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THE BRAZILIAN NATIONAL DAM SAFETY INFORMATION SYSTEM (SNISB)

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Abstract. *Many countries have enacted dam safety laws at the national level and have been applying them to dam safety management activities. In Brazil, the first Dam Safety Regulation was published in 2010. The National Dam Safety Information System (SNISB, by its Portuguese acronym) is an instrument of the Brazilian National Dam Safety Policy (PNSB), which was established by the Federal Law nº 12.334/2010. The SNISB consists of a system for collecting, processing, storing and recovering information related to dams under construction, in operation and decommissioned. The main purpose of SNISB is to inform about the safety conditions of regulated dams across the country and to allow the follow-up of the advances in the implementation of the PNSB. Its basic principles are the decentralization of data and information production and input; unified coordination of the system and access to information guaranteed to whole society.*

The main features of SNISB include the support for implementing the PNSB; the interaction with existing systems at ANA; the exchange of information with dam owners; the follow up activities from regulators and the support for the production of the annual Dam Safety Report.

The responsibility for keeping the information available in SNISB system belongs to the regulating entities, either federal or state, which are responsible for ensuring that dam owners comply with the dam safety regulations. Dam owners will be the main source of information to the system. Besides being a federal regulating agency, the National Water Agency (ANA) is also the system manager.

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1 INTRODUCTION

The Brazilian Dam Safety Law, Federal Law Nr. 12.334/2010¹, is a landmark in the field of dam safety in Brazil. It establishes the National Dam Safety Policy, defines which dams are to be regulated, assigns legal responsibility to the dam owner following dam safety requirements, creates the National Dam Safety Information System (SNISB) and assigns regulatory authority to specific institutions, as shown in Figure 1.

The Dam Safety Law has assigned to the National Water Agency (ANA) the responsibility for implementing and maintaining the SNISB, on top of many other important duties. In order to comply with the legislation requirements, ANA, supported by a program of technical assistance established with the World Bank, is implementing the PNSB including the design of SNISB, counting on the expertise of the National Laboratory for Civil Engineering (LNEC), from Portugal. The system implementation is now underway, with its first modules to be released in 2015.

SNISB will be accessible through ANA's website, thus being available to society. It will have the following main modules: Dams and Entities Inventory, Classification, Dam Safety Plan, Dam Safety Report, Adverse Events, Regulator, Document Manager, Reporting and Publishing and Administrator.

The information will be available in different levels depending on the user profile. The main users of the system will be the Regulating Entities, Dam Owners, Civil Defence System, Environmental Entities and Civil Society. The system will store information required to classify dams by vulnerability and hazard potential and it will provide tools to its classification according to the criteria of the National Council of Water Resources (CNRH) Resolution n°. 143/2012². Specific dam safety management tools included in SNISB will be available for all regulating entities in Brazil.

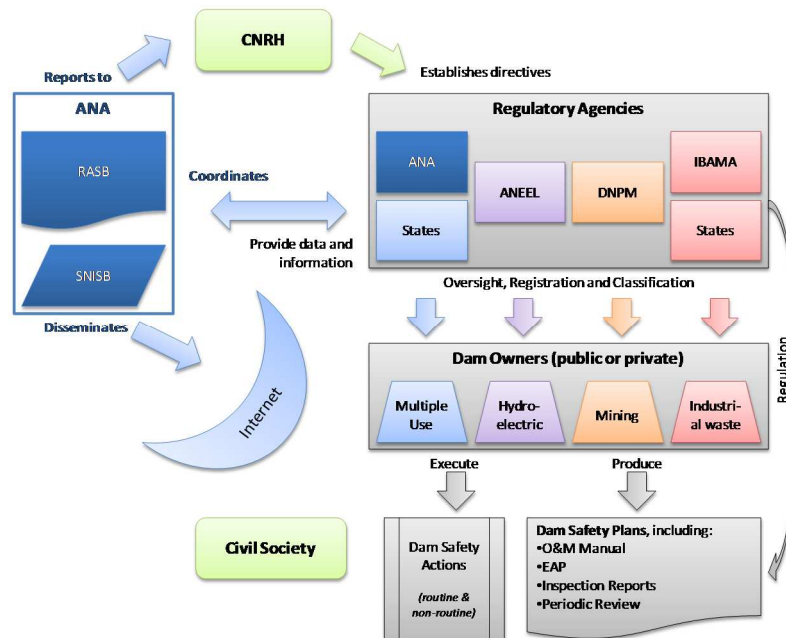


Figure 1: Dam Safety regulation institutional framework (adapted from ANA³)

2 LEGAL FRAMEWORK

One of the instruments of the Dam Safety Law is the National Dam Safety Information System (SNISB). The system will consolidate electronically dam safety information of all dams across Brazil, including dams that do not meet the criteria defined in the Dam Safety Law.

One of the main purposes of the SNISB is to support the generation of the annual Dam Safety Report (RSB) that ANA must submit to CNRH to inform the status of dam safety across Brazil. The information collected will also be available to the public through ANA's website to increase social awareness and participation on dam safety across the population.

Article 14 of Law 12.334/2010 establishes three basic principles for the operation of SNISB: i) decentralization of procurement and production of data and information; ii) unified coordination system and iii) access to data and information guaranteed to whole society.

Subsequently, in 2012, the CNRH issued the Resolution n° 144⁴ that establishes the guidelines for the implementation of PNSB and defines the scope and the entities responsible for SNISB information:

- **ANA**, as SNISB manager, is responsible for the design, organization and implementation of SNISB; to establish the integration rules and procedures of information exchange with other regulating entities; to define, along with other agencies, which information will be stored in the system and to provide access to data and information to society through the World Wide Web;
- **Regulating Entities** are responsible for maintaining in SNISB an up-to-date register of dams under their jurisdiction, including the dam classification. It will be up to the regulating entities to implement required changes in their own Information Systems (IS) to feed SNISB with their data;
- **Dam Owners** are responsible for keeping the information on its dams up-to-date and make it available to their regulating entities.

3 MAIN OBJECTIVES OF SNISB

One of the main objectives of the SNISB is to provide an overall picture of the dam safety situation across the country, consolidating and processing the dam safety management data from all federal and state regulating jurisdictions. Additionally, the SNISB will be the main source of data to generate the annual Dam Safety Report that ANA submits annually to CNRH. The annual report describes the status of the National Dam Safety program, including progress achieved by participating states and federal agencies, and recommendations for legislative and other actions that CNRH considers necessary.

In order to let some state entities use SNISB as their main dam safety management system, and to support some risk based screening process within SNISB, all dams can be uploaded into SNISB, including those that are out of the PNSB scope. Specific PNSB flag to identify dams within the scope of PNSB will be available. It will be up to regulating entities to use SNISB as their own full-scale dam safety management system in addition to the required information to meet Dam Safety Law obligations.

The submission of dams to the SNISB is done by the regulating entities. The regulating entity gets into dam inventory submission procedure (there is a specific module for dam submission) and can either proceed with a manual input of a new dam or review any pending submission reviewed by the system administrator.

4 SNISB DATABASE

SNISB is a custom application designed using a software engineering method to design a solution that addresses the specific requirements for SNISB.

SNISB will be integrated with ANA's website and other applications in use, such as the PROTON system, ANA's document management system. Some components might be shared within ANA's Information Technology (IT) resources to leverage existing tools, applications and technologies.

Dam safety data available in existing systems across the country will have to migrate to SNISB. This process can be characterized as one-step data integration where multiple data sources will be migrated into the SNISB database format. There will be no on-line integration among regulating entity systems and SNISB, thus a special migration tool will be available for the first load of the system. A standard Dam Template will be available to describe which information is to be collected for each dam in order to use the uploading mechanism implemented. Once a dam is registered for the first time, it will need to be managed directly in SNISB. The regulating entity will be accountable of the information they provide.

User access policy, as one of SNISB's principle, is to have information available to public through a website, where most information will be available in read-only mode. However, there are some restrictions for information such as dam inundation maps or information on accidents/incidents classified as non-public.

The level of details of current dam data varies significantly across regulating entities and most entities will need to complete their database to have key information about the dam. Indeed, this will also impact the use of SNISB modules, such as the classification module that requires specific data to be available in order to use the SNISB tools to classify dams.

5 SNISB MAIN MODULES

Figure 2 details the main modules of SNISB: Dams and Entities Inventory, Classification, Dam Safety Plan, Dam Safety Report, Adverse Events, Regulator, Document Manager, Reporting and Publishing and Administrator.

5.1 Dams and Entities Inventory

The **Dam Inventory** module contains information on the dam location, dam purpose, entities associated to the dam, a comprehensive set of fields to describe the dam structure and foundation, instrumentation, reservoir, appurtenant works, dam licenses, upgrading and rehabilitation works and operation and maintenance data. Figure 3 shows a high-level diagram with the main information classes of the dam inventory.

Each class has a detailed set of parameters and can be further decomposed. Figure 4 illustrates the details for associated entities (organizations) and technical data for the reservoir.

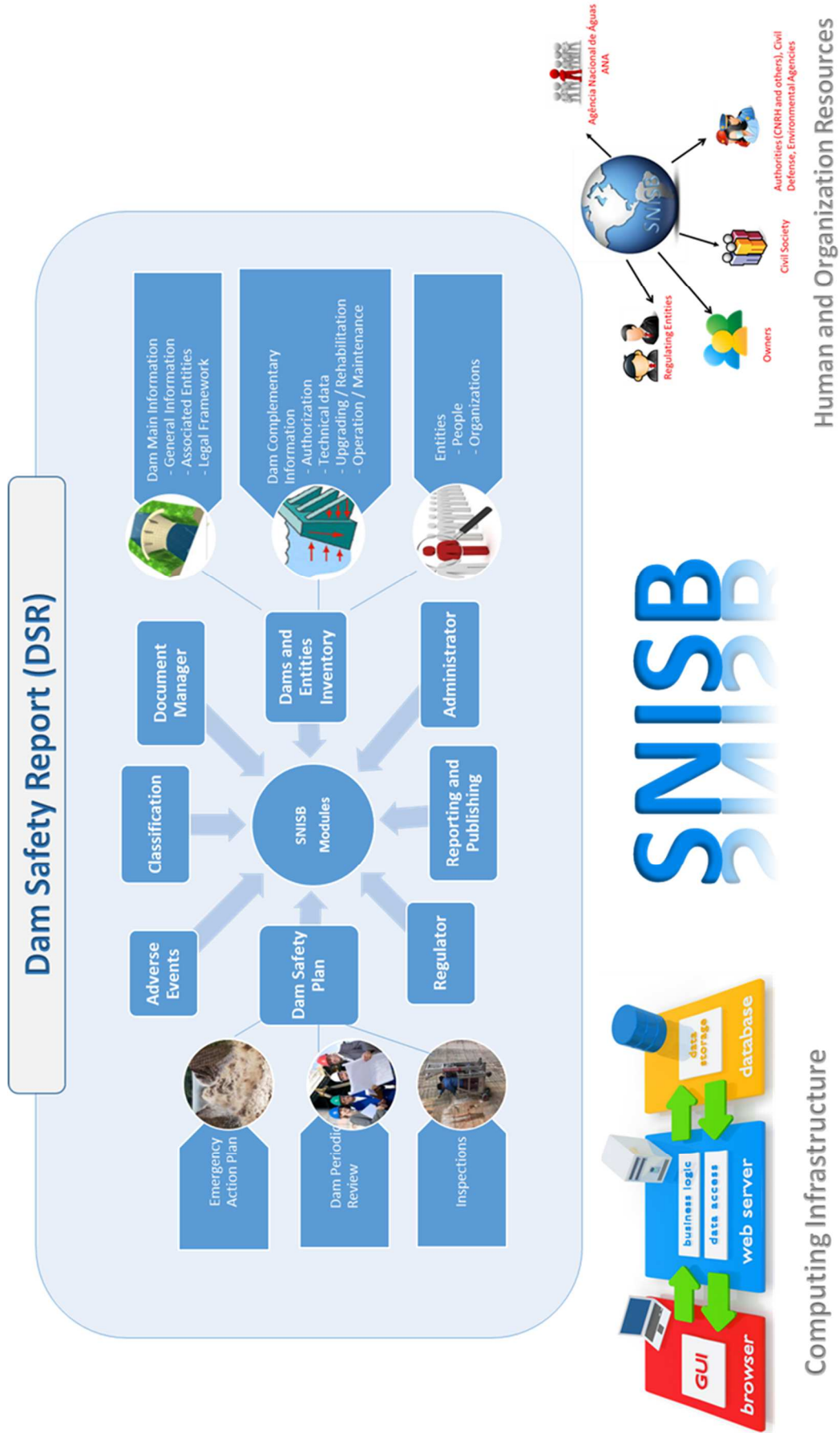


Figure 2: SNISB modules

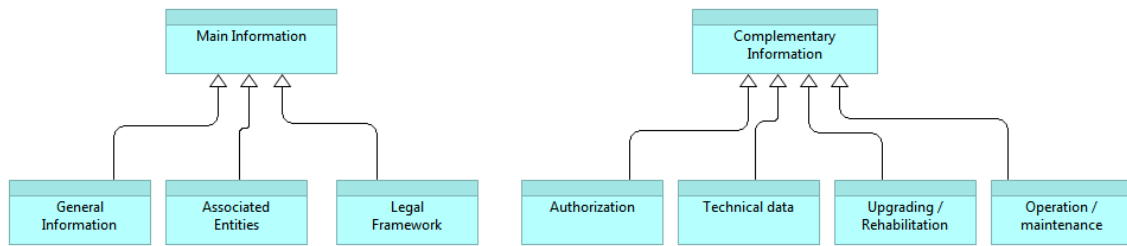


Figure 3: Dam inventory

Whilst the dam is the central element in SNISB inventory, ancillary information on the organisations and people that somehow interacts with the dam is also available in the **Entities Inventory** module, such as regulating entities details, dam owners' details, etc.

Figure 4: Organization and reservoir details

5.2 Classification

The SNISB includes a dam **Classification** module (based on risk and potential associated hazard) as defined by CNRH². Such classification is a key output of the dam safety system.

According to one of the PNSB principles, regulating entities may define specific requirements for the dam under their jurisdiction, based on general criteria established by CNRH. If the regulating entity follows the CNRH classification system, it is possible to

use SNISB's tools to support the classification process; otherwise, the results of the dam classification (risk and potential associated hazard) must be uploaded to the system.

By default, SNISB provides the tools for the classification of: i) multipurpose dams; ii) tailing dams and iii) hydroelectric dams, in this case the tool is adapted from CNRH, according to the specifications of the National Hydroelectric Agency, ANEEL.

5.3 Dam Safety Plan

The **Dam Safety Plan** (DSP) module is designed to provide a summary of the dam safety conditions regarding the implementation of the PNSB. Data can be input either on a summary-level basis, or on a record-basis in detailed related tabs.

As part of the DSP profile, information about dam **Inspections**, either regular or special inspections, are uploaded into SNISB using the inspection tab. It allows the regulating entity to keep track of the dam conformity according to the regulation requirements.

The **Emergency Action Plan** (EAP) identifies potential emergency conditions at a dam and specifies pre-planned actions to be followed to help prevent loss of life and minimize property damage. It contains procedures and information such as failure inundation maps to assist emergency management officials with early-warning notification and evacuation plans. Information on the EAP is available in the EAP tab. Inundation maps are available only for specific system users.

The **Dam Periodic Review** (PR) is also part of the DSP and the PR tab contains information regarding its implementation.

5.4 Dam Safety Report

The annual **Dam Safety Report** (DSR) depicts the actual PNSB implementation status. SNISB has a tool to support the generation of a questionnaire, which is prepared annually by ANA to retrieve information from regulating entities and feed the DSR. The tool provides the regulating entity the capability to answer the questionnaire on-line and keep track of all data related to the dams under its jurisdiction.

A specific report is generated showing the collected responses for the questionnaire and the information available in SNISB database for each dam.

5.5 Adverse Events

The **Adverse Events** module allows the registration of any abnormal situation such as floods, earthquakes or any accident or incident affecting a dam.

According to the Brazilian legislation, all accidents and incidents across the country, under the PNSB or not, have to be reported to ANA. Thus, ANA may enter information on accidents/incidents directly into SNISB.

To ensure that the information to be published on public website is consistent and ready to be disclosed, there will be a "Publication Status" field. Only accident and incident reports with such status set to "Public" will be disclosed on the website.

After the occurrence of an adverse event, corrective measures may be taken and they can be recorded in SNISB, including a process to follow-up the correction of deficiencies and non-conformities.

5.6 Regulator

The **Regulator** module is tailored to those regulating entities willing to use SNISB as their own dam safety management system.

The regulator module supports the regulating entity to follow up its supervision activities and verify the conformity of dam owner duties according to the requirements of the legislation in force.

This module will have further developments in the next upgrade of SNISB.

5.7 Document Manager

The Document Manager module enables search and review of documents of any particular dam.

Documentation should be maintained up-to-date so that a permanent record exists of the design, construction, operation and performance of the dam, and the management of its safety.

5.8 Reporting and publishing

Standard reports are available upon user request in the web interface and they can be generated in different formats. Figure 5 shows examples of graphs and diagrams outputs.

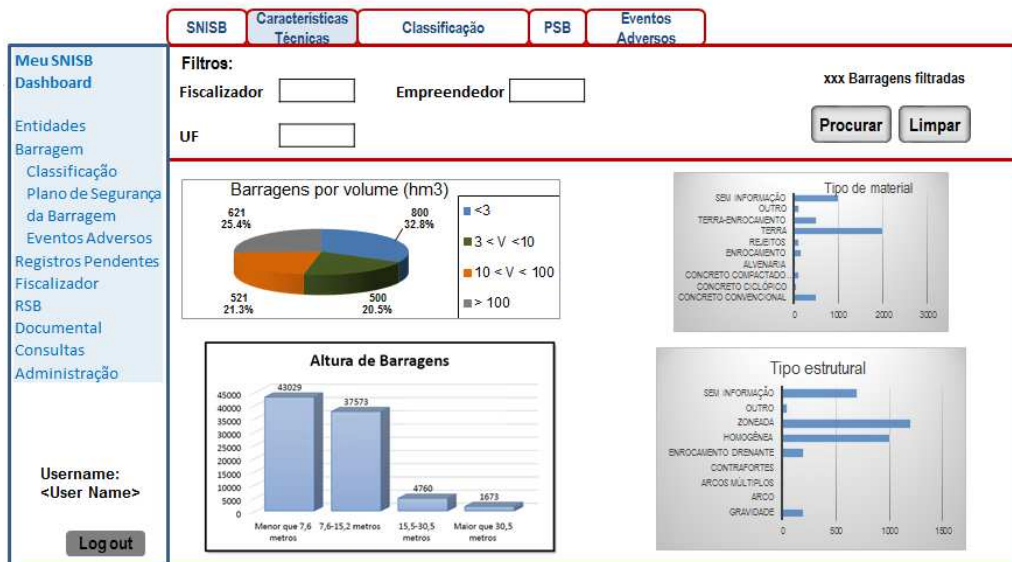


Figure 5: Graphs and diagrams output example

SNISB users, such as the system administrator or regulating entities, can design queries for their own analysis purposes to generate reports, including *ad hoc* reports for the annual dam safety report. Therefore, there will be a Report Generator / Business Intelligence tool to perform such analysis.

A map viewer component is available to characterise the physical environment of the dam and the associated downstream features. Figure 6 presents an example of this component showing a resume of dam safety information.

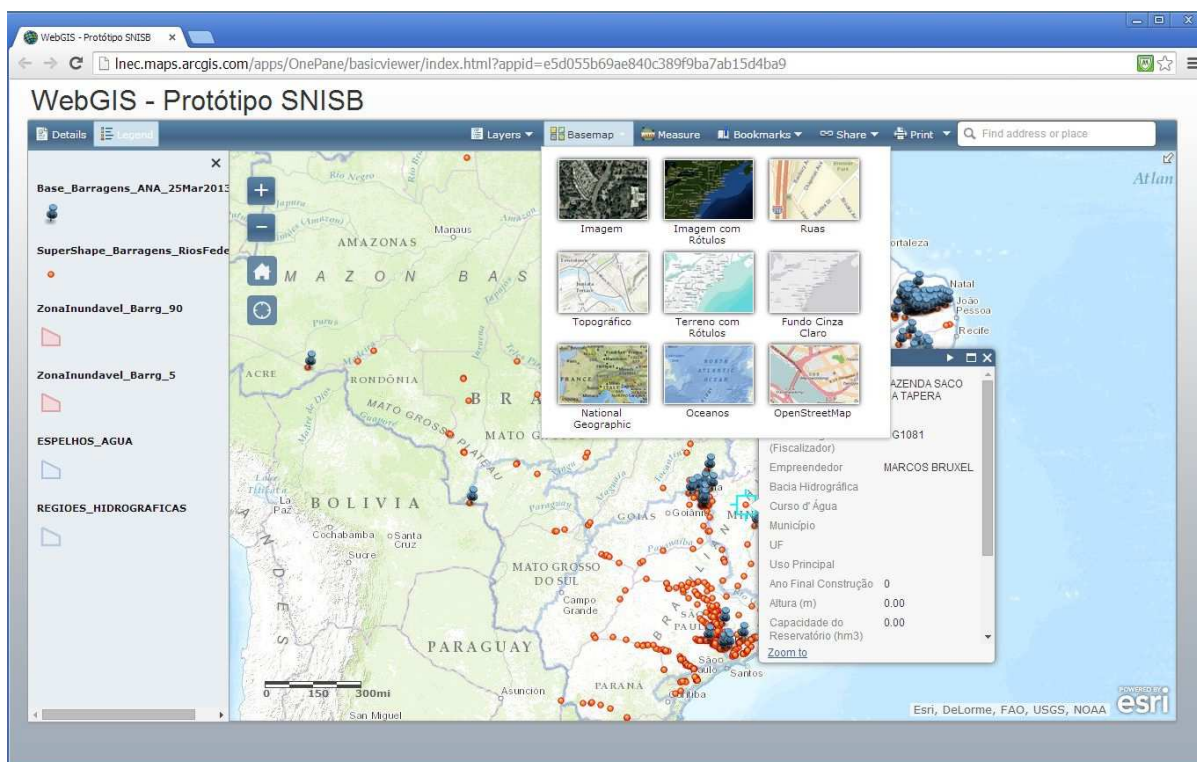


Figure 6: Map viewer interface example

5.9 Administrator

The **Administrator** module is designed for the system administrator and the regulating entities to manage the system users.

It is also available in this module a tool for managing domain values, which can be qualitative or semi-quantitative (a finite qualitative list of values with associated quantitative values, used as weights for the classification algorithms). This tool allows administrators to configure and update the list of domain values for each concept (e.g., the material type's list can be continuously updated to include any value that was not considered during the initial design). This tool supports the evolution and upgrade of SNISB without the need of intervention on source-code by the software developers.

6 CONCLUSIONS

Requirements for the safe operation, maintenance and surveillance of dams, shall be suitably documented and contain sufficient information in accordance with the consequences of dam failure.

In a country of continental dimensions like Brazil, with a great lack of adequate information on dam safety, SNISB will play a vital role for all organisations working with dam safety issues, either dam owners, regulating entities or government. It will also support the decision making process to ensure consistent levels of public protection when evaluating and modifying existing dams and appurtenant structures and when designing new dams and/or structures.

The SNISB design followed a software engineering method adopted by ANA projects, with the aim to design a solution aligned with the specific functional and non-functional requirements for SNISB. Design options and proposed solutions can be tracked back to requirements and business rules. On the other hand, SNISB was designed for scalability, through a modular approach for progressive growth. Improvements and new

developments are planned to be implemented in a second phase, towards a more comprehensive and helpful dam safety management system.

SNISB is currently being implemented by a team of software developers following the modules proposed by the SNISB design. This approach has proven to be effective, as the software construction could be decomposed by multiple software components (associated to SNISB modules), making it possible to release software prototypes for initial testing and validation by end-users. The first module to be deployed in 2015 will be the dam and entities inventory.

REFERENCIAS

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[2] National Council of Water Resources (CNRH). Resolution No. 143 of 10th July 2012.

[3] Agência Nacional de Águas. Relatório de Segurança de Barragens 2011 (Dam Safety Report 2011). ANA, 2013 (*in portuguese*).

[4] National Council of Water Resources (CNRH). Resolution No. 144 of 10th July 2012.