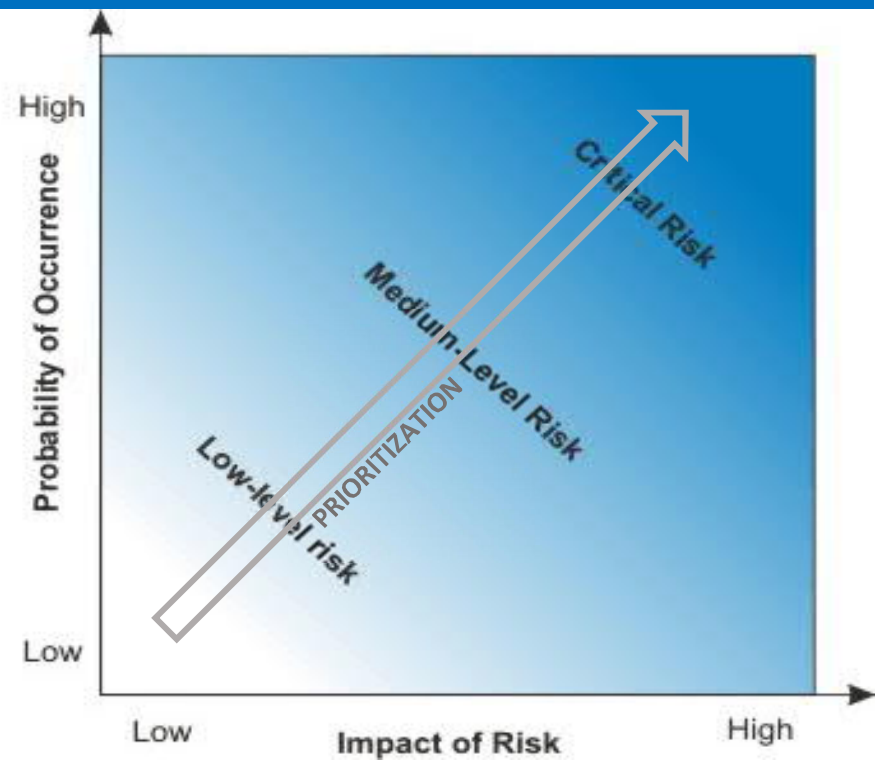
Using Risk to Prioritize Dam Safety Deficiencies

The application of risk analysis has fundamentally changed the practice of dam safety engineering in the United States and will continue to do so. Over the past couple of decades, federal and state dam safety agencies as well dam owner organizations have begun to introduce risk methodologies into their dam safety programs. The increasing application of risk analysis and risk consideration has resulted in the dam safety community 1) openly recognizing in a formal manner the many ways a dam can fail and the consequences of those failures, 2) using risk as a tool for prioritizing risk reduction actions, and 3) focusing monitoring programs and remediation efforts on the highest risk dams and potential failure modes. Prior to the application of risk, dam safety engineering practice focused on evaluating dams through visual inspections and comparison of analysis results with deterministic criteria (e.g. can it pass the full Probable Maximum Flood). Risk changed the basic thought process in dam safety engineering to one of critically assessing the ways a dam could fail, along with the relative likelihoods of the different failure modes and their consequences. Owners, regulators and engineers who have used the risk process have almost universally noted benefits of the process including:

- A deeper understanding of the dam
- A better understanding of the most important failure modes for a dam
- Focusing resources on risks associated with every day or frequent events, as compared to risks from rare events.
- Improved surveillance and monitoring that are targeted toward the dam's true vulnerabilities
- Better informed operators with regard to the dam's sensitivities to operational procedures
- In some cases, identification of serious safety concerns that had previously not been identified.
- Alternative evaluations and final design efforts becoming better informed using a risk process.
- Risk can quantify and evaluate impacts of unknowns.



RISK = A measure of both the likelihood and severity of adverse consequences

STEPS IN SEMI-QUANTITATIVE RISK ANALYSIS (SQRA)

1. Gather Data
2. Study / understand available information
3. Estimate load hazard curves (annual pool, floods, earthquakes)
4. Identify viable potential failure modes – screening to exclude physically impossible or non-credible potential failure modes (PFMs)
5. Development of remaining PFMs
6. List positive and adverse factors
7. Select order-of-magnitude failure likelihood category for each PFM
8. Select order-of-magnitude consequence category for each PFM
9. Select confidence category for each PFM and identify key missing data
10. Plot risk results on a risk matrix

WHY THE SHIFT TO RISK IN DAM INDUSTRY?

- Dams that meet deterministic criteria still fail.
- Dams that do not meet deterministic criteria (required flood passage) have varying degrees of failure probability and consequential impacts.
- Should a structure that has limited likelihood of causing loss of life warrant the same level of scrutiny as one that does?
- Accuracy of deterministic analyses is affected by uncertainties and unknowns