

# Spanish dams: overview and recent developments

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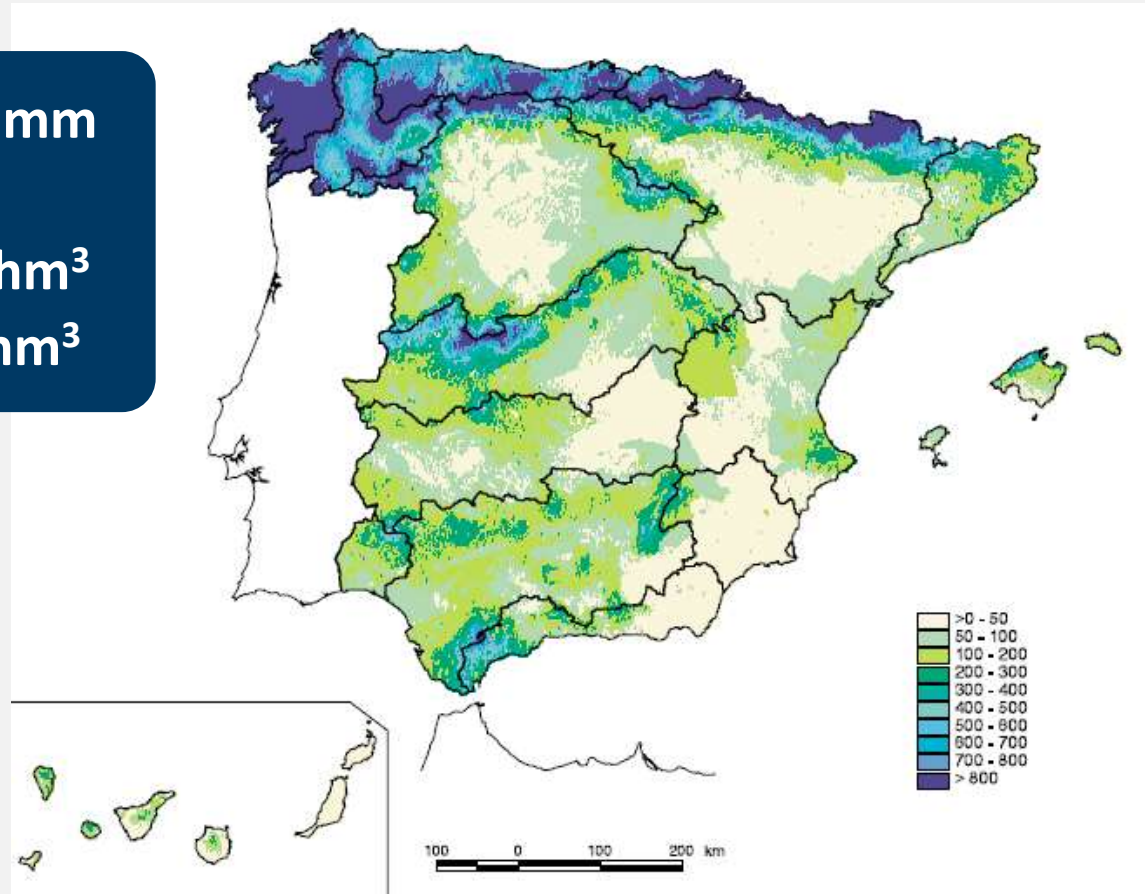


- There are around 1.350 large dams in Spain.
- The development of such number is primarily linked to the need of regulation.
- The romans constructed 72 dams and weirs (catalogued). Two of them still under operation, near the city of Mérida (*Emerita Augusta*).
- Hydropower and flood protection also pushed the dam construction in Spain.



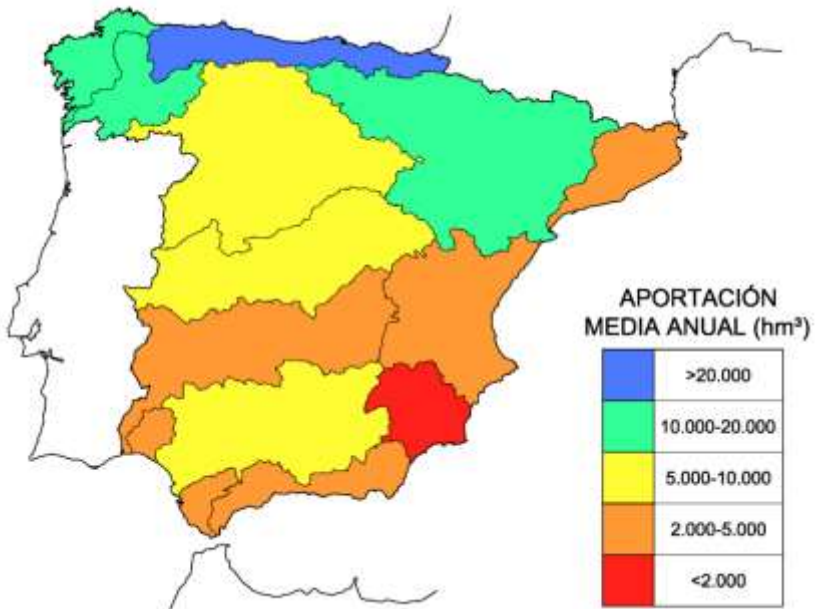
# WATER RESOURCES. SPATIAL DISTRIBUTION

Mean annual rainfall: 685 mm  
Surface: 505.000 km<sup>2</sup>  
Bulk resources  $\approx$  300.000 hm<sup>3</sup>  
Net resources  $\approx$  100.000 hm<sup>3</sup>

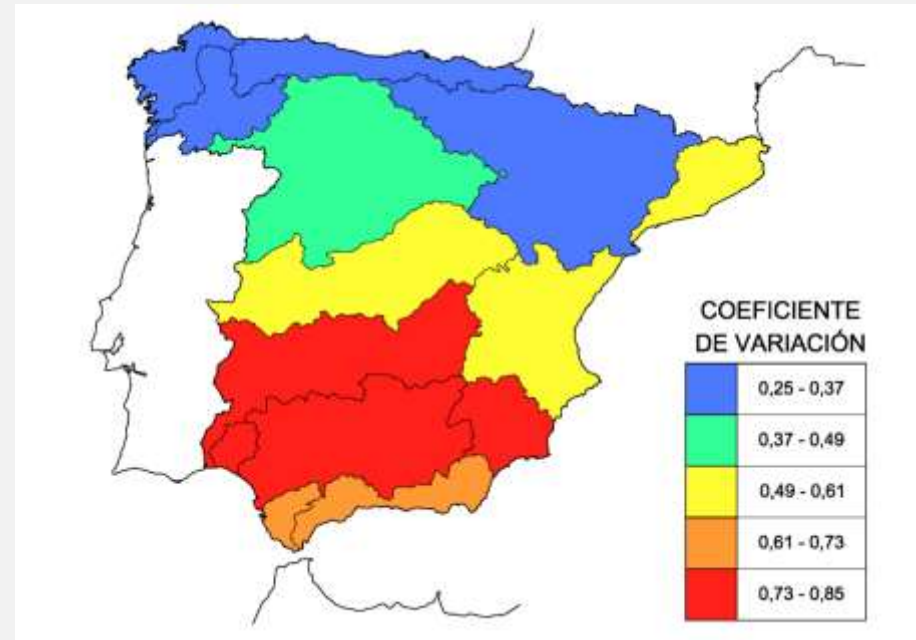


# WATER RESOURCES. MEAN & CV

## Mean annual flow (hm<sup>3</sup>)



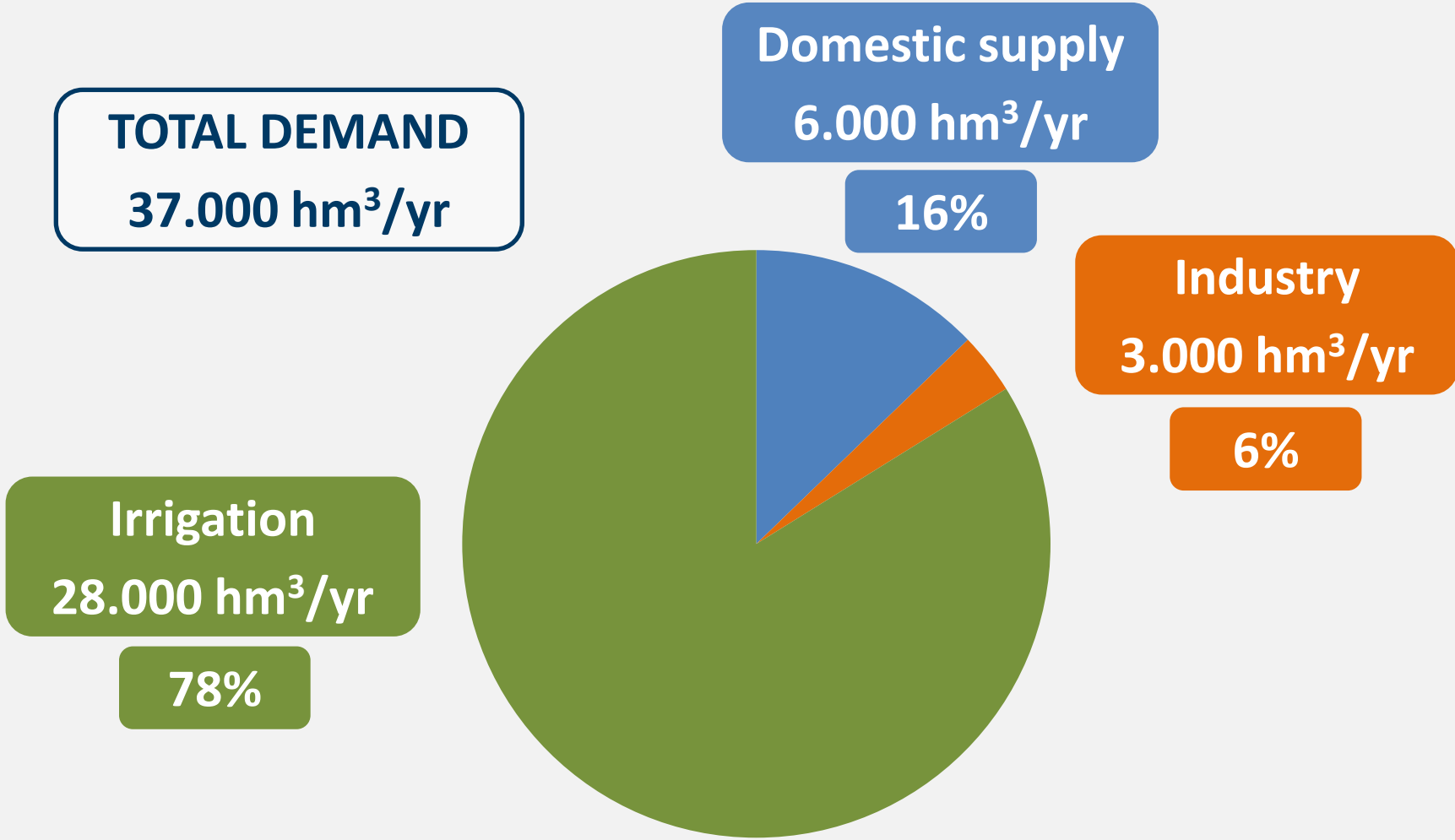
## Coefficient of variation



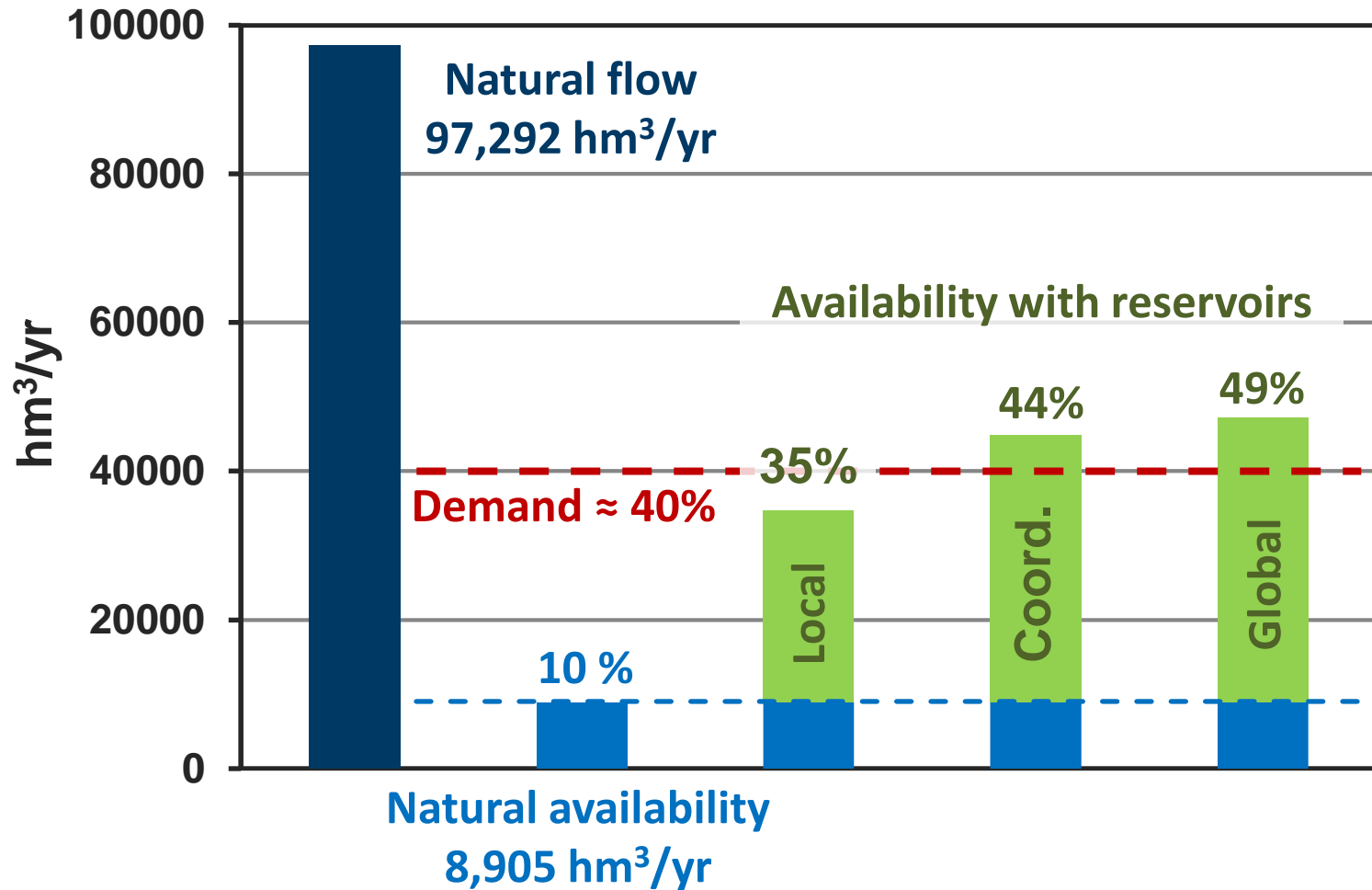
# WATER RESOURCES. TOTAL & PER CAPITA VALUES

BASIN	TOTAL RESOURCES (hm <sup>3</sup> /yr)	RESOURCES PER CAPITA (m <sup>3</sup> /person/yr)
NORTE	42.100	6.240
EBRO	18.200	6.600
DUERO	15.200	6.750
TAJO	12.860	2.030
GUADALQUIVIR	7.780	1.590
GUADIANA	6.170	3.710
JÚCAR	4.140	990
CUENCAS CATALUÑA	2.780	450
SUR	2.420	1.170
SEGURA	1.000	730

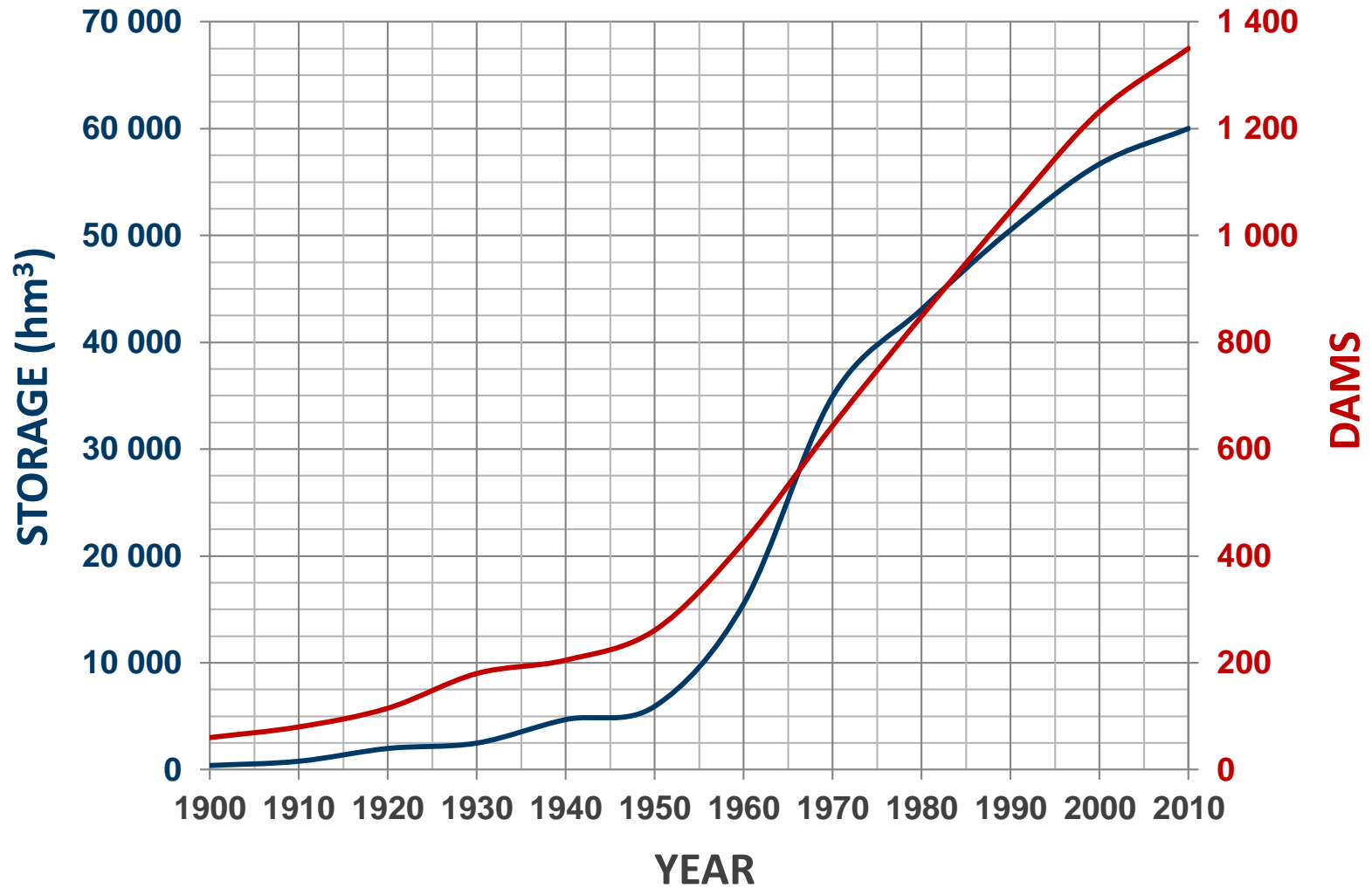
# WATER DEMANDS



# RESOURCES & AVAILABILITY



# DEVELOPMENT OF DAMS IN SPAIN





- **Storage volume of the hydroelectric reservoir: 24.000 hm<sup>3</sup> (40% of the total storage)**
- **Installed capacity: 18.000 MW**
- **Mean annual production: 36.000 GWh**
- **Maximum historical production: 47.500 GWh**
- **Maximum hydropower potential: 68.000 GWh**
- **Largest HPP in Spain:**
  - **Cortes-La Muela: 1.750 MW**
  - **Aldeadávila: 1.120 MW**
  - **Alcántara: 915 MW**

# Alcántara (buttress, 130 m)



# Aldeadávila (arch-gravity, 139 m)



# Cortes-La Muela (pumped-storage)



Lower reservoir

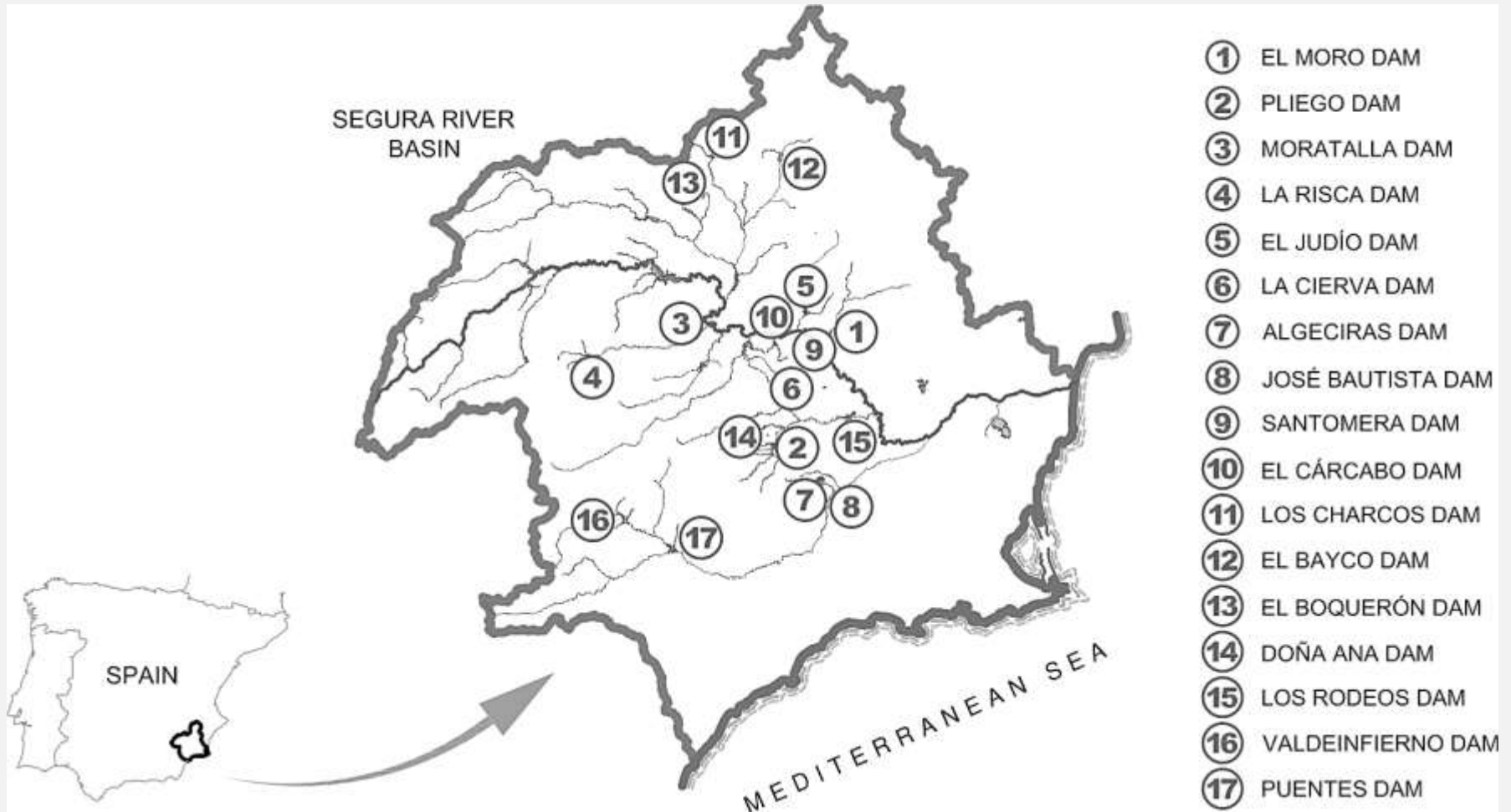
Upper reservoir

Head = 513 m

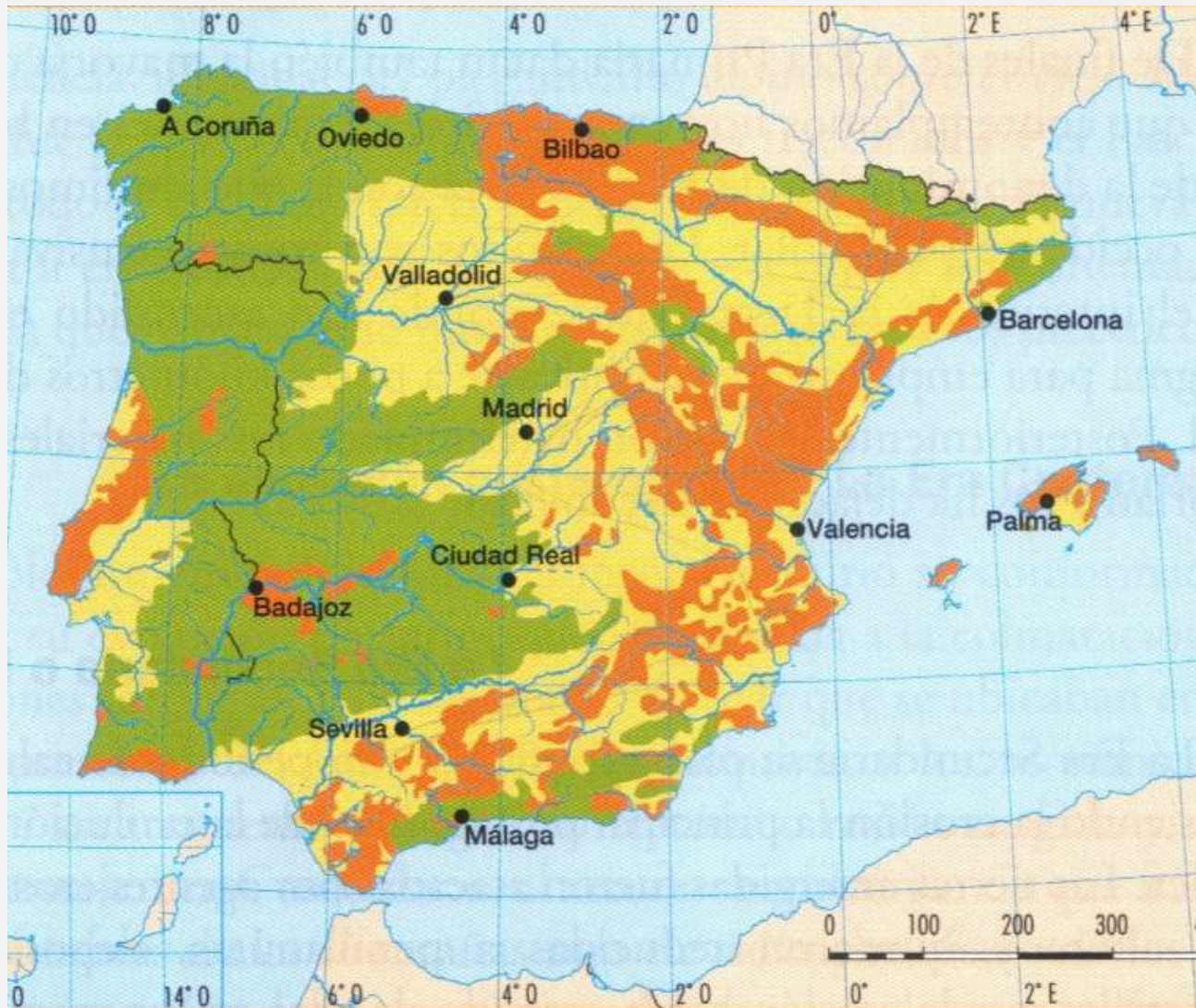
# FLOODS IN SPAIN



# FLOOD PROTECTION SYSTEMS



# GEOLOGY OF THE IBERIAN PENINSULA



Granites  
Gneiss  
Quarzites  
Volcanic rocks  
Siliceous rocks

Limestones

Clays  
Marls

# DAMS BY TYPE

TYPE (ICOLD notation)	WORLD (%)	SPAIN (%)
GRAVITY (PG)	17	60
EARTHFILL (TE)	62	17
ROCKFILL (ER)	9	11
ARCH (VA)	5	5
BUTTRESS (CB)	1	3
OTHERS	6	4

**BARRAGE – DAM**

**Poids – Gravity**

**Terre – Earthfill**

**Enrochement – Rockfill**

**Voûte – Arch**

**Contreforts – Buttress**



# HIGHEST SPANISH RESERVOIRS

DAM (river)	HEIGHT (m)	TYPE
ALMENDRA (TORMES)	202	ARCH
CANALES (GENIL)	157	ROCKFILL
CANELLES (NOGUERA RIBAGORZANA)	151	ARCH
LAS PORTAS (CAMBA)	141	ARCH
ALDEADÁVILA (DUERO)	139	ARCH-GRAVITY
TOUS (JÚCAR)	135	ROCKFILL
SUSQUEDA (TER)	135	ARCH
EL ATAZAR (LOZOYA)	134	ARCH
BEZNAR (IZBOR)	134	ARCH

# Almendra (arch, 202 m)



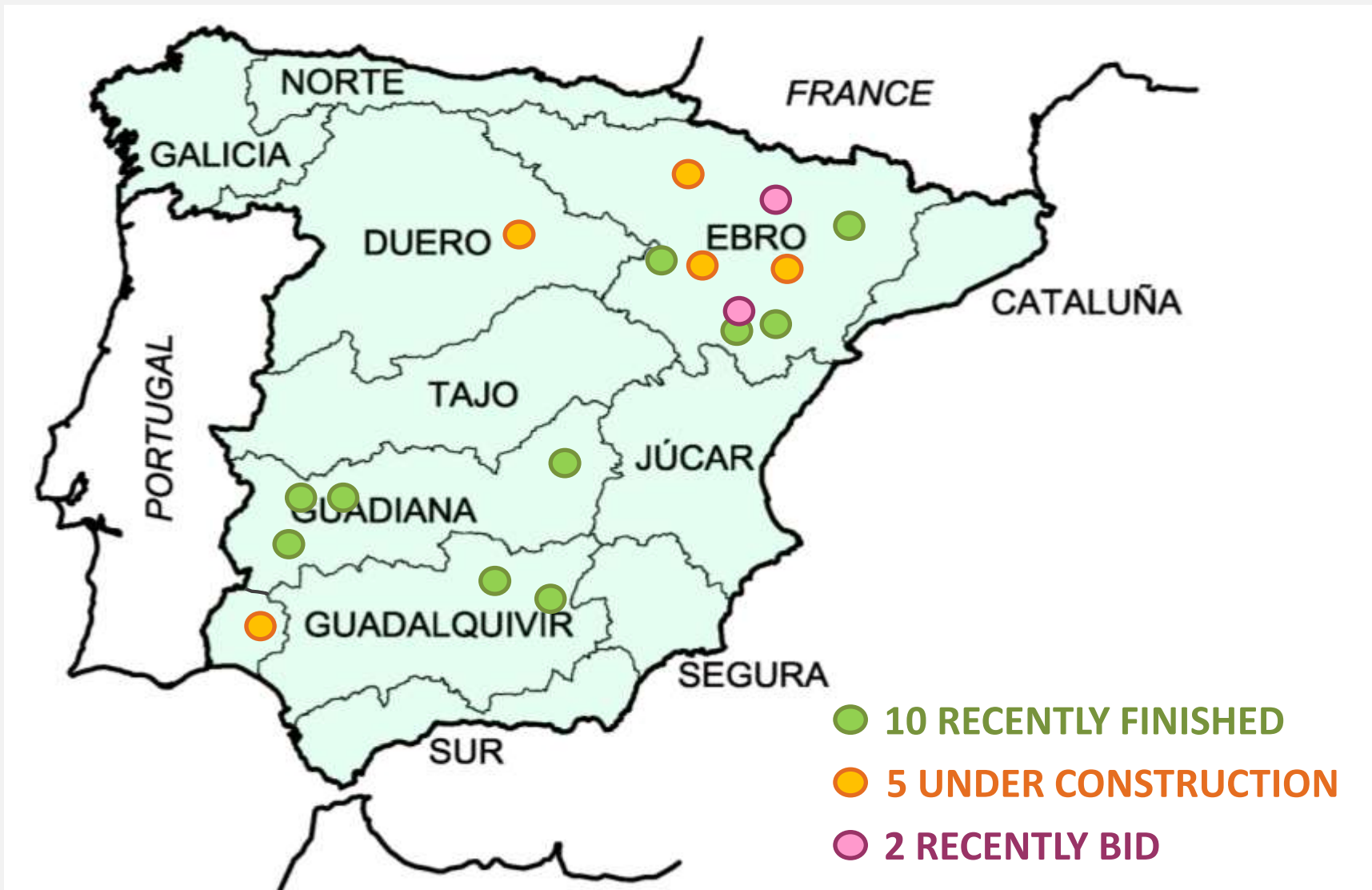
# LARGEST SPANISH RESERVOIRS

RESERVOIR (river)	STORAGE (hm <sup>3</sup> )
LA SERENA (ZÚJAR)	3.230
ALCÁNTARA (TAJO)	3.160
ALMENDRA (TORMES)	2.050
BUENDÍA (GUADIELA)	1.640
MEQUINENZA (EBRO)	1.530
CIJARA (GUADIANA)	1.505
VALDECAÑAS (TAJO)	1.450
RICOBAYO (ESLA)	1.200
ALARCÓN (JÚCAR)	1.110

# La Serena (gravity, 91 m)



# RECENT & CURRENT DEVELOPMENTS



# Yesa heightening

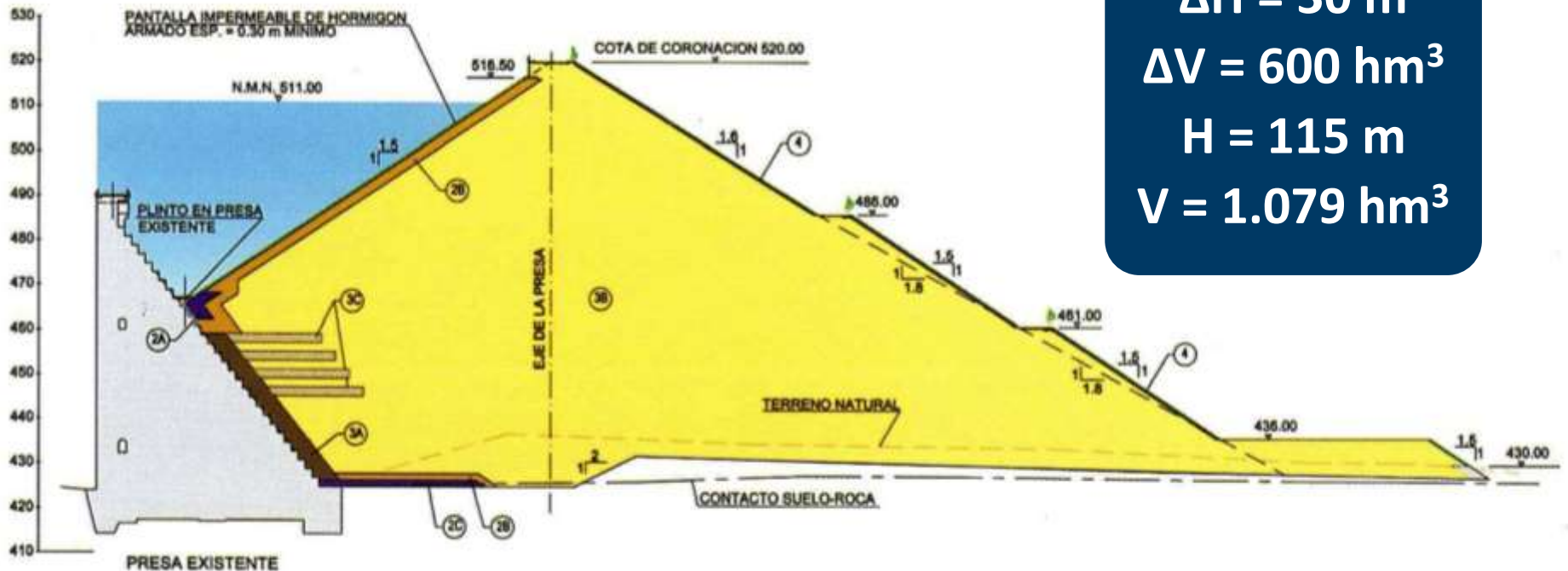
CFRD

$\Delta H = 30 \text{ m}$

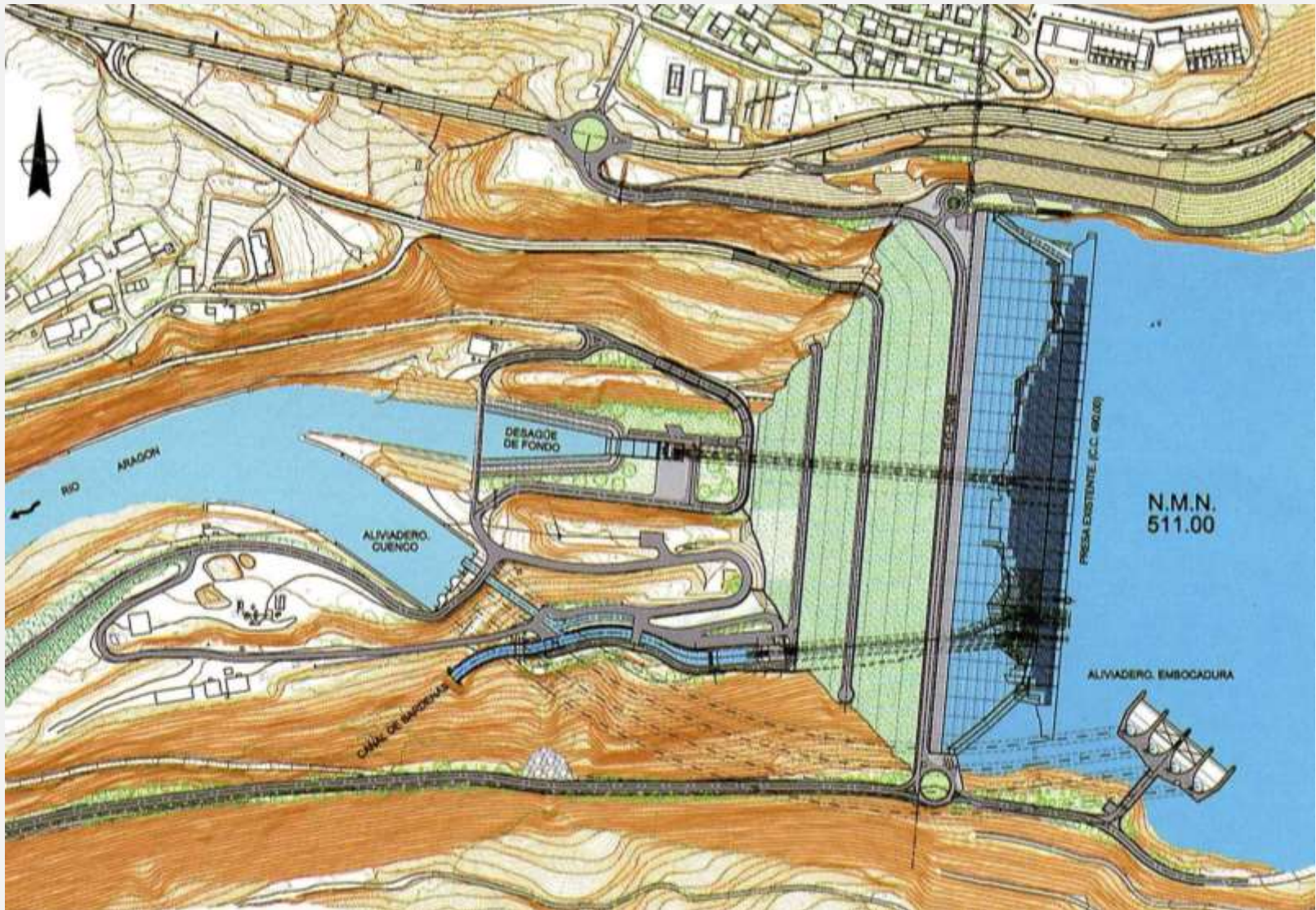
$\Delta V = 600 \text{ hm}^3$

$H = 115 \text{ m}$

$V = 1.079 \text{ hm}^3$



# Yesa heightening



# Yesa heightening





# Merci de votre attention

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