KAMARAJ IAS ACADEMY
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Tsunami

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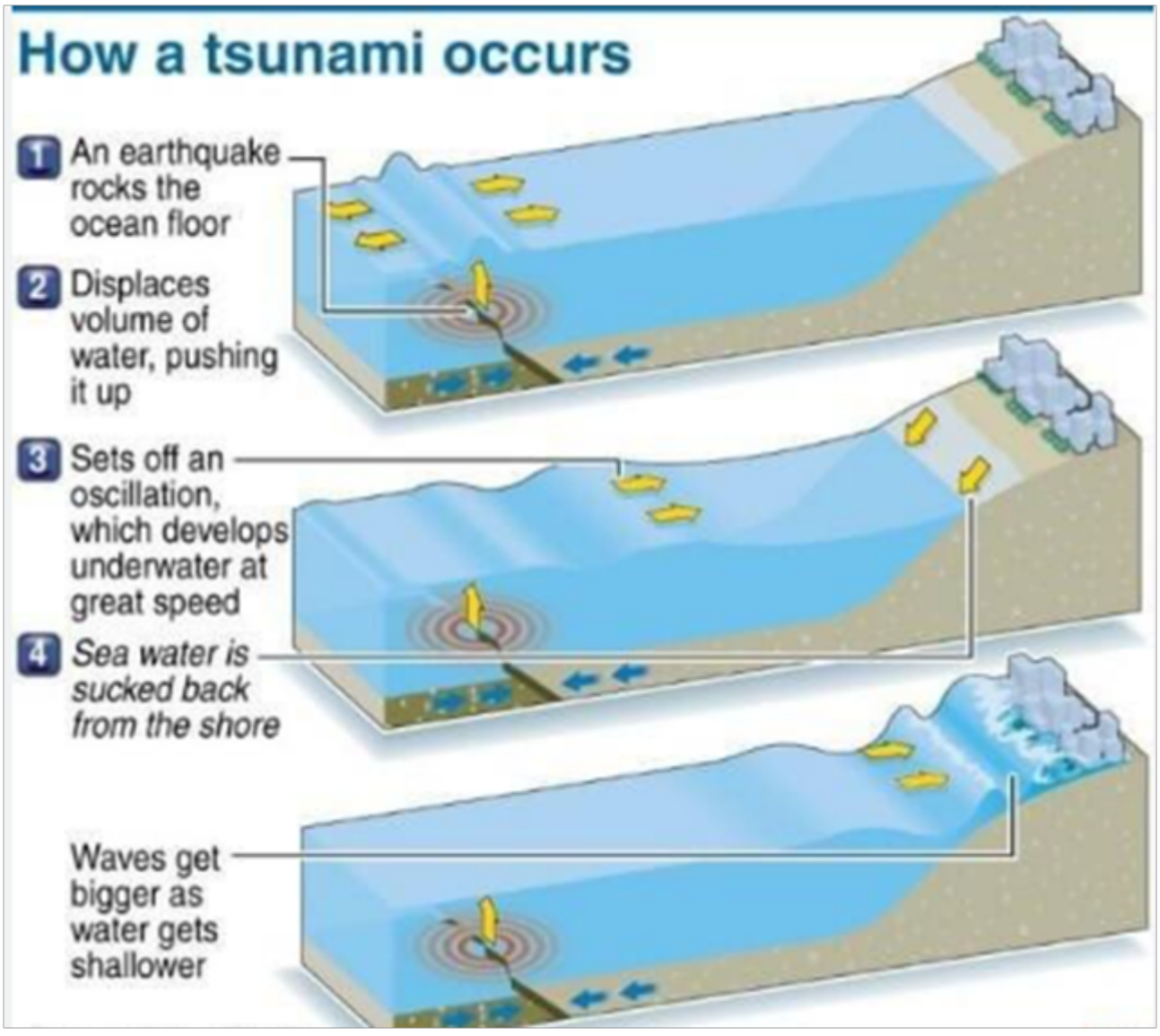
A**tsunami**is a series of long-wavelength ocean waves generated by the sudden displacement of large volumes of water, typically in oceans or large lakes

it literally means**“harbour wave,”**reflecting its devastating impact on coastal communities

They travel at speeds up to**800 km/h**in deep water—comparable to jet aircraft—and slow to**20–30 mph**near shore, where wave heights can surge dramatically.

CAUSES OF TSUNAMI:



Submarine Earthquakes

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Vertical displacement along seafloor thrust faults during large under-ocean earthquakes—particularly megathrust events at subduction zones—lifts or drops the water column, generating tsunami waves. Most tsunamis worldwide originate this way

Volcanic Eruptions

Explosive eruptions, caldera collapse, and pyroclastic flows entering water bodies abruptly displace large volumes of water. Example:The 1883 Krakatoa eruption generated waves up to 41 m high across the Sunda Strait.

Coastal (Subaerial) Landslides

When a large mass of rock or soil suddenly plunges from cliffs into the sea—such as historic slides in Alaska's Lituya Bay—it displaces water and creates waves that can exceed hundreds of meters in run-up height locally.

Glacier Calving

In polar fjords, massive icebergs détaching from glaciers can trigger tsunamis by sudden water displacement. While less studied, such events have been documented in Greenland and Alaska

Human?Induced Seafloor Disturbance

Activities such as deep-sea mining, dredging, or reservoir impoundment-induced seismicity could, in theory, destabilize slopes and cause localized tsunamis, but documented cases are lacking and remain speculative

Meteorite or Asteroid Impacts

Though extremely rare, a large extraterrestrial body striking an ocean would instantaneously displace millions of tons of water, creating a tsunami with global reach.

IMPACTS OF TSUNAMI:

Economic Losses : Property damage and loss of life, along with disruption in business and tourism, pose enormous economic problems to the affected communities and nations.

Example: The 2004 Indian Ocean tsunami caused approximately USD 15 billion in direct damage, disproportionately impacting lower-income countries.

Human Casualties and Injury: Tsunamis cause high mortality and injury rates due to rapid inundation and strong currents.

Example:The 2004 Indian Ocean tsunami claimed over 230 000 lives across 14 countries, with thousands more injured by debris and collapsing structures.

Environmental Degradation

Saltwater intrusion contaminates soil and freshwater aquifers up to kilometers inland, undermining agriculture and drinking water supplies. Coastal forests, mangroves, and coral reefs suffer catastrophic damage.

Example:The Andaman coast lost over 50% of its mangrove cover in 2004, reducing future natural protection.

Disruption of Livelihoods: Fishing fleets, aquaculture farms, and tourism infrastructure face complete destruction

Cascading Disasters: Secondary hazards include fires, chemical spills, and nuclear accidents.

Public Health Crises: Contaminated water and debris fields foster waterborne diseases and hinder medical response

Example:After 2004, cholera and diarrheal outbreaks occurred among displaced populations in makeshift camps with inadequate sanitation

Global Tsunami Mitigation Strategies

Comprehensive Early Warning Systems

Integration of seismic networks, deep-ocean buoys (DART), coastal tide gauges, and satellite communications ensures rapid detection and reliable alerts.

Example: The Pacific Tsunami Warning Center (PTWC) in Hawaii and U.S. National Tsunami Warning Center (NTWC) employ DART buoys to detect wave pressure changes and disseminate warnings within 10–20 minutes of major quakes.

Multi-Tiered Warning Dissemination

Tiered alerts (watch, advisory, warning) transmitted via sirens, SMS, radio, television, and mobile apps maximize reach and redundancy.

Example: Japan's "YureKuru Call" app issues combined earthquake-tsunami alarms nationwide within three minutes, enabling millions to evacuate before waves arrive.

Structural Coastal Defenses

Seawalls, breakwaters, tsunami gates, and elevated berms reduce incoming wave energy and delay inundation.

Example: Japan's 300 km of coastal dikes—some up to 15 m high—and the world's deepest breakwater at Kamaishi Bay cut tsunami force by ~40%.

Ecosystem-Based Mitigation

Preserving and restoring mangroves, coral reefs, sand dunes, and coastal forests attenuates wave height and buffers shorelines.

Example: Indonesia's mangrove forests protected Kabonga Besar Village during the 2018 Sulawesi tsunami, reducing wave impact and safeguarding lives.

Community Education and Drills

Regular school and workplace drills, public awareness campaigns on natural warnings (ground shaking, sea recession), and local volunteer training strengthen preparedness

Example: Aceh, Indonesia, mandates annual tsunami drills for all districts; community sirens and mosque loudspeakers relay hereditary warnings alongside modern alerts.

Technology-Driven Innovation

AI-based inundation forecasting, GNSS deformation monitoring, and hydroacoustic sensors enhance detection speed and accuracy.

Example: India’s ITEWC uses real-time GPS deformation fields and decision-support systems to predict wave heights and publish targeted advisories within 10 minutes of major quakes

Conclusion

Tsunamis are forces of nature capable of laying ruin to lives, infrastructures and ecosystems. They can never be prevented, but improvements in early warning systems, disaster preparedness, and public awareness must be sufficiently employed to mitigate losses. Understanding their causes and features is key in the development of resilience among coastal communities all around the world.