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Introduction

• Damwatch and GNS - International consultants
• 30+ years working together on design and safety assessment of new and existing dams

Dam engineering specialists
* design and rehabilitation
* dam safety & monitoring
* instrumentation

www.damwatch.co.nz

New Zealand’s leading provider of Earth, geoscience and isotope research and consultancy services.

http://www.gns.cri.nz
Introduction

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What is Dam Safety?

- The safe operation and management of dams and their reservoirs for all stages of the dam’s lifecycle

From: initial planning, investigation, design, construction, commissioning, assessment, rehabilitation and operation through to decommissioning
What is Dam Safety?

Necessary to protect:

people, property and the environment

from the potentially catastrophic impacts of a dam failure or unexpected release from the impounded reservoir.
Why should we focus on Dam Safety?

- Avoid these events !!!:
Why should we focus on Dam Safety?

Loss of lives, loss of assets, loss of trust and reputation
“...the MRC aims to ensure that the Mekong water is developed in the most efficient manner that mutually benefits all Member Countries and minimises harmful effects on people and the environment in the Lower Mekong Basin.”

http://www.mrcmekong.org/about-mrc/
Why should we focus on Dam Safety?

- Serious incidents and dam failure can occur at any time in a dam’s lifetime

# of Incidents vs. Age All Dams

![Chart showing the number of incidents vs. age range for all dams.](chart.png)

Courtesy P Regan FERC
International Organisations leading Dam Safety

- International Commission on Large Dams (ICOLD)
- Government Regulators
- International funders & NGO’s e.g. World Bank
- International Practice Leaders, e.g. USBR, USACoE, FERC
- Research Institutes and Universities

Technical Bulletins

Good Practice Guidelines

Laws, decrees, regulations

Policy and standards

Design Manuals, risk management procedures etc

Research publications Advances in practice

National Practice

Government Regulators

National Committees e.g. VNCOLD, ANCOLD, CDA, NZSOLD
The Viet Nam-NZ Dam Safety Project objective is to:

- reduce loss of life and economic damage resulting from extreme dam discharges

(i.e. dam spillway releases or dam failure events)
The Viet Nam-NZ Dam Safety Project

The V-NZ Dam Safety Project Phase 1 is being carried out over 2012 to 2015 with collaboration between

- **New Zealand Partners (Damwatch and GNS):**
  - Experience in management of cascade dam systems
  - Expertise in international dam safety regulations
  - Expertise in flood risk assessment
  - Expertise in seismic and landslide risks to dams
  - Expertise in renovation of existing dams
  - Successful history of dam safety

- **Viet Nam Partners (MARD - WRU, VNCOLD, IGP):**
  - Expertise in flood estimation
  - Expertise in flood modelling
  - Knowledge of Vietnamese dam safety regulations
  - Expertise in design of dams
  - Vietnamese agency for seismic hazard analysis

The funding partner is the New Zealand Government Aid Programme
Viet Nam has about 7,000 dams in total:

- **Large Dams** (> 6,000)
- **Small/Medium Dams**
- **Dams of National Importance**
The project involves:

- Application of internationally recognized methods on a catchment-wide basis to identify and quantify risks to dams and communities downstream of the dams.

- INTEGRATED APPROACH - unique
• PLAY VIDEO
Methodology

1. Quantify hazards
   - Flood, Landslide, Earthquake

2. Assess dam fragility
   - Spillway adequacy
   - Dam stability
   - Dam safety assessment

3. Quantify flooding and impacts
   - Inundation maps
   - Consequence assessment

4. Evaluate improvements
   - Dam upgrades
   - CBRM improvements
Dam Safety Project Pilot Catchment – Hieu River Nghe An Province, Viet Nam
Seismic hazard relating to inter-plate slip

San Fernando dam, USA post Mw = 6.7 earthquake, 1971

Landslide dammed lake, New Zealand post Mw = 7.8 earthquake, 1929

Large landslides in upper catchment of Hieu River
Impacts on dam safety from natural hazards

Need to understand the:
• occurrence,
• frequency, and
• magnitude

of external events that may impact on dam safety – earthquakes – landslides – floods

**BEST** to do this **BEFORE** dam design and construction begin

• Seismic analysis – regional – shared benefits?
Why is good design investigation important?

- Robust dam - get it right first time
- Avoid failure
- Avoid retrofit ($$) or compromised margins of safety
- Dam OK with natural hazards / external events
Good design investigation

- International experience – site investigations budget ~ 10% of total project costs
- Challenge – getting the data for incorporation in design (such as earthquake occurrence, frequency and magnitude)
- Good investment in project risk management – future dam safety reviews reputational and political risk social acceptance
## Ban Mong Dam, Flood Hydrology

<table>
<thead>
<tr>
<th>Flood Annual Exceedance Probability (1 in Y)</th>
<th>Reservoir Inflow (m³/s)</th>
<th>Spillway Outflow (m³/s)</th>
<th>Dam Freeboard (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 in 50</td>
<td>4,890</td>
<td>4,847</td>
<td>2.3</td>
</tr>
<tr>
<td>1 in 200</td>
<td>6,273</td>
<td>6,126</td>
<td>2.2</td>
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<tr>
<td>1 in 1,000</td>
<td>7,871</td>
<td>6,964</td>
<td>0.3</td>
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<tr>
<td>1 in 5,000</td>
<td>9,486</td>
<td>8,566</td>
<td>Dam Overtopped</td>
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<tr>
<td>1 in 10,000</td>
<td>10,150</td>
<td>9,182</td>
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</tr>
<tr>
<td>PMF</td>
<td>12,460</td>
<td>10,872</td>
<td>Dam Overtopped</td>
</tr>
</tbody>
</table>

**SCHEMATIC OF RESERVOIR FLOOD LEVELS**

### RESERVOIR INFLOW HYDROGRAPHS

### DAM FAILURE HYDROGRAPHS
Ban Mong Dam, Flood Inundation Maps (1 in 50 AEP Spillway Release)
Ban Mong Dam, Flood Inundation Maps (Dam Failure Scenario)
Consequence analysis tool that provides information about what could happen to people, buildings, agricultural activities and infrastructure in a natural hazard event / disaster

Ban Mong Dam, Consequence Assessment

What can it be used for?:
- Evacuation/response planning
- Building approvals
- Evacuation exercise planning
- Mitigation priorities
- Risk / impact analysis
- Basis for cost-benefit analysis
- Land-use planning
- Education / Information

GIS Layers:
### Examples of Dam Safety & CBDRM Recommendations after using DSM

<table>
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<tr>
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<tr>
<td><strong>Dam Safety Issue</strong></td>
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<td><strong>Dam Upgrade Recommended</strong></td>
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<tr>
<td><strong>Risk Reduction Achieved</strong></td>
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<th>Dam Safety Recommendation #2</th>
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<td><strong>Dam Safety Issue</strong></td>
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<td><strong>Dam Upgrade Recommended</strong></td>
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<td><strong>Risk Reduction Achieved</strong></td>
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VN-NZ Dam Safety Methodology Summary

Methodology:

• Delivers Evidence based Decision Making in Dam Safety for whole river basin

• Phase 1 Trialled successfully in Nghe An Province, Viet Nam

• 2016 – Phase 2 - Application of Tool in major river basin system – 1000km, 978 dams (905 small, 58 med, 15 large), 5 years – design complete, funding approval 95%
Summary – Project Benefits

• DDCSI provides dam owners/managers an understanding of:
  • The potential risks related to their dams
  • The natural hazards that can affect dams
  • The reasons why dams fail, and
  • Improvements that can be made to mitigate these risks

Phase 2 includes development of a prioritisation tool – identify where investment is best spent to reduce risk
Summary – Project Benefits

• **River-basin approach to dam safety assessment:**
  • Comprehensive approach that considers both upstream hazards **and** impacts on downstream communities
  • Provides solutions to improve dam safety and Disaster Risk Management practices

• Provides tools for compliance with aspects of (most) national regulations
Using VN-NZ Dam Safety Methodology Outputs

Engineers and Planners can use outputs to design projects, such as:

**Dam safety improvements**
- Dam upgrade/structural improvements
- Dam operational improvements/flood peak mitigation options
- Multiple reservoir operation rules
- Early warning systems for dam operators and authorities

**Community disaster risk management**
- Improved downstream community resilience
- Early warning systems for communities
- Improved evacuation planning

**Physical works**
- Protective measure locations (e.g. dykes)
- Road and bridge improvements to improve evacuation routes and flow paths
- Infrastructure upgrades

**Land use planning**
- Identification of areas to restrict future development