Japan Tsunami

Why in News?

Tsunami waves hit several parts of Japan's coastal areas and urgent evacuation warnings were issued after a 7.6-magnitude earthquake shook the country's north-central region.

What is Tsunami?

- **Tsunami**– A Japanese word meaning ***harbour wave.***
  - Tsu – harbour; nami - wave.
- It is a ***series of giant ocean waves*** caused by earthquakes or volcanic eruptions under the ocean.

Submarine earthquakes have generated about 80% of all tsunami events recorded globally.

Scientific Basis of Tsunami – Earthquake based
• **Movement of plates** – The *Earth's lithosphere is broken up* into a bunch of discrete pieces, called plates and there are *7 or 8 major plates* and many minor plates. • These plates move around the surface of the planet which are *driven by the flow of the mantle rock* beneath the plates and by the forces plates exert at their boundaries where they touch each other. • **Earthquakes** – Movement of plates *with respect to each other* causes friction and stress at the edges thus causing earthquakes. • **Tsunami** – When 1 plate is forced to dive beneath another plate, there is no way to do it except with some component of *vertical motion creating tsunami.* • Tsunamis are often incorrectly called tidal waves and have *no relation to the daily ocean tides*.

- **Physical attributes**
  - It can be 100's of feet tall.
  - It can travel as fast as jet planes over deep waters.
  - It slows down the travel speed on reaching shallow waters.
  - It has a long wavelength and period (time between crests) which can vary from a few minutes to over an hour.

The wavelength is a factor which distinguishes tsunamis from wind waves, a tsunami wavelength can be more than 200 km long which is considerably longer than a wind wave wavelength.

- **Lifetime of a tsunami** – It can be divided into 3 stages namely *generation, propagation, and run-up*.
- **The power of a tsunami** – It is highly dependent on ***2 factors***.
    - **The tide** – At high tide the tsunami will be able to do much more damage than at low tide.
    - **Seafloor morphology** – It alters the tsunami height by changing the ratio between their wavelength and wave height.
    - In general, this ratio decreases as the wave travels into shallower water, causing the tsunami to grow in size.
- **Sea depth** - As the *sea depth decreases,* the wavelength decreases and the *height increases.*
- **Size** – It is also influenced by the topography of the coastline.
- **Numbers** – There may be ***more than one wave*** and the succeeding one may be larger than the one before.
- That is why a small tsunami at one beach can be a giant wave few kilometres away.

What are factors responsible for the occurrence of Tsunami?

- **Earthquake tsunami** – When earthquake occurs under the ocean, a large chunk of the *ocean floor can suddenly move* upward or downward, leading to a sudden ***displacement of a large volume of water***, thereby causing tsunami waves.
- All earthquakes do not cause tsunamis and there 4 conditions necessary for it to cause a tsunami.

Conditions for an earthquake to cause Tsunami
• It must occur ***beneath the ocean*** or cause the material to slide into the ocean. • It must be strong, ***at least magnitude 6.5 on the Richter Scale*** • It must *rupture the Earth's surface* and it must occur at shallow depth – ***less than 70km below the surface*** of the Earth. • It must cause ***vertical movement of the seafloor*** (up to several meters).

- **Volcano tsunami**– When volcano erupts under the sea, the ***lava flowing out of the volcano displaces the water*** around it and that water can become a large wave.
- However, not all volcanic eruptions lead to tsunamis.
- **Erosion tsunami** – Large erosion of ocean floor displaces the water leading to displacement of water.
- **Extra-terrestrial collision**– Although no meteor/asteroid induced tsunami has been recorded in recent history, if they strike the ocean, a large volume of water would be displaced to cause a tsunami.
- **Landslide tsunami** – A landslide along the coast and underwater landslides can also disturb the water and generate a tsunami.
- The tsunamis generated tend to be *relatively localized* and typically *do less damage than the earthquake generated tsunamis.*

What are the effects of tsunami on life and economy?

- The effects of a tsunami depend on the characteristics of the seismic event that

generate it
    - The *distance* from its point of origin
    - Its size (*magnitude*)
    - The *configuration of the bathymetry* (the depth of water in oceans) along the coast.
- **Loss of Life** – Most deaths caused by tsunamis are because of drowning.
- **Flooding** – They arrive as forceful rapid increase in water levels that results in violent flooding.
- **Diseases** – Illnesses such as malaria arise when water is stagnant and contaminated.
- **Damages to key infrastructures** – Objects and buildings are destroyed by the sheer weight of the water, often *reduced to skeletal foundations and exposed bedrock*.
- **Fires –** Ruptured tanks or gas lines can damage life and property along with power supply.
- **Environmental impacts –** It has devastating effect on insects, animals, plants, and natural resources.
- **Changes the landscape** – By uprooting trees and plants and destroys animal habitats such as nesting sites for birds.
- **Waste management issues** – It dumps enormous solid waste and disaster debris.
- **Salination of water bodies** – Infiltration of sea water into freshwater bodies.
- **Contamination of drinking water** – Seawater along with carried debris contaminate groundwater and other water bodies.
- **Radiation issue** – There may be radiation resulting from damage to nuclear plants, as it happened in ***Japan in March 2011.***
- **Economical losses** – Reconstruction and clean up after a tsunami has costs huge.
- **Psychological effects** – Victims of tsunami events often suffer psychological problems like PTSD (post-traumatic stress disorder).

What are risks and vulnerability of India with respect to Tsunami?

India is one of the 10 worst disaster prone countries in the world.

- **Vulnerability profile** – Of the 7516 km long coastline, ***close to 5700 km is prone to tsunamis***.
- The geo-centric movement inside the ocean floor makes the coastal region prone to tsunami.
- **Tsunamigenic zones in Indian Coast** - *Both the east and west coasts of India and the island* regions are likely to be affected by ***tsunamis from the 5 potential source regions***
    - The Andaman-Nicobar Sumatra island arc
    - Indo-Burmese zone,
    - Nascent Boundary (in the central Indian Ocean)
    - Chagos archipelago
    - Makran subduction zone
- **Urbanization increases vulnerability** – For instance, about *25% of the Indian population lives within 50 km of the coastal line* and these people are vulnerable to river flooding, and coastal surges following cyclones or tsunamis.

- ***Tsunami in Indian Ocean occurred on 26th December 2004***, the hardest hit areas were on the Southern coast of Andaman and Nicobar Islands.

Why is Japan prone to earthquakes and tsunamis?
• **Location** – It is situated along the '***Pacific Ring of Fire***', the most active earthquake tectonic belt in the world. • Within the Ring of Fire, there are *different tectonic belts,* which keep meshing and colliding with each other, causing earthquakes, volcanic eruptions and tsunamis. • In 2011, Japan was hit by a 9.0 magnitude earthquake accompanied by a tsunami leading to a nuclear meltdown at the ***Fukushima power plant***, the most severe nuclear accident since the 1986 Chernobyl disaster in the Soviet Union.

What are the mechanisms for preparedness to reduce the risk as per NDMA?

National Disaster Management Authority (NDMA)
• **Established by** – NDMA Act 2005. • **Role** – The *apex body for Disaster Management (DM)* in India. • It is mandated to lay down the policies, plans and guidelines for disaster management for timely and effective response to disasters. • **Headed by** - Prime Minister of India.

- **Awareness generation** – State and District Disaster Management Authority (SDMAs & DDMAs) will conduct regular public awareness campaigns for *familiarising communities in coastal areas with the tsunami early warning mechanisms*.
- **Early warnings** - Effective dissemination of tsunami alert and warning messages to the concerned agencies and coastal vulnerable communities.

Indian National Centre of Ocean Information Services (INCOIS) *is the Nodal agency for Tsunami related early warning system.*

- **Capacity building** – It involves effective emergency response by involving local police network, civil defence volunteers, home guards, State and National Disaster Response Force.
- **Education** – NDMA has initiated the efforts in collaboration with nodal agencies like the UGC, AICTE, MCI, ICAR, etc. to include DM in the educational curricula.
- **Training** – ***National Institute of Disaster Management*** at the national level have been tasked to train administrative personnel from all Ministries and departments in DM.
- **Research & development** - For better tsunami risk management.
- **Structural Mitigation measures** – A brief guidance on design and construction of new structures as well as strategies for protecting lifeline and priority structures from Tsunamis.
- **Techno-legal regime** – It shall be brought through efficient land use practices, bio shields, shelter belt plantation and mangrove regeneration with community involvement.
- Further, it explore the provisions of ***Disaster Management Act 2005*** to mainstream

concern of Tsunami risk management in disaster management plans of various levels.

India's relief operation aftermath of Tsunami
• **Maldives** – Under "***Operation Castor*****",** 4 aircraft and 2 Naval ships were engaged in relief operations, after the *2004 Tsunami*. • **Sri Lanka** – Under "***Operation Rainbow***", India sent its forces to carry out rescue operations, after the *2004 Tsunami*.

References

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2. NDMA| Tsunami
3. NIDM| Tsunami Management in India

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