



DAM SAFETY MANAGEMENT IN SPAIN

REGIONAL COOPERATION MEETING
DAM SAFETY IN CENTRAL ASIA

Almaty, Kazakhstan
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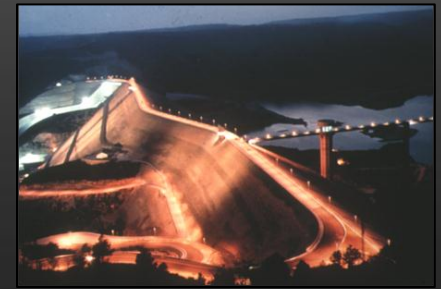
DamSafety



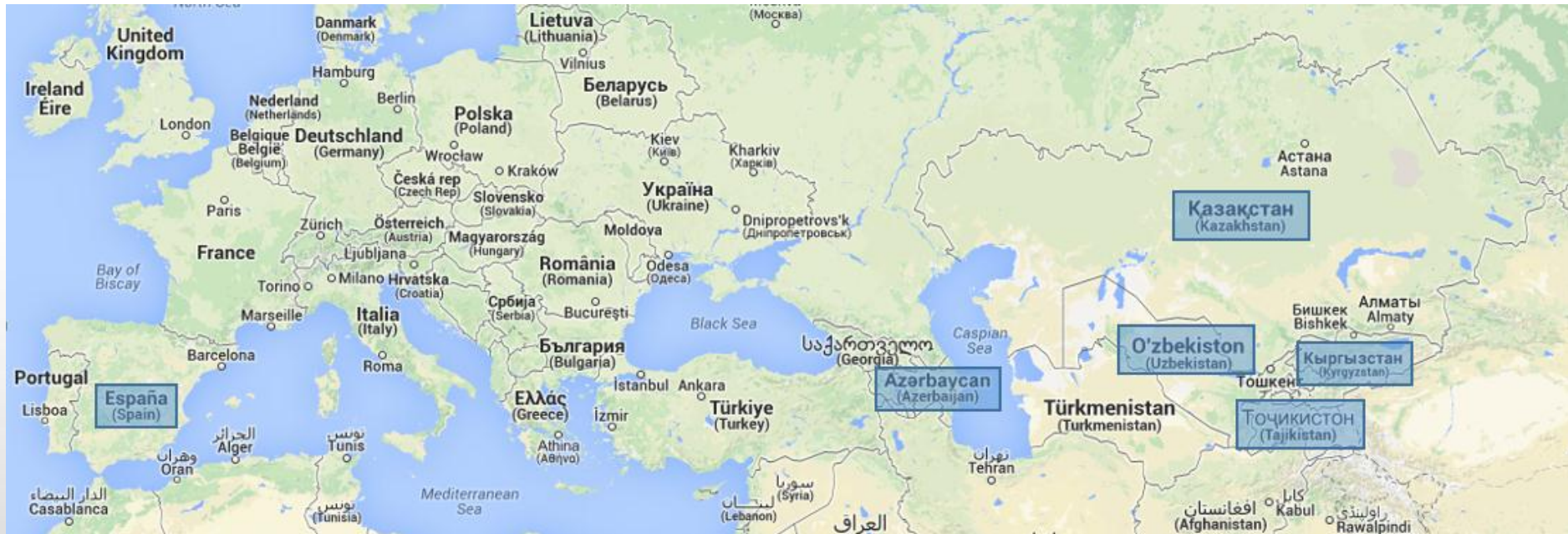
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1. Introduction. Water in Spain

2. Large Dams in Spain
3. Dam Safety Legislation
4. Guidelines on Dam Safety
5. Dam Safety Management
6. Conclusions



1. INTRODUCTION . WATER IN SPAIN

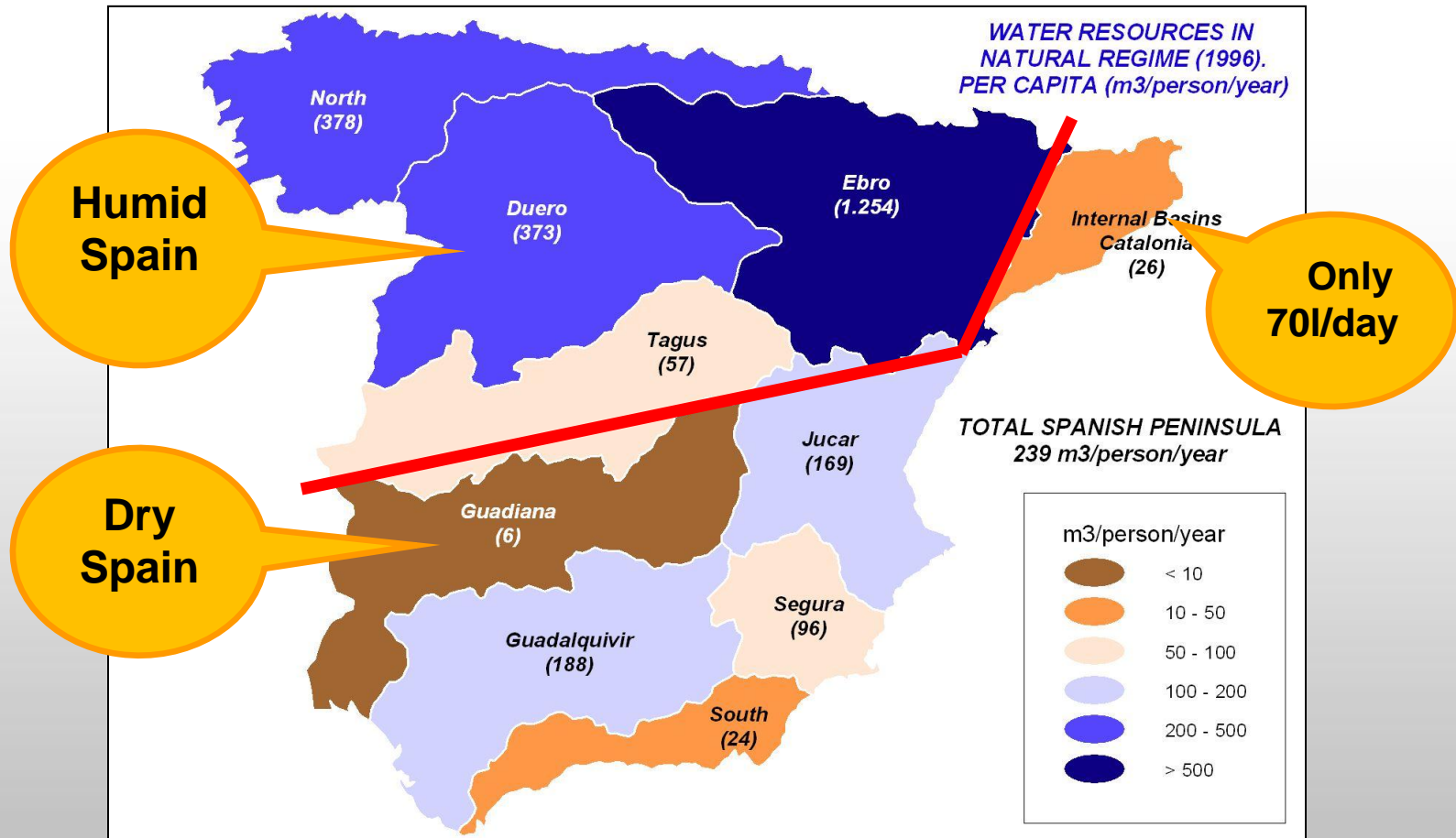


	ESPAÑA SPAIN	КАЗАХСТАН KAZAKHSTAN	КЫРГЫЗСТАН KYRGYZSTAN	ТАДЖИКИСТАН TAJIKISTAN	УЗБЕКИСТАН UZBEKISTAN	АЗЕРБАЙДЖАН AZERBAIJAN
						
Area (Km2)	504.645	2.717.300	198.500	143.100	447.400	86.600
Population (million)	47,2	17	5,5	6,5	29,4	9,1

Climate and hydrology

- Highly irregular rainfall and river flow, both in time and space.
- Temporal variation is not only seasonal but also from year to year.
- Only an 8,3% of the renewable resources is available in natural regime (9,19 km³/year).
- That means that there are only 239 m³/person/year available in natural regime.

Facts and Data on Water in Spain

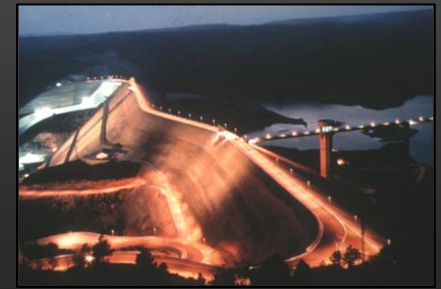


Facts and Data on Water in Spain

- Spain has required, since ever, an enormous effort in water resources planning.
- Dams and reservoirs made it possible to increase the natural regulation of only 8,3% up to 40 % of the water resources.

Natural resources	Available without regulation	Available with regulation	Reservoir capacity
112 km ³	9,19 km ³	46 km ³	56 km ³

1. Introduction. Water in Spain
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2. LARGE DAMS IN SPAIN

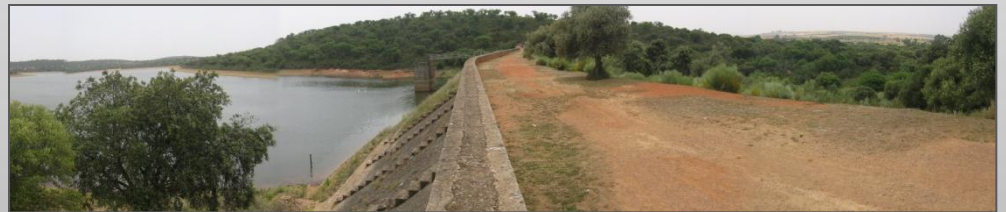
Dam construction in Spain has a long history of more than 2000 years, starting in the Roman period.

**Roman dams still
under operation**

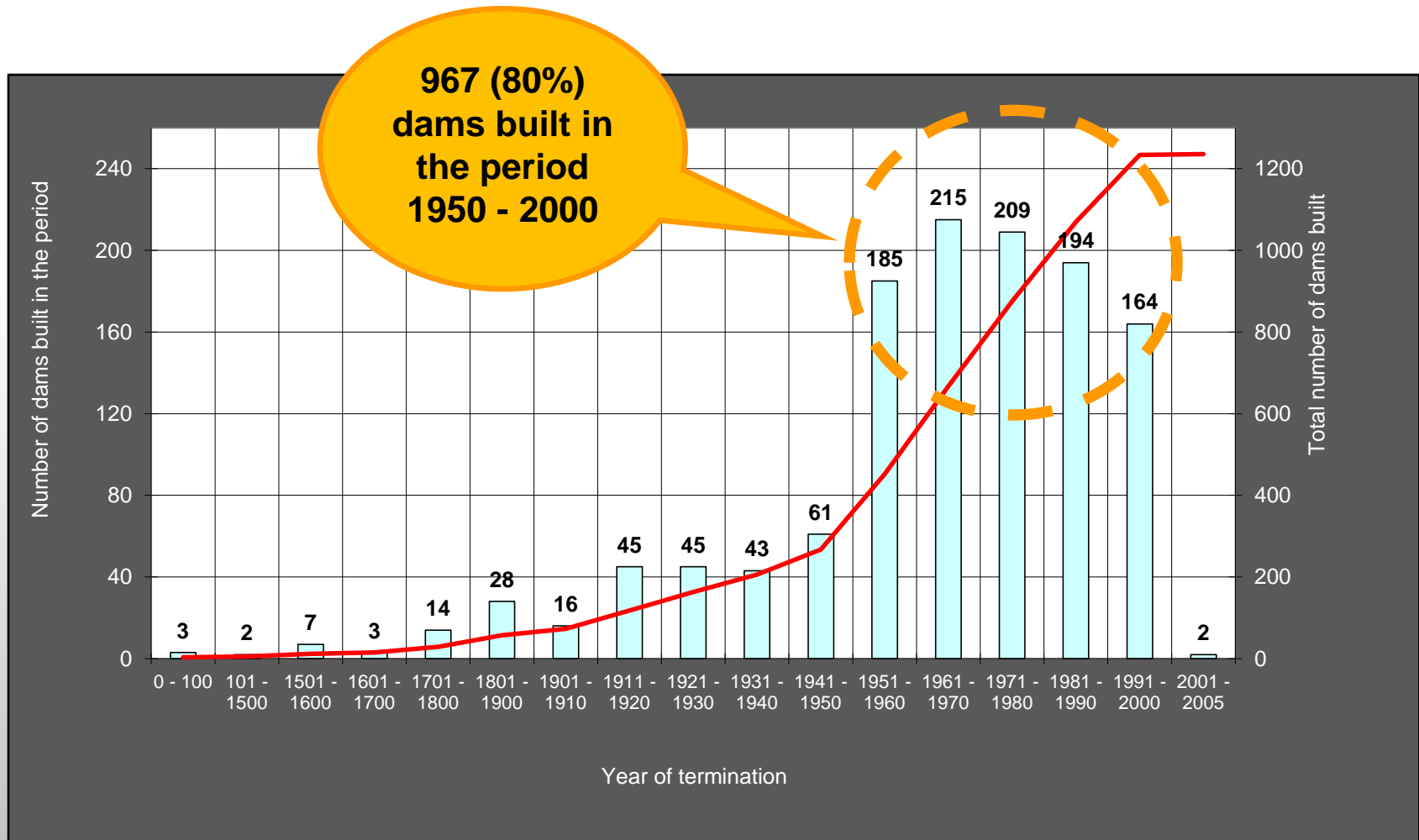
Proserpina



Cornalbo



2. LARGE DAMS IN SPAIN



- **At present there are more than 1200 large dams under operation:**
 - 1/3 aprox. are operated by the government
 - 2/3 operated by private companies under temporal license

- **Irrigation demand for irrigation: 24,2 billion m³**

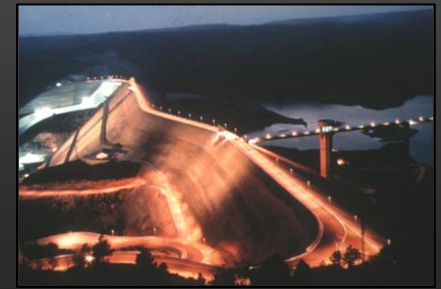
- **Water supply demand: 4,3 billion m³**

- **Industrial demand: 1,9 billion m³**

- **Irrigated area: 3,7 million hectares (37.000 km³)**

- **Benefits produced by Spanish Dams: ~ 30 billion €
(= 3% of GDP)**

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Legislation on Dam Safety: Historic Development

- **1905 Spain adopts the first European standards related with dams:**
“Instructions for developing reservoir projects”
- **1959 Failure of Vega de Tera buttresses dam killing 144 persons in Ribadelago.** This fact promoted:
 - The constitution of the Commission of Large Dams Regulations
Commitment: To develop new standards for dam projects
 - The creation of the National Service of Surveillance and Inspection of Dams
Commitment: To survey safety of dams
- **1967 The “Instruction for the Project, Construction and Operation of Large Dams”** is adopted.

Tous Dam failure in October 1982



Tous Dam after failure in 1982

Tous dam failure in 1982 originated a complete review of Dam Safety regulations:

- 1982** The failure by overtopping of Tous Dam originated the starting of a ***“Safety Program for Large Dams”*** that are state owned .
- 1992** The ***General Directorate of Hydraulic Works*** decided to prepare new standards for dam safety, commending this task to the Commission of Large Dams Regulations.
- 1995** The ***“Directive on Civil Protection in the case of flood risk”*** was published, including a section dedicated to emergency planning for the risk of failure or malfunctioning of dams.
- 1996** The ***“Technical Regulation on Dams and Reservoirs Safety”*** was approved, summarizing the works of the Commission of Large Dams Regulations and integrating the requirements of the ***“Directive on Civil Protection in the case of flood risk.”***
- 2008** A Royal Decree came into effect to establish common obligations and responsibilities for all dam owners. The text mentions that **dam safety management should be risk based.**

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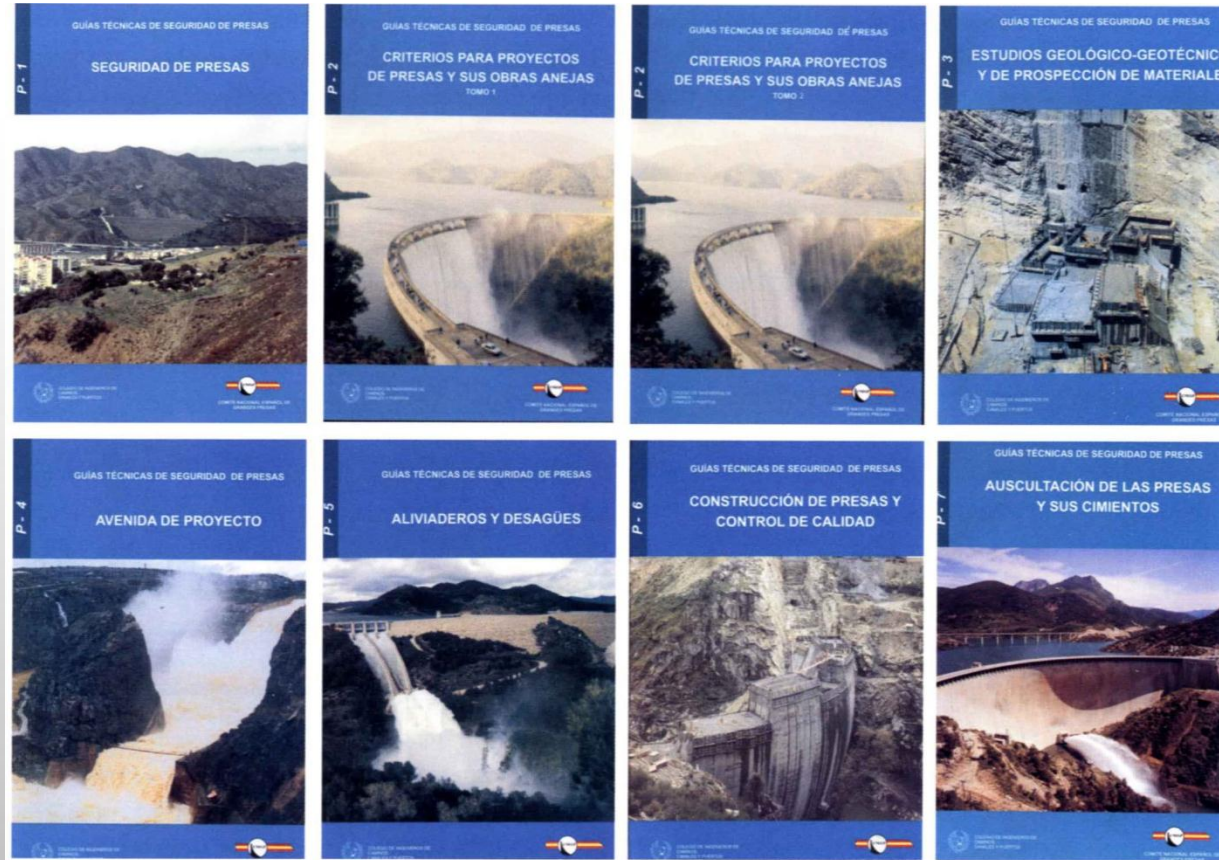


Guideline collection prepared by the Spanish Committee on Large Dams (SPANCOLD):

[http://www.spancold.es/Paginas/lista_publicaciones.asp?Categoria=Guias Tecnicas](http://www.spancold.es/Paginas/lista_publicaciones.asp?Categoria=GuiasTecnicas)

SPANCOLD Technical Guidelines	Year of Publication
Dam Safety	2005
Design criteria for dams and complementary works	2002
Geologic-geotechnical aspects and material studies	1999
Design Flow	1997
Spillways and Outlets	1997
Dam Construction and Quality Control	1999
Monitoring of dams and their foundations	2004
Operation and maintenance of dams: Vol. I: Risk Analysis applied to dam safety management	2012

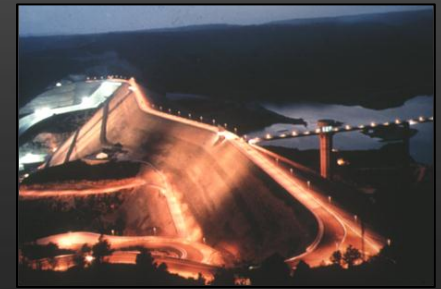
Guideline collection prepared by SPANCOLD



Guidelines by the General Directorate of Water

Spanish Ministry Technical Guidelines	Year of Publication
Dam classification according to potential risk	1996
Elaboration of Emergency Action Plans	2001
Operation and Maintenance	Draft version
Annual Report	Draft version
Safety Review	Draft version

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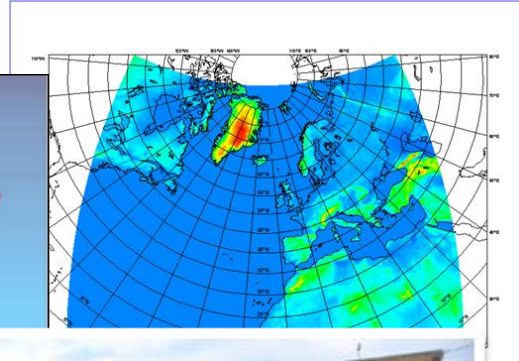
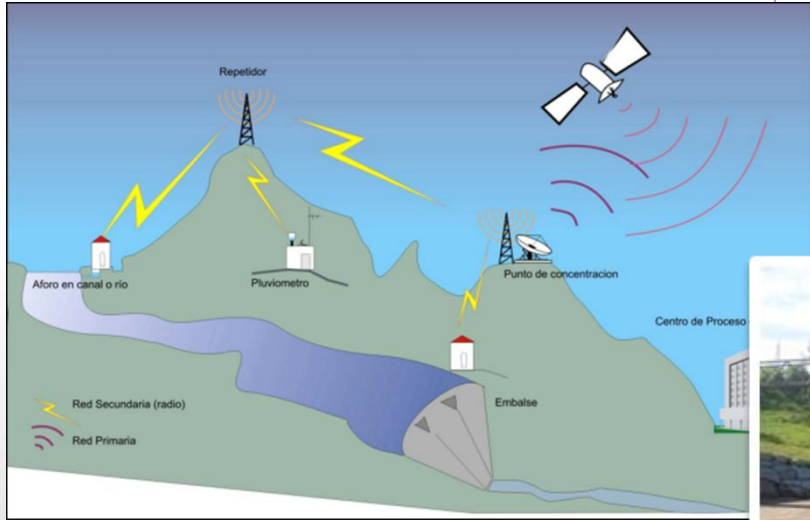
- Main focus on risk potential in the downstream areas of dams

- Implementation of non-structural measures such as:
 - Real time hydro meteorological information systems
 - Emergency action plans

- Comprehensive Dam Safety Management Programs
 - Detailed review of safety conditions of existing dams
 - Review and improvement of operation and maintenance procedures
 - On-going dam surveillance activities

Fundamental tools:

Real time early warning and flood forecast systems & DSS



Quantity and Quality

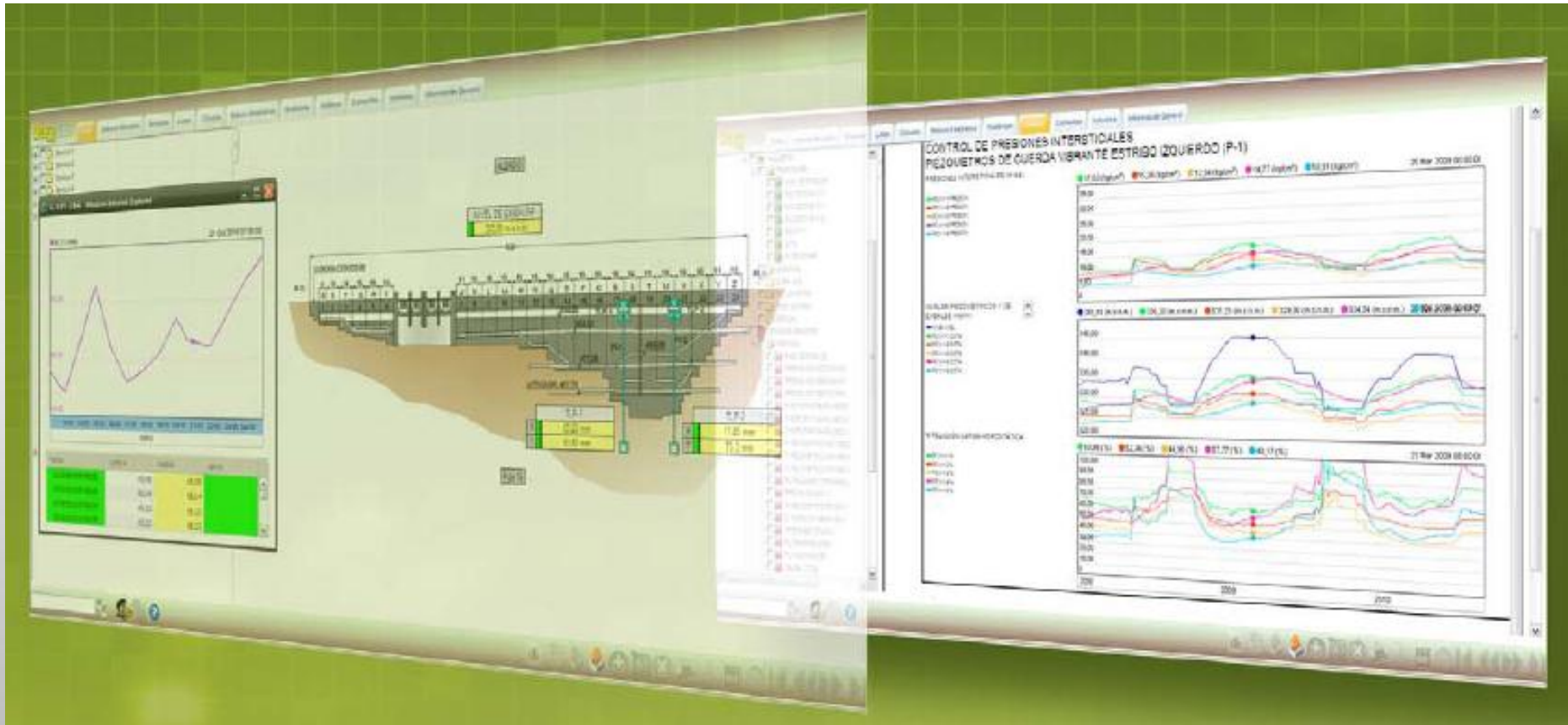


Fundamental tools: Dam monitoring and on-going safety assessment

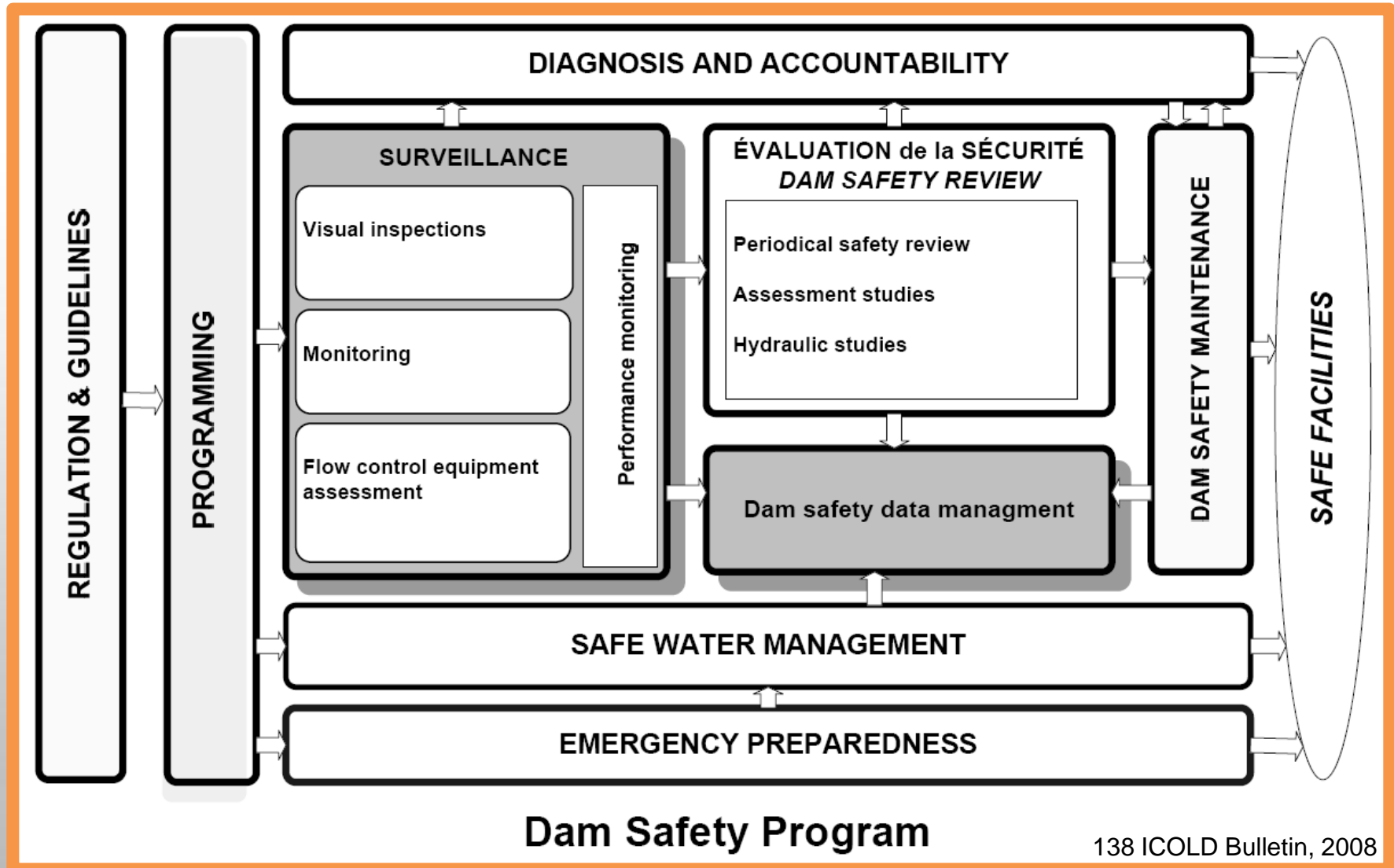


Web-based tool for an integrated management of real time & on site monitored data

DamSafety



Basic elements in a Dam Safety Process according to ICOLD:



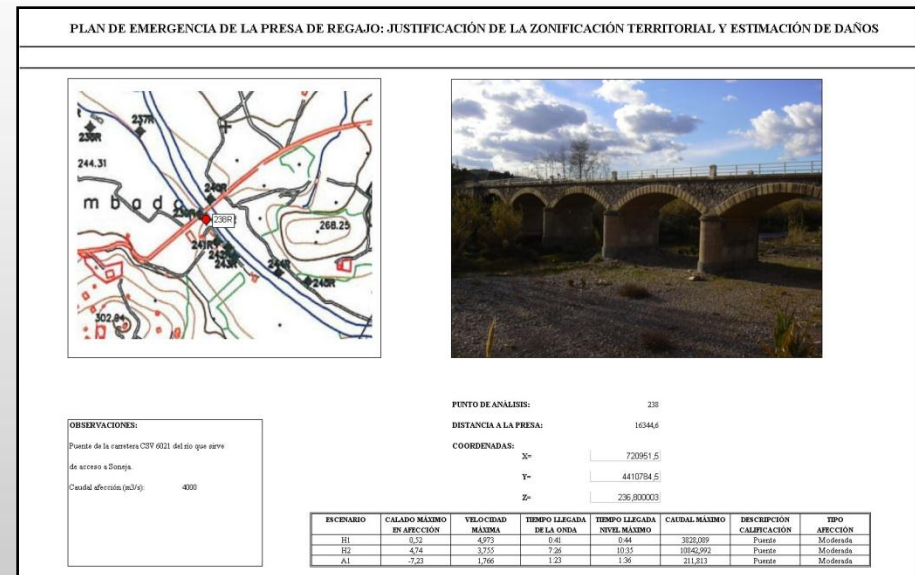
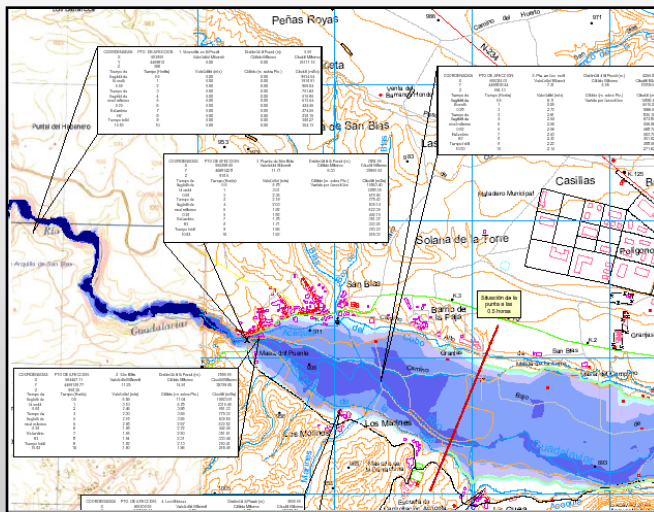
Detailed tasks and actions:

- *Constitution of Dam File containing all relevant documents*



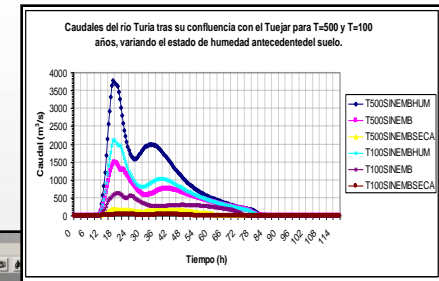
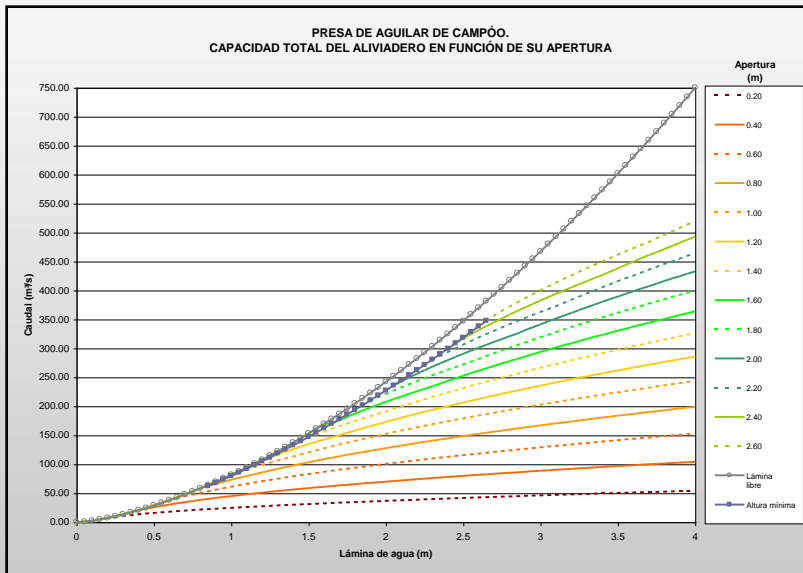
Detailed tasks and actions:

- Constitution of Dam File containing all relevant documents
- **Potential Risk Classification**



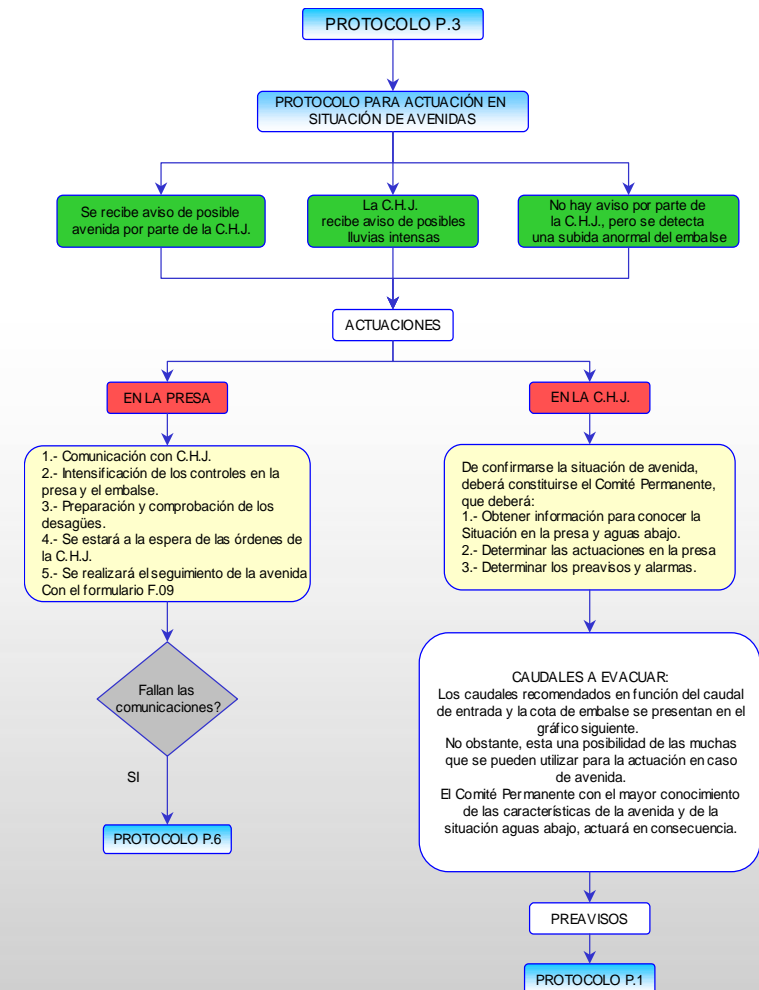
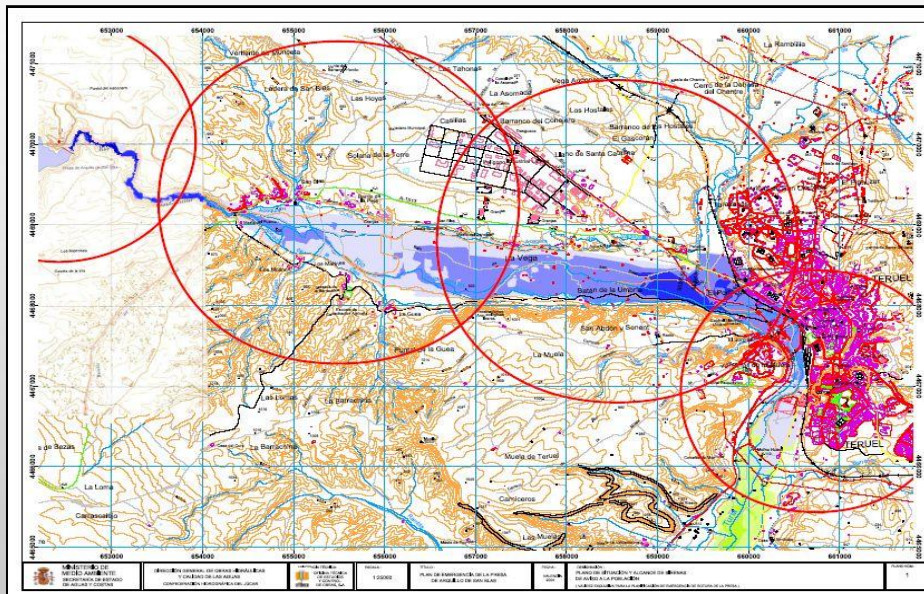
Detailed tasks and actions:

- Constitution of Dam File containing all relevant documents
- Potential Risk Classification
- **Operation & Maintenance rules**



Detailed tasks and actions:

- Constitution of Dam File containing all relevant documents
- Potential Risk Classification
- Operating procedures
- **Emergency Action Plan**



Action protocol

Detailed tasks and actions:

- Constitution of Dam File containing all relevant documents
- Potential Risk Classification
- Operating procedures
- Emergency Action Plan
- ***Inspection Reports***



Dam and reservoir inspection



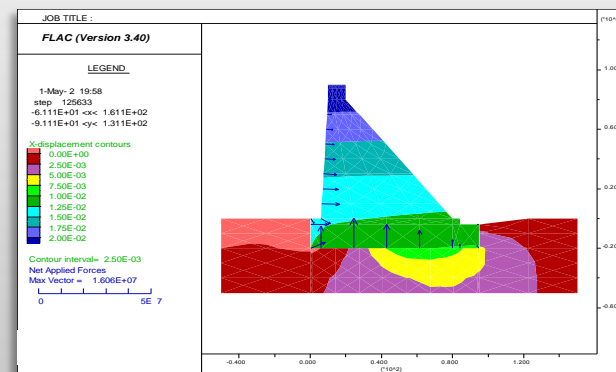
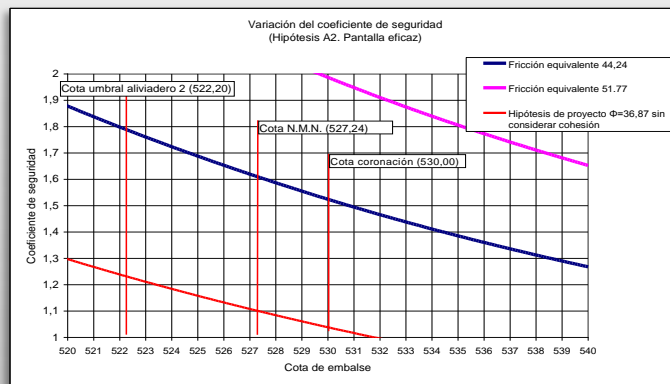
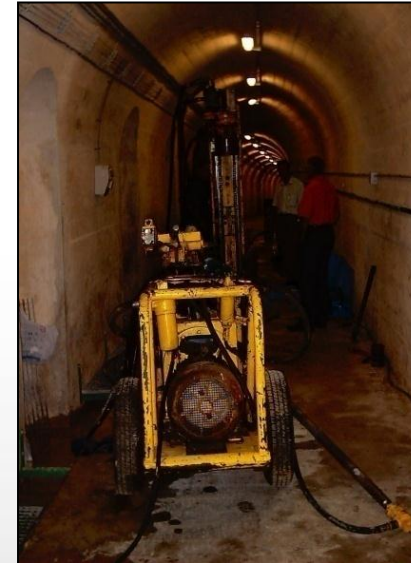
Hydromechanical equipment



Galleries and foundations

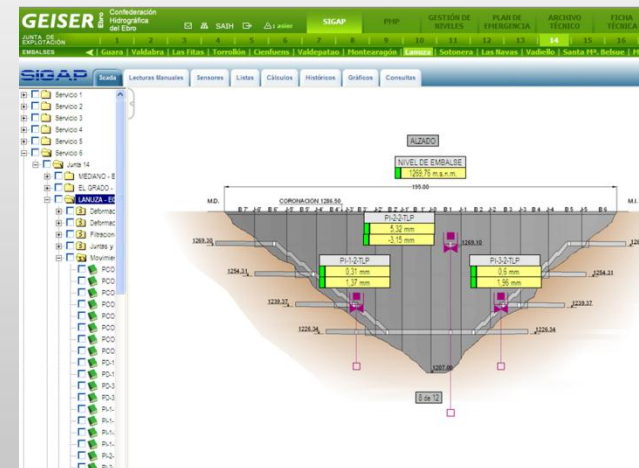
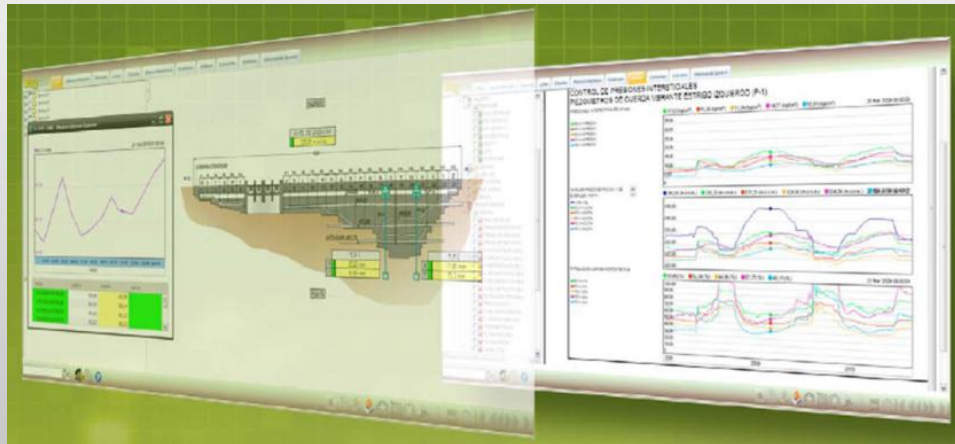
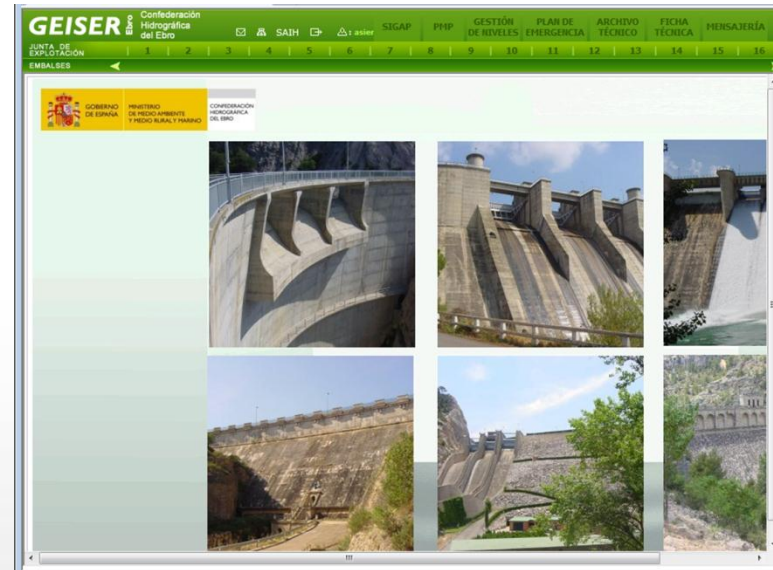
Detailed tasks and actions:

- Constitution of Dam File containing all relevant documents
- Potential Risk Classification
- Operating procedures
- Emergency Action Plan
- Inspection Reports
- **Safety Review**



Detailed tasks and actions:

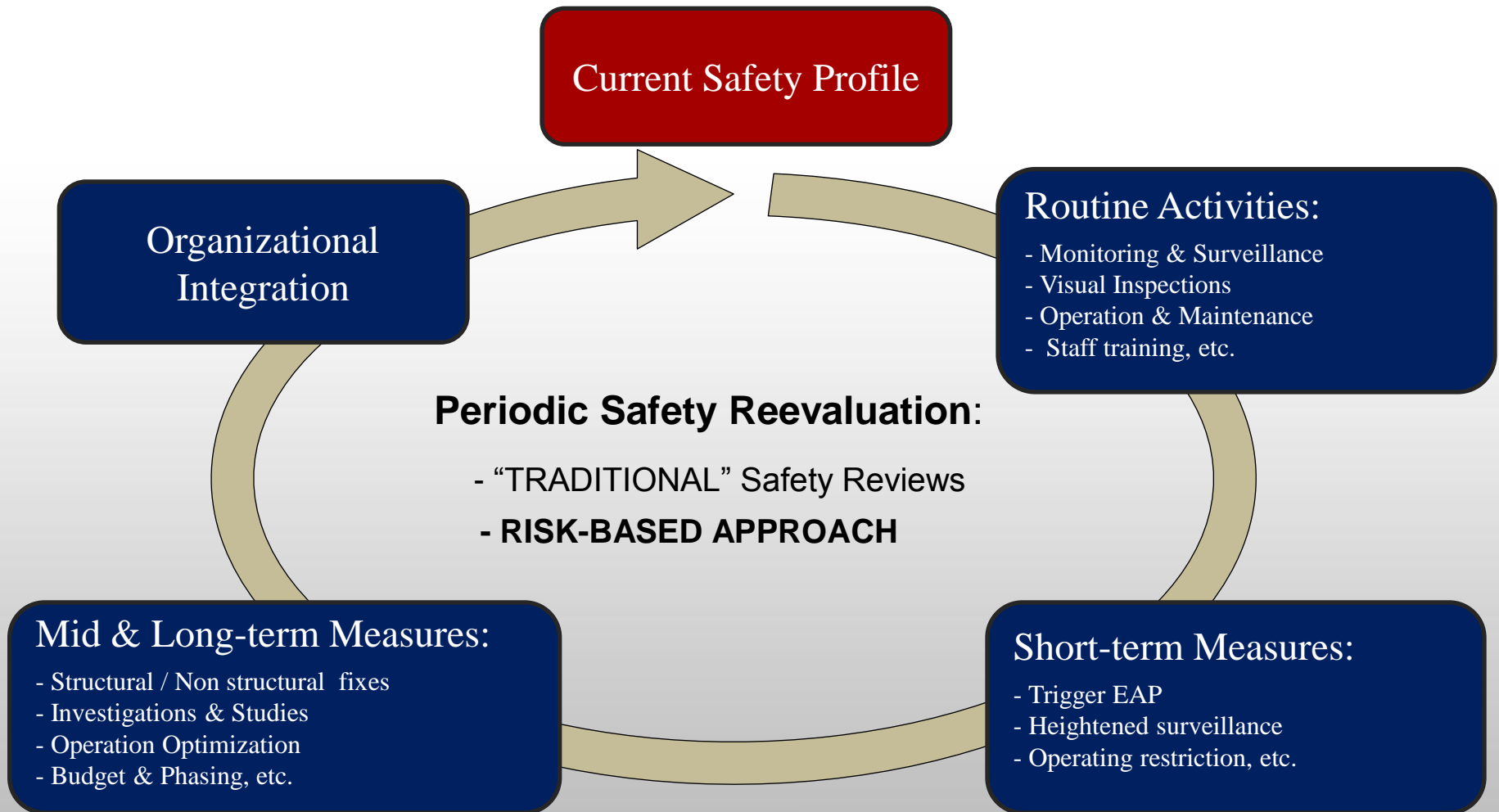
- Constitution of Dam File
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- Operating procedures
- Emergency Action Plans
- Inspection Reports
- Safety Review
- **Annual Reports**



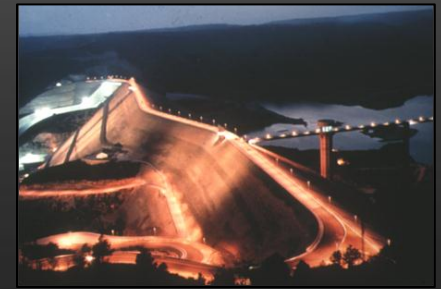
Future trends

- The dam engineering community agrees on the importance to update and unify regulations and safety requirements for both, state-owned and non state dams.
- Currently there is a clear trend towards a Risk-Based Dam Safety Decision Process.
- A dam safety law based on new technical regulations and the risk analysis methodology is under preparation.

Future trends: Overall holistic approach – on-going process

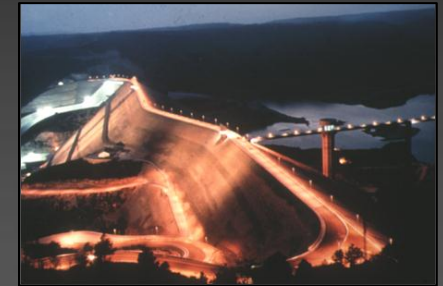


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- Spain has more than 1200 large dams and therefore a **strong tradition and technical capability** in this type of infrastructures and specifically in dam safety management.
- **Dam safety regulations are basic and fundamental** to establish dam safety programs aiming to reduce risk.
- All type of dam safety regulations should consider **not only technical aspects but also available economical resources and technical capabilities** of dam owners and regulators.
- **Training and capacity building of all personnel** involved is of crucial importance.
- A modern Dam Safety Program should have a **risk approach** and is an **on-going process**.
- Spanish organizations and institutions (e.g. General Directorate of Water belonging to the Ministry of Agriculture and Environment and the Spanish Committee on Large Dams SPANCOLD) are pleased to **share the experience** gathered over many years with other countries (**exchange and training programs**).

Thank you very much for your attention



Useful websites:

www.spancold.es

www.icold-cigb.org

www.damsafety.com