Satish Chandra Memorial School

Class 9 | Geography

NATURAL DISASTERS

WHAT IS A DISASTER?	A **disaster** is a serious disruption of a community's functioning that causes human, material or environmental losses exceeding the community's ability to cope on its own. It arises from the combination of a **hazard**, **vulnerability** of the exposed population, and their **limited capacity to respond**. A hazard alone — a fault line, a steep slope, a glacial lake — is not a disaster until it intersects with an unprepared community. This relationship is often expressed as: **Risk = Hazard × Vulnerability × Exposure**.

TYPES OF DISASTERS

Category	Sub-types	Indian Examples
Geophysical	Earthquake, Volcanic eruption, Tsunami	Bhuj 2001, Andaman volcanic arc
Hydrological	Flood, Flash flood, GLOF, Storm surge	Kedarnath 2013, Assam floods
Meteorological	Cyclone, Dust storm, Heatwave, Cold wave	Cyclone Amphan, Andhi storms
Climatological	Drought, Wildfire, Glacial retreat	Bundelkhand drought, Uttarakhand fires
Mass Movement	Landslide, Avalanche, Mudflow, Rockfall	Chamoli 2021, Siachen avalanche
Biological	Epidemic, Pandemic, Pest infestation	COVID-19, Locust attack 2020

HAZARD vs. DISASTER

Aspect	Hazard	Disaster
Meaning	A threatening natural or human-made event with potential to cause harm	When that threat strikes a vulnerable community and overwhelms its coping capacity
Status	Potential — it may or may not occur	Realised — has already happened with measurable losses
Impact on people	Depends entirely on exposure and preparedness	Direct — deaths, injuries, displacement, economic damage
Can it be prevented?	Can be monitored, mapped and predicted	Cannot be fully prevented; losses can be reduced through preparedness
Formula link	Hazard is one factor in the risk equation	Disaster = Risk that has materialised into actual harm
Indian example	Seismic Zone V in NE India and Himalayas	Bhuj earthquake 2001 — hazard became a disaster

1. EARTHQUAKE

CAUSES

- Movement of tectonic plates is the primary cause. When two plates collide, diverge or slide past each

STRATEGIES

- Enforcing earthquake-resistant building codes is the most effective long-term measure. This means other, enormous stress builds along fault lines and is suddenly released as seismic energy, shaking the ground above.

- Human activities such as impounding large reservoirs alter the pressure in underlying rock, a phenomenon called Reservoir-Induced Seismicity. The Koyna dam region in Maharashtra is a well-documented example of this in India.
- Shallow-focus earthquakes (depth under 70 km) cause far greater surface damage than deeper ones because the seismic energy travels a shorter path before reaching populated areas — most destructive Indian earthquakes fall in this category.

mandatory seismic design standards for all new construction, particularly in Zones IV and V which cover most of the Himalayan and northeastern belt.

- Seismic micro-zonation maps local soil conditions, identifying zones of amplified shaking and liquefaction risk within cities. This allows planners to restrict high-density construction in the most vulnerable pockets before disaster strikes.
- Expanding the National Seismological Network with more stations enables faster and more precise detection of epicentres, improving the speed at which evacuation and rescue decisions can be made after a major event.
- Community preparedness through regular Drop-Cover-Hold drills, particularly in schools and residential colonies in high-risk districts, builds muscle memory that saves lives in the crucial seconds when a quake strikes.

CASE STUDY | BHUJ EARTHQUAKE, GUJARAT — 26 JANUARY 2001

Bhuj, Kutch District (Magnitude 7.7)

A 7.7 magnitude earthquake struck Bhuj on Republic Day morning, lasting nearly two minutes at a shallow depth of 23 km. Over **20,000 people were killed** and 1.67 lakh injured. About 3.5 lakh homes were completely destroyed, with the towns of Bhuj, Bhachau and Anjar almost entirely flattened. The scale of the tragedy was worsened by poor construction quality and the absence of any seismic code enforcement in the region. In response, Gujarat established the GSDMA for dedicated disaster governance, and the event directly led to the national **Disaster Management Act of 2005** and the creation of NDMA.

2. LANDSLIDE

CAUSES

- Heavy and sustained rainfall is the most common trigger. When water saturates slope material faster than it can drain, it reduces the friction holding soil and rock in place, causing them to slide downhill rapidly.
- Steep terrain with weak or weathered geology is inherently unstable. The Western Ghats, northeastern hill states and the lesser Himalayas all have deeply weathered rock that loses cohesion quickly when wet.
- Large-scale deforestation removes the root network that binds soil on slopes. Once vegetation is cleared for agriculture or urban expansion, even moderate rainfall can dislodge large volumes of material.

STRATEGIES

- Landslide Hazard Zonation mapping by the Geological Survey of India classifies slopes by their risk level, allowing state governments to restrict construction in the most dangerous zones before settlements expand into them.
- Biological stabilisation using deep-rooted grasses, shrubs and bamboo on vulnerable slopes is a low-cost, effective approach. Combined with contour trenching to slow runoff, it significantly reduces the chance of failure.
- Engineering interventions such as retaining walls is needed for high-risk slopes near roads and settlements where biological measures alone are insufficient to hold the terrain.

- Road construction and infrastructure projects in hilly areas often involve undercutting natural slopes without adequate engineering support, creating artificially unstable faces that collapse during the monsoon season.
- Earthquakes can trigger landslides instantly by shaking already stressed slopes. Such co-seismic landslides can be far more widespread than the direct earthquake damage, blocking rivers and burying villages.

- Real-time rainfall monitoring with automatic threshold alerts allows district administrations to issue warnings before critical slopes fail, giving communities time to evacuate rather than responding only after the event.
- Restricting and regulating construction in notified landslide-prone corridors, combined with the rehabilitation of the most vulnerable villages to safer sites, reduces long-term exposure without relying solely on engineering fixes.

CASE STUDY | CHAMOLI DISASTER, UTTARAKHAND — 7 FEBRUARY 2021

Rock-Ice Collapse, Rishiganga Valley

A massive detachment of rock and glacial ice from Ronti Peak (5,596 m) sent roughly 27 million cubic metres of debris crashing down the Rishiganga and Dhauliganga valleys. The surge reached speeds that gave workers in downstream hydropower tunnels no time to escape, **killing over 200 people**. The Rishiganga hydel project was completely destroyed and NTPC's Tapovan-Vishnugad project was severely damaged. The disaster reignited debate over infrastructure development in fragile Himalayan terrain, and the Supreme Court subsequently stayed several hydropower projects pending fresh environmental review.

3. AVALANCHE

CAUSES

- Heavy snowfall depositing large volumes of snow on steep slopes faster than the snowpack can consolidate is the most frequent trigger. When the weight exceeds the slope's holding capacity, the entire slab breaks away and accelerates downhill.
- Rising temperatures in spring melt the base of the snowpack, lubricating the slope surface and causing wet avalanches that, while slower, carry enormous mass and are extremely destructive to anything in their path.
- Wind deposits snow unevenly, loading leeward slopes and ridge lines far beyond natural limits and creating overhanging cornices. These can break spontaneously or with the slightest disturbance, including the weight of a single person.
- Climate change is altering traditional snowfall patterns in the Himalayas, bringing more intense but shorter snow events, earlier spring warming and rain-on-snow episodes that destabilise the snowpack in unpredictable ways.

STRATEGIES

- DRDO's Snow and Avalanche Study Establishment (SASE) operates a network of automatic weather stations across high Himalayan passes and issues daily colour-coded forecasts that guide pass closures and troop movements.
- Passive protection structures including snow fences, snow bridges and deflection walls are installed above settlements and roads to either anchor the snowpack or redirect an avalanche flow away from inhabited areas.
- Search and rescue preparedness with trained Quick Reaction Teams, avalanche-detection dogs, probes and shovels is essential since survival rates drop sharply after 15 minutes of burial — speed of response is the primary determinant of survival.
- Restricting movement in high-risk passes and areas during Red-level advisories and mandatory use of avalanche transceivers by troops and mountaineers operating in these zones reduces both frequency and severity of casualties.

CASE STUDY | SIACHEN GLACIER AVALANCHES, LADAKH

World's Highest Battleground, Ongoing Hazard

The Siachen Glacier region, sitting above 5,400 metres, witnesses around 150 to 200 avalanche events every year, making it one of India's most dangerous avalanche zones. Over the past decade, **avalanche casualties among Indian Army personnel have outnumbered combat losses** at Siachen. DRDO's SASE has responded by deploying 35 automatic weather stations and issuing daily snow bulletins for 13 mountain routes. The Army now equips soldiers with RECCO locator reflectors and runs systematic companion rescue drills, while DRDO continues to develop indigenous cold-zone rescue equipment suited to the extreme altitude and temperatures.

4. GLACIAL LAKE OUTBURST FLOOD (GLOF)

CAUSES

- Global warming is accelerating glacial retreat across the Himalayas, producing large volumes of meltwater that accumulate in lakes held back only by unstable moraine dams — natural dams made of loose rock and sediment deposited by the glacier.
- Moraine dams are inherently fragile because they are composed of unconsolidated debris rather than solid rock. Internal seepage can erode them from within (a process called piping) until they fail suddenly, releasing the entire lake volume in a matter of hours.
- An avalanche or a chunk of calving glacier ice falling into a glacial lake can generate a large displacement wave that overtops the moraine dam, rapidly eroding it and triggering a catastrophic outburst even without the dam itself failing structurally.
- Seismic activity in the Himalayan belt can destabilise or rupture moraine dams without warning. Since glacial lakes and earthquake zones overlap significantly in this region, the combined risk is particularly high.

STRATEGIES

- Satellite-based monitoring by ISRO and the National Remote Sensing Centre tracks changes in glacial lake area and volume every year, enabling early identification of lakes that are expanding toward dangerous thresholds.
- Artificial drainage through siphoning or excavation of controlled spillways can safely lower lake levels in lakes identified as high-risk, reducing the volume available to cause damage in the event of a dam breach.
- Automated lake-level sensors connected to downstream siren networks and SMS alert systems give valley communities enough time to move to higher ground when lake levels rise abnormally, converting a potential disaster into a manageable emergency.
- Bilateral data-sharing arrangements with China and Nepal for transboundary glacial lakes are important since many Himalayan rivers originate across borders, and a GLOF upstream can strike Indian territory with almost no lead time.

CASE STUDY | KEDARNATH DISASTER, UTTARAKHAND — JUNE 2013

Chorabari Glacial Lake Outburst

Extreme cloudbursts dropping 375 mm of rain in 24 hours, combined with the outburst of Chorabari glacial lake at 3,900 metres, sent a massive wall of debris-laden water crashing through Kedarnath town and down the Mandakini valley. **Over 5,700 people were officially declared dead or missing**, with actual estimates considerably higher. The entire Kedarnath bazaar was swept away, along with bridges, roads and hydropower infrastructure across four districts. The disaster led to annual satellite monitoring of over 13,000 Himalayan lakes by ISRO and prompted the NDMA to publish its first formal GLOF risk assessment guidelines in 2020.

5. DUST STORM (ANDHI)

CAUSES

- Intense solar heating of bare, dry ground over the Thar Desert and the Indo-Gangetic Plain during May and June creates strong thermal instability. Hot air rises rapidly, drawing in surface winds that pick up and carry vast quantities of loose dust and sand.
- When thunderstorms develop in this unstable air, their downdrafts hit the ground and spread outward as powerful gust fronts called haboobs. These walls of dust can be several hundred metres high and reduce visibility to near zero within minutes.
- Recurring droughts reduce soil moisture and eliminate seasonal ground cover, vastly increasing the supply of erodible particles available to be lifted into dust storms. This effect is compounding as rainfall patterns become more erratic.
- Widespread deforestation and land degradation across the arid and semi-arid belt has left large areas of bare, unprotected soil. Without vegetation to anchor the surface, fine particles are easily entrained by wind even at moderate speeds.

STRATEGIES

- IMD's colour-coded warning system issues Yellow, Orange and Red alerts for dust storms at the district level up to 72 hours in advance. Expanding the Doppler radar network into interior Rajasthan has significantly improved the lead time of these warnings.
- Planting shelter belts — multiple rows of trees perpendicular to prevailing wind directions — across the arid belt reduces surface wind speed near the ground and anchors soil. Traditional practice in Rajasthan shows this can cut local dust lift by over 60 percent.
- Large-scale land restoration under the National Action Programme to Combat Desertification aims to stabilise degraded land through vegetative cover, reducing the reservoir of loose particles available to dust storms over the longer term.
- Public safety protocols activated on Red alerts — advising people to stay indoors, close windows, wear masks and avoid driving — directly reduce casualties. Clear communication through mobile SMS alerts and local radio is the most effective last-mile delivery channel.

CASE STUDY | NORTH INDIA DUST STORMS — 2–4 MAY 2018

Rajasthan, Uttar Pradesh and Madhya Pradesh

A series of severe dust storms and thundersqualls swept across Rajasthan, Uttar Pradesh, Madhya Pradesh and Uttarakhand over three consecutive days in early May 2018. Wind speeds reached **130 km/h in Agra** and over 100 km/h in parts of Rajasthan. More than **125 people were killed** and 300 injured, mostly from collapsing mud-brick homes, fallen trees and electric poles. The event exposed the limited reach of early warnings in rural areas, prompting IMD to extend its district-level SMS alert system and leading NDMA to update its standard procedures for pre-monsoon dust storm response.