



# Dams and Destruction

## Introduction

### ▪ About:

- A dam is a structure built across a river or stream to hold back water. Over the centuries dams have been built using different materials.
- Ancient dam builders used natural materials such as rocks or clay while today most dams are built using concrete.

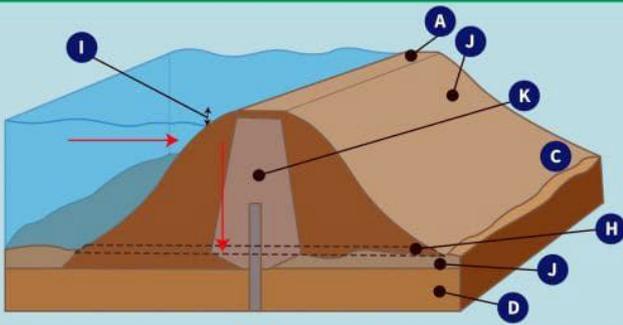
### ▪ Dams in India:

- India has 4,407 large dams, the third highest number in the world after China (23,841) and the USA (9,263).
  - **Tehri Dam** in Uttarakhand is the **highest dam in India** built on Bhagirathi river.
  - **Hirakud Dam** in Odisha built on river Mahanadi is the **longest dam of India**.
  - Kallanai Dam in Tamil Nadu is the **oldest dam of India**. It is built on the Kaveri river and is about 2000 years old.

### ▪ Significance of Dams:

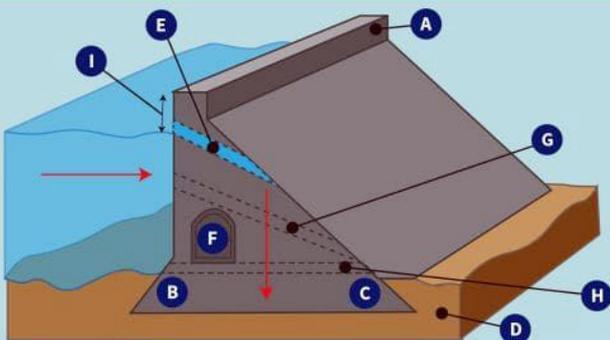
- **Source of Clean Energy:** Dams are the sources of clean power. Many countries have embraced dams as a way to reduce reliance on expensive fossil fuels.
- **Irrigation:** Dams and waterways store and provide water for irrigation so farmers can use the water for growing crops.
  - In areas where water and rain are not abundant (like the desert), irrigation canals from rivers and dams are used to carry water.
- **Prevent Flooding:** Dams, if planned well, help in preventing floods. They catch extra water so that it doesn't run wild downstream.
- **Source of Drinking Water:** Since the water stored in dams is freshwater, it can also be used as drinking water.

# TYPES OF DAMS



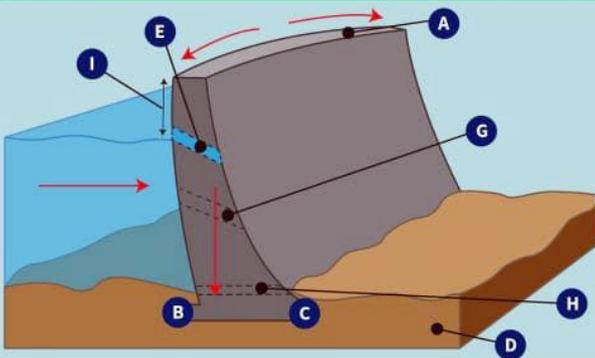
## EMBANKMENT

- Constructed from compacted soil ("earthfill") or rock ("rockfill") with an impervious core
- Designed to transfer the entire water load downward
- 80% of all large dams in the U.S. are embankment dams
- Used to retain water across wide river valleys or for flood control
- Typically shorter and wider than other types of dams



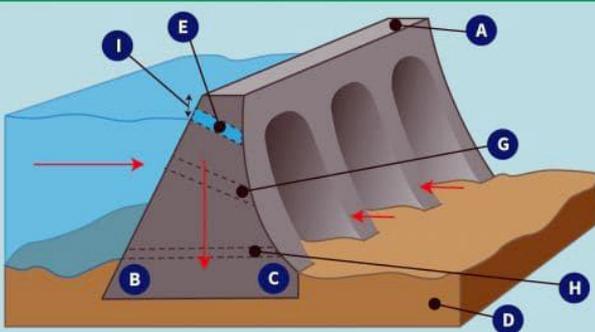
## GRAVITY

- Constructed of concrete or stone masonry
- Designed to transfer the entire water load downward
- Typically span narrow river valleys with bedrock abutments and foundations
- Retain water by utilizing the weight of the dam to resist the horizontal water load pushing against it
- Each section of the dam is independently stable



## ARCH

- Constructed of concrete
- Designed to transfer water loads to the adjacent rock formations
- Constructed only in canyons with solid rock walls that are able to resist the pressure of the dam
- Because the canyon walls bear the bulk of the load, arch dams are thinly constructed, requiring less material than other types of dams



## BUTTRESS

- Constructed of reinforced concrete
- Designed to transfer the water load both downward and to the buttresses
- Hollow gravity dams with a solid upstream face and a buttressed downstream side
- Buttresses are supports that transmit the water force to a bedrock foundation

**A Crest:** The top of the dam, in some cases used to provide a roadway or walkway over the dam

**B Heel:** The part of the dam in contact with ground on the upstream side

**C Toe:** The part of the dam in contact with the ground on the downstream side

**D Foundation:** Excavated surface or undisturbed material

**E Spillway:** Structure that provides for controlled conveyance of water flows downstream of the dam

**F Gallery:** Small room within large dams used to monitor the performance of the dam, with a drain on the floor for water seepage

**G Outlet:** Also called sluiceway, used to release water from the reservoir for water supply, irrigation, and hydro power

**H Blowoff:** Opening within the dam near the base to drain the reservoir

**I Freeboard:** Vertical distance between the spillway level and the crest of the dam

**J Pervious Material:** Substances that allow water to pass through

**K Impervious Material:** Substances that do not allow water to pass through

## Dams and Destruction

While dams can benefit the society in many ways, they are also one of the biggest menaces to river ecology, wildlife, aquatic habitat of fish and ultimately humans.

- **Affect the Aquatic Life:** Dams prevent fish migration and limit their ability to access spawning habitat, seek out food resources, and escape predation.
  - Aquatic organisms depend on steady flows to guide them while stagnant reservoir pools disorient migrating fish and can significantly increase the duration of their migration.
- **Dams block Rivers:** Dams and reservoirs are physical barriers to the flow of water bodies as they fragment them and reservoirs, which impact their seasonal flow.
  - They also change the way rivers function and trap sediment, burying rock riverbeds where fish spawn.
  - Gravel, logs, and other important food and habitat features can also become trapped behind dams. This negatively affects the creation and maintenance of more complex habitat downstream.
- **A Hazardous Infrastructure:** Large dams, even if structurally sound, are regarded as “high hazard” infrastructure because of the potential for a massive loss of human lives, livelihoods and destruction in the event of failure.
  - In the most recent [Uttarakhand flash floods](#), experts say the incident was induced by the effect of global warming on melting glaciers but the effect was worsened by construction of infrastructure (Hydroelectric Power Projects, HEPs).
    - HEPs which use large-scale blasting, tree felling and tunneling, most certainly added to the proportion of the impact. They became a force multiplier in the destruction.
  - The construction was against the recommendation of the Chopra Committee which submitted a detailed report warning that a glacial retreat in the state of Uttarakhand, coupled with structures built for hydroelectricity generation and dams, could lead to large-scale disasters downstream.
- **Reservoir Induced Seismicity:** There is a strong relation between the earthquakes and loading and unloading of water from the dam. The Koyna and Warna region is possibly the best example of **reservoir-induced-seismicity (RIS)**.
  - The Koyna and Warna reservoirs are responsible for the earthquakes in the south Maharashtra region which has experienced many earthquakes in five decades.
    - This series of earthquakes have occurred post the construction of dams in the region.
- **Displacement of People:** The land submergence and large scale displacement of people due to construction of large dams is one prevailing issue which is often overlooked by the authorities.
  - Construction of dams such as Hirakud, Bhakra Nangal and Tehri had displaced a number of families many of which were not rehabilitated at all.
    - Even after rehabilitation, lack of livelihood opportunities and poor living conditions are still observed.
  - [Sardar Sarovar dam](#), the largest structure on Narmada river, has displaced over 3 lakh families.
- **Older Dams are Greater Hazard:** [Older dams](#) pose greater safety risks, cost higher in terms of maintenance and have declining functionality due to sedimentation, stated
  - Globally, over 1,115 large dams will be about 50 years old by 2025.

- China, the US and India top the list of countries with a significant number of large dams.
  - China alone hosts 40% of the world's large dams (numbering 23,841), their average age being 45 years.
- India has 4,407 large dams of which more than 1,000 would be 50 years or older by 2025, a new study has shown.
  - India has 209 dams that are over 100-year-old, built when design practices and safety were far below current norms.
- **GreenHouse Gas Emissions:** Particularly in tropical regions, hydropower reservoirs emit significant amounts of greenhouse gases.
  - The water gathers behind the dam, creates an unnatural, stagnant lake that often kills off a lot of the existing ecosystem. Bacteria in the water decompose these plants and generate carbon dioxide and methane (potent greenhouse gas).
  - Methane from reservoirs accounts for more than 4% of all human-caused climate change comparable to the climate impact of the aviation sector.
  - In some cases, hydropower projects are producing higher emissions than coal-fired power generating the same amount of electricity plants.

### The Chopra committee

- The committee was appointed by the Ministry of Environment and Forests (now Ministry of Environment and Forests and Climate Change, MoEFCC) in October 2013, following the **Supreme Court's suo motto order** of August 13 2013.
  - The committee suggested that no hydroelectric power projects (HEPs) should be built in the paraglacial region as it has loose glacial debris which when carried downstream can be disastrous.
  - It also raised objections to the construction of HEPs in regions 2200-2500 metres above the sea level.

### Way Forward

- **Preferring Viable Alternatives:** Prioritizing **solar** and **wind** projects are viable and sustainable alternatives to hydroelectric power projects.
  - However, improving dam operations and finding more suitable locations for such infrastructure should also be part of the solution.
  - India should instead focus on technologies such as pumped storage, batteries and hydrogen for balancing the grid, Mishra said. As these technologies become economically viable, it will further weaken the case for large dams.
- **Timely Inspection of Dams:** It is evident that instead of focusing on building new dams, there is a need to look at the underperformance of existing projects.
  - India must conduct a cost-benefit analysis of its ageing dams, and conduct timely safety reviews in order to ensure their operational and ecological safety, as well as the safety of those who inhabit the areas downstream.
  - Fifty years is not a defining age for all dams because the design life also depends on factors such as construction and maintenance.
    - A well constructed and well-maintained dam can go up to 100 years.
    - However, 50 years is roughly the age when a dam may begin to show signs of ageing.
    - In some cases, dam components such as gates and motors may need to be replaced after 30 years to 50 years.
- **Steps Recommended by WCD:** The World Commission on Dams (WCD) lists seven steps as a remedy to issues arising from dams. These include:
  - Gaining wide public acceptance for construction of any dam.

- Exploration of alternatives to dams.
- Optimal usage of existing structures.
- Protection and restoration of ecosystems at river basin level.
- Recognising entitlements of the affected people.
- Compliance with applicable regulations.
- Regional cooperation on trans-boundary rivers.

### World Commission on Dams (WCD)

- The WCD is a global multi-stakeholder body established by the [World Bank](#) and [International Union for Conservation of Nature \(IUCN\)](#) in 1998 to investigate the effectiveness and performance of large dams around the world.
- The WCD released its landmark report in November 2000 on the enormous financial, environmental and human costs and the dismal performance of large dams.
  - It found that while the construction of large dams had brought some economic benefits, they had also forcibly displaced an estimated 40-80 million people in the 20th century alone.
    - These people lost their lands and homes to dams and often with no compensation.

### The Case of Mullaperiyar Dam

- **About:** The [Mullaperiyar dam](#), a **gravity dam** in Kerala is a **126-year-old** barrage that has dangerously outlived its 50 years of life.
  - The dam is located in the **Western Ghats**, adjacent to the [Periyar wildlife sanctuary](#), built during the British colonial period.
    - A gravity dam is one which is designed to withstand water by its own weight and resistance.
    - The weight and width of the base prevent the dam from overturning when subjected to the force of impounded water.
  - The dam is considered hazardous, not only because of its age but also for its location in an acknowledged seismic zone (zone-III).
- **Decommission of the Dam:** The government of Kerala carried out hydrological review studies between 2006 and 2011 that concluded that the Mullaperiyar Dam is unsafe for passing the estimated probable maximum flood limit.
  - Both IIT-Roorkee and IIT-Delhi have deemed the dam to be fit to be decommissioned.
    - However, decommissioning Mullaperiyar is strongly opposed by Tamil Nadu state, which inherited a lease agreement between the former princely state of Travancore (now Kerala) and the British government.
    - The lease allows Tamil Nadu to operate the dam and divert 640 million cubic metres of water annually for irrigation and power generation through a tunnel bored into the Western Ghat mountains that form a wall between the two states.