3rd Nordic Dam Safety Seminar October 14th – 15th

Current Nordic Issues and
Dam Monitoring and Surveillance

The Dam Safety and Climate Change

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Tragedy in Derna: Lessons from the Catastrophic Dam Failure in Libya (2023)

The recent dam failure in Libya occurred in the **city of Derna** due to the catastrophic **failures of two dams** on the night of 10–11 September 2023 following **Storm Daniel**. This event led to the release of an estimated **30 million cubic meters** of water, causing significant flooding downstream as the Wadi Derna overflowed its banks. The disaster was part of a larger crisis induced **by Storm Daniel**, which brought unprecedented rainfall and flooding to the region.

https://en.wikipedia.org/wiki/Derna_dam_collapses

The flooding caused by the dam collapse has led to a significant number of casualties, with estimates ranging from 5,300 to 20,000 people

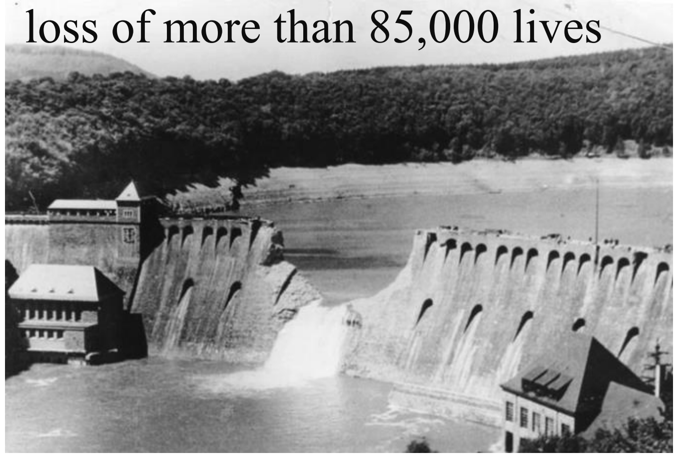
Image: https://www.bbc.com/news/world-africa-66799518

Dam failure

Dam failures are catastrophic events that can lead to significant loss of life, environmental destruction, and economic damage. These failures occur when a dam collapses or is breached, resulting in the uncontrolled release of the water it contains.

1. **Natural Disasters:** e.g., heavy rainfall, floods, earthquakes, or landslides …
2. **Design Flaws:** Inadequate design that fails e.g., underestimates water load and pressure can lead to failure.
3. **Construction Defects:** Poor construction practices, use of substandard materials,
4. **Lack of Maintenance:** Deterioration of the dam structure due to ageing, neglect of regular maintenance
5. **Operational Mistake:** improper handling of spillway gates,

1975 Banqiao Dam failure in China

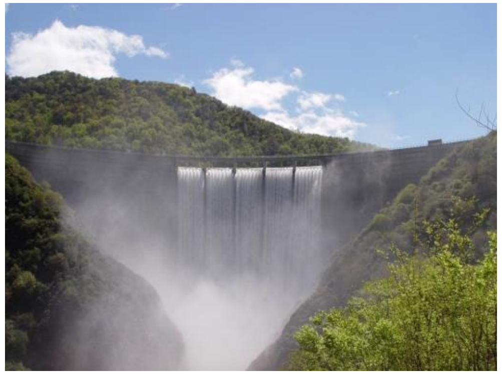


2023 Derna Dam Failure in Libya

2020 Sardoba Dam Failure, Uzbekistan

Overview

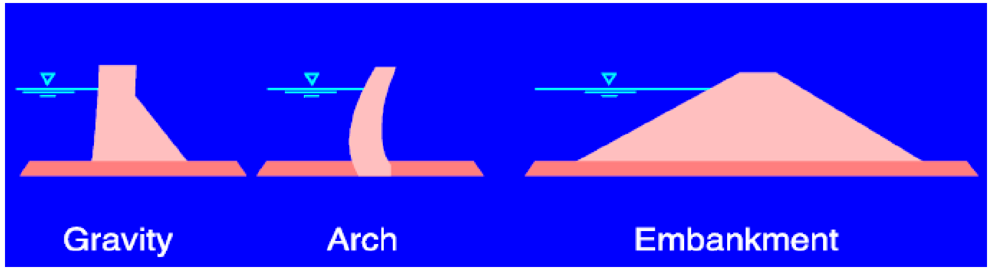
- Importance of Dams
- Dam failure mechaniem
- Dam safety
- Dam safety in the context of Climate change
- New Dam safety ratio
- Spatio-temporal change in dam safety
- Role of FB in the temporal dam safety
- Possible Solution





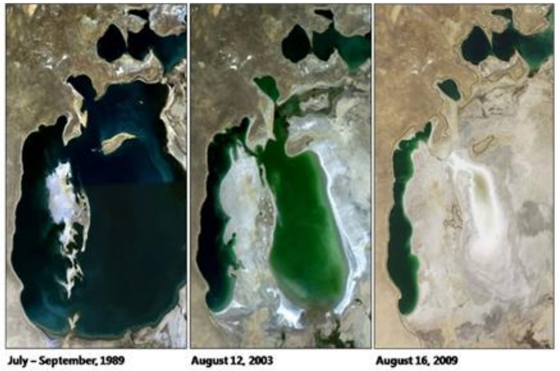

The Dual Faces of Dams: Weighing the Benefits Against the Drawbacks

A dam is a structure built across a river or stream to control water flow.



- Water supply
- Irrigation
- Renewable Energy
- Flood control
- Recreation
- Political
- Navigation
- and…..

- Altered river ecosystem
- Disappearing the lake
- Drying wetlands
- Sedimentation
- Dust storm
- Degrading water quality
- and …

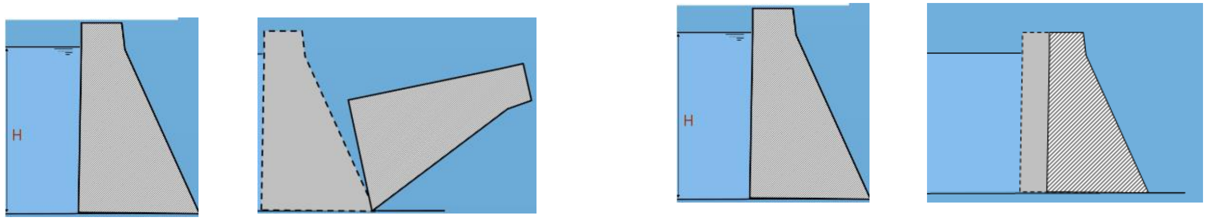


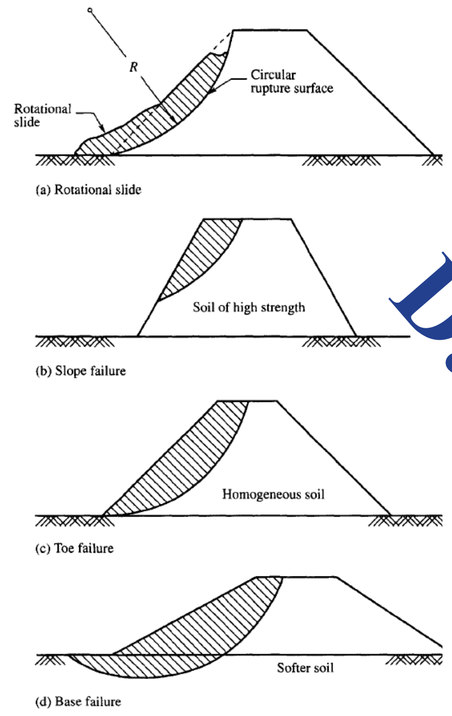
Dam failure

Mechanisms of Dam Failure

- **In earth dam (embankment) dam,** Overtopping, Sliding, Structural Failure, Foundation Failure, Piping and ….

- **In Gravity dams,** sliding and Turning …..





Dam safety

Around 7:00 am on June 5, 1976, a leak about 30 m from the top of Teton Dam was observed.

The Dam Broke at 11:59 AM

Dam safety

Dam safety refers to the comprehensive measures, practices, and technologies that ensure dam facilities' structural integrity and reliable operation. It involves regular inspections, maintenance, and upgrades to prevent failure and protect lives, property, and the environment downstream.

Dam safety encompasses

- ✓ design,
- ✓ construction,
- ✓ operation,

stages

By adopting a multifaceted strategy that combines engineering excellence, technology, community involvement, and regulatory adherence, we can significantly mitigate the risks associated with dam operations and ensure the safety of both people and the environment.

Dam safety process

Short-term: hourly, daily, weekly, monthly

Long-term: Annually, quinquennial, ….

Sensors

Piezometers
Inclinometers
Extensometers
Thermistors
…..

Checklist

Parameters

Earth dams: pore water pressure, seepage, settlement and sliding and …
Concrete dams: uplift, joint movement, and Concrete temperature and …

Short term

Monitoring Inspection

Insitu value

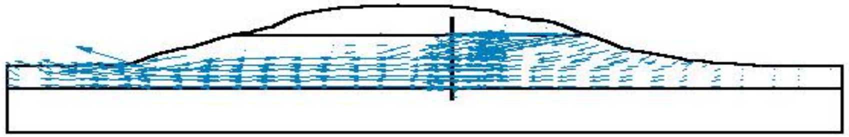
Compared

Business as usual

Rehabilitation

Design report
Model
Experiences
AI
……

Expected value



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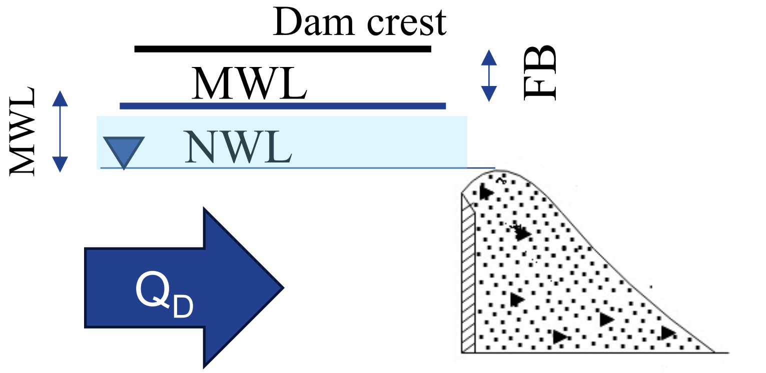
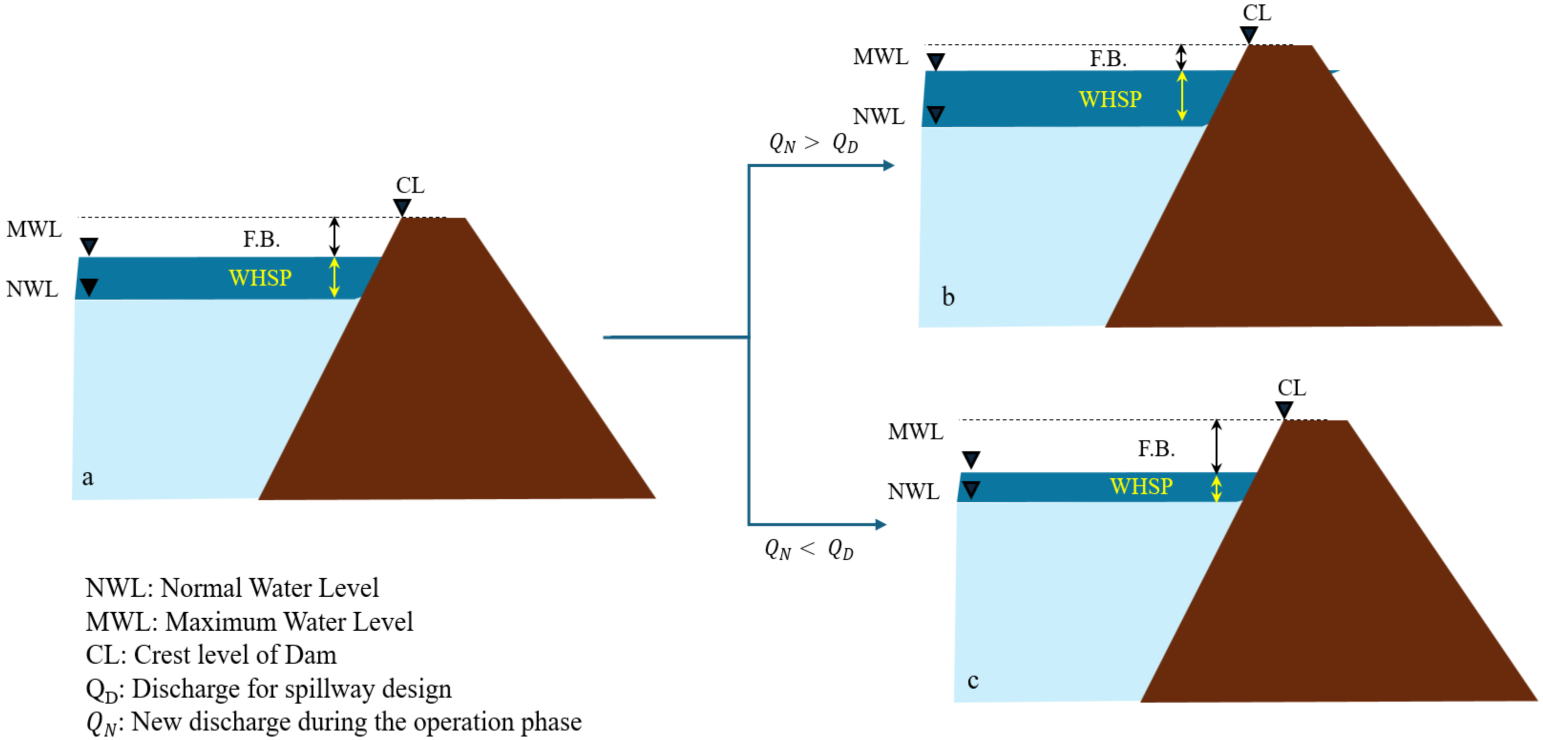
Dam Safety and climate change

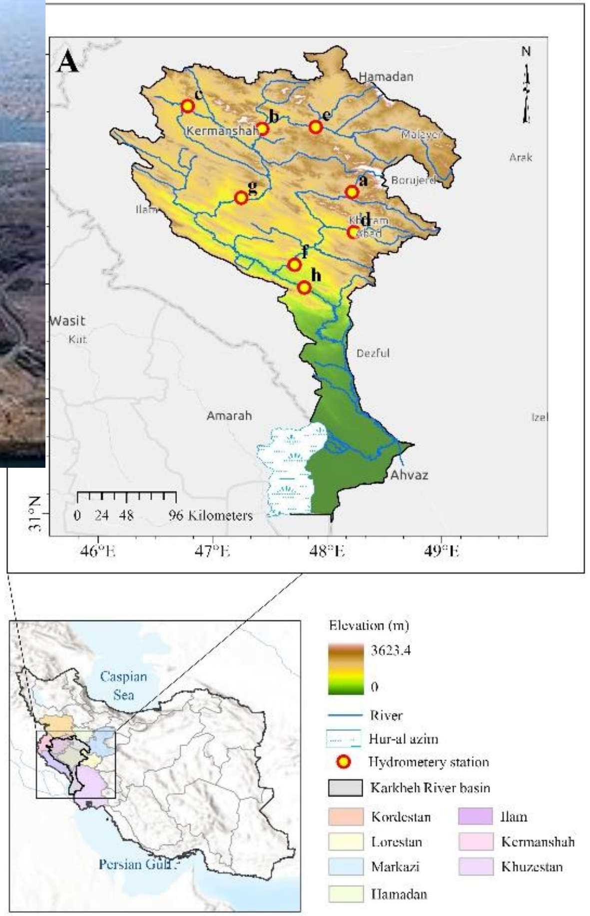


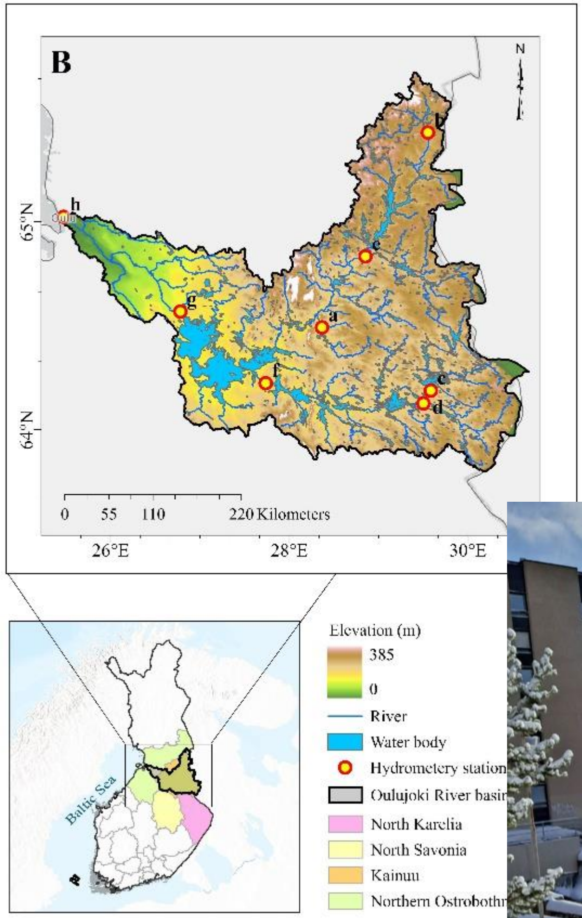
$$DSR = {\left(WHSP_{New} - WHSP_{Design}\right)}\Big/{FB}$$



i) Safe (DSR ≤ 0): The dam is stable and safe without immediate concerns;
ii) Caution (0 < DSR ≤ 0.33): The dam is stable, but close monitoring is recommended
iii) Alert (0.33 < DSR ≤ 0.66): The dam shows increasing risk.
iv) Critical (0.66 < DSR ≤ 1): The dam is in a critical condition with a high risk of overtopping.
v) If the DSR is greater than 1, the dam is at risk of overtopping, posing a significant risk of failure. Urgent operational changes and comprehensive rehabilitation measures are necessary to restore the dam's safety

Karkhe River, Iran Vs Oulujoki, Finland





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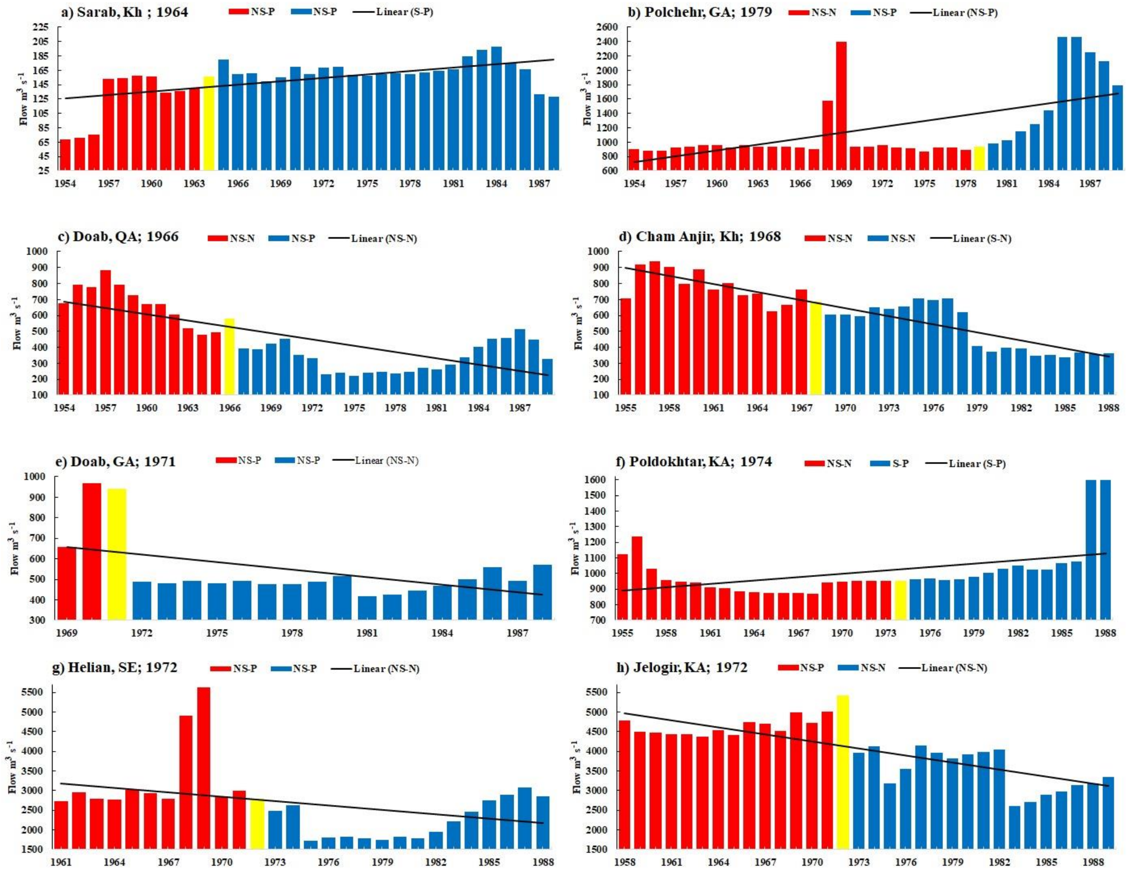
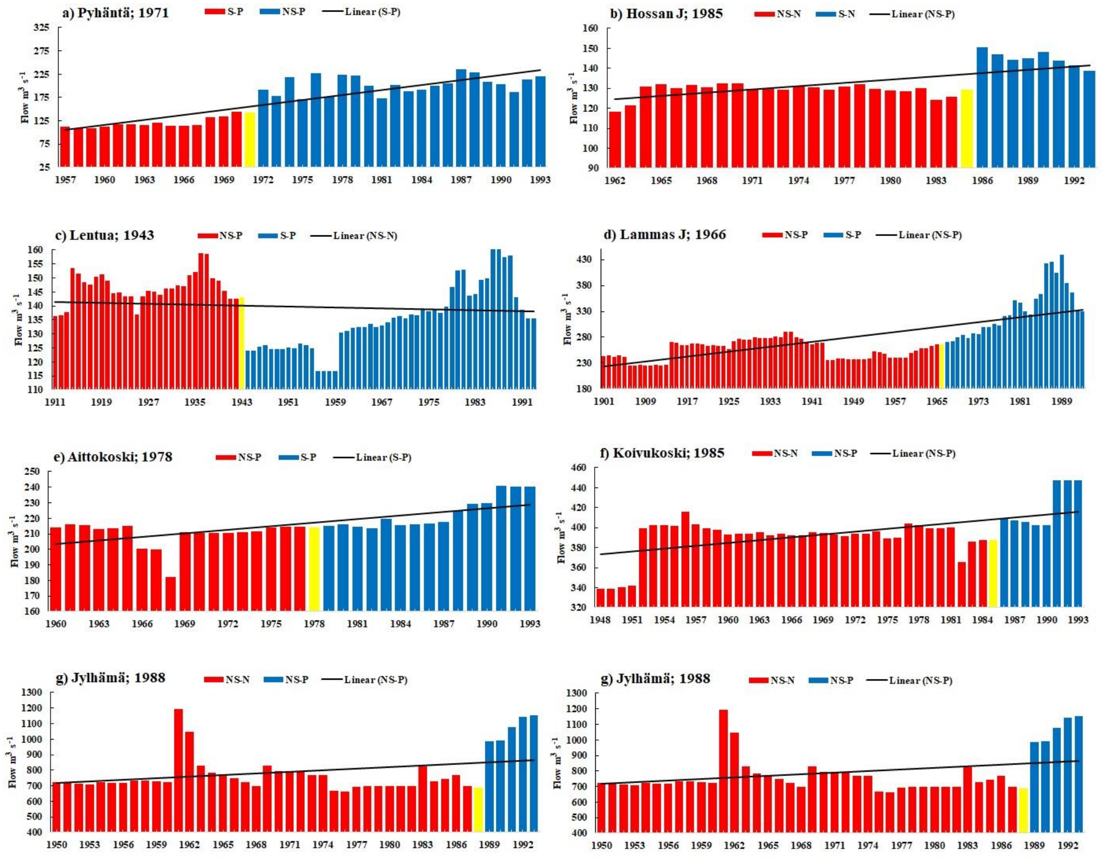
Spatio-temporal variation of 100 years flood

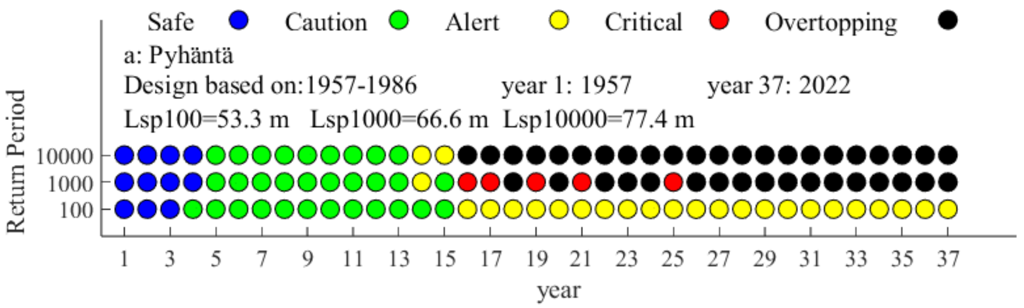
Karkheh Basin



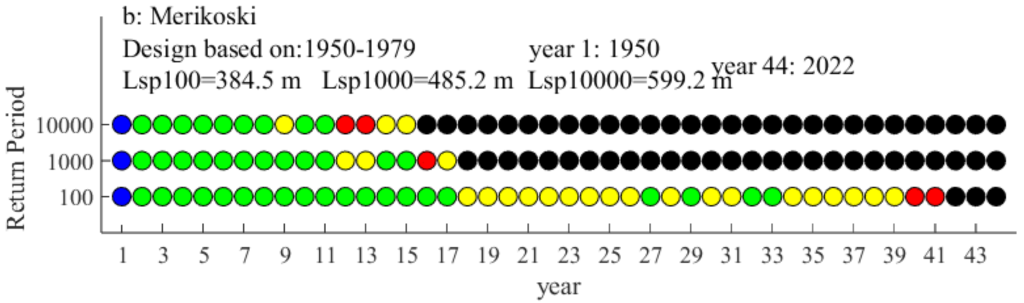
Oulujoki basin



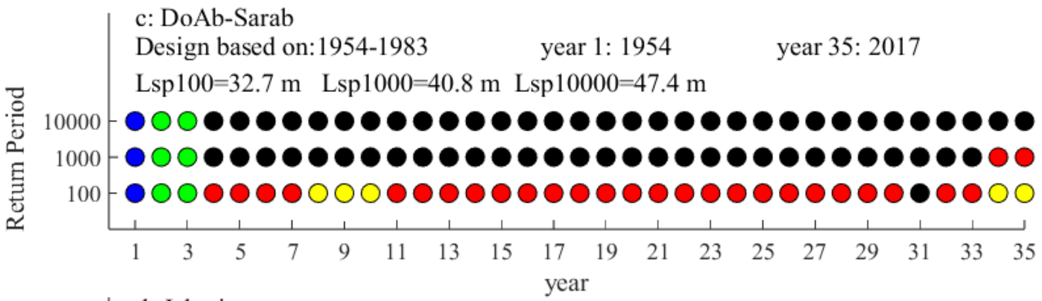
Pyhäntä
735 km²



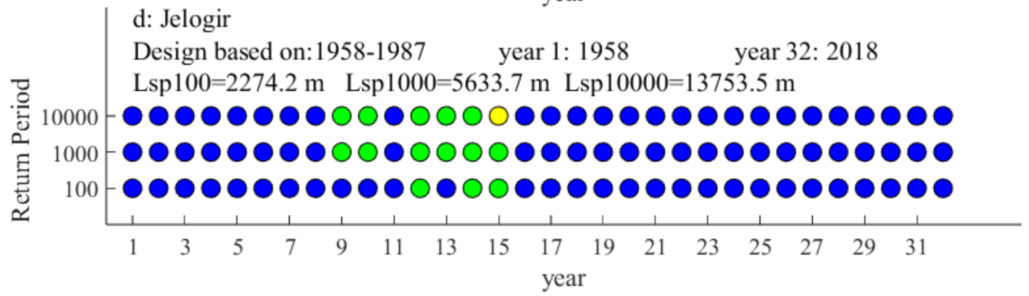
Merikoski
22841 km²

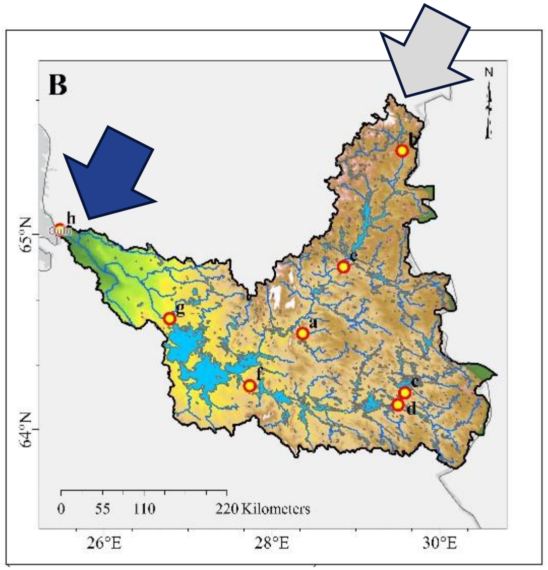


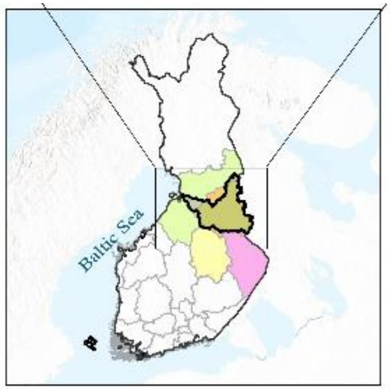
Sarab
776 km²

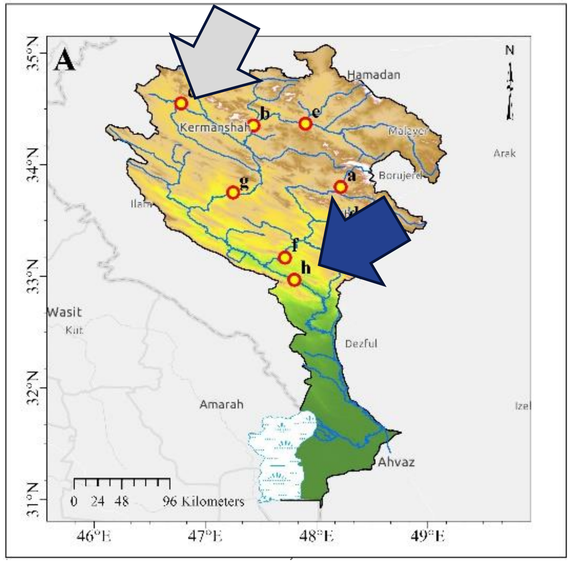


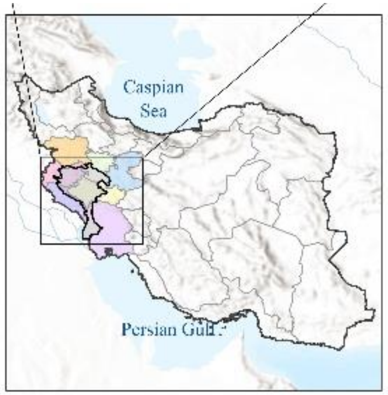
Jelogir
39380 km²









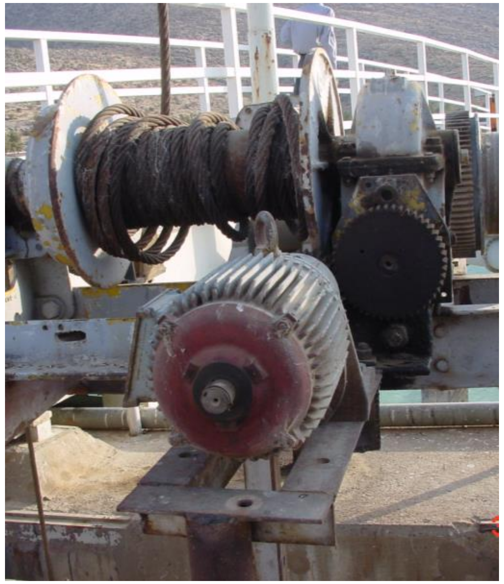


Increasing the length of the Spillway

Modifications from linear spillways, like ogee spillways, to more efficient nonlinear designs, such as labyrinth or piano key weirs,

Strategies for Dam Safety and Preventing Dam Failure

- ✓ Regular Inspections
- ✓ Monitoring Vs expected value
- ✓ Maintenance and Repairs
- ✓ Emergency Preparedness Plans
- ✓ Community Awareness
- ✓ Update Environmental and Hydrological Studies
- ✓ International Standards, Experiences and Best Practices




Thank you for your attention!