

DISASTER MANAGEMENT

Dams in India

- India has almost 6,000 large dams and about 80% of them are more than 25 years old and carry safety risks. A new Dam Safety Act (DSA) was passed in late 2021
- On October 2023, a glacial lake outburst flood (GLOF) in North Sikkim's South Lhonak Lake washed away one of the biggest hydropower projects in India, the Teesta III dam at Chungthang
- According to a parliamentary panel, there are 234 functional large dams in India that are more than 100 years old, some of them over 300 years old.

Classification of Dams:

Based on Purpose:

- **Irrigation Dams:** These dams are primarily built to store water for irrigation purposes, ensuring a continuous water supply for agriculture. Example: Bhakra Dam in Himachal Pradesh.
- **Hydroelectric Dams:** These dams generate electricity by harnessing the energy of flowing or falling water. Example: Tehri Dam in Uttarakhand.
- **Multipurpose Dams:** These serve multiple functions such as irrigation, hydroelectric power generation, flood control, and water supply for domestic and industrial use. Example: Sardar Sarovar Dam on the Narmada River.

Based on Size:

- **Large Dams:** These are typically taller and have a significant storage capacity. Example: Hirakud Dam in Odisha.
- **Medium Dams:** These have a moderate storage capacity and height. Example: TungaBhadra Dam in Karnataka.
- **Small Dams:** These are relatively smaller in size and are often built for local water supply and minor irrigation. Example: Panchet Dam in Jharkhand.

Based on Structure:

- **Gravity Dams:** These rely on their weight and gravity to hold back water. Example: Mettur Dam in Tamil Nadu.
- **Arch Dams:** These are curved dams that rely on arch action to resist the water pressure. Example: Idukki Dam in Kerala.
- **Embankment Dams:** These are constructed using compacted earth or rock fill. Example: Sardar Sarovar Dam (Narmada Valley Project).
- **Buttress dams:** They are made of reinforced concrete and supported by a series of buttresses at intervals on the downstream side. They differ from traditional gravity dams because they don't rely on their own weight to resist water thrust. Instead, the upstream face of a buttress dam inclines about 25° to 45. Example- The Mettur Dam on the Kaveri River in Tamil Nadu is an example of a buttress dam in India

Based on Ownership:

- **Government-Owned Dams:** These dams are owned and operated by government agencies at various levels (central, state, or local). Example: Nagarjuna Sagar Dam in Telangana/Andhra Pradesh.
- **Private Dams:** Some dams are owned and operated by private companies or entities. Example: Bhira Hydroelectric Project in Maharashtra

Causes of Failure of DAMS

Natural Disasters:

- **Floods:** Heavy rainfall or rapid snowmelt can lead to excessive inflow into reservoirs, causing dams to overflow or breach. Example: The 1979 Machhu Dam failure in Gujarat due to extreme rainfall resulted in massive flooding and loss of life and property.
- **Earthquakes:** Seismic events can cause ground shaking, leading to dam structural damage or failure.
 - ✓ Example: The 1967 Koyna Dam earthquake in Maharashtra caused significant damage to the dam and surrounding areas.

Design and Construction Flaws:

- **Poor Foundation:** Improper assessment of geological conditions can lead to settlement issues or foundation failure. Example: The failure of the Malaprabha Dam in Karnataka due to foundation problems in the early 2000s.
- **Inadequate Spillway Capacity:** Insufficient spillway capacity can cause dams to overflow during high inflow, leading to overtopping and potential failure. Example: The 2019 Tiware Dam breach in Maharashtra due to inadequate spillway capacity resulted in loss of life and property downstream.

Maintenance Negligence:

- **Siltation:** Lack of regular dredging and maintenance can lead to silt accumulation in reservoirs, reducing storage capacity and affecting dam safety. Example: The reduction in storage capacity of the Bhakra Dam in Himachal Pradesh due to siltation over the years.
- **Structural Deterioration:** Poor maintenance practices can lead to the deterioration of dam structures over time, increasing the risk of failure. Example: The aging Mullaperiyar Dam in Kerala/Tamil Nadu faces concerns regarding structural integrity and safety.

Human Activities:

- **Deforestation and Land Use Changes:** Alterations in land use patterns, such as deforestation or urbanization near dams, can impact watershed dynamics and increase flood risks. Example: Deforestation in catchment areas

contributing to increased sedimentation and flood risks for dams like the Tehri Dam in Uttarakhand.

- **Illegal Mining and Encroachments:** Unauthorized activities like illegal mining or encroachments near dam sites can weaken the stability of slopes and affect dam safety. Example: Encroachments near the Chembarambakkam Lake in Chennai, Tamil Nadu, impacting reservoir management and flood control.

Climate Change Impacts:

- **Increased Intensity of Extreme Events:** Climate change can exacerbate the frequency and intensity of extreme weather events such as floods and storms, putting additional stress on dam infrastructure.
- **Glacial Lake Outburst Floods (GLOFs):** Melting glaciers can lead to the formation of glacial lakes, and sudden outbursts due to damming by ice or moraine can pose risks to downstream areas.

Impact of Dam Failure

- **Loss of life and property:** Dam failures can result in loss of human lives, damage to infrastructure, homes, agricultural land, and livelihoods in downstream areas.
- **Environmental damage:** Floodwaters from failed dams can cause erosion, sedimentation, and contamination of water bodies, impacting aquatic ecosystems and biodiversity.
- **Disruption of services:** Failure of dams can disrupt water supply for irrigation, drinking water, industrial use, and hydroelectric power generation, affecting communities and industries.
- **Economic losses:** The cost of repairing or rebuilding damaged infrastructure, compensating affected populations, and restoring ecosystems can be substantial, impacting regional economies.

Adaptation and Mitigation:

- **Risk-Informed Decision Making:** Example: The Central Water Commission (CWC) in India conducts risk assessments for dams based on factors such as hydrological conditions, seismic hazards, structural integrity, and downstream population vulnerability. This information helps in prioritizing maintenance, upgrades, and emergency response planning.
- **Advanced Monitoring and Surveillance Systems:** Example: Many large dams in India are equipped with advanced monitoring and surveillance systems that continuously monitor parameters such as water levels, seepage rates, structural vibrations, and weather conditions. For instance, the Bhakra Dam in Himachal Pradesh uses remote sensing and real-time data analysis for early warning and decision-making during flood events.
- **Regular Inspections and Maintenance Programs:** Example: The Dam Safety Organization (DSO) in India conducts regular inspections of dams, including visual inspections, instrumentation checks, structural

assessments, and geotechnical investigations. For instance, the Tehri Dam in Uttarakhand undergoes comprehensive inspections and maintenance activities to ensure its safety and functionality.

- **Modernization and Retrofitting:** Example: Older dams in India are being modernized and retrofitted with improved spillways, floodgates, instrumentation systems, and structural reinforcements to enhance their resilience against extreme events. The Sardar Sarovar Dam on the Narmada River has undergone modernization efforts to strengthen its flood management capabilities.
- **Capacity Building and Training:** Example: The National Institute of Hydrology (NIH) and various state-level agencies conduct training programs, workshops, and seminars for dam operators, engineers, and stakeholders on dam safety practices, emergency response protocols, and risk management strategies.
- **Community Engagement and Awareness:** Example: Public awareness campaigns, community meetings, and stakeholder consultations are conducted to educate downstream populations about dam safety measures, evacuation plans, and early warning systems. For example, the Nagarjuna Sagar Dam authorities regularly engage with local communities to promote safety awareness and preparedness.
- **Integrated Emergency Response Plans:** Example: Dams in India have integrated emergency response plans that outline protocols for dam operation during emergencies, evacuation procedures, communication strategies, and coordination with disaster management agencies. The Hirakud Dam in Odisha has a well-developed emergency response plan that includes flood forecasting, dam release strategies, and evacuation drills.

Dam Safety Act 2021

- It provides for dam safety all across the country. DSA has created a regulatory and institutional framework at both the central and at state level.
- It lays down mandatory processes and procedures to be followed by the dam owners, state dam safety organisations (SDSOs) and National Dam Safety Authority (NDSA)
- SDSO is responsible for safe operation of all dams within its jurisdiction except the ones owned by central public sector undertakings or where a dam is an inter-state project. In such cases, the functions of SDSO shall be discharged by the NDSA.
- National Committee on Dam Safety (NCDS): It is the supreme body in the hierarchy of dam safety institutional framework, has been entrusted with specific functions enumerated in the schedule appended with the Act.
- This includes evolving dam safety policies and recommending necessary regulations as may be required. It is required to meet twice a year (once

before the monsoons) and can call in its meeting dam owners and experts as deemed appropriate for effective discharge of its functions.

- NDSA is responsible for implementation of the policies made by NCDS. It formulates regulations on various aspects of dam safety based on the NCDS' recommendations.

The Dam Rehabilitation and Improvement Project (DRIP)

- It is a program that aims to improve the safety and operational performance of existing dams, while also strengthening the dam safety institutional setup of participating states.

- The project was initiated in April 2012 with financial assistance from the World Bank and has three components:

- ✓ Rehabilitation and Improvement of dams and associated appurtenances: Focuses on structural and non-structural measures at 223 project dams, many of which are more than 25 years old
- ✓ Dam Safety Institutional Strengthening in participating States and CWC: Focuses on regulatory and technical frameworks for dam safety assurance
- ✓ Project Management: The Dam Safety Rehabilitation Directorate in the CDSO of CWC is responsible for project oversight and coordination

