



ICOLD Symposium on Sustainable Development of Dams and River Basins, 24<sup>th</sup> - 27<sup>th</sup> February, 2021, New Delhi

# WHAT INDIA CAN DO FOR THE WORLD ON DAM SAFETY RISK GOVERNANCE

## I. ESCUDER-BUENO

*Univeristat Politècnica de València & iPresas, Valencia, Spain*

## P. NARAYAN

*Central Water Commission, New Delhi, India*

### ABSTRACT

*The world has changed so much in just a few decades that we can't continue making the same questions and providing equivalent answers. If just some decades ago a reduce number of countries would be leading innovation and best practices, today "new comers" can do it faster and better. This is the importance of the role that India can play in what the international community calls "dam safety risk governance". India relies on more than 5000 large dams to provide drinking water, food, energy and flood protection for more than a billion citizens, and has recently introduced a legislation in Parliament that enables authorities, owners and users to build a world class governance system. Furthermore, the "ignition" point to become a key player has already happened under the leadership of the Central Water Commission, as the proper technical documents, capacity building and rehabilitation pilot cases are being successfully delivered within the DRIP program, including the recently published (2019) "Guidelines for Assessing and Managing Risks Associated with Dams". In summary, this article p strengthens the role that India is called to play in the coming years making a better country while becoming a mirror for others.*

### 1. INTRODUCTION

Dams and reservoirs are vital infrastructures for our societies as drinking water, irrigation, flood protection, or clean energy rely more and more on them, a fact exacerbated by climate change. Today, we do not have any other means of massively ensuring health and food, secure ourselves against floods and droughts, produce and storage energy equilibrating our grids or guarantee ecological flows in a many basins.

On the other hand, large dams in particular make a good example in terms of systemic risk derived from managing complex systems of civil infrastructures. That is why "dam safety" should be understood as a discipline that encompasses a broad range of knowledge, legislation, industrial applications, professional practices and investigative activities that are always present, from modest infrastructures of urban supply or irrigation to large continental flood protection systems.

Furthermore, it includes all type of geopolitical determinants, since large dams are present in almost every country. Many countries and entities around the world have implemented, systematically and cyclically, dam safety systems in the last 50 years, creating what we can call dam safety "fundamentals" or "standards".

A number of tasks are required to meet such standards, being among the more important the identification of inspection and analysis needs, performance of inspections and audits, detailed safety analysis and the integration of the generated documentation to the technical file of the dam. A series of documents and procedures such as Emergency Action Plans, Operating Rules, Periodic Monitoring Diagnostics and Safety review reports must also be in place to support what we have called dam safety fundamentals.

While the above describes what dam safety management meant since the 1970s, various agencies responsible for dam safety have recently introduced management practices based on the recognition, identification and risk quantification, which complements the traditional approach, without replacing it, providing an important added value. This is globally known as "dam safety risk governance", and it has happened in many countries (i.e.USA, Canada, Australia, Spain, Switzerland, Brazil, France, Japan etc.) regardless their scale or their degree of development, as some of the reasons that have motivated this new approach are quite common along the world with a need to; (i) prioritize risk reduction actions; (ii) optimize water resources management as well as to increase regulation capacity to respond to challenges such as climate change, which implies severe droughts and greater flood events; (iii) difficulties found to build new structures due to social and environmental reasons that will enhance the need to extend the exploitation phase of existing structures

for periods larger than initially expected and (iv) Dam ageing (most of the structures exceed thirty years of operation, and a very large percentage exceeds fifty years in operation), as well as the difference between the existing and current engineering knowledge and the one when dams were designed and built.

Retaking the concept of “risk governance” in a broader sense, according to the International Risk Governance Council (IRGC 2006), it includes the totality of actors, rules, conventions, processes, and mechanisms concerned with how relevant risk information is collected, analysed and communicated and how management decisions are made. Encompassing the combined risk-relevant decisions and actions of both governmental and private actors, risk governance is of importance in, but not restricted to, situations where there is no single authority to take a binding risk management decision but where, instead, the nature of the risk requires the collaboration of and coordination between a range of involved stakeholders.

However, risk governance not only includes a multifaceted, multi-actor risk process but also calls for the consideration of contextual factors such as institutional arrangements (e.g. the regulatory and legal framework that determines the relationship, roles and responsibilities of the actors and coordination mechanisms such as markets, incentives or self-imposed norms) and political culture, including different perceptions of risk.

Consequently, when the risk governance framework is applied to operation and safety of dams and reservoirs, the main challenge consists in aligning people, processes and policies to support decision making, and the factors that form the underlying basis to define the overall scope of this work: developing policies, implementing tools and training personnel to build the needed capabilities. This has been stated and extensively documented by Escuder-Bueno and Halpin (2016) among many other owners, regulators, professionals and scientists.

## **2. A GLOBAL STORY OF SUCCES AND THE IMPORTANCE OF THE GUIDELINES**

Among many other examples, in the last 15 years, the US Army Corps of Engineers (USACE) has followed an adaptive learning process to implementing risk governance which acknowledged a set of skills, policies, and procedures that were not perfect, but sufficient to begin a journey with. Fifteen years later, the bench of professionals has grown to several hundred engineers and scientists, policies and technologies are state of the art, and risk informed decisions have reshaped the very cultural of the agency.

It can be said that this culture has permeated through the USA further beyond the authorities of USACE. A very recent example would be the succesful evacuation of more than two hundred thousand people when an emergency was declared at Oroville dam in February 2017, followed by an extraordinary exercise of transparency and public communication.

As second example, around one third of the total Spanish large dams are owned and operated by MITECO (former MAGRAMA) through the surrogated authorities given to the River Basin Authorities (RBAs) which, in addition, hold the authority to enforce and develop integrated water resources planning and management, flood control and environmental protection, among other activities.

It can be said that, if MAGRAMA had not carried Pilot Case of Duero River Basin, in all probability, there would be no SPANCOLD (2012) Technical Guide on Risk analysis applied to management of dam safety which today serves as a reference guide towards risk governance for many operators in Spain and other countries and it is the key manual for capacity building in the matter in Spain.

As an example that highlights the global dimension of the paradigm shift, the Interamerican development Bank (IDB, 2018) has released a technical reference document for IDB project teams entitled “Disaster and Climate Change Executive Summary of the Risk Assessment Methodology for IDB” which goes beyond dams and is meant to impact all type of civil infrastrucruces projects.

This is part of a “roadmap” whose “ignition” point was the work undertaken by IDB (IDB, 2014) which resulted in the first index (“iGOPP”) correlating governance and public polices as applied to disaster risk management.

As we can infer from these and many other examples, any dam safety program requires a number of procedures and guidelines that need to be aligned with best international standards and become a key tool for capacity building at different levels and scales (from technicians to professionals and scientists, from a particular owner to a country as a whole).

Furthermore, as described by ICOLD in its Bulletin 130 (ICOLD, 2005), the path since the implementation of dam safety systems (traditional) to total integration in a (modern) risk management framework is a journey and requires a roadmap which is not independent of the departure situation or the context in which it is applied. As a matter of fact, risk analysis represents today the basis of dam safety programs for key institutions having mature risk governance systems (i.e. Australia, USA, Spain, United Kingdom or Canada), but it is also applied in developing countries such as South Africa, Ethiopia, Honduras and Colombia among many others.

In our view, driving along the “roadmap” is probably is the most exciting learning experience an owner, a regulator or a government in charge of dam safety can have. And it is not only that, it is that “new comers” bring new and fundamental insights, unveil problems in different ways and make improvements from which the rest of the world and not only them benefits.

### **3. INDIA: CURRENT SITUATION OF DAMS AND THE FUNDAMENTAL ROLE OF DAM SAFETY RISK GOVERNANCE**

#### **3.1 Overall context**

According to the Central Water Commission (CW) there are 5254 complete large dams in India, while 447 are being constructed, being the third country in the world by number of dams. So far, 36 dam accidents have been recorded in the country, where the overall accident rate is 0.685%, which is slightly lower than the world average (1%). In any case, due to the high population density in India, some of these dam failures have had very high consequences down-stream. Some examples of major dam failures which have happened in India were compiled at ICOLD technical Bulletin 99 (ICOLD 1995), included 21 failure cases between 1954 and 1983, and have not been the last failures to have occurred. The most historic is the failure of Machchu dam-II (Gujarat, year 1979) on record with substantial loss of lives and property. The recent flood of Chennai (December 2015) and Kerala (August 2018) directly or indirectly pointed out certain fundamental issues of dam safety management. Present handling of any disaster in India is mainly focussed on Rescue, Relief and Rehabilitation which needs to be oriented for Risk assessment, Risk Evaluation and Risk Communication in order to bring qualitative changes in our approach and management of disaster to see remarkable improvement to minimise loss of lives, environment and property.

Climate threats, such as those related to monsoons as well as some of the overall portfolio features where embankment dams are clearly predominant, make Indian dams particularly vulnerable to overtopping and internal erosion type of failure modes, which together with foundation related causes are the three prevalent worldwide causes of dam failure according to ICOLD (ICOLD 1995).

This helps to understand the importance of the role India can play in what the international community calls “dam safety risk governance”. India relies on more around 5000 large dams to provide drinking water, food, energy and flood protection for more than a billion citizens, and has recently passed a legislation that enables authorities, owners and users to build a world class governance system.

As a matter of fact, the Indian government introduced the Dam Safety Bill 2018 in December 2018 in Parliament and the “ignition” point to become a key player has already happened under the leadership of the Central Water Commission, as the proper technical documents, capacity building and rehabilitation pilot cases are successfully being delivered within the DRIP program, in collaboration with the World Bank. These include the provisions for preparation of Emergency Action Plans, O&M Manuals as well as data entry into web based asset management tool DHARMA for all 223 dams under DRIP. Globally, this kind of operational protocols placement at such a large scale in one go is being done in India.

#### **3.2 Dam Rehabilitation & Improvement Project (DRIP): A Program, enhancing the preparedness of Indian dam owners to deal with matter of dam safety in a more resilience and robustness**

The First India Dam Safety Project implemented between year 1991 to year 1998 at cost of US\$ 86 million in India. In an effort to address the dam safety challenge in a comprehensive way, in April 2012, Ministry of Water Resources, River Development & Ganga Rejuvenation through Central Water Commission with an objective to improve safety and operational performance of selected dams, along with institutional strengthening with system wide management approach, embarked upon the six year Dam Rehabilitation and Improvement Project (DRIP) with World Bank assistance at a cost of INR 2100 Crore (US\$M 437.5). The project originally envisaged the rehabilitation and improvement of 223 dam projects in four states namely, Kerala, Madhya Pradesh, Odisha, and Tamil Nadu. Later Karnataka, Uttarakhand (UJVNL) and Damodar Valley Corporation (DVC) joined the DRIP, and number of dams in DRIP portfolio increased to 257; due to the addition/deletion of few dams during implementation by partner agencies, presently 198 dam projects are being rehabilitated.

Government of India in September 2018, approved the revised cost of DRIP amounting to INR 3466 Crores (US\$M 533) along with two years extension with revised scheduled closure June 2020. Union Cabinet in June 2018 approved proposal for enactment of Dam Safety Bill, 2018 and introduced this Bill in Parliament in December 2018 to address legislative part of dam safety management. It is altogether a different fact, that print and electronic media didn't show the much interest in highlighting the importance of this Bill for broader public awareness and its need to deal with matter of dam safety management, as compared to media role in criticising the government in dealing with issue of Kerala flood of August 2018 wherein all were highlighting the missing operational dam protocols which are very well address in the current Dam Safety Bill 2018. Through this Act, government is gearing up to comprehensively address the issue of dam safety management in all respect.

DRIP has been successful in bringing together dam owners, engineers, scientists, academicians, industries, World Bank as well as renowned dam safety professionals. In addition to rehabilitation of dams, other important activities include design flood review, publication of important Guidelines as well as Manuals, preparation of O&M Manuals, Emergency Action Plans, development of web based asset management tool i.e. Dam Health And Rehabilitation Monitoring Application (DHARMA), Seismic Hazard Mapping along with development of Seismic Hazard Assessment Information System (SHAISYS), Risk Assessment of few selected dams, organisation of Dam Safety Conferences, national and international training programmes, technical exposure visits etc.

Under DRIP, capacity building in dam safety area of few selected academic institutions is being done. Also, capacity building of two Central Agencies i.e. Central Soil and Material Research Station (CSMRS) as well as Central Water and Power Research Station (CWPRS), is also one of the activities. Collaboration with few renowned international agencies for capacity building includes Deltares, the Netherlands, Bureau of Reclamation USA, Japan Water Agency Japan, Entura Australia etc. Also, few renowned global dam safety experts engaged in preparation of few technical protocols also helping government to achieve the objectives of DRIP. The overall supervision and coordination has been entrusted to Central Water Commission, and is being assisted by Egis Eau, Engineering and Management Consultant.

In the first three to four year, there were some bottlenecks and challenges in the Project. But now this Project is performing Satisfactory as rated by World Bank recently. Based on success of this ongoing Project, Ministry of Water Resources, River Development & Ganga Rejuvenation planned to extend it vertically as well as horizontally and invited proposals in year 2017 from all major dam owners of Country to initiate another Project to carry forward the gained momentum of dam safety management so far. The proposal from 18 States as well as two Central Agencies received by Ministry amounting to Rs. 11,487 Crores with a provision of rehabilitation of 733 dams. This Project is proposed to be of 10 years duration to be implemented in two Phases i.e., Phase-II and Phase-III each of six years duration with two years overlapping. In-principle, government of India has approved and very shortly going to pose before World Bank for funding. This proposed Project has all the necessary ingredient supposed to be for better dam safety management, and expected to inculcate a culture of mature dam safety management in India with long term sustainability.

#### **4. FINAL REMARKS**

India relies in around 5000 of large dams to provide security and health to more than a billion citizens, and the way India ensures dam safety and integrates its governance in the political systems will be in not only the basis for a better society but also a mirror where many others will reflect. This is why the role India can play in what the international community calls “dam safety risk governance” is so important, and deserves the attention of the country as a whole.

Government of India is on the path to convert Dam Safety Bill into an Act in coming future that enables authorities, owners and users to build a world class governance system while the “ignition” towards a modern dam safety program already happened under the leadership of Ministry of Water Resources, River Development and Ganga Rejuvenation, through the Central Water Commission (CWC).

It has the provision of comprehensive risk assessment of all the large dams of India in a phased manner over a period of five years. To achieve this goal, India needs to start strengthening its institutional capacity to take up this herculean task as presently risk based decision making is a relatively new concept in India without existence of requisite capacity at Union and State levels.

The guidelines, capabilities and examples delivered by CWC under the DRIP Program bring the unique opportunity to align “people, processes and policies” in a way that will reinforce scientific and practical robustness, transparency, equity, efficiency, participation and communication, being this last issue one of the most important.

Consequently, the role of media in arising social conscience on the value of dams (securing water, food and energy while providing flood protection and preserving the environment) becomes another fundamental pillar of this more than worth effort.

*The views expressed herein by both the authors are very personal, not in any way linked with the official views of government of India or any other federal or State Agency including Central Water Commission as well as that of Government of Spain.*

#### **REFERENCES**

- Central Water Commission, Government of India. 2019. Guidelines for Assessing and Managing Risks As-sociated with Dams.
- Ignacio Escuder-Bueno & Eric Halpin. 2018. Overcoming failure in infrastructure risk governance implementation: large dams journey, *Journal of Risk Research*, 21:11, 1313-1330.
- Inter-American Bank of Development (IDB). 2018. Disaster and Climate Change Executive Summary of the Risk Assessment Methodology for IDB Projects. A technical reference document for IDB project teams. Sergio Lacambra, Ginés Suarez, Maricarmen Esquivel, Melissa and Barandiaran, Daniela Zuloaga.
- International Commission on Large Dams (ICOLD). 1995. Bulletin 99 - Dam Failures. Statistical Analysis. International Commission of Large Dams.
- International Commission on Large Dams (ICOLD). 2005. Risk assessment in dam safety management: A reconnaissance of benefits, methods and current applications. Committee on dam safety. Bulletin 130.
- International Risk Governance Council (IRGC). 2006. Risk Governance: Towards an Integrative Approach. White Paper No. 1. Geneva.
- Spanish National Committee on Large Dams (SPANCOLD). 2012. Technical Guide: Risk Analysis Applied to Management of Dam Safety.