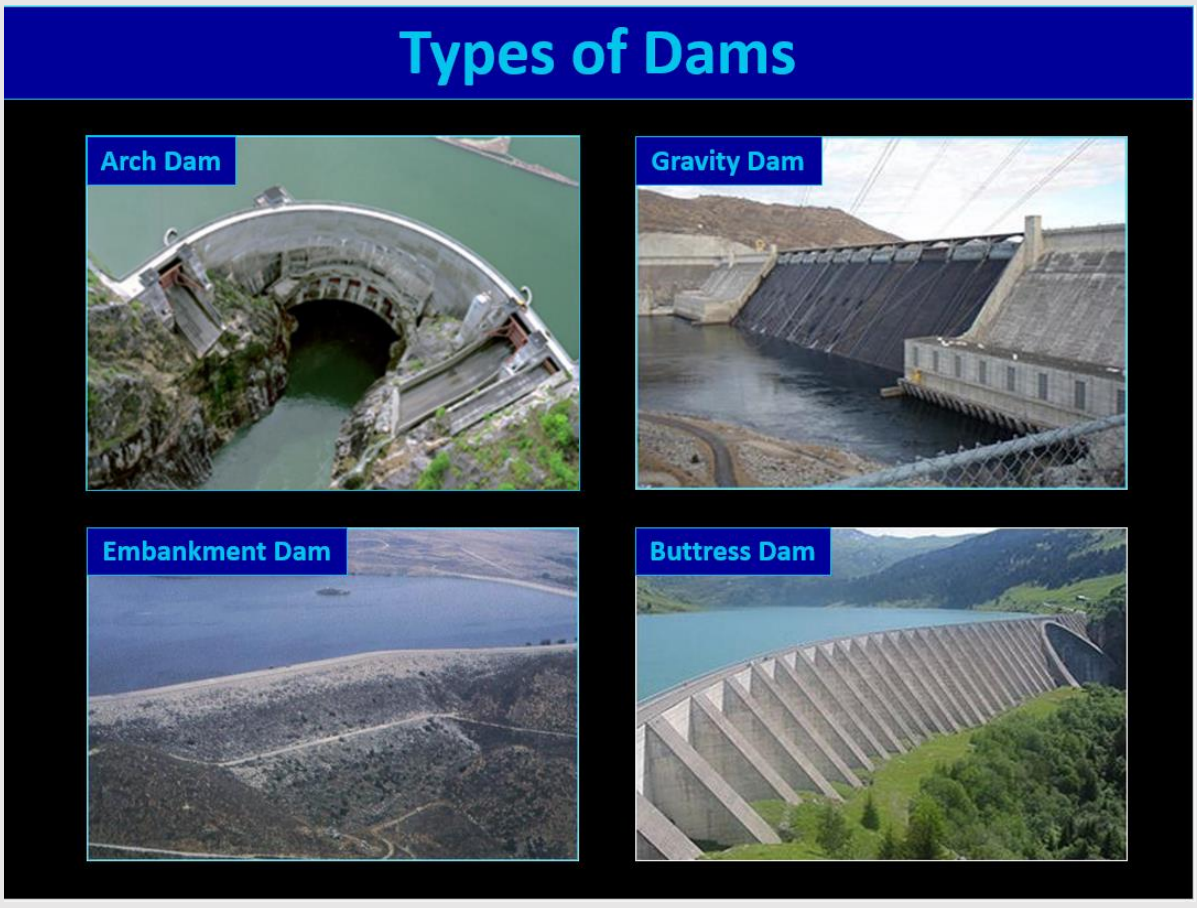
DAMS AND RESERVOIRS: THE ISSUES

WHY ARE DAMS BUILT?

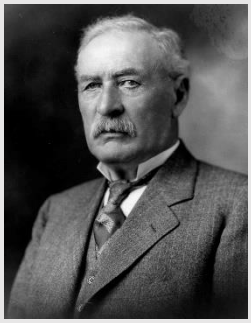
Learn all of these reasons but maybe only chose 2 or 3 of the specific case studies to learn

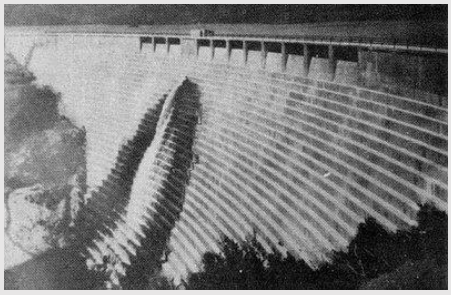
- To create a lake for recreational purposes (fishing, sailing, canoeing and windsurfing).
  An example is the Stithians Dam in Cornwall .
- For industrial and domestic water supplies.
  An example is the Hoover Dam and Lake Mead that supplies Las Vegas with water in the Nevada Desert.
- For irrigation water to be used in agriculture.
  An example is the Grand Coulee Dam, Washington State, USA.
- For the generation of hydroelectric power (HEP).
  An example is the Three Gorges Dam, Hubei Province China.
- To improve navigation/increase ability to transport down water ways
  An example is the Three Gorges dam, China. This has improved navigation on the Yangetze River and large ocean going vessels can now reach further inland.
- For river regulation and flood control.
  An example is the Aswan Dam on the River Nile in Egypt. This prevents annual flooding.
- To store waste from mining.
  An example is the* Tailings *Dam at Fort Knox Gold Mine, Alaska



Case study –St Francis dam

- 59m high dam
- Built in **San Francisquito Canyon** to supply the rapidly expanding **Las Angeles City**
- Little notice was taken of the underlying Geology; it was built on multiple faults, **sandstone** and **conglomerate** in the **West** but **mica schist in the east**. The **2m fault zone** separated these two rock types.
- During the construction phase, several cracks appear in the dam and begun to leak as the reservoir was filled.
- William Mulholland, the engineer responsible for the construction, **dismissed the cracks as minor** and normal for a concrete dam of that size.
- Less than 12 hours after this conclusion, the **dam failed catastrophically**, carrying huge pieces of concrete downstream and **destroying everything in its path** and **claiming the lives** of more than 600 people.





- **The point of failure of the dam was found to be at the contact between the two different rock types.**

Overall the St. Francis Dam had:

- Not followed its original design; with the height being slightly increased.
- Been built in a cheap way that led to poor construction.
- Been constructed on unsuitable Geology.

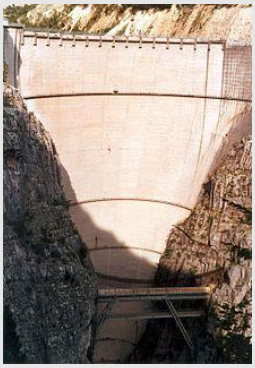
Case study –The Vaiont Dam disaster, Italy, 1963

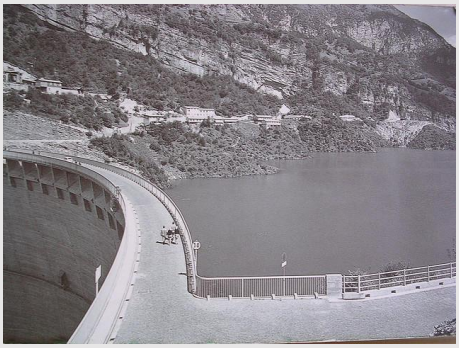
- One of the tallest dams in the world - 262m high and completed in 1961
- October 1963, there was a period of prolonged rainfall.
- Rainwater percolated through the permeable limestone on the valley sides and collected on top of the impermeable clay layers.
- A slip plane developed between the limestone and clay and a huge mass of some 260 million m^3 of limestone slid down the Southern Valley side into the reservoir.
- While the dam was strong enough to withstand the landslide's force, large volumes of water were displaced as the reservoir filled with rock material. A huge wave passed over the dam creating a flood.
- The flood killed more than 2000 people.

The Vaiont dam is still standing today but is disused. It is a good testament to high quality engineering accompanied by a poor choice of site.

From an engineering point of view, the narrow, deep Vaiont River valley in northern Italy seemed like an excellent site for a dam and reservoir. Unfortunately the following geological warning signs were ignored:

1. The **weakness of the interbedded limestone and clay** that **dipped toward the reservoir** (at least on the Southern side of the valley).
2. The **scar of an ancient landslide** on the valley side above the reservoir.
3. A **small landslide** that occurred in 1960 **while the reservoir was filling**.





DAMS, RESERVOIRS AND SEISMIC ACTIVITY

- There is a well-known link between the building of dams and reservoirs and an **increase in seismic activity**. The **high weight loa**d of the contained water may cause the **crustal layers to adjust, causing seismic activity**.
- Moreover, **infiltrating water increases** the **pore fluid pressure** in rocks so they become **saturated and more liable to fail.**
- Finally, **water acts as a lubricant**, making fault planes **more likely to slip.**

WHY DO DAMS FAIL?

There are usually many reasons why a dam can fail, and commonly it is due to a combination of them:

- Poor choice of site
- Poor design, construction or maintenance
- Extreme weather conditions

ENVIRONMENTAL AND SOCIAL CONSEQUENCES OF DAM AND RESERVOIR CONSTRUCTION

Dams and reservoirs are built with social considerations in mind. They provide a water supply can be sued to generate hydroelectric power and provide supply water for irrigation of agriculture. Unfortunately, dams and reservoirs have negative environmental impacts:

1. Flooding of the land to create space for a reservoir.

   - The **drowning of villages** and people having to **relocate elsewhere** (especially if the reservoir overflows or the dam fails).The **splitting up of communities** is likely.
   - **Valuable agricultural sites** may also be lost.
   - Where **forests are flooded**, the **decaying vegetation** releases large quantities of **carbon dioxide and methane,** both potent **greenhouse gases**.

2. **Silting o**f the reservoir. Over time the reservoir will **gradually silt up as** sediment is carried into it from upstream. Water released from the dam spillways contain very little sediment as it is t**rapped in the reservoir. Large quantities of silt reduce the volume to store water and much a higher load weight on the dam.**

3. **Risk of downstream flooding. Water engineers** are responsible for **calculati**ng **how much water need be released** from the reservoirs in order to **prevent them overflowing**. However, **unexpected weather** events – like melting snow during **the Spring thaw** or prolonged rainfall – may mean there is **not enough time to draw down the reservoir before it overflows.**

4. **Damage to aquatic ecosystems.**
   Changes in water depth, temperature, dissolved oxygen content downstream of the dam, etc.
   In addition, dams may **prevent fish** such as **Salmon from swimming upstream** to their **breeding grounds**. The dam may even cause ecological **problems beyond the river mouth.**

   For example, After the Aswan Dam was built on the River Nile, Egypt, the Mediterranean sardine fisheries collapsed due to the **lack of nutrients being carried downstream.**

5. Water released from the dam spillways has a **higher potential energy** / velocity and can increase the **scouring of material downstream**. On the reservoir side, **valley protection** may need to be ensured to **prevent bank erosion** and landslips.

Damage to aquatic ecosystems
Changes in water depth, temperature and dissolved oxygen downstream of the dams

Reservoirs need regular dredging

CASE STUDY – BRITISH ISLES FLOODING

Widespread flooding of the **British Isles during the summer of 2007** – the **wettest summer since records** began – was flooded.

The floods affected thousands of businesses, tens of thousands of homes, with an estimated cost of £2 billion.

At the end of June, **Cracks appeared in the Ulley dam**, near Rotherham, leading to **fear it might collapse**. As a safety precaution, **700 people were evacuated** and the M1 motorway closed between junctions 32 and 36. The emergency services were drafted in to **pump millions of gallons of water from the reservoir**. **Fortunately, the dam held and the disaster averted.**

Many embankment dams just like this are from the Victorian age and are **now well over 100 years old.**

CASE STUDY – HOOVER DAM

Built in 1963 on the **Colorado River**, on the border between **Arizona and the Nevada desert**.

Nearly 600 earthquakes were recorded in the **10 years following** the completion of the arch dam. Most were minor tremors but one was a magnitude 5 on the Richter scale.

The cause of the earthquake was attributed to an **increase in load due to the water behind Lake Mead,** the reservoir behind the dam. The water also **lubricated and reactivated old underlying faults.**