Transformation of Tsunami Science

Why in News?

December 26, 2024, marks the 20th year since the 2004 Indian Ocean earthquake and tsunami.

What was the 2004 Tsunami?

- **Tsunami** – Seismic Sea waves are massive ocean waves that are typically caused by underwater earthquakes, volcanic eruptions, or landslides.
- **2004 Tsunami** – It was generated by the quake of magnitude 9.1 created off the Sumatran coast.
- It was the third largest (by magnitude) in the world since 1900.
- **Hypocentre** - The source was 30 km below the ocean floor, in the Sunda trench, where part of the Indo-Australian plate subducts beneath the Burma microplate, which is a part of the Eurasian plate.
- **Effect** -The 2004 earthquake ripped through 1,300 km of the plate boundary, the fault tearing from Sumatra in the south to Coco Islands in the north.
- **Impact** - The quake was felt in Indonesia, Bangladesh, India, Malaysia, the Maldives, Myanmar, Singapore, Sri Lanka, and Thailand.
- **Tsunami impact** - The tsunami was most impactful on distant shores, affecting 17 countries lining the Indian Ocean.
- **Toll** – Tsunami had caused astounding death toll of around 227,000 plus 1.7 million more displaced.
- **Japan 2011 tsunami** - In 2011, a magnitude 9.1 earthquake hit the east coast of Japan, the largest ever recorded in that country.

How these events transformed the disaster risk management ?

- The two decades since 2004, researchers have made tremendous leaps in the scientific understanding of tsunami generation and the technical aspects of earthquake monitoring.
- **ITEWC** - Union Ministry of the Earth Sciences had established Indian Tsunami Early Warning Centre (ITEWC) in 2007 to issue tsunami advisories for India.
- **INCOIS** - ITEWC is operated from the Indian National Centre for Ocean Information Services (INCOIS) at Hyderabad.
- **Features of ITEWC** - It operates seismological stations as well as bottom pressure recorders and tidal stations across the Indian Ocean basin.
- **Functions** -ITEWC functions as an approved Tsunami Service Provider of the Indian Ocean Tsunami Warning & Mitigation System (IOTWMS) that is an integral part of the Global Tsunami Warning and Mitigation System, established and coordinated by the Intergovernmental Oceanographic Commission (IOC) of UNESCO.

- **IMD** - Earthquake data from the stations operated by the India Meteorological Department (IMD) and 350 global stations are also available at INCOIS.
- **Ocean monitoring systems** - In about 10 minutes the system can identify a potential tsunami-producing earthquake and issue tsunami alerts or warnings for countries bordering the Indian Ocean.

India is the fifth country in the world, after the U.S., Japan, Chile, and Australia, to have an advanced tsunami warning system of this kind.

- **Use of technology** - The demand for more knowledge about tsunamis also facilitated quantum leaps in the use of GPS systems and earthquake instrumentation.
- **Strengthening seismic observations and geodetic studies** – Several earth quake monitoring stations are established along the Andaman and Nicobar Islands.
- **Tsunami modelling** - Mathematical tools are used to determine inundation limits.
- **Nuclear disaster warning** - The disaster provided a stark reminder that nuclear power plants established along Indian coasts could be vulnerable to a hitherto underestimated risk.

Kalpakkam nuclear power plant withstood the giant waves and shut down automatically after the rising water levels tripped the detectors.

- **Fukushima Incident** - 2011 Tohoku earthquake affected the Fukushima facility and it's radiation had entered the human food chain.

Researchers even found radioactive caesium in the breast milk of some women tested near Fukushima prefecture three months after the disaster.

What is Tsunami geology?

- **Tsunami geology** – It was pioneered by Brian Atwater of the U.S. Geological Survey .
- His works prompted researchers in Asian countries including India to search for evidence of tsunamis in history.
- **Use of land elevation changes** –Atwater had used the imprints of earthquakes to determine when some piece of land had been deformed
- **Use of sedimentary deposits** – Sedimentary deposits along the islands and coastal areas of the mainland are used to find evidence of other ancient tsunamis.
- **Pre-2004 tsunami** - Excavations at Mahabalipuram, a port of the Pallava dynasty, unearthed evidence of a tsunami of the same vintage.

2004 earthquake had rendered changes in elevation of up to 3.5 metres at some places along the Andaman and Nicobar Islands.

How vulnerable the Indian ocean region is to Tsunami?

- **Unexamined regions** - The crust between Great Nicobar and Car Nicobar is still unexplored and its geological features are unknown.
- **Potential tsunami regions** - Makran Coast in the northern Arabian Sea and the Myanmar coast adjoining the Northern Indian Ocean have the potential to produce large tsunamis.

  The Makran Coast cuts through Iran and Pakistan.

- **Nuclear reactor** – Earthquake in makran coast could direct a tsunami's energy towards India's west coast, which also hosts nuclear reactors and the city of Mumbai.

What are the major developments in Tsunami prediction?

- **Zone of importance** - Subduction zones like the Andaman-Sumatra region are becoming significant as they provide clues to earthquake generation.
- **Discovery of slow slips** — Researchers have been studying seismic slips at plate boundaries to understand the processes that occur before and after major earthquakes.

  Slow Slips are tectonic faults that move many orders of magnitude slower and generally just a bit deeper , has also added a new dimension to tsunami studies.

- They have elucidated the occurrence of premonitory and post-seismic slip transients using laboratory experiments and numerical simulations.
- These studies indicate a creative process that initially involves stable, slow rupture growth within a confined zone on a fault just before unstable, high-speed rupture.

  One paper published in 2015 indicated a perceptible downward ground movement in South Andaman between 2003 and 2004, before the 2004 earthquake.

What lies ahead?

- Focus on problem spots, like the Makran Coast in the northern Arabian Sea and the Myanmar coast adjoining the Northern Indian Ocean, that have the potential to produce large tsunamis.
- Studying seismic slips at plate boundaries to understand the processes that occur before and after major earthquakes.

Reference

The Hindu | Transformation of Tsunami Science



SHANKAR
IAS PARLIAMENT
Information is Empowering