MINISTRY OF THE ENVIRONMENT

Secretary of State for Territory and Biodiversity

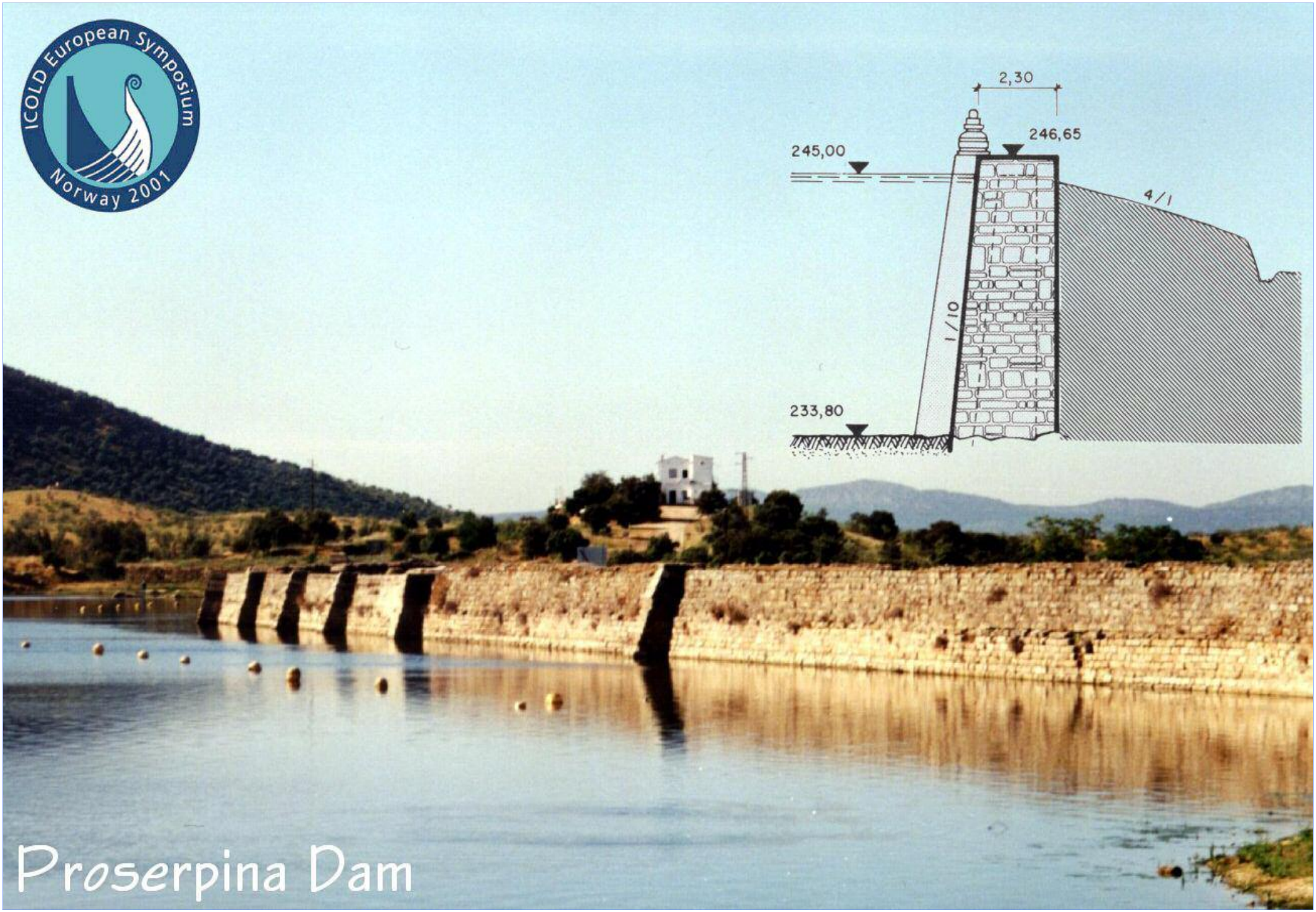
Directorate General of Water

DAM SAFETY DEPARTMENT

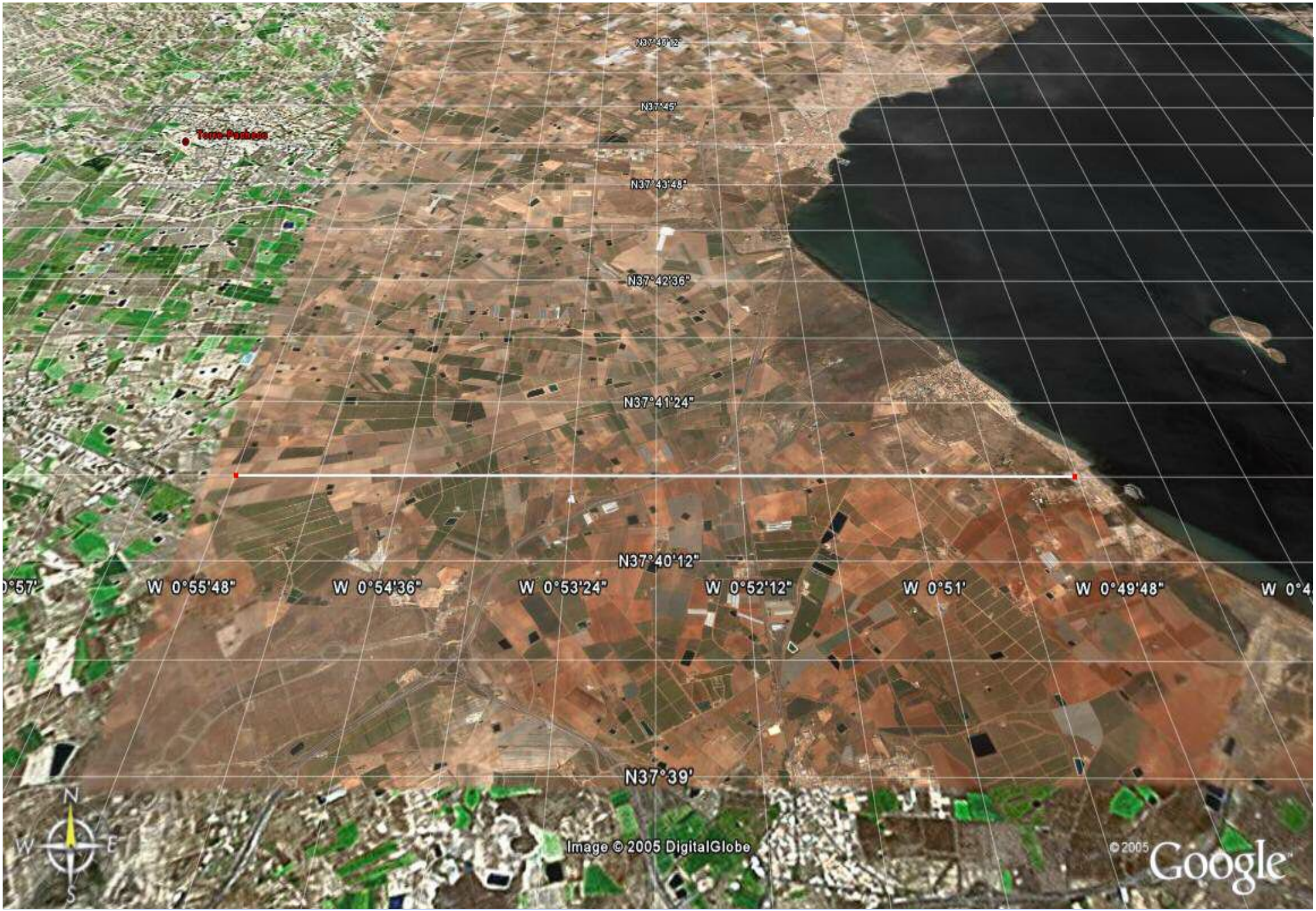
MINISTERIO
DE MEDIO AMBIENTE

CURRENT SITUATION

- 1200 Large Dams (H>15 m) → Under Control of D.S.D
- More than 50.000 farmer ponds → Uncontrolled
- 1º place in Europe; 4º place in the World
- 70% Concrete Dams, 25% Embankment Dams
- 30% Ministry of Environment
- 70% Hydroelectric and Private Companies, Farmers, Local Governements, etc.
- Oldest dams: Cornalbo (H=24 m) and Proserpina (H=19 m)



Proserpina Dam


N37°45'
Torre Pacheco
N37°43'48"
N37°42'36"
N37°41'24"
N37°40'12"
W 0°55'48"
W 0°54'36"
W 0°53'24"
W 0°52'12"
W 0°51'
W 0°49'48"
N37°39'
Image © 2005 DigitalGlobe
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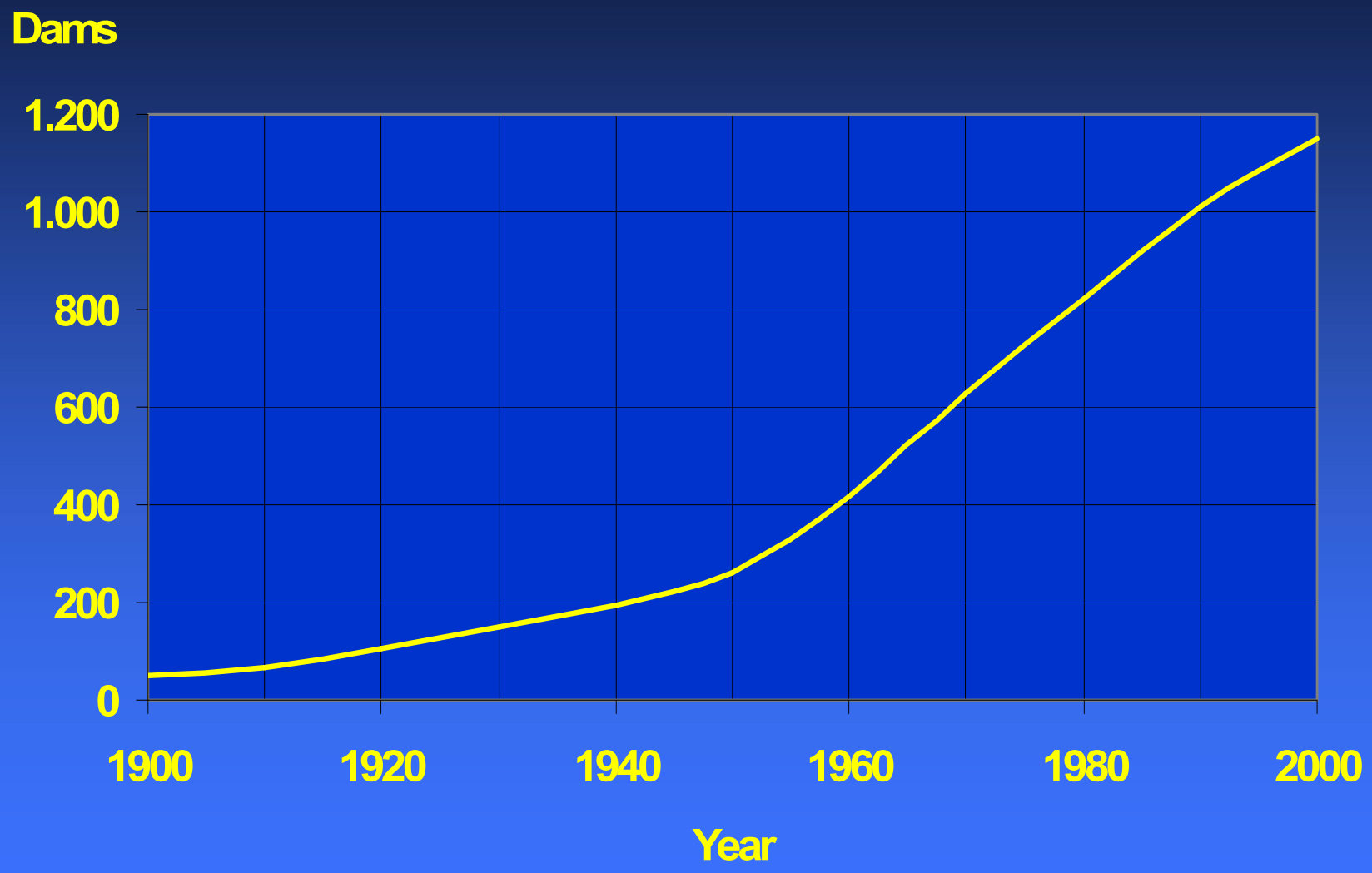
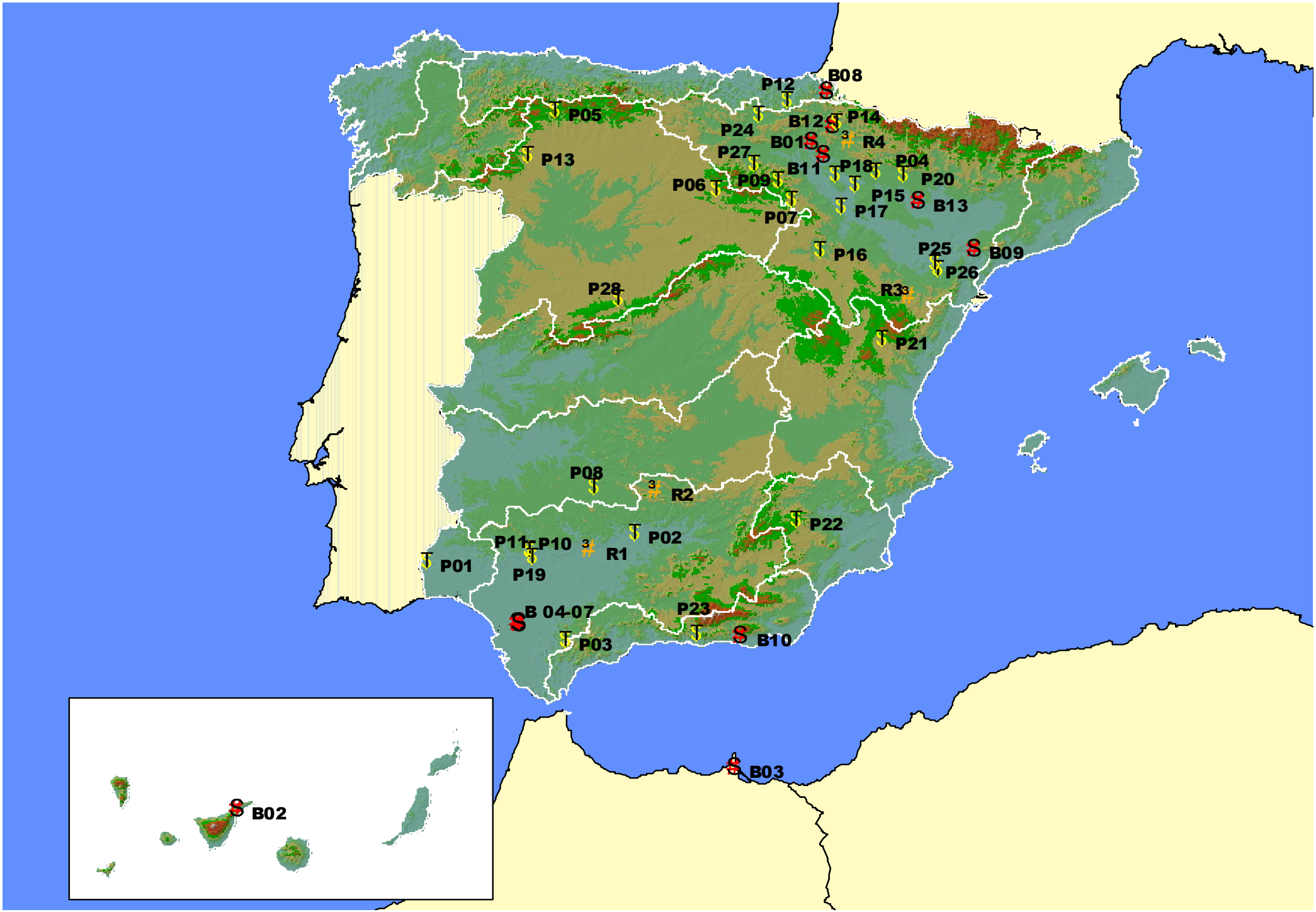
DAM EVOLUTION




B08
P12
P05
P14
B12
P24
B01
R4
P27
P13
B11
P18
P04
P09
P06
P20
P15
B13
P17
P07
P16
P25
B09
P26
P28
R3
P21
P08
R2
P22
P02
P11
P10
R1
P01
P19
B 04-07
P23
P03
B10
B03
B02

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	NAME	RIVER	BASIN	PROVINCE	TYPE	HEIGHT (m)	RESERVOIR CAPACITY (hm^3)
1	Arenoso	Arenoso	Guadalquivir	Córdoba	ER	80,0	160
2	Arroyo Montemayor	Montemayor	Ebro	Logroño	CFRD	29,0	0,4
3	Artajona	-	Ebro	Navarra	TE	45,5	2,0
4	Biscarrués	Gállego	Ebro	Huesca/Zaragoza	TE	84,0	192,0
5	Brandariz	Ulla	Norte	La Coruña	PG	37,0	2,4
6	Castrovido	Arlanza	Duero	Burgos	PG	95,5	82,0
7	Ceguilla	Ceguilla	Duero	Segovia	PG	40,0	1,0
8	Cigudosa-Valdeprado	Alhama	Ebro	Soria	RCC	65,5	41,8
9	Colada, La	Guadalmatilla	Guadiana	Córdoba	PG	48,5	57,7
10	Enciso	Cidacos	Ebro	Logroño	RCC	103,5	48,0
11	Ibiur	Ibiur	Norte	Guipúzcoa	PG	69,5	7,5
12	Laverné	-	Ebro	Zaragoza	TE	54,5	37,8
13	Lechago	Jiloca	Ebro	Zaragoza	TE	39,0	18,2
14	Loteta	Carrizal	Ebro	Zaragoza	TE	29,0	96,7
15	Melonares	Víar	Guadalquivir	Sevilla	PG	50,0	180,4
16	Monreal	Unciti	Ebro	Navarra	PG	21,9	0,57
17	Montearagón	Flumen	Ebro	Huesca	PG	78,0	51,5
18	Mora de Rubielos	Tosquillas	Júcar	Teruel	ER	35,0	1,0
19	Navas del Marques	Valtravies	Duero	Avila	PG	36,0	2,0
20	Pareja, Dique	-	Tajo	Guadalajara	TE	19,0	1,0
21	Touro	Ulla	Norte	La Coruña	PG	40,0	1,4
22	Villalba de los Barros	Guadajira	Guadiana	Badajoz	TE	45,5	106,0
23	Villaveta	Arroyo Olleta	Ebro	Navarra	TE	44,3	5,3

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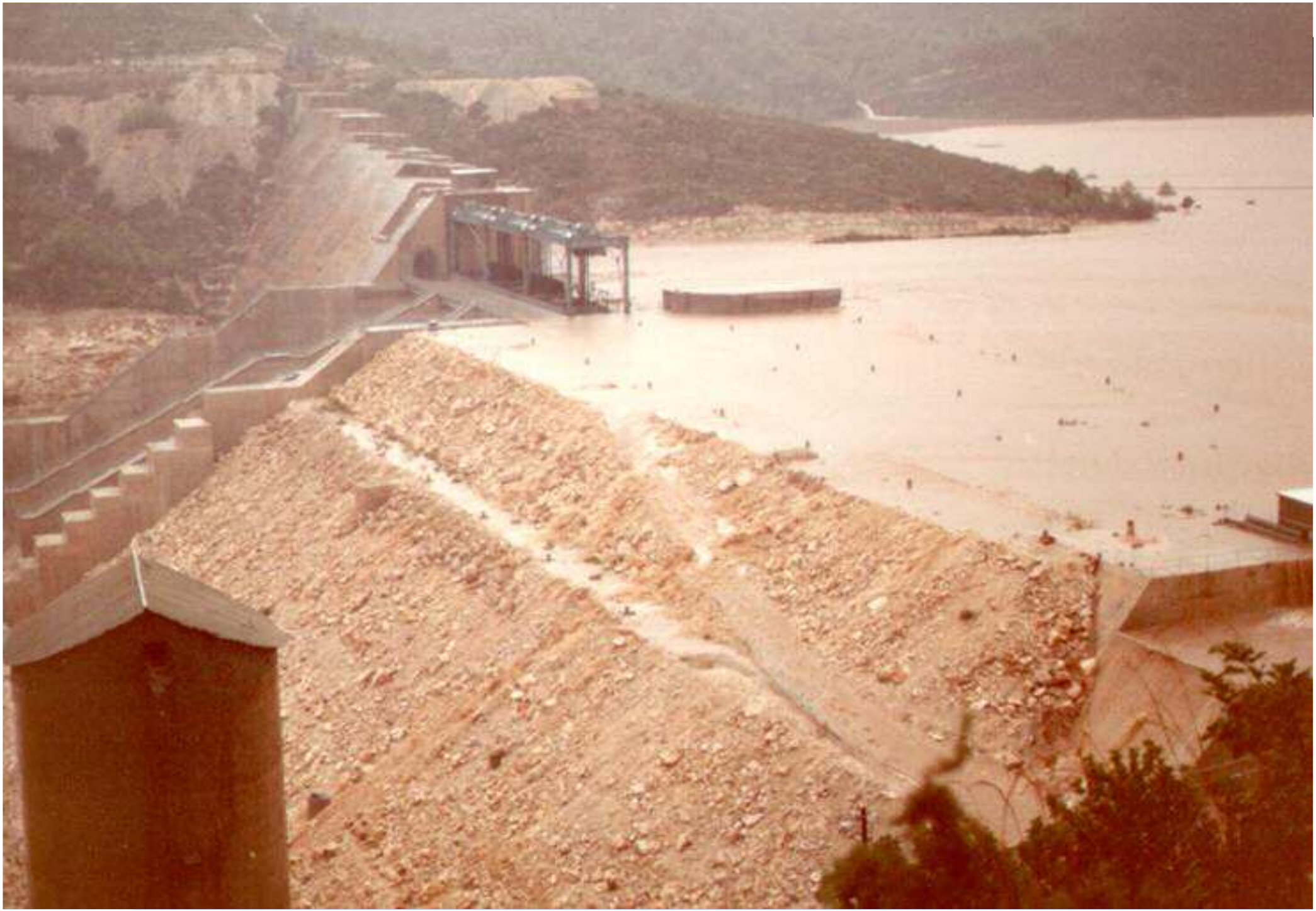
ENLARGEMENTS

	NAME	*BASIN*	*PROVINCE*	*HEIGHT INCREASE (m)*	*CAPACITY INCREASE (Hm^3)*
1	La Breña II (RCC)	Guadalquivir	Huelva	71	698,0
2	Montoro (PG)	Guadalquivir	Ciudad Real	60	67,0
3	Yesa (CFRD)	Ebro	Navarra	38	1050,0



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FLOODS AS A RISK

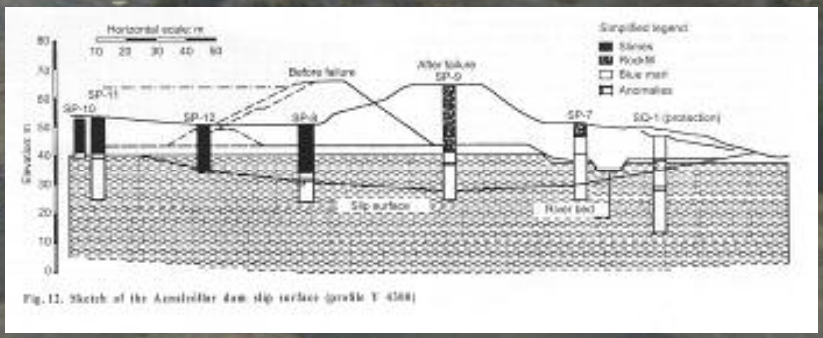

Fig. 12. Sketch of the Aconcagua dam slip surface (profile T 4500)

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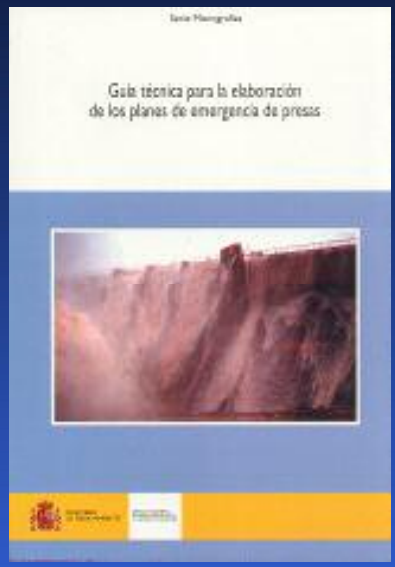
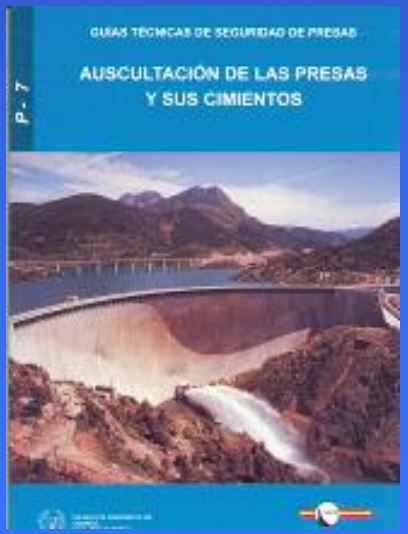
DEVELOPMENT OF SAFETY STANDARDS

- **Reservoir Design Standards (1905)**
- **Provisional Regulation on Dam Surveillance (1960)**
- **Large Dam Design, Construction and Operation Standards (1962-1967) [Instruction] – In force**
- **Basic Guidelines for the Planning of Civil Protection regarding Flood Risk (1994) [Directive] – In force**
- **Technical Regulations for Dam and Reservoir Safety (1996) – In force**
- **Guidelines by the Ministry of the Environment (2) and Spanish National Committee on Large Dams (SPANCOLD) (7) – In force**
- **Modification of Water Act (2006): Chapter IV: Dam Safety – (Green Paper)**





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Instruction for the Project, Construction and Operation of Large Dams (1967)

Text in which are included all the criteria needed for designing and constructing dams

Applied to all large dams

Main Disadvantages:

- **Obligatory**
- **Very Rigid**
- **Never Updated**
- **Many criteria for designing and constructing dams and only few paragraphs dedicated to their operation and maintenance**

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TECHNICAL REGULATIONS ON DAM AND RESERVOIR SAFETY (1996)

- Different philosophy: Very open norm
- It Applies to new dams and to existent ones under State ownership; Not to tailings dams nor small ponds
- Instead of focusing on design and construction aspects it is addressed to the operation and maintenance
- It defines clearly the holder's figure and their liabilities in all the phases of the dam's life
- Establishes safety conditions for all the stages of dam’s life, especially for dam operation
- It points out the need of carrying out a good maintenance of the dam, of making periodic inspections and an ongoing evaluation of the safety

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TECHNICAL REGULATIONS ON DAM AND RESERVOIR SAFETY (1996)

What obligations should be fulfilled by the holder?:

- To classify the dam (A Directive's demand)
- To elaborate Standard Operation Procedures, or SOP (An Instruction´s demand)
- To elaborate Emergency Action Plan, or EAP (A Directive's demand for dams classified in categories A or B)
- To elaborate First Filling Plan, or FFP (An Instruction's demand)
- To carry out periodic inspection, or PI (A Technical Regulation's demand)

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TECHNICAL GUIDELINES DEVELOPED BY SPANCOLD AND DIRECTORATE GENERAL OF WATER

Technical Guidelines Developed by the Spanish National Committee on Large Dams	
1	Dam Safety
2	Criteria for the design of dams and appurtenant structures Volume 1º: Concrete Dams Volume 2º: Embankment Dams
3	Geological and Geotechnical studies and Prospecting for Materials
4	Design Flood
5	Spillways and Outlets
6	Dam Construction and Quality Control
7	Monitoring of Dams and Foundations
Technical Guidelines Developed by the Directorate General for Water	
1	Dam Classification According To Potential Risk
2	Emergency Action Plans for Dams

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DIRECTIVE: DAM CLASSIFICATION CRITERIA

DAM CATEGORY	RISK FOR POPULATION	RISK FOR ESSENTIAL SERVICES	MATERIAL DAMAGES	ENVIRONMENTAL DAMAGES
A	Serious effect on towns or more than 5 inhabited dwellings	Serious effect	Very serious	Very serious
B	Would affect a small number of dwellings (from 1 to 5)		Serious	Serious
C	Incidental loss of life (no inhabited dwellings in the area)		Moderate	

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DAM CLASSIFICATION

Dam Classification (*)	
Categoría	Nº
A	652
B	81
C	246
Small Pond Classification (*)	
A	32
B	18
C	265

(*) Data include dams/ponds in project, under construction and on operation

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DIRECTIVE: EMERGENCY ACTION PLANS FOR DAMS

- ✓ **Categories A and B dams must develop and implement Emergency Action Plans in the case of failure or malfunction.**
- ✓ **The periods established for the preparation of the plan are:**

Category B Dams	4 years after Classification approval
Category A Dams	2 years after Classification approval

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DIRECTIVE: EMERGENCY ACTION PLAN CONTENT

ANALYSIS OF DAM SAFETY → Identify unusual and unlikely conditions which may endanger the dam.

↓

TERRITORIAL IDENTIFICATION AND DAMAGE APPRAISAL → Establish floodplain, flood arrival times and appraise potential damages.

↓

ACTION PROCEDURES → Measures to be adopted to reduce risk.

↓

ORGANISATION → Personnel necessary for the implementation of action procedures.

↓

MEASURES AND RESOURCES → Emergency lounge, downstream population warning system and necessary measures and resources.

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DIRECTIVE: SAFETY SCENARIOS

SCENARIO 0 OR SAFETY CONTROL SCENARIO

- Prevailing conditions and predictions require increased dam surveillance

SCENARIO 1 OR APPLICATION OF CORRECTIVE MEASURES SCENARIO

- The situation may be safely resolved by pre-established measures and available resources.

SCENARIO 2 OR EXCEPTIONAL SCENARIO

- Control may not be assured by the application of available measures and resources.

SCENARIO 3 OR LIMIT SCENARIO

- Failure is practically inevitable.

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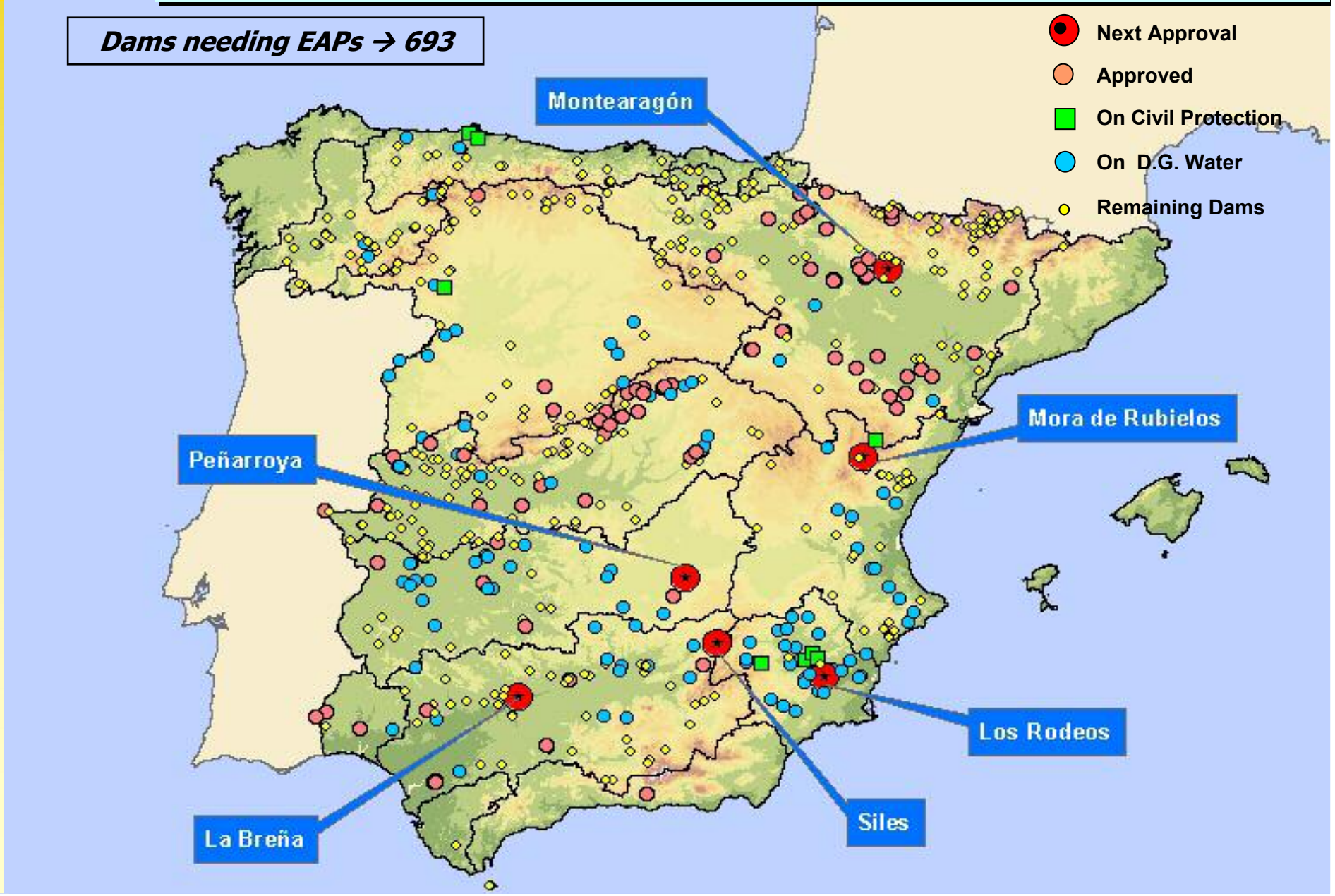
EMERGENCY ACTION PLANS APPROVED

Dams needing EAPs → 693



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EMERGENCY ACTION PLANS. IMPLEMENTATION

*Emergency Room**: Located in the vicinity of the dam***

*Communication system: **Primary and Secondary***

*Warning system to people located downstream within the first half hour zone: **Sound or other***

Information to downstream population located within the half an hour zone

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EMERGENCY ACTION PLANS IMPLEMENTED OR IN IMPLEMENTATION PHASE

EAPs implemented, 7.

On implementation phase , 35.

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TECHNICAL REGULATIONS ON DAM AND RESERVOIR SAFETY (1996): PERIODIC INSPECTIONS

- One of the principal legislative requirements
- Engineering Safety Assessment
- Ordinary (Daily, Weekly or Monthly) and Detailed (Less Frecuency)
- Specialized Technical Team (Project, Construction, Foundation Treatments, Geotechnics, Monitoring, etc.)
- First Full Detailed Inspection: After Classification
- Then, periodically:
  - ✓ 5 Years for Dams of Category A
  - ✓ 10 Years for Dams of Category B and C
  - ✓ When a particular problem has been identified or after important floods