

SERIES **Água .  
Brasil**

**DAM SAFETY IN BRAZIL**  
WHEN ENGINEERING SERVES SOCIETY



## DAMS: IMPORTANCE TO BRAZIL AND TO SOCIETY

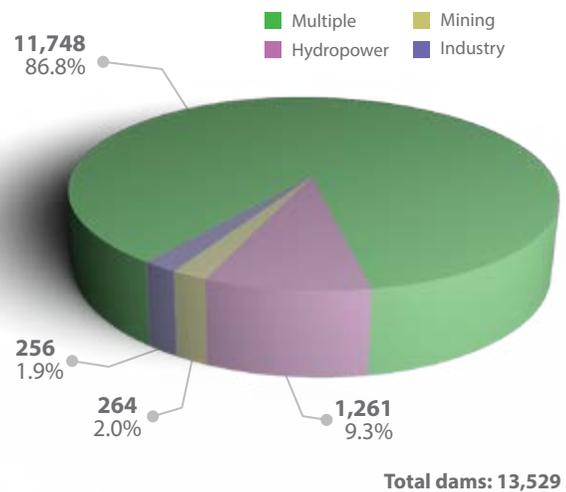
Over the course of history, dams have captivated the interest of society at large. Used to store large amounts of water, dams are also constructed to control flood waters and generate hydroelectricity. Due to their versatility in use, dams and their respective reservoirs are not only venues for economic activity, but also centers for leisure and recreational activities. Given society's dependence on these engineered structures, dams must be well-maintained and kept in good operating condition.

In order to promote a culture of enhanced dam safety and better risk management, dam owners should be held responsible for implementing safety measures. Equally as important as the reduction of possible accidents relating to dam failures is the enforcement of safety standards by regulatory entities in charge of promoting and spreading good practices.

The planning and construction of any new water-impounding structure must take into account its multiple potential uses (such as water for human consumption, livestock, irrigation, hydropower, and/or recreational activities), as well as the latest best practices in dam safety. Enforcement of dam safety standards is also crucial for structures built specifically to contain mine tailings and industrial waste.



In light of Brazil's notable continental landmass and extensive natural river systems, the country possesses a diverse collection of dams for various uses. The consolidation of registries from federal and state regulatory entities reports more than 13,000 dams in Brazil. The distribution and use of these dams is displayed in *Figure 1*. As noted in the graph, most dams are multi-purpose.



**Figure 1** – Dam use in Brazil (Source: Dam Safety Report, ANA, 2011).

Multi-purpose dams are most densely concentrated in Brazil's semi-arid Northeast, a region characterized by its semi-arid climate. Given its aridity, dams provide the most secure storage of water for human consumption, livestock grazing, and crop production. A significant number of multi-purpose dams are also located in the southern state of Rio Grande do Sul, where most of the water supplied is used for irrigation. It is not uncommon for the economy of a micro-region to become entirely dependent on a dam reservoir, which may provide benefits including support the region's irrigated agriculture as well as to fish and shrimp aquaculture.

Hydroelectric dams play a vital role in Brazil's economy, providing nearly 80% of the country's electric power (EPE, 2012). Despite accounting for only 9.3% of Brazil's 13,000 dams, these few structures

are the lifeline of people's day-to-day activities, from lighting homes to charging mobile devices. Dams are also widely employed throughout the country to store mining and industrial waste.

Notwithstanding the benefits that dams provide to society at large, the irrefutable risks that these mega-structures pose to natural waterways, aquatic life, the surrounding environment, and human lives cannot be overlooked.

## A STEP FORWARD: THE BRAZILIAN DAM SAFETY LAW

In Brazil, dam safety has traditionally struggled to compete with the attention and resources allocated to issues such as transportation, education, health and urban violence. The country as a whole, therefore, has never developed widespread awareness regarding dam safety.

Positively, Brazilian policy-makers and owners of large dams have been proactively working to improve the safety of dams around the country over the last two decades. Several owners of hydropower dams, for instance, have self-enforced the 1987 ELETROBRAS<sup>1</sup> guidelines. Likewise, the State of Ceará's Water Resource Management Company (COGERH) has carried out exemplary dam maintenance and dam safety measures on its irrigation dams since 1993. Another example is the Brazilian Dam Committee, founded in 1979, which has worked to promote dam safety through a series of conferences, courses and publications.

The collective work of dam-sector professionals resulted in the September 20, 2010 ratification of Law 12.334, colloquially known as the "Dam Safety Law", which instituted the National Dam Safety Policy (PNSB) to enforce safety standards and reduce the number of accidents relating to dam failures. The law imposed a new set of responsibilities on dam owners and established, under the National Dam Safety Policy, new mandates for regulatory entities based on the type of dam, origins of the water rights, or licensing for construction.

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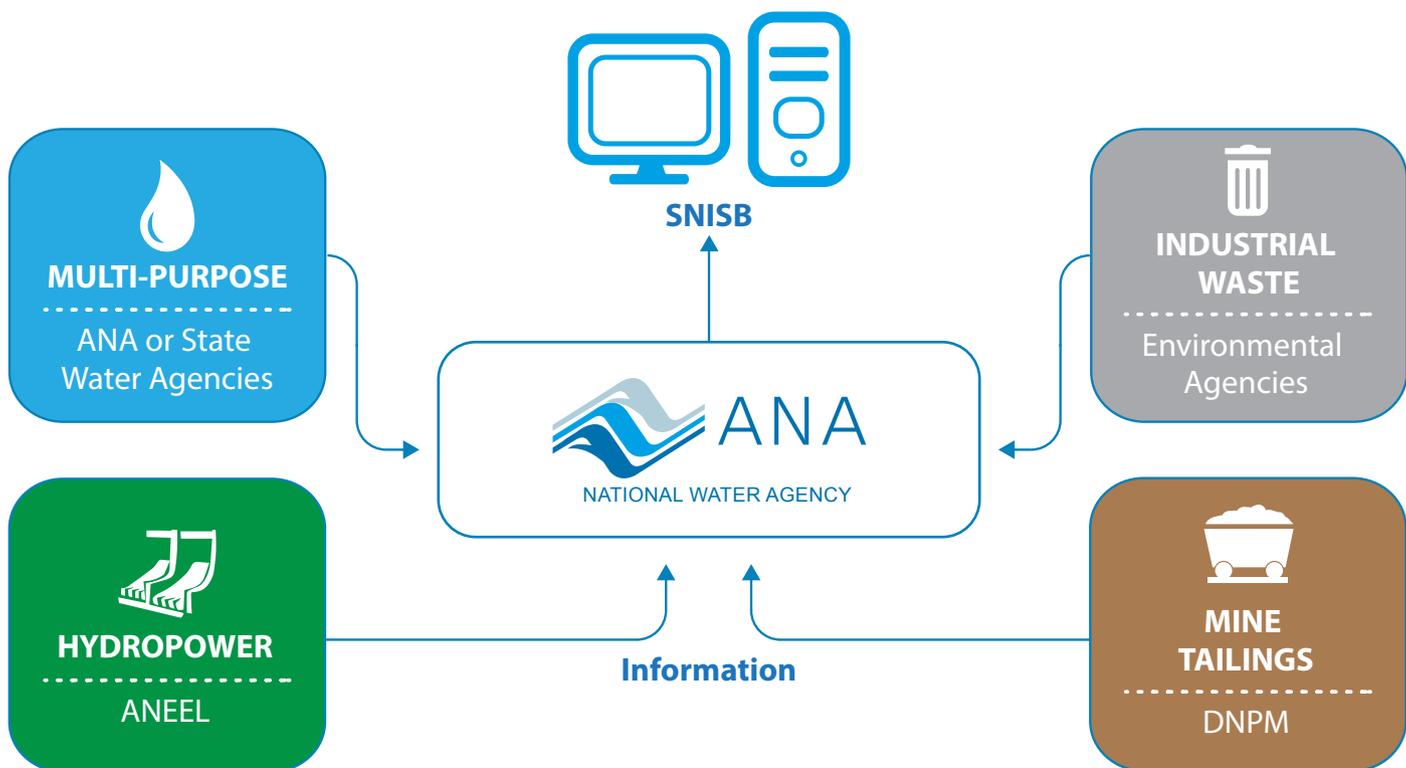
<sup>1</sup> ELETROBRAS is a major Brazilian company for electricity generation, transmission and distribution.

Today, Brazil has 45 dam safety regulatory entities: at the Federal level, these are ANEEL (Brazilian Electricity Regulatory Agency), ANA (National Water Agency), DNPM (National Department of Mineral Production), and IBAMA (Brazilian Institute for Environment and Renewable Natural Resources); other agencies operate at the state and municipal levels. Full implementation of the PNSB requires strong coordination amongst these different players in Brazil's federative system of government. The large number of existing dam safety regulatory entities has, however, complicated the institutional framework. One major challenge is ensuring uniform procedures across all regulatory entities, since a single dam owner may be subject to regulation by more than one of 45 regulatory entities. For example, the National Department of Works Against Drought (DNOCS) and the São Francisco and Parnaíba Valleys Development Company (CODEVASF), which together are responsible for approximately 700 dams, have dams which fall under the jurisdiction of ANA and well as some 10 state authorities.

Law 12.334/2010 only applies to dams with at least one of the following characteristics: (a) height equal to or greater than 15m; (b) total reservoir capacity equal to or greater than three million cubic meters; (c) reservoirs containing hazardous waste; or (d) reservoirs classified from medium to high in the levels of potential hazard. Within these criteria, Law 12.334/2010 can be applicable to any type of dam, including multi-purpose dams, hydropower dams, and dams built solely for the storage of mine tailings and/or industrial waste. *Figure 2* illustrates Brazil's four main types of dams, their respective regulatory entities, and their connection to the National Dam Safety Information System (SNISB) under the coordination of ANA.

Upon ratification of Law 12.344/2010, ANA began to play a more central role in the institutional framework relating to dam safety, assuming additional regulatory responsibilities apart from those it was already accountable for as stipulated by its creation law (Law n. 9.984/2000). This new set of tasks includes organizing, implementing and administering the National Dam Safety Information System (SNISB), and leading the coordination amongst the various dam safety regulatory entities in the production of the Dam Safety Report published every year.

Shortly after Law 12.344/2010 was signed, ANA, through the creation of two internal departments responsible for dam safety, began to carry out its



**Figure 2** – Types of dams and their regulatory agencies (Source: ANA, 2013).

new responsibilities and take actions in compliance with the new law. Amongst other new actions, ANA began to identify and oversee the dams under its jurisdiction through the development of procedures and resolutions, public hearings, and the proposal of a unified dam registry to be implemented by SNISB. At the same time, states are trying follow ANA's steps and do the same.

### **WORLD BANK TECHNICAL ASSISTANCE SUPPORTING THE IMPLEMENTATION OF THE DAM SAFETY LAW**

The World Bank and the Government of Brazil have a long-standing history of collaboration in the water, irrigation, sanitation, health, transportation, and environmental sectors, among others. In 2011, ANA requested World Bank technical assistance in the provision of analytical and advisory services on Dam

Safety given the Bank's international experience in the field. The technical assistance provided by the World Bank includes the following objectives:

- (a) reinforce the dam safety regulatory framework by helping ANA develop and review norms, standards, regulations, guidelines and manuals;
- (b) assist ANA in its monitoring inspections and evaluations of dam safety activities, reporting, and communication of findings to the authorities and the public;
- (c) help ANA in the design of the National Dam Safety Information System (SNISB);
- (d) provide capacity building for ANA and other agencies involved in dam safety management;
- (e) prepare manuals with orientations to dams owners and to regulations entities.



The work began in July 2012 and was scheduled to last three years. To achieve the objectives, the World Bank counts on its internal staff and on a set of national and international consultants with extensive experience in dam safety. These international consulting services are provided by the United States Army Corps of Engineers (USACE), the U.S. Geological Survey (USGS), individual experts and the COBA/LNEC consortium from Portugal.

The technical assistance provided by the World Bank is a participatory process, including ANA and other federal regulatory entities (ANEEL, DNPM and IBAMA), federal dam owners (e.g. Ministry of National Integration, DNOCS and CODEVASF), and several other state agencies; through seminars, workshops, and training sessions. Its main outputs are:

### **Dam Classification**

General criteria for a dam classification system were established by the National Water Resources Council (CNRH) in Resolution 143/2012. The system was based on different levels of risk, potential hazard, and reservoir volume. According to the Resolution, each regulatory entity may set its own procedures and deadlines.

ANA, as a national agency, solely regulates federal multi-purpose dams for which hydropower is not the primary purpose. Of the roughly 13,000 dams identified

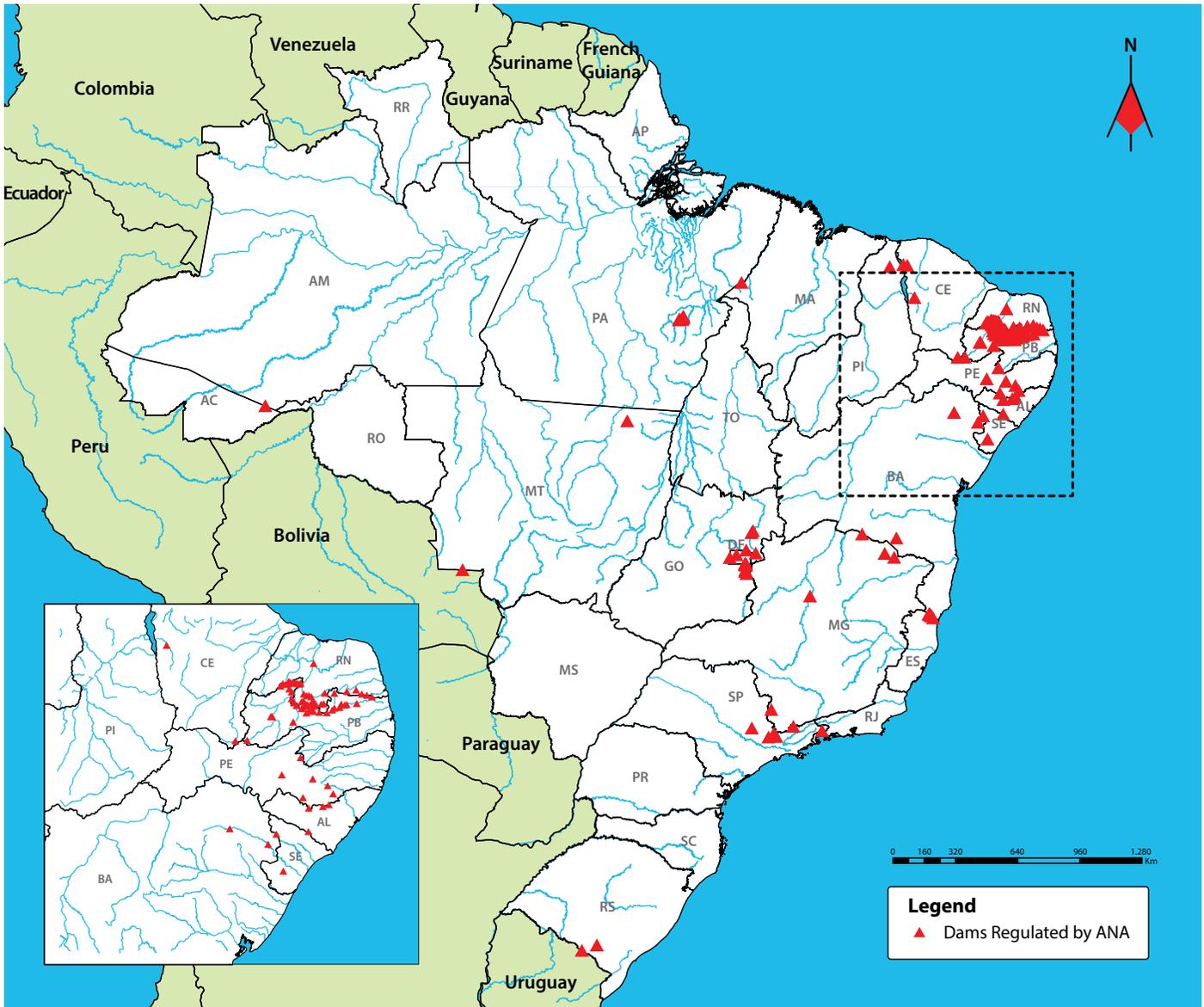
in the 2011 Dam Safety Report, 131 fall under ANA's jurisdiction. As can be observed in [Figure 3](#), most of those dams are located in Brazil's semi-arid region.

Upon development of the dam safety classification methodology, ANA began evaluating and classifying its 131 dams. The idea was that this same methodology could be applied by other regulatory entities to classify multi-purpose dams. Despite ANA's efforts, various challenges have inhibited the dam safety classification system from being fully adopted by related institutions. These challenges include the absence of or inadequate information pertaining to registry data, engineering designs, cartography at an adequate scale, or satellite images of satisfactory resolution. The plan is to gradually address these specific issues through in situ visits.

### **Dam Safety Plan**

The Dam Safety Plan consolidates dam and dam-owner's registry data, reports from regular and special inspections, and periodical safety reviews. The Dam Safety Plan also includes an Emergency Action Plan (EAP) which is applicable to any potential dam failure.

The World Bank's Technical Assistance includes the development of dam safety manuals and guides for regulatory entities, dam owners, and society at large, in order to raise the awareness and contribute to the



**Figure 3** – Location of dams under ANA’s jurisdiction (Source: Annual Dam Safety Report, ANA, 2011)

enforcement of Law 12.334/2010. Notable amongst these publications are:

■ **Dam Safety Policy Manual for Regulated Dams**

Contains a description of the Dam Safety Plan, an elaboration of ANA’s role as the principle regulating agency for national dams, and a synthesis on best practices in dam safety. A related publication also useful for dam operators is the Guide for the Development of an Emergency Action Plan (EAP) which provides response mechanisms to be adopted by owners of high-risk/hazard dams in the event of a dam rupture.

■ **Dam Safety Orientation Manual for Dam Owners**

Contains general safety information for dam owners and establishes safety procedures for the various stages of a dam’s life, beginning with its design and continuing with its construction, initial use of its reservoir, operation, and maintenance and finally finishing with its decommissioning. The manual also provides specific guidelines for drafting engineering designs for the construction of dams, as well as their monitoring, inspection, and operation and maintenance. A specific manual is being developed for owners of small dams.

**National Dam Safety Information System (SNISB)**

The law creating ANA was amended by the 2010 Dam Safety Law, extending the agency’s role and responsibilities in organizing, implementing, and

administering the National Dam Safety Information System (SNISB). The objective of the SNISB is to keep a digitalized national dam safety record, which would include systems for the collection, processing, storage, and recovery of information from dams under construction, in operation, and already decommissioned.

The design of this system is completed and the system is being implemented in two phases. The first phase covers the basic procedures needed to achieve PNSB's goal of serving as a registry of dams and dam safety regulations, interacting with society and publishing its progress, in order for the SNISB to be fully operational at the end of 2015. The second phase establishes safety management tools to be used by regulatory entities.

### **Dam Safety Report**

The Dam Safety Law also extended ANA's responsibility to include the coordination and production of an annual Dam Safety Report and its delivery to the National Water Resources Council. Every year, after a thorough review process, the report is subsequently sent by the Council to Brazil's National Congress.

The first Dam Safety Report was released in November 2012 based on 2011 data. The objective of this report was to establish a baseline that could be used to track the evolution of the implementation of the National Dam Safety Policy. The report aims to assess the policy's effectiveness in reducing the number of accidents related to dam use. The 2011 Dam Safety Report also published a list of dams regulated by ANA, announced the publication of dam safety regulations, and commented on the progress made by the National Dam Safety Policy through its regulatory entities.

### **RESULTS ACHIEVED TO DATE**

The World Bank's Technical Assistance has helped ANA in the implementation of key National Dam Safety Policy tools, such as the dam classification system, the design of the SNISB, and the dam safety manuals. In efforts to strengthen dam safety officials, specific training courses and seminars have been designed and made available to anyone with an interest in the field.

Participants were very pleased with training sessions on dam safety in Brazil, and appreciated the role of the Bank in fostering this exchange among national and international professionals. Topics covered included dam break models, instrumentations, inspections and potential failure model analysis.

### **IMPLEMENTATION CHALLENGES FOR THE NATIONAL DAM SAFETY POLICY**

Two outstanding challenges for the PNSB are to help dam owners achieve greater awareness of their responsibilities and to integrate the different procedures from the various regulatory entities. For some sectors, the enforcement of new regulations will mean considerable changes to their traditional operational practices. Another challenge is attracting academics, university students and professionals with technical knowledge and skills in dam safety, a relatively new and innovative field.

There is also a need to promote greater awareness within civil society about dam safety issues. The PNSB is launching an education and communication program aimed at making society more aware of the importance of dam safety. The proposal is that all dam safety documentation will be published, and communities will have the opportunity to participate in disaster preparation exercises through dam break simulations organized by dam owners with Civil Defense authorities. Since dams and their respective reservoirs play a vital role in the life of many communities by providing a source of livelihood and spaces for leisure and recreational activities, these structures must be kept protected and safe.

It is hoped that by its completion date, the World Bank Technical Assistance Activity will have significantly contributed to the strengthening of ANA in its coordinating role of dam safety regulatory entities. Part of the goal of the assistance activity is also to expand the technical framework available to all regulatory entities as well as to public and private dam owners who will in turn create and spread good practices in dam safety and enhance their communication with society at large. ■



## For more information:



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