# Economía y Finanzas del Agua

## Mercados de Agua en la Gestión Integrada del Agua

### Escasez y Sequía en España y los Nuevos Retos de la Directiva Marco del Agua

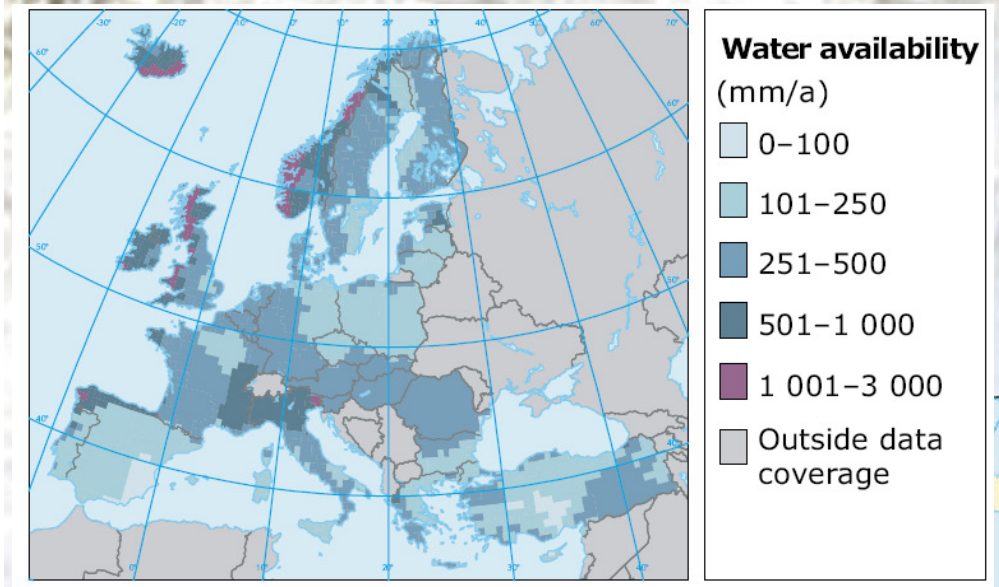
### Water scarcity, droughts and climate change in Spain

**Teodoro Estrela**

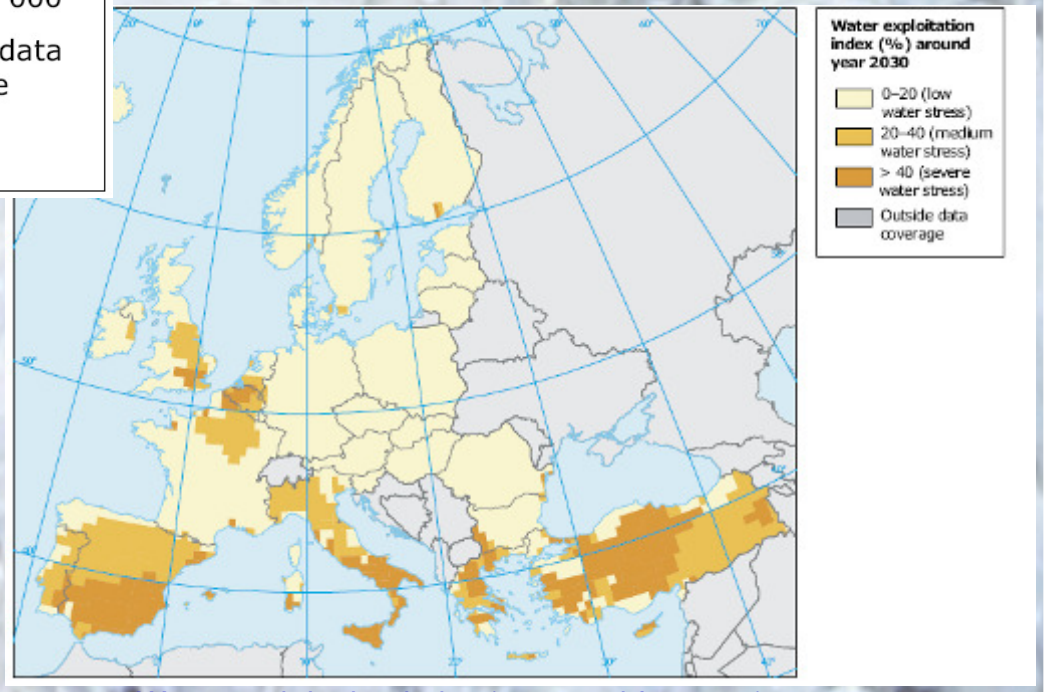
*Zaragoza, 31 julio 2008*


Water scarcity

# Water scarcity in European Union




Current water availability




Water exploitation index (expected for 2030)

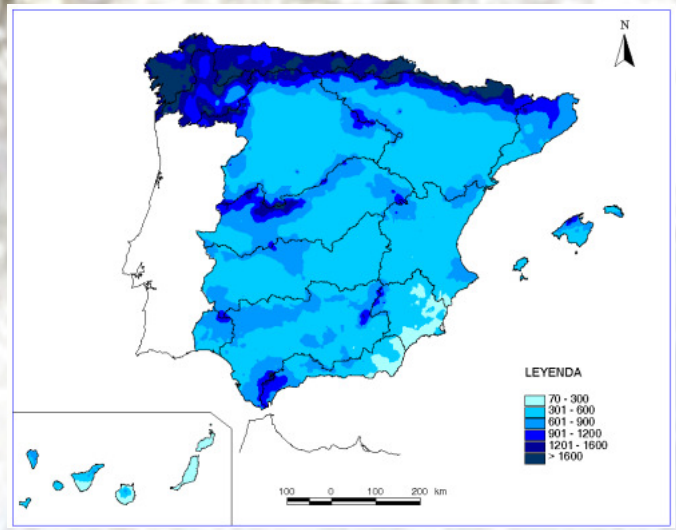
Source: European Environment Agency, 2005

# Water scarcity in Spain

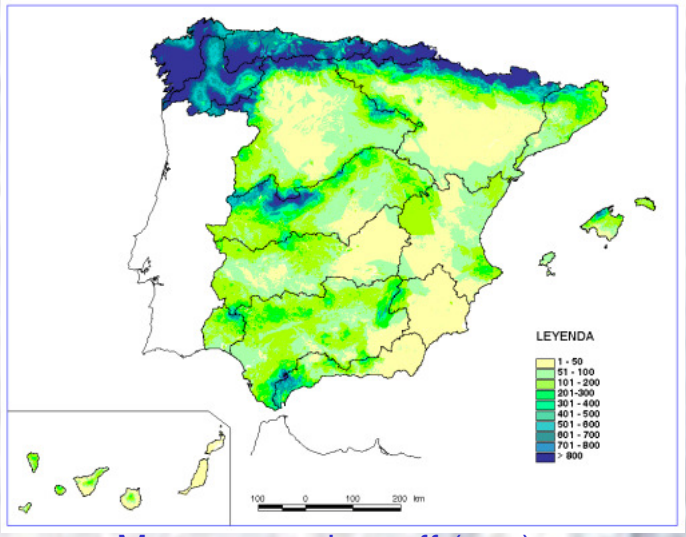
- **Water scarcity means that water demands exceeds the available water resources under sustainable conditions**

- **Water is a scarce resource in some areas of Spain**
  - High irregularity in time and space
  - Limited water resource: conflicting water demands

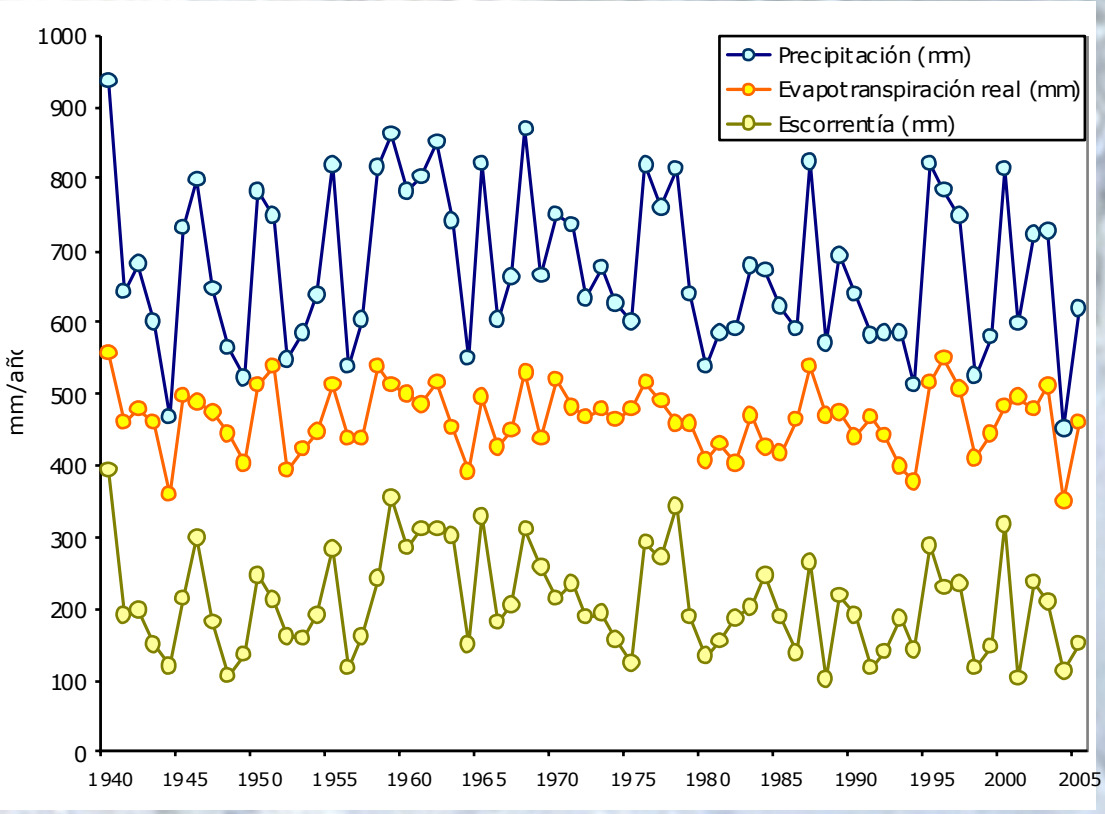
# Irregular hydrological regimes in Spain




Mean annual precipitation (mm)

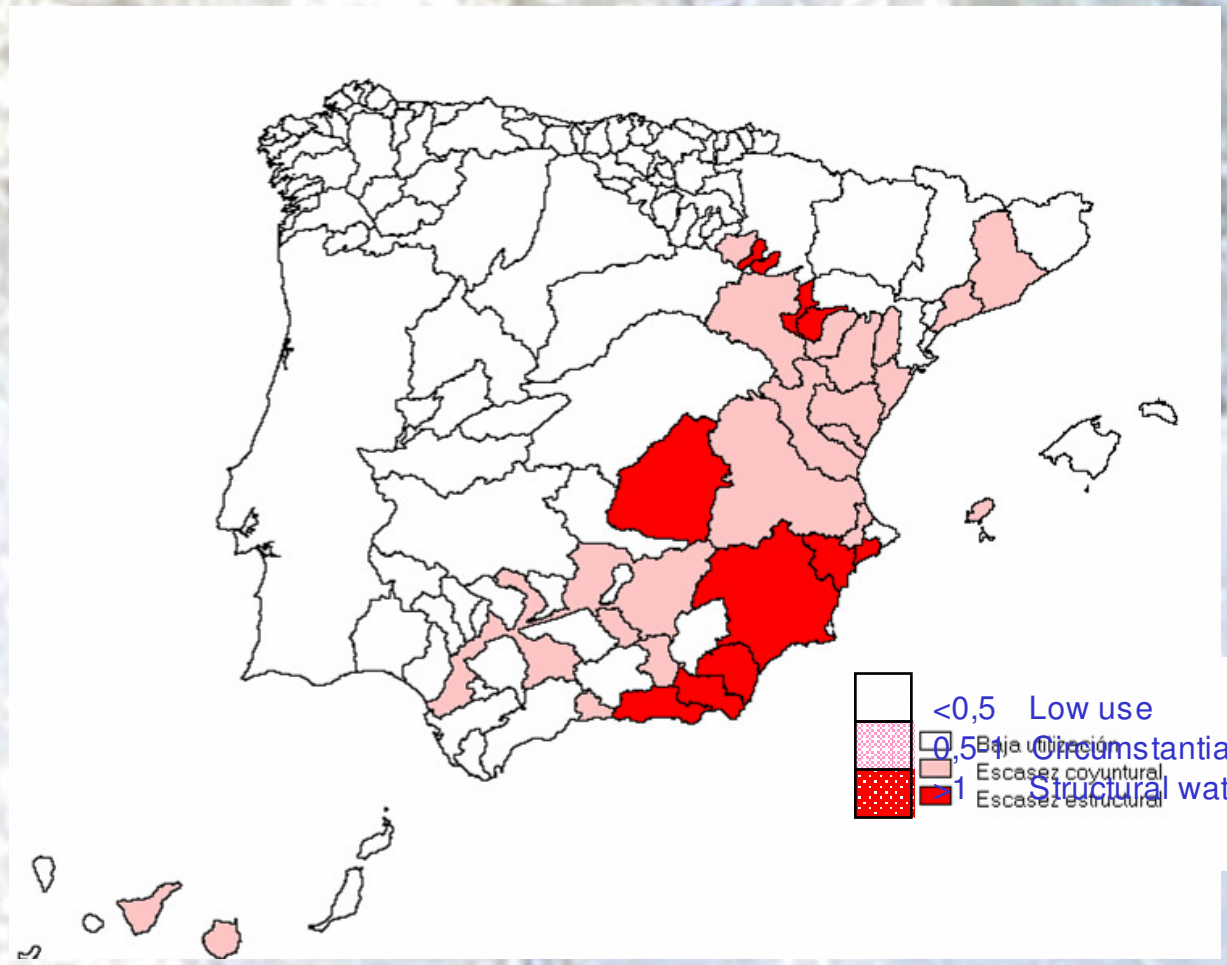



Mean annual runoff (mm)




Precipitation, actual evapotranspiration and runoff in Spain in mm (period 1940-2005)

# Water stress




Water consumption index: water consumption / potential water resource

# Measures to fight water scarcity

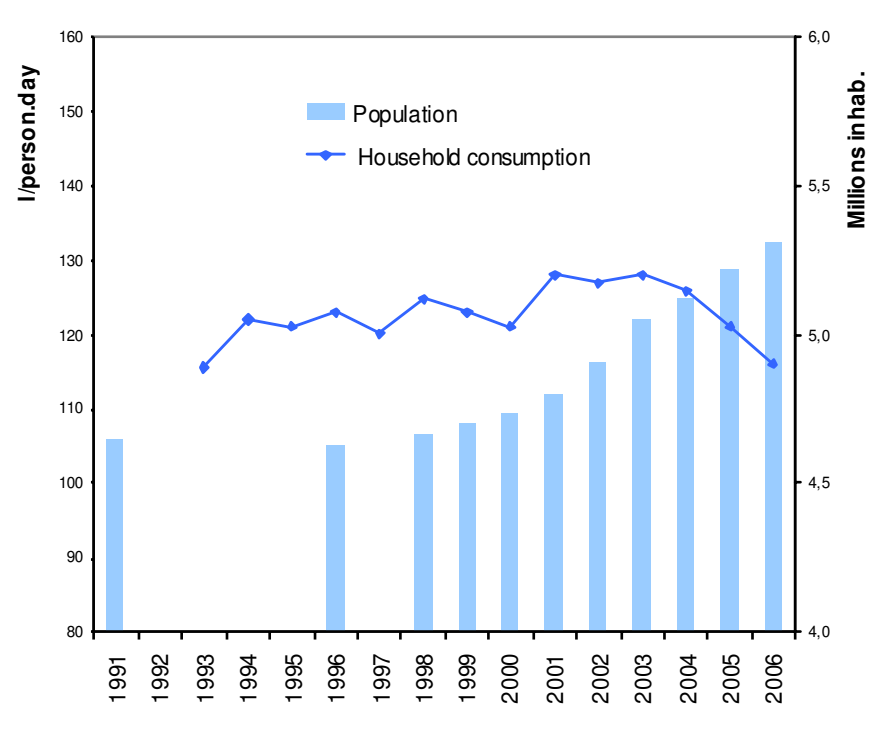
Main measures to fight water scarcity in Spain:

- Development of water supply infrastructures
- Metering programmes of water abstractions
- Water savings and water-efficient technologies
- Joint management of surface water and groundwater
- Use of non-conventional water resources: waste water reuse and desalination

# Public water supply

| Country | City | Water consumption l/pers/day |
|---|---|---|
| Bélgica | Bruselas | 112 |
| España | Barcelona | 119 |
| España | Valencia | 121 |
| Dinamarca | Copenhague | 123 |
| España | Madrid | 124 |
| España | Sevilla | 137 |
| Grecia | Heraclión | 139 |
| Portugal | Lisboa | 144 |
| Hungría | Budapest | 146 |
| Austria | Viena | 147 |
| Holanda | Amsterdam | 149 |
| Italia | Roma | 150 |
| Chipre | Nicosia | 166 |
| Finlandia | Helsinki | 170 |
| Suecia | Estocolmo | 190 |
| Noruega | Oslo | 200 |
| Suiza | Berna | 250 |

Domestic water consumption in different European cities (l /person . day)




Water consumption in Barcelona (l /person . day)


Droughts

# Droughts

**Drought management in Spain: traditionally as an emergency situation**

Spanish Water Law (TRLA), in article 58, foresees in extraordinary drought situation the adoption, by the Government, of necessary measures to overcome these situations, related to the use of the public water domain.

# Policy bases for Drought Management Plans

Law 10/2001, July 5, of the Hydrological Water Plan, establishes the bases for the drought planned management.

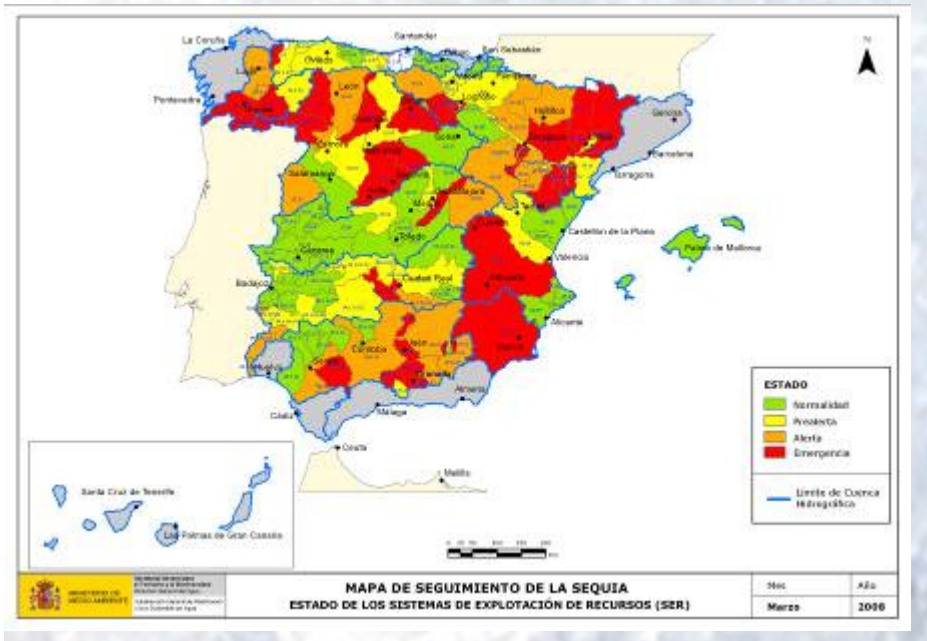
Article 27. Drought management

Section 1. The Ministry of Environment, for dependent river basins, in order to minimize environmental, economic and social impacts of eventual drought situations, will establish a global hydrologic indicator system that will allow foreseeing these situations, and will serve as general reference for river basin authorities for the formal declaration of emergency situations and eventual drought. This declaration will imply the entry into force of Drought Management Plans (DMP).

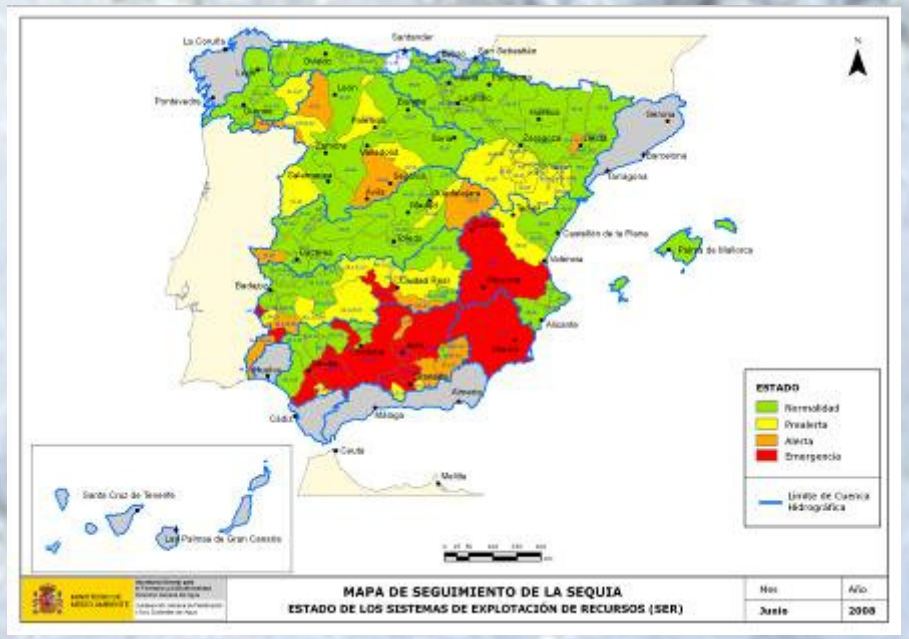
Section 2. Basin Organizations will develop Drought Management Plans (DMP) for alert situations and eventual drought (exploitation rules and measures)

# Global hydrological indicator system

- Global hydrological indicator system has been developed
- Drought maps being developed since December 2005 and published in the web page of Spanish Ministry of Environment, Rural and Marine Affairs.



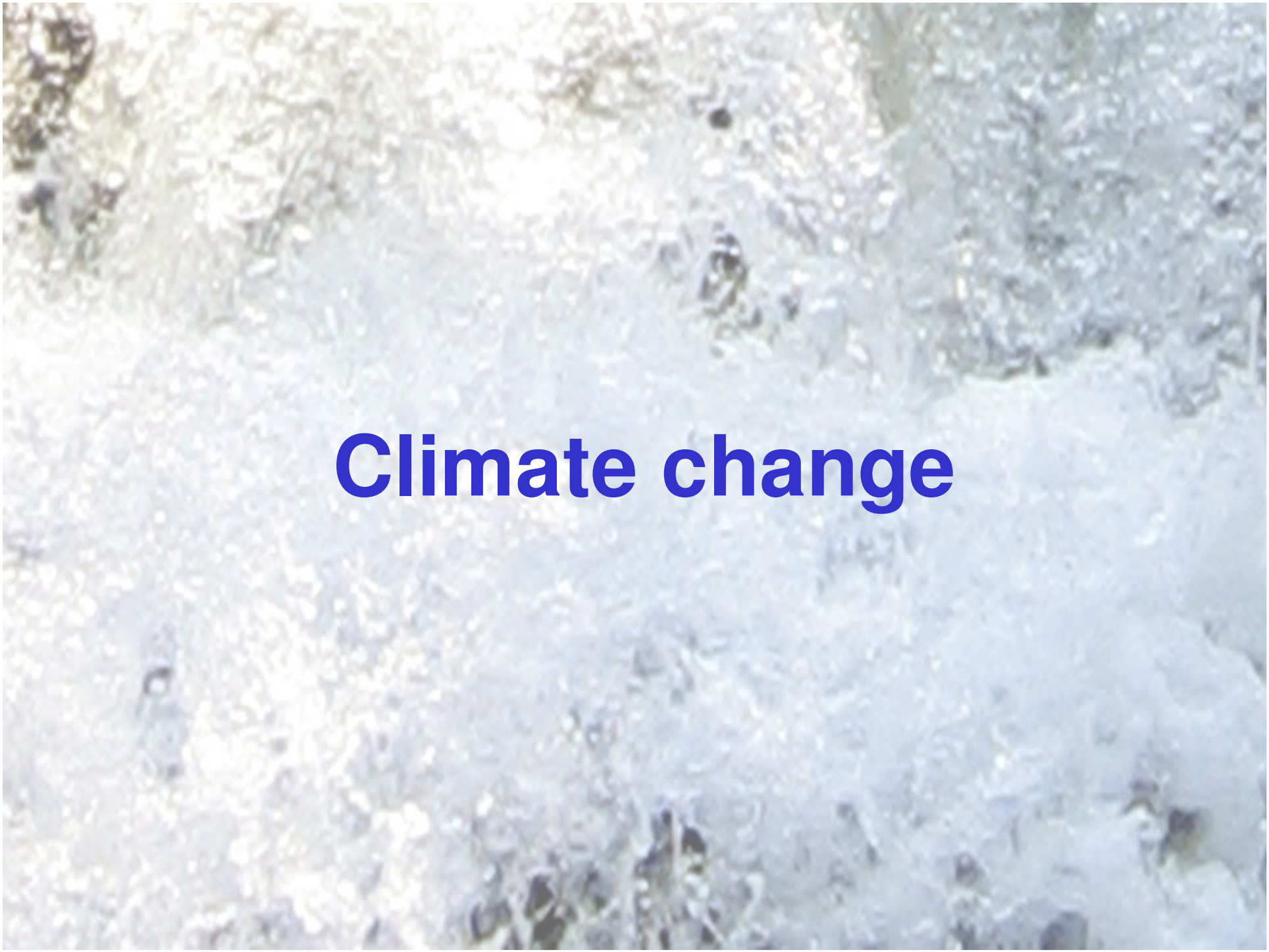

march 2008




june 2008

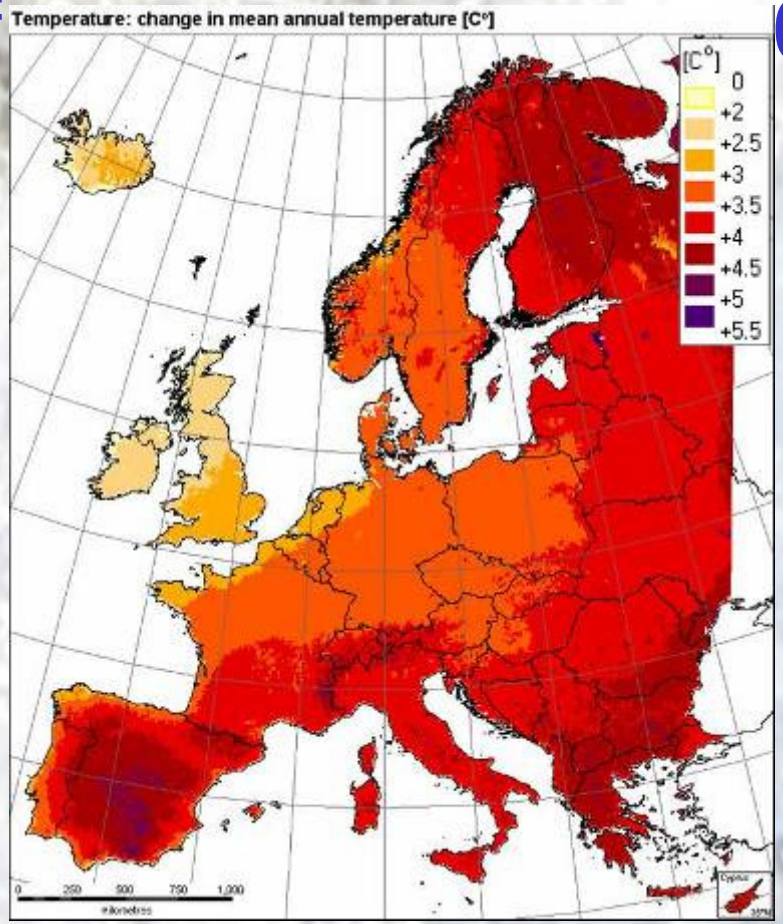
# Droughts: “Albufera Lake” Ramsar wetland

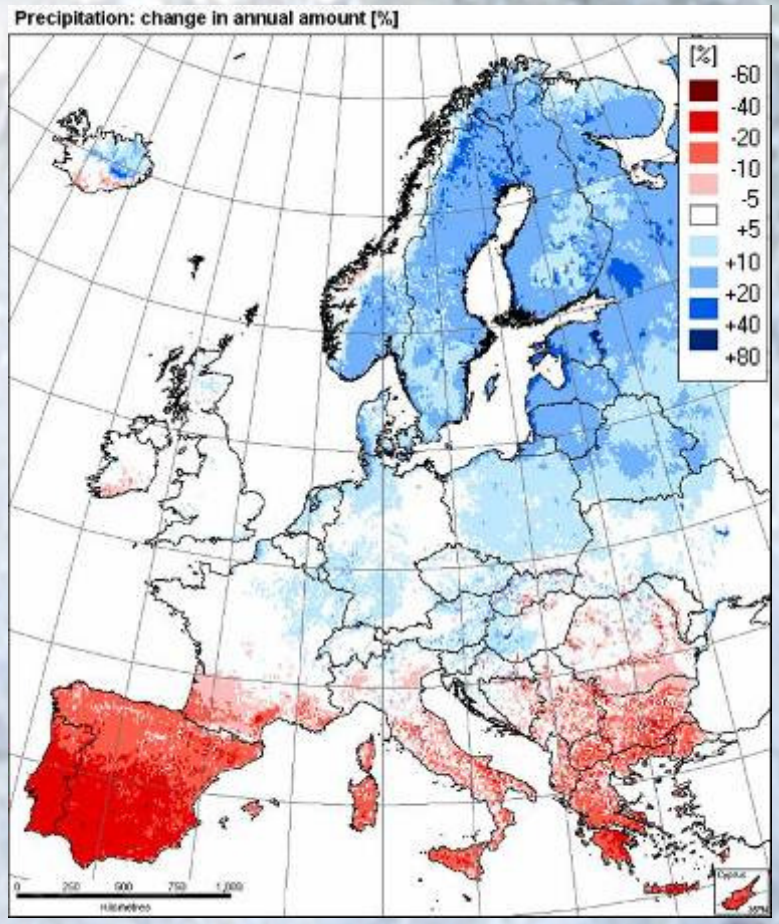

Example of measure included in DMPs: Drought wells and environmental control (specific groundwater level network)


Climate change

# Impact of Climate Change

## EC Green Paper. A2 scenarios. Climatic changes f 00



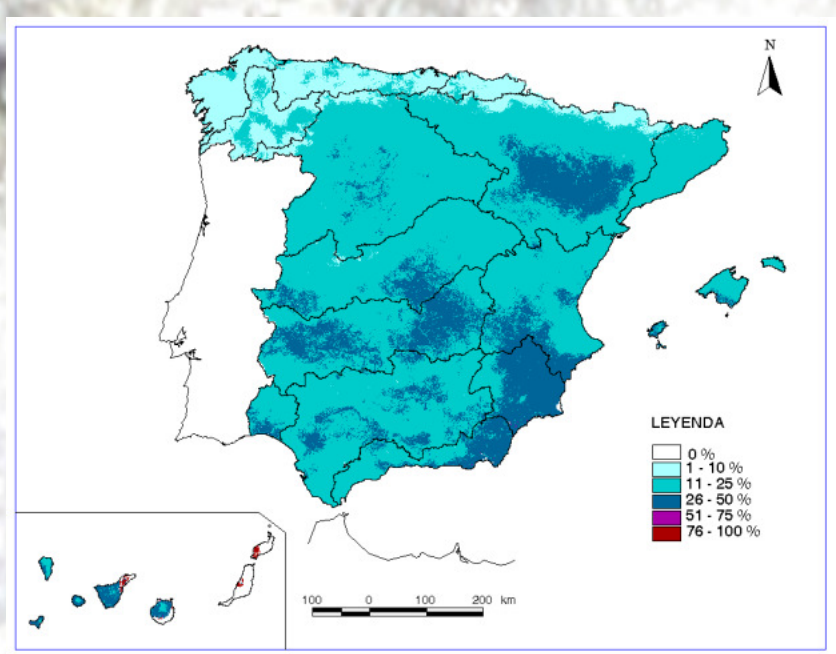




Change in mean annual temperature and precipitation

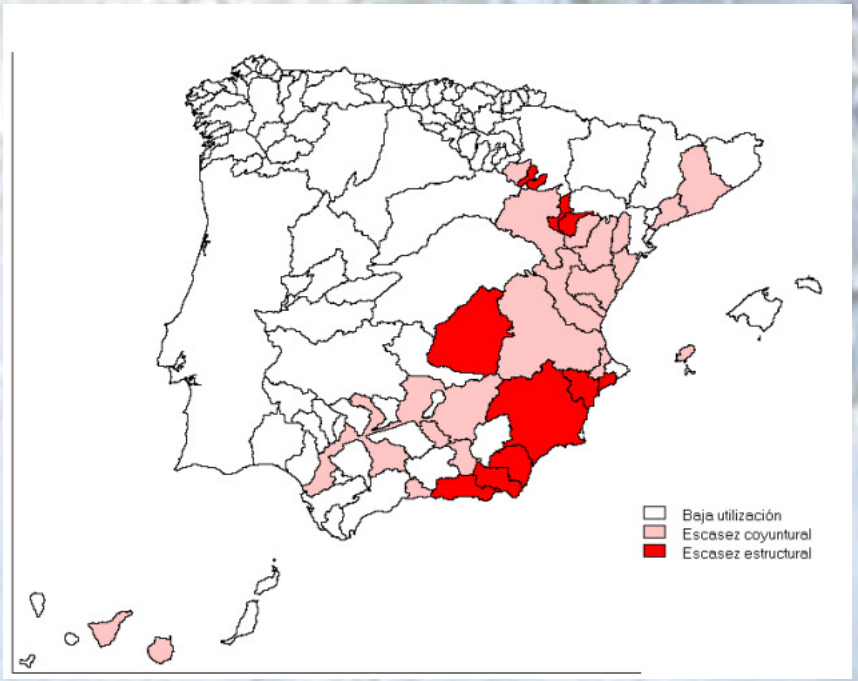
# Climate Change

- Preliminary assessment reports on climate change impacts in Spain:
  - Decrease in water resources mean values are expected.
    - » For a decrease of 5% in mean annual precipitation and an increase of 1ºC in mean annual temperature, a decrease between 9 and 25% in runoff is expected depending on the river basin districts.
  - Increase in water resource variability is expected.
  - The most critical Spanish areas are arid and semiarid ones where water scarcity and drought problems are greater.

# Impact on water resources and vulnerability in Spain




Impact on runoff reduction for a decrease of 5% in mean annual precipitation and an increase of 1ºC in mean annual temperature (year 2030)



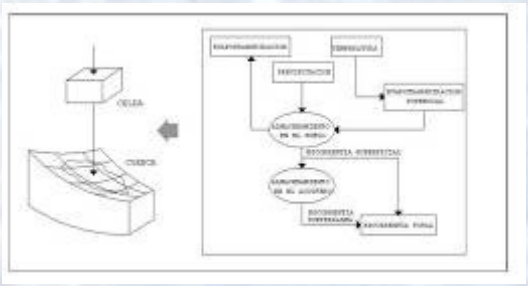

Vulnerability: water scarcity risk in water resource systems

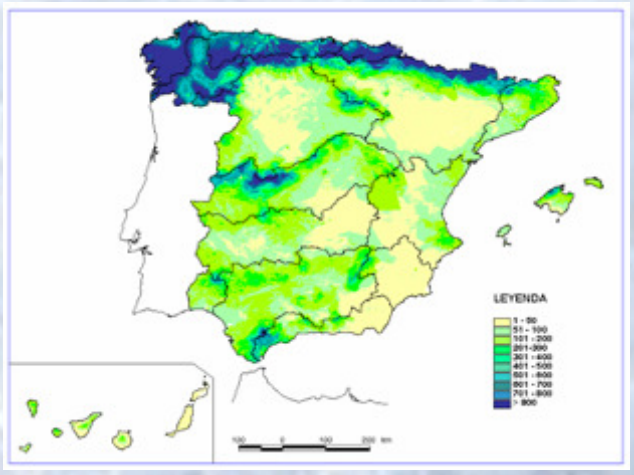
Source: White Paper on Water in Spain, MMA (2000)

# Climate Change and Water resources in Spain

- National Adaptation Plan on Climate Change. Aim: Integration of adaptation to climate change into the planning strategy of the different socio-economic sectors in Spain
- Water resources sector: assessment of impacts on natural resources, water demands, available resources and ecological status

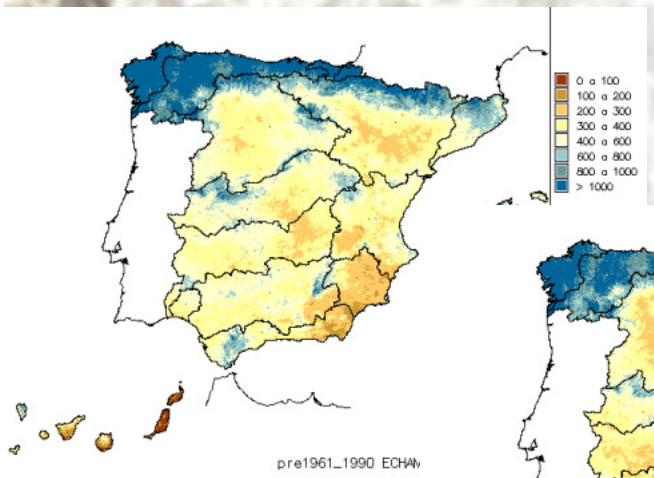




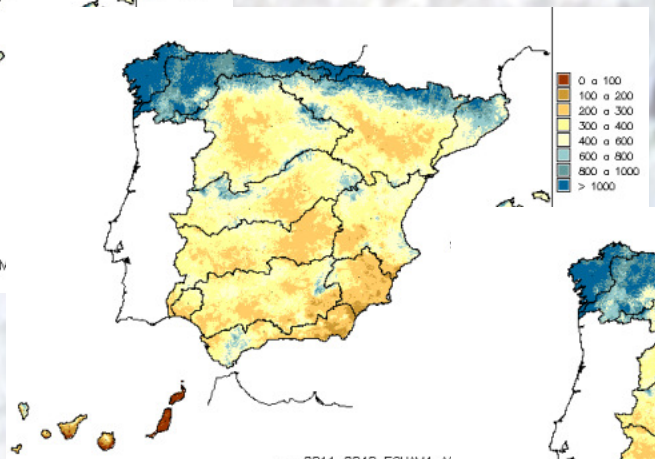


# ECHAM4 Model. Escenario A2

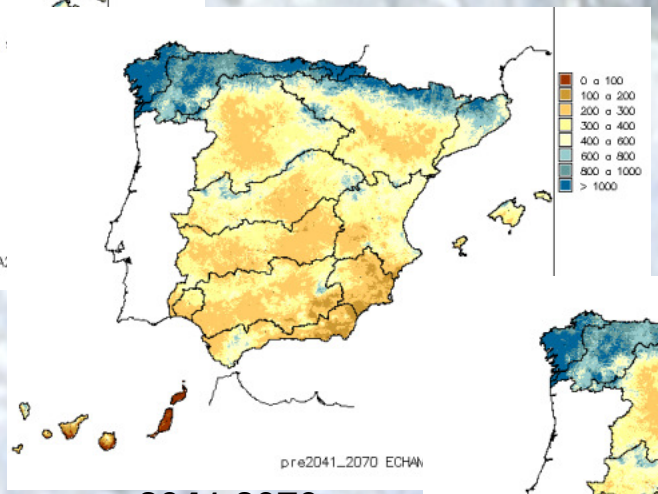
Precipitations



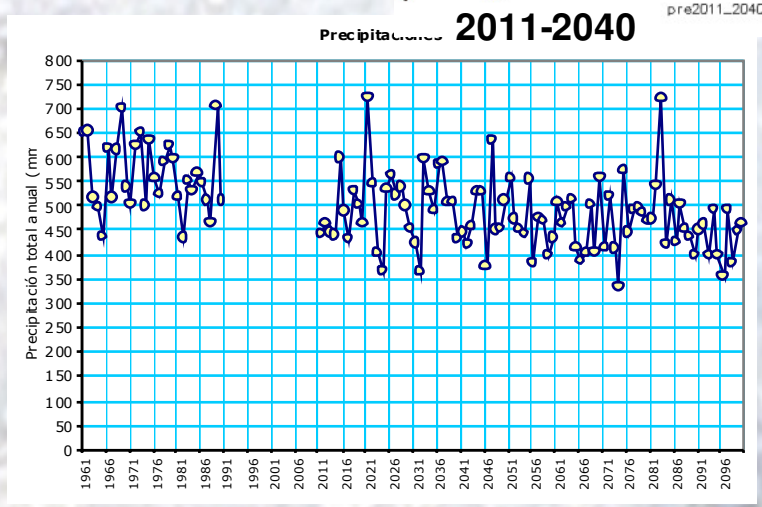

1961-1990

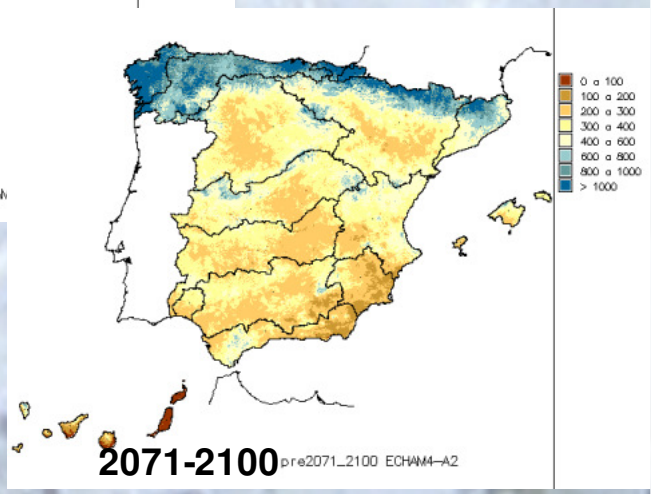



2011-2040




2041-2070

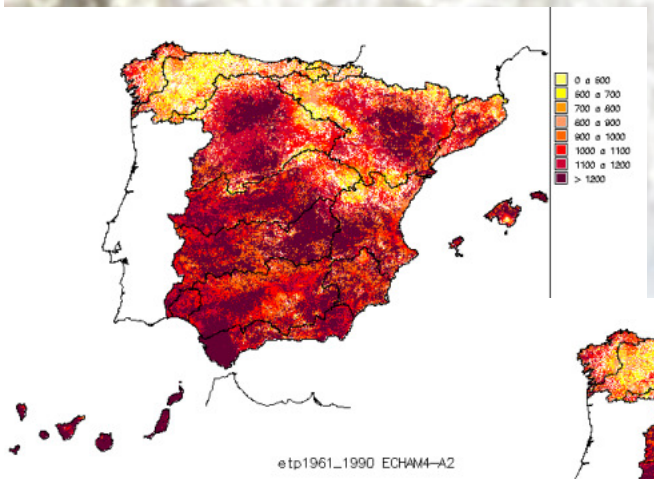


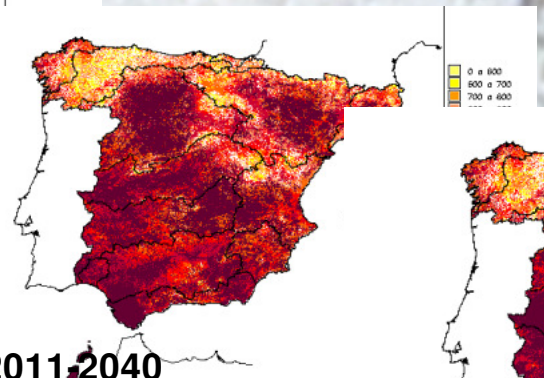

2071-2100

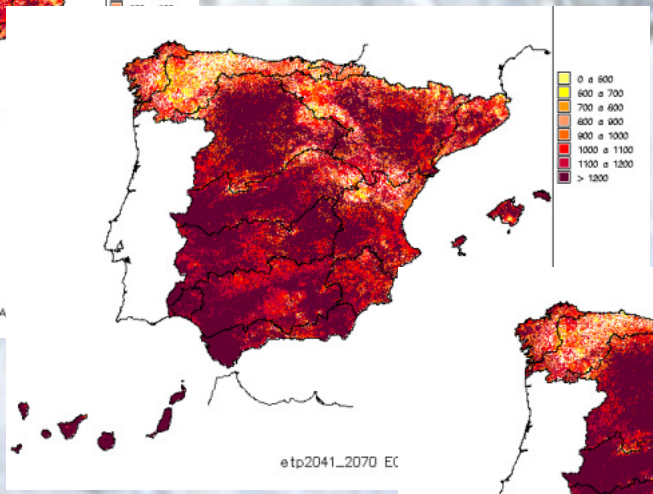
# ECHAM4 Model. Escenario A2

Potential evapotranspiration

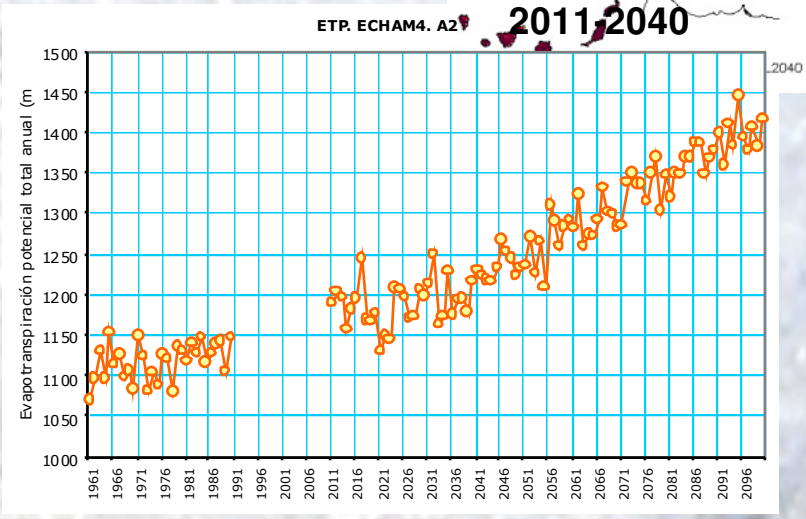


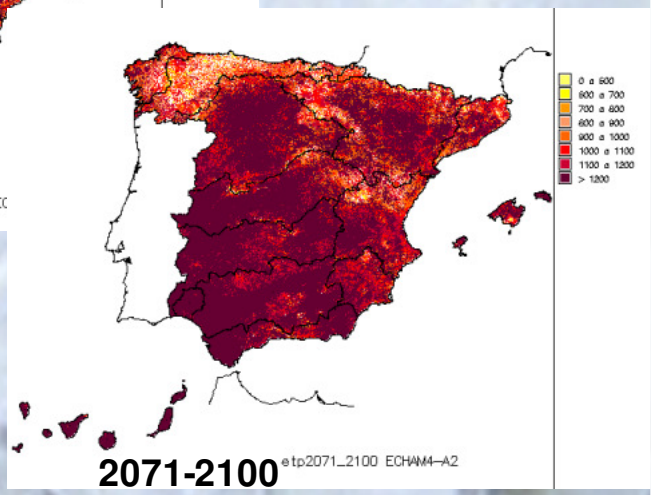

1961-1990




2041-2070

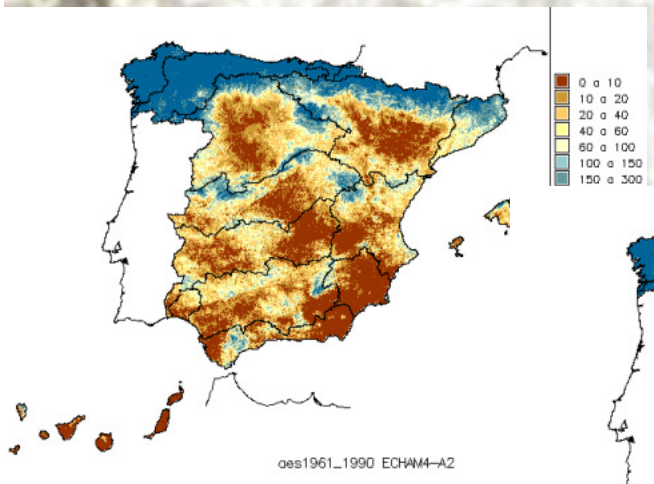


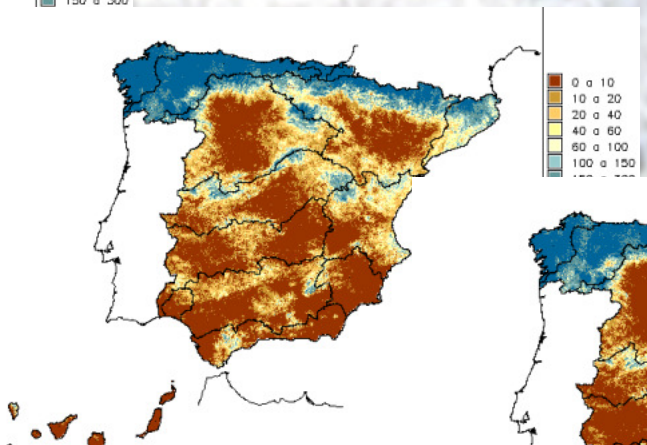

2071-2100

# ECHAM4 Model. Escenario A2

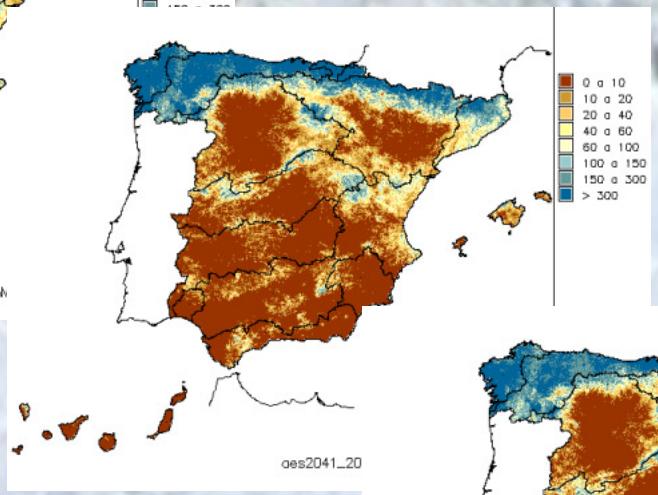
Runoff



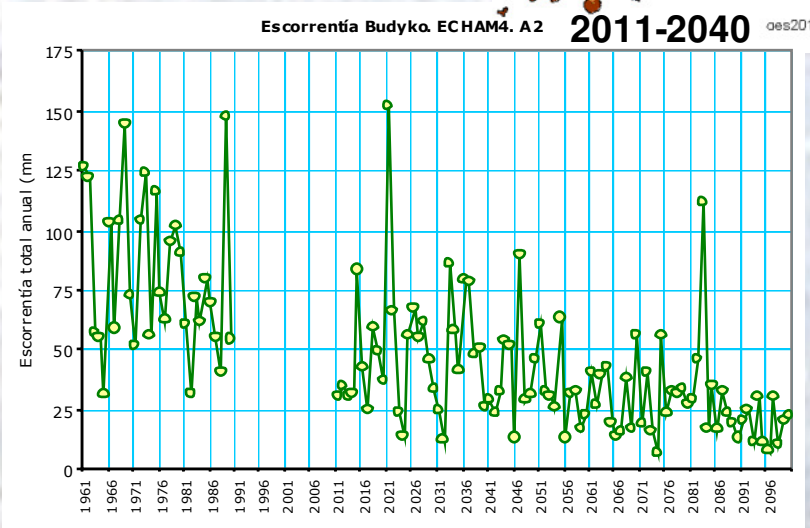

1961-1990

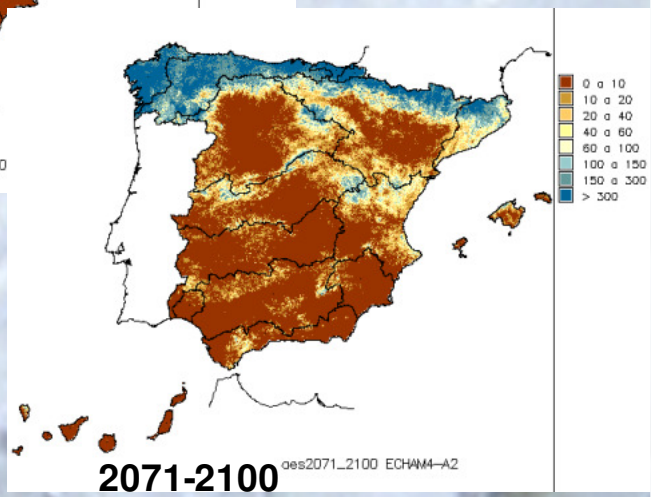



2011-2040




2041-2070



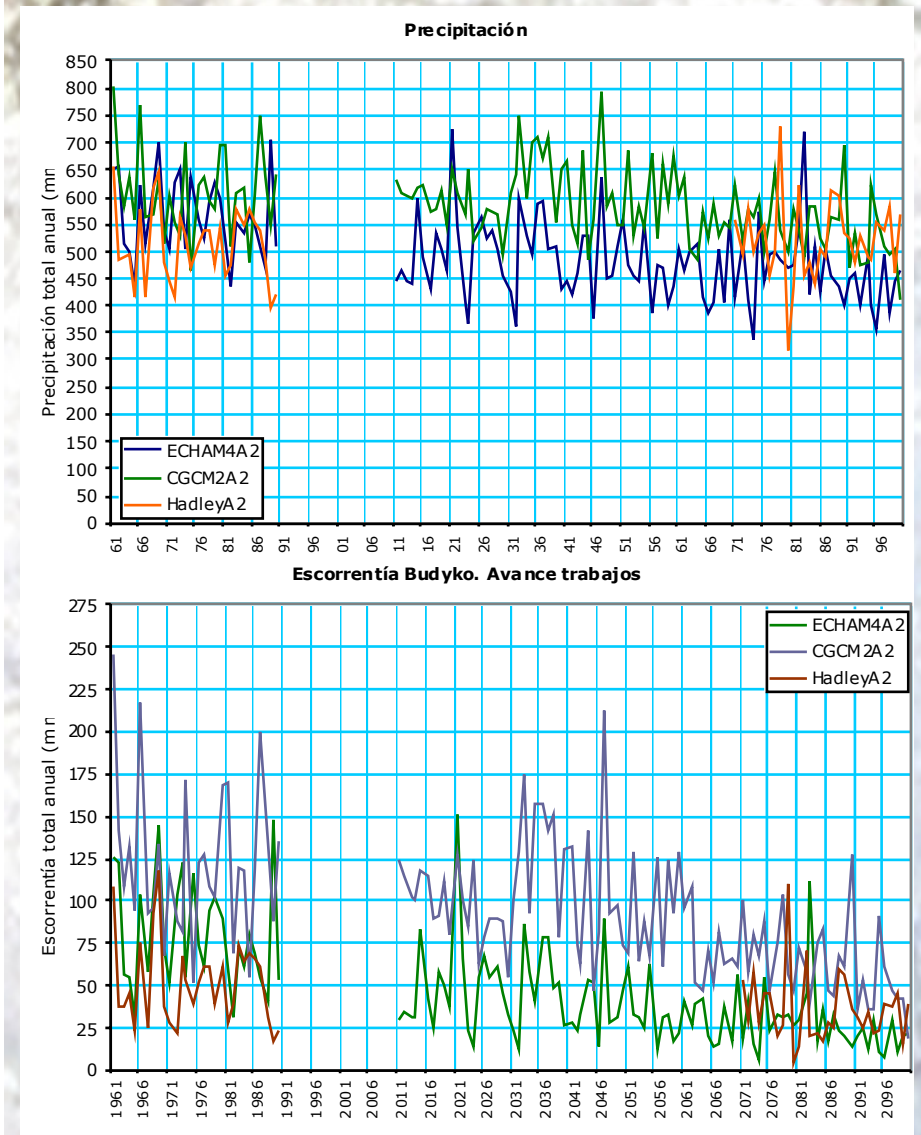

2071-2100

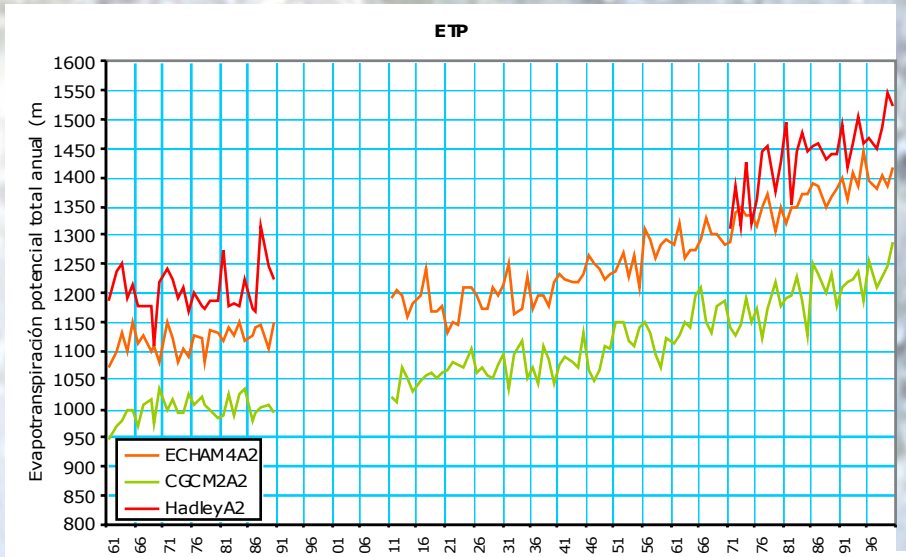
# ECHAM4 model results

| | PRE | ETP | AES | PRE | ETP | AES |
|---|---|---|---|---|---|---|
| 1961-1990 | 563 | 1118 | 80 | 563 | 1118 | 80 |
| 2011-2040 | 500 | 1189 | 50 | 505 | 1191 | 52 |
| 2041-2070 | 471 | 1263 | 34 | 497 | 1246 | 44 |
| 2071-2100 | 463 | 1364 | 27 | 492 | 1291 | 39 |
| | | | | | | |
| 1961-1990 | - | - | - | - | - | - |
| 2011-2040 | -11% | 6% | -38% | -10% | 7% | -36% |
| 2041-2070 | -16% | 13% | -57% | -12% | 12% | -46% |
| 2071-2100 | -18% | 22% | -66% | -13% | 16% | -52% |

Escenarios A2 y B2

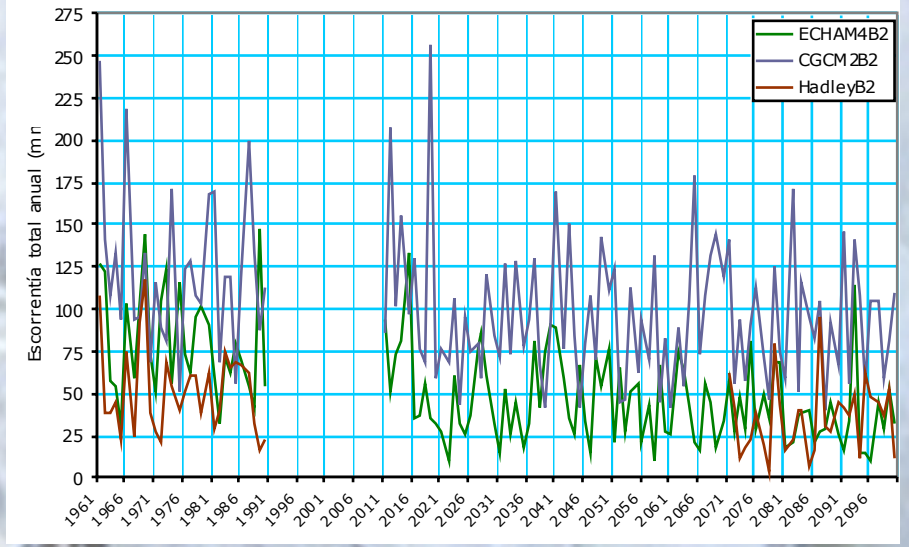
# ECHAM4, CGCM2 and Hadley model results









# Regulation in Spain

- First River Basin Planning cycle (year 2009): a Climate-Check of Programme of Measures will be carried out in EU Member States.
- Royal Decree, RD 907/2007 regarding River Basin Management Plan Regulations was approved in July 2007
  - Mandatory to consider the effects of climate change on water resources in the development of plans