COMPARISON OF FLOOD HAZARD ESTIMATION METHODS FOR DAM SAFETY - Phase 1

Project Summary

22 September 2010
CEATI Project No. DSIG-2010-02
Project information

Project Title: Comparison of Flood Hazard Estimation Methods for Dam Safety – Phase 1

Project Number: DSIG-2010-02

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Start Date: 19th September 2010
Finish date: June 2011

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EDF, France
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Hydro-Quebec, Canada
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Background

Hydrology was of course one of the first civil engineering disciplines to benefit from modern statistical thinking. Sophisticated descendants of these early statistical methods are now used worldwide within the dam industry to estimate the flood hazard. Such methods, if applied correctly, provide powerful tools capable of exploring the extremes of hydrological hazard whilst at the same time honestly acknowledging the uncertainty in these estimates.

In addition to statistical methods, the Probable Maximum Precipitation (PMP) and Probable Maximum Flood (PMF) approaches aims to define a “maximum” design event that is a reasonable worst combination of meteorological and hydrological factors for a particular reservoir project.

As a result, a plethora of approaches now exist, each with its perceived advantages and disadvantages, and hence a wide diversity of practice exists. In some cases this reflects the differing demands of regulation and physical setting, whilst others simply reflect analyst preference.

Beyond the established approaches, the dam safety community throughout the world has a growing interest in moving towards a risk-informed management paradigm. This is not an easy transition. It is however clear that fundamental to its success, as in traditional approaches, is a transparent and reliable means of estimating extreme flood flows.

This project will provide an unbiased and structured review of the available and evolving methods, how and why they are used in across the world and, importantly, how they perform.

Project Tasks

The project consists of two tasks:

Task 1 Analysis of the regulatory framework on flood hazard around the world

This task will provide an overview of the regulatory frameworks concerning flood hazard estimation for dam safety from around the world, including a review of:

- **Context** - the context of each regulatory framework, including:
  - legislation
  - governance structure (including who is responsible for what and who manages risk).
  - details about the regulatory body responsible for dam safety
  - cultural, social geographical and other related factors.

- **Standards or risk-informed** - the degree to which the regulatory framework incorporates risk management practices including prescriptive or goal-oriented approaches to regulated.

- **Effectiveness in delivering dam safety** – The relative advantages and dis-advantages of each regulatory framework in terms of its effectiveness in:
  - delivering dam safety effectively and efficiently
  - identifying and adapting to good practice as it evolves.

- **The approach to determining the flood hazard:**
  - Performance standards – how is this described, either standards based (if so how are these described), risk-informed (if so how are these described)
  - What assumptions made (e.g. initial watershed conditions, priming, design rainfall meteorology, reservoir and dam operation)
Emerging trends in regulation
- Are they moving towards risk-informed approaches? If so, how?

Approach to considering climate change
- What time horizons are used, or is only present day considered?
- Are scenarios used if so how?
- Or, is a common degree of precaution prescribed centrally – if so how?

Rationale for public safety and risk reduction expenditure
- How do potential hazard categories or tolerable/acceptable risk guidelines consider public safety (potential life loss) in the justification of risk reduction expenditures?
- Is the cost of risk reduction weighed against the need to improve dam safety of public safety and if so how?
- Is staging of the implementation of risk reduction measures allowed and if so what the considerations that govern it?

Task 2 Analysis of existing flood hazard estimation approaches

This task will provide an overview of various approaches both in practical applications and in scientific literature for flood hazard estimation for dam safety. A range of methods (from Classical Flood Frequency Analysis, Multifractal Flood Frequency Analysis, Regional Flood Frequency Analysis, PMP/PMF (Probable Maximum Precipitation/ Probable Maximum Flood), through to Rainfall Runoff simulation methods) will be listed. Each will be summarized and compared using a range of criteria that will differentiate the techniques, including:

- **Mathematical basis** - statistical stochastic or physically based modelling
- **Climate assumption** – stationary or not?
- **Data demands / needs** – spatial and temporal resolution, record length etc
- **Applicability** - Region over which the technique is considered applicable
- **Capable of supporting standard based approaches, risk-informed or both?**
- **Degree of modeller skill** – Some approaches are more complex than others to applicable. What level of user skill is required – both local knowledge and subject skills?
- **Computational resources required** – how computationally demanding is the analysis?
- **Suitability for onward use in forecast mode** – can the effort devoted towards developing the flood estimation be reused to improve forecasts?
- **Use of historical data, and the degree of confidence in the approach (through documented examples of validation any historical flood events)**. For example, the review will also consider where observed flood events have been used for calibration of approaches or indeed where approaches have been modified following the experience of a severe flood event.
- **Representation of uncertainty** – what types of uncertainty are included and excluded? Is the uncertainty explicitly communicated, if so how?

**Deliverables**

Separate reports covering the findings and recommendations from Task 1 and 2, together with an associated presentation resource and technical briefing providing a short description of project, its findings and recommendation.

**Next steps**

The project findings may be tested through a follow-on application stage to compare the various techniques on a series of pilot studies.