



Operational safety of dams and reservoirs

OUTLINE

- 1. Concept
- 2. Systems
- 3. Simulation
- 4. Mattagami
- 5. Path forward





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Operational safety of dams and reservoirs

Sponsors (alphabetically)

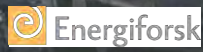
- BC Hydro
- Ontario Power Generation
- US Army Corps of Engineers
- Vattenfall

Project Manager

Mona Bechai, Mobec Engineering

Working group (alphabetically)

- Romanas Ascila, Vattenfall
- Gregory Baecher, University of Maryland
- Des Hartford, BC Hydro
- Bob Patev, USACE
- Karl Rytters, Sekond AP
- Andy Zielinski, OPG





ARGO DAM

Looking back on Argo Dam from down stream where someone Thomas Wilson looked

JUL 7 1981

Gate at Argo Dam open to 3 feet, as the position it was in during the malfunction Saturday

Ruf Abbott, director of City of Ann Arbor utility department, checks the computer operated control box at Argo Dam which malfunctioned to sound Saturday's incident

Argo Dam accident blamed on two malfunctions

By Doug Fisher

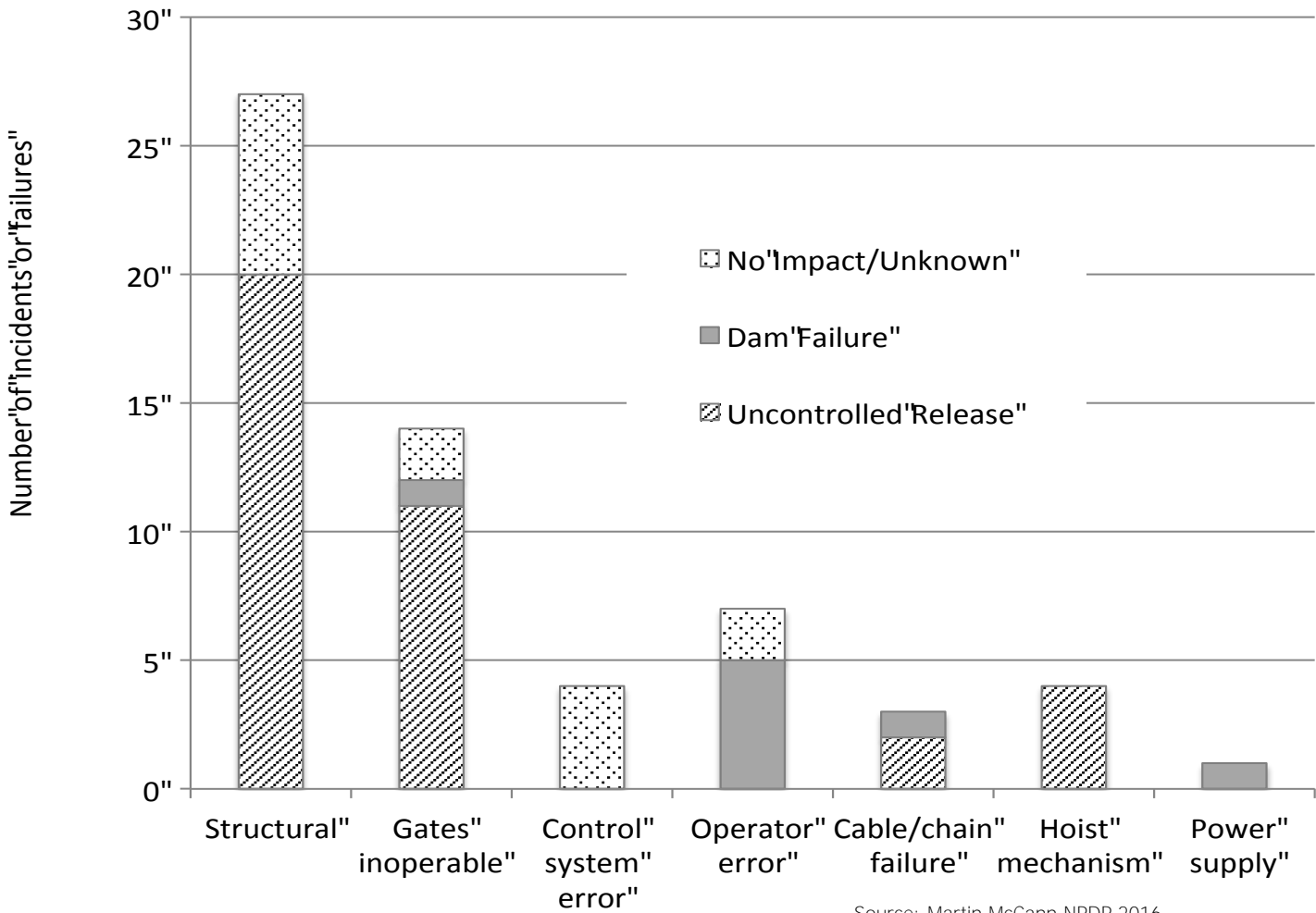
The catastrophe caused by a malfunction of the gate of the dam which in normal or other waters, then creating an opening which the water slipped through. The gate had fallen off the dam or slid a foot, and either drove that opening down through the gate or back there against the dam.



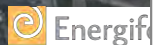
Concept

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Source: Martin McCann NPDP 2016



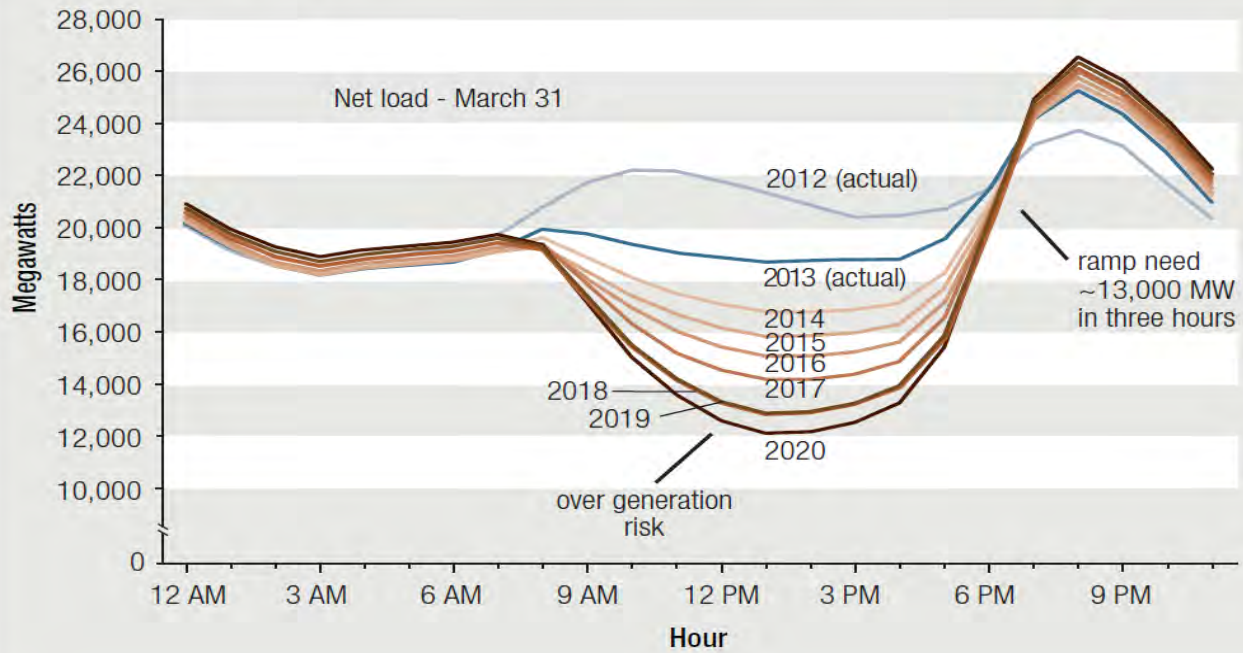
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FIG. 1 CALIFORNIA'S DUCK CURVE

Trends in resource development are leading toward a growing need for flexible generating capacity starting in 2015.



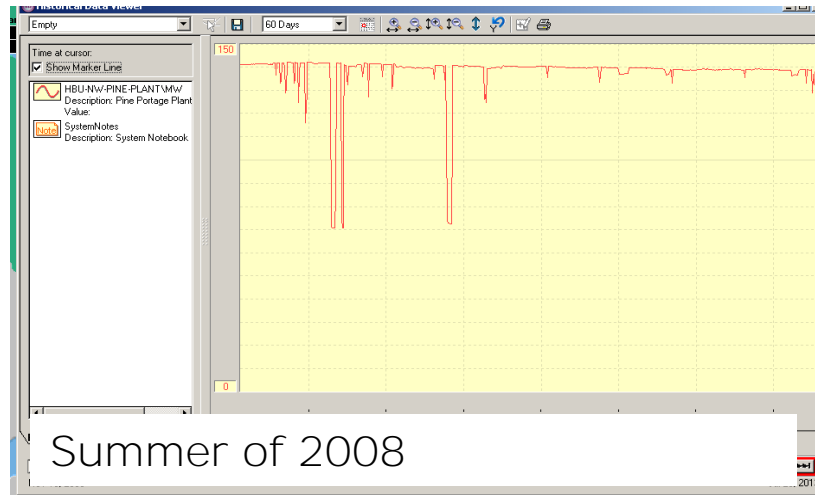
Source: California ISO



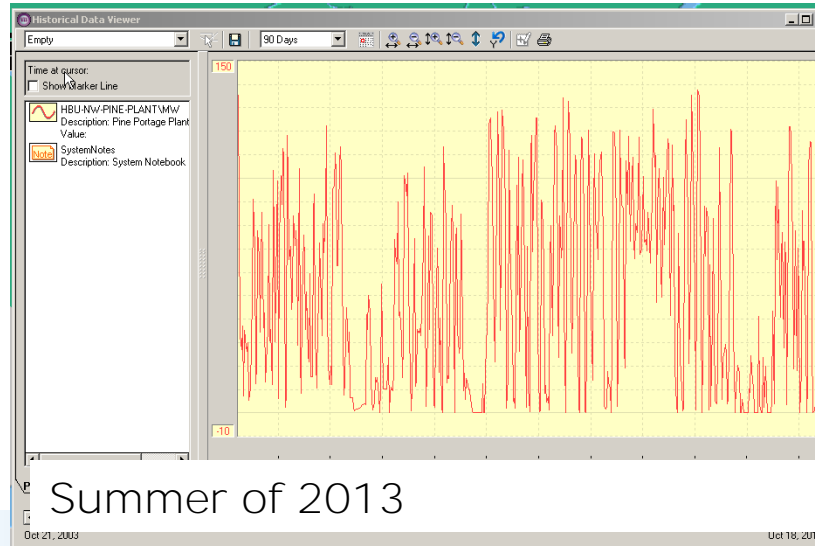
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Summer of 2008

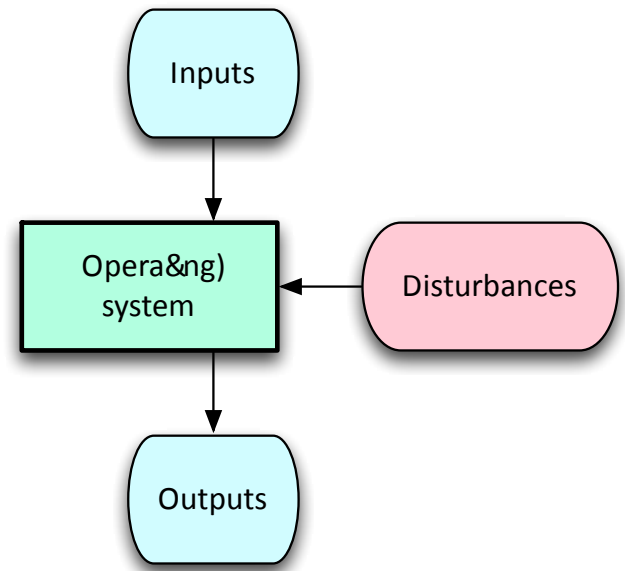
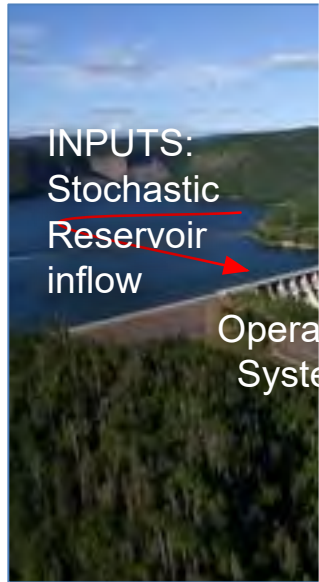


Summer of 2013

Identical flow conditions in 2008 and 2013, but entirely different generation profile in response to market pricing.

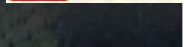
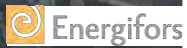
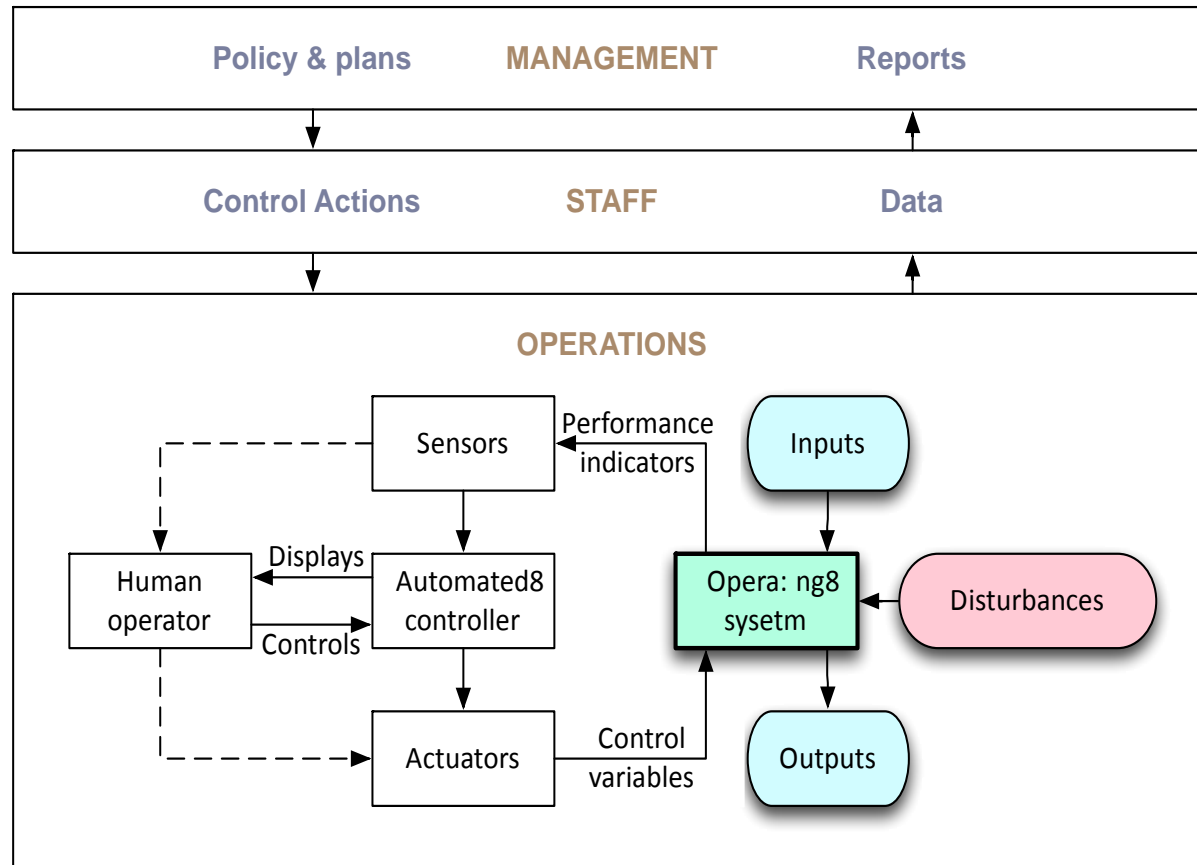
Source: Tony Bennett OPG





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Concept

Operational determinants of incidents and failures

Incidents and failures are not usually caused by extreme events
Operational issues are more often to blame

Systems issues of dam safety

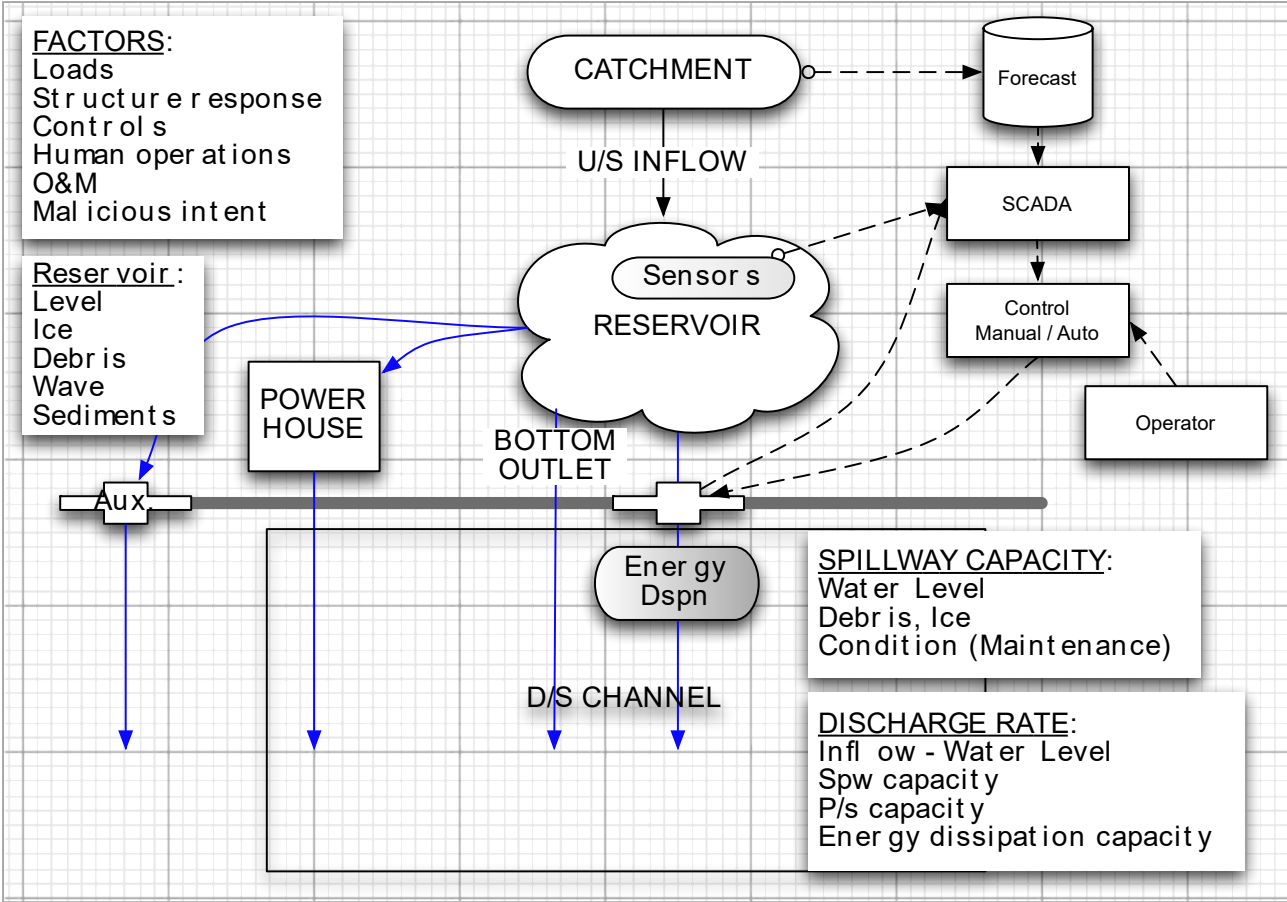
Who else is going this way?

- Chemical industry
- Civil and military aviation
- Coastal storm protection
- Nuclear power
- Offshore oil & gas



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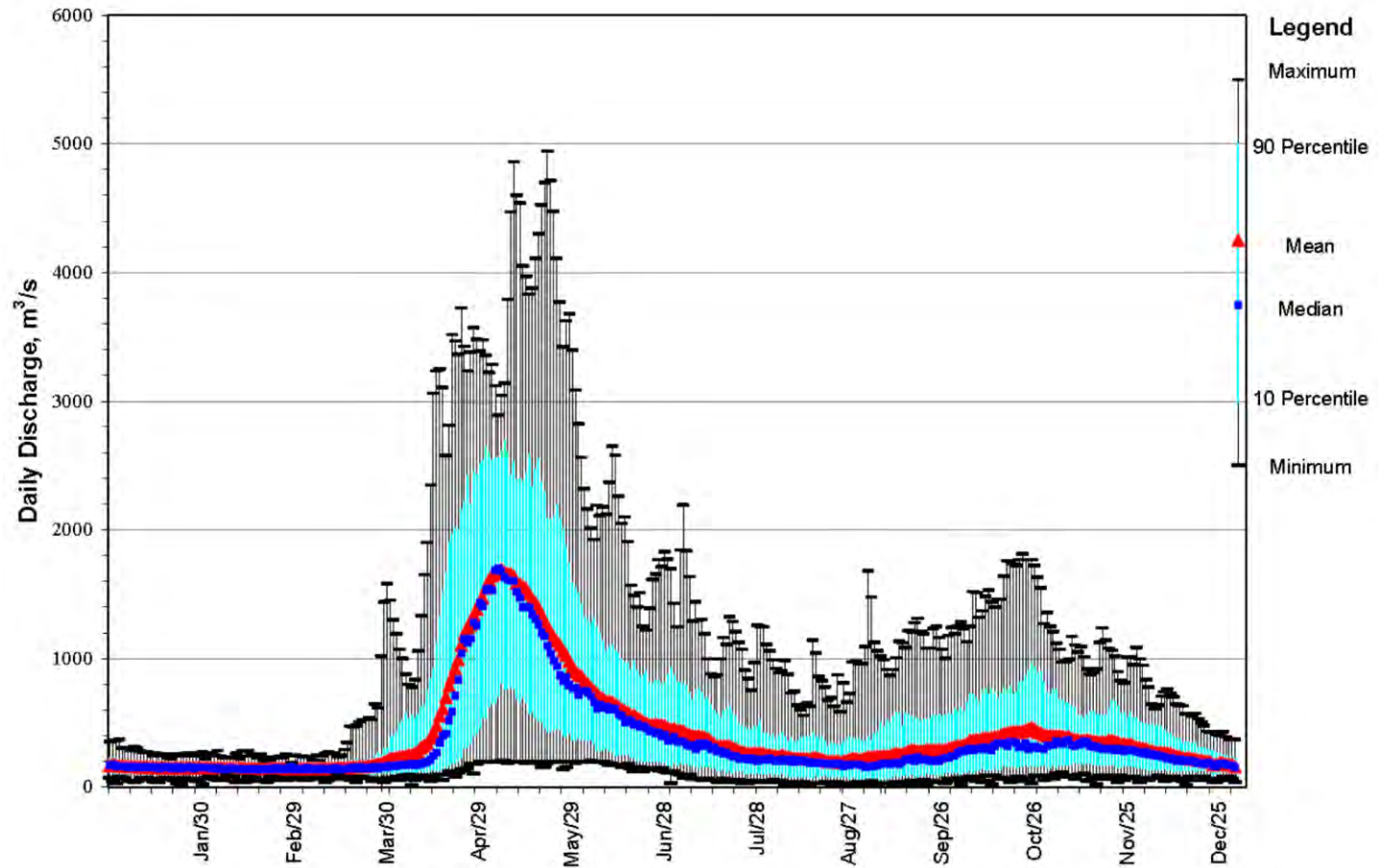
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Systems

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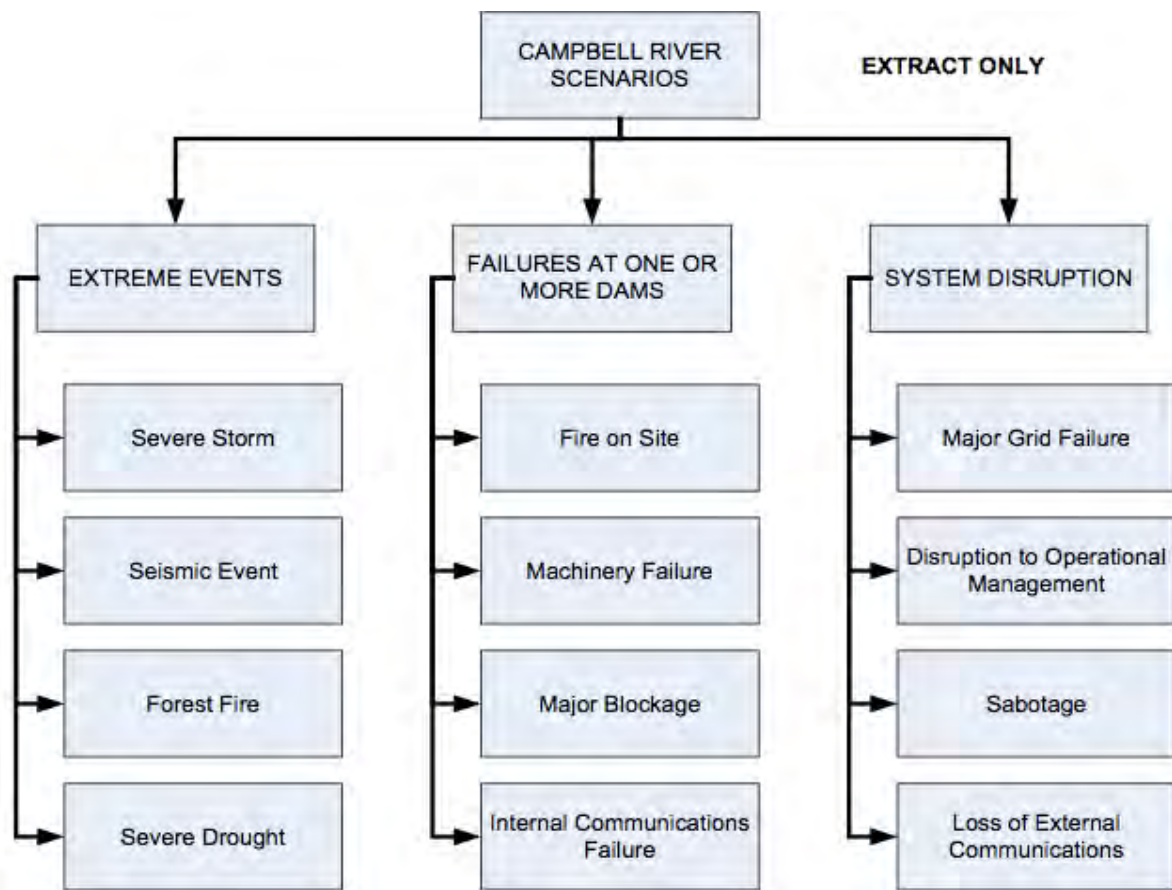


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Systems

Dam safety considerations in the Campbell River system



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Systems

Gate (un-)reliability
Dehli Dam, USA, 2010

- Embankment dam with concrete cutoff wall
- 3 (25 ft x 20 ft) vertical lift gates (maintenance problems)
- Only two gates could be opened



Systems

Humans in the loop

External:

- Situational Characteristics (e.g., Quality of the Work Environment)
- Task and Equipment Characteristics (e.g., Continuous, Dynamic, Step by Step Sequential, static)
- Job and Task Instructions (e.g., Operating Procedures)

Internal:

- Psychological Stressors (e.g., Task Load)
- Physiological Stressor (e.g., Fatigue)
- Organizational Factors (e.g., Previous Training/Experience)

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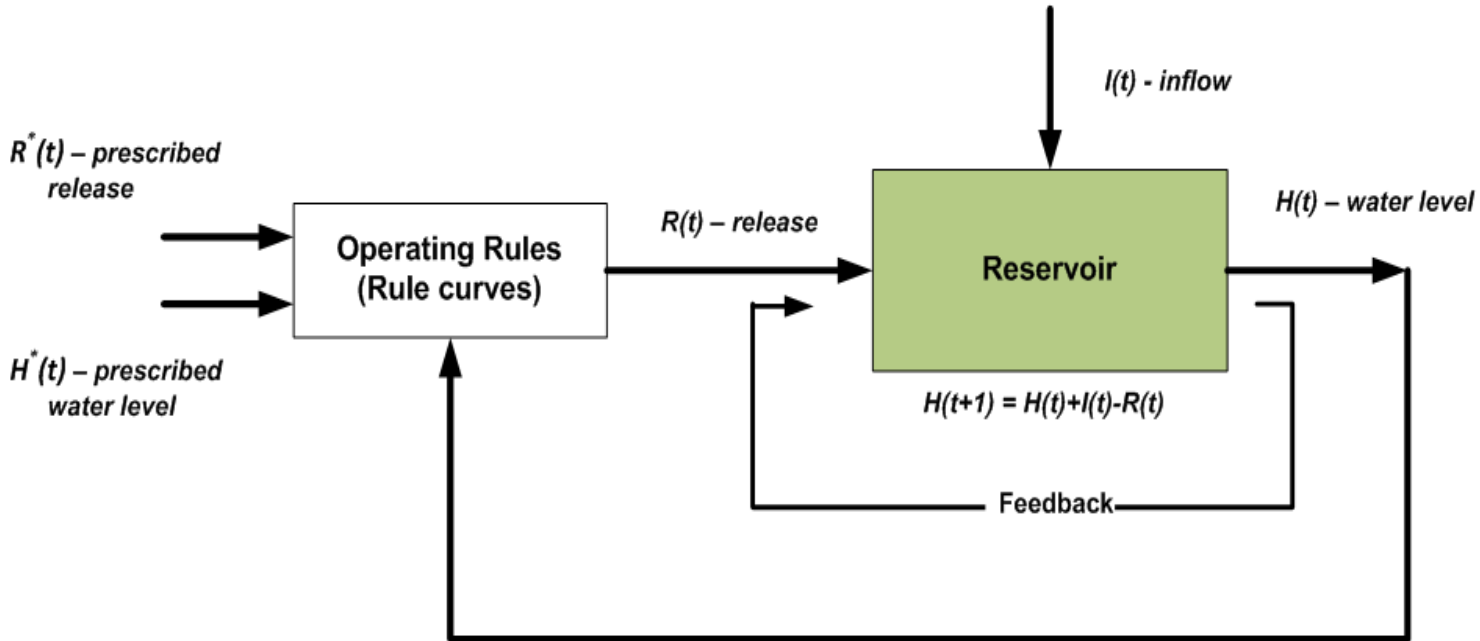




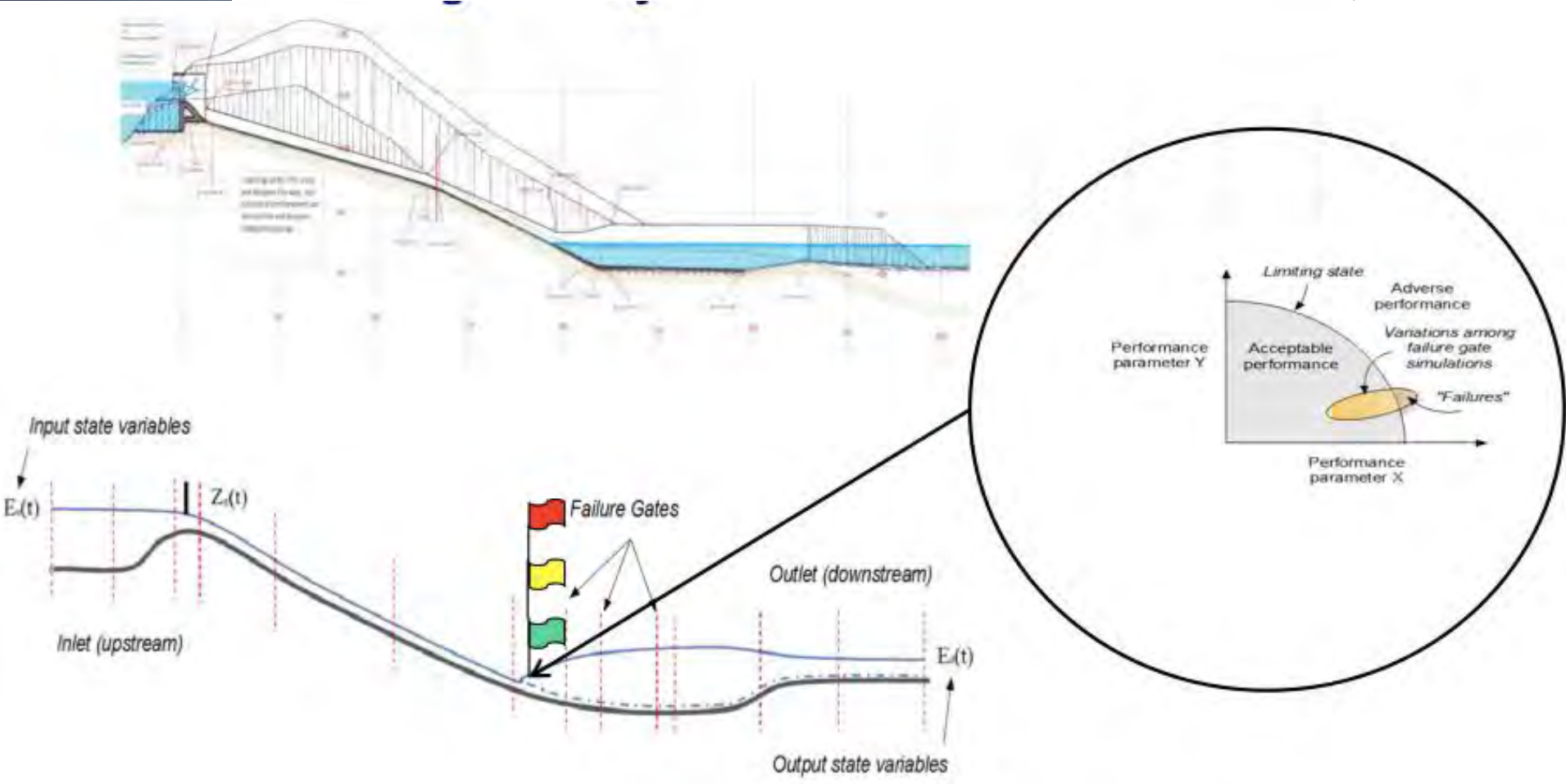
Simulation of operations

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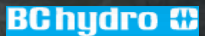
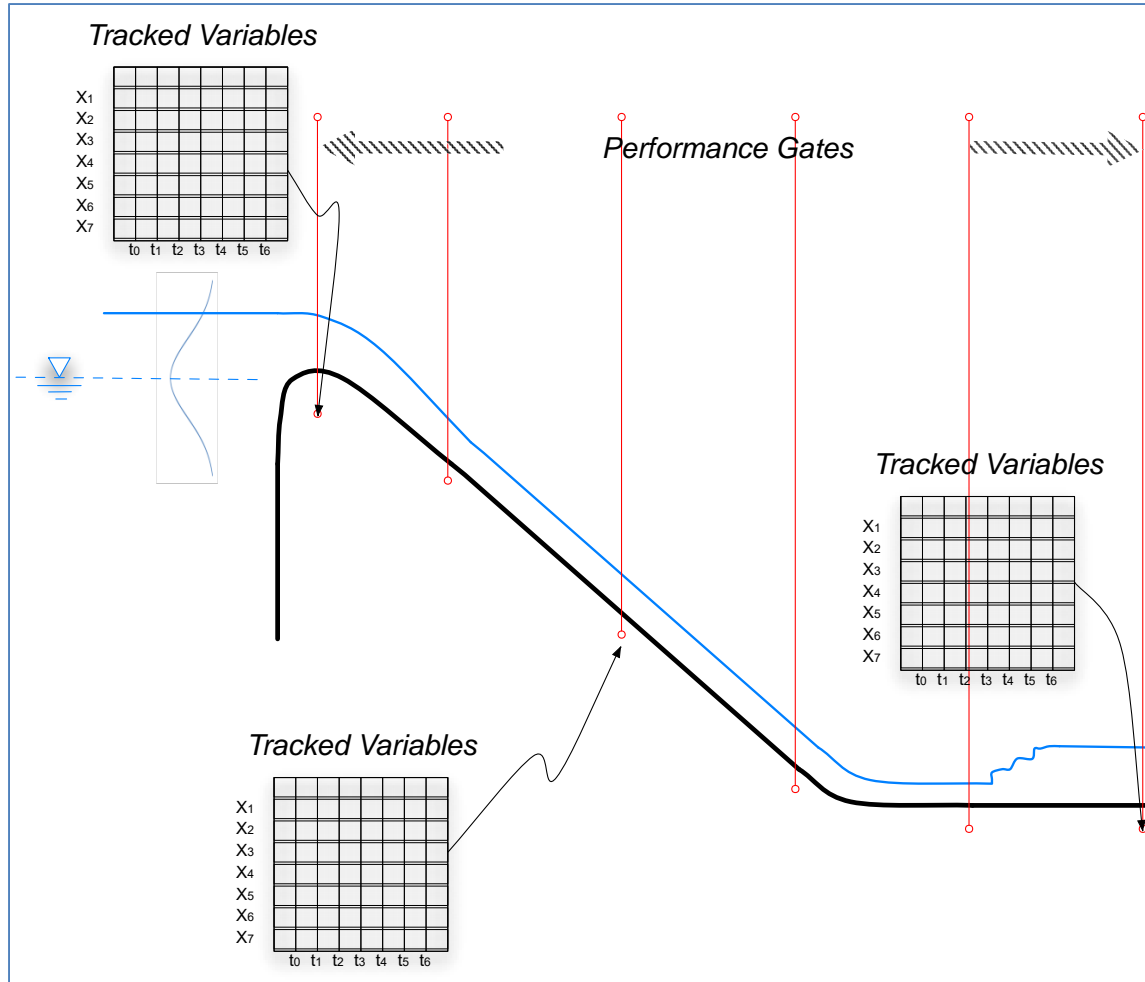


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Simulation of operations

Current projects

- Mattagami River (OPG)
- Matawaska River (OPG)
- Göte River (Vattenfall)
- Wolf Creek Dam (USACE)
- John Day Dam (USACE)
- Missouri River main stem dams (USACE)
- Campbell River (BCHydro)
- Chao Phraya Basin (Thailand)



Mattagami River system

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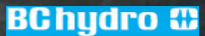
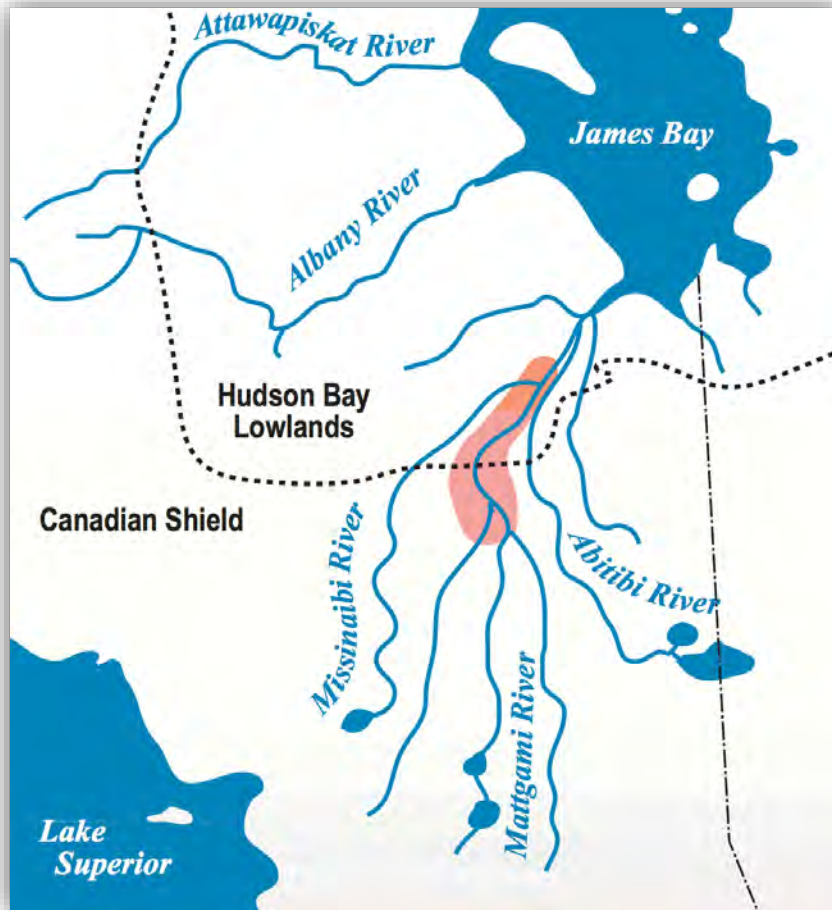
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