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Q7

What are Tsunamis? How and where are they formed? What are their consequences? Explain with examples.

UPSC Civil Services Mains 2025 · GS I · 10 marks · Geophysical Phenomena

Important Geophysical phenomena such as earthquakes, tsunami, volcanic activity, cyclone etc., geographical features and their location-changes in critical geographical features (including water-bodies and ice-caps) and in flora and fauna and the effects of such changes.

Core demand of the question

- Define a tsunami as a sea wave train from sudden seafloor motion
- **Explain generation:** quake, volcano, landslide; the subduction map
- Give consequences and Indian Ocean examples, especially 2004

Revision summary

A tsunami is a train of long ocean waves caused by sudden motion of the seafloor.

Most begin on subduction megathrusts; landslides and volcanoes can also trigger them.

In deep water they are fast and low; near shore they flood.

The 2004 Sumatra quake devastated the Andamans, Tamil Nadu, Sri Lanka, the Maldives and coasts as far as Africa.

Warning systems work only with drills, and mangroves take some of the blow.

Introduction

A tsunami is not a high wind sea. It is a **series of long waves** set off when the **ocean floor suddenly moves** and shoves the whole water column. In deep water the wave is fast and low. Near shore it slows, stands up, and floods. That is why a fishing village can look calm ten minutes before it disappears.

Body

How and where they form

Most tsunamis start at **subduction zones**, where one plate dives under another and the locked interface **slips in a megathrust earthquake**. The 2004 event began off **Sumatra on the Sunda megathrust**. **Similar belts ring the Pacific: Japan, Chile, Alaska, Kamchatka**. **A undersea landslide**, a volcanic flank collapse, or a rare **meteor** can do the same job. **Krakatoa** in 1883 coupled explosion and wave. Not every sea quake makes a tsunami; the slip must **lift or drop the seafloor**.

Waves cross oceans at jet-airliner speeds. The 2004 train hit the **Tamil Nadu and Kerala coasts**, the **Andaman and Nicobar Islands, Sri Lanka**, the **Maldives** and East Africa hours after Sumatra. India's **Makran** coast (Pakistan-Iran) is another local source for Gujarat and Oman. The **Sunda trench** is the neighbour India must watch to the southeast.

Consequences

- **First is drowning**: more than two lakh dead in 2004, with the Andamans and the Tamil fishing coast among the Indian wounds. Then come **saline fields**, broken boats, ruined tourism, and **trauma**. A tsunami does not look like a curling surf poster. It can arrive as a **fast flood** or as the sea **withdrawing** first, which is a warning if people have been taught to run inland.

Consequences are worse where **mangroves and coral** were already cut, because those buffers take some energy. Early warning - **INCOIS** buoys and tide gauges after 2004 - saves lives only if a siren and a drill exist on the beach. Japan's 2011 Tohoku wave showed that even a prepared country can lose a nuclear plant to a wave taller than the wall.

The map of formation is the map of **convergent plate edges**. The map of death is the map of **low, crowded coasts** in the same ocean basin.

Flow diagram

Subduction sources

Sunda Sumatra 2004

Makran

Japan trench

Sunda Sumatra 2004 -> Andaman Nicobar

Sunda Sumatra 2004 -> Tamil Nadu Kerala

Sunda Sumatra 2004 -> Sri Lanka

Sunda Sumatra 2004 -> Maldives

Sunda Sumatra 2004 -> East Africa

Makran -> Gujarat coast

Conclusion

Tsunamis are long waves from sudden seafloor change, usually a megathrust quake. They grow deadly on shallow coasts. The 2004 Indian Ocean disaster, from Sumatra to Africa, is the example India cannot treat as ancient history.

Facts & figures

26 December 2004

A magnitude-9 class Sunda megathrust earthquake launched the Indian Ocean tsunami that killed on a basin-wide scale.

INCOIS

India's ocean information centre that now runs tsunami warning after the 2004 failure of surprise.

Drawback

The sea sometimes pulls back before the flood; that withdrawal is a natural siren to run inland and uphill.

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