a region. • Rapidly and effectively disseminate warnings to a much wider audience.	
10	**Increasing Intensity & Frequency of Arabian sea Cyclone than Bay of Bengal Cyclone.**	
	Historically, tropical cyclone in the Bay of Bengal is generally higher than that in the Arabian Sea. Researchers (1982 and 2020), there was a significant increase in the frequency, duration, and intensity of cyclonic storms over the Arabian Sea. • **52%** increase in the frequency of cyclonic storms • **80%** increase in their duration, and an increase in intensity of about 20% in the pre-monsoon period and 40% post-monsoon. **Reasons** • Surface temperatures in the Arabian Sea have increased - 1.2–1.4 °C higher - support active convection, heavy rainfall, and intense cyclones • Arabian Sea - conducive wind shear for cyclones • Rising temperature - energy for the intensification of cyclones • Strong mid-level relative humidity (RH), positive low-level relative vorticity (RV), weak vertical wind shear (VWS), warm sea surface temperature (SST) – increased cyclonic activity. • Role of additional parameters such as water vapor and zonal Sea Level Pressure gradients • La Niña years experienced almost double the number of intense cyclones compared to the El Niño years. (2000-2020).	

11	**Recent Cyclones and its impact on environment**	
	Cyclone Jawad - Odisha and Andhra Pradesh. **Cyclone Gulaab -** Andhra Pradesh and adjoining Odisha coasts **Cyclone Tauktae -** southern Gujarat, Maharastra **Cyclone Yaas –** West Bengal , Odisha **Cyclone Nisarga –** Maharastra **Cyclone Amphan -** Odisha and West Bengal **Cyclone Vayu** - Gujarat. **Cyclone Fani** - Odisha, West Bengal, Andhra Pradesh and East India. **Impact on Environment** • Strong winds cause damages to infrastructure, uproots trees, and lead to other catastrophes. • Torrential rainfall leads to unprecedented floods and damages to houses and buildings. • Due to storm surge, seawater levels rise, and the coastal areas are exposed to floods. • The rise in seawater level also erodes beaches and embankments. • Severe cyclonic storms resulting in floods can damage vegetation and livestock. • Due to the strong winds and flood conditions, the soil becomes infertile	
12	**Twin cyclones**	
	A pair of tropical **cyclones**, **Asani & Karim (one in the northern hemisphere and one in the southern hemisphere)** one on each side of the equator, have been formed. The interplay of the wind and the monsoon system combined with the Earth system produces these synchronous cyclones. **Reason** **Equatorial Rossby waves -** huge waves in the ocean with wavelengths of around 4,000–5,000 kms- **arose due to the rotation of the Earth.** This **system has a vortex in both the northern and southern hemisphere -** have a **positive value of the vorticity.**	
13.	**Hot Deserts**	
	Hot deserts are hot arid areas with little precipitation, extreme temperatures and sparse vegetation with average rainfall below 200 – 250 mm per annum. **Distribution and reason for the location:** • Great basin – Mojave – Sonoran (North America) - rain shadow regions of the Sierra Nevada Mountains, California surface cold current. • Atacama Desert (South America) – Lies between Andes and Chilean coastal range which prevents moisture from nearby ocean. North-flowing Humboldt Ocean current. Presence of the strong Pacific anticyclone. • Saharan Desert (Northern Africa)- Saharan region was once a grassland but changes in monsoon rainfall due to tilt of earth axis made it as a desert. Presence of high-pressure belt. Dry offshore winds and cold surface ocean current (canary current) • Namib Desert (Southern Africa)- Subtropical high-pressure zone and Benguela cold current and its desiccating effect	

	• Kalahari Desert (Southern Africa)- Sub tropical high, continentality, leeward side of Drakensberg Mountain. • Arabian Desert (Arabian Peninsula) – It is the extension of Saharan desert. Lies in the western side of Indian monsoon so misses rain bearing clouds. Sub-tropical high-pressure belt • Great Indian Desert (Western India) - The Arabian Sea branch of the southwest monsoon blows over Kathiawar region of Gujarat and escapes towards the north-west. • Gibson – Victoria – great sandy Desert (Western Australia) – Western Australian cold current. Continentality factors. Sub-tropical high-pressure belts 	
14	**Desertification / Land Degradation**	
	Degradation process by which fertile land turns into desert region by losing its flora and fauna due to natural and anthropological phenomenon. **Causes/process of desertification** • Anthropological (Over grazing, Expansion of agriculture, water table depletion, urbanization, deforestation) • Natural causes (Increasing global warming, reduced precipitation, increasing evaporative demand, wind erosion, soil erosion) **Measures to mitigate** Afforestation, reduce pressure on land, agriculture, water shed management, prevention of soil erosion (wind break, shelter belt), hyper fertilization of soil, planned ecofriendly urbanization, Value addition (Bonn challenge, SDG goal 15, ISRO's desertification atlas, PMKSY)	



15 **Cold waves**

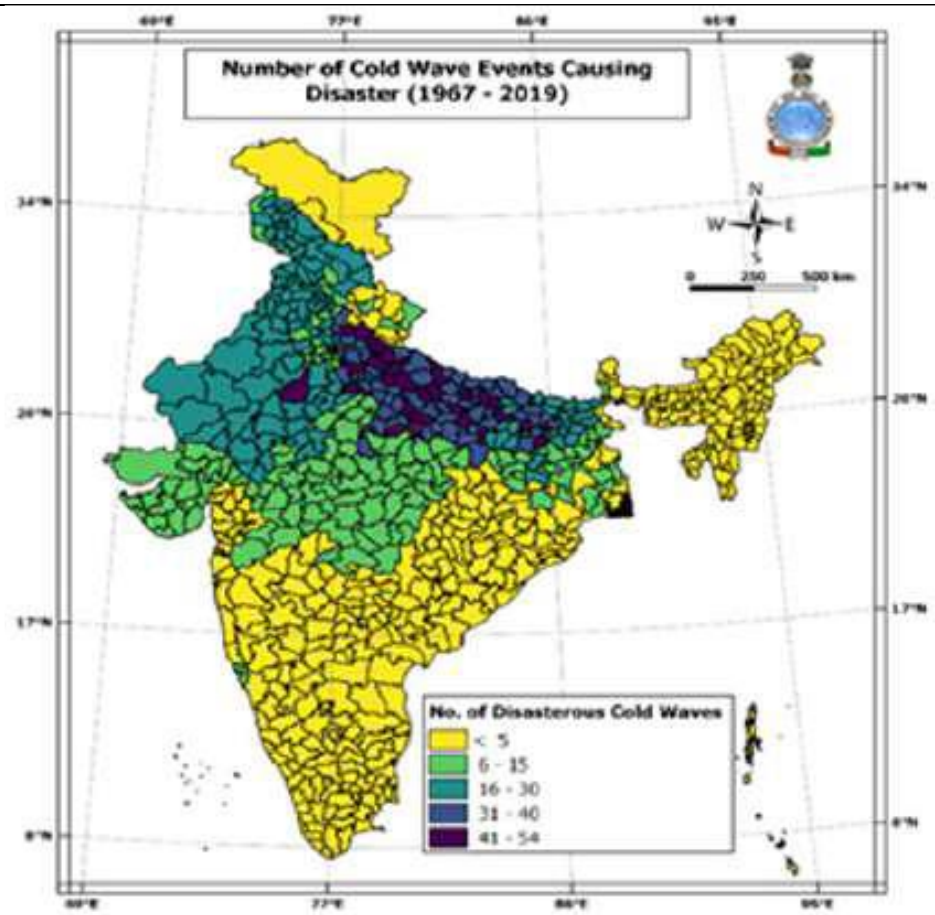
Criteria:
The minimum temperature recorded by a meteorological station on the i) plains must be 10 degrees Celsius or less. ii) In high-altitude hills the minimum must be below or at 0 degrees - and the highest temperature must be 4.5-6.4 degrees Celsius below normal, according to the IMD

Causes:

- Dry cold northern western disturbances
- High pressure traps in Jetstream.
- Absence of clouds
- Himalayan snowfall
- La Nina conditions.
- Dense fog formation

Regions affected:
Northern and north western part of India which includes Delhi, Punjab, Haryana, Rajasthan, Uttarakhand, Himachal Pradesh, Uttar Pradesh, Bihar etc.

Mitigation measures:
Adequate winter clothing like mittens, Stay indoors, Ensure emergency supplies are easily accessible, Regular hot drinks, Hats help to prevent heat loss. Do not drink alcohol as it will reduce your body temperature.



16 **Heat waves**

Criteria:
i)Based on Departure from Normal Heat Wave: Departure from normal is 4.5 deg Celsius to 6.4 deg Celsius.
ii) Based on Actual Maximum Temperature Heat Wave: When actual maximum temperature ≥ 45 deg Celsius.
If above criteria met at least in 2 stations in a Meteorological sub-division for at least two consecutive days and it declared on the second day.

Causes:
When a high pressure is formed in the upper atmosphere over a region for several days to week: Heat wave is generated.

- Late arrival of Western disturbances
- No pre-Monsoon rainfall
- Passing of cyclones like Amphan brings dry wind to Northern region
- Unusual jet stream pattern
- Climate change due to global warming.
- Dust storms

Regions affected:

Heat wave generally occurs over plains of northwest India, Central, East & north Peninsular India during March to June and in some regions of Coastal Andhra and Odisha.

Globally – Brazil and Argentina, Australia, parts of United states of America, Russian heatwave of 2021, Winter heat wave in Europe

Mitigation measures:

To reduce the impact (Prior awareness, National action plan, Include in National disaster, Heatwave hotline, recognize the signs of heat stroke, heat cramps, Urban forestry, rejuvenation of wetlands.)

17 Urban Heat Islands

A local and temporary phenomenon in which certain pockets within a city are experiencing higher heat load than its surrounding area.

Causes

- Lack of green space → regulation of temperature is less
- Black soot and GH gases → less albedo effect and trapping Heat
- Urban architecture and mass transportation.
- Urban canyon effect.
- Reduction of wetlands.

Effects

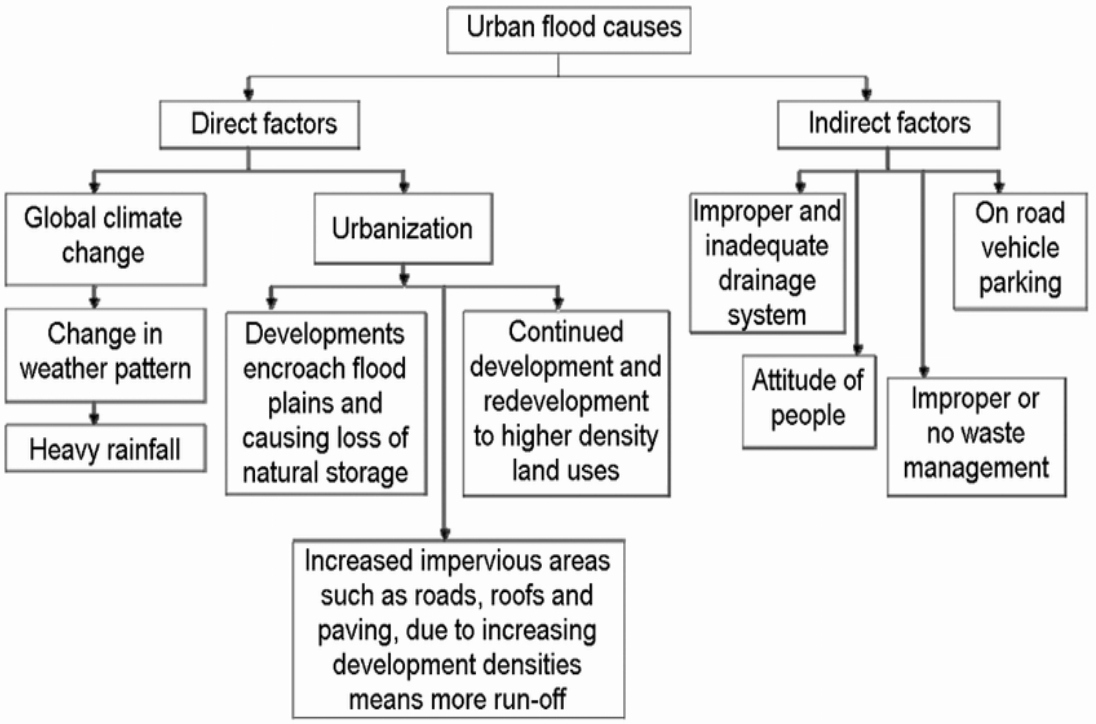
- Increased energy consumption
- Elevated Greenhouse emissions and Air pollution
- Affects human and animal health
- Secondary impact on weather and climate.
- Reduced water quality.

18 Urban flooding

Causes:

Metrological (Sudden down pour, Cyclone, Snow thawing and landslide, river meandering, silting of river)

Anthropological (Inadequate drainage, reduction in seepage, encroachment, destruction of wetland, inadequate data about water management, poor solid waste management)



	Remedial measures: Concept of sponge cities, AMRUT schemes, proper and separate drainage and sewage system, embankment of rivers, desiltation of rivers, flood wall, flood control reservoir, building raised platform, Flood hazard zone mapping and risk studies.	
19	**Urbanization**	
	Unplanned and haphazard urbanization would have following socioeconomic and environmental problems. **Socioeconomic problems** • Proliferation of slums and ghettos with inadequate infrastructure. • Sub culture of poverty and urban crimes. • Commodification of social relation with less social capital. • Rising inequality, inflation, cost of living. • Migrants issues (Livelihood, health, sanitation, education) • Cultural shock. • Relative deprivation **Environmental problems.** • Drainage and sewage problems coupled with solid waste issue. • Air pollution particularly SO2, PM2.5 and PM10 due to transport. • Urban heat island and greenhouse gases emissions. • Water pollution associated with industrial and household waste. • Growing e-waste in urban areas and improper disposal	
20	**Ocean Currents**	
	Factors - Primary forces • Influence of insolation • Influence of wind (atmospheric circulation) - The oceanic circulation pattern – corresponds to earth's atmospheric circulation pattern. • Influence of gravity - Gravity tends to pull the water down to pile and create gradient variation. • Influence of Coriolis force **Secondary forces -** Temperature difference**,** Salinity difference **Role in Global climate pattern** • Ocean absorb, store and move heat delivering huge quantities of heat energy to the global climate system, help to counteract the high levels of solar radiation that the Earth's equator receives. • Globally redistributes heat and water vapor • Cycling of water produces different climate in diff parts of the world • driven by surface winds & influences climate ✓ Gulf stream – north west Europe not frozen ✓ California current – Hawaii cooler than usual tropic temp. • Results in horizontal and vertical water movement. ✓ Horizontal surface currents - local, short term include rip currents, longshore currents, and tidal currents. ✓ In upwelling currents, vertical water movement and mixing brings cold, nutrient-rich water toward the surface while pushing warmer, less dense water downward, where it condenses and sinks. ✓ This creates a cycle of upwelling and downwelling.	

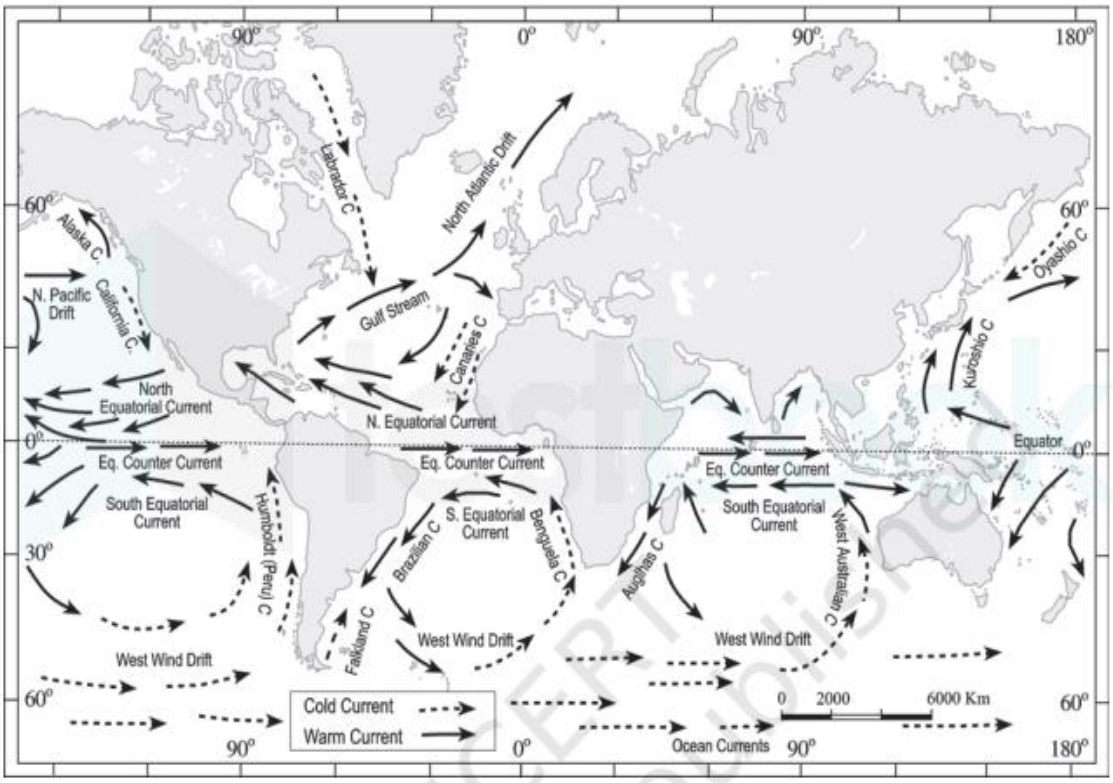
- ✓ Prevailing winds, ocean surface currents, and the associated mixing influence the physical, chemical, and biological characteristics of the ocean, as well as global climate.
- Warm ocean currents bring rain to coastal areas and even interiors.
  - ✓ E.g., Summer Rainfall in British Type climate.

Role in regional climate influence

- Ocean currents & distance from the sea influences climate.
- They are responsible for moderate temperatures at coasts. E.g.,
  - ✓ North Atlantic Drift brings warmness to England.
  - ✓ Canary cold current brings cooling effect to Spain, Portugal etc.,
- Mixing of cold and warm ocean currents create foggy weather where precipitation occurs in the form of drizzle. E.g., Newfoundland
- Warm currents flow parallel to the east coasts of the continents in tropical and subtropical latitudes, resulting Warm and rainy climates. E.g., Florida, Natal etc.,
- Cold and dry climates on the western margins in the sub-tropics due to desiccating effect. Cold ocean currents have a direct effect on desert formation in west coast regions of the tropical and subtropical continents.
  - ✓ cold Peruvian Current along the Chilean coast- Atacama dessert
- They pile up warm waters in tropics and this warm water is the major force behind tropical cyclones.
- El nina, La nina.

Impact on Marine and Coastal environment due to climate change

- Changes in precipitation - consequences for the water balance of coastal ecosystems.
- Sea level rise - inundate coastal lands and eroding susceptible shores.
- High temp - influence organism metabolism and alter ecological processes such as productivity and species interactions - species' geographic distributions changes - Species unable to migrate or compete with other species for resources may face local or global extinction.
- Warm water species extend their range – threat to biodiversity
- Habitat loss – e.g., species under sea ice threatened.
- Ocean deoxygenation
- Ocean acidification
- Coral bleaching, coral reef degeneration
- alter patterns of wind and water circulation in the ocean environment- upwelling, downwelling - availability of nutrients changes
- Shifting of fishes' deep ward & pole ward – to find preferred temp & oxygen levels



21 **Ocean Salinity**

Salinity is the total amount of dissolved salts in sea water. It's generally expressed as parts per thousand (ppt).

Factors for variation

- Rate of evaporation and precipitation
- Amount of fresh water added in the ocean: fresh water flow from rivers, and in polar regions by the processes of freezing and thawing of ice.
- Wind
- Ocean currents
- Salinity, temperature and density of water are interrelated - any change in the temperature or density influences the salinity of an area.

Multidimensional effects

- Density difference - the cold water at the poles sinks - moves towards the equator -warm-water moves from equator to poles → formation and circulation of oceanic currents via the **thermohaline process.**
- Earth's temperature and rainfall is affected by currents, the level of salinity has indirect role in Earth's overall climate.
- Salt water - lower freezing temperature and affecting the movements of both fish-schools and cargo ships.
- The objects that might sink in freshwater are able to float in seawater. This has a big effect on life in the sea.
- Human-induced changes in oceanic salinity – threat

22 **Cryosphere**

The frozen water part of the Earth system-areas of snow or ice, oceans, glaciers, frozen rivers and lakes whose temperature <**0°C** for at least part of the year, compose the cryosphere.

Role in global climate influence and impact on climate change:

Snow and ice- reflect heat from the sun- regulate our planet's temperature.

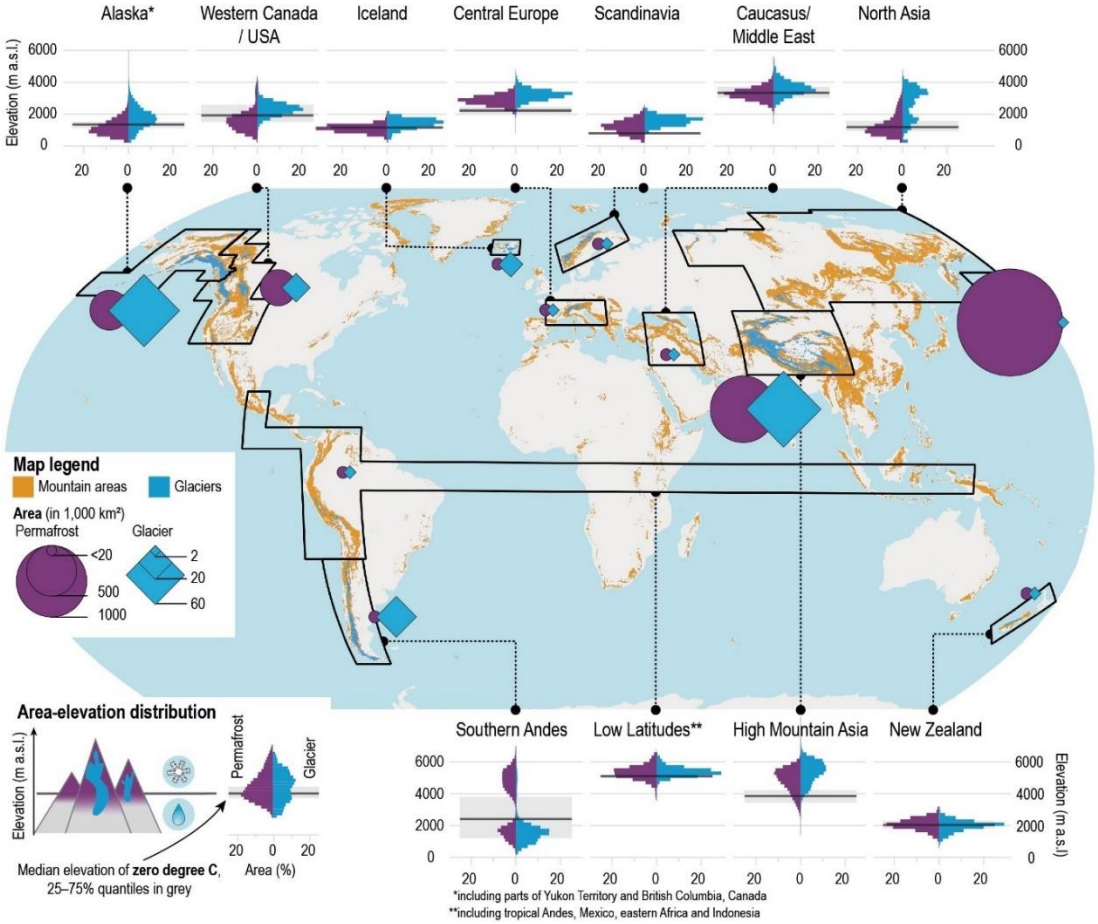
Melting of cryosphere

- Melting ice -reduces reflective surface- oceans and land become dark in colour -aggravates in global warming -known as feedback loop.
- Permafrost areas -traps carbon -aggravation of feeback loop-releases methane .
- Initiates thermohaline circulation -impacts El nino and La-nina -influence of monsoon rainfall
- Impacts the volume of water in oceans- causes , changes in the water cycle, affects global energy / heat budget - global climate.

The cryosphere -the first places where scientists are able to identify global changes in climate.

Conclusion:

Integrated adaptation planning-strengthening international mechanisms (WMO'S global cryosphere watch)-need of the hour .



23 Melting of Arctic and Antarctic glaciers

Causes

- Historically -Industrial revolution
- Global warming -increased co2 emissions
- Larsen C, Shackleton, Pine Island and Wilkins ice shelves as most at-risk under four degrees Celsius of warming.
- Warming of the Arctic - due to slowing of the jet stream.

Impacts on global climate pattern

- Allowing unimaginable amounts of water from glaciers to pour into the sea-significant sea level rise.

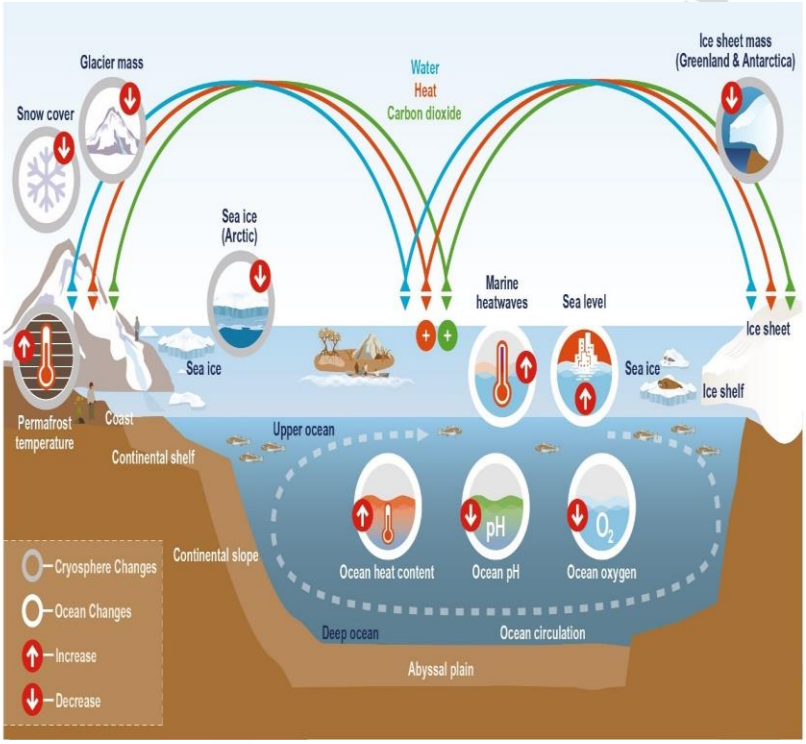
- Slowing of Atlantic meridional overturning circulation -in Antartic
- Emergence of Elnino -due to disturbed global climate pattern
- Impact on monsoon -erratic nature increases
- Melting of Arctic ice is linked to Central Pacific Trade wind intensification-weaking of extra tropic cyclones

Impacts on environment

- Buffers between land and sea-breaks -Ecosystem collapse.
- Droughts, floods (increased sea level), coastal erosion, storm surges will lead to displacement, migration.
- Salinization of groundwater -water shortages
- Mining of minerals in arctic -Resource war
- Fishing -greater impact.
- Arrival of Invasive alien species

Conclusion

Arctic and Antarctic will have irreversible consequences -need of the hour is to adopt sustainable approach to minimise the effects of global warming.



24 Melting of Himalayan Glaciers

There are about 15,000 glaciers in the Himalayas-third pole -melting of glaciers – rate of loss of glaciers that is at least 10 times higher than the average rate over past centuries.

Causes

Natural process -changing temperatures and precipitation patterns

Global warming -rising co2 levels and other greenhouse gas emissions.

- Air-borne particles generated by incomplete combustion from brick kilns,
- Diesel exhaust,
- Burning of biomass –are accelerating glacier and snow melt in these ranges

Impact on mountain ecosystem

- Natural disasters -landslides, earthquakes, drought may occur
- Changing monsoon patterns
- Changes in energy production -hydroelectricity
- Changing the agricultural patterns- and lower agricultural yields
- Tourism -will be adversely impacted

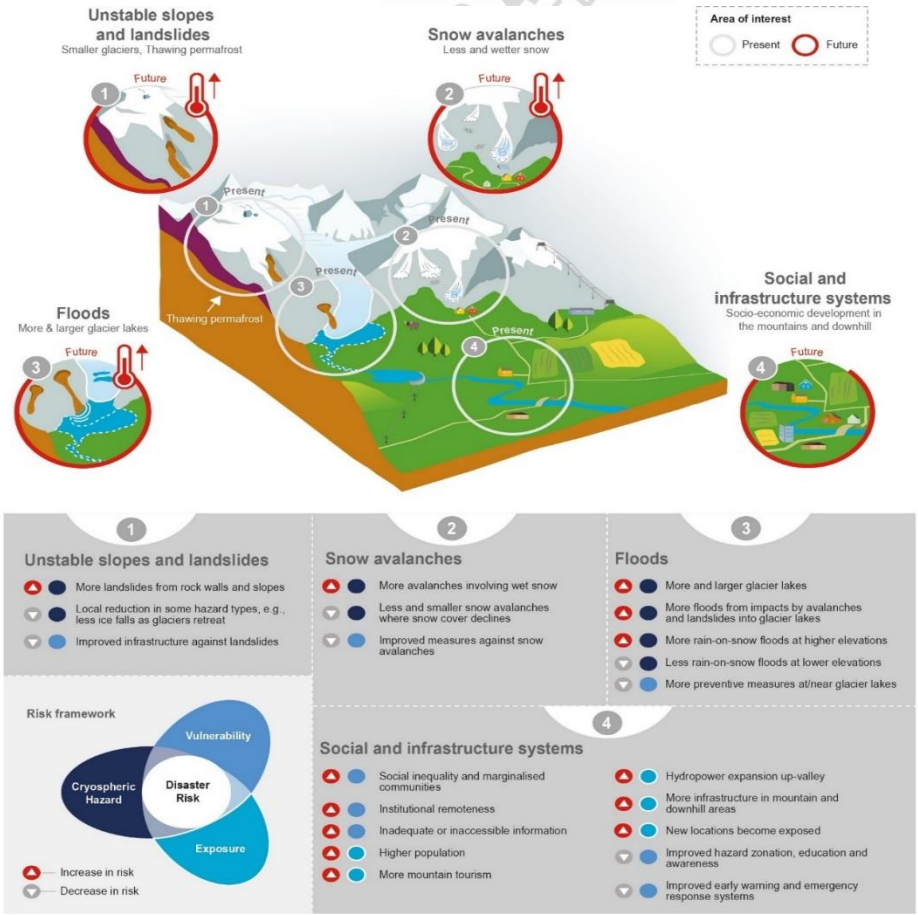
Impacts On water resources

Critical source of water - 250 million people in the mountains and an additional 1.65 billion who live in the river valleys below.
Melting glaciers and loss of seasonal snow -significant risks not just to the people who live at their foot but to the stability of water resources in the South Asia region more broadly.
Glacier melting will lead to change

- in glacier basin hydrology
- downstream water budget
- impact on hydropower plants due to variation in discharge,
- flash flood.
- sedimentation.

Conclusion

Regional cooperation + active and agile cooperation between researchers and policymakers will be necessary to create joint adaptation strategies



25 Black carbon and glacier melting

Black carbon is a short-lived pollutant that is the second-largest contributor to warming the planet behind carbon dioxide (CO2), which

	leads to glacier melting **However the strong policy on black carbon can sharply cut glacier melt.** **Impact** Impact on jet stream, Rise of global temperature, Natural disaster, Impact on ocean and sea, Reduction on agriculture productivity, Increase in global warming **Recent events** Conger ice shelf collapse in Antarctic, Green land melting glacier, hindu kush Himalaya.	
26	**Deglaciation and Threats**	
	The gradual melting away of a glacier from the surface of a landmass is known as **deglaciation**. The process of deglaciation, that intensified in the 20th century, is leaving our planet iceless. **Causes:** Rapid industrialisation, global warming, ocean warming. **Impact:** Rising sea level, loss of species, floods in Himalayan region, Increase in global warming **Recent events** Melting of Thwaites Glacier, glacier collapse at Nanda devi.	
27	**Cloud burst**	
	If rainfall of about 10 cm or above per hour is recorded over a place that is roughly 10 km^2 in area, it is classified as a cloudburst event. **Impact:** Flash floods, landslides, mud flows, land caving. The difficulty arises out of the fact that they take place over a very small area **Recent events:** Have been reported from several places in J&K, Union Territory of Ladakh, Uttarakhand and Himachal Pradesh.	
28	**Flash flood**	
	A flash flood is a rapid flooding of low-lying areas: washes, rivers, dry lakes and depressions. It may be caused by heavy rain associated with a severe thunderstorm, hurricane, tropical storm, or meltwater from ice or snow flowing over ice sheets or snowfields **Impact:** Clogged drains, water stagnation, sewage mixing with drain, loss of mobility, damage to infrastructure, loss of human lives **Recent events:** Assam floods, Mumbai floods	
29	**Glacial Lake outburst**	
	A glacial lake outburst is a release of meltwater from a moraine-dam or ice-dam glacial lake due to dam failure. **Causes:** Erosion, A build-up of water pressure, An avalanche of snow or rocks, An earthquake under the ice, massive displacement of water in a glacial lake when a large portion of an adjacent glacier collapses into it.	

	Impact: Serious death tolls and destruction of valuable natural resources, such as forests, farms etc. **Recent events:** Fatal Himalayan glacial lake outburst, flash floods in Uttarakhand's Chamoli.	
30	**NDMA guidelines to tackle Glacial bursts**	
	• Identify and Mapping Dangerous Lakes • Use of Technology • Structural Measures • Land Use Planning • Trained Local Manpower • Early Warning System • Emergency medical response team • Psychological Counselling	
31	**Landslides in Himalayas**	
	Landslide refers to the sudden movement of rock mass, debris, soil, or vegetation down the slope due to the force of gravity. It is a type of mass wasting, which denotes any downward movement of soil and rock, and areas with steep slopes are more susceptible to landslides. According to the Geological Survey of India (GSI), **12.6 per cent of the total country's land area** is prone to landslides • The Western Himalayas (Jammu & Kashmir, Uttaranchal, Himachal Pradesh, and Uttar Pradesh) • The Eastern & North-eastern Himalayas (Arunachal Pradesh, Sikkim, and West Bengal) • The Naga-Arakkan Mountain belt (Nagaland, Manipur, Mizoram and Tripura). **Reason** **Plate Tectonic movement -** Indian Plate is moving towards the Eurasian Plate and collides with it (Isostatic imbalance). Earthquakes are the most important factor for the landslides in folded mountain regions **Topography and Exogenetic Forces**: Many young and rapid-flowing rivers such as the Ganges, the Indus, and the Brahmaputra originated in the Himalayan region (Denudation and Erosion) Concentrated rainfall: Heavy or continuous downpours may result in severe landslides particularly in the regions of steep slopes. **Human Interference**: Roadways and railways, unplanned and haphazard urbanization, Deforestation, Mining and Quarrying.	
32	**Landslides in Western Ghats**	
	Landslides in the Western Ghats are mainly due to concentrated rainfall, overburdening of hills, mining, and quarrying. It is tectonically more stable and has less frequency of tremors and landslides due to it **Peninsular India** • The Western Ghats region (Maharashtra, Goa, Karnataka, Kerala & Tamil Nadu). • The Plateau margins of Peninsular India and Meghalaya plateau in North-East India.	

Reasons

- It experiences landslides during the monsoon season. This is because of the heavy rainfall and high humidity along with the steep topography in this region.
- As a Biodiversity Hotspot, the Western Ghats have less human intervention and are less prone to landslides than the Himalayan region.
- Geologists, who have studied the Western Ghats, say construction activities such as highways lead to haphazard cutting of mountain slopes
- The windmill projects that have come up on the ghats have caused huge fractures on the mountains loosening structures

33 Aging Dams 0f India - Dams and Destruction

United Nations University's Canadian-based Institute for Water, Environment and Health released a report titled **'Ageing water infrastructure: An emerging global risk'**

- Most of the 58,700 large dams worldwide were constructed between 1930 and 1970 with a design life of 50 to 100 years.
- The report said that 32,716 large dams **(55 per cent of the world's total)** are found in just **four Asian countries: China, India, Japan, and South Korea** – a majority of which will reach the 50-year threshold relatively soon.

India

- There are over **1,115 large dams** that will be roughly **50 years old** in 2025
- more than **4,250 large dams** will be **over 50 years old in 2050**
- 64 large dams will be more than 150 years old in 2050

Dams and Disaster management

- Dams, and large dams in particular, even if structurally sound, are considered to be "**high hazard**" forms of infrastructure.
- The consequences of dam failure would be forced displacement, the destruction of livelihoods and potential loss of human life
- Dam failure mechanisms include seismic activity, flooding, seepage/internal erosion, deterioration, and structural instability.
- Such triggers of failures are more likely in older dams because ageing increases the vulnerability of a dam to such triggers.
- Also, climate change may accelerate a dam's ageing process. Extreme weather events, especially floods, are expected to become more severe and frequent with the changing climate.
- Thus, a comprehensive safety review and audit of old dams in India is necessary as a precautionary and preventive measure.
- If a dam is found unsafe, suh dam should be considered for **Dam decommissioning**.
- Early warning systems and regular checks are also necessary for better preparedness during dam related disasters.
- The **Dam Safety Act, 2021** deals with engineering, construction, operations, surveillance, maintenance and safety of dams in the country.

34 Flood Plain zoning

The Ministry of Jal Shakti has informed the Rajya Sabha that the states of Manipur, Rajasthan, Uttarakhand and erstwhile State of Jammu & Kashmir had enacted the National Floodplains Zoning Policy**.**

	• **Model Bill** for Flood Plain Zoning clauses about flood zoning authorities, surveys and delineation of flood plain area, notification of limits of flood plains, prohibition of the use of the flood plains, compensation and most importantly removing obstructions to ensure free flow of water. • It seeks to replace dwellings in low-lying areas by parks and playgrounds as absence of human settlement in those areas would cut down loss of lives and property. • It is an effective non-structural measure for flood management. • The basic concept is to regulate land use in the flood plains to restrict the damage caused by floods. • It aims at determining the locations and the extent of areas for developmental activities in such a fashion that the damage is reduced to a minimum. • It envisages laying down limitations on development of both the unprotected as well as protected areas. • Flood plain zoning is not only necessary in the case of floods by rivers but it is also useful in reducing the damage caused by drainage congestion particularly in urban areas.	
35	**Hydro Meteorological calamities**	
	Hydro-meteorological disaster is a phenomenon of **atmospheric, hydrological or oceanographic nature** that cause loss of life, social and economic disruption and environmental damage. It includes flash floods, cloudbursts and landslips etc triggered by extreme rainfall events • It accounted for **14% of the deaths** in the country, nearly 6,800 people lost their lives in the country over the past three years. • Various types of fatal landslip events are common almost every year, mainly in the Himalayan States, in the Western Ghats, and Konkan areas. • **West Bengal** has recorded the highest deaths due to such calamities among all States, followed by Madhya Pradesh and Kerala. • In Madhya Pradesh and Kerala, the spike in the casualties has been caused by floods. • In West Bengal, for three consecutive years, the deaths due to natural calamities are high. The reason could be the geography of the State where there are both mountains and coastline. • West Bengal is susceptible to both landslides, cyclones and floods. Over the past three years, West Bengal had braved four tropical cyclones — Fani (May 2019), Bulbul (November 2019), Amphan (May 2020) and Yaas (May 2021).	
36	**Early warning system**	
	It can be defined as a set of capacities needed to generate and disseminate timely and meaningful warning information of the possible extreme events or disasters. **Key elements** • Disaster risk knowledge based on the systematic collection of data and disaster risk assessments; • Detection, monitoring, analysis and forecasting of the hazards and possible consequences;	

	• Dissemination and communication, by an official source, of authoritative, timely, accurate and actionable warnings and associated information on likelihood and impact; and • Preparedness at all levels to respond to the warnings received. A **multi-hazard early warning system** with the ability to warn of one or more hazards increases the efficiency and consistency of warnings through coordinated and compatible mechanisms and capacities, involving multiple disciplines for updated and accurate hazards identification and monitoring for multiple hazards.	
37	**Coastal Vulnerability Index**	
	Recently assessment by **INCOIS**. Aim: Preparing an atlas on CVI. ~7500km coastline across 13 states and UTs **Significance** • Coastal vulnerability is a spatial concept that identifies people and places that are susceptible to disturbances resulting from coastal hazards. • Hazards in coastal environment: cyclone, sea level rise, coastal erosion, tsunami etc • CVI: Maps will determine coastal risks due to future sea-level rise are quantified based on parameters like: tidal range, wave height, coastal slope, elevation, shoreline change rate, geomorphology, historical rate of relative sea-level change. • Same parameters are also used in Multi-Hazard Vulnerability Mapping (MHVM) • The composite hazard zones which can be inundated all along coastal low-lying areas owing to extreme flooding events were created using these factors. • Can provide valuable information for disaster preparedness and the development of resilient coastal communities; can help avert loss of life and property as well as help city planners develop coastal hazard resilient designs.	
38	**Dead Zones on Marine ecosystem**	
	• Low-oxygen areas in the oceans and lakes across the world where aquatic life cannot survive. • Hypoxic zones. 10% or more oceans are now under dead zone. • Low DO, high BOD and high COD. **Causes:** • Water body receives too much nutrients like phosphorus and nitrogen → change in the productivity of the ecosystem → eutrophication: a process due to which dead zones occur. • Normal nutrient level: helps in the growth of cyanobacteria or blue-green algae • High nutrient levels: cyanobacteria grow out of control(dangerous). They deplete the oxygen in water before decomposing, thereby suffocating the species living in that area. • Man-made: Fertilizers (animal manure and commercial); untreated sewage; industry; burning of fossil fuel → release nitrogen → redeposited on land and water through precipitation. • Natural: During summer, oxygenated surface water pushed offshore → replaced by low-oxygen but nutrient rich water from depths(upwelling).	

	Impacts: • Effects on marine ecosystem: increases metabolism, kills coral reefs, other physiological impacts, loss of biodiversity. • Effects on Humans: water scarcity, illness, global food supply and fisheries. **Mitigation Measures** • Eliminate human related nutrient pollution at source: plastic, chemical and other organic wastes. • Use of microbes that can regenerate the living conditions through bioremediation. • Better practices, accountability, awareness, sustainability.	
39	**Coral reefs**	
	IPCC: Great Barrier Reef in crisis – 3 mass bleaching events from 2016-2020; "mass mortality" of some coral species. **Coral features:** • Fringing, Barrier and Atoll(island forming). • Coral polyps(animal) - limestone skeletons – zooxanthallae(symbiotic algae) • Conditions: 20-29°C, east coast(absence of cold current), semi-hard surface, shallow, clear water, mild salinity. • Coral Bleaching: 60-90% loss of zooxanthallae and each zooxanthallae losing 50-80% photosynthetic pigments. • Causes of bleaching: temperature changes, sub-aerial exposure, fresh water dilution, inorganic nutrients, pathogens, pollutants, high sedimentation, over fishing. **Significance on Marine Ecosystem:** • Act as home and nurseries for 25% of all marine life (Rainforests of the ocean). • Covers less than 1% of ocean floor but provide habitat and food to 250,000 known species. • Coastal protection: Prevents land mass directly being exposed to waves causing erosion. • Other importance: recreation, medicine, food & fishing, coastal protection etc **Impact of Global Warming:** • Bleaching events occur during sudden temp drops accompanying intense upwelling(El-Nino) • Bleaching events occurs mostly during summer. • Coral reefs' susceptibility to increase water temp combined with ocean acidification. • High temp and acidity leads to reduced calcifying ability. • Harmful UV radiation absorbing compounds present in coral reduces when temp rises • ENSO related sea level drop can expose corals or change radiation levels. **Suitable restoration measures:** • Biorock technology: to produce natural building materials in the sea. Substance formed by electro-accumulation of minerals dissolved in seawater on structures lowered into sea. Successful restoration of Acroporidae(extinct) in Gulf of Kachchh.	

	• Reducing local stressors causing coral bleaching like tourism, pollution, fishing, coastal construction, fertilizer use etc. • Strengthening reefs using genetic engineering. **Initiatives:** • India: Coral Bleaching Alert System (CBAS) by measuring SST using satellite, Coastal Zone Regulations (CRZ), Integrated Coastal and Marine Area Management (ICMAM) • Global: ICRI, Intl Coral Reef Action Network (ICRAN), Coral Triangle Initiative, Blue Flag Certification of beaches.	
40	**Mangroves**	
	Features: Saline environment, low oxygen-pneumatophores (breathing roots), succulent leaves, viviparous, location-tropical and subtropical, high solar radiation, highly productive ecosystems. **Significance on coastal ecology:** • Coastal protection: bio-shield against cyclones, storms, tsunamis etc • Wildlife habitat: Edge effect, ecotone, high biodiversity and a lot of endangered species. • Clean Water: Maintains coastal water quality through retention, removal and cycling of nutrients and pollutants. Protects seaward habitats like Coral reefs and seagrass meadows. • Carbon Storage: Waterlogged soil sequesters around 10-15% carbon in it while being just 2% of marine environment. Buried as "blue carbon". • Ecological and coastal stabilisation: Reduces erosion and helps in building the soil. **Causes for depletion:** • Natural threats: Cyclones, tsunamis, wildfires, overgrazing, etc • Anthropogenic: Agriculture – deforestation, coastal development, shrimp farming, charcoal and lumber industry, commercialisation of coastal areas, oil spills etc • Shrunk by half in the last 40 years. Less than 1% tropical rainforest is mangroves. **Suitable measures for its sustainability:** • Conservation measures: Mangroves for the Future (MFF), Blue Carbon Initiative, Coastal Regulation Zone (CRZ), SMART tool in Sundarbans, etc • Techniques: direct seed sowing, raised bed plantation and fishbone channel plantations to restore degraded mangroves.	
41	**El Nino, La-Nina & IOD**	
	Causes: **El Nino:** Weakening of trade winds→So Warm Water not pushed towards West→Changes in Pacific Walker circulation→Warmer Water over East pacific **La Nina:** Strengthening of trade winds- Opposite of El Nino **IOD:** Variation in the pressure on either side of Indian ocean (western and eastern)	

Effects:

El Nino:

Flooding of South America's Eastern Coast, Dry Conditions in India, Australia, But rainfall in Africa East→Overall Warming of Global Temperature→Diseases outbreak, etc

La Nina:

Try to correlate with the effects of EL Nino (Dry in African regions)

Role in Global climate and Indian Monsoon:

El Nino Phase –

Dry Conditions Prevail, Changes in Sea Surface Temperature (SST)→ Monsoon Deficit

La Nina Phase-

Cold Wave- North Westerly Winds→Stronger Monsoon, North East Monsoon

IOD:

+ve phase→Negates the effect of EL Nino, More Cyclones→

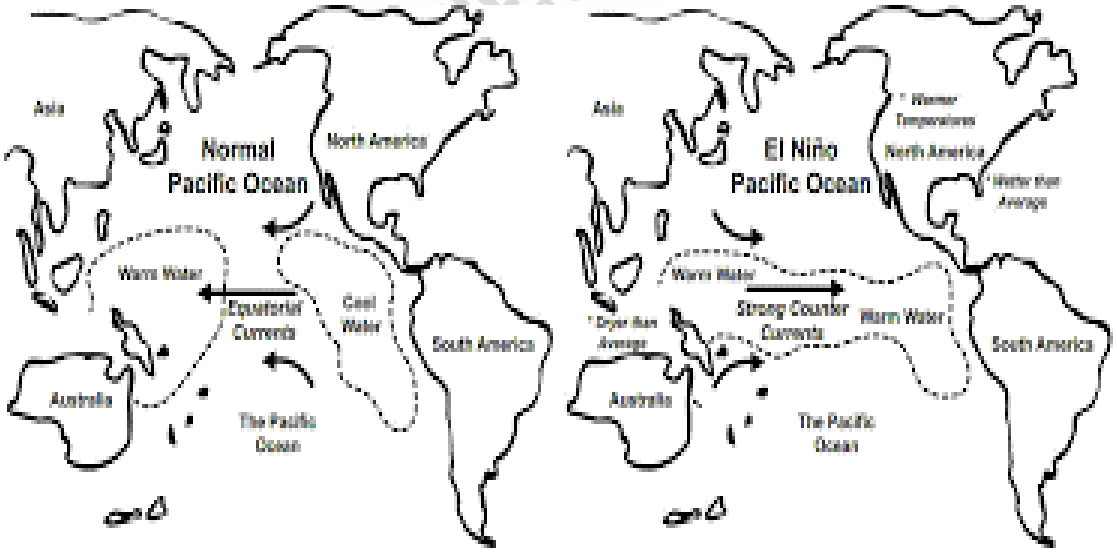
-ve phase→ Compounds impacts of El Nino→Suppressed Cyclogenesis-Low Precipitation

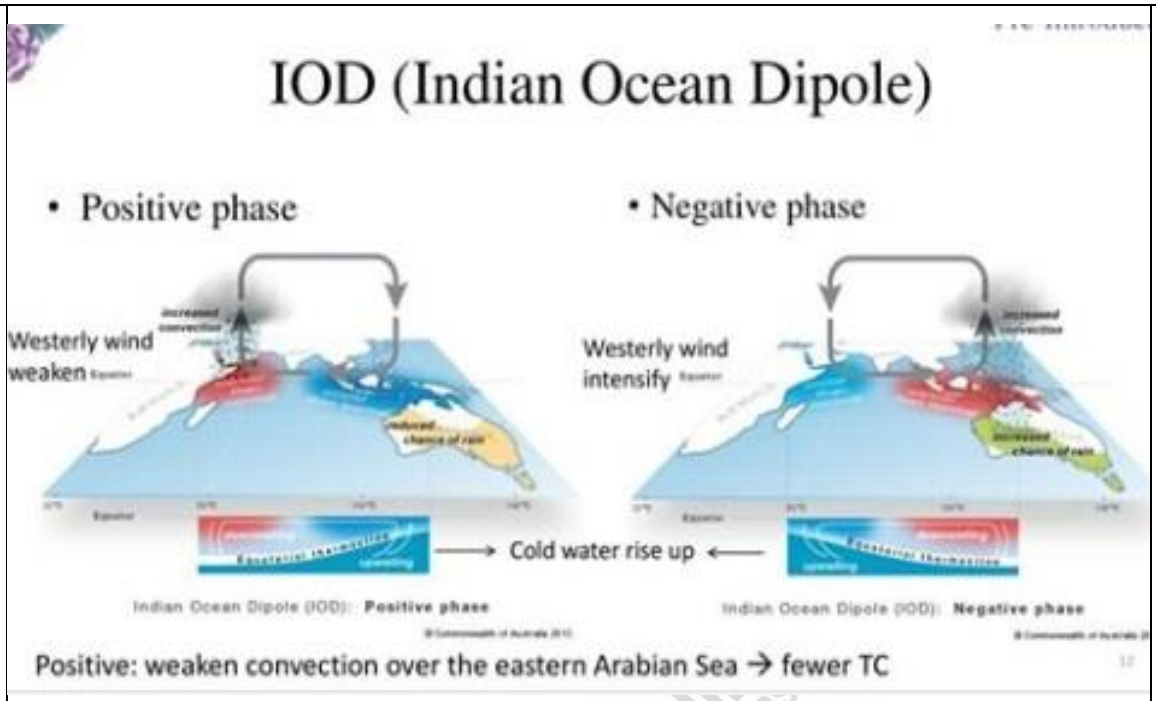
Effect of Climate change on it:

Nature climate change Report:

El Nino events would most likely lose heat to the atmosphere at a quicker rate

due to the evaporation of water→Weakening of Sea surface temperature variability→Likely disruption of La Nina→Forecasting to be more difficult





42 Indian Monsoon

Seasonal Reversal of Winds, Biggest Phenomenon to impact Life in India.

Causes/Pattern

ITCZ shifting→ Temperature Gradient→ Jet Stream→ Easterly-Burst→2 branches- Arabian sea/ Bay of Bengal→Retreating Monsoon

Significance in Agriculture and Food security:

- Agro-Industry – 80% of Prime Agri season Monsoon fed→50% output in summer months
- During Good Monsoon season- Agri GVA is higher.
- Rice- Most consumed and Dependent on Rainfall –Food security
- Monsoon also helps keep the underground water table in check. So, winter crops like Wheat have moisture levels.
- Inflation pressures are lower- So the Subsidy burden on Food lower.

Erratic nature due to global warming and climate change:

Monsoon patterns—more unpredictable—>Pre-Monsoon Greening due to early onset→Himalayan Retreat→ Changes in Tibetan Highlands

- Results in **Drought and Floods.**

43 Watershed management and development

- Attempt to halt land degradation→ maximum production out of the land:
- Judicious management of Resources on Watershed Basis
- Eco-Technological measures

Purpose:

Manage, Control, and utilize the water Runoff→Optimum infiltration and percolation minimize Soil Erosion→ Increase irrigation and rainwater conservation (crops)→Minimum Natural Hazards

Components:

- Land Management (Structures like bunds, mulching, vetiver fence, Cropping techniques, Runoff collection)→

	• Water→Rainwater Harvesting, Farm Ponds, Drip irrigation • Biomass Management→Forest Management→ Biomass regeneration→Plant, Animal Productivity **Steps in watershed management** Recognize→ Analysing→ Develop Solutions→ Ascertain→ Protect, Improve **Govt schemes:** PM-Krishi Sinchaaye & Neeranchal Programme	
44	**Water bodies reclamation and its environmental implication:**	
	Need Urbanization→ Development Works→Infra structure etc. **Implication:** • Frequent Flooding: Chennai floods- conversion of Water bodies as concrete jungles, Mumbai, Hyderabad Floods • Ecological Damages: Water cycle, Nutrient cycle is damaged • Pollution of Ecosystem: Toxic Foam in Yamuna River • Biodiversity Loss: Shrinking Water Bodies • Changes in micro- Climate **Conclusion:** Diversion of Waterbodies needs to be urgently stopped → threats of desertification→ Water stress etc high in India	
45	**Interlinking of rivers**	
	Interlinking of Rivers programme (ILR) programme →surplus rivers→with deficient rivers **National River Linking Programme (NRLP)- 2 components- Himalayan and Peninsular** **Need**: Drought, floods and shortage of drinking water→Population and food security (Agri depends on irrigation)→Navigation Waterways-Low carbon footprint→ Declining surface water and ground water **Feasibility** Slope of regions vary→Higher lift power needed in Peninsular Rivers→ Hydrological Parameters→ Difficult in assessing surplus quantity **Issues**: • Ecological/Env Issues: Ex: Ken- Betwa- Panna Tiger Reserve, Loss of Biodiversity • Displacement of People: Tribals oppose • Financial Issues: Prohibitive costs→ Delays • Political Issues: Interstate Water disputes • International Framework absent- Issues with Bangla or Nepal **Recent interlinking projects Budget announced**: • Damanganga-Pinjal • Par-Tapi-Narmada • Godavari-Krishna • Krishna-Pennar • Pennar-Cauveri **Conclusion**: Proper assessment and appraisal needed; till then alternative and existing forms of water conservation needs to be given focus.	


ARABIAN SEA
LAKSHADWEEP
BAY OF BENGAL
ANDAMAN & NICOBAR
INDIAN OCEAN
GHAGRA
GANDAK
KOSI
TEESTA
SANKOSH
MANAS
BRAHMAPUTRA
BARAK
CHAMBAL
GANGA
GOMTI
LUNI
SABARMATI
BETWA
SONE
NARMADA
TAPI
MAHANADI
PENGANGA
GODAVARI
MANER
KRISHNA
PENNAR
CAUVERY
PALA

TOPICS AND POINTERS

2022- MAINS STUDY MODULE

Geography Mains Important Themes & PYQ's (Part -II)

Distribution of Natural resources

1. Land, Water & Ocean resources – significance, challenges and effective management
2. Oil resource in Arctic sea, South China sea etc – Geopolitical significance & environmental impact.
3. India's role in harnessing resources in Arctic, Africa etc.
4. Distribution of Mineral Oil and its multi-dimensional implications.
5. Shale oil & gas, Atomic energy – Distribution, significance & challenges in India
6. Blue revolution, Inland water transport – Problems & Prospects in India
7. Effective water resource management in India – Water stress, water scarcity, ground water, flood water, watershed development etc.
8. Reclamation of water bodies and its environmental implications.
9. Interlinking of rivers – solution to drought, floods and navigation.
10. Sustainable tourism in India – ecological benefits.
11. Solar energy potential and regional variation in its development in India.
12. Status of Forest resources of India and its impact on Climate change.

Factors responsible for Industries

1. Mining Industry in India and its contribution to India's GDP.
2. Iron & Steel industries – Spatial distribution.
3. Present location of Iron and Steel industries away from the source of raw materials with examples.
4. Petroleum refineries location not necessary with respect to crude oil areas.
5. Tea plantation success – locational factor in Darjeeling
6. Decentralization of Cotton textiles & Sugar mills in India
7. Green revolution – factors
8. Resource based manufacturing and its linkage with employment
9. Localization of Agro – Processing Industry in N.W.India
10. IT industry in cities – its main socio economic implications.

Previous Year Questions

1. Discuss the multi-dimensional implications of the uneven distribution of mineral oil in the world. 2021
2. It is said the India has substantial reserves of shale oil and gas, which can feed the needs of country for quarter century. However, tapping of the resources doesn't appear to be high on the agenda. Discuss critically the availability and issues involved. 2013
3. With growing scarcity of fossil fuels, the atomic energy is gaining more and more significance in India. Discuss the availability of raw material required for the generation of atomic energy in India and in the world. 2013
4. India has immense potential of solar energy though there are regional variations in its development. Elaborate. 2020

1. What are the economic significances of discovery of oil in Arctic Sea and its possible environmental consequences? 2015
2. Why is India taking keen interest in resources of Arctic Region? 2018
3. How does India see its place in the economic space of rising natural resource rich Africa? 2014

4. Present an account of the Indus Water Treaty and examine its ecological, economic and political implications in the context of changing bilateral relations. 2016
5. South China Sea has assumed great geopolitical significance in the present context. Comment. 2016

1. Critically evaluate the various resources of the oceans which can be harnessed to meet the resource crisis in the world. 2014
2. India is well endowed with fresh water resources. Critically examine why it still suffers from water scarcity. 2015
3. In what way micro-watershed Development projects help in water conservation in drought prone and semi-arid regions of India. 2016
4. "The ideal solution of depleting ground water resources in India is water harvesting system." How can it be made effective in urban areas? 2018
5. Examine the status of forest resources of India and its resultant impact on climate change. 2020

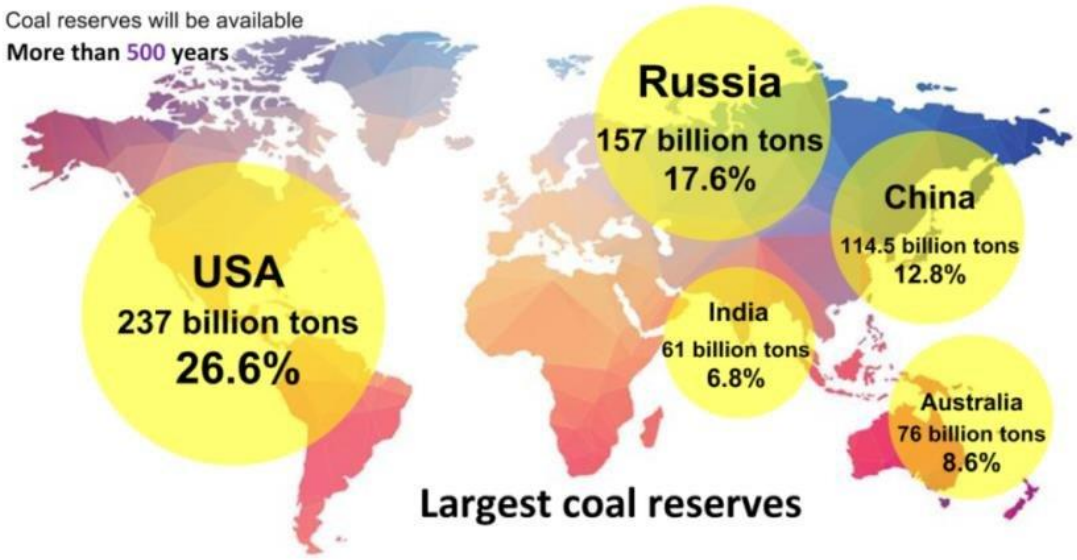
1. Despite India being one of the countries of the Gondwanaland, its mining industry contributes much less to its Gross Domestic Product(GDP) in percentage. Discuss. 2021
2. Analyze the factors for highly decentralized cotton textile industry in India 2013
3. Do you agree that there is a growing trend of opening new sugar mills in the Southern states of India? Discuss with justification 2013
4. Account for the change in the spatial pattern of the Iron and Steel industry in the world. 2014
5. Account for the present location of iron and steel industries away from the source of raw material, by giving examples. 2020
6. Petroleum refineries are not necessarily located nearer to crude oil producing areas, particularly in many of the developing countries. Explain its implications. 2017
7. Why did the Green Revolution in India virtually by-pass the eastern region despite fertile soil and good availability of water? 2014
8. Define blue revolution, explain the problems and strategies for pisciculture development in India. 2018
9. Discuss the factors for localization of agro-based food processing industries of North-West India. 2019
10. What are the main socio-economic implications arising out of the development of IT industries in major cities of India? 2021

1. Enumerate the problems and prospects of inland water transport in India. 2016
2. What is the significance of Industrial Corridors in India? Identify industrial corridors, explain their main characteristics. 2018
3. How is efficient and affordable urban mass transport key to the rapid economic development of India? 2019
4. The effective management of land and water resources will drastically reduce the human miseries. Explain 2016
5. Can the strategy of regional-resource based manufacturing help in promoting employment in India? 2019

46.	Coal	

Major Reserves in the World

Commercially exploitable coal reserves are found mainly in China, USA, India, Australia, Indonesia, Russia, Canada, South Africa, Columbia, Kazakhstan, and Ukraine.



Major Producers in the world

- China, India, Indonesia, United States of America, and Australia were the top five Coal producing countries (by volume) in 2021
- **China** was the leading Coal producing country (by volume) in 2021, with a Coal production of 3,942.2 million tonnes, up 2.5% YoY
- **India** ranked second (by volume in 2021) with a Coal production of 766.9 million tonnes (up 1.0% YoY), with the other three countries (Indonesia, United States of America, and Australia) cumulatively produced 1,638.0 million tonnes of Coal in 2021

Distribution in India

Gondwana Coalfields (250 million years old)

- **Makes up to 98% of the total coal reserves in India and 99% of the coal production in India.**
- These basins occur in the valleys of certain rivers viz., the **Damodar** (Jharkhand-West Bengal); the **Mahanadi** (Chhattisgarh-Odisha); the Son (Madhya Pradesh Jharkhand); the **Godavari** and the **Wardha** (Maharashtra-Andhra Pradesh); the Indravati, the Narmada, the Koel, the Panch, the Kanhan and many more.

Tertiary Coalfields (15 to 60 million years old)

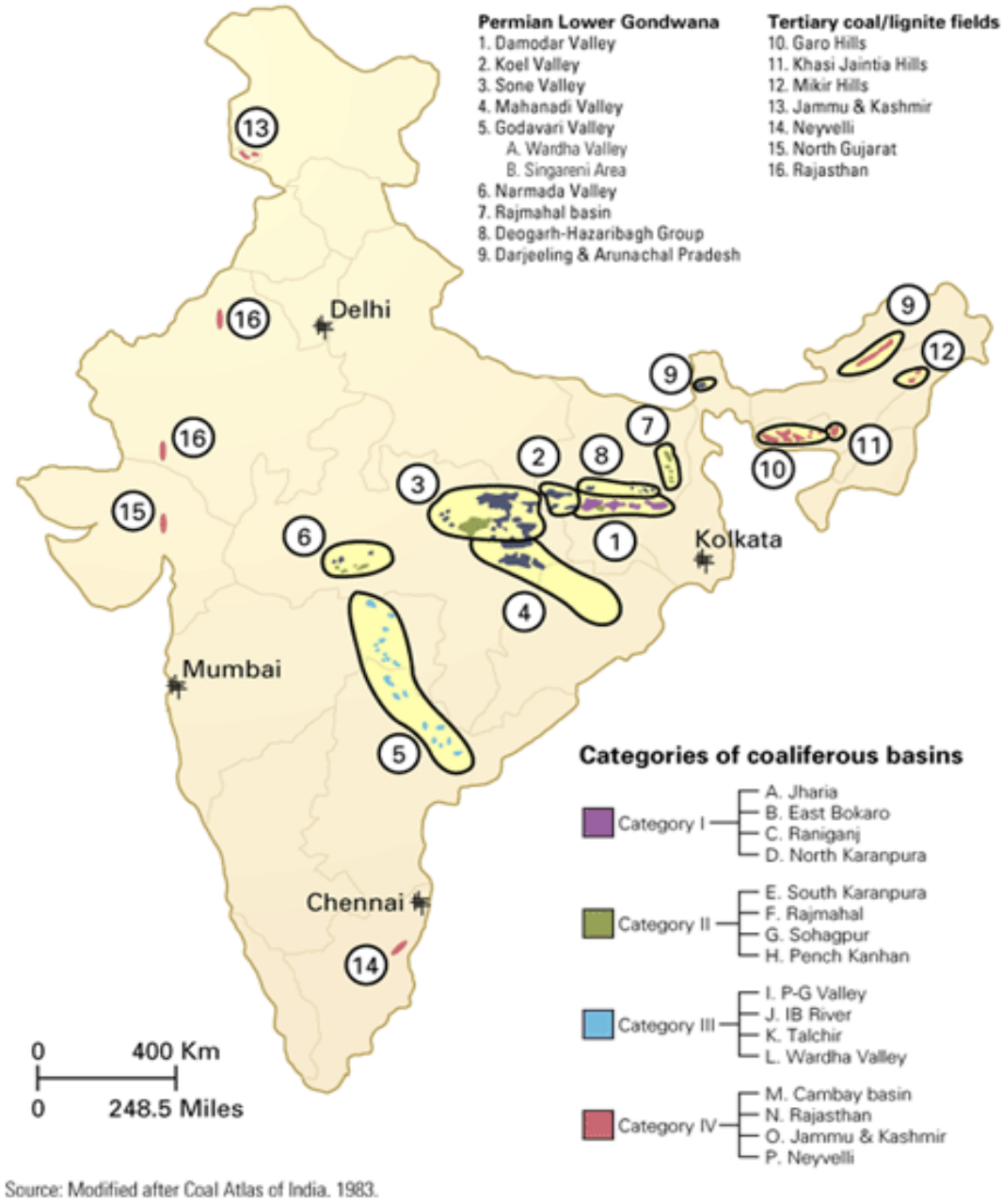
- Important areas include Assam, Meghalaya, Nagaland, Arunachal Pradesh, Jammu and Kashmir, Himalayan foothills of Darjeeling in West Bengal, Rajasthan, Uttar Pradesh, and Kerala.
- Tamil Nadu and the union territory of Pondicherry also bear tertiary coal reserves

On the basis of carbon content

- **Anthracite (80 to 95 percent carbon) -** found only in Jammu and Kashmir (in Kalakot) in small quantities**.**
- **Bituminous coal (60 to 80 percent) -** Jharkhand, Orissa, West Bengal, Chhattisgarh, and Madhya Pradesh.
- **Lignite (40 to 55 percent carbon)** - Palna of Rajasthan, Neyveli of Tamil Nadu, Lakhimpur of Assam, and Karewa of Jammu and Kashmir.

INDIA'S COAL BASINS AND FIELDS

Fig. 3



Source: Modified after Coal Atlas of India. 1983.

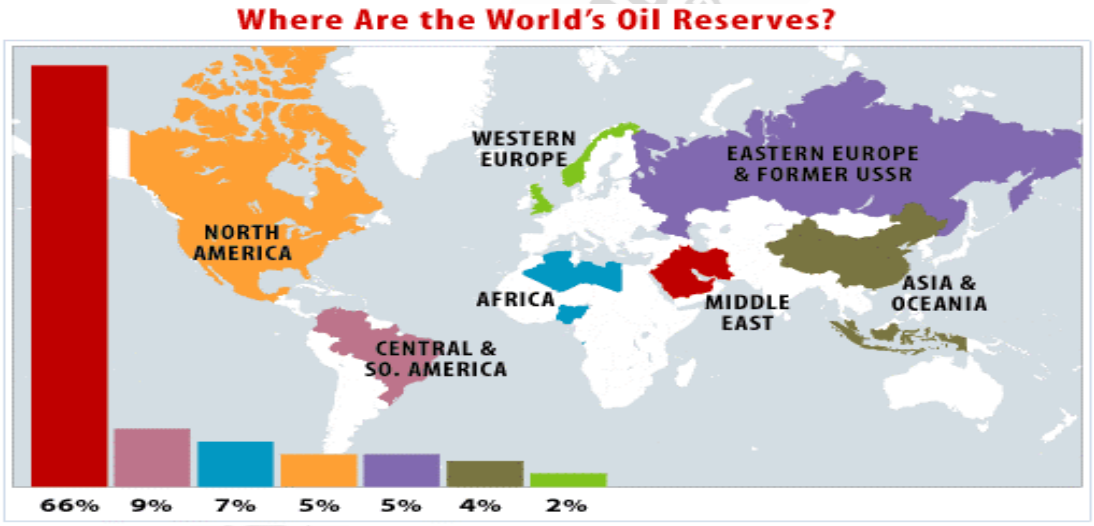
Problems associated

- The distribution of coal is uneven - involves high transport cost
- Indian coal has high ash content and low caloric value - reduces the energy output of coal and complicates the problem of ash disposal.
- productivity of labour and machinery is very low.
- There are heavy losses due to fires in the mines and at pit heads.
- Pilferage at several stages -a hike in the price of coal
- Environmental pollution- open cast mining leads to rugged and ravenous land.
- The coal dust -health hazards
- Sustainability – recent coal crisis

47. Petroleum/Mineral Oil

Major Reserves in the World

- Arabian-Iranian sedimentary basin in the Persian Gulf region contains two-thirds of supergiant oil fields.
- The remaining supergiants are distributed in the United States, Russia, Mexico, Libya, Algeria, Venezuela, etc.
- Middle East - Iran, Iraq, Saudi Arabia, Bahrain, Kuwait, UAE, Qatar, Oman, and Syria constitute the richest oil region on the earth.



The 10 largest oil producers & share of total world oil production in 2021

Country	Share of world total
United States	20%
Saudi Arabia	11%
Russia	11%
Canada	6%
China	5%
Iraq	4%
United Arab Emirates	4%
Brazil	4%
Iran	4%
Kuwait	3%

Distribution of reserves in India (Onshore & Offshore)
North-eastern India - Brahmaputra valley and its neighbouring areas -

- Assam : Digboi field, Naharkatiya field
- Arunachal Pradesh: Manabhaum, Kharsang and Charai.
- Tripura: Manmumbhanga, Manu, Ampi Bazar.

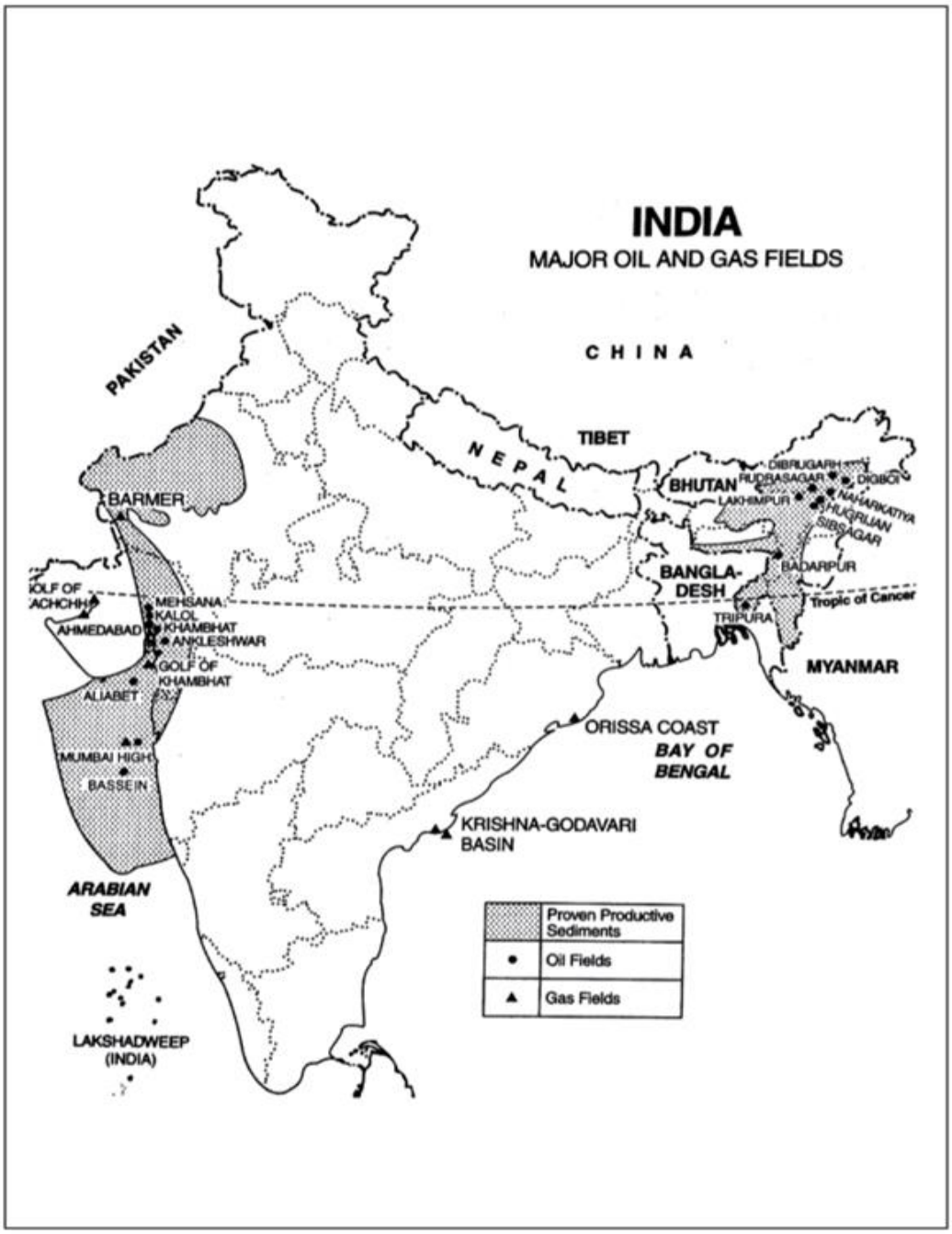
Western India Onshore field

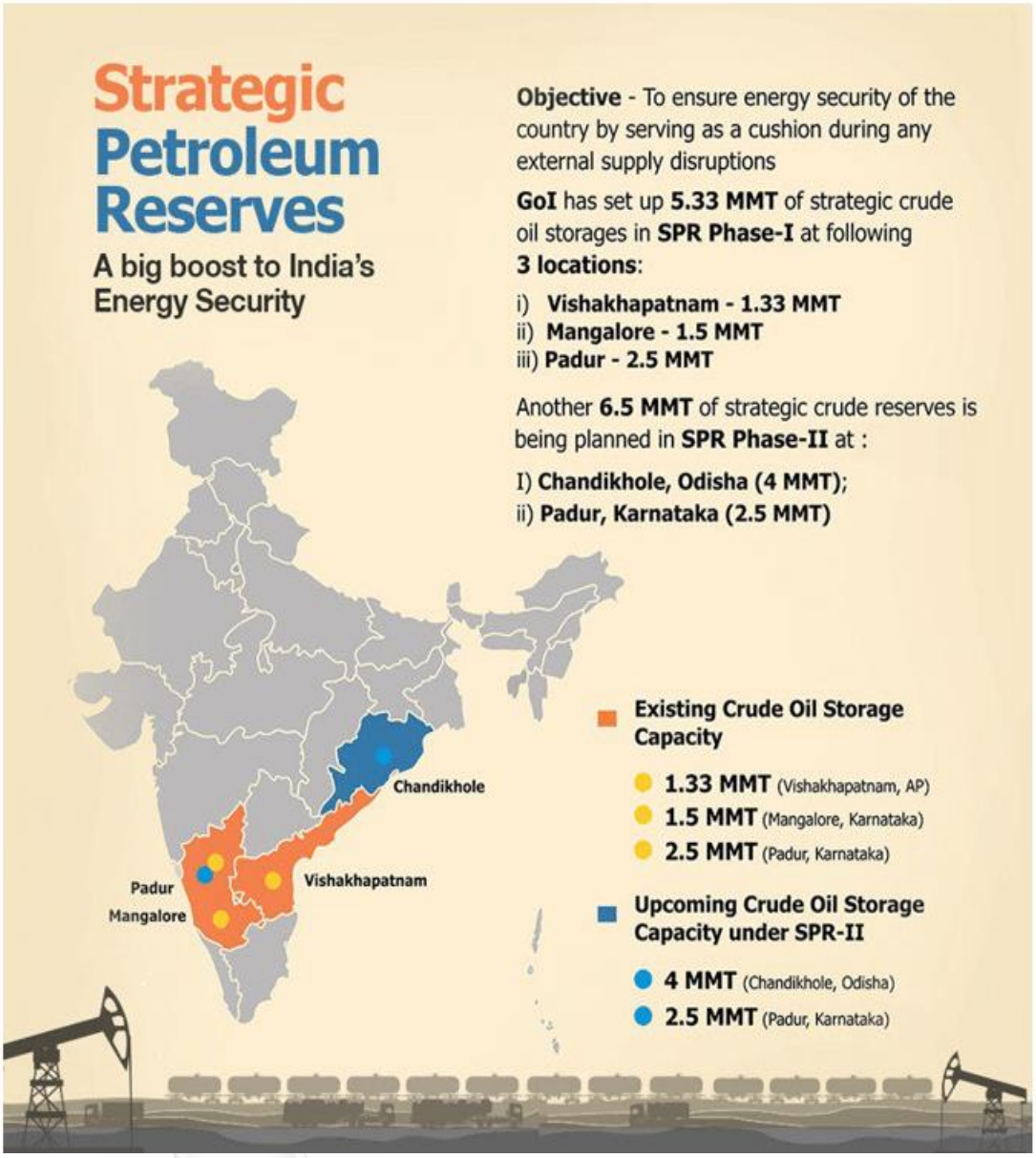
- Gujarat - found around the **Gulf of Khambat**. The main oil belt extends from Surat to Amreli, Kachchh, Vadodara, Bharuch, Surat, Ahmedabad, Kheda, Mehsana, etc. are the main producing districts.
- Ankleshwar, Lunej, Kalol, Nawgam, Kosamba, Kathana, Barkol, Mehsana, and Sanand are the important oilfields of these regions.
- **Rajasthan - Banner district of Rajasthan**

Western Coast Off-Shore Oilfields - Mumbai High (on the continental shelf off the coast of Maharashtra), **Bassein**: Located to the south of Mumbai High, **Aliabet:** Aliabet Island in the Gulf of Khambhat

East Coast - The basin and delta regions of **the Godawari, the Krishna, and the Cauvery rivers**, **Tamil Nadu:** The Narimanam and Kovilappal oilfields, **Andhra Pradesh:** Krishna-Godavari basin.

Refinery	State
Jamnagar Refinery	Gujarat
Vadinar Refinery	Gujarat
Kochi Refinery	Kerala
Mangalore Refinery	Karnataka
Paradip Refinery	Odisha
Panipat Refinery	Haryana
Gujarat Refinery	Gujarat
Mumbai Refinery	Maharashtra
Manali Refinery	Tamil Nadu
Visakhapatnam Refinery	Andhra Pradesh
Nagapattinam Refinery	Tamil Nadu
Digboi Refinery	Assam


INDIA
MAJOR OIL AND GAS FIELDS
CHINA
PAKISTAN
TIBET
NEPAL
BHUTAN
BARMER
DIBRUGARH
RUDRASAGAR
DIGBOI
LAKHIMPUR
NAHARKATIYA
HUGRIJIAN
SIBSAGAR
BADARPUR
BANGLA-DESH
Tropic of Cancer
TRIPURA
MYANMAR
GULF OF ACHCHH
MEHSANA
KALOL
AHMEDABAD
KHAMBHAT
ANKLESHWAR
GULF OF KHAMBHAT
ALIABET
MUMBAI HIGH
BASSEIN
ORISSA COAST
BAY OF BENGAL
KRISHNA-GODAVARI BASIN
ARABIAN SEA
LAKSHADWEEP (INDIA)
Proven Productive Sediments
Oil Fields
Gas Fields



Problems associated

- Declining domestic crude production: Most of the producing fields (in Cambay, Assam-Arakan and Mumbai Offshore) are maturing or have already matured.
- inadequate new oil and gas discoveries
- Large crude import bills: - India imported more than 80% of its crude consumption
- Inadequate transmission & distribution infrastructure
- Technology constraints
- Low share of MNCs
- Environmentally friendly fuel's contribution very low

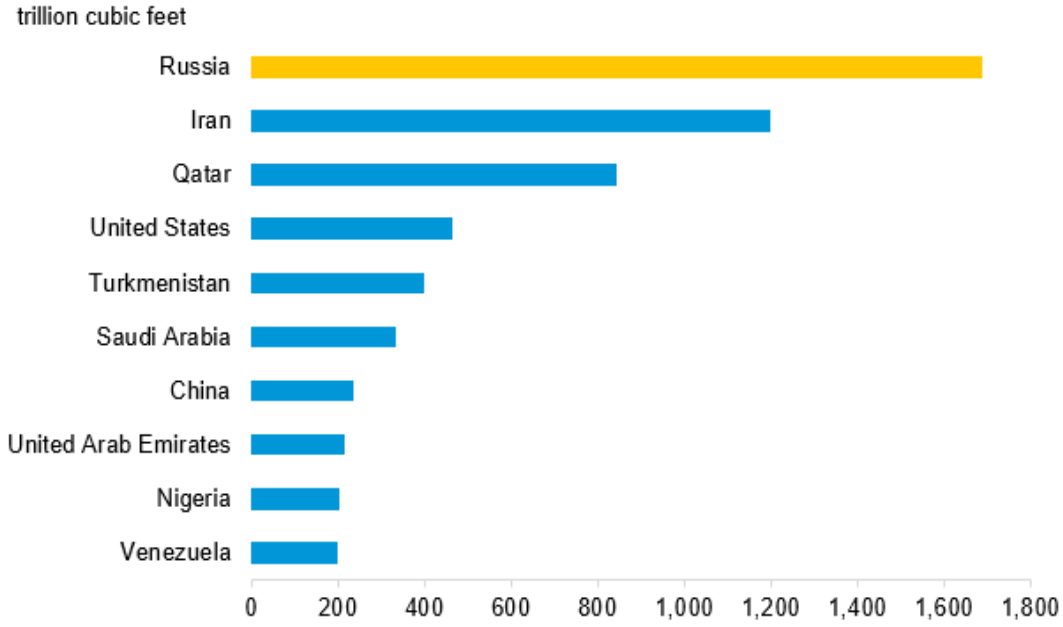
48. Natural Gas

Major Reserves in the World

- Russia
- North America - USA - second-largest natural gas producer, Canada

- West Asian Region - Saudi Arabia, Iran, UAE, Qatar and Iraq.
- China, Indonesia, Bangladesh, India, Pakistan
- Europe - Norway, United Kingdom, Italy, France, and Netherlands
- Africa -Algeria, Egypt, Nigeria, Gabon, South Africa and Tunisia

Figure 3. Estimated proved natural gas reserves, as of January 1, 2021



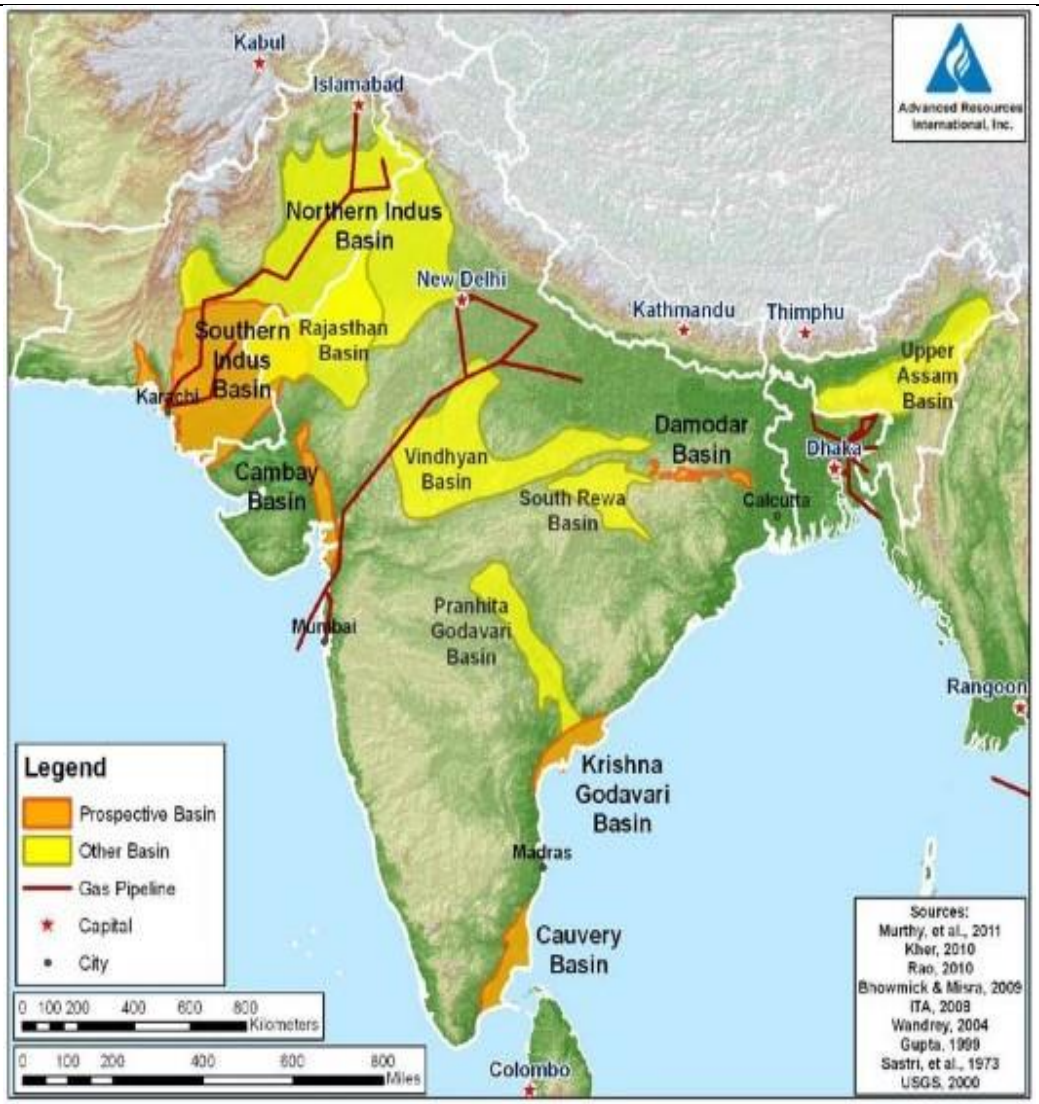
Sources: Graph by the U.S. Energy Information Administration, based on EIA's U.S. reserve values as of December 31, 2019, and other values from the Oil & Gas Journal's Worldwide Look at Reserves and Production, January 1, 2021.

Top 10 Countries that Produce the Most Natural Gas (Cubic Meters, 2020):

1. United States — 914.6 billion
2. Russia — 638.5 billion
3. Iran — 250.8 billion
4. China — 194 billion
5. Qatar — 171.3 billion
6. Canada — 165.2 billion
7. Australia — 142.5 billion
8. Saudi Arabia — 112.1 billion
9. Norway — 111.5 billion
10. Algeria — 81.5 billion

Distribution in India (Onshore & Offshore)

- **Gulf of Kutch**, **Gulf of Khambhat, Bassein field**, **Bombay High**, **Barmer in Rajasthan, KG basin, Cuddalore district of Tamil Nadu, Odisha, Assam, Tripura, etc.**
- India's economically viable reserve of natural gas - **(on-shore, Assam, and Gujarat**
- **Offshore in Bay of Cambay , Bombay High.**
- **Recently a huge reserve of 400 BCM is reported in Tripura Basin.**
- Besides them a **huge reserve is reported around Andaman and Nicobar island.**



Importance of Natural Gas to India

- About 40%, is consumed in the production of fertilizers.
- About 30% is used in power generation and 10% is used in LPG.
- Power stations using gas accounted for nearly 10 percent of India's electricity.
- **Excess usage of fossil fuels -** The average global share of fossil fuels in the **energy basket** is 84% which is even more for India.
- Dependence on coal and oil needs to be reduced and natural gas has to be replaced as much as possible.
- Share of Natural Gas: While the world average share of natural gas in the energy basket is 23%, it is only 6% for India.
- However, the government of India has set the target to make it 15% by 2030.
- Our consumption has been 1/3rd of world average.

Problems

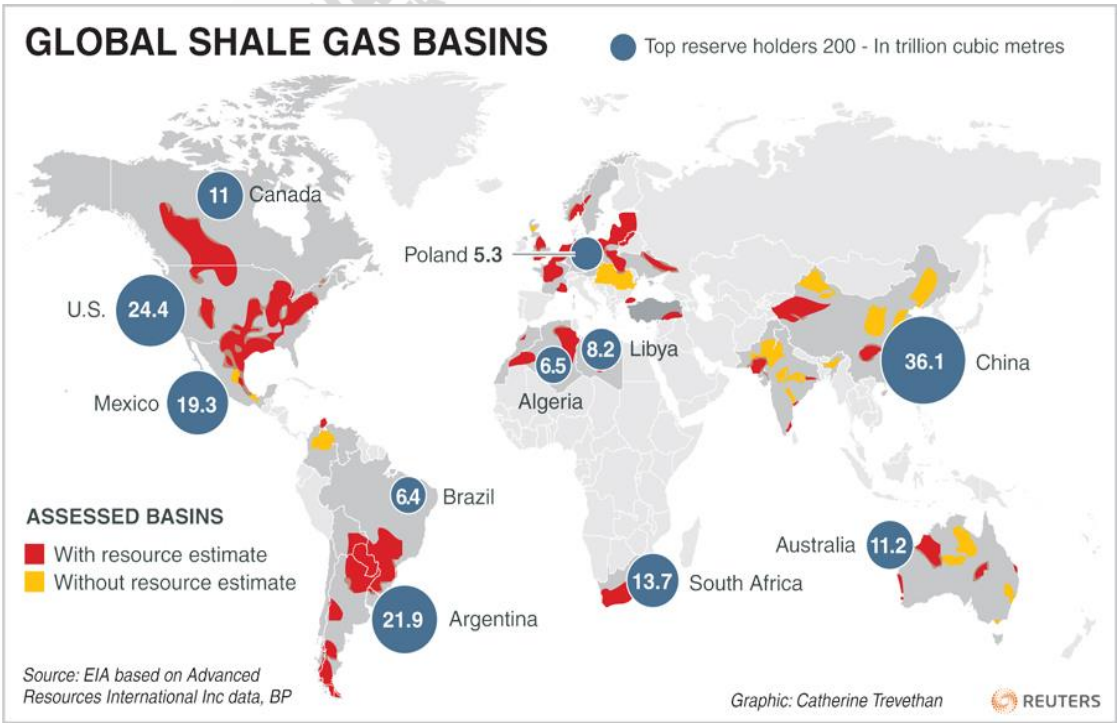
- **Decline in Production -** Declined by 8.1% and in 2020-21 only 28.67 billion cubic meters was produced compared to 31.18 billion cubic meters in 2019-20.
- Ageing Sources have become less productive over time.
- Need of Intensive Technology - difficult fields such as ultra-deep-water fields.
- Domination of State Owned Companies -These companies are the key bidders for hydrocarbon blocks and were the only successful bidders in the fifth and latest round of auctions under the Open Acreage Licensing Policy (OALP) Low
- Lack of Interest of Foreign Companies
- Climate Change – Clean energy focusGas power stations are lying idle due to a lack of feedstock.
- **Varied Prices -** natural gas is sold at varied prices- the gas under administered price regime.

49. Shale oil/Gas

Shale gas/oil

- The key difference between shale oil and conventional crude is that the former, also called 'tight oil', **is found in smaller batches, and deeper than conventional crude deposits.**
- **Shale Gas:** Unlike conventional hydrocarbons that can be extracted from the permeable rocks easily, shale gas **is trapped under low permeable rocks.**

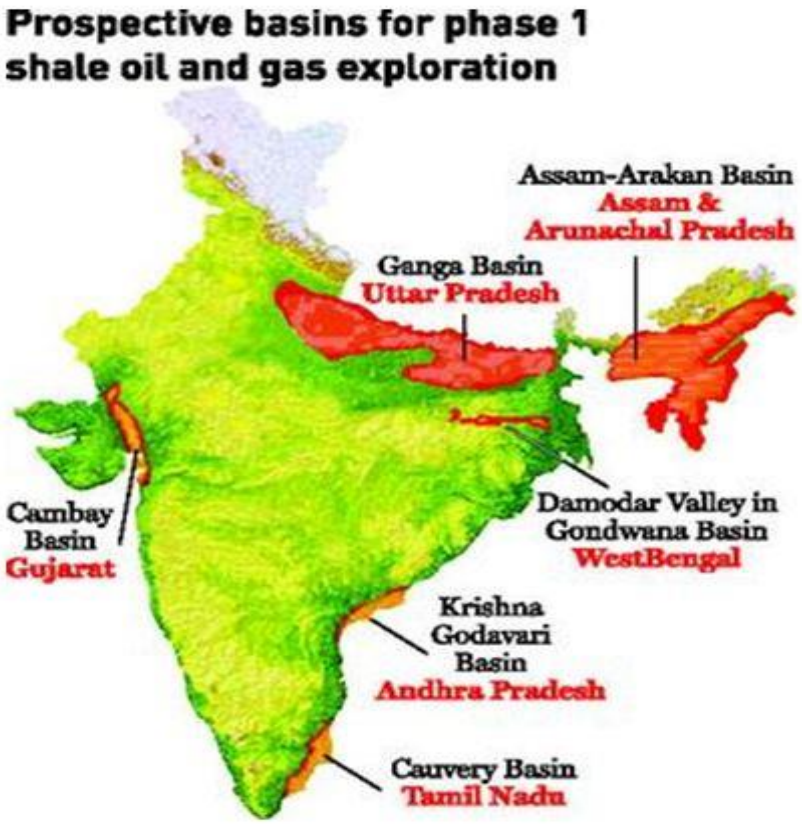
Major Reserves in the World
China, Argentina, Algeria, USA, Canada, Mexico, Australia, South Africa, Russia, Brazil, India



Major Producers in the world

- **Russia and the US** are among the largest shale oil producers in the world, with a surge in shale oil production in the US having played a key role in turning the country from an importer of crude to a **net exporter in 2019.**

Distribution in India



- The recoverable reserves are identified in Cambay, Krishna – Godavari, Cauvery, Damodar Valley, Upper Assam, Pranahita – Godavari, Rajasthan and Vindhya Basins.
- The ONGC has drilled the first exploratory shale gas well in Jambusar near Vadodara, Gujarat, in Cambay basin

Prospects

- Currently, there is **no large-scale commercial production** of shale oil and gas in India.
- Alternative to fossil fuel
- Shales even in non-producing basins could be holding hydrocarbons, opening up a potential in not only the 7 producing sedimentary basins, but in all the 26 basins.

Problems

- It requires large amounts of water, relatively larger surface area.
- It is bound to impact irrigation and other local requirements.
- In the US, experience out of 260 chemical substances shows that, 58 have been identified to pose a risk to human life and environment, out of them eight are carcinogens and 17 are toxic to freshwater organisms.
- Fracking can cause tremors on the deeper areas of earth

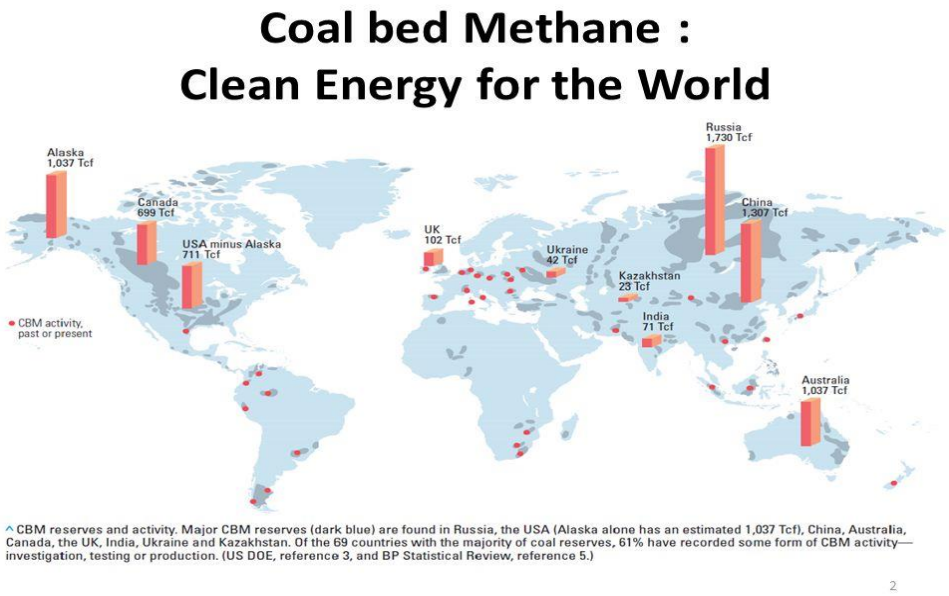
- 25-90% of the fluid is not retrieved- risk of pollution to nearby underground water.
- The instances of underground pollution in US and Canada.
- Germany and France and sub-national Governments like Scotland have **banned fracking.**
- ➢ Drill Pad construction and Operation ➢ Hydraulic Fracturing and Flowback Water Management ➢ Groundwater Contamination ➢ Blowouts and House Explosions ➢ Water consumption and Supply ➢ Spill Management and Surface Water Protection ➢ Atmospheric Emissions ➢ Health Effects

50. Coal Bed Methane

Also called Coal seam gas, coal-mine methane, coalbed gas - is a form of natural gas that is extracted from the coal beds

Major Reserves in the World

	Coalbed methane (Tcf)	Ranking
Russia	1730	1
United States	711 (lower 48) + 1037 Alaska	2
China	1307	3
Australia	1037	4
Canada	699	5
United Kingdom	102	6
India	71	7
Ukraine	42	8
Kazakhstan	23	9

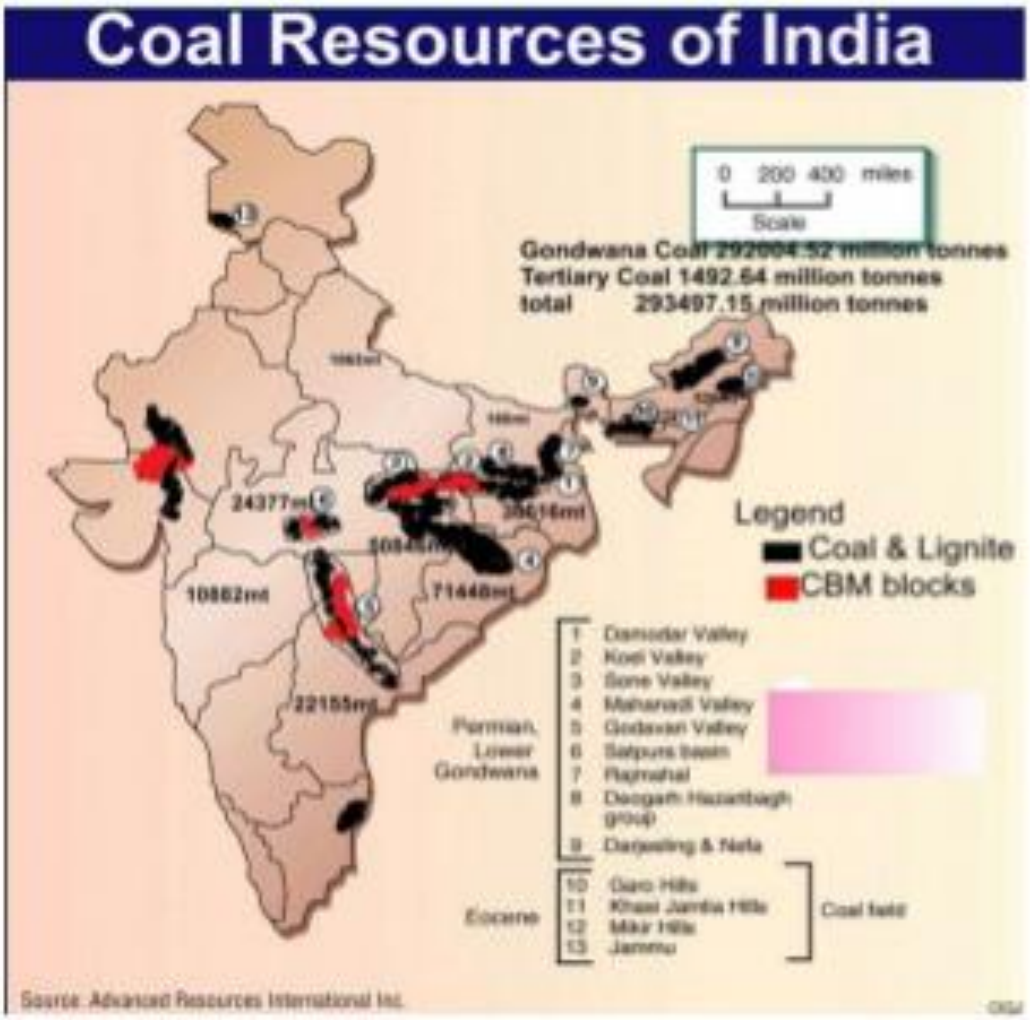


^ CBM reserves and activity. Major CBM reserves (dark blue) are found in Russia, the USA (Alaska alone has an estimated 1,037 Tcf), China, Australia, Canada, the UK, India, Ukraine and Kazakhstan. Of the 69 countries with the majority of coal reserves, 61% have recorded some form of CBM activity—investigation, testing or production. (US DOE, reference 3, and BP Statistical Review, reference 5.)

Distribution in India

- The Gondwana sediments of eastern India
- The vast majority of the best prospective areas for CBM development are in eastern India, situated in Damodar Koel valley and Son valley.
- CBM projects exist in Raniganj South, Raniganj East and Raniganj North areas in the Raniganj coalfield, the Parbatpur block in Jharia coalfield and the East and west Bokaro coalfields.
- Son valley includes the Sonhat North and Sohagpur East and West blocks.
- Currently, commercial production has commenced from Raniganj South CBM block

Indian CBM Reserves..



Prospects

- India has the fifth largest proven coal reserves in the world and thus holds significant prospects for exploration and exploitation of CBM.
- The prognosticated CBM resources in the country are about 92 TCF (2600 BCM) in 12 states of India.

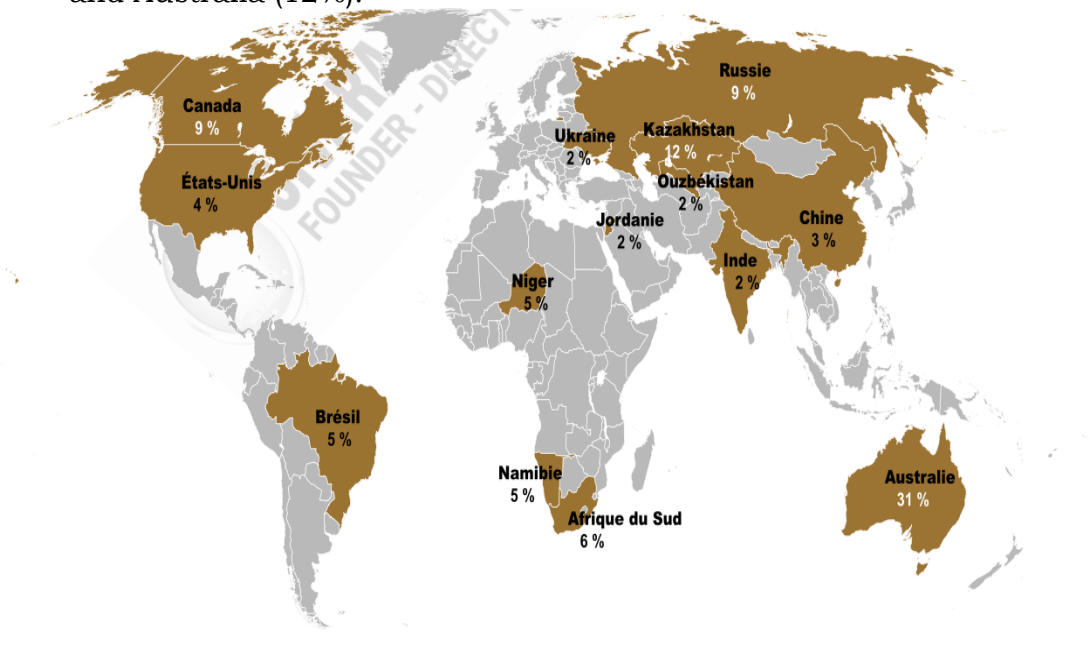
Problems

- Methane is *a greenhouse gas* emitted through CBM extraction. *Global methane emissions from coal mines are projected to account for approximately 8 percent of total global methane emissions.*
- Disturbance of lands drilled and its effect on wildlife habitats results in *ecosystem damage.*
- *Water discharges from CBM development – pollute downstream water sources.*
- *Disposal of the highly salinized water that must be removed in order to release the methane creates a challenge*

51. Uranium & Thorium

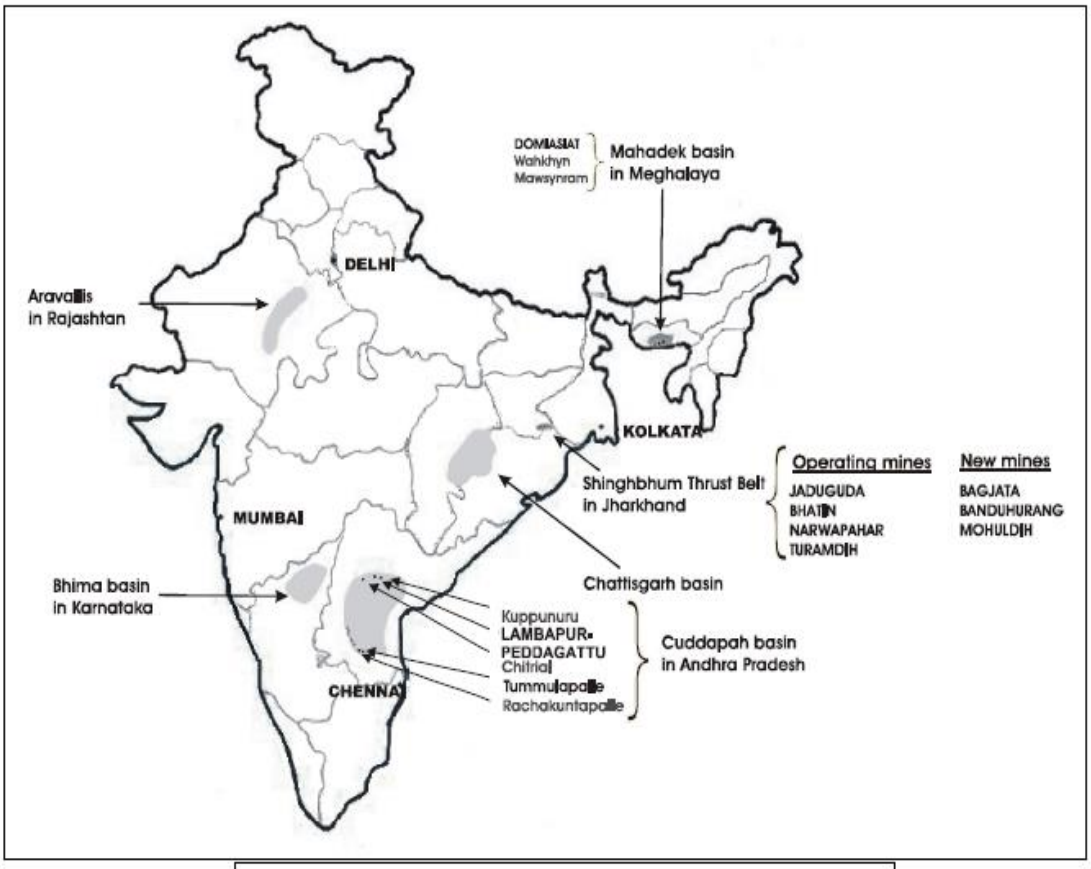
Uranium distribution

- The largest deposits are found in **Australia, Kazakhstan,** and **Canada**.
- Olympic Dam and the Ranger mine in Southern Australia are important mines in Australia.
- High-grade deposits are only found in the **Athabasca Basin** region of Canada.
- Cigar Lake, McArthur River basin in Canada are other important uranium mining sites.
- The Chu-Sarysu basin in central Kazakhstan alone accounts for over half of the country's known uranium resources.
- **Kazakhstan produces the largest share of uranium from mines (42% of world supply from mines in 2019)**, followed by Canada (13%) and Australia (12%).



In India

- India has no significant resource base and majorly the requirement is met through imports from Australia and Canada.
- Some quality reserves were recently discovered in parts of **Andhra Pradesh and Telangana between Seshachalam forest** and **Sresailam**

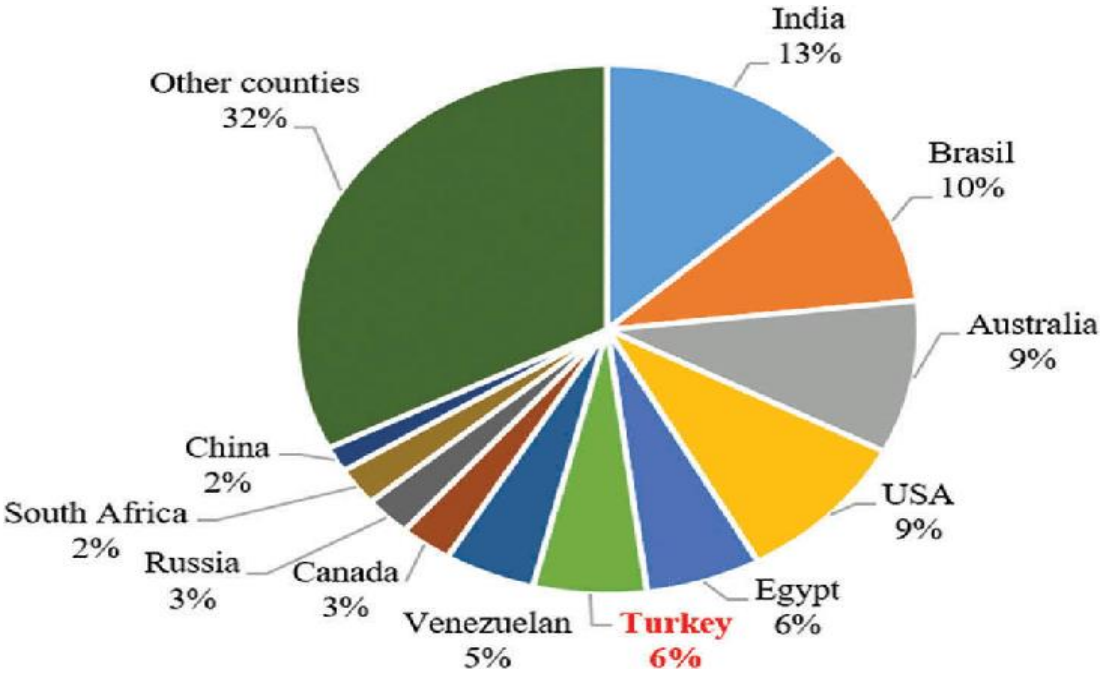


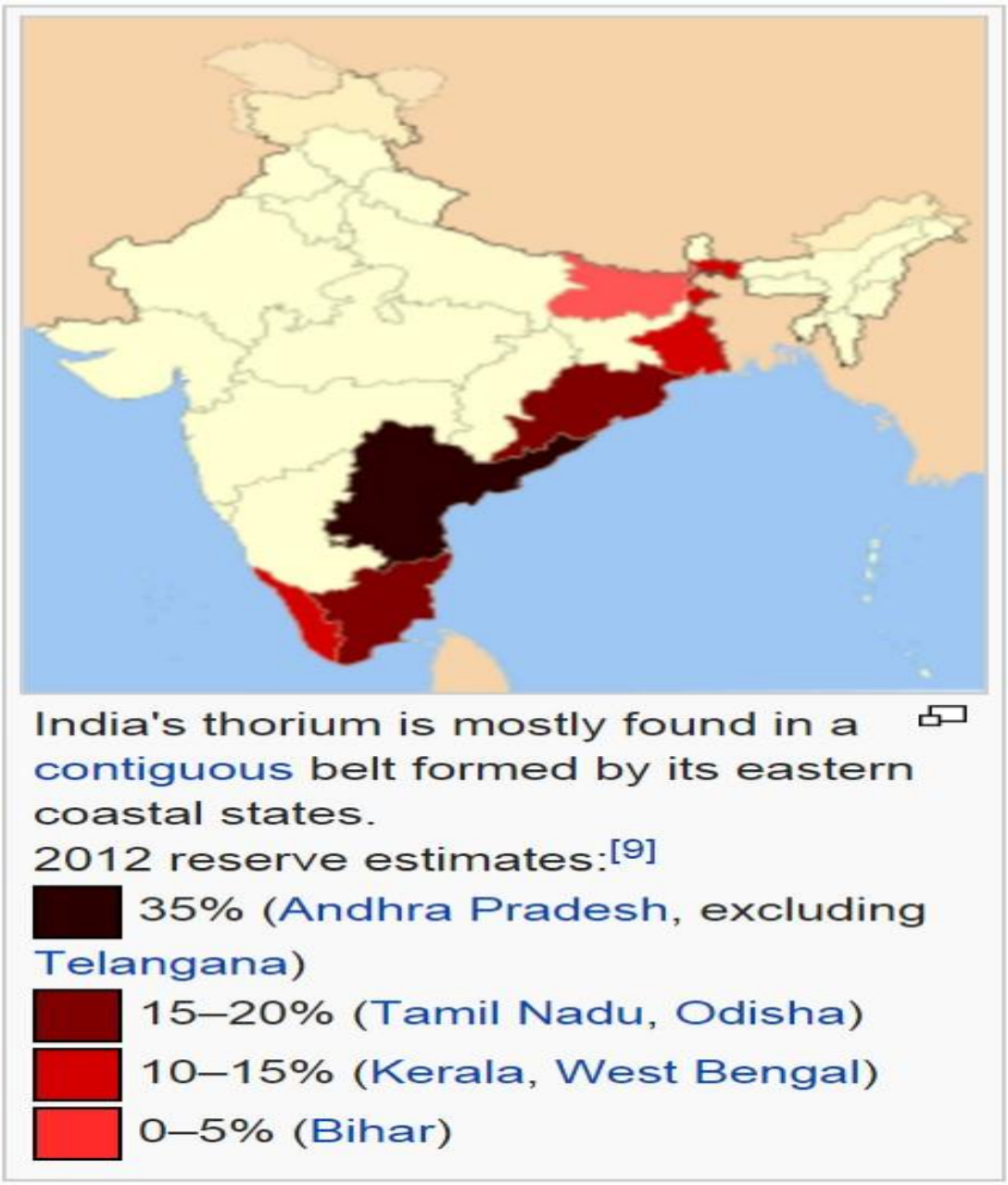
Major uranium provinces of India

1

Thorium distribution

- **India** and **Australia** are believed to possess more than half of world's thorium reserves.
- Brazil, United States, Australia, and India have particularly large reserves of thorium.

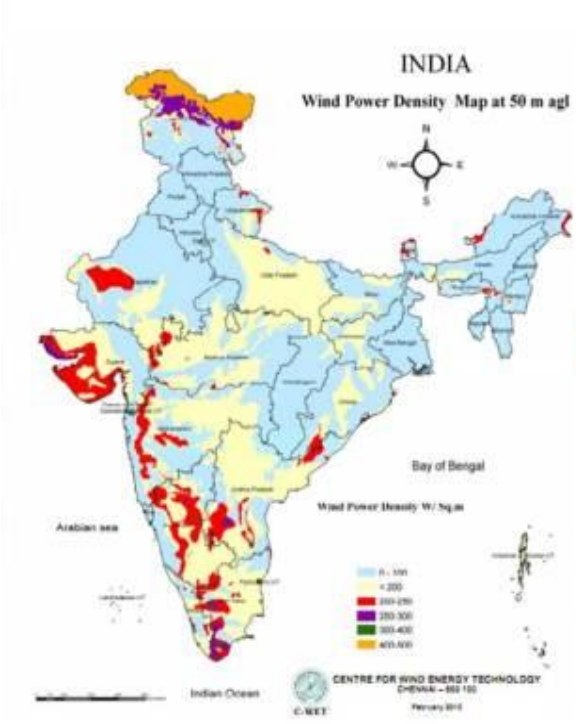




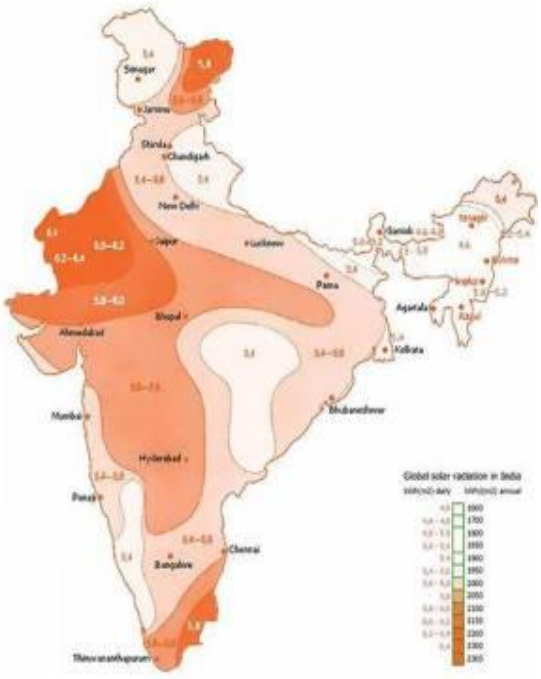
Prospects and Challenge

- Thorium is more abundant in nature than uranium and is fertile rather than fissile, meaning it can be converted into fissile material through radiation. It is meant to be used alongside fissile materials that are able to go through nuclear fission, like recycled plutonium and uranium.
- Despite its benefits, using thorium as a primary source of nuclear energy is challenging. The World Nuclear Association notes that extracting latent energy is still difficult to do in a cost-effective manner, and research into refinement technology will be needed if thorium is to be turned into a viable source.

52.	**Solar & Wind Energy**	



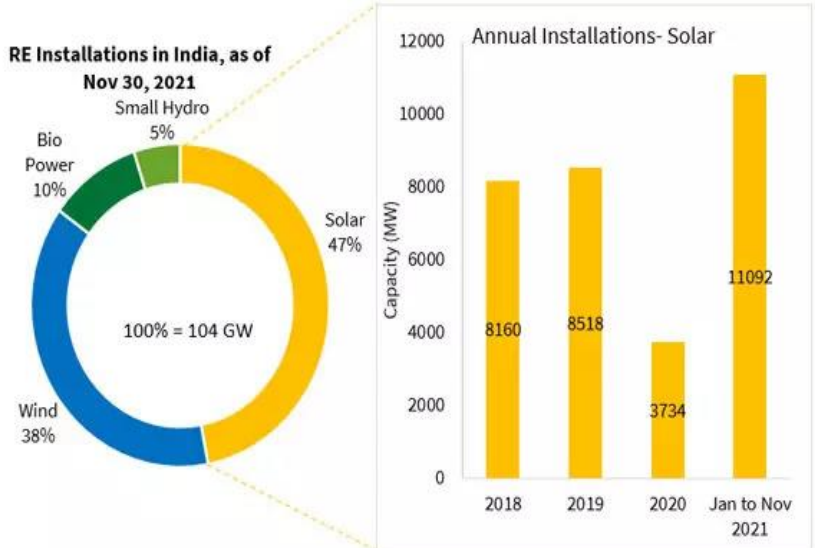
Wind Energy Resources



Solar Energy Resources

Solar energy – Potential & Installed capacity

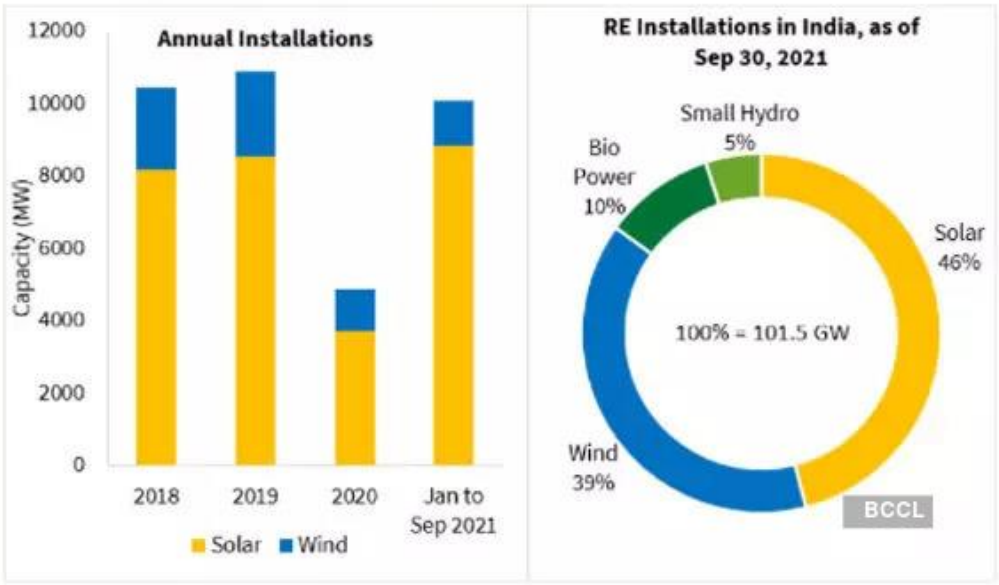
- India is endowed with vast solar energy potential. About 5,000 trillion kWh per year energy is incident over India's land area with most parts receiving 4-7 kWh per sq. m per day. Solar photovoltaics power can effectively be harnessed providing huge scalability in India.
- National Institute of Solar Energy has assessed the Country's solar potential of about **748 GW assuming 3% of the waste land area** to be covered by Solar PV modules. At this time, there are two advantages—the air is overheated and the sun is exactly over the equator.



Wind energy - Potential & Installed capacity

- The Government, through National Institute of Wind Energy (NIWE), has installed over 800 wind-monitoring stations all over country. The recent assessment indicates a gross wind power potential of **302 GW** in the country at 100 meter and 695.50 GW at 120 meter above ground level.
- The country currently has the fourth highest wind installed capacity in the world with total installed capacity of **39.25 GW** (as on 31st March 2021)

Figure 1: RE installation trends in India



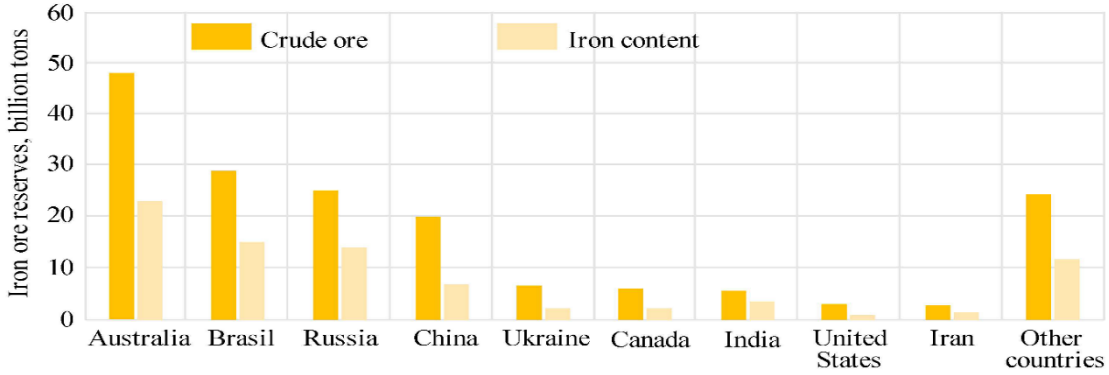
National Wind – Solar Hybrid Policy

The Ministry of New and Renewable Energy issued National Wind-Solar Hybrid Policy on 14th May, 2018. The main objective of the policy is to provide a framework for promotion of **large grid connected wind-solar PV hybrid system** for optimal and efficient utilization of wind and solar resources, transmission infrastructure and land

1. It has been provided in a hybrid project, subject to the condition that, rated power capacity of one resource be **at least 25%** of the rated power capacity of other resources for it to be recognised hybrid project.
2. The Policy provides for the integration of both energy sources i.e., wind and solar at alternating current (AC) as well as direct current (DC) level.
3. It seeks to promote new hybrid projects as well as hybridisation of existing wind and solar projects. It allows hybridisation of existing projects (wind or solar) with higher transmission capacity than sanctioned one, subject to availability of margin in existing transmission capacity.
4. It will be on the tariff-based transparent bidding process for which Government entities may invite bids.
5. The policy permits the use of battery storage in hybrid projects for optimising output and reducing variability.
6. It mandates the regulatory authorities to formulate necessary standards and regulations for wind-solar hybrid systems.

53.	**Iron Ore**	

Crude iron ore reserves in the world



1. Australia

Australia is home to the largest reserves of iron ore worldwide

The majority of the country's iron ore resources are located in the state of Western Australia, particularly the Pilbara region, with much of the remainder based in South Australia.

2. Brazil

Brazil holds the second-largest iron ore reserves globally. The country is home to the world's biggest iron ore mining operation – the Carajás Mine based in the northern state of Pará.

3. Russia

Russia is third on the list of global deposits. Key reserves in Russia are located in the Kursk magnetic anomaly in the west of the country, as well as in areas around the Ural Mountains, the regions of Tula and Siberia.

4. China

China ranks fourth on the list of the world's largest iron ore reserves. Liaoning, Sichuan, Hebei, Inner Mongolia and Shanxi are among the most iron ore-rich regions of China.

5. Ukraine

Rich iron ore reserves located in the vicinity of Kryvyy Rih, Kremenchuk, Bilozerka, Mariupol, and Kerch form the basis of Ukraine's large iron-and-steel industry.

6. Canada

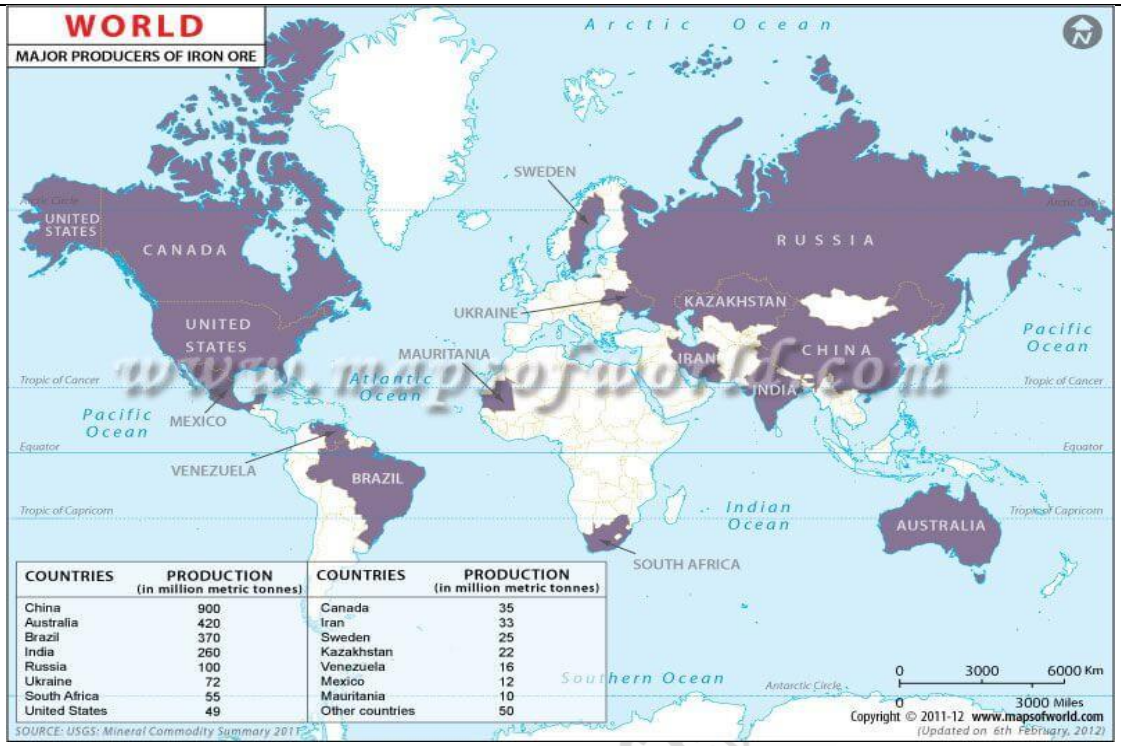
The majority of the country's resources are located in the Labrador Trough region, along the border between Quebec, Newfoundland and Labrador, as well as from Nunavut.

7. India

Resources are spread widely throughout the country, although the states of Odissa, Jharkhand, Karnataka and Chhattisgarh are notable for their productivity.

Production

China is the world's largest producer of iron-ore followed by **Brazil** and **Australia** at the second and third position respectively.



COUNTRIES	PRODUCTION (in million metric tonnes)	COUNTRIES	PRODUCTION (in million metric tonnes)
China	900	Canada	35
Australia	420	Iran	33
Brazil	370	Sweden	25
India	260	Kazakhstan	22
Russia	100	Venezuela	16
Ukraine	72	Mexico	12
South Africa	55	Mauritania	10
United States	49	Other countries	50

Iron ore distribution in India

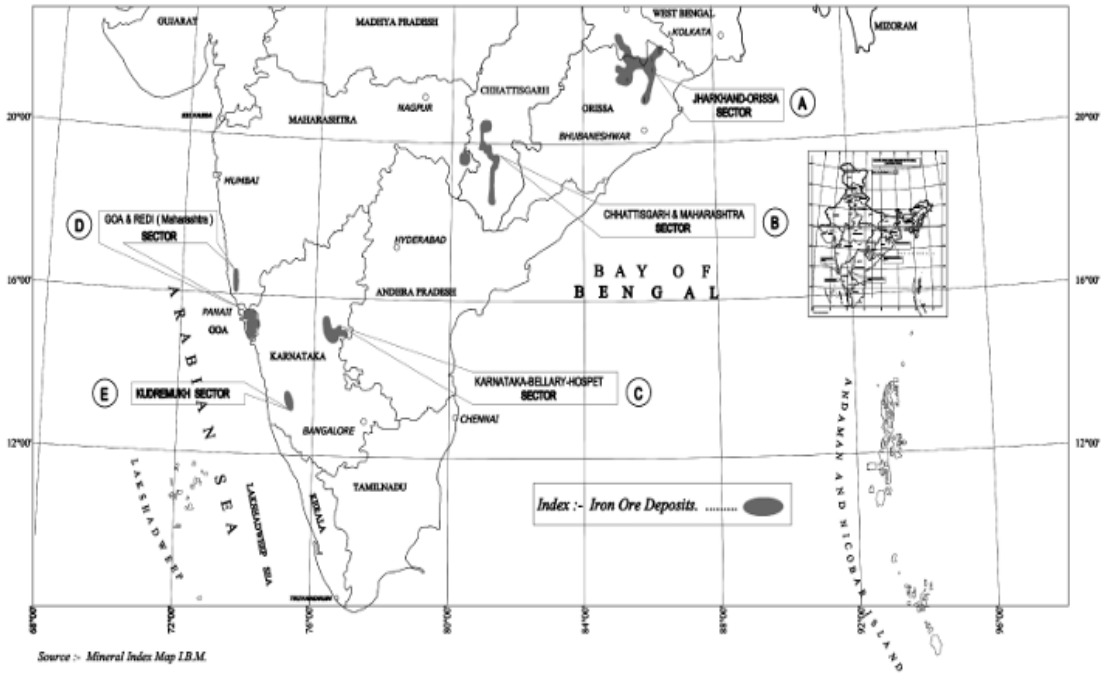


Fig. 8 : Major Iron Ore Deposits of India (Zonewise / Sectorwise

	Iron • About 95% of total reserves of iron ore is found in the States of Odisha, Jharkhand, Chhattisgarh, Karnataka, Goa, Telangana, Andhra Pradesh, and Tamil Nadu. • Sundergarh, Mayurbhanj, and Jhar are the major iron ore regions in Odisha and the important mines are Gurumahisani, Sulaipet, Badampahar (Mayurbhaj), Kiruburu (Kendujhar), and Bonai (Sundergarh). • Noamundi (Poorbi Singhbhum) and Gua (Pashchimi Singhbhum) are important mines in Jharkhand. • Dalli and Rajhara in Durg district are the important mines of Chhattisgarh. • Sandur-Hospet area of Ballari district, Baba Budan hills, and Kudremukh in Chikkamagaluru district, and parts of Shivamogga are the important iron ore regions in Karnataka. • The districts of Chandrapur, Bhandara, and Ratnagiri are the iron regions in Maharashtra. • Other iron ore regions in India are Karimnagar and Warangal district of Telangana, Kurnool, Cuddapah, and Anantapur districts of Andhra Pradesh, and Salem and Nilgiris districts of Tamil Nadu. **Prospects** • India's leading state that produces iron ore is **Odisha**. It accounts for more than 55% of the total production followed by **Chhattisgarh** producing almost 17%, this is followed by **Karnataka** and **Jharkhand** producing 14% and 11% respectively. • India is the **fifth largest exporter of iron ore in the world.** We export **about 50 to 60** percent of our total iron ore production to countries like Japan, Korea, European countries, and lately to Gulf countries. • **Japan** is the biggest buyer of Indian iron ore accounting for about three-fourths of our total exports. • Major ports handling iron ore export are **Vishakhapatnam, Paradip, Marmagao, and Mangalore**. **Problems** • Lack of adequate mechanization • Infrastructure • Financial Resources • Human Resources • Environmental Concerns • Export orientation • Trade Policy	
54.	**Arctic region**	
	Energy resources • Currently, the region produces about **one tenth of the world's oil and a quarter of its natural gas.**	

- The **Russian Arctic** is the source for about **80 percent** of this oil and virtually all of the natural gas; Arctic Canada, Alaska, and Norway are the other leading producers.
- The main regions in the Arctic linked to oil and gas exploitation are the **Beaufort Sea** (North Slope, Alaska and Mackenzie Delta, Canada), and the northwest part of the **Russian Arctic** (Barents Sea and West-Siberia). Oil and gas are also found in the **Canadian Arctic Archipelago** (Nunavut).

Mineral resources

- The most developed sector of the region, the Russian Arctic also holds abundant deposits of **nickel, copper, coal, gold, uranium, tungsten, and diamonds**. As well, the North American Arctic contains pockets of **uranium, copper, nickel, iron**, natural gas, and oil.
- The main areas for mining activities are the **Fennoscandian shield** with rich metallic and non-metallic mineral resources, as well as the Pechora coal basin in the **Russian Federation**.

Environmental consequences of extraction of resources

- **Oil spill** if occurs causes much damage to already fragile and vulnerable arctic ecosystem. This spill is impossible to clean up and takes much to recover because of factors like, lack of sunlight, high wind, low visibility and moving icebergs
- Exploration of these resources would impact **marine ecology** as it is one of fragile regions in the world. Many wild life species like polar bears would be extinct once exploration starts.
- **Toxics** like Mercury, lead and arsenic could be released into arctic region.
- Excessive **oceanic noises** during extraction process will cause damage to species like whales which uses sound for navigation and hunting.
- Once transportation linkages are established and with increase in human activity, it will lead to **complete melt** which could significantly impact sea levels across and could have impact on low lying coastal countries.

India's Arctic Policy

India's Arctic policy titled '**India and the Arctic: building a partnership for sustainable development**' lays down six pillars: strengthening India's scientific research and cooperation, climate and environmental protection, economic and human development, transportation and connectivity, governance and international cooperation, and national capacity building in the Arctic region.

India's Arctic policy **aims to promote** the following agenda—

1. Strengthening national capabilities and competencies in science and exploration, climate and environmental protection, maritime and economic cooperation with the Arctic region. Institutional and human resource capacities will be strengthened within Government and academic, research and business institutions.
2. Inter-ministerial coordination in pursuit of India's interests in the Arctic.

	3. Enhancing understanding of the impact of climate change in the Arctic on India's climate, economic, and energy security. 4. Contributing 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. 5. Studying linkages between polar regions and the Himalayas. 6. Deepen cooperation between India and countries of the Arctic region under various Arctic forums, drawing expertise from scientific and traditional knowledge. 7. 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.	
55.	**Africa**	
	Energy and Mineral resources • **Petroleum and coal** are among the most abundant minerals for 22 out of Africa's 54 countries. As of 2019, Nigeria produced most of the continent's petroleum (25 percent), followed by Angola (17 percent), and Algeria (16 percent). • **Metals** including gold, iron, titanium, zinc and copper are the top produced minerals for 11 countries. Ghana is the continent's largest producer of gold, followed by South Africa and Mali. • **Lithium** and **cobalt** are some of the key metals used to produce batteries. In 2019, about 63 percent of the world's cobalt production came from the Democratic Republic of the Congo. • **Tantalum** is another metal used in electronic equipment. Tantalum capacitors are found in mobile phones, laptops and in a variety of automotive electronics. The DRC and Rwanda are the world's largest producers of tantalum. Together they produce half of the world's tantalum. • **Industrial minerals** such as diamonds, gypsum, salt, sulphur and phosphates were the main commodity for 13 African countries. The DRC is Africa's largest industrial diamond producer, followed by Botswana and South Africa. Botswana ranks number one in Africa for the production of gem-quality diamonds – used for jewellery. Significance of Africa to India • **Resource rich region** – Africa is a resource rich nation dominated by commodities like crude oil, gas, pulses and lentils, leather, gold, and other metals, all of which India lack in sufficient quantities. • **Energy Security** – India is seeking diversification of its oil supplies away from the Middle East and Africa can play an important role in India's energy matrix. • **Strategic Interests** – especially with regards to the **Horn of Africa region**, which is an essential shipping lane that connects the Indian Ocean to the Suez Canal. • **Investment Opportunities** – several African countries have been providing incentives to attract foreign investors and partners in growth thus providing an opportunity for India. • African continent has a population of over one billion with a combined GDP of 2.5 trillion dollars making it a huge potential market.	

	• **Exports** – Africa has emerged as an important market for Indian goods and services. India can also unleash massive possibilities in digital penetration in the continent. • **Economic Growth** – Africa is home to over half a dozen of the fastest growing countries of this decade such as Rwanda, Senegal, and Tanzania etc making it one of the growth poles of the world. • **Reform in Global institutions** – India's ambition to become a permanent member of the UN Security Council makes it imperative that it engages with all 54 countries of the continent.	
56.	**Ocean/Marine Resources**	
	Energy resources • Wave energy (Uses kinetic energy of wave) • Tidal energy (harvest power between high and low tide; tidal-current or tidal-stream technologies) • Salinity gradient energy (Technology involves pressure retarded osmosis and reverse electro dialysis) • Ocean thermal energy conversion. (It generates power from the temperature difference between warm surface seawater and cold seawater at 800–1,000 metres depth.) **Mineral resources** • Exploration for offshore petroleum and natural gas. • Poly metallic sulphides and manganese nodules. • ilmenite (a mixture of iron and titanium oxide) • Placer Gold, Tin, Titanium, and Diamonds. • Phosphorites **Biological resources** • Invertebrate animals like bacteria, fungi, other microorganisms, cyanobacteria, micro- and macro-algae, sponges, molluscs, • Major global fisheries are herring, cod, anchovy, flounder, tuna, shrimp, mullet, squid, crab, salmon, lobster, scallops and oyster. • Sea weed and sea grass in particular are most sought after • Apart from food, many biological species are important for ocean ecosystem (Marine turtles, Sea dolphins, Whales) • Primary consumers in the ocean play a primary role in carbon sequestration. (Phytoplankton, cyanobacteria, green algae etc.) **Environmental consequences of extraction** • Disturbance of the seafloor due to dredging • Sediment plumes would harm marine biodiversity • Disruption in carbon transport • Noise, vibrations, light pollution. **Effective sustainable management practices** • Rigorous and transparent impact assessments • Real time monitoring of mining activities using sensors and underwater drones • **Bridge The Knowledge Gap With Open Data** • The Precautionary Principle and the 'Polluter Pays Principle' are implemented; Circular economic principles to reuse and recycle minerals	

57.	**Blue revolution**	
	The Blue Revolution scheme concentrates mainly on enhancing the production and productivity of aquaculture and fisheries both from the inland and marine sources. **Prospects** • Providing food and nutrient security • Providing employment and livelihood opportunity (From fisheries to ship development) • Major foreign exchange earner. • Extraction of different resources. • Commerce and trade (Primary and secondary) • Coastal led development (Socio-economic factors) • Carbon sequestration through Blue carbon • Coastal habitat protection and restoration **Problems** • Degradation and loss of natural coastal resources. (Unsustainable extraction) • Fear of monoculture and loss of diversity (Invasive species) • Environment degradation (noise pollution, micro plastic pollution, water pollution) • Impact on climate change (Global warming, hydrogen sulphide clathrate) • Marine piracy and terrorism. • Divide between North and south bloc • Gender divide (women representation is less than 1% in industry) **Indian context** • 95% of the country's trade is being carried on by sea. • Growth catalyst for 10 $1 trillion economy • Trade in IOR region increased four times since 2012 • Fish production – As per FAO, except Indian ocean all other ocean nearing their fisheries limit • Deep sea minerals – Poly metallic nodules, Poly metallic sulphides, • Ship building industries and ship breaking industries – Alang port is a dominant player in it.	
58.	**India's Policy towards utilizing Indian Ocean resources**	
	India has a unique maritime position. Its 7517 km long coastline is home to nine coastal states and 1382 islands. The Government of India's Vision of New India by 2030 enunciated in February 2019 highlighted the Blue Economy as one of the ten core dimensions of growth. **Deep Ocean Mission** It explore deep ocean for resources and develop deep sea technologies for sustainable use of ocean resources. It consists of six major components . 1. Development of Technologies for Deep Sea Mining, and Manned Submersible	

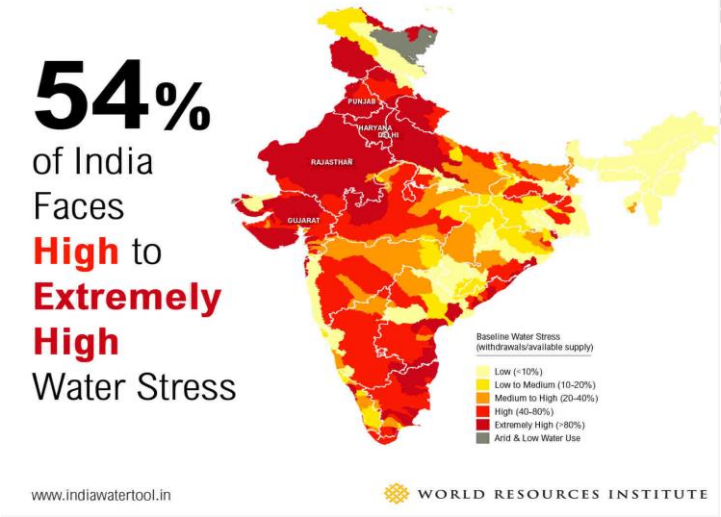
	2. Development of Ocean Climate Change Advisory Services 3. Technological innovations for exploration and conservation of deep-sea biodiversity. 4. Deep Ocean Survey and Exploration 5. Energy and freshwater from the Ocean 6. Advanced Marine Station for Ocean Biology. **Samudrayan** It is India's first unique manned ocean mission that aims to send men into the deep sea in a submersible vehicle for deep-ocean exploration and mining of rare minerals. It will send three persons in a manned submersible vehicle MATSYA 6000 to a depth of 6000 metres into the sea for deep underwater studies. It is a part of deep ocean mission. **Blue revolution/Neel Kranti** It is aimed at enhancing the economic prosperity of the country by augmenting fisheries, fish farmers and contributes towards food and nutritional security. The mission utilizes water resources for fisheries development in a sustainable manner, considering the bio-security and environmental concerns. **Matsya Sampada Yojana** It is a flagship scheme for focused and sustainable development of the fisheries sector in the country. It will bring about the Blue Revolution by harnessing of fisheries potential in a sustainable, responsible, inclusive and equitable manner. **Fisheries And Aquaculture Infrastructure Development Fund (FIDF)** It is an umbrella scheme designed to address critical gaps in fish production and productivity, quality, technology, post-harvest infrastructure and management, modernisation and strengthening of value chain, traceability, establishing a robust fisheries management framework and fishers" welfare.	
59.	**Fresh water resources in India**	
	Distribution In India • 4% of the world's water resources and India receives the second most amount of rainfall. • Freshwater resources in India can be divided into Surface water and Ground water. • Four significant surface water resources: rivers, lakes, ponds, and tanks. • India's river basins are estimated to be 1,869 cubic kilometres. However, but only roughly 690 Cubic's kilometres of accessible surface water. (90% of the annual flow is from **Himalayan Rivers.)** • Total replenishable groundwater resources are around 432 cubic kilometres. About 46% are in Ganga and Brahmaputra basin • Groundwater utilization is relatively high in Northwestern and southern India • States like Kerala, Odisha, and West Bengal have huge surface water resources in these lagoons and lakes.	

Water Scarcity Issues

Causes →Population (4% water resources but 17% of world population), →pressure by agriculture through ground water extraction, → per capita water storage (200 m^3) is well below the minimum threshold of 1000 m^3, →natural calamities such as drought and flood, →water contamination, →destruction of water recharging area like wetlands, aquifers. → rapid unplanned urbanisation.

Effects → Food and nutrient security affected → Reduced access to sanitation → Water wives → farmers suicide → Widening urban rural divide (Urban cities would extract water from near by villages) → Poverty and violence

Solution → Shift in agricultural practises (replace water intensive crops, flood irrigation, free electricity) → mandatory water harvesting → Afforestation, wetland conservation, micro dams → prevents export of virtual water → scaling up micro irrigation → Water management practices including water recycling → Use of technology like desalination



Water Harvesting and Conservation Techniques

Roof top harvesting →Gully Plug →Contour → Bund Gabion Structure →Percolation tank →Check Dam/ Cement Plug/ Nala Bund →Recharge shaft → Dugwell Recharge →Ground Water Dams/Subsurface Dyke.

Advantages:

Counter disasters like flood and drought → Reliable and cheap mechanism for recharging groundwater → Reduces soil erosion → Best method for urban water scarcity.

Challenges:

Lack of community participation → Private investment → Financial and technical support → Poor awareness.

60. Effective management of Land resources

Problems

- Agricultural land diversion – food insecurity
- Unplanned urbanization→ congestion, inefficient resource utilization
- Deforestation, Groundwater depletion
- Land pollution→ groundwater percolation → water scarcity, health hazards
- Overgrazing, erosion etc.,

Way Forward

- Innovative & inclusive land Pooling Scheme for infra projects – E.g., Andhra's capital Amravati
- Cooperative farming – more capital → modernisation → increased yield & productivity e.g. –China's farmers' cooperative
- Improve productivity, resilience and viability of land
- Protection of soils from erosion, salinization, and other factors responsible for degradation.
- Modern, scientific and viable --New farming techniques – terrace farming, vertical farming, mixed farming
- Proper, sustainable urban planning, afforestation
- **5R - refuse, reduce, reuse, repurpose, and recycle**→ reduced landfill, Pollution

61. Forest resources in India

Ecological & Economical significance

- Indian forests produce → **90% of which are commercially valuable.**
- Major forest products - timber, softwood, and fuelwood, teak, mahogany, logwood, iron-wood, ebony, Sal etc., & Minor forests products.
- Secondary sector dependance for raw material, Interconnectedness with tribes for their lives and livelihood
- Aesthetic value, research & medicinal value, Tribal – medicinal knowledge
- **Ecological value** → Conservation of Biodiversity, maintain ecological balance, generation and absorption of rainfall, Prevention and control of soil erosion, Flood control, checks on spreads of deserts (Great Green Wall of Africa), Increase of soil fertility, carbon absorption- carbon sink, cushion against climate change, Oxygen supplier, Amazon – lungs of the world
- Forests are home to 80% of the world's terrestrial biodiversity.
- nearly 25% of the world's population rely on forests for their livelihoods

Reasons for depletion

- Deforestation, Mining, Jhum cultivation, forest fire (Brazil & Australian forest fire)
- Plant Diseases, Insects, and Pests
- Obsolete Methods of Lumbering and Sawing
- Indiscriminate mining, construction of dams & check dams, infrastructure projects e.g., Chardam project -road widening
- Environment vs economy
- Climate change induced natural disasters -- Earthquake, landslide, flooding etc.,
- "**Man finds forests but leaves deserts**" – Overexploitation, ineffective and scientific utilisation of resources

Impact on climate change

- Approximately 2.6 billion tonnes of carbon dioxide, one-third of the CO_2 released from burning fossil fuels, is absorbed by forests every year.
- Forest – carbon sink – absorb and store carbon over an extended period of time – plays an important role in carbon cycle.

	• Carbon stock - the amount of carbon stored in the world's forest ecosystem • Forest - stabilising force for the climate, environmental stability • Climate change → Reduced precipitation → affects the carbon storage and above ground biomass of forests. • Tropical forests – more diverse – more vulnerable to the impacts of climate change • Drought and heat impacts → tree mortality → alters species composition and diversity → migration and species distribution → competition for resources increases. • Forest fire - decreased seedling and sapling densities & species diversities.	
62.	**Green revolution**	
	Reasons for regional variation • Impact of GR felt only 40 percent of the total cropped area; 60 per cent is still untouched. • Limited to irrigated areas – as HYVS require intense water irrigation, mostly concentrated on Wheat, only regions having assured water supply and a package of other inputs (on whose -availability the success of HYVP crucially depends) derived benefits ➢ **Green revolution areas** - Punjab, Haryana and western Uttar Pradesh in the north and Andhra Pradesh and Tamil Nadu in the south – areas better placed from an agriculture point of view • Hardly touched -Eastern region, including Assam, Bihar, West Bengal and Orissa and arid and semi-arid areas of Western and Southern India. • Problem of regional disparities has further aggravated as a result of the Green Revolution. **Problems** • High Yielding Variety Programme (HYVP) was restricted to only five crops: Wheat, Rice, Jowar, Bajra and Maize – other grains left out. • Excessive usage of Chemical fertilizer & pesticides → health hazard – increased water consumption, Water resources became polluted and depleted, eutrophication ➢ Punjab is a major wheat- and rice-cultivating area - hence - highest waters depleted regions in India. • Repeated crop cycle depleted soil nutrients • Negative impact on environment, poor landless laborers • Soil degraded it to an extent of non-restoration. • Regional disparity aggravated. **Prospects** • Diversification in crop production, value addition, and agri-business development in the rural sector →key to livelihood security • Building on the strengths of the Green Revolution- avoid its weaknesses→ sustainable food security in the country. • Diversion of food crops, mixed farming, permaculture, Sustainable agriculture, suitable technological support, promotion of organic farming, ZBNF etc., • Issues such as suitable technologies for rainfed areas, resource management, better livelihood strategies and trade should be Incorporated In the policy	

63.	**Mining Industry**	
	Distribution and location factors in India India produces -95 minerals, which includes 4 fuel, 10 metallic, 23 non-metallic, 3 atomic and 55 minor minerals. **Northern belt:** • Chota Nagpur region: Kynite, Iron, Chromium, Mica, Coal, Manganese, copper, and limestone. • Assam region: petroleum and lignite coal, tertiary coal, etc. **Central belt:** • Chattisgarh and Maharashtra-Iron and limestone • Godavari-Wardha valley **-** huge coal reserves **South Eastern region:** • Eastern Karnataka –iron ore hotspots • Andhra –Cuddapah and Kurnool –Mica reserves • Telengana –Bauxite • Tamil Nadu –Lignite coal **South Western region:** • Karnataka –Dhrawad -High mineral reserves • Goa –High mineral reserves • Ratnagiri –Iron reserves **North Western region:** • Gujarat –Petroleum, Salt • Rajasthan –Salt, Building stones (sandstone, granite, marble, Dolomite and limestone) **Conclusion:** Utilisation of District Mineral Foundation - construct physical & social infrastructure and efforts- integration of the local population in the process.	
64.	**Sand Mining and its impact on river beds**	
	Sand mining –is said to increase in future: • Urbanisation • Increasing global population • People's Prejudice about construction in River sands **Illegal sand mining causes:** • Prevalence of Unemployment, poverty and other socio economic inequalities. • Environment ministry guidelines - just advisory in nature. • Conviction of –illegal sand mining by NGT –low. • Lack of integerated framework –governance,planning and management of resources . **Impact of sand mining on river beds:** • Change the course of river→degraded river banks →flooding • Increased sedimentation in rivers • Destroys-aquatic habitat –Invasive alien species prevalence • Ground water recharge gets affected –negatively –salinization of groundwater. • Channel widening –shallow of river beds –death of aquatic animals.	

	• Impact on riparian buffers –trees get affected –negative impact on water cycle. **Conclusion:** M-sand, innovation in construction sector.	
65.	**Footloose Industries**	
	Footloose industry is a general term for an industry that can be placed and located at any location without effect from factors of production Role in regional climate influence. **Characteristics** • **Location:** Can be established at any place- I.T parks • **Eco friendly**: Less polluting industries –camera making industry. • **Less transport cost:** High value addition and small in size- precision instruments. • **Small plant size:** Diamond cutting –no need of complex processing machines. • **Less raw material dependence:** less dependent on specific raw material-mobile manufacturing industry. • **Less labour force:** production in small numbers –so less labour force – crafting of gold. • **Skilled work force: need** for high quality precision –skilled workforce - watch making industry. **Conclusion:** Footloose industries → high-value employment opportunities + competitive advantage in world trade	
66.	**Resource based manufacturing**	
	Developing industry from –locally available resources **Significance:** • Promotes mining and manufacturing resource • Provides market for mined resource by cost cutting measures • Promotes the expertise of resource –region. • Promotes - growth - secondary industries ex: automobile industry growth via growth of Iron and steel industry • Promotes employment through creation of more supply chains – example: AMUL in Gujarat • Narrows the scope for regional imbalance. **Problems Associated:** • Land acquisition and settlement issues (migration) • Resultant environmental degradation • Environment impact assessment and the flaws in it • Intra-regional disparities **Conclusion:** One district one product, North East Industrial Development Scheme, GI-tagged products, are aligned towards resource-based manufacturing.	

67.	**Iron and Steel Industry**	

Locational factors for its Global distribution

Raw materials, Transportation and other infrastructure, Investment and Entrepreneurship, Labour, Market Government policy.

China

- Is the highest producer of iron and steel in the world. The iron and steel industry is concentrated in **Anshan, Wuhan and Paotow triangle**.
- For Wuhan plants, ore is obtained from Taylh, i.e., 130 km away, and coal from Pingtinghan to the north of Yangtze River.

Japan

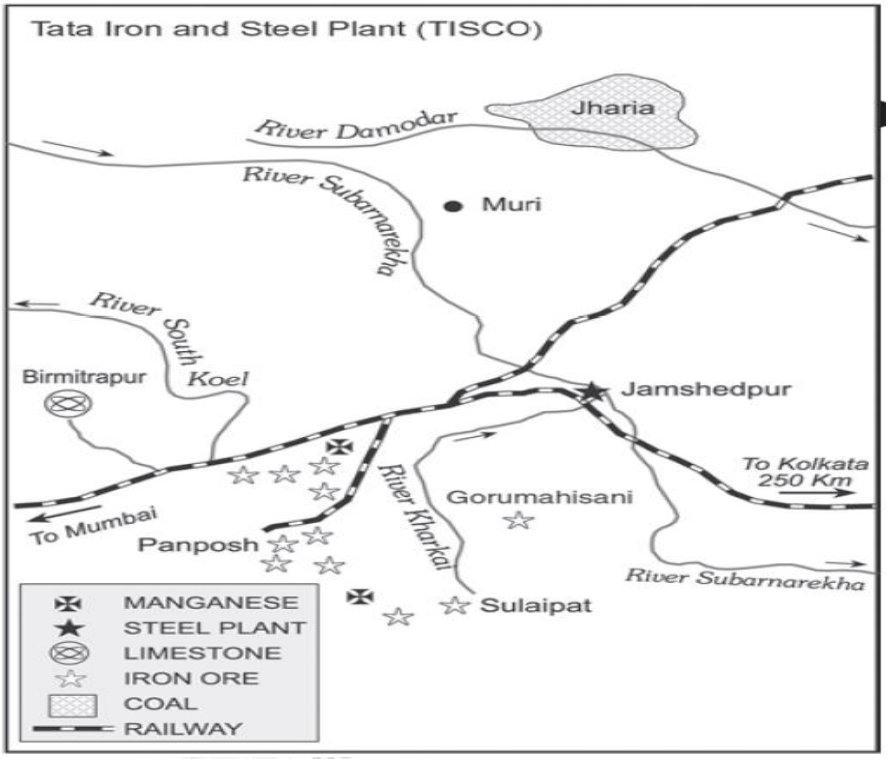
- **Yawata** is a major centre of heavy industry plants directly connected with regional mineral resources over half of the Japan's steel capacity is concentrated near the major port cities of Himeji, Kobe-Osaka.
- These steel plants, at or near tidewater, are thus able to draw raw materials from many parts of the world and similarly to ship finished products.

United States of America

- **Pittsburgh Region** This district contains about 42.5 per cent of the blast furnace capacity of the country is the second greatest centre of steel industry in the world.
- The industries in this region are located almost exclusively in the narrow valleys of the headwater streams of the Ohio River, including the upper reaches of the Ohio itself.

Locational factors for its distribution in India

- **Raw material**: Concentration of Iron and steel industry in Chota Nagpur region-Presence of Iron ore in this region. TISCO at Jamshedpur.
- **Availability of electricity** Eg: Bokaro steel plant on banks of river Damodar, Visheshwarya steel plant, Kar near river Bhadra.
- **Markets:** Visakhapatnam steel plant located near the coast has excellent import-export facility
- **Cheap labour** : Rourkhela plant, Orissa; Bhilai steel plant in Chattisgarh, mostly in **Chota Nagpur** region



68. Cotton Textile Industry

Factors influencing location and distribution

- **Raw material**: Distribution of over 90% of the industry is conterminous with the cotton-growing tracts in the relatively drier western parts of the peninsula and the Great Plains. **Large centers like Ahmadabad, Coimbatore, Solapur, Nagpur and Indore** are situated in areas of large-scale cotton cultivation.
- **Market**: Market is the second most important factor responsible for the development of these industries. Situated in the **tropics and sub-tropics the country enjoys a warm climate and cotton cloth** is in use for the whole year
- **Cheap labour: plays a vital role in production example: Coimbatore, Ahmedabad**

	Distribution • **Maharashtra**: It is the **leading producer of cotton yarn and cloth**. Here **Mumbai is known as cottono-polis of India** followed by Solapur, Nagpur, Pune, Jalgaon, Kohalpur, etc. • **Gujarat**: It **ranks second in cotton yarn and cloth production** and in terms of a number of mills. Important centres are Ahmadabad, Surat, Broach, Baroda, Bhavnagar, Cambay, Rajkot, Kalal, etc. • **Tamil Nadu**:It has the **largest number of mills**. Important centres are Coimbatore, Madras, Madurai, Tirunelveli, Tuticorin etc. **The problems of Cotton Textile Industry in India:** • Long staple cotton is not well grown in many parts of India. • Many of the factories are old and, as such, productivity has been lowered. • High cost of advanced machinery is an unavoidable hindrance for the procurement of new machinery. For this reason, the much-needed replacement had to be deferred for many years. • The high cost of production is also effectively retarding the growth of this important industry. • There is competition from synthetic fibers like polyester, etc. • There is competition in the International Market from Bangladesh, Japan, China, and Britain, etc. • Great difficulties are being experienced by mill-owners in obtaining the capital needed for modernization. The **ten largest cotton producers** in the world are: 1. India - 6,188,000 tons 2. China - 6,178,318 tons 3. United States - 3,593,000 tons 4. Pakistan - 2,374,481 tons 5. Brazil - 1,412,227 tons 6. Uzbekistan - 1,106,700 tons 7. Australia - 885,100 tons 8. Turkey - 846,000 tons 9. Argentina - 327,000 tons 10. Greece - 308,000 tons	
69.	**Sugar Industry**	
	Factors for the localization of sugar industry • Sugarcane is the main raw material for making sugar. Sugar mills can be set up only in the sugarcane producing areas. Sugarcane gets dry soon after harvesting. It can neither be stored nor kept for long period of time. Sugarcane should be taken immediately to the sugar mills after harvesting. • Transportation cost of sugarcane is high. Generally, sugarcane is transported through bullock carts which can carry it upto 20-25 kilometers. • Beside these factors, capital, market, labour and power also play significant role in localization of this industry.	

Distribution

- **Uttar Pradesh –** It holds a significant position in the production of sugar. The sugar mills are highly concentrated in the western Uttar Pradesh in the districts of Meerut, Muzaffar Nagar, Saharanpur, Bijnor, Moradabad and Bulandshahar. In the eastern Uttar Pradesh Deoria, Basti, Gonda and Gorakhpur are important centres. Uttar Pradesh has largest area under sugarcane cultivation. It has about half of the total area under sugarcane cultivation.
- **Maharashtra –** Maharashtra is the most important state in the peninsular India producing about one fourth of the total sugar production in India. Major centres of sugar production are Nasik, Pune, Satara, Sangli, Kolhapur and Sholapur.
- **Andhra Pradesh –** East and West Godawari, Visakha-pattnam, Nizamabad, Medak and Chittoor districts are the centres of sugar mills in this state.
- **Tamil Nadu –** In Tamil Nadu North and South Arcot, Madurai, Coimbatore and Tiruchirapalli are the important districts for sugar production.
- **Karnataka –** It is also an important sugar producing state. Belgaum, Mandya, Bijapur, Bellary, Shimonga and Chitradurga are sugar producing districts.

Reasons for shifting of sugar industry from North India to Peninsular India

Over the period, sugarcane industry is gradually shifting from north Indian states to states in Peninsular India. Some of the important reasons are as follows:

- The production of sugarcane per hectare is higher is Peninsular India. In fact, sugarcane crop grows well in the tropical climate of south India.
- The sucrose contents is higher in the tropical variety of sugarcane grown in the south.
- The crushing season in south India is longer than in north India.
- In south India most of the mills have modern machinery.
- Most of the mills in Peninsular India are in cooperative sector, where profit maximization is not the sole objective.

Problems of Sugar industry

- **Low Yield of Sugarcane**: Although India has the largest area under sugarcane cultivation, the yield per hectare is extremely low as compared to some of the major sugarcane producing countries of the world.
- **Short crushing season**: Manufacturing of sugar is a seasonal phenomenon with a short crushing season varying normally from 4 to 7 months in a year.
- **Fluctuating Production Trends**: Sugarcane has to compete with several other food and cash crops like cotton, oil seeds, rice, etc.
- **High cost of Production**: High cost of sugarcane, inefficient technology, uneconomic process of production and heavy excise duty result in high cost of manufacturing

70.	**Factors Affecting the location of Food Processing Industry**	

Transport.

- Most agricultural products either lose weight and bulk in processing, meaning they can be transported more cheaply after they have been processed, or they are perishable and so can be more easily transported in processed form. Therefore, connectivity and transport availability is a key factor in determining the location of processing industries.

Availability of Labour.

- Abundant and Cheap labour is a prerequisites for the location of processing industries due to its labour intensive nature.

Availaiblity of Power.

- Food Processing requires a high degree of preservation of raw agriculture produce (especially of perishable products) therefore, requires continuous power supply to run cold storage chains and facilities.

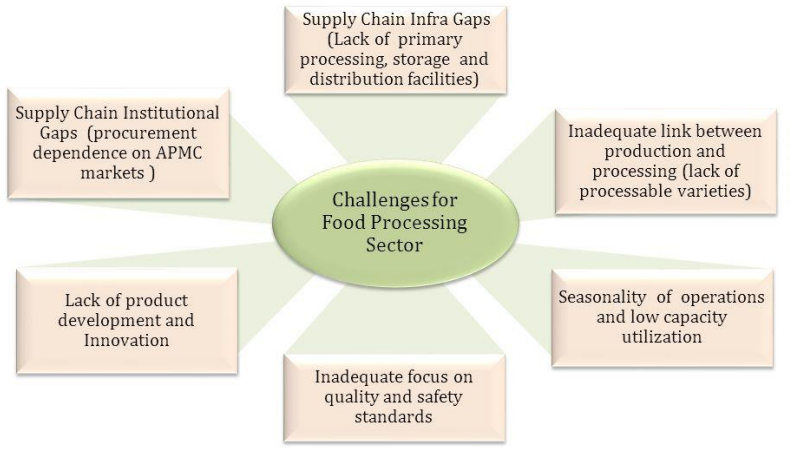
Infrastructure.

- The Growth of any industrial unit depends on the ease of physical infrastructure like roads, highways, railways etc. for transportation of both raw materials and end products.

Production Centres where raw materials are produced.

- Food Processing industries based on raw products can often be set up economically in the area where the raw material is produced.
- They can therefore contribute to the relief of the rural underemployment which is characteristic of developing countries.

Food Processing Sector– Impediments



71.	**IT Industry**	

The information technology industry deals in the storage, processing and distribution of information.

Locational factors for its distribution in India:

- **Resource availability**: labour like technicians, computer engineers and management staff and cost. High number of students with B.Tech and BCA degrees in cities like Chennai, Bangalore, Hyderabad, Pune etc, willing to work for lesser wages than western countries in providing the same service.
- **Conducive climate for working**. Silicon Valley in the US, Bengaluru in India have a mild climate.
- **Proximity** to doesn't matter as clients can even be abroad. **Tertiary sector** – so no requirement of raw material. Startups are highly decentralised in nature. A footloose industry.
- **Govt policies**: newer opportunities, ease of doing business, demand for digitisation, impetus towards e-gov, better delivery of public services like power supply and providing infrastructure like SEZs and new security policies like data localisation.
- **Others**: Pandemic driven work from home (WFH) culture made companies discover a new efficient way to manage resources at a lesser cost.

Significance and contributions:

- One of the greatest job providers for graduates in the last two decades.
- Contributes to over 8% of India's GDP.
- Instrumental in tapping into the demographic dividend of India.
- India is the largest exporter of IT servies.
- India's talent pool in the sector. CEOs of many top global firms are Indians.

Socio-economic implications:

- **Economic empowerment rise** of new middle class through higher employment opportunities and development of ancillary businesses.
- **Gender parity**: Labour force participation of women in quality jobs is comparatively more in major cities, due to development of IT industries. Led to their financial independence and empowerment.
- **Cultural changes**: Shift towards accepting western language, rise in nuclear families, and change in food and clothing choices and modes of recreation. Ex: Cafe culture in Bengluru.
- **Social infrastructure**: Development of IT industries have given boost to the social infrastructure. This could be seen in high availability of schools, hospitals etc.
- **Migration**: Preference among youth to migrate into these cities for better career opportunities leaving senior citizens behind.
- **Un-balanced development**: Concentration of IT industry in a handful of cities, have led to the neglect of many tier 2, tier 3 towns. Un-healthy development divide in the country. Huge wage gap between IT workers and other workers.
- **Security challenges**: The late-night work culture, rise in affluency have parallelly enhanced the security challenges for the citizens and administration alike with incidents of thefts, eve-teasing and sexual

harassment at work place etc. on a rise, especially in fringe areas of such cities owing to speedy urbanization.

Way forward:

- Challenges like loss of jobs due to pandemic and automation should be foreseen and a robust IT industry should be developed.
- Should be decentralised into tier 2 and 3 cities as well, to balance the growth and provide an inclusive development.

72. Pharmaceutical Industry

Location factors:

- **Market**: Proximity to global markets like Africa, making west coast of India ideal. Export oriented.
- **Raw materials**: Proximity to petrochemical hubs. Gujarat has 40% of pharma custers in India.
- **Capital**: Mumbai-Ahmadabad-Pune region has been the traditional hub of trade and capital.
- **Labour**: Cheap supply of skilled and semi-skilled labour.
- **Power and water supply** and suitable climatic conditions. Ex:
- **Government policies**: opening up FDI to 100%, Jan Aushadhi Campagins, stable industrial policies of states like Gujarat and Maharashtra.

Prospects:

- One of lowest manufacturing costs in the world. Largest provider of generic drugs.
- Huge demand for life-saving drugs: Both domestic and global. Ex: Covid vaccines and drugs.
- The traditional system of medicine is also being promoted by the govt.

Concerns:

- **Overdependence**: Indian pharma industries import about 80% of Active Pharmaceutical Ingredients(API) from China. Risky during times like trade-war, pandemic and similar uncertainties.
- **Technology**: Lags in R&D.
- **Compliance issues**: Diversifying the global market has been a problem with countries like USA imposing Sanitary and Phyto-Sanitary(SPS) barriers of WTO against generic drugs. Ex: selective targeting by USFDA.
- **Drug Price Control Order**: The companies cite that the reforms of the Government for the essential medicines has caused them to lower the price of drugs.
- **Stronger IP regulations**: The companies strongly feel that the rules have to be amended and the so-called victim of the lax regulations have been the foreign entrants.

Way forward:

- Overcoming the challenges like IPR issues by designating a think-tank and better multilateral treaties as the country is slowly becoming 'pharmacy of the world'.
- Schemes like PLI scheme of pharmaceuticals, PMBJP, Promotion of Bulk Drugs, PMBJK shops etc.

73. Electronic parks

UP govt planning to set up an electronic park at Yamuna Expressway Industrial Development Authority(YEIDA). Maharastra govt in Ranjangaon, Pune.

Relevance

- Global semi-conductor and IC shortage.
- India is likely to achieve electronics production of $300 billion by 2026. Targets $400 billion by 2025 as per the National Policy on Electronics (NPE) 2019.
- Electronic hardware are used as components across a wide range of products like computers, telecommunication, automobiles, mobile devices, white goods and much more.
- Benefits for India: Potential to become top exporter in next 3-5 years, forex earnings and employment generation.

Factors influencing location:

- Availability of labour like engineers and mid to top level management
- Proximity to the market is more crucial than source of raw materials as it is neither weight-losing nor forms a significant cost of the final product and raw materials come from various sources.
- Labour relations in the region, ease of doing business and governmental policies. Ex, 100% FDI allowed through automatic route in India.

Policies and schemes in India:

- Production Linked Incentive Scheme (PLI) for large scale electronics manufacturing. To boost domestic manufacturing and attract large investments in the electronics value chain including electronic components and semiconductor packaging.
- Scheme for Promotion of Manufacturing of Electronic Components and Semiconductors (SPECS). A financial incentive of 25% of capital expenditure for the manufacturing of goods that constitute the supply chain of an electronic product.
- Modified Electronics Manufacturing Clusters Scheme (EMC 2.0). To provide financial assistance.
- Electronic Hardware Technology Park(EHTP) Scheme. Duty free imports/domestic procurement permissible for capital goods, raw materials, components and other inputs, Central Sales Tax refundable for MSMEs.

Way forward:

- Overcoming various challenges being faced by the industry across qualitative (non-tariff, infrastructure related) and quantitative (tariff, free trade agreements etc.) aspects.
- Exploiting opportunities like increasing labour cost in China, US-China trade war and providing an alternate solution for the global electronics companies.

74. Fishing clusters

Significance:

- An important source of food production, nutritional security, employment, and income in India.
- Direct source of livelihoods for more than 20 million fishers and fish farmers. Long coastline.
- Contributes 1.07% to GDP. 3rd largest fish producing and 2nd largest aquaculture in the world.
- Major export earner – 4th largest exporter, with fish being one of the country's largest agriculture commodities exported.

Blue Revolution:

- Started in 1970s during the 5th Five Year Plan.
- Adopted new techniques of fish breeding, rearing, marketing and export.
- Led to huge increase in shrimp production. Nellore – shrimp capital of India.
- From 0.75 million tonnes in 1950-51 to 3.8 MT in 1990-91. Currently over 14 MT per year.

Concerns:

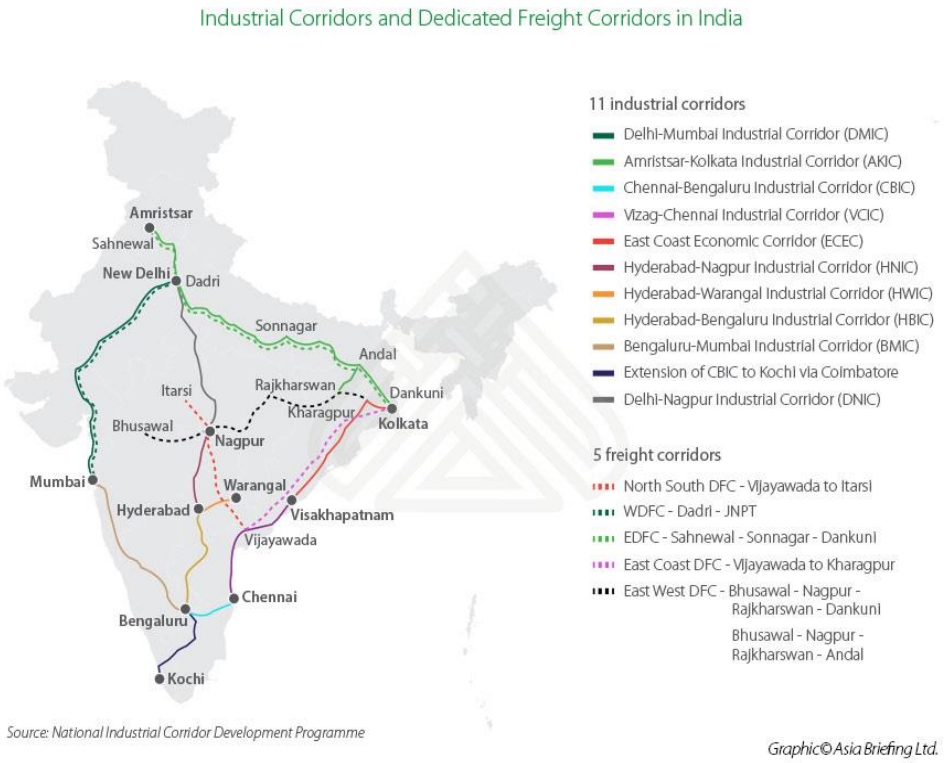
- India's tropical climate: Fish cannot be preserved for long. Heavy expenditure and requirement of cold chain systems.
- Seasonal phenomenon affecting marine fishing. Strong monsoonal winds and tropical cyclones hinder fishing operations.
- About 60% of fishermen still use small non-mechanised boats. Most of them are poor and don't have good equipment to improve catch.
- Diminishing area: Pollution of water bodies, area of paddy fields that supported fisheries declining.
- Environmental: Overfishing, by-catch, bottom trawling, sustainability etc.
- Territorial issues: Disputes with Sri Lanka and Pakistan.

Government measures:

- National Fisheries Policy 2020. Merged marine, inland, aquaculture and mariculture policies.
- Sagar Parikrama: To know the problems of coastal fishing communities.
- Pradhan Mantri Matsya Sampada Yojna: To bring out intergrated, sustainable, inclusive development of marine and inland fisheries.

75.	**Industrial corridors**	

The different sectors of an economy are interdependent on each other. The industrial corridor is a package of infrastructure spending allocated to a specific geographical area, with the intent to stimulate industrial development→ Key to Manufacturing GVA



Location Factors:

Industrial Areas and Parks to be connected, Existing Infrastructure→ Proximity to Industrialised cities→ Availability of Raw materials→ Weight Losing Industries

Significance and characteristics:

→Jobs Opportunities, several industries are linked- Export- Reduction in logistics cost.

→Regional Imbalances→ Resource-Based Manufacturing can be benefical (PYQ- Read more on it if u don't know)→

→Distress Migration→Balanced Regional Growth

Challenges:

Funding- Nearly 100 billion Needed→ Private Participation→Land Acquisition Problems→ Environmental Clearances→ Cost overruns

Most of the corridor's feasibility is based on Urban Infrastructure Linkages and Rural-Urban Divide widens.

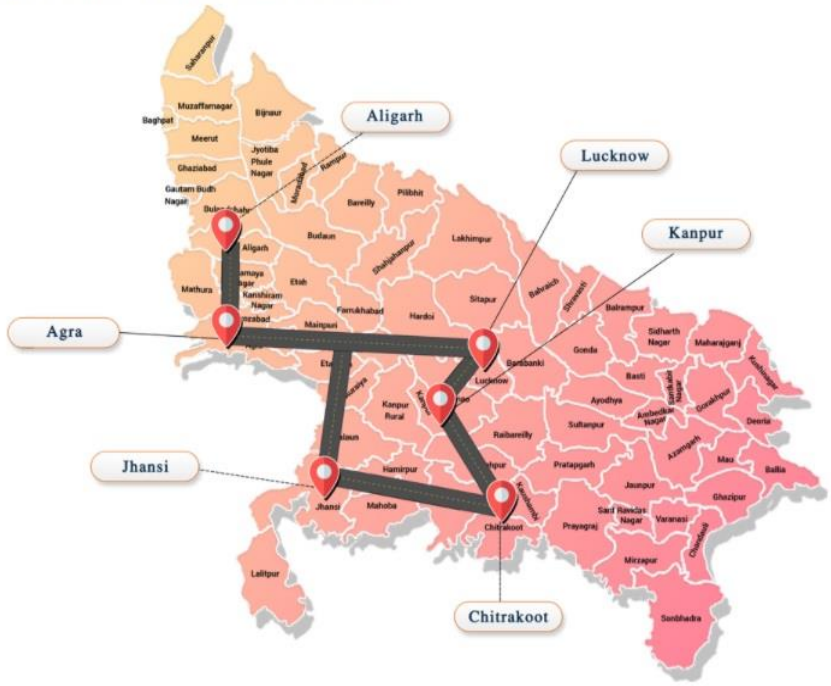
Conclusion:

NIMZ, SEZ, Industry 4.0, Interlinking of Corridors for Industry, Infrastructure Push- GATI Shakthi etc

76.	**Defence corridors**	

To meet the twin objectives of Defence Manufacturing and Industrial Development→ Two Defence Industrial Corridors (DICs), one in each state-- **Uttar Pradesh and Tamil Nadu**

Uttar Pradesh Defence Industrial Corridor



Bundelkhand Region as part of DIC- to usher developmental opportunities to the under-developed areas of the country.

Issues:

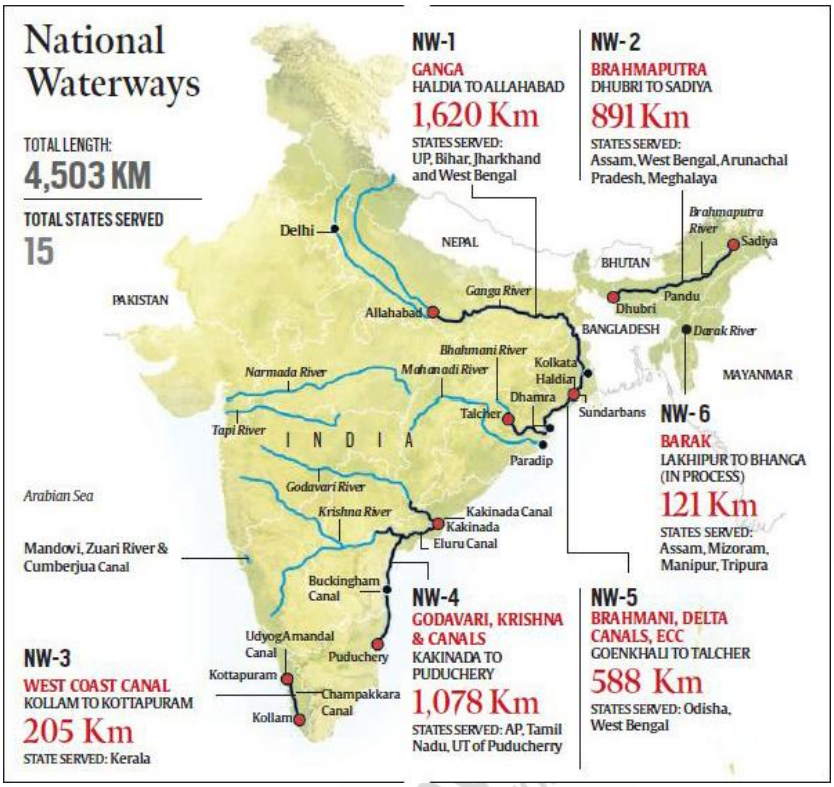
Competitive resource politics- States demand for more DIC- So spatial imbalances cannot be corrected→ No Small Players → Ancillary Industries not well developed→ Federal Complexities etc

Way forward:

More DIC's needed but optimised planning → Integrate with existing corridors

77.	**Inland Water transport- Only Geographic Angle Given (Economy Module Will Also Have this Topic)**	

7.5k KM Coastal line but more than 14.5k Inland→ Underutilised→ Enormous Potential→Currently only1% Share in Transport



Feasibility and Prospects

- **NW1: Ganga**
  Connects Industries like- Thermal Plants- Coal Mines- Sugar- Cement- Agri Trade. Important River Bank Cities-Terminals etc
- **NW 2: Brahmaputra**
  De-congestion of Chicken Neck Corridor- N. E Industrial Development- Watershed Management due to huge catchment area
- **NW-3:** West Coast Canals
  Kochi Port Access- Shipping Routes access and Lesser Costs for Exports Logistics
- **NW-4**: Godavari-Krishna
  Important Cities from Andhra, TN, Pondy connected- Canals Redevelopment – Ease of Port Traffic. (NW with most ports)
- **NW-5**: Brahmani- Mahandi
  Contribute to movement of coal & other ores to thermal plants, fertilizer plants, etc.
- **NW-6**: Barak River
  Difficult to connect as a Roadways Grid- But out of 6- 4 waterways have potential to form a connected grid.

Conclusion:

Industrial Corridors now can be established on the basis of Waterways- Cheap, Easier, Multi-Modal, Regional Imbalances of Hinterland can be addressed