



AN INITIATIVE

by:



*Dr. Piyush Chaubey*



*Piyush Kumar*

GENERAL STUDIES-1

# GEOGRAPHY

Most Expected Topics for  
UPSC Mains 2022



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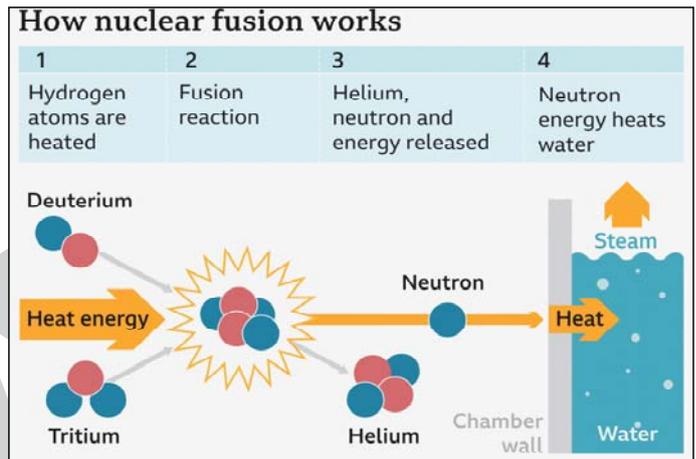
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# ENERGY RESOURCES

## NUCLEAR ENERGY

### WHAT IS IT ?

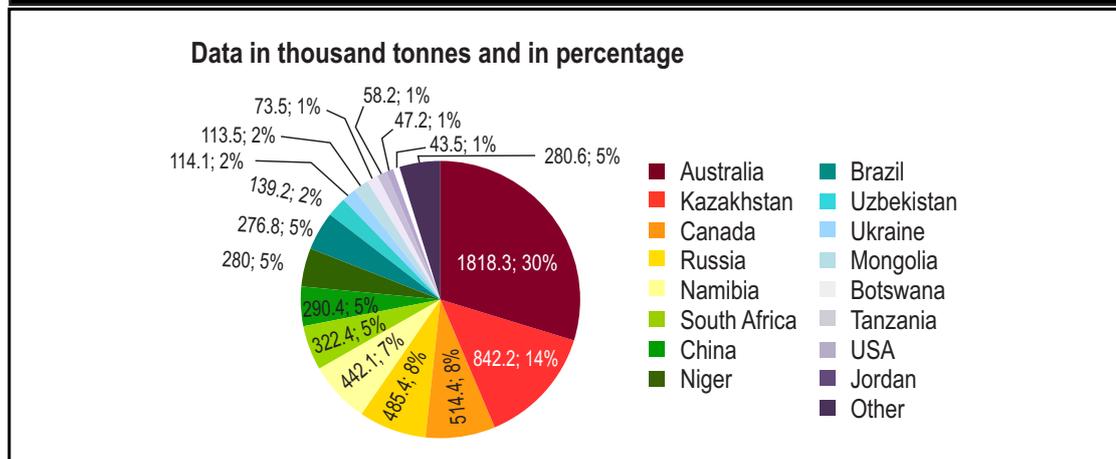
- Radioactive minerals are used to generate nuclear energy through high technological methods.
- There are two methods which can be used to release energy from radioactive minerals:
- **Nuclear fission** – In this process, the nucleus of heavy atom namely of uranium (U 235) or plutonium (P239) breaks apart into smaller fragments, releasing an enormous amount of energy.
- **Nuclear fusion** – In this process, small nucleus like those of isotopes of hydrogen, namely deuterium and tritium fuse or join together to form heavier nuclei, releasing vast amounts of energy.



### PROBLEMS RELATED TO NUCLEAR ENERGY GENERATION

- The major problems associated with the generation of nuclear power are disposal of nuclear waste, contamination of environment with long lasting radioactive materials (radioactive pollution), thermal pollution, health effects from exposure to low levels of radiation, limited supplies of uranium ore, high construction and maintenance costs, questionable reactor safety, human or technical error that could result in a major accidents and vulnerability to sabotage, developing nuclear weapons by processing reactor waste.
- Problems of dismantling of a nuclear plant's, after their useful life of 30-40 years is over.

### WORLDWIDE DISTRIBUTION OF NUCLEAR FUEL



## NUCLEAR PLANTS IN INDIA

# INDIA PLANNING HUGE INCREASE IN NUCLEAR POWER

India is making nuclear power one of its key policy initiatives, with plans to build 48 new reactors and boost output to 63,000 megawatts by 2032- an almost 14-fold increase on current levels. The country's existing 20 nuclear reactors generate about 4,700 megawatts



## REASON FOR ADOPTING NUCLEAR ENERGY

- **Availability of Thorium:** India is the leader of the new resource of nuclear fuel called Thorium, which is considered to be the nuclear fuel of the future.
  - ▶ With the availability of Thorium, India has the potential to be the first nation to realise the dream of a fossil fuel-free nation.
- **Cuts Import Bills:** Nuclear energy will also relieve the nation of about \$100 billion annually which we spend on importing petroleum and coal.
- **Stable and Reliable Source:** The greenest sources of power are definitely solar and wind. But solar and wind power, despite all their advantages, are not stable and are dependent excessively on weather and sunshine conditions.
  - ▶ Nuclear power, on the other hand, provides a relatively clean, high-density source of reliable energy with an international presence.
- **Cheaper to Run:** Nuclear power plants are cheaper to run than their coal or gas rivals. It has been estimated that even factoring in costs such as managing radioactive fuel and disposal nuclear plants cost between 33 to 50% of a coal plant and 20 to 25% of a gas combined-cycle plant.

## INDIA'S 3 STAGE NUCLEAR POWER PROGRAMME

- India's three-stage nuclear power programme was formulated by Homi Bhabha in the 1950s to secure the country's long term energy independence, through the use of uranium and thorium reserves found in the monazite sands of coastal regions of South India.
- The ultimate focus of the programme is on enabling the thorium reserves of India to be utilised in meeting the country's energy requirements.
- Thorium is particularly attractive for India, as it has only around 1–2% of the global uranium reserves, but one of the largest shares of global thorium reserves.
- However, at present thorium is not economically viable because global uranium prices are much lower.
- **Stage-1:** Pressurised Heavy Water Reactor
- **Stage 2:** Fast Breeder Reactor
- **Stage 3:** Thorium Based Reactor:
  - Prototype Fast Breeder Reactor at Kalpakkam:
  - The Prototype Fast Breeder Reactor (PFBR) is a 500 MWe fast breeder nuclear reactor presently being constructed at the Madras Atomic Power Station in Kalpakkam, India.

## SOLAR ENERGY:

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- Direct solar energy can be used as heat, light, and electricity through the use of solar cells. Direct use of solar energy can be used through various devices broadly directed into three types of systems a) passive, b) active c) photovoltaic.
- Photovoltaic Cells:
- Solar energy can be converted directly into electrical energy (direct current, DC) by photovoltaic (PV) cells commonly called solar cells.

## BOON OR BANE ?

### Advantages of Solar Energy

- **Renewable Energy Source:** Among all the benefits of solar panels, the most important thing is that solar energy is a truly renewable energy source. It can be harnessed in all areas of the world and is available every day. We cannot run out of solar energy, unlike some of the other sources of energy.
- **Reduces Electricity Bills:** Since you will be meeting some of your energy needs with the electricity your solar system has generated, your energy bills will drop. For example, if you are a business using commercial solar panels this switch can have huge benefits because the large system size can cover large chunks of your energy bills.
- **Diverse Applications:** Solar energy can be used for diverse purposes. You can generate electricity (photovoltaics) or heat (solar thermal). Solar energy can be used to produce electricity in areas without access to the energy grid, to distil water in regions with limited clean water supplies and to power satellites in space.
- Solar energy can also be integrated into the materials used for buildings. Not long ago Sharp introduced transparent solar energy windows.



- **Low Maintenance Costs:** Solar energy systems generally don't require a lot of maintenance. You only need to keep them relatively clean, so cleaning them a couple of times per year will do the job. If in doubt, you can always rely on specialised cleaning companies, which offer this service from around £25-£35.
- Most reliable solar panel manufacturers offer 20-25 years warranty. After covering the initial cost of the solar system, you can expect very little spending on maintenance and repair work.
- **Technology Development:** Technology in the solar power industry is constantly advancing and improvements will intensify in the future. Innovations in quantum physics and nanotechnology can potentially increase the effectiveness of solar panels and double, or even triple, the electrical input of the solar power systems.

### Disadvantages of Solar Energy

- **Cost:** The initial cost of purchasing a solar system is fairly high. This includes paying for solar panels, inverter, batteries, wiring, and the installation. Nevertheless, solar technologies are constantly developing, so it is safe to assume that prices will go down in the future.
- **Weather-Dependent:** Although solar energy can still be collected during cloudy and rainy days, the efficiency of the solar system drops. Solar panels are dependent on sunlight to effectively gather solar energy. Therefore, a few cloudy, rainy days can have a noticeable effect on the energy system. You should also take into account that solar energy cannot be collected during the night.

- **Solar Energy Storage Is Expensive:** Solar energy has to be used right away, or it can be stored in large batteries. These batteries, used in off-the-grid solar systems, can be charged during the day so that the energy is used at night. This is a good solution for using solar energy all day long but it is also quite expensive.
- **Uses a Lot of Space:** The more electricity you want to produce, the more solar panels you will need, as you want to collect as much sunlight as possible. Solar PV panels require a lot of space and some roofs are not big enough to fit the number of solar panels that you would like to have.
- **Associated with Pollution:** Although pollution related to solar energy systems is far less compared to other sources of energy, solar energy can be associated with pollution. Transportation and installation of solar systems have been associated with the emission of greenhouse gases.

## REGIONAL DISTRIBUTION OF SOLAR ENERGY

State	Total area (1500 ha)	Total solar potential energy	High Irradiation Insolation level
Karnataka	19,050	24.7 GW	3.5–4.0 kWh/m <sup>2</sup> /day
Rajasthan	34,270	4.8 GW	5–7 kWh/m <sup>2</sup> /day
Maharashtra	30,758	64.32 GW	3–4 kWh/m <sup>2</sup> /day
Himachal Pradesh	4548	33.8 GW	3–4 kWh/m <sup>2</sup> /day
Jammu Kashmir	3781	111.05 GW	3–4 kWh/m <sup>2</sup> /day
Andhra Pradesh	27,505	38.4 GW	3–4.5 kWh/m <sup>2</sup> /day
Gujarat	18,866	35.7 GW	4–4.7 kWh/m <sup>2</sup> /day
Odisha	15,043	25.7 GW	4–4.7 kWh/m <sup>2</sup> /day
Madhya Pradesh	30,756	61.6 GW	2.9–4.0 kWh/m <sup>2</sup> /day
Uttar Pradesh	24,170	22.8 GW	2.9–3.9 kWh/m <sup>2</sup> /day
Haryana	18,096	73.2 MW	3.5–4.5 kWh/m <sup>2</sup> /day

## INITIATIVES TO PROMOTE SOLAR ENERGY

### National Solar Mission:

- The National Solar Mission (NSM), launched on 11th January, 2010, had set a target for development and deployment of 20 GW Solar Power by the year 2022. The Cabinet in its meeting had approved revision of the target from 20 GW to 100 GW.

### Schemes Under National Solar Mission

- Scheme for Development of Solar Parks and Ultra Mega Solar Power Projects:
- Solar Park is a large chunk of land developed with all necessary infrastructure and clearances for setting up of Solar projects.. Approximately 4 to 5 acres per MW of land is required for setting up Solar Parks.
- The Ministry introduced the Solar Parks programme with the objective of facilitating solar project developers to set up projects in a plug-and-play model. The scheme for development of solar parks has a target capacity of 40 GW. All States and Union Territories are eligible for getting benefit under the scheme.

## Grid-Connected Solar Power Projects:

### ■ Defence Establishment:

- ▶ Scheme for Setting Up Over 300 MW of Grid-Connected Solar PV Power Projects by Defence Establishments Under Ministry of Defence and Para Military Forces With Viability Gap Funding :
- ▶ The projects under this Scheme will mandatorily use solar cells & modules which are made in India.

### ■ Solarization of Konark Sun Temple

- ▶ A 10 MW grid connected Solar Project and different O-grid applications are to be installed in the Konark city

### ■ Solar Wind Hybrid Plant:

- ▶ A Scheme for setting up of solar PV capacity of 20 MWac/ 50 MWp with battery storage of 50 MWh at Phyang, Leh and 1 MW solar-wind hybrid plant with battery storage of 1 MWh at Nyoma under J&K Prime Minister Development Package (PMDP) – 2015

### ■ Pradhan Mantri Kisan Urja Suraksha Evam Utthaan Mahabhiyaan (PM-KUSUM) Scheme:

- ▶ The Cabinet Committee on Economic Affairs approved PM-KUSUM scheme in its meeting held on 2019.
- ▶ PM-KUSUM scheme aims to install grid connected ground mounted solar power plants
- ▶ **Component-A:** 10,000 MW of Decentralised Ground Mounted Grid Connected Solar Power Plants.
- ▶ **Component-B:** Installation of 20 lakh standalone Solar Powered Agriculture Pumps.
- ▶ **Component-C:** Solarisation of 15 Lakh existing Grid-connected Agriculture Pumps.
- ▶ Scope of scheme has been increased by including pasturelands and marshy lands owned farmers.
- ▶ Size of solar plant has been reduced so that small farmers can participate and completion period increased from nine to twelve months. Further, penalty for shortfall in generation removed for ease of implementation by farmers.

### ■ Solar Off-grid Programme in Ladakh

O-grid solar power plants of 5 kWp each have been installed in Kargil under Prime Minister Development Package announced in the year 2015 with financial support by MNRE.

### ■ Green Energy Corridor

In order to facilitate integration of large scale renewable generation capacity addition, the Cabinet Committee of Economic Affairs (CCEA) in FY 2015-16, approved the creation of Intra-State Transmission System in the Renewable Energy rich states

### ■ Rooftop Solar (RTS) Programme

Rooftop Phase-I of this programme was launched on 30th December, 2015 in which incentives and subsidies were provided for residential, institutional and social sectors. For Government sector, achievement linked incentives were also provided.

## ■ Greening of Islands

The Government intends to fully convert Andaman and Nicobar, Lakshadweep islands to Green Energy where energy needs will be met using RE sources.

## ■ National Wind-Solar Hybrid Policy:

- ▶ The main objective of the policy is to provide a framework for promotion of large scale grid connected wind-solar PV hybrid systems for optimal and efficient utilisation of wind and solar resources, transmission infrastructure and land.
- ▶ The wind-solar PV hybrid systems will help in reducing the variability in renewable power generation and achieving better grid stability. The policy also aims to encourage new technologies, methods and way-outs involving combined operation of wind and solar PV plants.

## GEOHERMAL ENERGY:

- Geothermal energy is natural heat from the interior of the earth that can be used to generate electricity as well as to heat up buildings.
- The natural examples of geothermal energy are given below.
  - ▶ Geysers
  - ▶ Lava Fountain
  - ▶ Hot Springs

### ADVANTAGES

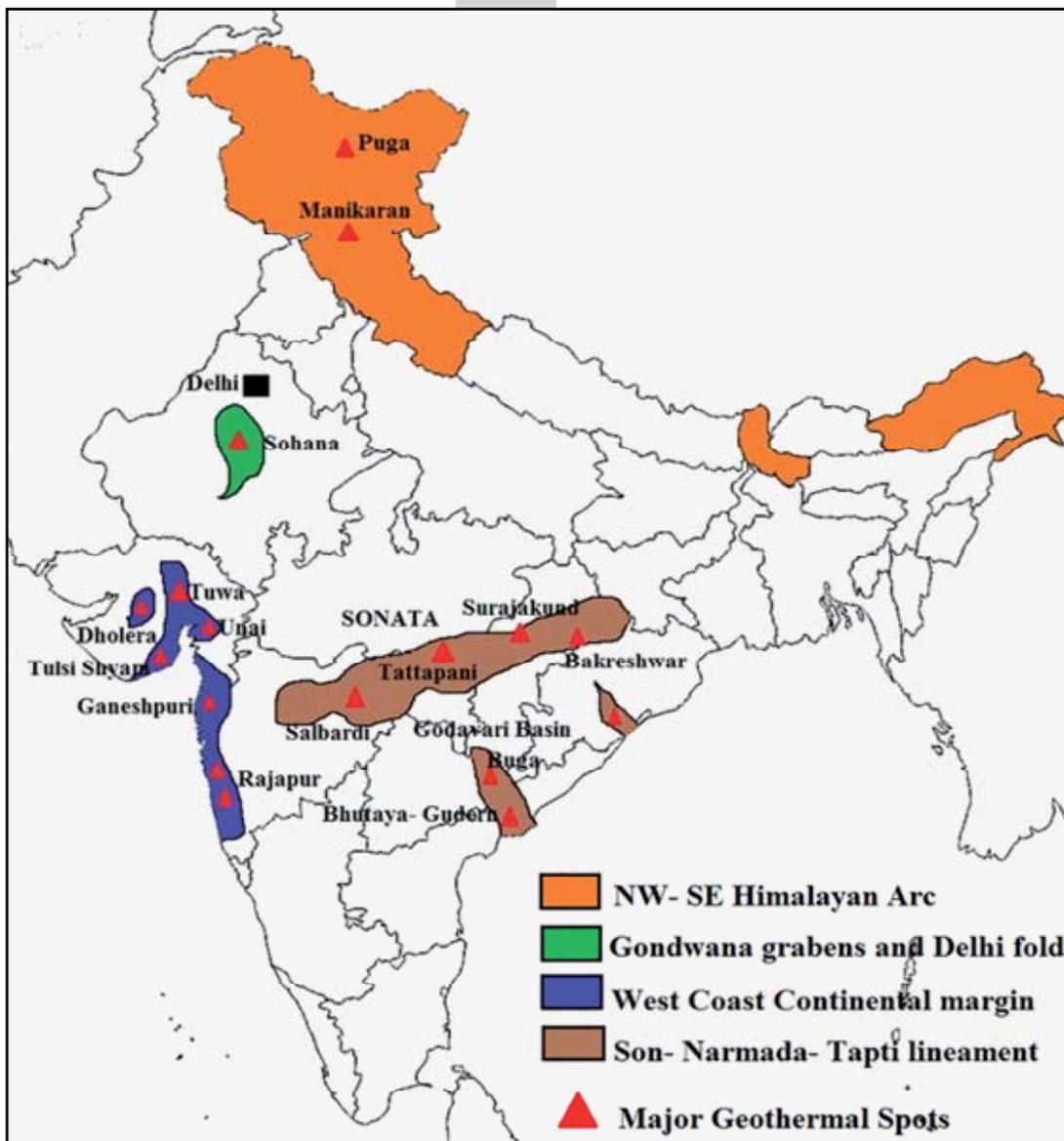
Cheap to operate	Long life and lower operating costs than all other power plants
Renewable	
High yield	Lower energy cost than any other method
Pretty plentiful	Some countries depend almost entirely on it
Not intermittent (if reservoirs is large enough)	
Reservoirs have multiple uses	Flood control, drinking water, aquaculture, recreation
Less air pollution than fossil fuel combustion	

### CHALLENGES

- **The Resource and Location**
  - ▶ There is geothermal energy beneath the entirety of the earth's surface, but not all of that energy can be harnessed. There is only a small percentage of land that lies above suitable pockets of water and steam that can heat homes or power electrical plants, limiting the possibility of installation of geothermal power plants. .
- **Infrastructure/High Cost**
  - ▶ Equipment for drilling wells and setting up power plants is extraordinarily expensive and training people to staff a geothermal power plant is time consuming and costly.

- **Renewable Does Not Mean Unlimited**
  - ▶ Contrary to popular belief, the water and steam that is extracted from the earth is not boundless.
- **Location Restricted**
  - ▶ The largest single disadvantage of geothermal energy is that it is location specific. Geothermal plants need to be built in places where the energy is accessible, which means that some areas are not able to exploit this resource.
- **Transmission barrier**
  - ▶ Geothermal power plants must be located near specific areas near a reservoir because it is not practical to transport steam or hot water over distances over distances greater than two miles.
- **Environmental Side Effects**
  - ▶ Although geothermal energy does not typically release greenhouse gases, there are many of these gases stored under the Earth's surface which are released into the atmosphere during digging.
- **Earthquakes**
  - ▶ Geothermal energy also runs the risk of triggering earthquakes. This is due to alterations in the Earth's structure as a result of digging.

## GEOTHERMAL ENERGY IN INDIA



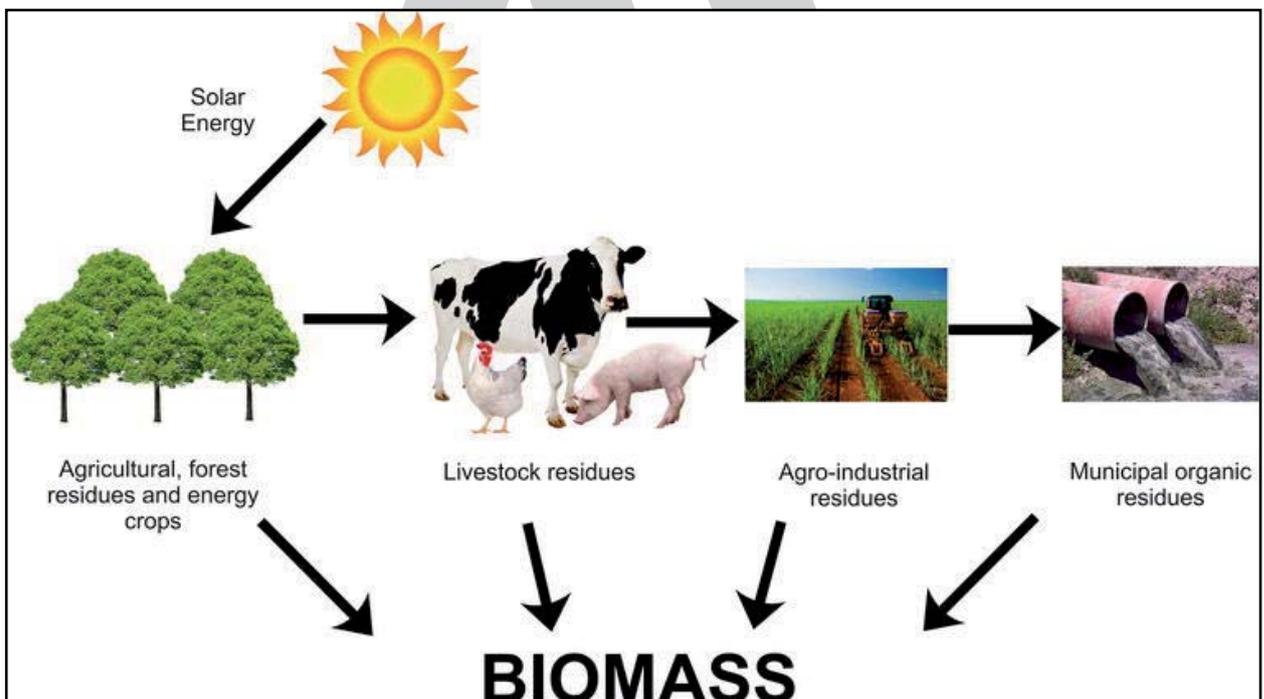
- Geological Survey of India has found around 350 geothermal energy locations in the country. The most promising of these is in the Puga valley of Ladakh.
- India has 7 geothermal provinces [viz. Himalayas, Sohana, West Coast, Cambay (Gujarat), Godavari, Mahanadi and Son-Narmada-Tapi (SONATA)] and a number of geothermal springs.

## GOVERNMENT INITIATIVES

- For Industrial Projects, the government has planned to provide a capital subsidy of up to 30%.
- First Geothermal power plant to come in Chhattisgarh by joint cooperation of NTPC and Chhattisgarh Renewable Energy Development Agency (CREDA). Tattapani geothermal field in SONATA geothermal province.
- Ministry of renewable energy has planned to generate geothermal energy up to 1000 MW by 2022.

## BIOMASS ENERGY:

- Biomass is a renewable energy resource from plant and animal waste.
- The energy from biomass (biomass conversion) is released on burning or breaking the chemical bonds of organic molecules formed during photosynthesis.
- Sources of biomass
- By-products from the timber industry, agricultural crops and their byproducts, raw material from the forest, major parts of household waste and wood.
- Solid Biomass fuels: Wood logs and wood pellets, charcoal, agricultural waste (stalks and other plant debris), animal waste (dung), aquatic plants (kelp and water hyacinths) urban waste (paper, cardboard and other combustible materials).



## ADVANTAGES OF BIOMASS ENERGY

- Burning of biomass does not increase atmospheric carbon dioxide because to begin with biomass was formed by atmospheric carbon dioxide and the same amount of carbon dioxide is released on burning.

- Biomass is an important source of energy and the most important fuel worldwide after coal, oil and natural gas.
- Biomass is renewable and is abundantly available on the earth in the form of firewood, agricultural residues, cattle dung, city garbage etc.
- Bio-energy, in the form of biogas, which is derived from biomass, is expected to become one of the key energy resources for global sustainable development.

## BAGASSE AS BIOFUEL

- Indian sugar mills are rapidly turning to bagasse, the leftover of cane after it is crushed and its juice extracted, to generate electricity.
- This is mainly being done to clean up the environment, cut down power costs and earn additional revenue.

## NATIONAL MISSION ON USE OF BIOMASS IN COAL-BASED THERMAL POWER PLANTS

- To address the issue of air pollution due to farm stubble-burning and to reduce carbon footprints of thermal power generation, the Ministry of Power has decided to set up a National Mission on the use of Biomass in coal-based thermal power plants.
- The proposed National Mission on biomass will also contribute to the National Clean Air Programme (NCAP).
- It would further support the energy transition in the country and our targets to move towards cleaner energy sources.

### Objectives of the mission:

- ▶ To increase the level of co-firing from the present 5% to higher levels to have a larger share of carbon-neutral power generation from the thermal power plants.
- ▶ Biomass co-firing stands for adding biomass as a partial substitute fuel in high efficiency coal boilers.
- ▶ To take up R&D activity in boiler design to handle the higher amount of silica, alkalis in the biomass pellets.
- ▶ To facilitate overcoming the constraints in the supply chain of biomass pellets and agro-residue and its transport up to the power plants.
- ▶ To consider regulatory issues in biomass co-firing.

## NATIONAL POLICY ON BIOFUELS 2018

### The Highlights of the Policy are:

- As per the policy, GOI aims at increasing the utilization of biofuels in the energy and transportation sectors by promoting the production of biofuels from domestic feedstock in the coming decade.
- Larger goals such as the adoption of green fuels, national energy security, fighting CC, generating employment, etc. would be facilitated through this policy.
- MNRE has set an indicative target of **20% blending of ethanol in petrol** and **5% blending of biodiesel in diesel** to be achieved by 2030.
- The Policy categorises biofuels as: –
- **Basic Biofuels** – First Generation (1G) bioethanol & biodiesel and

**Advanced Biofuels** – Second Generation (2G) ethanol, Municipal Solid Waste to drop-in fuels, **Third Generation** (3G) biofuels, bio-CNG etc.

- Use of damaged food grains and surplus food grains for production of ethanol will increase its availability for **Ethanol Blended Petrol (EBP) Programme**.
- **Biodiesel:** This category includes methyl or ethyl ester of fatty acids derived from non-edible vegetable oil, acid oil, used cooking oil, animal fat and bio-oil.
- Advanced biofuels: Second-generation (2G) ethanol, drop-in fuels, algae-based 3G biofuels, bio-CNG, bio-methanol, dimethyl ether (DME) derived from bio-methanol, bio-hydrogen, drop-in fuels produced from municipal solid waste (MSW), etc. have been included in this category.
- **Drop-in fuels:** These are fuels derived from biomass, Agri-residues, MSW, plastic wastes, etc. that can be used in existing engines without having to modify their fuel distribution system.
- **Bio-CNG:** These fuels are purified form of biogas produced from agricultural residues, dung, food waste, sewage water but their composition and energy potential are comparable to fossil-based natural gas.

## HYDROGEN ENERGY:

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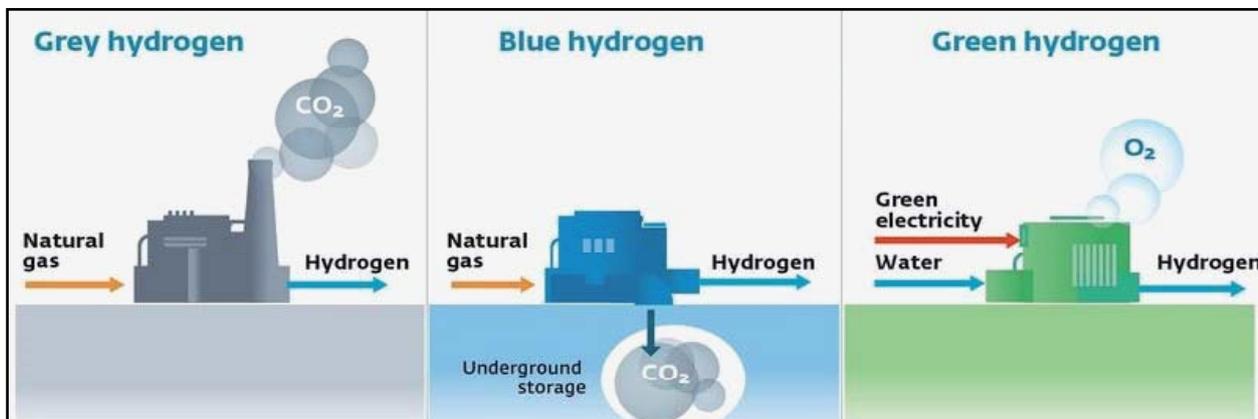
### ADVANTAGES

- Hydrogen, like electricity, is an energy carrier that must be produced from another substance.
- Hydrogen can be produced—separated—from a variety of sources including water, fossil fuels, or biomass and used as a source of energy or fuel.
- Hydrogen has the highest energy content of any common fuel by weight (about three times more than gasoline), but it has the lowest energy content by volume (about four times less than gasoline).
- Hydrogen is emerging as an important source of energy since it has zero carbon content and is a non-polluting source of energy in contrast to hydrocarbons that have net carbon content in the range of 75–85 per cent.
- Hydrogen energy is expected to reduce carbon emissions that are set to jump by 1.5 billion tons in 2021
- It has the highest energy content by weight and lowest energy content by volume.
- As per International Renewable Energy Agency (IRENA), Hydrogen shall make up six per cent of total energy consumption by 2050.
- The current global demand for hydrogen is 70 million metric tons per year, more than 76 per cent of which is being produced from natural gas, 23 per cent comes from coal and the remaining is produced from electrolysis of water.
- Hydrogen has potential to reduce fossil fuel imports
- At present, hydrogen produced from natural gas is widely utilised for production of nitrogenous fertilisers, and petrochemicals. **Substituting this with green hydrogen could allow use of renewable energy in these important sectors and reduce import dependence.**

### VARIOUS USES OF HYDROGEN

- Hydrogen use today is dominated by industry, namely: oil refining, ammonia production, methanol production and steel production. Virtually all of this hydrogen is supplied using fossil fuels, so there is significant potential for emissions reductions from clean hydrogen.
- In transport, the competitiveness of hydrogen fuel cell cars depends on fuel cell costs and refuelling stations while for trucks the priority is to reduce the delivered price of hydrogen. Shipping and aviation have limited low-carbon fuel options available and represent an opportunity for hydrogen-based fuels.

- In buildings, hydrogen could be blended into existing natural gas networks, with the highest potential in multifamily and commercial buildings, particularly in dense cities while longer-term prospects could include the direct use of hydrogen in hydrogen boilers or fuel cells.
- In power generation, hydrogen is one of the leading options for storing renewable energy, and hydrogen and ammonia can be used in gas turbines to increase power system flexibility. Ammonia could also be used in coal-fired power plants to reduce emissions.



- ▶ Use of hydrogen in the steel industry could substitute imported coking coal. During 2018-19, the total demand of coking coal for the steel industry was 58.37 million tonnes (MT). Out of this, 51.83 MT was met through imports.
- ▶ Hydrogen-based Transport
- ▶ Fuel cell electric vehicles (FCEVs) run on hydrogen fuel and have no harmful emissions. Battery Electric Vehicles (BEVs) may be suitable for light passenger vehicle segments for shorter driving range. For heavy duty vehicles with longer trip range, such as buses, trucks and other commercial vehicles, FCEVs are likely to become cost competitive in the coming years.
- ▶ While Battery Electric Vehicles (BEVs) are dependent on imported raw materials like lithium and cobalt for lithium-ion batteries, the hydrogen fuel cell supply chain can be wholly indigenized, making India Atma Nirbhar in the clean transportation segment.

## INDIA'S PROGRESS TOWARDS GREEN HYDROGEN

- Prime Minister Narendra Modi aims to transform India into an energy independent nation by 2047 where green hydrogen will play an active role as an alternate fuel to petroleum/ fossil-based products.
- In 2020, India's hydrogen demand stood at 6 million tonnes (MT) per year. It is estimated that by 2030, the hydrogen costs will be down by 50 per cent.
- The demand for hydrogen is expected to see a five-fold jump to 28 MT by 2050 where 80 percent of the demand is expected to be green in nature.
- India has declared its ambition to become an exporter of hydrogen to Japan, South Korea, and Europe.
- Various hydrogen powered vehicles have been developed and demonstrated under projects supported by the Government of India. These include 6 Cell buses by Tata Motors Ltd., 50 hydrogen enriched CNG (H-CNG) buses in Delhi by Indian Oil Corporation Ltd. in collaboration with Govt. of NCT of Delhi,

## ISSUES/CHALLENGES AHEAD

India is confronted with major challenges in moving towards higher deployment levels for renewables. Some of these are listed below-

- **Mobilisation of the necessary finance and investment on competitive terms:** Gearing up the banking sector for arranging finances for larger deployment goals, exploring low-interest rate, long-term international funding, and developing a suitable mechanism for risk mitigation or sharing by addressing both technical and financial bottlenecks are major challenges.
- **Land acquisition:** Land acquisition is one of the major challenges in renewable power development. Identification of land with RE potential, its conversion (if needed), clearance from land ceiling act, decision on land lease rent, clearance from revenue department, and other such clearances take time. State governments have to play a major role in acquisition of land for RE projects.
- Creating an innovation and manufacturing eco-system in the country;
- Economically integrating larger share of renewables with the grid;
- Enabling supply of firm and dispatchable power from renewables;
- Enabling penetration of renewables in the so called hard to decarbonize sectors.

## NATIONAL COAL GASIFICATION MISSION:

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### WHAT IS COAL GASIFICATION ?

- Coal gasification offers a practical means of utilizing coal for meeting stringent environmental control requirements.
- In the gasification process, sulphur present in the coal is converted to hydrogen sulphide (H<sub>2</sub>S) and minor amounts of carbonyl sulphide (COS). These sulphur compounds can be easily and economically removed from gas streams by a wide variety of commercially available processes (i.e., acid gas removal systems). The separated acid gas is further processed to recover elemental sulphur. After the acid gas removal treatment, only a few ppm of sulphur remains in the coal gas. Nitrogen oxides (NO<sub>x</sub>) are not formed to any appreciable extent in the reducing atmosphere of coal gasification. The particulate content in the fuel gas after gasification is negligible since the gas cleaning steps (hot cyclones, water scrubbing or hot gas cleaning) capture almost all the particulate. Except for hot gas clean up, other two systems are commercially established and practiced. Most part of the wash water is recycled and the residual waste waters from gasification plants can be effectively treated.



### ADVANTAGES

- Coal gasification process has several other advantages besides minimum environmental impacts which are briefly discussed below.
- A broad range of coals with varying ash content, coal fines, middling and washery rejects can be successfully gasified.
- Oxygen enriched Air or oxygen can be used as a gasification medium. If oxygen is used in a coal gasifier instead of air, carbon dioxide is emitted as a concentrated gas stream.
- Coal to Liquids is an upcoming industry which can play a vital role in India's chemical and petrochemical industry as majority of chemicals and petrochemicals are derived from products which are derived from crude oil and natural gas.
- Coal can be used to make the following products:
  - ▶ Methanol

- ▶ Ethanol
- ▶ Olefins – (Primarily - Ethylene and Propylene)
- ▶ DME, Acetic Acid and Formaldehyde
- The world moves towards cleaner forms of energy, India, being a signatory to the Paris Agreement, 2016 has declared three quantitative climate change goals as its Nationally Determined Contribution (NDC)4 :

## FOREST RESOURCES

### FOREST SURVEY REPORT 2021

- India State of Forest Report (ISFR) is a biennial publication of Forest Survey of India (FSI), an organization under the Ministry of Environment, Forest & Climate Change, Government of India.
- The National Forest Policy of India, 1988 envisaged a goal of achieving 33 per cent of the geographical area of the country under forest & tree cover. The remote sensing based nation-wide Forest Cover mapping at biennial interval, serves as a monitoring mechanism towards achievement of this goal. Periodic forest cover assessment at definite intervals helps in assessing the status of forests in the country and its broad trend.
- In the present ISFR 2021, FSI has included a new chapter related to the assessment of forest cover in the Tiger Reserves, Corridors and Lion conservation area of India. In this context, the decadal assessment of change in forest cover within Tiger Reserves, Corridors and Lion conservation area helps in assessing the impact of conservation measures and management interventions that have been implemented over the years.
- A new initiative of FSI has also been documented, where the 'Above Ground Biomass' has been estimated. The results for the States of Assam and Odisha (as well as AGB maps), were presented earlier in ISFR 2019. The interim results for AGB estimates (and AGB maps) for the entire country have been presented as a new chapter in ISFR 2021.
- The total forest and tree cover of the country is 80.9 million hectare which is 24.62 percent of the geographical area of the country. As compared to the assessment of 2019, there is an increase of 2261 sq km in the total forest and tree cover of the country. Out of this, the increase in the forest cover has been observed as 1540 sq km and that in tree cover is 721 sq km.
- Increase in forest cover has been observed in open forest followed by very dense forest. Top five states showing increase in forest cover area Andhra Pradesh (647 sq km) followed by Telangana (632 sq km) and Odisha (537 sq km), Karnataka (155 sq Km) and Jharkhand (110 sq. Km).
- Area-wise, Madhya Pradesh has the largest forest cover in the country followed by Arunachal Pradesh, Chhattisgarh, Odisha and Maharashtra. In terms of forest cover as percentage of total geographical area, the top five States are Mizoram (84.53 per cent), Arunachal Pradesh (79.33 per cent), Meghalaya (76.00 per cent), Manipur (74.34 per cent) and Nagaland (73.90 per cent).
- 17 states/UT's have above 33 per cent of the geographical area under forest cover. Out of these states and UTs, five states/UTs namely Lakshadweep, Mizoram, Andaman & Nicobar Islands, Arunachal Pradesh and Meghalaya have more than 75 percent forest cover while 12 states/UTs namely Manipur, Nagaland, Tripura, Goa, Kerala, Sikkim, Uttarakhand, Chhattisgarh, Dadra & Nagar Haveli and Daman & Diu, Assam, Odisha, have forest cover between 33 percent to 75 percent.



- Tree Cover (small patches outside the forests) of the Country is on the rise. The tree cover of the country is estimated to be 95,748 sq km which is 2.91 percent of the geographical area. There is an increase of 721 sq km in the tree cover of the country as compared to assessment of 2019.
- The country's forests & Trees Outside Forests (TOF) are better stocked as compared to the last assessment. The total growing stock of wood in the country is estimated as 6167.50 million cubic metres out of which 4388.15 million cubic metres is inside forest areas and 1,779.35 million cubic metres is outside recorded forest areas (TOF). There is a total increase of 251.74 million cubic metres (4.26 per cent) in total growing stock of the country as compared to previous assessment reported in ISFR 2019. Out of this, the increase in growing stock inside the forest is 114.68 million cubic metres (2.68 per cent) and 137.06 million cubic metres (8.35 per cent) outside the forest area.
- The Stock of Bamboo in the country has increased. The total number of bamboo culms has increased by 13,882 million as compared to the assessment of 2019. The total estimated green weight of bamboo culms at national level is 402 million tonnes.
- Total mangrove cover in the country is 4992 sq km. An increase of 17 sq Km in mangrove cover has been observed as compared to the previous assessment of 2019. Top three states showing mangrove cover increase are Odisha (8 sq km) followed by Maharashtra (4 sq km) and Karnataka (3sq km).
- Total carbon stock in the country's forest is estimated to be 7204 million tonnes and there is an increase of 79.4 million tonnes in the carbon stock of the country as compared to the last assessment of 2019. The annual increase in the carbon stock is 39.7 million tonnes.
- There are 52 tiger reserves, spread across eighteen major states of the country covering a total notified area of 73,972.50 sq km. Gir Wildlife Sanctuary (excluding National Park), has 177.60 sq km of grassland whereas Gir National Park has 33.58 sq km of grassland, summing up to 211.18 sq km, which is 26.11 per cent of the area of Gir National Park and WLS.
- The total forest cover in the seven major cities is 509.72 sq km which is 10.21 per cent of total geographical area of the cities. Delhi has the largest forest cover (194.24 sq km) followed by Mumbai (110.77 sq km) and Bengaluru (89.02 sq km.). Hyderabad has shown a maximum decadal increase of 48.65 sq km in Forest cover followed by Delhi with an increase of 19.91 sq km.

## LOCATION OF INDUSTRIES

### SUGARCANE INDUSTRY

- Sugarcane is a **water-intensive crop** that remains in the soil all year long. As one of the world's thirstiest crops, sugarcane has a significant impact on many environmentally sensitive regions, like the Mekong Delta and the Atlantic Forest.
- **Sugar industry is an important agro-based industry** that impacts rural livelihood of about 50 million sugarcane farmers and around 5 lakh workers directly employed in sugar mills. **Employment** is also generated in various ancillary activities relating to transport, trade servicing of machinery and supply of agriculture inputs.



- **India is the second largest producer of sugar in the world after Brazil** and is also the largest consumer. Today the Indian sugar industry's annual output is worth approximately Rs.80,000 crores.
- **Traditionally, Uttar Pradesh and Maharashtra** produce the majority of sugarcane in India. This can be attributed to rich soil surrounding major rivers present in both states. However in 2019 Maharashtra was hit with floods thus affecting total production.



- With the amendment of the Sugarcane (Control) Order, 1966 on 22.10.2009 and the concept of Statutory Minimum Price (SMP) of sugarcane was replaced with the **'Fair and Remunerative Price (FRP) of sugarcane'** for 2009-10 and subsequent sugar seasons. Under the FRP system, the farmers are not required to wait till the end of the season or for any announcement of the



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profits by sugar mills or the Government. The new system also assures margins on account of profit and risk to farmers, irrespective of the fact whether sugar mills generate profit or not and is not dependent on the performance of any individual sugar mill.

## LOCALISATION OF SUGAR INDUSTRY

- Sugar industry in India is based on sugarcane which is a heavy, low value, **weight losing and perishable raw material**.
- Sugarcane cannot be stored for long as the loss of sucrose content is inevitable.
- Besides, it cannot be transported over long distances because any increase in transportation cost would raise the cost of production and the sugarcane may dry up on the way.

## DIFFERENCE BETWEEN SUGAR INDUSTRY OF NORTHERN AND PENINSULAR INDIA

- Peninsular India has tropical climate which gives higher yield per unit area as compared to north India.
- The sucrose content is also higher in tropical varieties of sugarcane in the south.
- The crushing season is also much longer in the south than in the north. For example, the crushing season is of nearly four months only in the north from November to February, whereas it is of nearly 7-8 months in the south where it starts in October and continues till May and June.
- The co-operative sugar mills are better managed in the south than in the north.
- Most of the mills in the south are new and are equipped with modern machinery.

## ISSUES RELATED TO SUGAR INDUSTRY

- 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.
- Manufacturing of sugar is a seasonal phenomena with a short crushing season varying normally from 4 to 7 months in a year. The mills and its workers remain idle during the remaining period of the year, thus creating financial problems for the industry as a whole.
- Sugarcane has to compete with several other food and cash crops like cotton, oil seeds, rice, etc. Consequently, the land available to sugarcane cultivation is not the same and the total production of sugarcane fluctuates. This affects the supply of sugarcane to the mills and the production of sugar also varies from year to year.
- The average rate of recovery in India is less than ten per cent which is quite low as compared to other major sugar producing countries. For example, the recovery rate is as high as 14-16 per cent in Java, Hawaii and Australia.
- High cost of sugarcane, inefficient technology, uneconomic process of production and heavy excise duty result in high cost of manufacturing. The production cost of sugar in India is one of the highest in the world. Intense research is required to increase the sugarcane production in the agricultural field and to introduce new technology of production efficiency in the sugar mills. Production cost can also be reduced through proper utilisation of by-products of the industry.
- Most of the machinery used in Indian sugar mills, particularly those of Uttar Pradesh and Bihar is old and obsolete, being 50-60 years old and needs rehabilitation. But a low margin of profit prevents several mill owners from replacing the old machinery with the new one.
- Over half of sugar mills are located in Maharashtra and Uttar Pradesh and about 60 per cent of the production comes from these two states. On the other hand, there are several states in the north-east, Jammu and Kashmir and Orissa where there is no appreciable growth of this industry. This leads to regional imbalances which have their own implications.

# COTTON TEXTILE INDUSTRY

The close linkage of the textiles industry to agriculture (for raw materials such as cotton) and the ancient culture and traditions of the country in terms of textiles makes it unique in comparison to other industries in the country.



## FACTS

- The domestic apparel & textile industry in India contributes 5% to the country's GDP, 7% of industry output in value terms, and 12% of the country's export earnings. India is the 6th largest exporter of textiles and apparel in the world.
- India is one of the largest producers of cotton and jute in the world. India is also the 2nd largest producer of silk in the world and 95% of the world's hand-woven fabric comes from India. The Indian technical textiles segment is estimated at \$16 bn, approximately 6% of the global market.
- The textiles and apparel industry in India is the 2nd largest employer in the country providing direct employment to 45 million people and 100 million people in allied industries.
- India has also become the second-largest manufacturer of **PPE** in the world. More than 600 companies in India are certified to produce PPEs today, whose global market worth is expected to be over \$92.5 bn by 2025, up from \$52.7 bn in 2019.
- The Indian technical textiles market was estimated at \$17.6 bn in 2020-21 and grew at a CAGR of 10% since 2015-16
- India is the world's largest producer of cotton. Production stood at 360.13 lakh bales for the crop year October 2021-September 2022. Domestic consumption for the 2021-22 crop year is estimated to be at 335 lakh bales.

## ISSUES RELATED TO COTTON TEXTILE INDUSTRY

- The industry is also in dire need of technology upgradation.
- The rise of Bangladesh and Vietnam as export hubs is not just due to their lean production times and technological advancements, but also due to free trade agreements (FTAs) and preferential trade agreements (PTAs) they have with western and European countries.
- The PLI scheme is for technical and man-made textiles only, whereas apparel constitutes about 73 per cent of the total market. Even some key man-made textiles are not covered.
- Textile parks don't address the constant labour issues plaguing manufacturers. The key to make the textile sector less labour intensive is automation. But this would mean job losses and that's why labour unions have for long opposed major technological upgrades, say manufacturers. China, on the other hand, has a hire-and-fire policy, with wages tied to a labourer's output. Indian manufacturers say that labour laws need some reforms to strike a fine balance. Neither the plan for integrated textile parks nor the PLI scheme addresses that.

## FACTORS AFFECTING COTTON TEXTILE INDUSTRY

- **Proximity to Water:** Water plays an important factor, considering that it is a requirement of several operations. Hence, many of the textile clusters are found near river systems or water channels.
- **Moderate Climate:** The other key element that affects the location of the textile industry is that there is a need for neither a very dry nor wet climate. Dry climate creates the hindrance when it

comes to the process of spinning while a constant wet climate will increase the cost of production in plants as there will be a need for installation of humidifiers.

- **Power:** Power is another key source of location of textile industries. Coal is a conventional form of energy and its availability and price of availability is a crucial factor. But environmental concerns may shift this to other sources of energy, especially hydropower.
- **Labour:** Textile industry is the second biggest source of employment in India with 45 million directly involved in it and 60 million indirectly in India. Hence, it proves that it is a labour intensive industry that demands cheap labour. Therefore, any place that provides a big chunk of cheap labour will be preferable for the setting up of a textile industry.
- **Raw Materials:** The availability of raw materials is one of the most imperatives of this industry as it will somewhat reduce the cost of producing the finished goods.
- **Transport:** Easy means of transportation are needed for all industries, and particularly for textile, the product of which is cheap and for which the market is sometimes situated thousands of miles away. It is an interesting fact that all the leading textile centres – unlike the iron and steel industry – cater to distant markets.

## GOVERNMENT INITIATIVES

The Indian government has come up with several export promotion policies for the textiles sector. It has also allowed **100% FDI** in the sector under the automatic route. The Rs. 10,683 crore (US\$ 1.44 billion) PLI scheme is expected to be a major booster for the textile manufacturers. The scheme proposes to incentivise MMF (man-made fibre) apparel, MMF fabrics and 10 segments of technical textiles products.

- In March 2022, the Bihar government submitted a proposal to the Union Textiles Ministry to set up a **mega hub under the PM Mitra Mega Textile Park**.
- Under the Union Budget 2022-23, the total allocation for the textile sector was Rs. 12,382 crore (US\$ 1.62 billion). Out of this, Rs. 133.83 crore (US\$ 17.5 million) is for Textile Cluster Development Scheme, Rs. 100 crore (US\$ 13.07 million) for National Technical Textiles Mission, and Rs. 15 crore (US\$ 1.96 million) each for PM Mega Integrated Textile Region and Apparel parks scheme and the Production Linked Incentive Scheme.
- For the export of handloom products globally, Handloom Export Promotion Council (HEPC) is participating in various international fairs/events with handloom exporters/weavers to sell their handloom products in the international markets under NHDP.
- The Ministry of Textiles has also been implementing Handloom Marketing Assistance (HMA), a component of the National Handloom Development Programme (NHDP), all across India.

## PHARMACEUTICAL INDUSTRY

### FACTS

India is the largest provider of generic drugs globally. The Indian pharmaceutical sector supplies over 50% of global demand for various vaccines, 40% of generic demand in the US and 25% of all medicine in the UK. Globally, India ranks 3rd in terms of pharmaceutical production by volume and 14th by value. The domestic pharmaceutical industry includes a network of 3,000 drug companies and ~10,500 manufacturing units.

According to the Confederation of Indian Industry, India's API industry is ranked the third largest in the world, and the country contributes approximately 57 percent of APIs to the pre-qualified list of the WHO.

- According to the Indian Economic Survey 2021, the domestic market is expected to grow 3x in the next decade. India's domestic pharmaceutical market is at US\$ 42 billion in 2021 and likely to reach US\$ 65 billion by 2024 and further expand to reach ~US\$ 120-130 billion by 2030.

- India's biotechnology industry comprises biopharmaceuticals, bio-services, bio-agriculture, bio-industry, and bioinformatics. The Indian biotechnology industry was valued at US\$ 70.2 billion in 2020 and is expected to reach US\$ 150 billion by 2025.
- India's medical devices market stood at US\$ 10.36 billion in FY20. The market is expected to increase at a CAGR of 37% from 2020 to 2025 to reach US\$ 50 billion.

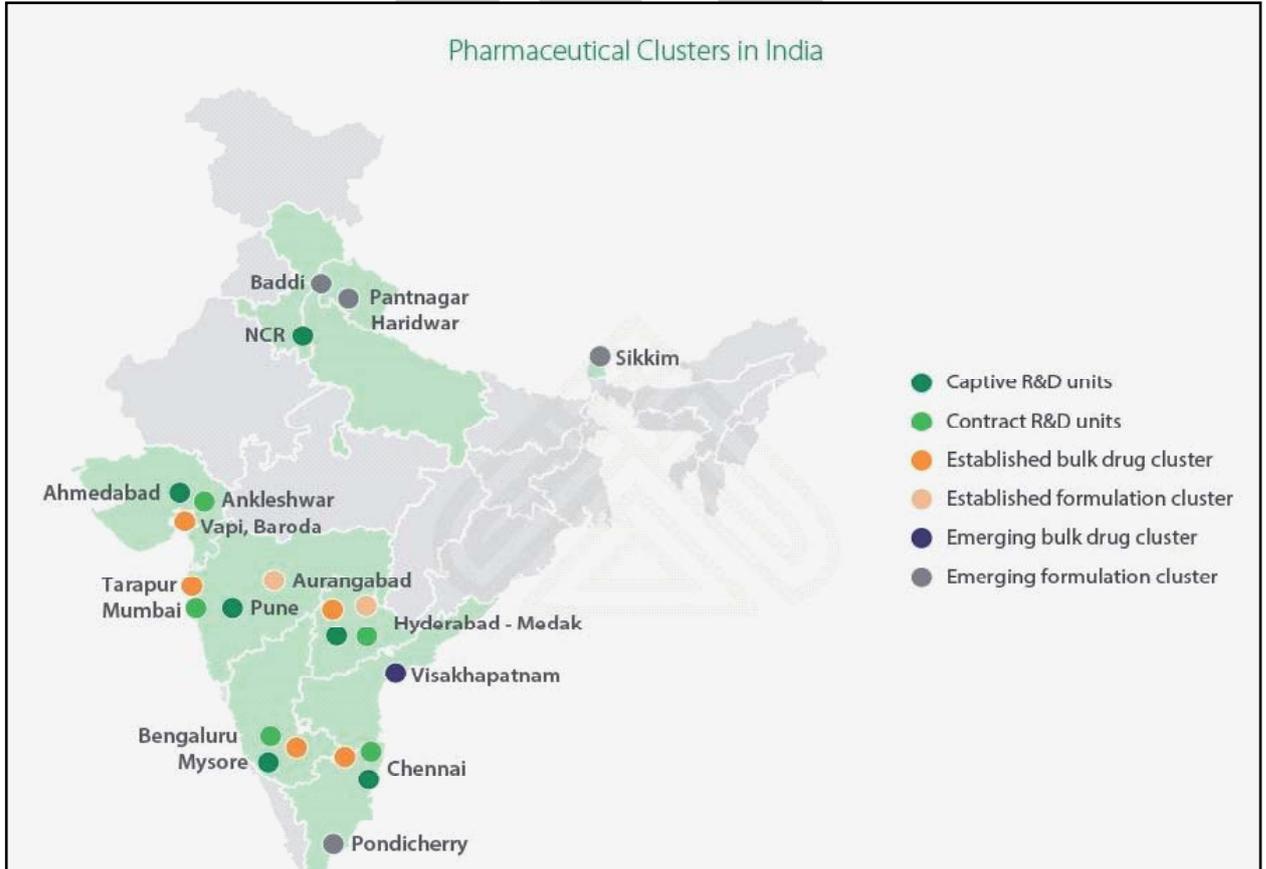


Indian pharmaceutical exports stood at US\$ 24.44 billion in FY21 and US\$ 22.21 billion in FY22 (until February 2022). As of May 2021, India supplied a total of 586.4 lakh COVID-19 vaccines, comprising grants (81.3 lakh), commercial exports (339.7 lakh) and exports under the COVAX platform (165.5 lakh), to 71 countries. Indian drugs are exported to more than 200 countries in the world, with the US being the key market.

Generic drugs account for 20% of the global export in terms of volume, making the country the largest provider of generic medicines globally. India's drugs and pharmaceuticals exports stood at US\$ 3.76 billion between April 2021 and May 2021. The foreign direct investment (FDI) inflows in the Indian drugs and pharmaceuticals sector reached US\$ 1.206 billion between April-December 2021. In FY21, North America was the largest market for India's pharma exports with a 34% share and exports to the US, Canada, and Mexico recorded a growth of 12.6%, 30% and 21.4%, respectively.

## WHY ARE PHARMACEUTICAL CLUSTERS MORE IN WESTERN PART OF THE COUNTRY?

- Proximity to the trade ports influences this sector for the export of key and crucial medicines.



- Better accessibility to capital due to the taste of trading and business has been there for a very long time.
- Government policies of Maharashtra and Gujarat give that conducive environment and better ecosystem in terms of ease of doing business.
- Proximity to petrochemical hubs for the processing of the raw materials.

## CONCERNS RELATED PHARMACEUTICAL INDUSTRY

- India imports almost 80% of the Active Pharmaceutical Ingredient (APIs) from China, which forms the base of the drug.
- International barriers due to imposition of sanitary and phyto-sanitary provisions create a deadlock for the Indian pharmaceutical to export its medicines in a better and smoother way.
- Provisions like Drug Price Control Order somewhere creates a mindset in the pharma preneurs to lower the price of essential drugs.
- Stronger IP regulations has always been a form of hurdle for India who wants to sell generic drugs at a cheaper rate but faces roadblocks from several European countries and USA
- Tropical climate of the country with not so consolidate cold chain ecosystem somewhere compels to inhibit the growth of pharmaceutical industry

## ROAD AHEAD

- Medicine spending in India is projected to grow 9-12% over the next five years, leading India to become one of the top 10 countries in terms of medicine spending.
- Going forward, better growth in domestic sales would also depend on the ability of companies to align their product portfolio towards chronic therapies for diseases such as cardiovascular, anti-diabetes, anti-depressants and anti-cancers, which are on the rise.
- The Indian Government has taken many steps to reduce costs and bring down healthcare expenses. Speedy introduction of generic drugs into the market has remained in focus and is expected to benefit the Indian pharmaceutical companies. In addition, the thrust on rural health programmes, life saving drugs, and penetrative vaccines also augurs well for the pharmaceutical companies.

## FOOD PROCESSING INDUSTRIES

Food processing is the transformation of raw ingredients into food, or of food into other forms (ie. food processing may denote direct manufacturing of food or value addition on existing food). Food processing typically takes harvested crops or butchered animal products and uses these to produce long shelf-life food products. From a very long time, one can witness the prominence of food processing industries, since the advent of baking, fermenting, and other key processes related to this domain.



## WHY IS THE VALUE OF FOOD PROCESSING INDUSTRIES SIGNIFICANT IN INDIA?

- Food processing industries are the right aspect of linkage to bring a bridge between industry and agriculture. FPIs can support to diversify the income of farmers and amplify them to ensure the doubling of farmers' income by 2022 as articulated in Agro-Export Policy of 2018.

- Food processing industries can bolster farmer producing organizations (FPOs) to promote, collaborate, and coordinate with the secondary sector regarding the production of food grains and other raw materials.
- Food processing industries can absorb a major share of workers from the agriculture sector, who face disguised unemployment. It can lead to better productivity and GDP growth.
- Food processing industries in recent times are contributing to 9% of the GDP and have attained a double-digit CAGR in the past few years.
- Food processing prevents food wastage and helps in attaining food security. Thus, it consolidates SDG-12.
- India ranks 1 in terms of production of milk, guava, banana, ghee, etc., and number 2 in rice and other raw food materials. Hence, any surplus production of these goods, apart from egg and meat will lead to expansion of this domain in a rampant manner.

## GEOGRAPHICAL METRICS

- Basic amenities like water, electricity should be in closer proximity with these areas.
- Key transport services like road, railway, etc., should have easier access
- These food processing facilities should be near housing areas to get easier access to human capital for the work, apart from cheap labor
- Easier and smoother availability of raw materials at a lower cost
- On climate front, it is the north-western India which is suitable for food preserving products due to cooler conditions
- Closer to readily available market

## RECENT TRENDS

100% FDI is allowed in this sector. According to the Confederation of Indian Industries, this sector has the potential to attract an investment of 33 billion USD in the span of next two-three years and thus, creating a massive employment.

- By 2020, India's organic market has increased three times.
- Currently, India's food and grocery market is sixth in the world, with retail contributing to 70% of the sales.
- This industry is expected to reach 250 bn USD turnout by 2015 and 350b\$ by 2020. Youth population, middle class, rising income, nuclear families, media penetration etc cited as positive factors.
- 100 % Income tax exemption to food processing units on profits for the first five years of operation.
- Reduction of Excise Duty on refrigerated containers from 12.5% to 6%.
- Reduction of Basic Customs Duty from 10% to 5%

## BENEFITS OF FOOD PROCESSING INDUSTRIES

- Expansion of India's agro-export basket, thus, giving diversification.
- Control inflation and volatility.
- Promotion of corporate and contract farming.
- Greater value addition to farm produce.
- Provides employment in rural areas, hence reducing migration from rural to urban. Resolves issues of urbanization.

## UPSTREAM AND DOWNSTREAM OF FOOD PROCESSING INDUSTRIES

- **Upstream stage:** In this stage, there is a focus on extraction of raw materials and it does not do anything with the material itself, such as processing the material. The key requirements of this stage are:
  - ▶ Accessibility of raw materials
  - ▶ Transport facilities
  - ▶ Quality testing facilities
  - ▶ Modern extraction techniques
  - ▶ Storage facilities
- **Downstream stage:** In this stage, there is a stress on transformation of those raw materials or the materials that have been collected or accumulated in the nascent stage or upstream stage, into a finished one. During this stage, the actual sale of processed food products to other retail consumers, businesses, and governments also happens. Thus, it creates a direct contact with customers. The key requirements of this stage are:
  - ▶ Latest processing techniques.
  - ▶ Latest processing machinery.
  - ▶ Quality testing facilities.
  - ▶ Organized retail stores for faster distribution.
  - ▶ Workforce

## CHALLENGES IN FOOD PROCESSING INDUSTRIES

- Lack of R&D made in this sector that restricts to modernize to a great extent and compete with international players and stakeholders present in the global market
- Low human capital in the food technology
- Poor transportation facilities and logistics sector existing in the country
- Lack of storage facilities to keep processed foods

## INITIATIVES

### Food Processing Industries Infrastructure Development

- 51 cold chain projects have been completed
- 6 Mega Food Parks operationalized
- 4 abattoirs (slaughterhouse) have been operationalized
- 11 Quality Testing Food Labs commissioned and 8 upgraded
- Infrastructure status has been granted to Food Parks

### Food Processing Industries - Mega Food Park Scheme

- The Scheme of Mega Food Park aims at providing a mechanism to link agricultural production to the market by bringing together farmers, processors and retailers so as to ensure maximizing value addition, minimizing wastage, increasing farmers income and creating employment opportunities particularly in the rural sector.

- The Mega Food Park Scheme is based on the “Cluster” approach and envisages creation of state of art support infrastructure in a well-defined agri / horticultural zone for setting up of modern food processing units in the industrial plots provided in the park with a well-established supply chain.
- Mega food parks typically consist of supply chain infrastructure including collection centers, primary processing centers, central processing centers, cold chains and around 25-30 fully developed plots for entrepreneurs to set up food processing units.
- The Mega Food Park project is implemented by a Special Purpose Vehicle (SPV) which is a Body Corporate registered under the Companies Act. State Government, State Government entities and Cooperatives are not required to form a separate SPV for implementation of the Mega Food Park project. Subject to fulfillment of the conditions of the Scheme Guidelines, the funds are released to the SPVs.

## NORTH EAST INDIA

### RESOURCES IN NORTHEAST INDIA

- For the British, North-East India was a **storehouse of raw materials** such as coal, natural oil, forests and tea. There was a mass extraction of these resources which were then exported to the other parts of the country for processing.
- **Water Resources:**
  - ▶ The **North East Region (NER)** has immense natural resources, accounting for around **34% of the country’s water resources** and almost **40% of India’s hydropower potential**.
  - ▶ The NE Region is blessed with a huge **hydro potential of about 58,356 MW**, out of which **2027 MW (about 3.47%)** has so far been **harnessed** as of 2021.



- **Mineral Resources:**
  - ▶ The Northeast region of India has an **abundant mineral chiefly of lime- stone, coal, natural oil and gas, uranium, feldspar, and others.**
  - ▶ The total **hydrocarbon deposits (oil and gas) accounts for 20%** of the total India.
  - ▶ **Assam and Tripura** together are estimated to have a combined reserve of **48 billion natural gases.**
  - ▶ Assam and Meghalaya have a huge reserve of coal which is known as **‘Black Gold’.**
  - ▶ NER has a **coal reserve of 1738 Million tonnes against the National reserve of 344.02 Billion tonnes.** Meghalaya and Assam in northeast India contain 73 % of the total tertiary coal reserves. Nagaland and Arunachal Pradesh contribute 21 % and 6 % of the total tertiary coal reserves, respectively.
  - ▶ According to a survey of the Geological Survey of India, the **Brahmaputra and Barak rivers and floodplains are a rich reservoir of oil and natural gas.**
  - ▶ **Manipur** has a huge reserves of **platinum group of elements (PGE) massive chromite;** Meghalaya is rich in minerals such as dolomite, phosphates, sillimanite, kaolin and China clay, carborundum which includes high quality uranium in west Khasi hills district .
  - ▶ **Estimated potential for renewable energy** in the North Eastern Region from Solar, Small Hydro and Bio-energy is around **65,837 MW.**
- **Forest Resources:** North Eastern Region (NER) is endowed with enormous forest resources. The **India State of Forests Report (ISFR) 2021**, released by the **Ministry of Environment**, revealed that the north-eastern states have a total forest cover of **1,69,521 square km**, out of their total geographical area of 2,62,179 sq km, which is **7.98% of the country’s geographical area.**

## INDUSTRIES IN NORTH EAST INDIA

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- In the last two decades, economic growth in the Northeast has been satisfactory with an annual growth rate in excess of 8 percent. A spectacular **rise in the service sector** has helped in the sustenance of high growth in the region.
- The North Eastern region has plenty of various resources. On the basis of availability of resources in North Eastern region the industries of the NE can be broadly classified under:
  - ▶ **Agro Based Industries:** It includes tea industry, textile industry, grain mill products industry (rice, oil and flour industry) and food processing industry.
  - ▶ **Mineral Based Industries:** Mineral industries of north eastern region include aluminium utensils industry, railway workshops, steel work etc. Moreover, the non- metal based industries include petroleum oil industry and natural gas based industry.
  - ▶ **Forest Based Industries:** It includes plywood industry, sawmill industry, paper industry and hard board industry.
  - ▶ **Other industries:** It includes power generation industry, fertilizer industry and chemical industry.
- The NER region is still maintaining a bright prospect for the development of different industries like, tea industry, tourism industry and sericulture industry etc.
- **Tea Industry:**
  - ▶ There is huge potential for growing tea in the non-traditional areas of the North Eastern region. Especially in Assam, tea is the main industry.
- **Tourism industry:**
  - ▶ Tourism industry is not only a growth engine but also an employment generator that has the capacity to create the large-scale employment opportunity both direct and indirect from the most specialised to unskilled workforce.

- ▶ Tourism in the North East is based on wildlife, natural beauty, unique flora and fauna, holy shrines, lush green gardens, turbulent rivers, vibrant and colourful culture festivals.
- ▶ **Scheme: Swadesh Darshan Scheme, Incredible India .**
- **Sericulture:**
  - ▶ Sericulture has been practised in NE region from time immemorial and continues to be an important labour intensive and agro based areas of NE region.
  - ▶ The state of Assam is proud of traditionally producing Muga, Eri and Mulberry.
- **Entrepreneurship development:**
  - ▶ Assam is better in terms of entrepreneurship development when compared to the other states in the Northeast. With an upscale market and good road/rail connectivity, Guwahati is naturally placed to lead the entrepreneurial activities and attract large-scale investments.
  - ▶ **Schemes: North East Industrial Development Scheme (NEIDS), North Eastern Region Vision 2020, Digital North East Vision 2022.**
  - ▶ **Infrastructure Scheme: Bharatmala Pariyojana, Regional Connectivity Udan Scheme.**
  - ▶ **Connectivity Schemes: Kaladan Multi Modal Project, India Myanmar Thailand Trilateral Highway.**
- **Petrochemical industry:**
  - ▶ The NER is very rich in petrochemical reserves.
  - ▶ Various kinds of petrochemicals can be produced in this region.
  - ▶ With adequate investment support, regional connectivity with the mainland, capital investment and infrastructure development this industry has the potential to provide employment and generate income.
  - ▶ **Scheme: 100% FDI permitted through automatic route except for few hazardous chemicals.**

## LOCATION OF INDUSTRIES

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- The main strength of the region for industrial development comes from its natural resource base.
- The theories of industrial location suggest that development of industries in a region may depend on a variety of factors such as:
  - ▶ availability of efficient and economic labour
  - ▶ availability of raw materials and their proximity
  - ▶ cheap and quick credit supply
  - ▶ a network of transport system
  - ▶ marketing facilities
  - ▶ conducive natural and economic climate
  - ▶ availability of efficient and effective management personnel
  - ▶ presence of scientific and technological know-how
  - ▶ sound and stable and well consolidated political atmosphere
  - ▶ existence of complementary industries and
  - ▶ historical and regional importance.
- Industries are situated where some or all of these factors are easily available.
- Sometimes, the government provides incentives like subsidised power, lower transport cost and other infrastructure so that industries may be located in backward areas.

## MEASURES TO PROMOTE INDUSTRIAL DEVELOPMENT IN NER

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- **Infrastructure development:** Adequate steps should be taken to improve the economic and basic infrastructural facilities to develop power, transport and communication facilities in the North Eastern region.
- **Implementation of proper market:** For the marketing of products produced by various industries of the North East region steps should be taken to implement proper marketing facilities in this region so that large and medium industries do not depend on the market outside.
- **Minimum cost structure:** Cost structure in the region should be minimised because high cost structure always reduces the profit outlook of the industries. For this purpose higher price levels in the region should also be reduced.
- **Policy framework of the government:** The government should provide effective policy and active support for the promotion of new industries as well as for the expansion of the existing industries in the region.
- **Ensuring credit flow:** In order to remove industrial backwardness in this region the various financial institutions should ensure easy flow of credit to promote rapid growth of industrialization.

## FACTORS CONSTRAINING THE DEVELOPMENT OF INDUSTRIES NER

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- **Geographical factors:** The hills account for about 70% area of the NER and accommodate about 30% of the population and the plains constituting the remaining 30% of the area hold about 70% of its population. The region's **accessibility has always remained weak due to geographical reasons and underdeveloped transport links** with the rest of India. Also, as the region witnesses floods and landslides in the Brahmaputra and Barak valleys of Assam, considerable strain is exerted on the economy of not only Assam but other NER states too.
- **Infrastructural factors:** One of the reasons for economic backwardness of the NER is the poor state of basic infrastructural facilities like the roadways, waterways, energy and so on as well as social infrastructure like educational institutions, health facilities etc.
- **Constraints on Industrial Growth:** Post-Independence, due to the partition of India, Assam received a serious setback as its trade routes were cut off from the rest of India. Northeast India is a storehouse of natural resources but these are either underutilised, unutilized, and mismanaged.
- **Primitive Agriculture:** The **Green Revolution was largely limited** to the North Western parts of the country and has not been of benefit in the NER. One of the most common agricultural practices in the NER is the shifting/Jhum cultivation. Approximately **1.7 million hectares** of land is under it which leads to a large-scale deforestation resulting in soil erosion and loss of soil fertility.
- **Dearth of Capital Formation:** Industrialization is meaningless without capital formation. Capital formation depends upon various factors like **savings habits, per capita income**, etc. Unfortunately the North East is suffering from low capital formation, less investments, low opportunities for entrepreneurship and low expansion of the financial system.
- **Lack of entrepreneurial motivation:** Local initiative and enterprise are lagging behind the requirements necessary for the successful industrialization in the region. Without active entrepreneurial motivation among the local people the industrial development of the region would be incomplete.
- **Natural Resource Base:** The resources are being indiscriminately exploited and mismanaged, thereby leading to the depletion of the very assets that are usually highlighted as triggering the greatest potential for growth and development of the NER. Also the biodiversity of the region is under severe threat.

- **Lack of market accessibility:** Proper market has not been developed in the NER due to which the local manufacturers do not find a space for their products in the market. Also due to its proximity to many foreign countries there is a heavy risk of investment from a political viewpoint.
- **Investment Risk:** Due to heavy risk involved in the investment arising through natural calamities and political risks as the region itself is a border area. NER is unfortunately one of these few states which are every now and then visited by natural calamities such as floods and droughts. Moreover, due various **socio-political reasons, the law and order situation** in the region is not always smooth rather it is often disturbed. These reasons raised the problem of insecurity for the new industrial projects in the region.
- **High cost structure:** Production cost structure in the region is very high in comparison to the other states of India. High cost structures always reduce the profit outlook of the industries.

## GLOBAL WARMING / CLIMATE CHANGE (WITH REFERENCE TO LATEST IPCC REPORTS)

### EFFECTS/ IMPACTS

#### WATER RESOURCES

- Climate change will have its most pronounced effects on not only ocean waters but also on **inland freshwater wetlands** through **altered precipitation and more frequent or intense disturbance events** (droughts, storms, floods).
- Coastal areas will see **continued sea-level rise** throughout the 21st century, resulting in **coastal erosion** and more frequent and **severe flooding in low-lying areas**.
- Its impact on **inland water resources like lakes**, include an extended growing period at high latitudes, **intensified stratification** and nutrient loss from surface waters, decreased hypolimnetic oxygen (below the thermocline) in deep, **stratified lakes**, and expansion in range for many invasive aquatic weeds.
- Effects of warming on **riverine systems** can be observed in the form of **drying of streambeds and lakes for extended periods** thus **reducing ecosystem productivity** because of the **restriction on aquatic habitat**, combined with lowered water quality via increased oxygen deficits and pollutant concentrations.
- **Seas** will see changes in the timing and volume of freshwater runoff will **affect salinity, sediment and nutrient availability**, and moisture regimes in coastal ecosystems. It will thus impact the millions of people who rely on marine source for food and income.





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## CRYOSPHERE

- The **cryosphere** refers to frozen components of the Earth system that are at or below the land and ocean surface. These include “snow, glaciers, ice sheets, ice shelves, icebergs, sea ice, lake ice, river ice, permafrost and seasonally frozen ground”.
- Since the mid-20th century, the **shrinking cryosphere** has led to predominantly **negative impacts** on food security, water resources, water quality, livelihoods, health, and well-being, as well as the culture of human societies, particularly for Indigenous peoples.
- **Retreating snowlines and melting glaciers** is a cause for alarm as this can cause a change in the water cycle, the precipitation patterns, increased floods as well as an increased scarcity of water in the future in the states across the Himalayas.
- The **melting glaciers are the dominant source of sea-level rise**, exceeding the effect of thermal expansion of ocean water (due to rising temperatures).
- A **warming climate increases the emission of CO<sub>2</sub> and methane as permafrost thaws**, “thus accelerating the pace of climate change”.
- **For instance**, in recent times, high temperatures have been recorded in the **Siberian region**, causing a prolonged heatwave, which have been attributed to absence of sea ice among other factors.

## BIODIVERSITY-FLORA FAUNA

- **Alter ecosystem functioning:** As climate change progresses, the distribution, functioning and interactions of organisms, and thus ecosystems, are increasingly altered.
- **Extinction Risk:** It is the highest on island-like biodiversity hotspots such as mountains, islands, coral reefs and coastal embayments, or fragments of formerly more extensive habitats, now separated by altered land-, freshwater- and seascapes less supportive of biodiversity.
- **Stress on ecosystem:** Increased number of draughts, floods and other extreme events would add to stress on many ecosystems.
- **Exacerbated desertification:** Reduced annual rainfall and increased evaporations would lead to reduced runoff and soil moisture.
- **Increase forest Fires:** Frequency and intensity of forest fires and pest attacks are likely to increase further.
- The **shifting of ITCZ decreased monsoon rains**, drying up rivers have made agriculture difficult.

## HUMAN RESOURCES

- The climate crisis **threatens to undo the last fifty years of progress in development**, global health, and poverty reduction, and to further widen existing health inequalities between and within populations.
- Over **3.5 billion people, over 45% of the global population**, are living in areas highly vulnerable to climate change.
- Climate change will **affect the social and environmental determinants for humans** – clean air, safe drinking water, sufficient food and secure shelter.
- Between **2030 and 2050**, climate change is expected to **cause approximately 250000 additional deaths per year, from malnutrition, malaria, diarrhoea and heat stress**.
- Climate change is **already impacting health in a myriad of ways**, including by leading to death and illness from increasingly frequent extreme weather events, such as heatwaves, storms and floods, the disruption of food systems.

- The **direct damage costs to health** (i.e. excluding costs in health-determining sectors such as agriculture and water and sanitation), is estimated to be between **USD 2-4 billion/year by 2030**.
- **Areas with weak health infrastructure** – mostly in developing countries – will be the least able to cope without assistance to prepare and respond.

## MIGRATION

- The expert said that of **59.1 million people internally displaced in 2021** across the world, most were displaced by climate-related disasters.
- There is an **intolerable tide of people moving from their homes** due to the impacts of climate change.
- Already, **close to 90% of the world's refugees** come from countries that are the most affected by climate change – and the least able to adapt.
- For example, in **2020, wildfires and flooding exacerbated** the existing humanitarian crisis in Syria, prompting the evacuation of thousands of already internally displaced persons.
- **Small island states are particularly affected by disasters**. For instance, large proportions of Vanuatu's population were displaced by Cyclone Pam in 2015 and by Cyclone Harold just five years later.
- According to a **UN forecast**, such countries could face average annual disaster-related losses equivalent to nearly **4% of their GDPs**.
- Thus migration due to climate change also burdens the host country in managing the inflow of migrants and refugees.

## LAND DEGRADATION & DESERTIFICATION

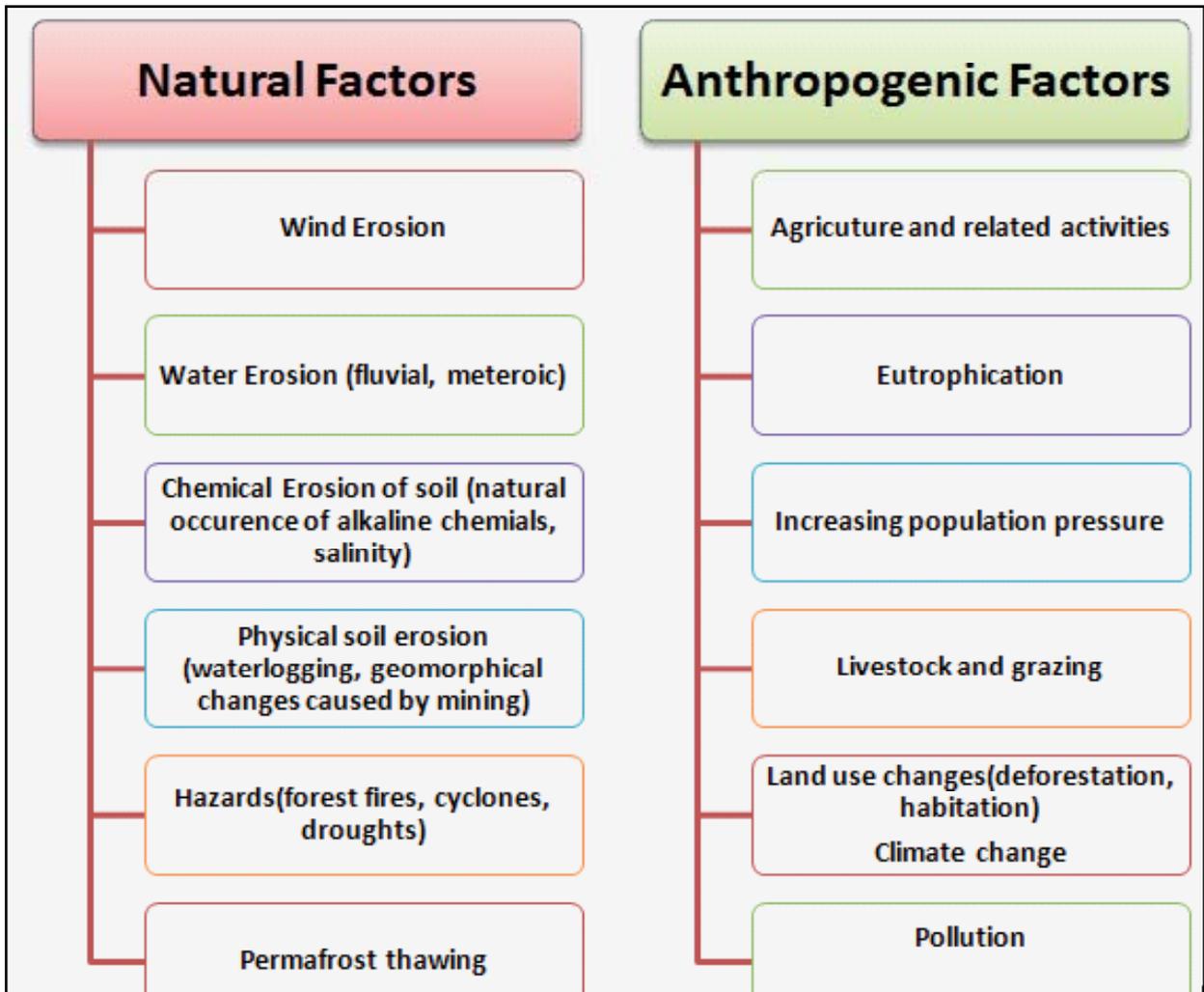


### WHAT IS IT ABOUT ?

- **Land degradation** is defined as a negative trend in land condition, caused by direct or indirect human-induced processes including anthropogenic climate change, expressed as long-term reduction or loss of at least one of the following: biological productivity, ecological integrity, or value to humans.

- **Land degradation** that occurs within dryland regions (arid, semiarid and dry sub-humid regions) is termed as Desertification, which turns fertile land into desert.

## FACTORS RESPONSIBLE



## MULTIDIMENSIONAL IMPACT OF LAND DEGRADATION & DESERTIFICATION

- **Impact on the Economy:** Agricultural production is threatened by land deterioration. It has a negative influence on soil health, which has a negative impact on rural people's livelihood.
- **Climate Change:** It is amplifying climate change events, which is leading to even more devastation. Degraded land, for example, reduces its ability to absorb carbon dioxide (CO<sub>2</sub>), a greenhouse gas (GHG) that is the leading cause of climate change. Land degradation is a driver of climate change through emission of greenhouse gases (GHGs) and reduced ability of land to act as a carbon sink.
- **Socio-Economic impacts:** Reduces land productivity threatening food security and livelihoods of indigenous populations, small farmers etc. Exacerbates existing societal tensions and forces migration.
- **Water Scarcity:** It reduces the land's ability to store water resulting in water scarcity. Under ideal conditions of 1.5 degrees Celsius warming, the dryland population subject to water stress and drought intensity is expected to reach 178 million by 2050.

- **Environmental impacts:** Its impacts can be far-reaching, including loss of soil fertility, destruction of species habitat and biodiversity, soil erosion, and excessive nutrient runoff into lakes. It causes extreme weather events, accelerates biodiversity loss and disruption of ecosystem services. Thus environmental land use conflicts amplify environmental impacts.

## RECENT FACTS

- Degradation is currently **affecting 25% of Earth's land** and **40% of Earth's agricultural land**.
- **State of India's Environment 2019** states around 30% (97.85 million ha) of the Total Geographic Area (TGA) of the country has undergone land degradation during 2018-19, an increase from the findings for the years 2011-13.
- Findings from **ISRO (Indian Space Research Organisation) Desertification and Land Degradation Atlas:**
  - ▶ Some 97.85 million hectares (29.7%) of India's total geographical area (TGA) of 328.72 mha underwent land degradation during 2018-19.
  - ▶ 82% of these degraded land lies in just nine states: Rajasthan, Maharashtra, Gujarat, Jammu & Kashmir, Karnataka, Jharkhand, Odisha, Madhya Pradesh and Telangana.
  - ▶ In 2018-19, 83.69 million hectares (mha) were desertified. This was higher than the 81.48 mha of desertification in 2003-2005 and the 82.64 mha of desertification in 2011-13.

## MEASURES TO COMBAT LAND DEGRADATION & DESERTIFICATION

- **Desert Development Programme:** It began in 1995 with the goal of reducing the negative effects of drought and revitalising the natural resource base of the selected desert areas. It was designed for the scorching deserts of Rajasthan, Gujarat, and Haryana, as well as the frigid deserts of Jammu and Kashmir
- **Adoption of watershed approach:** planning based on micro-watersheds, use of remote sensing data and spatial data in planning at the micro-watershed level. E.g. Integrated Watershed Management Programme (IWMP).
- **Integrated farming-based approach:** National Afforestation Programme (NAP), National Mission for Green India (GIM), incorporating fodder and fuelwood supply, farm-forestry and agroforestry and silvi pastures (combination of trees, forage plants and livestock together as an integrated, intensively-managed system), stall feeding, improved chullahs etc.
- **Focus on social aspects:** e.g. Constitution of Watershed Committee under the Gram Sabha, Water User Association development, Social Audit under MGNREGA, Joint Forest Management (JFM) and Social Fencing by involving local communities.
- **Adoption of climate-adaptation related solutions:** Both with regard to floods and intense precipitation as well as temperature and moisture stress.
- **National Mission on Green India:** With a 10-year deadline, it was authorised in 2014 to conserve, restore, and improve India's depleting forest cover.
- **United Nations Convention to Combat Desertification (UNCCD):** Established in 1994, it is the **sole legally binding international agreement** linking environment and development to sustainable land management. In 1994, **India signed the UNCCD, which it ratified in 1996**. **By 2030, India plans to rehabilitate 26 million hectares of degraded land**. India is putting forth a lot of effort to meet its national goal to attain **Land Degradation Neutrality (LDN)** (Sustainable Development Goal target 15.3).
- The **National Action Plan (NAP)** to combat desertification was launched in 2001 for 20 years.

## UNCCD (COP-15)

### In News:

Recently, the Union Minister for Environment, Forest and Climate Change addressed the fifteenth session of the **Conference of the Parties (COP15) of the United Nations Convention to Combat Desertification (UNCCD)** in Cote d'Ivoire (Western Africa).

### Highlights Of The Meet:

- **Theme:** The COP15 theme, '**Land. Life. Legacy: From scarcity to prosperity**', is a call to action to ensure land, the lifeline on this planet, continues to benefit present and future generations.
- **Agenda:** **Drought, land restoration, and related enablers such as land rights, gender equality and youth empowerment** are among the top items on the Conference agenda.
- **Objective:** COP 15 builds on the findings of the second edition of the **Global Land Outlook (given by UNCCD)** and offers a concrete response to the interconnected challenges of land degradation, climate change and biodiversity loss.

### UNCCD 2018-2030 Strategic Framework

- To improve the condition of affected ecosystems, combat desertification/ land degradation, promote sustainable land management and contribute to land degradation neutrality.
- To improve the living conditions of affected populations.
- To mitigate, adapt to, and manage the effects of drought in order to enhance resilience of vulnerable populations and ecosystems.
- To generate global environmental benefits through effective implementation of the UNCCD.
- To mobilize substantial and additional financial and non-financial resources to support the implementation of the Convention by building effective partnerships at global and national level.

## CRYOSPHERE

### INDIA AND ANTARCTICA

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- It contains the geographic South Pole and is situated in the Antarctic region of the Southern Hemisphere, almost entirely south of the Antarctic Circle, and is surrounded by the Southern Ocean.
- At 14,000,000 square kilometres (5,400,000 square miles), it is the fifth-largest continent.

### SIGNIFICANCE FOR INDIA

- **Research and development:** One major world region, least explored and yet most promising now, is the Antarctic region with the South Pole, which is being rightly explored by India through its scientific expeditions there. India has been sending expeditions to Antarctica for the past 40 years. Research stations of India in Antarctica- Dakshin Gangotri, Maitri, Bharti.
- **Geopolitical:** The India's entry into the elitist Antarctic treaty system (ATS) and its innermost circle has added a new dimension to the geopolitics of Antarctica. India decides to play an important role within the ATS and moreover as a consultative member with rights and duties.

- **Biodiversity:** Indian scientists are also working on cold adaptive microbes, mosses and lichens and the mapping of biodiversity in this region. India has to its credit discovery of some new species and a monograph on the lichens of Schirmacher Oasis has been published.
- **Economic:** Scientific expeditions have found valuable minerals in some of these Antarctic areas, including antimony, chromium, copper, gold, lead, molybdenum, tin, uranium, and zinc.

## INDIAN INITIATIVES

### The Indian Antarctic Programme (1981-82)

It is a multi-disciplinary, multi-institutional programme under the control of the National Centre for Antarctic and Ocean Research, Ministry of Earth Sciences, Government of India. Under the programme, atmospheric, biological, earth, chemical, and medical sciences are studied by India, which has carried out 35 scientific expeditions to the Antarctic till now.

#### Antarctica treaty:

- The Antarctic Treaty was signed in 1959 by 12 countries including Union of South Africa, USSR, the UK of Great Britain and Northern Ireland and the US of America, and came into force in 1961.
- The Treaty covers the area south of 60°S latitude.
- The objectives of the treaty are to demilitarize Antarctica and establish it as a zone used for peaceful research activities and to set aside any disputes regarding territorial sovereignty, thereby ensuring international cooperation.

### The Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR)

Was set up in 1980 for the protection and preservation of the Antarctic environment and, in particular, for the preservation and conservation of marine living resources in Antarctica.

#### About PACER Initiative

The Polar Science and Cryosphere Research (PACER) scheme comprises the Antarctic program, Indian Arctic program, Southern Ocean program and Cryosphere and Climate program.

- Objective: To study various aspects relating to Polar and the Cryosphere with special emphasis on the Antarctic, Arctic and Glaciers of the Himalayas.

## THE INDIA ANTARCTICA BILL 2022

- Nearly 40 years after India first signed the Antarctic Treaty, the government has brought in a draft Indian Antarctic Bill, 2022.
- The draft bill is the first domestic legislation with regard to Antarctica in India.
- **Major provisions –**
  - ▶ extending of jurisdiction of Indian courts to Antarctica, and the investigation and trial for crimes committed on the Arctic continent.
  - ▶ Introduces an elaborate permit system for any expedition or individual who wishes to visit the continent.
  - ▶ The Bill further enlists elaborate standards for environmental protection.

- ▶ The Bill specifies penalties for contravention of its provisions. For instance, conducting a nuclear explosion in Antarctica will be punishable with an imprisonment of 20 years may extend to life imprisonment and a fine of at least Rs 50 crore.

## INDIA AND ARCTIC

The Arctic refers to the polar region above the Arctic Circle, which includes the Arctic Ocean with the North Pole at its centre. Antarctica, though uninhabited, is governed by the 1959 Antarctic Treaty ensuring that it is used for exclusively peaceful purposes. There is no similar international regime for the Arctic.

## WHY THE ARCTIC IS IMPORTANT FOR INDIA ?

India's interests in the Arctic region are scientific, environmental, commercial as well as strategic. All the undertakings in this region cater to wider causes, concerning both immediate and futuristic aspects.

### Commercial and Strategic Interests:

- The Arctic region is very rich in minerals, and oil and gas. With some parts of the Arctic melting due to global warming, the region also opens up the possibility of new shipping routes that can reduce existing distances.
- The Arctic Council does not prohibit the commercial exploitation of resources in the Arctic. It only seeks to ensure that it is done in a sustainable manner without harming the interests of local populations and in conformity with the local environment.
- Therefore, to stay relevant in the Arctic region, India should take advantage of the observer status it has earned in the Arctic Council and consider investing more in the Arctic.

### New sea route:

- Shipping routes might change as warming continues to the middle of the century. It will reduce decade on decade, and open up vast swathes of the Arctic Ocean.
- As voyage times fall to less than three weeks in some cases, Arctic shipping could become more attractive than the southern routes in coming decades.

### Political and Economic significance :

- Melting of the Arctic ice caps, resultant access to Arctic Ocean routes and fossil fuels, as well as deterioration of Arctic States relations encourages non-regional actors' activity. The process predominantly refers to the Asian players who face lack of inner recourses.
- Diversification of energy imports : Diversification of energy imports remains a crucial endeavour for India which has always remained sceptical of alignment with any power.
- The Arctic region also holds mineral resources, as mentioned earlier, including gold, nickel, copper, graphite and uranium. These minerals are utilised in the manufacture of high-technology products such as mobile phones and nuclear energy, which can help push India's 'Make in India' programme.

### Ecological and Environmental Significance :

- India's Arctic research objectives are centered on ecological and environmental aspects, with a focus on climate change.

- Generally, India is seen to have taken the lead among Asian Observer states placing more weight on environmental and scientific rather than the economic potential of the region.
- Support for such focus is certainly strengthened by the fact that the importance of agriculture to the Indian economy and its dependence on monsoons, along with its long coast-line with a high population make the country extremely vulnerable to climate change.

### Research and Development :

- Under the banner of science and research, the Indian government hopes to build its research capabilities in the region by strengthening existing facilities, such as the Himadri Arctic station in Svalbard.
- It also hopes to align Indian research with international Arctic priorities.

## INITIATIVES

### India's acquaintance with the Arctic:

- India launched its first scientific expedition to the Arctic Ocean in 2007 and opened the Himadri research base in Svalbard (Norway) archipelago and has been actively engaging in research there ever since.
- India got elected to Council of the International Arctic Science Committee (IASC) in 2012, followed by its induction to the Council with observer status in 2013.

**The Multidisciplinary Drifting Observatory for the Study of Arctic Climate (MOSAIC)** is an international research expedition to study the physical, chemical, and biological processes that coupled the Arctic atmosphere, sea ice, ocean, and ecosystem. MOSAiC is the first year-round expedition into the central Arctic exploring the Arctic climate system.

### 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.

### Arctic Council:

It is an Intergovernmental forum which addresses issues faced by the Arctic governments and people living in the Arctic region. It is Not a treaty-based international organization but rather an international forum that operates on the basis of consensus.

## GLACIAL LAKE OUTBURST FLOODING (GLOF)

The Himalayas are witnessing an increasing threat of glacial lake outburst flooding (GLOF). Over the years, several GLOFs hit the Himalayas, causing massive destruction to the infrastructure, while also claiming thousands of lives.

## WHAT IS A GLOF?

- GLOF is the term scientists use to describe the incident when the water levels of glacial lakes breach their boundaries, causing large amounts of water to flow into nearby streams and rivers. These also create flash floods.
- Experts attribute GLOFs to climate change and the increase of anthropogenic footprints on glaciers.

## GLOFS HAVE THREE MAIN FEATURES

- They involve sudden (and sometimes cyclic) releases of water.
- They tend to be rapid events, lasting hours to days.
- They result in large downstream river discharges (which often increase by an order of magnitude).

## WHY ARE GLOFS IMPORTANT?

- Some of the largest floods in Earth's history have been GLOFs. They have caused large-scale landscape change, and even altered regional climate by releasing huge quantities of freshwater to the oceans.
- Today, GLOFs pose a risk downstream communities and infrastructure. In Peru alone, GLOFs were responsible for ~32,000 deaths in the 20<sup>th</sup> century. They have killed hundreds to thousands of people in other mountain regions (e.g. the Himalayas), and destroyed roads, bridges, and hydroelectric developments.
- An increasing hazard : Glaciers are retreating due to climate change. The increase in the anthropogenic footprint in the glaciers leads to the increasing threat of GLOFs, and over 200 glaciers in the Himalayas are vulnerable to outbursts.
- When a glacial lake bursts, its water flows into downstream areas at extreme speed. This causes massive damage to the infrastructure. GLOFs remain a persistent threat to downstream communities and infrastructure, besides flora and fauna.
- Many floods in Nepal have originated in Tibet and similarly, floods from Nepal do not respect national boundaries and have the potential to run into India and even Bangladesh.
- In June 2013, Uttarakhand had received an unusual amount of rainfall leading to the melting of the Chorabari glacier and the eruption of the Mandakini river. The floods affected large parts of Uttarakhand. Reportedly, the worst hit was the Kedarnath valley in Uttarakhand, as the flood left behind a death toll of more than 5,000.

## NDMA GUIDELINES AND INDIA'S PREPAREDNESS

- Identify and Mapping Dangerous Lakes: Potentially dangerous lakes are often identified. This identification are going to be supported by field observations, past events, geomorphologic and geotechnical characteristics, etc.
- Use of Technology: It is recommended to utilize the Synthetic-Aperture Radar imagery. It will automatically detect changes in water bodies, including new lake formations, during the monsoon months.
- Structural Measures: It recommends reducing the number of water with various methods to manage lakes structurally. Methods are pumping or siphoning out water and making a tunnel through the moraine barrier or under an ice dam.
- Constructions and development in High prone areas should be prohibited. it's a very efficient means to reduce risks at no cost.
- Land Use Planning: Land use planning regulations need to be developed. In downstream areas, Infrastructure development should be monitored before, during, and after the construction.

- **Empowered Local Manpower:** Apart from specialized forces like NDRF, ITBP, and the military, there is a requirement for trained local manpower. They can assist in planning and fixing emergency shelters, distributing relief packages, identifying missing people, and addressing the requirement for food, healthcare, water, sanitation, etc.
- **Early Warning System:** A robust early warning system in vulnerable zones should be put in place.
- **Emergency response team:** Quick Reaction Medical Teams, mobile field hospitals, Accident Relief Medical Vans, and heli-ambulances should be found out in areas inaccessible by roads.

## MISCELLANEOUS

### SAGARMALA PROJECT: COMMEMORATING THE SEVEN YEARS OF SAGARMALA PROGRAM

#### ABOUT SAGARMALA

- It is the flagship programme of the Ministry of Ports, Shipping and Waterways (MoPSW) launched in March 2015 to promote port-led development in the country through harnessing India's 7,500 km long coastline, 14,500 km of potentially navigable waterways and strategic location on key international maritime trade routes.
- The main vision of the Programme is to reduce logistics cost for EXIM and domestic trade with minimal infrastructure investment.

#### COMPONENTS OF THE PROGRAMME

- **Port Modernization & New Port Development:** Debottlenecking and capacity expansion of existing ports and development of new greenfield ports
- **Port Connectivity Enhancement:** Enhancing the connectivity of the ports to the hinterland, optimizing cost and time of cargo movement through multi-modal logistics solutions including domestic waterways (inland water transport and coastal shipping)
- **Port-linked Industrialization:** Developing port-proximate industrial clusters and Coastal Economic Zones to reduce logistics cost and time of EXIM and domestic cargo
- **Coastal Community Development:** Promoting sustainable development of coastal communities through skill development & livelihood generation activities, fisheries development, coastal tourism etc.

#### 7 YEARS OF SAGARMALA PROJECT: ESTIMATES

- The Ministry showcased that 802 projects worth Rs. 5.48 lakh Crore under the Sagarmala program targeted to be executed by 2035 out of which 194 projects worth Rs. 99,000 Crore have been completed.
- A total of 29 projects worth Rs. 45,000 Crore have been successfully implemented under PPP model, thus, reducing the financial burden on the exchequer.
- Several projects have been undertaken across various categories such as port modernization, road, cruise tourism, RORO, ROPAX, fisheries, coastal infrastructure and skill development.

- there are 218 projects worth Rs. 2.12 lakh Crore under construction and expected to be completed in 2 years' time. This apart, 390 projects worth Rs. 2.37 Lakh Crore are under development pipeline.
- Centre of Excellence in Maritime and Shipbuilding (CEMS) which has trained over 5000 candidates in 50+ courses since inception.
- National Technology Centre for Ports, Waterways and Coasts (NTCPWC) at IIT Madras has carried out more than 70 research and technical support projects related to ports and waterways.
- Multi Skill Development Centres (MSDC) for training are already operational at the premises of Jawaharlal Nehru Port and Chennai Port.
- Development of a new deep draught port at Vadhavan, on the north coast of Maharashtra is taking shape. The port will cater to Ultra Large Container Vessels (UCLVs).

## IMPACT OF PLASTICS ON MARINE ECOSYSTEM

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### VARIOUS CAUSES OF PLASTIC POLLUTION

- As plastic is less expensive, it is one of the most widely available and overused items in the world today.
- Rapid urbanization and population growth increase the demand of cheap plastics.
- Since it is an affordable and durable material, it is utilized in every other way possible, from packaging materials to plastic bottles and containers, straws to plastic carry bags.
- Plastic takes 400 years and even more to Decompose. The decomposition rate of plastic typically ranges from 500 to 600 years, depending on the type.
- Abandoned Fishing Nets
- Disposal of plastic is often mismanaged; it ends up in landfills.

### IMPLICATIONS ON MARINE ECOSYSTEM

- Ingestion, suffocation, and entanglement of hundreds of marine species are the most evident effects of plastic pollution. Various studies have shown that once ingested, microplastics can settle in the stomach and
- lead to reduction in feeding capacity of organisms. They can also be detrimental to the
- intestinal function and reproductive system.
- Seabirds, whales, fish, and turtles mistake plastic waste for food, and the majority of them starve to death as their stomachs fill with plastic.
- They also have lacerations, infections, impaired swimming abilities, and internal traumas.
- Invasive marine organisms are also transported by floating plastics, posing a hazard to marine biodiversity and the food web.
- A new study of the faeces of captive seals has shown that microplastics can travel high up the food chain and affect even the large predators of the oceans. Microplastics are ingested directly by the zooplankton -- the lowest link in the food chain. The zooplankton is eaten by fish; and the microplastic finally reaches the seal, which consumes the fish.
- Climate Change : Almost all plastic is made from fossil fuel-derived ingredients such as ethylene and propylene (mostly oil and gas). The extraction and transportation of those fuels, followed by the manufacture of plastic, produce billions of tonnes of greenhouse gases. Plastic emits significant greenhouse gases as a result of sunlight and heat, resulting in a dangerous feedback cycle.
- Impact on Habitats: Seafloor plastic waste sheets could act like a blanket, inhibiting gas exchange and leading to anoxia or hypoxia (low oxygen levels) in the aquatic system, which in turn can adversely affect the marine life.

- **Invasive Species:** Plastic waste can also be a mode of transport for species, potentially increasing the range of certain marine organisms or introducing species into an environment where they were previously absent. This, in turn, can cause subsequent changes in the ecosystem of the region.

## INITIATIVES TO TACKLE PLASTIC

- **Elimination of Single Use Plastic:** In 2019, the Prime Minister of India pledged to eliminate all single-use plastic in the country by 2022, with an immediate ban in urban Delhi.
- The single-use plastic items that are difficult to collect are banned –
- Earbuds with plastic sticks, plastic sticks for balloons, plastic flags, candy sticks, ice-cream sticks, invitation cards, cigarette packets, plastic or PVC banners less than 100 microns, stirrers, etc.
- **Plastic Waste Management Rules, 2016** state that every local body has to be responsible for setting up infrastructure for segregation, collection, processing, and disposal of plastic waste. **Plastic Waste Management (Amendment) Rules 2018** introduced the concept of Extended Producer Responsibility (EPR).
- **Un-Plastic Collective:** Un-Plastic Collective (UPC) is a voluntary initiative launched by the UNEP-India, Confederation of Indian Industry and WWF-India.
- The Collective seeks to minimise externalities of plastics on the ecological and social health of our planet.

### Global Partnership on Marine Litter (GPML):

The GPML was launched at the Earth Summit in 2012 in response to a request set out in the Manila Declaration.

### Plastic Pacts:

The Plastics Pacts are business-led initiatives to transform the plastics packaging value chain for all formats and products.

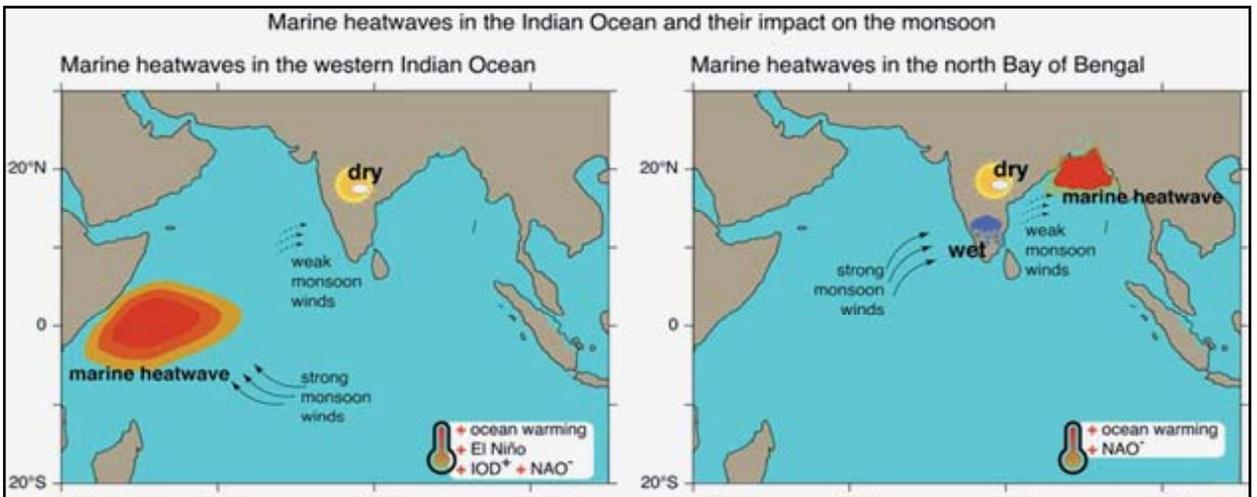
## MARINE HEAT WAVES

### WHAT ARE MARINE HEATWAVES?

- A marine heatwave is defined a when seawater temperatures exceed a seasonally-varying threshold (usually the 90th percentile) for at least 5 consecutive days. Successive heatwaves with gaps of 2 days or less are considered part of the same event.
- These events cause habitat destruction due to coral bleaching, seagrass destruction, and loss of kelp forests, affecting the fisheries sector adversely.

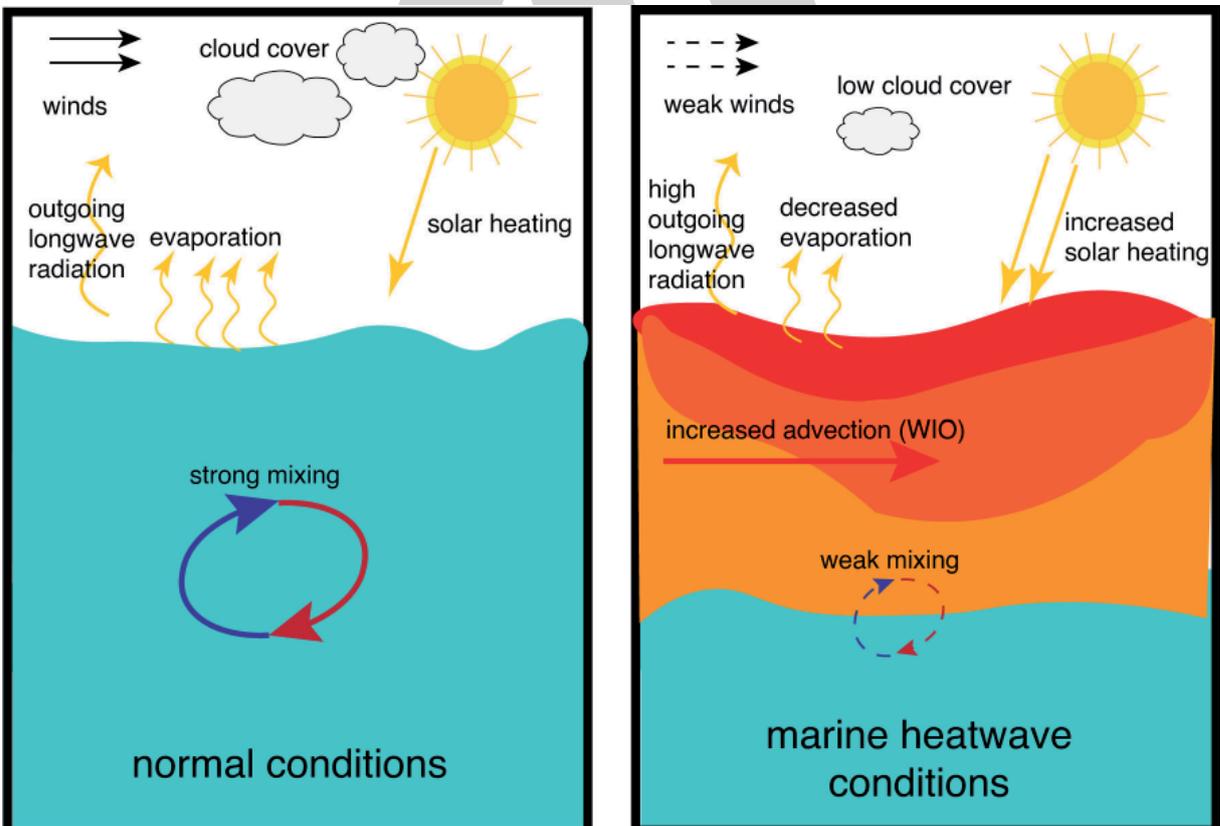
### IMPACTS OF MARINE HEAT WAVES ON MONSOON

- They are one of the major results of human-induced global warming.
- During an MHW, the average temperatures of the ocean surface (up to a depth of 300 feet) goes 5-7 degrees Celsius above normal.
- The increase in marine heat waves was due to rapid warming in the Indian Ocean and strong El Nino.
- In 2015-16, the world witnessed a strong El Nino event that had wide-ranging impacts on weather conditions around the world, including marine heat waves.



- Rapid warming of Indian ocean.
- Increases the likelihood of Marine heat waves.
- Heatwaves manifests as extreme events .
- Strong El- Nino events.
- Impacts by reducing rainfall over the central Indian sub-continent while enhancing it over southern peninsula
- Leads to ecosystem vulnerability

## LOCAL DYNAMICS INVOLVED IN THE GENESIS OF MARINE HEATWAVES



- Other than rapid ocean warming, the co-occurrence of either an El Nino, positive Indian Ocean Dipole (IOD), or the negative North Atlantic Oscillation (NAO) can trigger and intensify the marine heatwaves.
- The western Indian Ocean region experienced the largest increase in marine heatwaves at a rate of about 1.5 events per decade, followed by the north Bay of Bengal at a rate of 0.5 events per decade.
- Result in drying conditions over the central Indian subcontinent. At the same time, there is a significant increase in the rainfall over south peninsular India in response to the heatwaves in the north Bay of Bengal. The local ocean-atmospheric dynamics through which these marine heatwaves manifest over the Indian Ocean is shown in the figure below

## **FUTURE CHALLENGE**

“Climate model projections suggest further warming of the Indian Ocean in the future, which will very likely intensify the marine heat waves and their impact on the monsoon rainfall. Since the frequency, intensity, and area covered by the marine heat waves are increasing, we need to enhance our ocean observational arrays to monitor these events accurately, and update our weather models to skillfully predict the challenges presented by a warming world”





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