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Indian Maritime

Chapter 1: Paradigm of Coastal Security

India, due to its geographical location, faces a multitude of maritime threats and challenges.

India's vital geo-strategic location in the Indian Ocean has helped for its growth as an emerging economy. Her prominent peninsular orientation and flanking island chains overlook strategic sea lanes in the Indian Ocean, linking her security and prosperity inextricably to the seas. But due to its strategic position, it is facing many threats.

Maritime Security Challenges
Coastline Vulnerability

- The coastal areas host major commercial cities, and significant strategic and vital installations of Defence, Atomic Energy, Petroleum, and private ventures besides 12 major ports and more than 239 non-major ports which increases the coastline's vulnerability.
- The geostrategic location of the Indian peninsula poses typical oceanic challenges owing to proximity to major international shipping lanes, hostile neighbourhood-sponsored cross-border terrorism, transnational maritime crimes like narcotics and weapon trafficking, human trafficking, etc., and dense fishing traffic around the Indian cape.
- Increased oceanic traffic may translate into an increased likelihood of maritime incidents and challenges in the proximity of the Indian coast.
- The use of sea routes by terrorists during the attacks of 26/11 highlighted the vulnerabilities of India's coastline and its security.

COVID-19 has highlighted the fragility of the global logistic supply chain, and India too has been affected. India's exports have been hit by the pandemic-induced scarcity of shipping containers, so much so that the country has now decided to make its own containers.

- Control of Choke Points: Access to the Indian Ocean is geographically controlled by a number of choke points leading to and from the Arabian Sea and the Bay of Bengal, and from the Southern Indian Ocean, which are critical for safeguarding the Indian maritime interests. Examples: Straits of Hormuz, Straits of Bab-el-Mandeb, Gulf of Aden, and Malacca Strait.
- Regional Instability: The Indian Ocean littoral has been witness to large areas of political instability in the recent past. Examples: Yemen, Indonesia, Somalia, Iran-Iraq, Sri Lanka, and Myanmar

Indian maritime security forces then had to conduct dedicated operations to combat this menace, like the Indian intervention in the Maldives in 1988 to foil a coup d'état.

- **Piracy:** India has not only escorted numerous merchant ships of all countries but concerted efforts of its maritime security forces has ensured that this piracy has been controlled. Statistics have shown an increase in piracy, off the coast of Bangladesh, Malaysia, and Indonesia.
- **Trafficking:** The Indian Ocean Region is regrettably home to the world's most notorious areas of drug production, the Golden Crescent and the Golden Triangle. The trans-national networks established by the drug smugglers also serve as conduits for other destabilising activities like gunrunning and human trafficking.
- **Maritime Terrorism:** India's huge coastline, a thriving maritime commercial community along its coast with nearly 200,000 fishing boats and a fishermen population of 4 million make the job of monitoring maritime activity an unenviable task.

The ability of adversarial interests to exploit this vast maritime activity for launching attacks on land is therefore quite high, as was witnessed in the 26/11 terrorist acts.

- Extra Regional Military Presence: It is intended to further the strategic interests of various nations. China's presence in India's backyard is a constant concern for India.
- Illegal Unreported and Unregulated (IUU) Fishing: A World Wildlife Fund report on illegal fishing has found that 87 percent of the fish stocks surveyed in the Western and Eastern Indian Ocean were experiencing high levels of IUU fishing.
- Geopolitical shifts: These geopolitical shifts have led to great power contestation at sea, generating various maritime flashpoints in different waters, naval rivalries and build-up and more aggressive naval warfighting doctrines.
- There are rising tensions between China and Japan, China and US, China and ASEAN in South China Sea, and tensions in the Mediterranean and the Black Sea and the northern Atlantic.
- Infiltration, Illegal Migration, and Refugee Influx: India's land boundaries have always been porous to infiltration by terrorists/militants and large-scale illegal migration. Example: creek areas of Gujarat have been highly vulnerable.

The simultaneous rise of India and China is an important paradigm shift in the international system. This new paradigm shift will require India to focus on not only land boundaries but also maritime security. India has taken efforts to upgrade its navy by inducting new aircraft carriers, building integrated command centre and inducting new submarines. Further, the recent efforts of India to take advantage of its Naval diplomacy with the Indian Ocean Rim countries and outer world powers & modernizing its naval fleet would provide a peaceful solution to the ambitions of India in the Indian Ocean.

What are the emerging security risks in the Indo-Pacific?

The different reactions in Asia to the Russian invasion will affect a geopolitical landscape already experiencing a deep transformation taking place around the concept of the Indo-Pacific. The war in Ukraine might also divert the EU's interest in the short term but there is consensus on the fact that the Indo-Pacific will still be among its priorities.

- It is relatively accepted today (primarily among Western nations) that the Indo-Pacific has no set strategy to contain China, the containment concept has largely been driven by China's rise and its aggressive expansion.
- Indo pacific is the confluence of both these oceans and the ever-increasing maritime trade that brings the nation-states together irrespective of their ideological differences or dogmatic changes.
- The liberal trading order has encountered protectionism in the form of tariff and non- tariff barriers.
- The cheaper imports from China are on a steady growing scale which is not appealing for the domestic economy in developing economies.
- One cannot argue for increased imports from China as this directly jeopardizes the trading and services in the domestic economy. Looming trade war tensions although quite on the downswing owing to many other vital international attentions.

How is India strategizing to counter those?

- The idea of a free and inclusive Indo pacific stands to promote trade and simultaneously extends its strategic vision upon the security concerns of the littorals.
- Being a major power in the region and at the same time having a greater chunk of Indian Ocean to be on its controlled maritime zone provides India with the strategic advantage to be a rule maker rather than a rule follower in the region.
- India's role in the Indo-Pacific is considered crucial by countries such as Australia, Japan, and the United States. However, despite New Delhi's presence in the Indian Ocean, maritime security has actually remained outside of India's strategic interests, concerns, and thinking, due to its continental threats.

- The Indo-Pacific therefore is a new domain in India's foreign policy engagements, representing a shift in New Delhi's strategic environment—expanding its threats solely from its continental borders to its maritime space.
- In the South Asian region, India inherited strategic advantage owing to the geopolitical privilege it enjoys by having a shared border with the maximum states in the region unlike any other power in the same region.
- This geostrategic backup has helped this great nation to be evolved as a net security provider around its strategic domain.
- One of the main reasons to be cited as a cause for India's increased engagement in the Indian ocean on the side-lines of quadrilateral cooperation (India, USA, Japan and Australia) and the Indo-Pacific is the long due presence of the Pakistan rhetoric in its foreign policy.
- The continental way of thinking is rigorously turning towards a more maritime-induced active engagement which is factually visible through the continuous engagement in these two areas.
- Providing naval assistance and ensuring the smooth flow of goods and services through its controlled waters India has been protecting the status quo. The bilateral relations between both nations have also developed in diverse fields.
- Through its Indo-Pacific initiatives, along with partnering with nations to secure its strategic interests, India is now actively presenting collaborative initiatives to address regional challenges, such as infrastructure development and non-traditional threats, among others.
- At a broader level, these partnerships help India secure strategic interests, offer options to mitigate its own capacity challenges, and lend credibility toward its role and profile as a world leader in the wider geopolitical competition.

The Indo-Pacific construct has provided an opportunity for India to maximize its strategic interests while responding to changes in the security environment. Despite political enthusiasm between New Delhi and its partners, however, the pace of implementation and the road map to realizing the Indo-Pacific vision remains limited. As the key partners move forward, countries must acknowledge and accept that their Indo-Pacific visions will never align completely with each other. New Delhi and its partners must continue to underline the broader and foundational principles of democracy, rule of law, and other shared interests while focusing on issue-based partnerships in the Indo-Pacific.

Maritime India Vision 2030 (MTV 2030)

The Maritime India Vision is a 10-year blueprint with the aim of overhauling the Indian maritime sector. The Maritime India Vision 2030 was launched by Prime Minister Narendra Modi at the Maritime India Summit in November 2020.

- Recently, a Direct Port Entry (DPE) facility of V O Chidambaranar Port Trust (VOCPT) has been inaugurated by the Union Minister of State for Shipping.
    - o Will make Indian ports world-class ports aligning with the 'Maritime Vision 2030' of the Ministry of Shipping.
    - o Help in increasing the Ease of Doing Business for the exporters as it is cost-effective.
    - o It is the latest venture of the Sagarmala programme which outlines a series of policy initiatives and development projects.
- Maritime India Vision 2030 will create the **Waterways Connectivity Transport Grid**, a project that will develop connectivity with **Bangladesh, Nepal, Bhutan and Myanmar**.
- Additionally, a Riverine Development Fund (RDF) will extend low-cost funding to finance inland vessels and for extending the coverage of the tonnage tax scheme to inland vessels.

- The Port Charges: Will be rationalised to make them more competitive along with the scrapping of hidden charges levied by ship liners, thereby bringing in more transparency and accountability.
- Will help for decongestion of urban areas, and developing waterways as an alternative means of urban transport.

Coastal Regulation Zone

In India, the CRZ Rules govern human and industrial activity close to the coastline, in order to protect the fragile ecosystems near the sea.

- They restrict certain kinds of activities — like large constructions, setting up of new industries, storage or disposal of hazardous material, mining, reclamation and bunding — within a certain distance from the coastline.
- Under Section 3 of the Environment Protection Act, 1986 of India, Coastal Regulation Zone notification was issued in February 1991 for the first time.
- In 2018-19, fresh Rules were issued, which aimed to remove certain restrictions on building, streamlined the clearance process, and aimed to encourage tourism in coastal areas.
- While the CRZ Rules are made by the Union environment ministry, implementation is to be ensured by state governments through their Coastal Zone Management Authorities.

COAST CUTTER

CLASSIFICATION

CRZ I | Ecologically sensitive areas like sanctuaries, reserve forests, mangroves, coral reefs, turtle-nesting grounds, which could be inundated due to rise in sea level

CRZ II | Areas which have already been developed up to the shoreline within municipal or corpn limits

CRZ III A | CRZ III areas with a population of more than 2,161 per sqkm. Here, 50m from high tide will be no-development zone (NDZ)

CRZ III B | Other CRZ III areas with less population. Here area up to 200m from the HTL on the landward side will be earmarked as NDZ

BOOST FOR TOURISM

➤ With the freeze on constructions along the coastal zone more or less lifted, the tourism sector will be the biggest beneficiary

➤ Toilets, changing rooms, drinking water facility and temporary shacks can be constructed even on beaches

➤ Existing residential buildings can be converted into homestays without increasing the plinth area

➤ CRZ will not be a bar for public utilities like roads even if it passes through mangrove forests

➤ Introduction of CRZ–III into A and B clauses will address state's main concern of issuing permission to dwelling units as well

BACKGROUND

➤ Under Environment Protection Act, 1986 a notification was issued in February 1991 for regulation of activities in coastal area by the ministry of environment and forests

➤ Coastal land up to 500m from the high tide line (HTL) and area of 100m along banks of estuaries, backwater, creeks and rivers which are subject to tidal fluctuations are called coastal regulation zone (CRZ)

Classifications of Coastal Zones under CRZ Notification 2011

CRZ-I (ecologically sensitive areas like mangroves, coral reefs, biosphere reserves etc.).

- No new construction shall be permitted in CRZ-I except
- Projects relating to the Department of Atomic Energy;
- Construction of trans-harbour sea link and roads without affecting the tidal flow of water, between LTL and HTL. etc.
- Between Low Tide Line and High Tide Line in areas which are not ecologically sensitive, the following may be permitted;

- Exploration and extraction of natural gas;
- Construction of basic amenities like schools, roads, etc. for traditional inhabitants living within the biosphere reserves;
- Salt harvesting by solar evaporation of seawater;
- Desalination plants;
- Storage of non-hazardous cargo such as edible oil, fertilizers within notified ports;

CRZ-II (Areas which are developed up to the shoreline and falling within the municipal limits; includes built-up area – villages and towns are that are already well established),

- Buildings are permissible on the landward side of the hazardous line.
- Other activities such as desalination plants are also permissible.
- Some construction is permitted only as per guidelines specified by the notification.

CRZ-III: Areas that are relatively undisturbed and do not fall under either in Category I or II and also include rural and urban areas that are not substantially developed.

- Between 0-200 metres from HTL is a No Development Zone where no construction shall be permitted.
- Only certain activities relating to agriculture, forestry, projects of Department of Atomic Energy, mining of rare minerals, salt manufacture, regasification of petroleum products, non-conventional energy sources and certain public facilities may be permitted in this zone.
- Between 200-500 metres of HTL, those permitted in 0-200 metres zone, construction of houses for local communities and tourism projects are permissible.

CRZ-IV: The aquatic area from low tide line up to territorial limits is classified as CRZ-IV including the area of the tidal influenced water body.

- There is no restriction on the traditional fishing undertaken by local communities.
- No untreated sewage or solid waste shall be let off or dumped in these areas.

New Rules under CRZ regulations

- The government notified new CRZ Rules with the stated objectives of promoting sustainable development and conserving coastal environments.
- For the so-called CRZ-III (Rural) areas, two separate categories have been stipulated.
- In the densely populated rural areas (CRZ-IIIA) with a population density of 2,161 per sq km as per the 2011 Census, the no-development zone is now 50 m from the high-tide level, as against the 200 m stipulated earlier.
- In the CRZ-IIIB category (rural areas with population density below 2,161 per sq km) continue to have a no-development zone extending up to 200 m from the high-tide line.
- The new Rules have a no-development zone of 20 m for all islands close to the mainland coast, and for all backwater islands in the mainland.

National Centre for Sustainable Coastal Management (NCSCM)

- The aims and Objectives of the Center are:
  - Strive for being a World Class Knowledge Institution related to coastal zones, environment, resources and processes,
  - To promote integrated and sustainable management of the coastal and marine areas in India for the benefit and wellbeing of the traditional coastal and island communities, and
  - Advice the Union and State Governments and other associated stakeholder(s) on policy, and scientific matters related to Integrated Coastal Zone Management (ICZM).
- For the first time, Integrated Island Management plans including holistic island development plans have been prepared by NCSCM for implementation by coastal States/ UTs.

Chapter 2: Blue Economy

Oceans are the world's single largest ecosystem, covering nearly 3/4th of the earth's surface, where according to estimates by the Global Ocean Commission, ocean resources contribute five percent of the world's GDP, secure the jobs of three billion people, and sustain the livelihoods of 350 million. This clearly demonstrates the importance of ocean-based economy for humanity.

Blue Economy concept

- 'Blue Economy' (BE) conceptualizes the oceans as "shared development spaces". It is defined by the World Bank as the "sustainable use of ocean resources for economic growth, improved livelihood and jobs, and ocean ecosystem health."
- Blue economy is a shift from the old, "brown" business-as-usual development model where oceans are perceived as a means of free resource extraction and waste dumping. This paradigm does not consider the costs of the negative externalities to resource accounting, failing to take into cognisance the costs of environmental damage and ecological imbalance by consumption.
- The United Nations has recognized the importance of the blue economy and its important role in a sustainable future for the world's oceans. Sustainable Development Goal 14, aims to "conserve and sustainably use the oceans, seas and marine resources."
- Recognizing the great potential of the blue economy, world leaders and scientists united for strategic talks about the future of our oceans at the first Sustainable Blue Economy Conference held in Nairobi, Kenya, in November 2018.
- The core of Blue economy is to realize socio-economic development and dynamic balance of resources and environment. In their second preparatory meeting summary, The United Nations Commission on Sustainable Development acting as the Preparatory Committee highlighted approaches to adopt "blue economy," and believes it is consistent with the core contents of RIO+20 Summit.

There are two elements for the Blue Economy –

- The first is the necessity of protecting and restoring where needed the existing ocean resource base that already supplies food and livelihoods to billions of people.
- The other side of the Blue Economy is where opportunities may exist for enhanced or new sustainable economic activity derived from the ocean.

In context of India, Blue economy holds great potential as seen from the following points:

- The Indian Ocean Region is abundant with resources, particularly in the sectors of fisheries, aquaculture, ocean energy, sea-bed mining and minerals, and provides tremendous economic opportunities to develop marine tourism and shipping activities. Commercial and artisanal fisheries sustain the livelihoods of more than 38 million people worldwide.
- In the Indian Ocean, fish production increased drastically from 861,000 tons in 1950 to 11.5 million tons in 2010. The United Nations Food and Agriculture Organization (FAO) report states that while other world oceans are nearing their fisheries limit, in certain areas, the Indian Ocean"s resources have the potential to sustain increased production.
- Polymetallic nodules and polymetallic massive sulphides are the two mineral resources of commercial interest to developers in the Indian Ocean. India had received exclusive rights for the exploration polymetallic nodules in 1987, in the Central Indian Ocean Basin. Since then, it has explored four million square miles and established two mine sites.
- The Indian Ocean Region is of strategic importance to India's economic growth as the most of the country's oil, and gas is imported through the sea. Further, this dependency is expected to rise by 2025 exponentially

- The Indian Ocean Region presents tremendous trade potential for the country. The countries in the Indian Ocean Rim Association (IORA) exhibited significant dynamism in the past few years as the trade in the region increased by over four times.
- Under the Make in India program of the Government, shipbuilding industry can benefit from a major thrust. This industry has a high multiplier effect on investment and can accelerate industrial growth along with its large number of associated industries.
- The India Maritime Security Strategy published by the Indian Navy articulates country's policy in the Indian Ocean region. It states that in the Indian Ocean region, India is committed to Building Indian Ocean Region as a frontier of sustainable economic development.
- The Sagarmala project, launched by the Ministry of Shipping, is the strategic initiative for port-led development through the extensive use of IT enabled services for modernisation of ports. It tackles the issue of underutilized ports by focussing on port modernization, efficient evacuation, and coastal economic development.

The Deep Ocean Mission

Deep ocean mission is an important mission for India from the perspective of geopolitics, energy security, economic development and scientific advancement which will achieve targets of both blue economy and New India by 2030.

Six major components:

Indian Space Research Organisation (ISRO) & Ministry of Earth Sciences has identified National Institute of Ocean Technology (NIOT), an autonomous institute under the Ministry of Earth Sciences for implementation. It is developing a manned submersible with a capacity to carry three human beings to 6000 m ocean depth.

- The Vikram Sarabhai Space Centre (VSSC) of ISRO is involved in developing a titanium alloy human sphere of 2.1 m diameter for the manned submersible.

1. Development of Technologies for Deep Sea Mining, and Manned Submersible:
- A manned submersible will be developed to carry three people to a depth of 6,000 metres in the ocean with a suite of scientific sensors and tools.
- An Integrated Mining System will also be developed for mining Polymetallic Nodules from a depth of 6,000 metres in the central Indian Ocean.

2. Development of Ocean Climate Change Advisory Services:
- A suite of observations and models will be developed to understand and provide future projections of important climate variables on seasonal to decadal time scales under this proof of concept component.

3. Technological innovations for exploration and conservation of deep-sea biodiversity:
- The bio-prospecting of deep-sea flora and fauna including microbes and studies on sustainable utilisation of deep-sea bio-resources will be the main focus of the mission.

4. Deep Ocean Survey and Exploration:
- The primary objective of this component is to explore and identify potential sites of multi-metal Hydrothermal Sulphides mineralisation along the Indian Ocean mid-oceanic ridges.

5. Energy and freshwater from the ocean:
- Studies and detailed engineering design for offshore Ocean Thermal Energy Conversion (OTEC) powered desalination plant is envisaged in the concept proposal.

6. Advanced Marine Station for Ocean Biology:
- This component is aimed at the development of human capacity and enterprise in ocean biology and engineering.
- This component will translate research into the industrial application and product development through on-site business incubator facilities.

The blue economy can provide a model for people to rethink how they preserve and sustain and improve the biodiverse ocean resources for future generations. It is necessary for India to tap the enormous potential of the Ocean based Blue Economy, which will propel the nation into a higher growth trajectory. The development of Blue Economy can serve as a growth catalyst in realizing the vision to become a $10 trillion economy by 2032.

Chapter 3: Marine Resource Endowment of India

The third largest and gifted ocean in the world "Indian ocean" surrounds India on three sides.

With an exclusive Economic Zone (EEZ) of 2.02 million sq.km and a long coastline of 8,118 km with rich and diverse marine living resources, the Indian Government is promoting 'Blue Growth Initiative' which focus on utilisation of wealth from the marine and other aquatic resources of the country for improving the lives and livelihoods of fishermen and their families.

The Resources
- Manganese nodules contain significant concentrations of manganese, iron and copper, nickel, and cobalt all of which have a numerous economic use.
- Indian Ocean contain vast amount of minerals, including the cobalt, zinc, manganese and rare earth materials. These minerals are needed for electronic industry to make smart phones, laptops and car components etc. This can help Make in India initiative.
- Seawater contains economically useful salts such as gypsum and common salt. Gypsum is useful in various industries.
- Marine fisheries wealth around Indian coastline is estimated to have an annual harvestable potential of 4.4 million metric tonnes. It will lead to food security through fishery sector and other sea food resources. It would also help in reducing malnutrition issue in India as fishes are good source of nutrition.
- The main energy resources present in Indian Ocean are petroleum and gas hydrates. Petroleum products mainly includes the oil produced from offshore regions. Gas hydrates are unusually compact chemical structures made of water and natural gas. It will help in diversification of energy resources and will provide new resources for energy e.g., gas hydrates.

Marine resources from Indian Ocean can serve as the backbone of India's economic growth and can help India to become a 5 trillion-dollar economy by 2022. Blue economy, through sustainable use of oceans, has great potential for boosting the economic growth.

Issues Pertaining to The Efficient And Sustainable Extraction Of Marine Resources
- Oil spills are considered to be a major cause of marine pollution. Leakage from tankers during the transportation of crude oil, a collision of tankers, rigs operation, pipeline leaks and washing of tankers are major sources of oil spills. Oil spills destroy the fish habitats and alter the ecological conditions of seawater which led to the mass mortality of fish and other organisms.
- Extinction of a species affects other species is accelerating the extinction of more species through a chain reaction.
- every year tsunamis, cyclones, hurricanes typhoons etc. leave thousands of people stranded and property worth millions destroyed.
- Increasing population density, industrial growth, and socio-economic development is giving rise to a variety of activities, the collective impact of which is multiplying the pressures on the coastal zone and its resources.

- Impact of climate change or the changes in sea temperature, acidity, threaten marine life, habitats, and the communities that depend on them. Burning of fuels, industrialization, urbanization, etc. are major sources of different harmful gases such as CO_2, CH_4, NO and CFCs which led to the production of the greenhouse effect. The heating of earth's surface resulting into melting of ice in glaciers and poles are expected to further raise the sea level in the range of 21–71 cm by the year 2070. This could mean that many fisheries dependent on upwelling will suffer or cease to exist.
- Adverse environmental change, especially in spawning habitats, decreases the stock strength of the coastal fish. The lack of a sustainable management regime is accelerating the rate of resource decline further.
- Marine pollution in form of excess nutrients from untreated sewerage, agricultural runoff, and marine debris such as plastics
- Overexploitation of marine resources like illegal, unreported, and unregulated extraction of marine resources.

Significance Of Fisheries for India's Coastal Economy

Fisheries are the primary source of livelihood for several communities. India is the world's second-largest fish producer. Fisheries are the country's single-largest agriculture export, with a growth rate of 6 to 10 percent in the past five years.

Significance:

- Its significance is underscored by the fact that the growth rate of the farm sector in the same period is around 2.5 percent.
- Fish constituted about 10% of total exports from India and almost 20% of agriculture exports in 2017-18.
- According to the CMFRI Census 2010, the total marine fisherfolk population was about 4 million comprising in 864,550 families. Nearly 61% of the fishermen families were under BPL category.

The sector has immense potential to more than double the commerce and trade as envisioned by the government:

- The geographic, base of Indian marine fisheries has 8118 km coastline, 2.02 million sq of Exclusive Economic Zone including 0.5 million sq km of the continental shelf, and 3937 fishing villages.
- India having a tropical climate cannot preserve the fish in open for long time there is a requirement capex for heavy refrigerators and deep freezing machine to prosper the food processing industry.
- The investment of Rs 3,000 crore in the Blue Revolution is being supplemented through the Rs 7,523-crore Fisheries and Aquaculture Infrastructure Development Fund. This will meet the capital investment requirement of this sector.
- The government has invested in hatcheries to meet the ever-increasing demand for good quality fish seed it will boost commercial fishing.
- India is processing less than 10% of its agricultural output, thus, presenting immense opportunities for increasing fish processing levels and leading to investments.
- With an increase in urban working culture and fast-paced lifestyles, there is limited time available for cooking raw fish for meal preparation therefore processed with use of online applications will boost the sector, for example, Licious fish.

SWOT Analysis Of India's Marine Resources

With an exclusive Economic Zone (EEZ) of 2.02 million sq.km and a long coastline of 8,118 km with rich and diverse marine living resources. There is need to focus on utilisation of wealth from the

marine and other aquatic resources of the country for improving the lives and livelihoods of fishermen and their families.

Marine resources as lifeline for coastal economy and livelihood:
- Employment generation: It will provide jobs, and improve livelihoods of many. This will help in inclusive growth. E.g improving fishery resources exploitation can provide a livelihood to many.
- Food security: It will lead to food security through fishery sector and other sea food resources. It would also help in reducing the malnutrition issue in India as fishes are good source of nutrition.
- Essential mineral: Seawater contains economically useful salts such as gypsum and common salt. Gypsum is useful in various industries.
- Efficient transportation and logistics: Indian Ocean is a major gateway of trade with 80% of global oil trade happening through it. Better connectivity in the region will significantly cut the transport cost and will reduce logistics inefficiencies.

Weakness and threat:
- **Sewage:** Sewage or polluting substances flow through sewage, rivers, or drainages directly into the ocean.
- **Toxic Chemicals From Industries:** Industrial waste which is directly discharged into the oceans, results in ocean pollution. Also, they raise the temperature of the ocean and cause thermal pollution. Aquatic animals and plants have difficulty surviving at higher temperatures.
- **Land Runoff:** Land-based sources (such as agricultural run-off, discharge of nutrients and pesticides and untreated sewage including plastics) account for approximately 80% of marine pollution. The runoff picks up man-made, harmful contaminants that pollute the ocean, including fertilizers, petroleum, pesticides and other forms of soil contaminants.
- **Large Scale Oil Spills:** Pollution caused by ships, is a huge source of ocean pollution, the most devastating effect of which is oil spills.
- **Ocean Mining:** Ocean mining sites drilling for silver, gold, copper, cobalt, and zinc create sulfide deposits up to three and a half thousand meters down into the ocean.
- Plastic Pollution: In 2006, the United Nations Environment Programme estimated that every square mile of ocean contains 46,000 pieces of floating plastic.

Opportunity:
- Reducing marine pollution and debris including from land-based activities.
- Promoting sustainable exploitation of marine resources.
- Halting the destruction of marine resources especially through acidification.
- Eliminating harmful subsidies that promote fishing overcapacity.

What measures have been taken to protect biodiversity?
- The International Convention for the Prevention of Pollution from Ships (MARPOL) is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. The MARPOL Convention was adopted on 2 November 1973 at IMO. It came into force in 1983 after much deliberation.
- Prevention of Marine Pollution is also dealt with by Merchant Shipping Rules, 2009 framed under the Merchant Shipping Act, 1958.
- Convention for the Prevention of Marine Pollution by Dumping from Ships and Aircarft (1972) The Oslo Convention Convention for the Prevention of Marine Pollution from Land-based Sources (1974) The Paris Convention.
- Global Programme of Action for the Protection of the Marine Environment from Land Based Activities is another initiative and the only global intergovernmental mechanism directly addressing the connectivity between terrestrial, freshwater, coastal and marine ecosystems.

- Also in 2015, India ratified the International Convention on Civil Liability for Bunker Oil Pollution Damage, 2001 (Bunker Convention) which ensures adequate, prompt, and effective compensation for damage caused by oil spills.
- Wetland (Conservation and Management) Rules 2010 have been framed for the protection of wetlands, in the States. The Centrally Sponsored Scheme of National Plan for Conservation of Aquatic Eco-System also provides assistance to the States for the management of wetlands including Ramsar sites in the country.

Sustainable Development Goal (SDG 14), calls to conserve and sustainably use the oceans, seas and marine resources for sustainable development. India should expedite its efforts to exploit oceanic resources in Indian Ocean. What is required is use of technology to exploit oceanic resources in Indian Ocean with government Blue growth initiative. India has rightly launched **O-SMART scheme** aiming at regulated use of oceans, marine resources for sustainable development in this direction.

Chapter 4: India's Port Development

According to the Ministry of Shipping, around 95 percent of India's trading by volume and 7percentnt by value is done through maritime transport. India is the sixteenth largest maritime country in the world, with a coastline of about 7,517 km. The Indian ports and shipping industry plays a vital role in sustaining growth in the country's trade and commerce. Thus port development have both strategic and economic implications for India.

- India has an extensive 7,500 km coastline with 12 major ports and just under 200 minor ports, of which 139 are functioning.
- Primarily, the major ports deal with, by volume, 95% of India's total foreign trade. But, across the board, these ports are underperforming because of serious infrastructure and connectivity problems.
- In 2014-15, out of the 200 Non-Major Ports, 69 ports were reported to have handled cargo traffic. The infrastructure sector, particularly the Maritime Sector, is expected to grow significantly with the increase in international and domestic trade volumes.
- Considering the objective on US $5 trillion economy, ports have an instrumental role to play. They constitute both strategic as well as economic significance.

Significance of Ports

Economic Significance

- **Port development and modernization:** New port infrastructure like better handling capacity, modernization etc will help improve the turnaround time of ships (From 2015-16 to 2017-18, it got reduced by 25%).
- **Infrastructure:** Development new infrastructure like new ports, road connectivity to ports, coastal economic zones (CEZs), multi-modal logistics parks etc will provide new infrastructure to handle more cargo which will be needed in future.
- **Reduced logistics cost-** At present, logistics cost in the country is in the range of 14-16 per cent against 8-10 per cent in other countries. Ex: The project Sagarmala can help reduce these costs.This will help in improving exports and increasing the speed of trade.
- **Inter-connectivity:** It leads to inter-connection between roadways, railways, waterways and airways, thus reducing the overall cost of transportation as well as improving connectivity.
- **Employment:** Provides employment opportunity to coastal area people and increase their standard of living. It is estimated to create an estimated 10 million new jobs (four million in direct employment).
- **Development:** Will help in development of regions around ports by increase in investment, new sectors presence like manufacturing, services etc. The cities like Kolkata, Chennai,

Mumbai owe a great deal to the presence of large ports. Similarly new ports can lead to new cities being developed.

- **Efficiency:** Will reduce the cost of transportation and make India a new transit hub. Developing rivers as inland waterways can also help save domestic logistics costs too. India is investing in inland transportation over the last 7 years. This will help in reducing load on railways and increase profits as it's a cheaper mode of transportation. Project Unnanti is focused on increasing the efficacy of existing ports.
- **Export competitiveness-** Ports could help the country and industries to gain a competitive advantage compared to its neighbours. It is expected to boost India's merchandise exports to $110 billion by 2025
- **Power sector-** The project aims to shift the movement of coal to the coastal route, which would cut down electricity costs by up to 35 percent, especially for coastal power plants in Andhra Pradesh and Karnataka, which receive coal by rail networks.
- **Blue economy:** Developed coastal infrastructure, livelihood development of coastal communities, exploitation of ocean resources will help improve India's Blue economy.
- **FDI:** It will also help in attracting foreign container companies to set up their facilities.

Strategic Significance

- Strong port infrastructure is necessary for securing India's strategic policy objective of Security and Growth for All in the Region (SAGAR).India recently provided Covid relief materials to the Seychelles, Comoros, Maldives and Madagascar under mission Sagar through INS Kesari.
- Role on securing objective of Net Security Provider for Indo-Pacific region. India have provided security to countries in Indian ocean in past. Operation Cactus which thwarted the efforts of rebels to capture the Maldives in 1990s was one such mission.
- Ensuring influencing naval presence to enable free sea lines of communication (SLoC). The growing dominance of China in Indian ocean needs to be countered trough strong infrastructure in the region. Development of a strategic command centre at Andaman and Nicobar is part of the initiative.
- Vital role in safeguarding maritime border. India has played an important role in curbing the piracy in West Indian ocean. Also the attack in 2008 was from the seafront therefore better investment in security is needed.
- Coastal security: It also enhances coastal security along with economic development.
- Check Chinese intrusion- The project is an effective way to counter China's Belt and Road Initiative (BRI) in the Indian Ocean region (IOR). India has tied with Singapore, UAE and Maldives for better monitoring of Chinese activities.
- ASEAN- With increasing ties with ASEAN countries, the importance of ports and port infrastructure further increases and Sagarmala can help address it.
- Relief measures: Ports can also use these capabilities to support emergency relief activities.

Significance Of Small Ports

1. **Reduce pressure on Bigger ports:** Nhava Sheva on Mumbai, Ennore on Chennai etc.
2. **Region specific:** Having vast maritime boundaries, smaller ports on either sides can cater to specific regions.
3. **Product specific:** Certain ports are opened to cater to certain trade like Paradip to export Iron ore, Petroleum products at Jamnagar etc.
4. **Tourism:** Cruise tourism can be promoted.
5. **Transit facility:** Certain ports can act as transit or hanger for ships.

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6. **Port of Call**: With expanding maritime trade via Indian ocean, small ports can act as fuel suppliers or emergency service providers etc.

The challenges facing in the development of a world-class port infrastructure include the following:

- **Issues with PPP Model-** Most port PPPs impose strict limits on what private operators are allowed to do, usually in terms of the types of cargo they are allowed to handle.
- **Limited Hinterland Linkages-** Inefficiency due to poor hinterland connectivity through rail, road, highways, coastal shipping and inland waterways.
- **Incoherent Policy Measures –** Port Infrastructure has been a neglected space in terms of policy focus due to multiple factors.
- **Sub-optimal Transport Modal Mix –** Lack of requisite infrastructure for evacuation from major and non-major ports leads to sub-optimal transport modal mix.
- **Lack of adequate berthing facility**, number of berths, sufficient length for proper berthing of the vessels at the Non-Major Ports is another problem.
- **Processes and operations across India's ports** are not standardized or uniform, costs and time for key processes are unpredictable and there is an unacceptable level of variation across ports as well as within ports.
- **Financial constriants –** Years of underinvestment have left the port infrastructure in dismal condition especially with regards to the non-major ports.
- **Deficient dredging capacity –** Draft is also a major limitation in India as terminals and ports are unable to cater to vessels beyond Panamax (Draft over 13 meters) size that are increasingly dominating global trade.
- **Land acquisition and environmental clearances** are some specific challenges for port infrastructure.

Due to India's inadequate port infrastructure, many investors are wary of getting involved in this business. This hampers the overall economic prospects. To overcome this, the government has taken the following measures as well as to usher in the ideal of port-led development:

- In 2016, India passed the **Central Port Authority (CPA) Act**. The act grants more autonomy to the major ports.
- **The Revised Model Concession Agreement (MCA)** was released in 2016, which includes incentives for the private sector to get involved with the ports through updated tariff guidelines and discounted revenue shares.
- The government provides a 10-year-tax holiday to companies that help maintain and operate ports. If these companies undertake a port development project, the government will help with up to 50% of the cost.
- **Sagarmala Project:** The programme aims to modernize India's ports so that port-led development can be augmented and coastlines can be developed to contribute in India's growth. Port Modernization & New Port Development, Port Connectivity Enhancement, Port-linked Industrialization and Coastal Community Development form the component of this Project.
- **Project Unnati:** It has been started by Government of India to identify the opportunity areas for improvement in the operations of major ports.
- **Introduction of Port Enterprise Business System –** A was tender issued by the Indian Ports Association (IPA) to maintain an Enterprise Business System (EBS) to modernise and automate port processes for five central government-owned ports.

Way Forward:

- Priority should be given on expanding capacity and improving operational efficiency.
- Environmental clearances, Tariff norms, land acquisition etc. need to be standardized and implemented for the port sector so as to boost foreign investments.

- The regulatory regime should be made less complex and less rigid.

India's cargo traffic handled by ports is expected to reach 1,695 million metric tonnes by 2021-22, according to a report of the National Transport Development Policy Committee and to capitalise on this potential, expedient development of port infrastructure becomes vital which will further help in realising the dream of $5 trillion economy by 2024.

Green Ports & Green Shipping in India

A number of initiatives have been taken in India to promote green ecosystem in maritime sector, in line with International Maritime Organization (IMO)'s 2030 Decarbonization strategy and 2050 Green House Gases (GHG) strategy.

- Ministry is also working on draft of a "Green Port Policy" document to suggest framework and guidelines for incorporation of green initiatives in the port sector.
- The proposed target outcomes will help India in achieving the "Intended Nationally Determined Contributions (INDCs) target, as well as the International Maritime Organization (IMO) 2030 target.

Initiatives include

- Increase share of renewable energy to more than 60% across major ports by 2030, setting up of solar power plants, availing of shore power supply to vessels via berths,
- Multi-clean fuel adoption for vehicles within port ecosystem,
- Gradual phasing out of diesel locomotives at ports
- Acquisition of equipment for monitoring environmental pollution,
- Acquisition of dust suppression systems,
- Setting up of sewage/ wastewater treatment plants,
- Setting up of garbage disposal system for ports and ships,
- Developing shore reception facility for wastes from ships,
- Setting up projects for energy generation from renewable energy sources,
- Providing shore power to ships at berths,
- Creating Oil Spill Response (Tier-1) capabilities at all ports,
- Taking actions to improve harbor water quality,
- Inclusion of sustainable practices in terminal design, development and operation,
- Increasing green cover within port premises

In order to enhance the share of Green Shipping, various projects are being implemented by Cochin Shipyard Ltd., India's largest shipbuilding and maintenance facility–

- Green urban mobility solutions like Hybrid Electric Ferries
- Autonomous Zero-emission vessels
- Pilot project on Hydrogen Fuel Cell Ferry, Electric Catamaran Water Taxi, Hybrid Electric Ro-Ro, Hybrid LNG-Electric Inland Cargo Carrier, Hybrid Tugs, etc.

The Way Forward

- Possibilities are also being explored for deployment of fully electric ferry and hydrogen fuelled ferries on Inland Waterways for enhancement of river cruise tourism in the country.
- Ports to take the Green Initiatives forward by putting dedicated proactive efforts towards greening of maritime sector including finalization of green port policy.

The pace at which the Green initiatives are undertaken by the 12 major ports will surely bring a green revolution in the sector making the ports cleaner and greener, which is also a key component of 'Blue Economy', creating environmental benefits and balancing the investments and cash flow.

Chapter 4: Coastal Erosion

Coastal Erosion is the wearing away and redistributing of solid elements of the shoreline as well as sediment, normally by such natural forces as waves, tidal and littoral currents, and deflation.

- Erosion occurs when the material being removed, for deposition elsewhere, exceeds the rate of supply finally resulting in the landward shifting of the shoreline.
- The coastal sediments, together with those arising from inland erosion and transported seaward by rivers, are redistributed along the coast, providing material for dunes, beaches, marshes, and reefs.
- The removal of the sand from the sand-sharing system results in permanent changes in beach shape and structure.

Natural Causes

Waves, winds, tides, near-shore currents, storms, sea level rise, etc. The combined action of different processes on the coastline like waves and tides maintains the stability of the shoreline.

- If for any reason, the sediment supply to a section of beach is reduced due to littoral drift/sea level rise or constant impact of waves, it can cause severe erosion.
- Sea level rise
- Catastrophic events like severe storms, tidal surges and cyclones

Coastal Erosion by Waves

- Waves are the main cause of coastal erosion. Waves bring an enormous amount of energy to the coast that is dissipated through wave breaking, generation of currents, water level changes, and movement of sediment, turbulence, and heat.
- Waves are the major factor in determining the geometry and composition of the beaches. The action of waves dictates the processes of removal and addition of material/sediment on the coast.
- The two processes of accretion and erosion play a major role in defining coastal geography. The shoreline changes induced by coastal erosion and accretion are natural processes that take place over a range of time scales.
- With respect to temporal scale, these processes may occur in response to both small-scale events, such as storms, regular wave action, tides, and winds, and large-scale events such as glaciation or orogenic cycles, or tectonic activities that cause coastal land subsidence or emergence.

Man-induced erosion

Most of the human-induced erosion is due to human interventions in the natural transportation process as well as in the sediment load of the rivers. Human activity may be enumerated as coastal defence structures, river regulation works, dredging aggregate extraction/sand mining, oil/gas exploration and ports/harbours that impact sediment transport.

- Coastal activities:
  - Construction of buildings via land reclamation or within sand dune areas has a long-term impact on coastal processes and sediment stability.
  - Breakwaters, which obstruct the long-shore transport of sand and cause accretion on the up-drift side, and erosion downdrift.
  - The mining of sand/gravel along beaches and in the surf zone will cause erosion by depleting the shore of its sediment resources.
  - The removal of dune vegetation and mangroves due to man interventions causes exposure of the low-energy shorelines to increased energy and reduced sediment stability. This further promotes erosion of the coastal zone.
- Climate change
- The rising atmospheric concentrations of carbon dioxide are causing the oceans to absorb more of the gas and become more acidic. This rising acidity can have significant impacts on

coastal and marine ecosystems. The low-lying areas along the coast are likely to be prone to salinisation due to seawater intrusion (surface and ground).

Coastal Protection measures:

Coastal protection measures moderate the long-term average erosion rate of shoreline change from natural or man-made causes.

- Reduced erosion means a wider buffer zone between the land and the sea. Protection of the coastline from erosion is provided by nature in the form of a stable beach, capable of dissipating incident wave energy.
- Protection works to prevent erosion should be on a long-term basis and must be planned to suit the particular site conditions on the basis of thorough field investigation and available data which require observations over an extended period of time.

Non-structural measures

- The non-structural measures aim at the dissipation of the wave energy by mirroring the natural forces and maintaining the natural topography of the coast. These measures are also called soft solutions. Some of these are:
    - Artificial nourishment of beaches
    - Coastal vegetation such as mangrove and palm plantation
    - Sand bypassing at tidal inlets
    - Dune reconstruction/rehabilitation
- These measures have limitations. While artificial nourishment of beaches is complicated and costly, mangrove plantation is possible only in marshy land and in semi-tropical or tropical conditions.

Structural Measures

- The structural measures, also known as the hard structural/engineering measures, use physical structures constructed near the coast to prevent or restrict water from reaching the potential damage areas.
- Influence the coastal processes to stop/reduce the rate of coastal erosion.
- Include seawalls, revetment, off-shore breakwaters, groins/groynes/spurs, offshore reefs, and artificial headland.
- Seawall is a popular measure and is generally used in almost all maritime states in varying proportions.

Combination of both measures

- Using a combination of structural and non-structural measures helps in providing better efficacy and efficiency.
- The combination gives synergetic outcomes and provides an environmentally and economically acceptable coastal protection system.
- The hard solutions offer a wide variety of disadvantages like causing erosion and unnecessary accretion at various points, being expensive, and also, at times, spoiling the economic value of the site by making it look less beautiful.
- Soft solutions take time to be effective and these are effective only in a medium to long-term perspective.
- Therefore, a combination of both measures is preferred for optimal results, for example: Combining beach nourishment with artificial headlands/groynes
- Revegetation with temporary offshore breakwaters/ artificial reefs is commonly used

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Shoreline Change Atlas of Indian Coast:

Coastal Protection and Development Advisory Committee (CPDAC) recommended the need for the preparation of a Coastal Atlas showing information related to coastal erosion derived from satellite data and protection measures undertaken by all maritime states of India.

- Accordingly, a project entitled, "Shoreline Change Atlas of the Indian Coast", was initiated by the Space Applications Centre (ISRO), Ahmedabad, in collaboration with the Central Water Commission.
- SAC and CWC worked jointly to bring out a shoreline change atlas for the time frame 1989-91 and 2004-06 in 2014.
- The maps show eroding, stable and accreting coasts along with the status of coastal protection measures taken up by maritime States/UTs.
- Around 15% of the 7549 km coastline has eroded, 14% of the coast has accreted, and the remaining of the coast remained stable w.r.t 2004-06. The area under accretion is higher than the area under erosion with a net gain of 362 ha of land.
- The shoreline along the eastern Indian peninsula is observed to be more dynamic and along the west coast, the shoreline changes are more along the Kerala and Karnataka coasts.

Indian Coastal Community and Climate Change

Poorer households are often less able to adapt and are more vulnerable to tackling climate change risks. Prioritisation of problems due to climate change based on the risk and vulnerability using the Livelihood Vulnerability Index shall support identifying the location-specific problems to mitigate climate change risks.

- Coastal habitats shall be demarcated and suitable locations for shelter during the flood which are the high elevated areas along the coasts shall be identified.
- In the potential saltwater intrusion areas and drought-prone areas, sites for water tanks in the coastal habitats to mitigate the water scarcity problems due to climate change shall be constructed.
- The identified suitable evacuation location during cyclone and flood shall be informed to coastal communities through awareness creation activities, capacity-building activities, and mock drills.
- Fish stock trends and assessments shall be conducted to develop policies and schemes to replenish the economically important fishery resources with the involvement of local stakeholders.
- To reduce captured fishery demand from the natural coastal environment, nearshore cage culture, aquaculture, and mariculture activities shall be encouraged with the participation of local communities under the Public-Private Partnership (PPP) mode.

Science And Technology

Chapter 5: Technology and Innovation in Healthcare

According to WHO "Universal health coverage (UHC) is the single most powerful concept that public health has to offer. It is a powerful social equalizer and the ultimate expression of fairness."

- In 2020, the Ministry of Health and Family Welfare (MoHFW), NITI Aayog, and the Board of Governors (BoG) Medical Council of India (MCI) issued the Telemedicine Practice Guidelines. This regulation has helped to democratise the provision of health services.
  - It has also helped bridge the urban-rural healthcare gap
- The Indian healthcare system has experienced a paradigm shift in ensuring quality healthcare delivery to citizens in the last 10 years as technology has now been leveraged for better reach and patient care.
- The application of digital technologies such as artificial intelligence (AI), machine learning (ML), data analytics, Internet of Things (IoT), cloud computing, and robotics is increasing in every facet of the healthcare system.

Emerging technologies can be leveraged to move towards the goalpost of UHC, some of these are

- **Robots**: Hospitals can use robots to deliver medicines and food to COVID-19 patients. This helps to reduce the chances of hospital staff contracting the infection.
- **Blockchain technology**: The health blockchain would contain a complete indexed history of all medical data, including formal medical records and health data from mobile applications & wearable sensors. This can help in addressing the interoperability challenges that health information and technology systems face.
- **AI and the Internet of Medical Things**: IoMT is defined as a connected infrastructure of medical devices, software applications, and health systems and services. IoMT can be utilized to provide health-care applications that can help in quick diagnosis of illness.
- **Cloud computing** is another application that can facilitate collaboration and data exchanges between doctors, departments, and even institutions and medical providers to enable best treatment.

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eSanjeevani

- It is a national telemedicine service that offers tele-consultations enabling patient to doctor consultations from the confines of their home, as well as doctor to doctor consultations.
- This eSanjeevani platform has enabled two types of telemedicine services viz. Doctor-to-Doctor (eSanjeevani) and Patient-to-Doctor (eSanjeevani OPD) Tele-consultations
- The former is being implemented under the Ayushman Bharat Health and Wellness Centre (AB-HWCs) programme.
- The telemedicine platform is hosting over 40 online OPDs, more than half of these are speciality OPDs which include Gynaecology, Psychiatry, Dermatology, ENT, Ophthalmology, antiretroviral therapy (ART) for the AIDS/HIV patients, Non-Communicable Disease (NCD) etc.

Note:
- eSanjeevaniOPD now enables creation of Ayushman Bharat Health Account (ABHA), which will facilitate access and shareability of health data with consent of the beneficiary, with participating healthcare providers and beneficiaries as per Ayushman Bharat Digital Mission (ABDM).
- eSanjeevani is an exemplification of the 'Make in India' initiative as it has been developed indigenously

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What are the possible challenges to above technologies?

The possible constraints in this effort are

- Standardisation of health data
- Developing a template for sharing data
- Reengineering many of the institutional and structural arrangements in the medical sector
- Organisational silos in bureaucracy
- Data security and Data privacy
- High investments

Scope of Remote Healthcare in India

India is a country with around 65% of the population residing in rural areas. However, access to timely and quality healthcare is lacking.

- One of the significant challenges faced by rural communities is the lack of healthcare expertise. The most proven way to solve these challenges is to bring specialised training to the existing health professionals.
- Virtual reality can be used in rural areas to assist healthcare professionals with training and experience through training simulations with a headset that places you in a natural healthcare environment.
- Virtual and telementoring groups with experts will ensure that training and support are continuous and ongoing.
- The existing health model has endless potential for inducing massive improvements, especially in the rural health sector and revolutionalising the rural medical landscape.
- Also, it is to be noted that the purpose of incorporating technology into healthcare in rural areas is **not to replace doctors but to improve the efficiency** of healthcare systems.

Way Ahead

- **Digital Strategy:** India needs to own its digital health strategy that works and leads towards universal health coverage and person-centred care. Such a strategy should emphasise the ethical appropriateness of digital technologies, cross the digital divide, and ensure inclusion across the economy.
- **Using Local Knowledge**: In addition to robust health systems, an effective national response must also draw upon local knowledge. Primary health centres in India could examine local/traditional knowledge and experience and then use it along with modern technology.

National Digital Health Mission

What is the basic idea of NDHM?

- By Digital Health Infrastructure created by NDHM,instead of ferrying medical records in polythene bags from doctor to doctor, Indians will be able to access their lab reports, x-rays and prescriptions irrespective of where they were generated, and share them with doctors or family members — with consent.

What are the key features of NDHM?

- **Six key building blocks** or digital systems namely, HealthID, DigiDoctor, Health Facility Registry, Personal Health Records, e-Pharmacy & Telemedicine
- **Unique Health ID:** Every Indian under the mission would get an ID card containing all relevant information about his/her medical conditions and treatments, tests etc
- **Comprehensive Health Profile**: Ranging from doctor appointment to the medication prescribed, medical tests, every bit of detail will be available in the health profile of an individual across public and private healthcare.
- **National Health Authority (NHA),** the attached office of the Ministry of Health & Family Welfare has been given the mandate to design, build, roll-out and implement the NDHM in the country.

- **Encouraging Private Players for promotion of Health Data Analytics &Medical Research**
- Private stakeholders will have an equal opportunity to integrate with these building blocks and create their own products for the market.
- However, core activities and verifications, for example, generation of Health ID or approval of a doctor/facility shall remain with the government.
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    - o Additional components, like Personal Health Record (PHR) and Electronic Medical Record (EMR) solutions can be developed by private players in line with the guidelines that will be issued.

Merits of NDHM

- **Creates Digital Health Ecosystem:** It will reduce the existing gap between various stakeholders such as doctors, hospitals and other healthcare providers by bringing them together and connecting them in an integrated digital health infrastructure.
- **Voluntary Scheme**: The NDHM is a holistic, voluntary healthcare programme. While option of digital Health ID will be there, in case a person does not want Health ID, then also treatment needs to be provided.
- **Data Safeguards**: All products by private participants shall be as per official guidelines taking care of security, privacy and standards of the NDHM ecosystem
- **Improves Healthcare Service Efficiency:** The created Digital Health infrastructure enables users to obtain a longitudinal view of their healthcare records. Electric Medical Records will increase accountability, improves patient outcomes, and advances evidence-based policymaking.
- **Addresses Healthcare Challenges:** The Digital Healthinfrastructuregreatly reduces the risk of preventable medical errors and significantly increase quality of care.
- **Reduces Information Asymmetry:** The Digital datawill empower all Indians with the correct information and sources enabling them to take an informed decision to avail the best possible healthcare.
- **Aligned with International Goals**: NDHM will be a major stride towards achievement of the United Nations Sustainable Development Goal 3.8 of Universal Health Coverage, including financial risk protection
- **Last Mile Connectivity Issue:** The provision of promoting e-pharmacy & Telemedicine will enable people in rural areas access quality healthcare providers.
- **Data Ownership issues addressed:**
    - o The health data will reside at individual hospital servers in a federated architecture.
    - o Citizen will own his/ her health data and would require consent to share data.
    - o All the basic registries of patients/hospital/medical professionals that enable data sharing will be owned by a government entity.

Challenges Ahead

- **Cannot be a Substitution**: Digitalisation is welcome but is no substitute for inadequate human resources and infrastructure in the health sector.
- **Doesn't address core concern of Health care sector:**The real issue in India's health sector is the abject lack of primary health facilities in much of India.
- **Digital awareness** about the utility of the scheme is needed for its successful adoption by beneficiaries so that it eases the process and not
- **To enable seamless data exchange**, all users (pharmacists, laboratories, radiology clinics, insurers and hospitals) must be incentivised to adopt a standard language of communication.

An effective healthcare system of a nation is determined by its ability to deliver high-quality and efficient care that is affordable and accessible for all. Access to quality healthcare has been a traditional problem in the country, especially in the hinterlands. However, government-led innovations are taking place at a rapid pace in rural communities.

As teleconsultation, e-pharmacy, and remote monitoring have gained the trust of all stakeholders, more efforts have to be initiated to leverage other advanced technologies such as AI, ML, and Blockchain to enhance interoperability in healthcare as they also help create jobs and employment opportunities. Adopting an integrated approach for addressing both the public's health needs and investing in robust information and communications technology infrastructure is the way forward.

Chapter 6: Technology - Empowering the Masses

In recent years, there has been a significant increase in investments in the field of science and technology. Due to the efforts of the government, India is currently ranked 40th in the Global Innovation Index 2022 as compared to the 81st rank in 2015.
- In India, science and technology have a huge potential to revolutionise agriculture, financial inclusion, education, roads and transport, healthcare and housing sectors.
- Technological interventions not only help boost productivity, better service levels and efficiency but also help ensure that the benefits of modern science reach the bottom of the pyramid, ensuring ease of living and access to various government schemes.
- Technology has been the proverbial catalyst in turning the tide in favour of citizens and their ability to access government schemes.

Key developments spearheaded by Technological Advancements
- **India Stack and Aadhaar:** The foundation of India's digital revolution was laid by the development of India Stack which is a unified software platform that brought over 140 crore-plus population of India's into the digital age.
  - The adoption of India Stack has helped promote financial and social inclusion.
  - The bedrock of India Stack is a set of digital identity products centred around Aadhaar and Aadhaar has also been the foundation of multiple Building Blocks.
- **Direct Benefit Transfer:** Aadhaar identification programme has ensured the success of the Direct Benefit Transfer (DBT) system which was initiated by the government in 2013.
  - The main aim of the programme was the transfer of subsidies and cash benefits directly to citizens through their Aadhaar-seeded bank accounts which reduce leakages, and associated delays
  - DBT has emerged as a high-priority focus area of the government, in reforming the government delivery system in a variety of welfare schemes for a simpler and faster flow of information/funds.
  - DBT has become the most accepted way of delivering development schemes with the delivery of over 450 schemes such as the Public Distribution System (PDS), PM-KISAN, MGNREGS, Prime Minister's Matru Vandana Yojana (PMMVY), National Rural Livelihood Mission (NRLM), National Health Mission, etc.
  - The DBT scheme that began as a pilot in 2013-14 could not have achieved the size and scale it has today without the government's financial inclusion programme, which helped
    - Eliminated leakages in welfare schemes
    - Excluded fake or ghost beneficiaries and
    - Transfer funds to genuine beneficiaries.
    - This ensured significant savings to the exchequer and enabled efficient utilisation of government funds.

- **Digital Platforms for e-Governance:** The National Informatics Centre (NIC) under the Ministry of Information Technology is playing a huge role in executing key IT projects, in collaboration with Central and State Governments ensuring the last-mile delivery of government services to the citizens through a variety of digital solutions.
  - NIC, as the technology partner of the government of India, aims to cater to ICT needs at all levels of governance and several government initiatives like Swachh Bharat Mission, My-Gov, e-Hospital, fertiliser distribution, e-Courts, e-Transport, etc. have been completely managed using digital platforms developed by NIC.
  - NIC has also developed various digital platforms for the socioeconomic development of the country in line with the vision of "One-Nation One-Platform".
  - **Outcomes of E-Governance**
    - Enhanced Transparency and Accountability.
    - Expanded reach of Governance.
    - Improved Public Administration.
    - Enables Environment for Promoting Economic development.
    - Improved service delivery in the form of better access to information and quality services to citizens.
  - **Initiatives under e-governance**
    - A National Task Force on Information Technology and Software Development was set-up in 1998.
    - The Ministry of Information Technology was created at the Centre in 1999. A 12-point agenda was listed for e-Governance for implementation in all the central ministries and departments.
    - The National e-Governance Plan (NeGP), provides a holistic view of e-Governance initiatives across the country.
    - Bhoomi Project (Karnataka): Online Delivery of Land Records- Bhoomi is a self-sustainable e-Governance project for the computerized delivery of 20 million rural land records to 6.7 million farmers of Karnataka.
    - e-Seva (Andhra Pradesh)- Designed to provide 'Government to Citizen' and 'e-Business to Citizen' services. All the services are delivered online to consumers /citizens by connecting them to the respective government departments and providing online information at the point of service delivery.
    - e-Courts- Launched by the Department of Justice, Ministry of Law and Justice. The Mission Mode Project (MMP) aims at utilizing technology for improved provisioning of judicial services to citizens.
- **Unified Payments Interface (UPI):** The UPI developed by the National Payments Corporation of India (NPCI), has emerged as a game changer in the payments space.
  - Rolled out in 2017, UPI accounts for about 16% of total retail payments, with over 30 million UPI QR codes registered by merchants.
  - Since the launch of UPI, India has been improving financial inclusion at a CAGR of more than 5%, and since 2018, the country has more than doubled the extent of digitisation of payments.
  - With UPI other digital payment options such as Bharat Bill Payment System (BBPS), BHIM Aadhaar, Aadhaar Enabled Payment System (AePS) and *99# services have also developed.
  - **Significance of UPI**
    - **It created interoperability** between all sources and recipients of funds (consumers, businesses, fintechs, wallets, 140 member banks),

- **Settled instantly** inside the central bank in fiat money – Convenience to consumers and merchants and
- **Blunted data monopolies** -big tech firms have strong autonomy but weak fiduciary responsibilities over customer data).
  - o **UPI offers the following policy lessons**.
    - First, th**e India stack** — interconnected yet independent platforms or open APIs — are a public good that lowers costs, spurs innovation, and blunts the natural digital winner-takes-all..
    - Second, **collaboration** can create ecosystems that **overcome existing obstacles**— the execution deficit of government, the trust deficit of private companies, and the scale deficit of nonprofits.
    - Third, **complementary policy interventions** are important. Demonetisation and GST acted as a catalyst for the transition to digital payments .
    - Fourth, **human capital and diversity matter**. This revolution needed career bureaucrats to partner with academics, tech entrepreneurs, venture capitalists, global giants and private firms.
- **Smart Cities Mission:** One of the most visible examples of the impact of technology in changing the lives of our people is the evolution of our Smart Cities.
  - o Launched in 2015, the Smart Cities Mission (SCM) identified 100 cities across the country for higher economic growth and better quality of life for people by enabling local area development and harnessing technology,
  - o Application of Smart Solutions enables these cities to use technology to improve solid waste management, lower air and water pollution levels, better space utilisation, beautification of the cities, efficient urban mobility, improved city infrastructure and health facilities for the citizens.
- **Integrated Command and Control Centre (ICCC):** ICCC are said to be the nerve centre in each Smart City.
  - o ICCCs monitor all the activities taking place in the city from a technology-enabled and responsive, central location and are designed to aggregate the information across multiple applications with the help of sensors deployed.
  - o As of March 2022, ICCCs are operationalised in 76 Smart Cities in the country and are playing a key role in ensuring better monitoring and efficiency in areas like traffic management, crowd management, detection of crimes, disaster management, etc.
  - o During the COVID pandemic, these ICCCs were converted into COVID-19 war rooms and became the epicenter of coordinated actions amongst various stakeholders for dealing with the pandemic, continuously monitoring hospital beds, oxygen, ventilator and ICU bed availability.

Technologies like Blockchain and Internet of Things (IoT)

Emerging technologies such as block chain and Internet of things (IoT) are often perceived as capable of changing the status quo. Emerging technologies have wide ranging application hence, possess the potential to transform the lives of common citizens.

Emerging technologies can be applied in various fields such as health, finance, agriculture and various other sectors which would aid the government in implementing various programmes and in turn assisting to transform the lives of people.

- Block chain technology as a public ledger system, records and validate each and every transaction made, which makes it secure and reliable. Which can overcome the challenge of securing each and every transaction over the internet.

- It will also help to increase the number of cashless trade. Block chain technology can also be used in the preservation an use of large scale data like Aadhar card data, PAN card data etc.
- The transfers are done through mining that makes hacking difficult. All transactions carried out are authorized by miners, making the transactions unchanged and preventing the hacking threat. Hence, this technology will also help to build more trust in the online payment system.
- Blockchain could be used to improve a variety of healthcare-related processes, including record management, healthcare surveillance, tracking disease outbreaks, management crisis situations and many more.
- A growing portion of IoT devices are created for consumer use, including connected vehicles, home automation, wearable technology, connected health, and appliances with remote monitoring capabilities.
- Donation tracking: With the help of block chain capabilities, donors can see where funds are most urgently required and can track their donations until they are provided with verification that their contributions have been received to the victims.
- Blockchain could also manage a crisis situation. It could instantly alert the public about the virus by global institutes like the WHO using smart contracts tracing concept.
- In education sector the blockchain-based SuperCert promises anti-fraud identity intelligence blockchain solution for educational certificates. It ensures authenticity and minimizes fraud. In turn it will help to have genuine learners who can complete their studies more neatly and obtain a certificate accordingly. It will transform life of people by providing more learned individuals in the society.
- The Internet of Medical Things (IoMT) is an application of the IoT for medical and health related purposes, data collection and analysis for research, and monitoring.
- IoT devices can be used to enable remote health monitoring and emergency notification systems. These health monitoring devices can range from blood pressure and heart rate monitors to advanced devices capable of monitoring specialized implants, such as pacemakers, Fitbit electronic wristbands, or advanced hearing aids. So these kind of technologies will help the people to have a healthy life style and good health care.
- Application of the IoT extends to all aspects of transportation systems (i.e. the vehicle, the infrastructure, and the driver or user). Dynamic interaction between these components of a transport system enables inter- and intra-vehicular communication, smart traffic control, smart parking, electronic toll collection systems, logistics and fleet management, vehicle control, safety, and road assistance.
- Smart cities: IoT will solve major problems faced by the people living in cities like pollution, traffic congestion and shortage of energy supplies etc. Products like cellular communication enabled Smart Belly trash will send alerts to municipal services when a bin needs to be emptied.
- Agriculture: Farmers are using meaningful insights from the data to yield a better return on investment. Sensing for soil moisture and nutrients, controlling water usage for plant growth and determining custom fertilizer are some simple uses of IoT.
- Environmental monitoring: To assist in environmental protection by monitoring air or water quality, atmospheric or soil conditions, and can even include areas like monitoring thmovements of wildlife and their habitats.

Despite the numerous applications and its wide scale benefits these emerging technologies have some drawbacks to transform human lives, they are as follows:

- Over-reliance on technology: Relying on technology on a day-to-day basis, making decisions by the information that it gives up could lead to devastation. No system is robust and fault-free.

- Security: As the IoT systems are interconnected and communicate over networks. The system offers little control despite any security measures, and it can be lead the various kinds of network attacks. Hence, it jeopardises personal lives of people.
- Lack of understanding comes next as many executives have a vague understanding of blockchain and the changes it will bring. Many still connect it only with crypto currencies management.
- A lack of general regulation is a problem. The Supreme Court of India has ruled against a decision imposed by the country's central bank nearly two years ago that stifled crypto trading in Asia's third-largest economy.

NITI Aayog has released recommendations to establish IndiaChain which will ensure the Creation of a national infrastructure for the deployment of blockchain solutions with inbuilt fabric, identity platform and incentive platform. Along with it NITI Aayog has also proposed to use the Internet of Things to tackle the water crisis in various parts of India.

Hence, we can conclude that emerging technologies such as blockchain and the Internet of things possess a big potential to transform human lives. But at the same time their implementation challenges needs to be addressed so that these technologies will not just be useful to transform the lives of the common citizens but also to transform the whole world and make it a better world.

Chapter 7: Science and Technology in Agriculture

The agriculture and allied sector play a critical role in rural livelihood, employment and national food security. The sector provides the largest source of livelihood in the country. The proportion of the Indian population depending directly or indirectly on agriculture for employment opportunities is more than that of any other sector.

- The Committee on Doubling Farmers' Income in its report 2018 has highlighted the role of digital technology, which can play a transformational role in modernising and organising how rural India performs its agricultural activities.
- Digital technologies are finding increasing use in the agricultural value system, and farmers are increasingly becoming more informed, as various measures are taken to provide them ready access to technology and information.
- The Government has finalised the core concept of India Digital Ecosystem of Agriculture (IDEA) framework which lays down the architecture for the federated farmers database.
    - o The IDEA would serve as a foundation to build innovative agri-focused solutions leveraging emerging technologies to contribute effectively in creating a better ecosystem for agriculture in India.
    - o This ecosystem shall help the Government in effective planning towards increasing the income of farmers in particular and improving the efficiency of the agriculture sector as a whole.
- Under the National e-Governance Plan in Agriculture (NeGP-A), the funds are released to the States and UTs for projects involving use of modern technologies such as AI, ML, Robotics, Drones, Data Analytics, Block Chain, etc.

Issues involved to improve agricultural efficiency:
- Conversion of agricultural land for alternative uses, declining average size of farm holdings have drastically reduced the average land holding in turn posing a challenge to implement efficiently the traditional methods of farming.

- Dependence on rainfall and climate: Indian agriculture is heavily dependent on monsoon rain and ever-increasing global temperature has made agriculture more prone to extreme weather events.
- Absence of marketing infrastructure, Large gaps in storage, Cold chains, limited connectivity have posed transport & marketing challenges.
- Lack of Mechanisation: Introduction of latest technology has been limited due to various reasons like accessibility for credit and low awareness.
- Profiteering by middlemen is reducing farmers income in turn reducing farmers purchasing power for new technology adoption.
- Food processing efficiency is low in India, It's at 3% when compared to 30-70% in developed countries and wastage of agriculture produce is as high as 40%.

S&T interventions in the Agriculture Sector

- **e-NAM:** The National Agriculture Market (e-NAM) is a pan-India electronic trading portal that networks the existing Agricultural Produce Market Committee (APMC) mandis to create a unified national market for agricultural commodities.
    - e-NAM was constructed with the goal of creating a seamless national market where buyers and sellers can transact without being in the same location. Through e-NAM platform, more buyers can bid for a specific lot. The dispersed set of online buyers bidding anonymously reduces the opportunities traders have for colluding.
    - **Controlling Ministry:** Ministry of Agriculture and Farmers' Welfare
    - Digital services are provided to traders, farmers, Farmers Producer Organisations (FPOs), mandis through various modules of e-NAM platform
    - So far, 1260 mandis of 22 States and 3 UTs have been integrated with the eNAM platform for providing market access to farmers and over 1.73 crore farmers and 2.26 Lakhs traders have been registered on e-NAM platform.
    - Trading parameters for 193 agricultural and horticultural commodities like cereals, pulses, oilseeds, spices, flowers and fiber crops have been provided.
    - In July 2022, the Agriculture Ministry launched the **Platform of Platforms (PoP)** under e-NAM intended to promote trade and marketing of agricultural produce wherein farmers will be facilitated to sell the produce outside their state borders.
- **PM KISAN Digital Payment:** Under the PM KISAN scheme, Rs. 6,000 is directly transferred into the bank accounts of the eligible farmers under DBT mode annually in three installments.
    - (PM-KISAN): To provide income support to all farmers' families across the country, to enable them to take care of expenses related to agriculture and allied activities as well as domestic needs
    - The PM-KISAN mobile app was launched to broaden the reach of the scheme where farmers can view the status of their application, update or carry out corrections of name based on their Aadhaar card and also check the history of credits to their bank accounts.
    - Milestones that were achieved in the agriculture sector in the recent years-
        - Food grain production touched 300 million tonnes
        - Horticulture and floriculture production reached 330 million tonnes
        - Milk production also increased almost 45 per cent in last 6-7 years.
        - About 60 lakh hectare land was brought under micro irrigation; more than 1 lakh crore were given in compensation under Prime Minister FasalBimaYojna, whereas premium received was just 21 thousand crores.

- Ethanol production increased from 40 crore litres to 340 crore litres in just seven years.
- **AGMARKNET portal:** Providing backend subsidy support to State, cooperative and private sector investments through AGMARKNET portal.
  - o Provides agricultural market information and price trends
  - o AGMARKNET portal is a G2C e-governance portal that caters to the needs of various stakeholders such as farmers, industry, policy makers and academic institutions by providing agricultural marketing related information from a single window.
- [National Mission on Horticulture](): Promotes holistic development of the horticulture sector (including bamboo and coconut).
  - o HORTNET project is a web enabled work flow-based system for providing financial assistance under the mission for Integrated Development of Horticulture.
- **Agriculture Infrastructure Fund:** Created to mobilise a medium to long-term debt finance facility for investment in viable projects for post-harvest management Infrastructure and community farming assets through incentives and financial support
  - The funds will be provided for setting up of cold stores and chains, warehousing, silos, assaying, grading and packaging units, e-marketing points linked to e-trading platforms and ripening chambers, besides PPP projects for crop aggregation sponsored by central/state/local bodies.
  - o Financial assistance is provided digitally in the form of Interest Subvention and Credit Guarantee for setting up post-harvest management Infrastructure
- **National Project on Soil Health and Fertility:** The Government has recommended soil test based balanced and integrated nutrient management through conjunctive use of both inorganic and organic sources
  - o The project recommends a 4Rs approach:
    1. Right quantity
    2. Right time
    3. Right mode and
    4. Right type of fertiliser for judicious use of chemical fertilisers
  - o Further, integrated Nutrient management has been promoted through the implementation of Soil Health Cards scheme since 2015.
- **Kisan Suvidha App:** The development of Kisan Suvidha mobile application aims to facilitate dissemination of information to farmers covering range of issues such as weather forecast, extreme weather alert, market price of commodities, information about dealers of fertiliser, seeds, pesticide, soil testing labs, crop insurance government schemes, etc.
  - o Besides, **Pusa Krishi mobile app** provides information about the latest technologies developed by the Indian Agricultural Research Institute.
- [Usage of Drones in Agriculture](): To promote the use of drones in agriculture, the Department of Agriculture and Farmers Welfare has released the SOPs for use of drones in pesticide and nutrient application
  - o To make drone technology affordable and available to the farmers and other stakeholders of this sector, financial assistance of 100% cost of drone.
  - o Further, contingent expenditure is provided under submission on Agricultural Mechanisation to the institutions such as ICAR, KVKs, State Agricultural Universities (SAUs), and Public sector undertakings (PSUs).
  - o FPOs are provided grants of 75% for purchase of drones for its demonstration on the farmers' fields to provide agricultural services through drone application.
- **Thrust on Genetic Improvement:** The government's thrust has been on the use of new technology in agricultural research.

- - The research by ICAR focuses on genetic enhancement of crops, livestock, fish for high yield, quality and climate resilience, conservation of resources and, development of intelligent information technology-enabled platform for technology transfer among farmers and stakeholders.
  - According to reports, ICAR during 2021-22 has developed and released about 309 varieties of hybrid field crops including 35 varieties with special traits and 94 varieties of horticultural crops for cultivation.

Though technology adoption has improved agricultural efficiency in Indian agricultural sector, some areas still need attention:

- As per FICCII's "Knowledge Paper on Indian farm equipment sector" Farm equipments use in India stands at about 40-45 percent. This is still low when compared to countries such as the US (95percent), Brazil (75 percent) and China (57percent).
- 'Tractor-isation' and not mechanisation of Industry is happening.
- As per National Digital literacy mission, digital literacy is almost no-existent among more than 90% of India's population.

Technology adoption has proved that it has the potential to improve agricultural efficiency by improving farmers knowledge, access to credit, and agriculture output in many ways. Hence, technology adoption can help the farm product to reach from "local to global" market in an efficient way. If addressing the remaining issues in the technology adoption, it will also help to convert the image of the Indian "Peasant farmer" into an "Entrepreneur farmer".

National Task Force for Women in Science

In 2002, the President of Indian Nation Science Academy (INSA) constituted a committee to examine the status of women in science in India.

- The recommendations of the INSA report on "Careers of Women in Science" prompted the Scientific Advisory Committee of the Prime Minister to constitute a National Task Force for Women in Science in December 2005 under the Department of Science and Technology (DST).
- Recommendations of Task Force:
  - Recruitment of deserving women scientists in institutions,
  - Selection committees to include women scientists
  - Refresher training, mentorship programs and schemes
  - Creating women friendly workplaces with availability of creches and safeguarding policies against sexual harassment
  - Promote scientific temperment among school girls
  - New policies with focus on maternity leave
  - Developing avenues to promote entrepreneurship and self-employment

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Use of Technologies to Facilitate Smart Water Management

- Active leakage control can be achieved by technological interventions such as real-time monitoring of water supply infrastructure, use of geographic information systems (GIS) tools, installing smart devices, and telemetry.
- Implementation of Internet of Things (IoT) technology helps transmit data or information about water usage to longer distances through wireless, and uninterrupted means.
- The use of Sensors, remote sensing technologies, and visualisation tools help manage water resources at the service area, watershed, and regional scales.

- Satellites and drones can be used to provide data for mapping water resources, measuring water fluxes, and utility asset management. Data from such technologies can better prepare water resource management policies.
- Mobile phones can be utilised to provide near real-time data on water quality, flows, pressures and water levels, among other parameters. It can also help in spreading useful information on water resources to all the stakeholders.
- Smart meters can be used to record customer water usage that will provide a clear picture of water consumption and convey data to both consumer and utility.
- Artificial Intelligence in water can allow for the strategic and cost-effective operation of utilities, including better planning and execution of projects, better tracking and understanding of resource loss and more efficient collection and distribution networks. Further, the use of AI in reservoir operation, flood forecasting, and inundation mapping can help to mitigate floods and save thousands of lives.
- Augmented Reality and Virtual Reality technologies have the potential to support decision-making in the field by providing holographic representation of pipes, cables and other assets and facilitate immersive scenario-based training.
- Blockchain applications have the potential for direct, secure transactions between resource providers and consumers and other players.

All the best,
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