



## 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.*

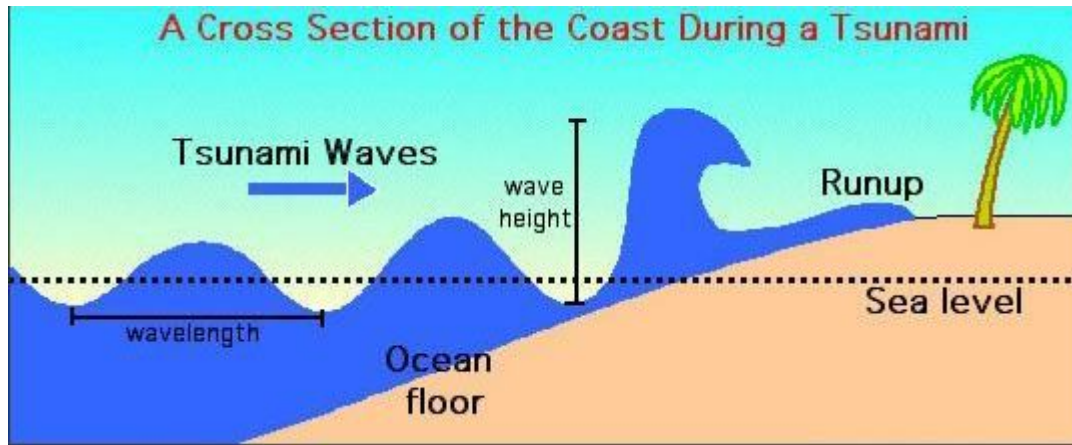
### Scientific Basis of Tsunami - Earthquake based

- **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

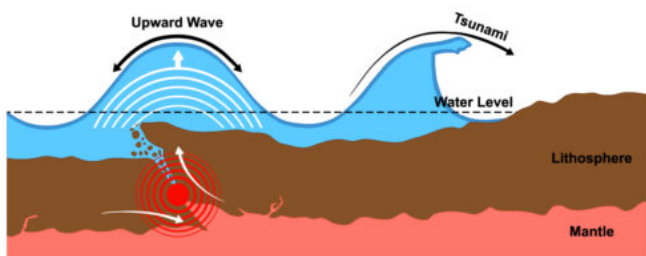
- It must occur **beneath the ocean** or cause the material to slide into the ocean.
- It must be strong, **at least magnitude 6.5 on the Richter Scale**
- It must rupture the Earth's surface and it must occur at shallow depth - **less than 70km below the surface** of the Earth.
- It must cause **vertical 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

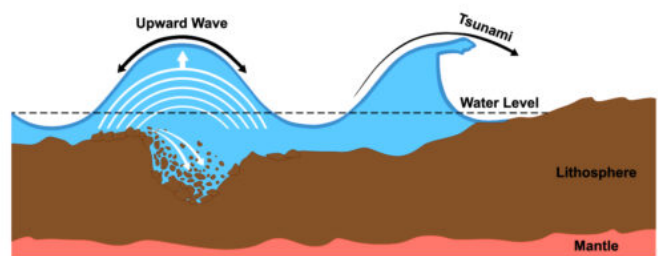
recorded in recent history, if they strike the ocean, a large volume of water would be displaced to cause a tsunami.

- **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*.

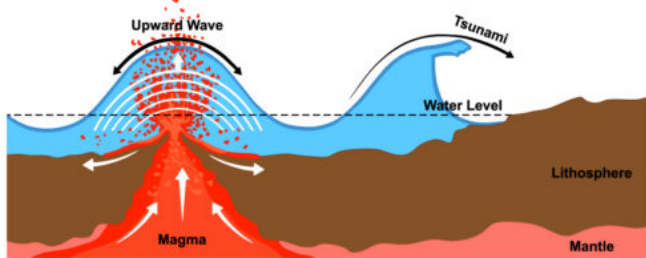
### Earthquake Tsunami



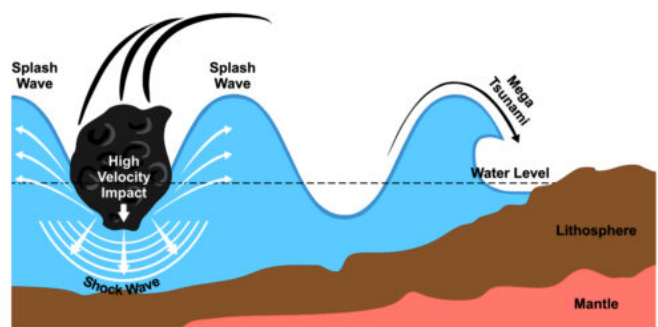
### Erosion Tsunami



### Volcano Tsunami



### Falling Meteors Mega Tsunami



## 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).

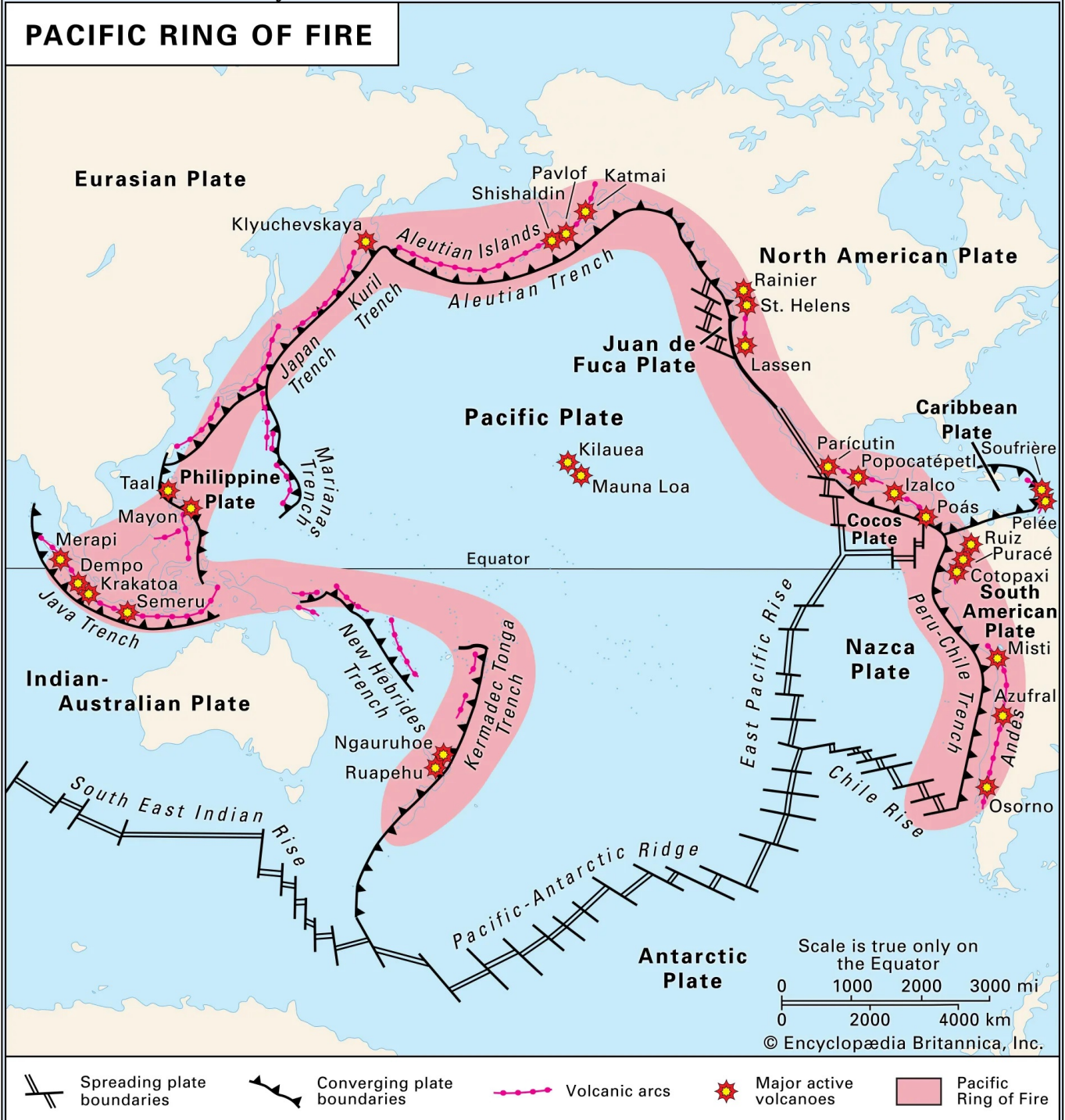
### **What are risks and vulnerability of India with respect to Tsunami?**

*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 26<sup>th</sup> 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 & DDMAAs) 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

1. [The Indian Express| Japan Earthquake triggers Tsunami warnings](#)
2. [NDMA| Tsunami](#)
3. [NIDM| Tsunami Management in India](#)



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