Regulatory Framework for Dam Safety

Preliminary Results of the WB Global Dam Safety Legal & Institutional Framework Study

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WORLD BANK GROUP
Water

Introduction: Diverse Global Portfolio of World Bank Group Dams-Related Projects

- 322 projects in ~ 90 countries
- Project costs US$ 72 billion
- Bank Commitments >US$ 38 billion

- Increasing lending portfolio, including new dam construction & major rehabilitation works
- Ensure economic & financial viability of investment and sustainable asset management
- Require dam safety instruments in place as per the WB Dam Safety Policy and new Environmental & Social Framework, including risk management and public safety assurance
- Provide increased technical support and capacity building opportunities
Dam Safety related Publications

- WB publication on Regulatory Frameworks for Dam Safety: A Comparative Study (2002)

- Series of ICOLD Bulletins, such as
  - #130 Risk Assessment in Dam Safety Management: A Reconnaissance of Benefits, Methods and Current Application (2005)
  - #154 Dam Safety Management: Operation Phase of Dam Life Cycle (2011)

- Technical guidelines (USACE, FEMA, Canada, Australia, etc.)
Global Dam Safety Legal & Institutional Study: Objectives & Analytical Framework

1. to provide a comprehensive set of country case studies with a balanced representation among a diverse set of countries with varying economic, political and cultural circumstances.

2. to carry out a comparative analysis of the legal, regulatory, and institutional metrics along with financial and operating model analysis to identify a continuum of elements of exemplary practice and precedents;

3. to recommend a set of legal, regulatory and institutional frameworks suitable for different country circumstances supported by a menu of different options.

**Country Case Studies**
- Deep dive into country frameworks according to common template

**Comparative Analysis**
- Extract options & identify exemplars
- Produce a continuum of legal and institutional frameworks

**Guidance & Recommendations**
- Construct pathways for different types of jurisdictions
- Advise countries of appropriate menu of options
Study Snapshot

- 18 High Income (OECD) countries
- 1 High Income (non-OECD) countries
- 14 Upper Middle Income Countries
- 14 Lower Middle Income countries
- 4 Low Income Countries

Map showing countries by income level:
- Low ($1,045 or less)
- Lower middle ($1,046-$4,125)
- Upper middle ($4,126-$12,735)
- High ($12,736 or more)
- No data

Countries listed include:

High Income (OECD) countries:
- Norway
- Sweden
- Russia
- U.K.
- Poland
- Ukraine
- Bulgaria
- Turkey
- France
- Spain
- Switzerland
- Portugal
- Czech Rep.
- Austria
- Italy
- Albania

Upper Middle Income Countries:
- Morocco
- Egypt
- Burkina Faso
- Nigeria
- Ethiopia
- Cameroon
- Zimbabwe
- South Africa

Lower Middle Income countries:
- Lebanon
- Iraq
- Iran
- Uzbekistan
- Pakistan
- Nepal
- India
- Sri Lanka
- China
- S. Korea
- Japan
- Myanmar
- Myanmar
- Lao PDR
- Thailand
- Vietnam
- Philippines
- Indonesia
- Malaysia
- New Zealand
- Australia

Note: This map was produced by the Prop Design Unit of The World Bank. The boundaries, colors, denominations and any other information shown on this map do not imply, on the part of The World Bank Group, any judgment on the legal status of any territory, or any endorsement or acceptance of such boundaries.
**Topic 1: Institutional & Governance Arrangements**

**Context & Rationale**

- **Legal Framework**
  - The regulatory frameworks for dam safety are provided through legal framework
  - The legal framework defines the institutions responsible for ownership, operation and oversight / regulation of dam safety elements

- **Institutional Background Factors**
  - Governance system (national/centralized or regional/decentralized)
  - Institutional forms (cross-sectoral, sectoral, or mixed)
  - Size of portfolio of dams and ownerships (public, semi-public, or private)

- **Regulatory Framework and Capacity**
  - Range of different levels of institutional independence (independent to self-regulation)
  - Institutional capacity critical to ensuring dam safety (financial, human, technical, etc.)
Topic 1: Institutional & Governance Arrangements:

Key Messages

- The Owner or Operator should be clearly responsible for safety of the dam and appurtenant structures.
- The Government/Regulator should be responsible for protecting the safety of the people living downstream of the dam by establishing the standards and monitoring/reporting procedures with which owners/operators must comply.
- Oversight mechanisms independent from ownership help ensure proper accountability, but complete independence is not necessarily common.
- Regulatory mechanisms need to be aligned to size & complexity of portfolio, financial/ human capacity as well as within legal regime.
- Multiple authorities can create complicated institutional framework, particularly as portfolio increases and issues around coordination and competing uses of water become more complex.
**Topic 1: Institutional & Governance Arrangements: Powers and Responsibilities of the Regulator**

<table>
<thead>
<tr>
<th>Role</th>
<th>COMPLIANCE AUDIT</th>
<th>QUALITY ASSURANCE</th>
<th>DIRECTED HANDS-ON SURVEILLANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Function</td>
<td>Random quality assurance audits only</td>
<td>All over assurance, check all information/reports provided by owners engineers</td>
<td>Goes in and actually does the dam safety inspections and assessments</td>
</tr>
<tr>
<td>Capacity</td>
<td>Otherwise just rubber stamping reports and certifications provided by owners engineers</td>
<td>May also do the hazard classification</td>
<td></td>
</tr>
<tr>
<td>Liability</td>
<td>Low need for capacity/expertise in authority</td>
<td>Medium need for capacity/expertise in authority</td>
<td>High need for capacity/expertise in authority</td>
</tr>
<tr>
<td>Accepting no liability</td>
<td>Authority makes no decisions related to the safety of the dam</td>
<td>Accepting some liability</td>
<td>Accepting full liability Legislation can exempt the authority but individuals can always be sued</td>
</tr>
</tbody>
</table>

- Majority of dam safety authorities (43%) focused on quality assurance / compliance-audit roles
- Twelve per cent are mixed QA / hands-on assessor
- Nearly one third (27%) have more hands-on assessor role
Topic 2: Content of the Regulatory Regime (incl. O&M & EPPs)  Context & Rationale

• Dams capturing criteria regulated by laws (large dams vs small dams)

• Dams classification system’s key elements:
  • structural risk (height, reservoir capacity, etc.)
  • hazard assessment and classification,
  • combined (structural risk and hazard).

• Design standards mandated for design of new dams or review of existing dams, such as flood and earthquake, are typically defined by dams class

• Safety assurance requirements also typically defined by dams class

• Risk Assessment / Risk-informed decision making are increasingly common: some countries recommend or mandate risk analyses.

• Emergency Preparedness Plans (EPPs) including downstream notifications, are increasingly mandated by regulations depending on hazard level or at least practiced.
# Dams Classification System (e.g. Ontario, Canada)

<table>
<thead>
<tr>
<th>Hazard Potential</th>
<th>Life Safety</th>
<th>Economic Loss</th>
<th>Environmental Losses</th>
<th>Cultural – Built Heritage Losses</th>
</tr>
</thead>
</table>
| Low              | No potential LOL | ≤ $300,00 | • Minimal habitat loss  
• High capability of restoration  
• Very low probability of impacts on population | No or reversible damage to municipally designated sites |
| Moderate         | No potential LOL | ≤ $3 million | • Moderate habitat loss  
• Moderate capability of restoration  
• Low probability of impacts on population | Irreversible damage to municipally designated sites |
| High             | Potential LOL 1-10 | ≤ $30 million | • Appreciable habitat loss or deterioration  
• Reasonable likelihood of natural or assisted recovery  
• Loss of a portion of endangered species population or reversible damage to their habitat | Irreversible damage to provincial designated sites |
| Very High        | Potential LOL > 10 | ≤ $300 million | • Extensive habitat loss or deterioration  
• Low likelihood of natural or assisted recovery  
• Loss of a viable portion of endangered species population or irreversible damage to their habitat |
### Selection of Inflow Design Flood (e.g. Ontario, Canada)

<table>
<thead>
<tr>
<th>Hazard Potential Classification</th>
<th>Range of Minimum Inflow Design Floods</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Life Safety</td>
</tr>
<tr>
<td>Low</td>
<td>25 Year Flood to 100 Year Flood</td>
</tr>
<tr>
<td>Moderate</td>
<td>100 Year Flood to 1000 year flood or Regulatory Flood whichever is greater</td>
</tr>
<tr>
<td>High</td>
<td>1 - 10: 1/3 between the 1000 year Flood and PMF</td>
</tr>
<tr>
<td>Very High</td>
<td>11 – 100: 2/3 between the 1000 year Flood and PMF</td>
</tr>
</tbody>
</table>
## Inspection Requirements (e.g. Ontario, Canada)

<table>
<thead>
<tr>
<th>Type of Inspection</th>
<th>Incremental Hazard Potential Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>V HIGH</td>
</tr>
<tr>
<td>Dam Safety Assessment</td>
<td>Every 5 years</td>
</tr>
<tr>
<td>Scheduled inspection</td>
<td>annually</td>
</tr>
<tr>
<td>Routine visual inspection</td>
<td>Monthly</td>
</tr>
<tr>
<td>Special Inspection</td>
<td>As required following a dam safety event, flood or earthquake</td>
</tr>
<tr>
<td>Mechanical equipment testing</td>
<td>annually</td>
</tr>
</tbody>
</table>
• Clear legal responsibility for owner’s dam safety requirements including dam safety monitoring and reporting procedures
• Reservoir operation procedures considering public safety and emergency preparedness including downstream warning
• Disclosure of operational performance data (incl. accidents /incidents report, etc.)
• Benchmarking mechanisms for multiple dams under owners and regulators, with disclosure through annual dam safety reports
• Sufficient institutional and funding mechanisms is critical for proper monitoring and reporting.
Topic 3: Funding Mechanisms for Dam Safety

Assurance Findings

- Regulator is government-funded
  - ~10% of case studies
  - Earmarked funds
  - Funded annually from consolidated fund as a public good
- Regulator is funded from user payments
  - <5% of case studies
  - Fees for Registration or Inspections
  - Permits or Licenses
  - Provides consulting services for a fee
- Regulator is funded from government and user payments (mixed system)
  - 28% of case studies
  - Dam/water license fees (~30% of mixed funding mechanisms)
  - Supervision/inspection/auditing fees (~20% of mixed funding mechanisms)
  - Dam registration fees (~10% of mixed funding mechanism)
  - Alternative systems, e.g. taxes or PPP structures (2 cases)
- No funding mechanism specified
  - ~25% of case studies
# Topic 4: Risk Informed Approach – Gradually moving from Standard Design-Based to Risk-informed Approach

<table>
<thead>
<tr>
<th>Standard Design-Based</th>
<th>Risk-informed</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Safety judged by compliance with engineering standards and good practice</td>
<td>- Making the case with understanding of failure modes and tolerable risk</td>
</tr>
<tr>
<td>- Focus on design loading events</td>
<td>- Considers entire ranges of loading events and all significant failure modes</td>
</tr>
<tr>
<td>- Engineers are prime safety decision makers</td>
<td>- Decision makers are better informed of failure risk characterization by engineers</td>
</tr>
<tr>
<td>- Consequences of failures usually limited to dams risk/hazard classification</td>
<td>- Includes estimation of potential failure consequences</td>
</tr>
<tr>
<td>- Compliance / goal sometimes interpreted as zero risk</td>
<td>- Seeks to identify and manage residual risks</td>
</tr>
<tr>
<td>- Generally not well integrated with owner’s business plan</td>
<td>- Can be well integrated with owner’s business plan</td>
</tr>
</tbody>
</table>
Topic 4: Risk-Informed Approach – Risk Assessment Guideline (e.g. United Kingdom)

- Rapid, simple, qualitative assessment
- An initial assessment to understand potential risks
- Provides support for a Section 10 assessment

- Quantitative risk assessment
- Detailed consideration of specific processes and risks, including interdependencies


Selecting an initial tier of risk assessment depends on the level of threats, potential consequences and confidence of results.

Simplistic analysis is undertaken first and followed by more detailed analyses if required.

- Failure Mode Identification
- Estimation of likelihood and consequence, represented on an impact matrix (i.e. risk described as high, medium, low etc).

- Failure Mode Identification
- Provides numerical estimate of failure probability and risk

- Failure Mode Identification
- Provides a more refined numerical estimate of failure probability and risk
Topic 4: Risk-Informed Approach – Tolerable Risk

- Societal risk guidelines based on F-N charts used by regulators in the UK, the Netherlands, the State of New South Wales.
- US ACE & BUREC use for self-regulation and FERC is introducing over private hydropower dams.
- ALARP – as low as reasonably practicable is a common law legal principle relating to the dam owners’ duty of care.
- France (New regulations in 2007 / amended 2015): Risk analysis is legally mandated for high hazard dams but no formal acceptance criteria by the regulator.
Topic 4: Risk-Informed Approach - Some Challenges

- Relatively high level resources required for detailed studies and screening of large portfolios
- Limited data available for proper hydrological / seismic assessments, etc. particularly in developing countries
- Complicated risk assessment, such as earth dams deterioration with time (progression of internal erosion), and failure probability estimation
- The tolerable risk (life loss) is difficult to quantify, discuss and agree on between key stakeholders depending on societies
- Complicated real disaster situations where multiple dams and other infrastructures are affected by major storms and earthquakes
Defining a legal and institutional continuum for dam safety assurance

- **Determining Characteristics**
  - Legal system (common vs civil)
  - Laws & Administration (centralised vs decentralised)
  - Portfolio characteristics
    - Size (small single to large multi-sectoral)
    - Sectors (irrigation, hydro, supply, protection)
    - Ownership (public or private) and Oversight
    - Hazard level

- **Elements**
  - Institutional options
  - Roles & Responsibilities of owners and regulators
  - Oversight (self-regulation vs independent regulatory)
  - Regulatory contents
  - Classification systems
  - Funding mechanisms
  - Transboundary considerations
Evolution of Dam Safety Regulatory Framework

- **A**
  - No supervisory regulation
  - With dam owners free to self-regulate
  - A but mandate only EPPs under DM legislation for community right to know

- **B**
  - Only self-regulation
  - But Government elects to pass dam safety responsibility on to "temporary owner" or operator (e.g., concessionaire) and the assurance/ supervisory checking mechanism is the contract or can be legislated and independent check body can also be set up to supervise concessionaire and contracted responsibilities

- **C**
  - Different versions of A, B, C or X, Y, Z for different sectors (e.g., Vietnam)

- **M**
  - Full command and control assurance regulation
  - With fully independent supervisory regulator supervising ALL public/private dam owners in ALL sectors

- **X**
  - Only self-regulation
  - But the owner/self-regulator elects to set up an independent/semi-independent checking mechanism upon itself (e.g., DROC Nigeria)

- **Y**
  - Only for certain owners or sectors
  - Eg. fully regulate only private dams, does not bind the Crown, Government dams just self-regulate (e.g., USA Fed/State, Aus Vic)

- **Z**
  - Full command and control assurance regulation
  - With semi-independent regulator (e.g., Government also owns dams so not really independent for those)
Key Questions for Discussions

- Institutional arrangements: Owners, Operators, and Regulators
- Required design standard & safety requirements depend on dam’s risk/hazard:
  - New Dams
  - Existing Dams
- Dams classification system
- Risk-informed approach
- Human and financial capacity of Regulators and Owners
- Required technical support and capacity building
Thank you

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