



MINISTERIO
DE MEDIO AMBIENTE

Secretaría General para el Territorio y la Biodiversidad
Dirección General del Agua

Cyprus Conference
"Coping with Drought and Water Deficiency:
from Research to Policy Making"

**PAST and FUTURE of DROUGHT
MANAGEMENT in SPAIN**

Cyprus 12-13 May 2005

Eng. Justo Mora A.-Muñoyerro

Summary

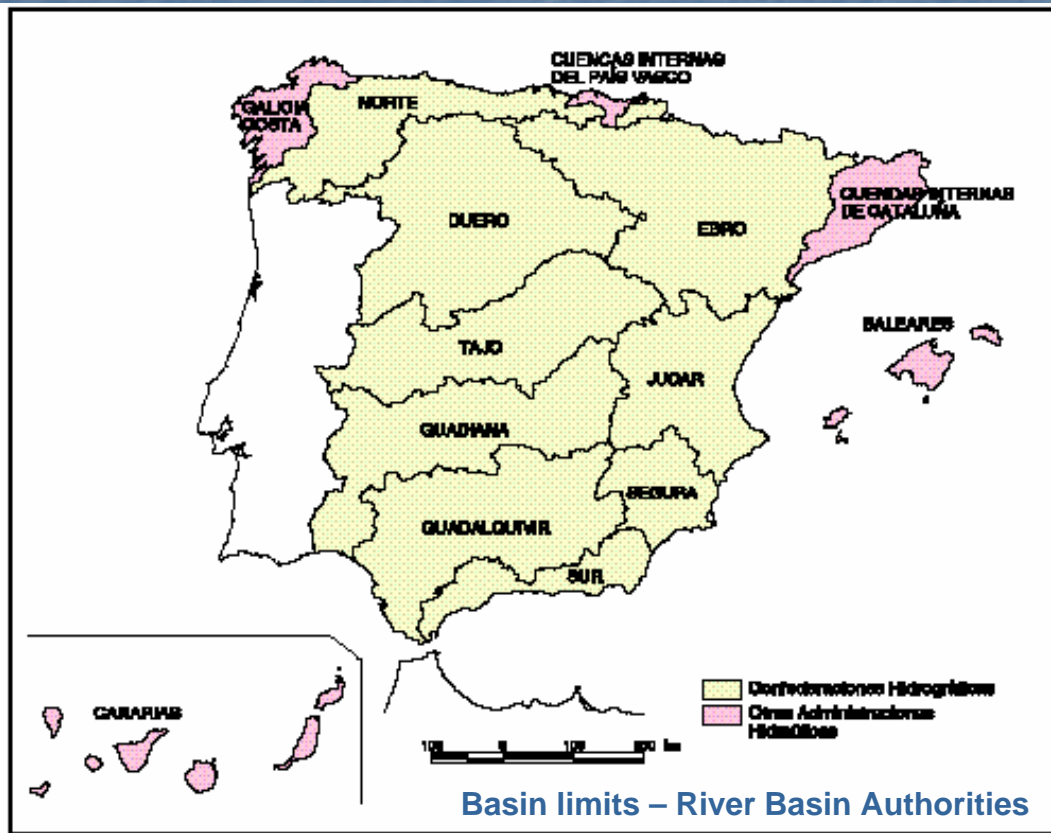
1. Former regulations and crisis management
 2. Recent droughts: measures taken and lessons learned
 3. A new legal framework
 4. Hydrological Indicator System
 5. Basin Special Plan for Droughts
Example of Júcar River Basin
 6. Conclusions
-

1. Former regulations and crisis management

Former Spanish General Regulations

- Drought planning tendencies nowadays move from crisis to risk management
- Former Spanish Water Act (Act 29/1985) faced drought as a crisis management through emergency measures:
 - Reservoir Committee
 - Exceptional case (Water Act Article 58)

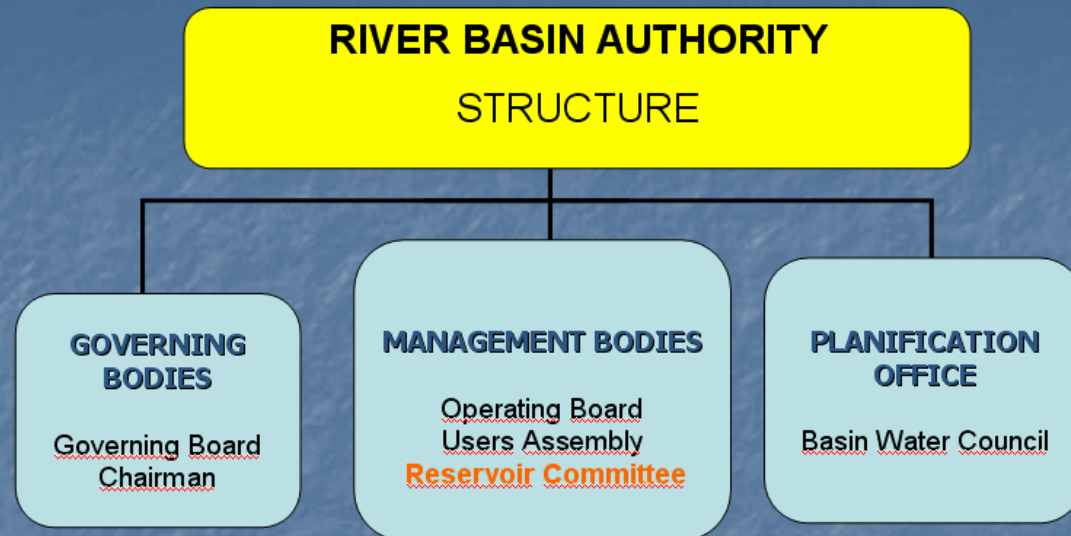
Basin Institutional Organization



Public Water Administration General Principles in Spain (Water legislation)

1. Management units, integral water treatment, water economy, de-centralization, co-ordination, effectiveness and public participation
2. Related to the the hydrographic river basin, hydraulic systems and hydrological cycle
3. Public water management compatible with territory arrangement, environment conservation, protection and nature recovery

Basin Institutional Organization



- Reservoir Committee draws up and discusses proposals to be submitted to the Basin Authority Chairman with regard filling and emptying reservoirs and aquifers, according the rights of the different users and the current hydrological situation

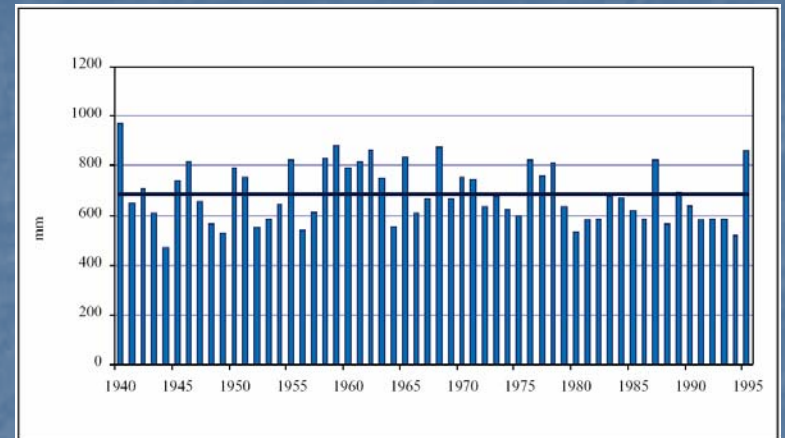
Exceptional Drought situation

- Former Spanish Water Act (Act 29/1985) faced drought as a crisis management through emergency measures:
 - Exceptional case (Water Act Article 58)
In circumstances of unusual drought, the Government may adopt exceptional measures in order to address the situation, even if concessions (rights of water use under certain conditions) have been granted. Such measures may include the building of emergency infrastructure.

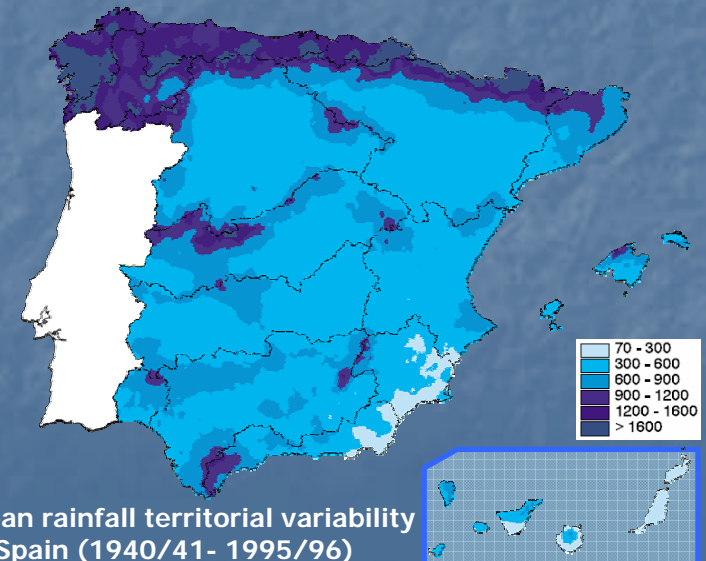
2. Recent droughts: measures taken and lessons learned

Spanish Hydrology Special Features

- The irregular Spanish hydrologic regime makes water a special scarce resource, with restricted availability and strong regional and time contrasts, situation not comparable to the rest of EU
- In Spain mean relationship between natural global resources and water demands for consuntive uses is 3 times minor rest of EU, while available resources represents 8 % of total resources (40-50 % in central EU countries)
- Spanish water resources occur with high irregularity in time (interannual and annual) and in space (humid north regions versus arid mediterranean regions)

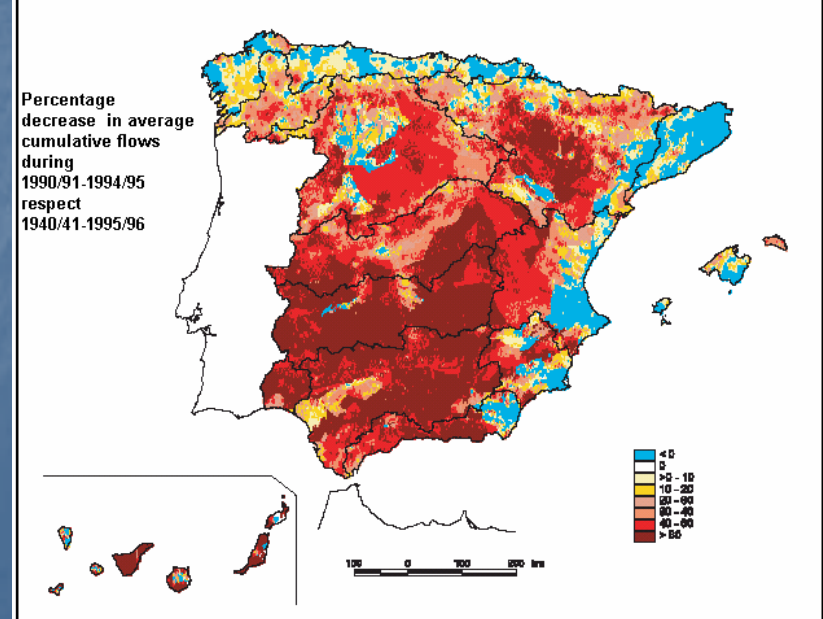
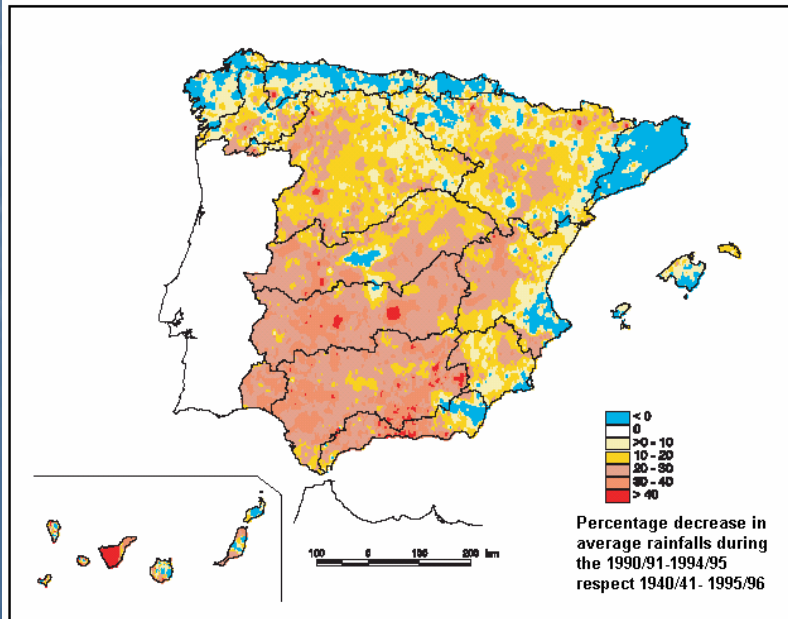
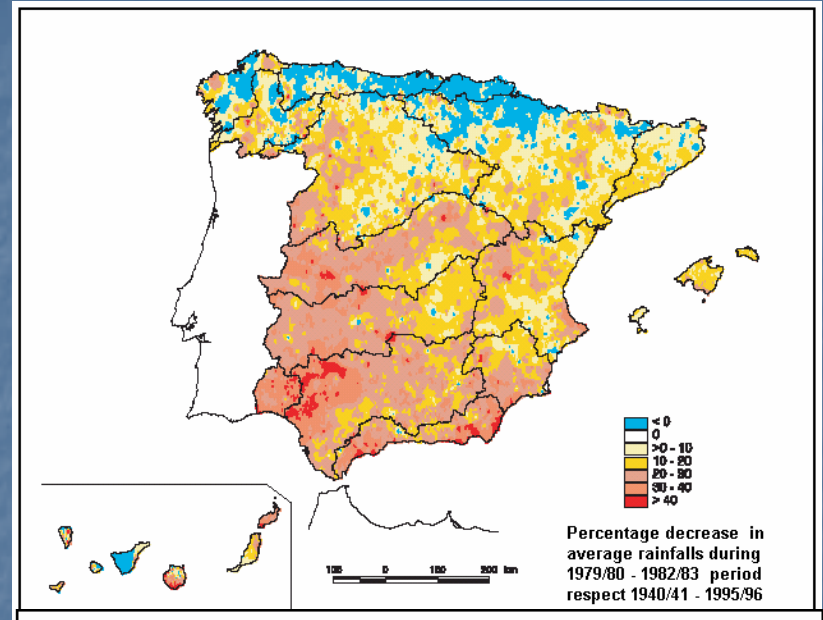
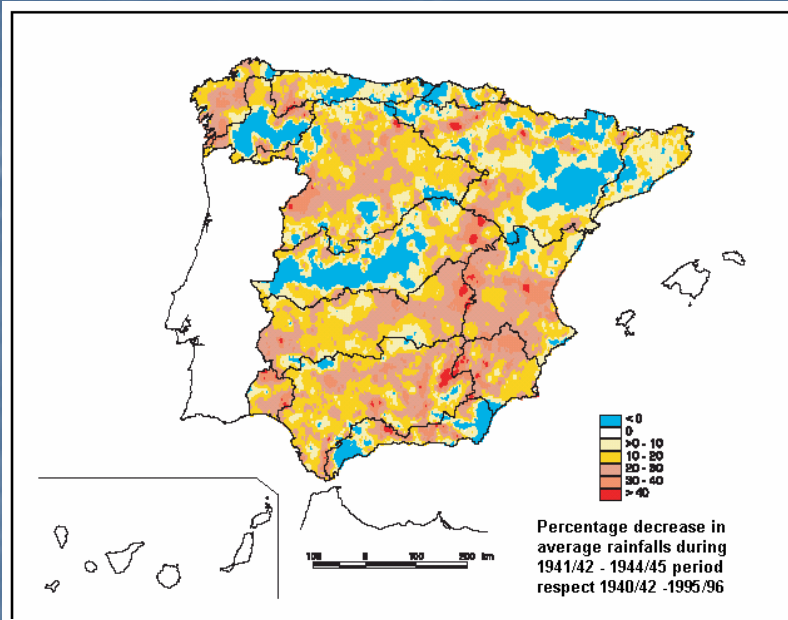


Mean rainfall time series variability in Spain
(1940/41- 1995/96)

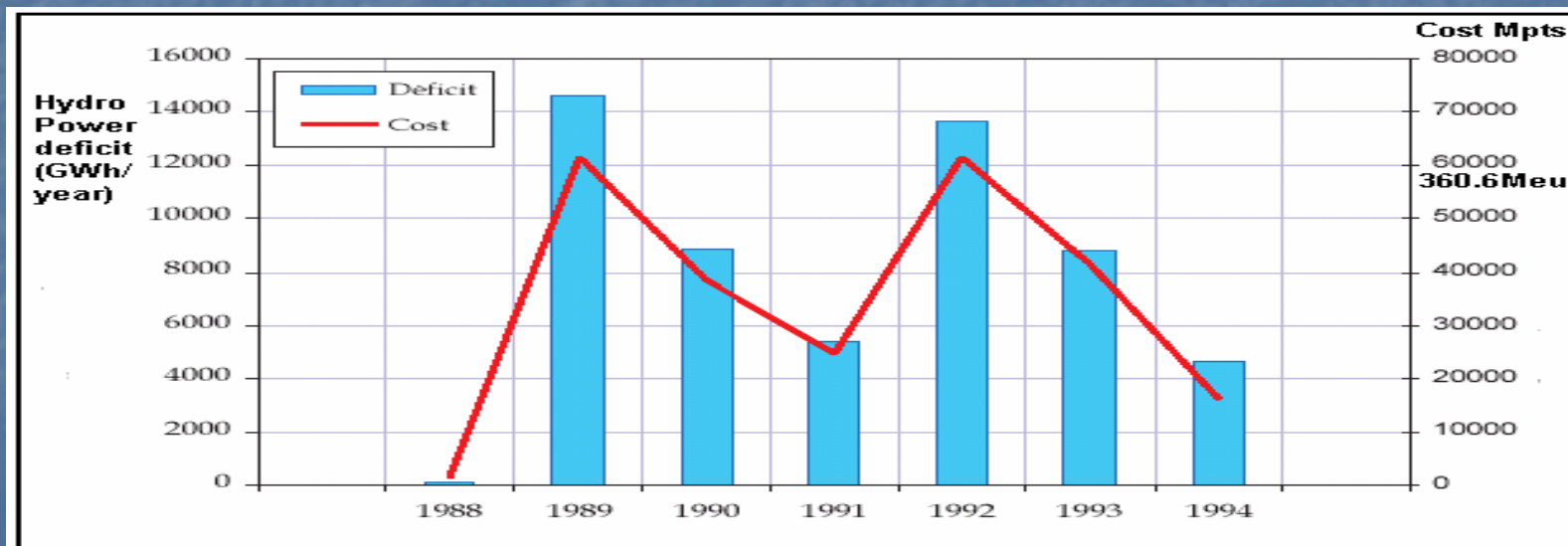
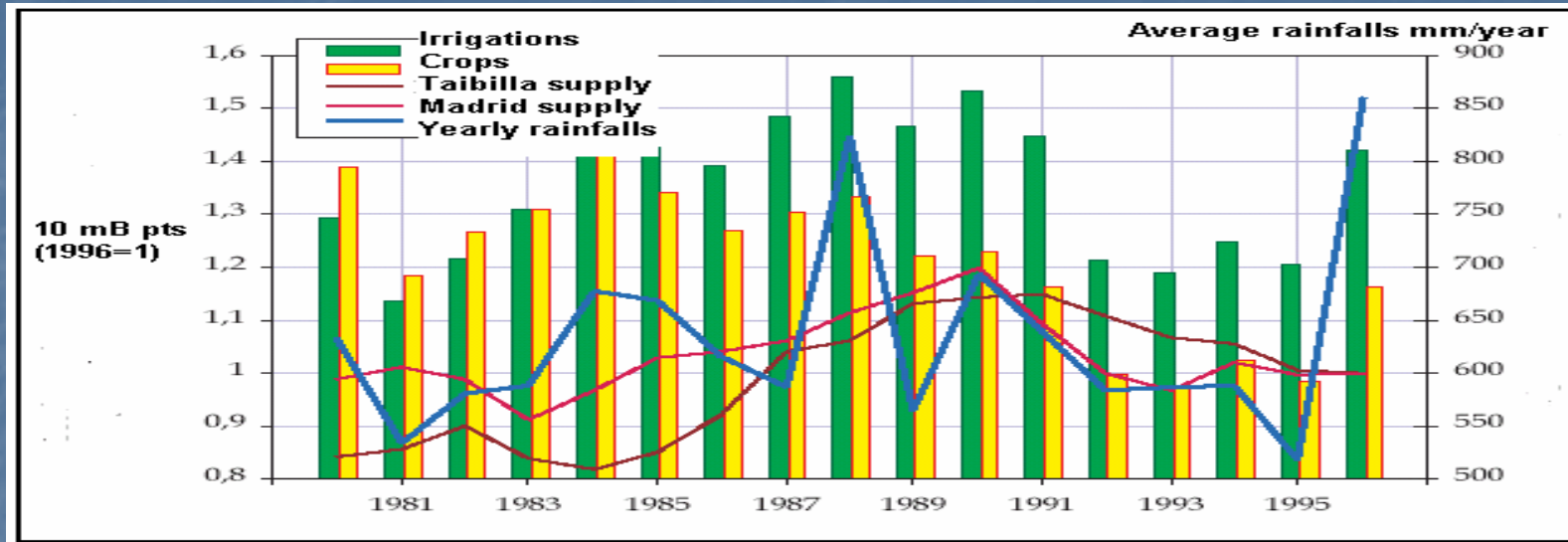


Mean rainfall territorial variability
in Spain (1940/41- 1995/96)

Maps of percentage decrease in average rainfalls/flows during different periods in comparison with 1940/41 – 1996-96 period



Historical Droughts and Economic Impact



Economic impact derived from recent droughts on crops, irrigated land, main urban systems and hydropower (1980/81 – 1995/96 period)

Most Common Measures Taken

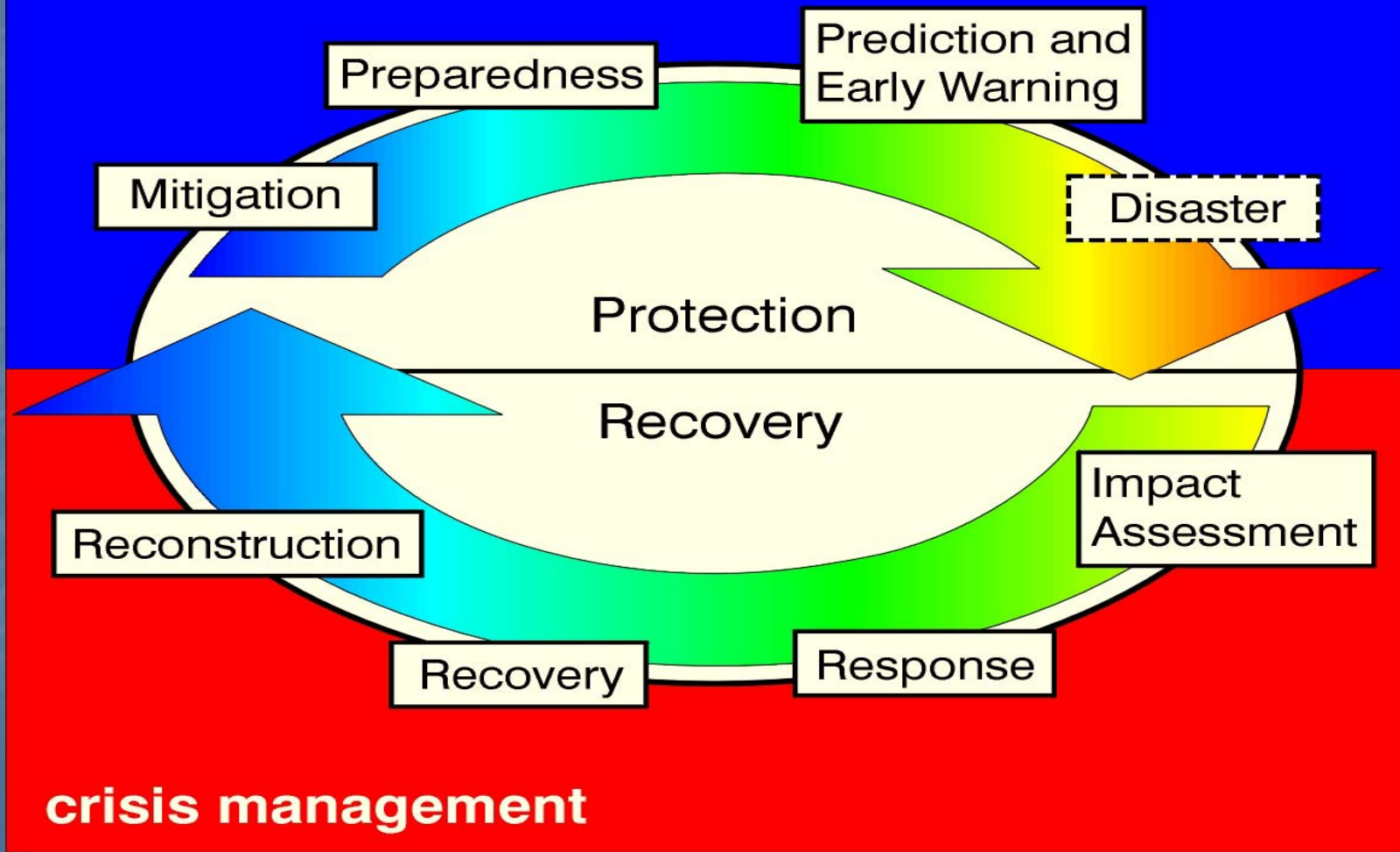
- Early restrictions settings and special procedures to allow exchanges between users
- Localization and exploitation of new groundwater resources. Emergency wells
- Development of non-conventional resources. Desalination. Wastewater reuse. Boat supply
- Development of infrastructures for basin connections

Lessons Learned

- No previous plans specifically designed for this type of emergency situations
- It is necessary to take into account the public awareness, the social perception of the shortage and to educate users in responsible behaviors towards water conservation
- It is suitable a Permanent Commissions on Droughts (Administration and Sectorial coordination, public participation)
- Legal gaps were detected
- New conception needed: mitigation measures, preparedness, warning and Emergency Plans

Risk versus Crisis Management

risk management



crisis management

3. A new legal framework

Drought Management: Current Legal Framework

-Different articles of current Water Act includes modifications to former Water Act facing drought:

Government may authorize the River Basin Authority to set up Water Interchange Centers (Water Banks) to enable user rights to be waved by voluntary agreement (Water Act Article 71)

-Act 10/2001, 5th July, of the National Hydrologic Plan (NHP) refers in Article 27 to drought management specifically

Drought Management (NHP Law)

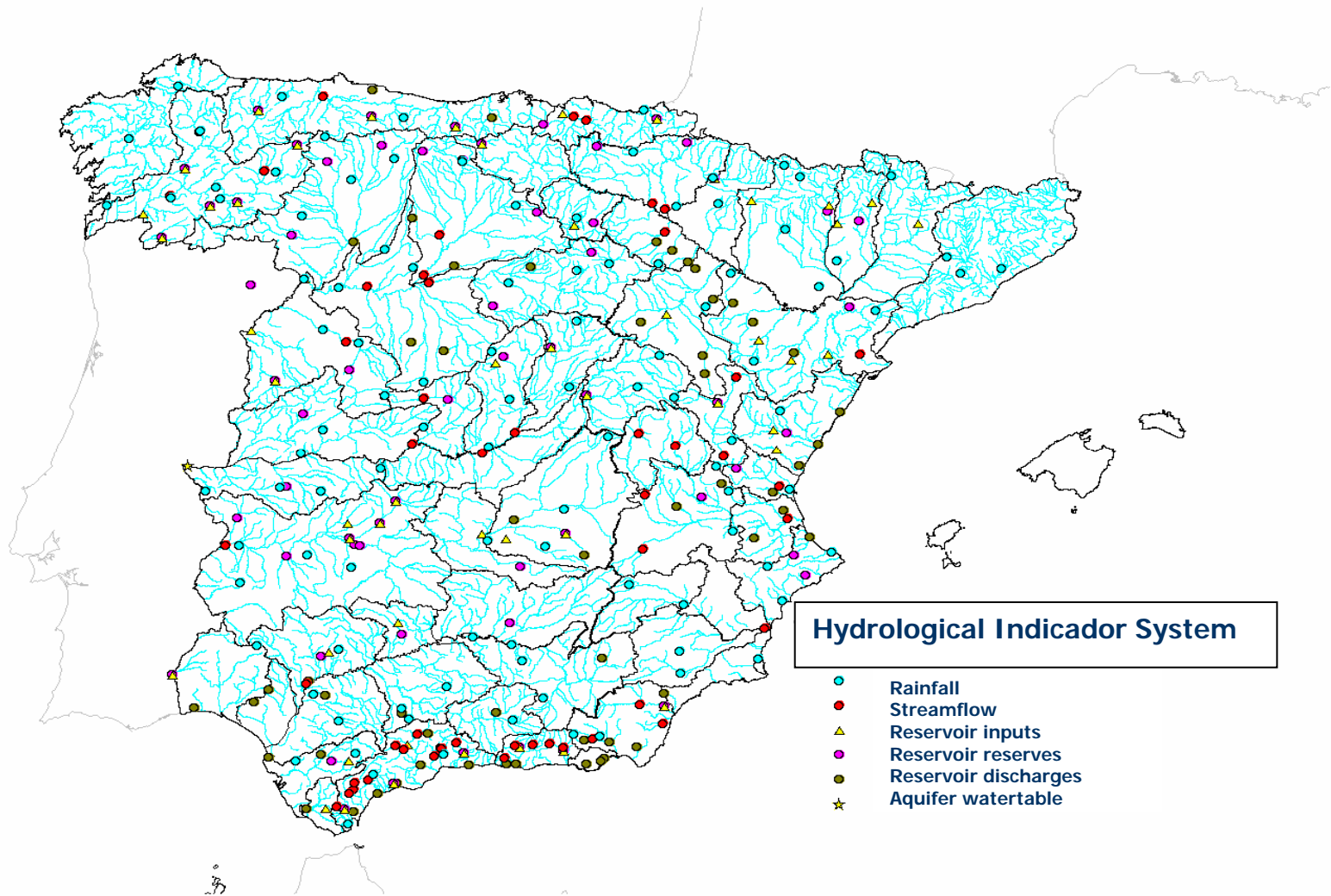
- **Drawing process:**
- Ministry of Environment: establishes a Global Hydrological Indicators System (HIS)
- River Basin Authority (Confederación Hidrográfica) prepares a Special Plan submitting it to the River Basin Council and the Environment Ministry for approval
- This Special Plan includes urban water supply directives (concern cities of more than 20.000 inhabitants) in case of drought or drought warning
- The institutions responsible for urban water supply (more than 20.000 inhabitants) have to draw up a Drought Emergency Plan
- **Carrying out:**
- According to HIS thresholds River Basin Authority declares state of Drought or Drought Warning, initiating the measures included in the Special Plan
- The responsible for urban water supply have to implement it when the state of drought or warning has been declared by the River Basin Authority

4. Hydrological Indicator System

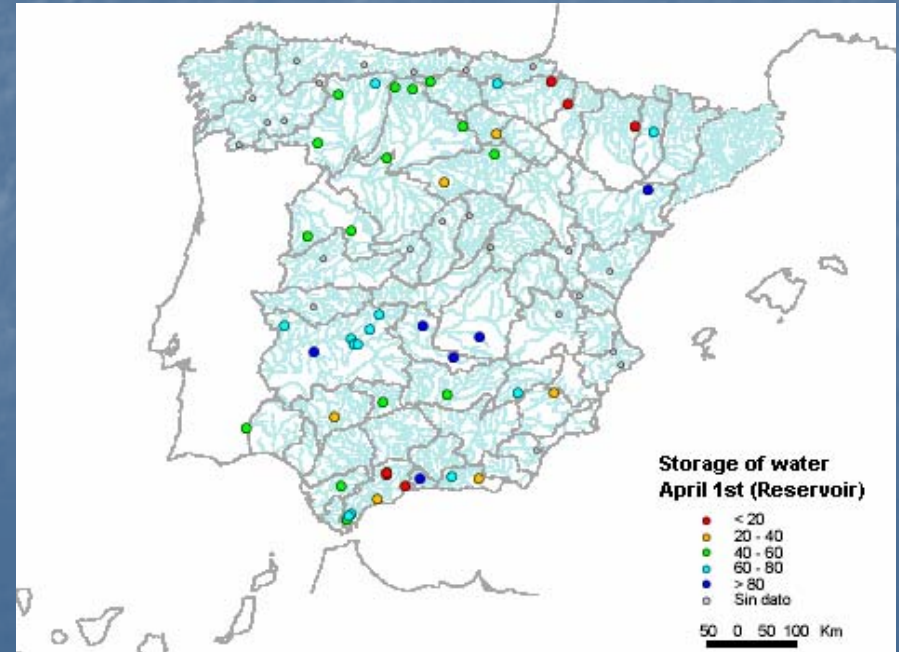
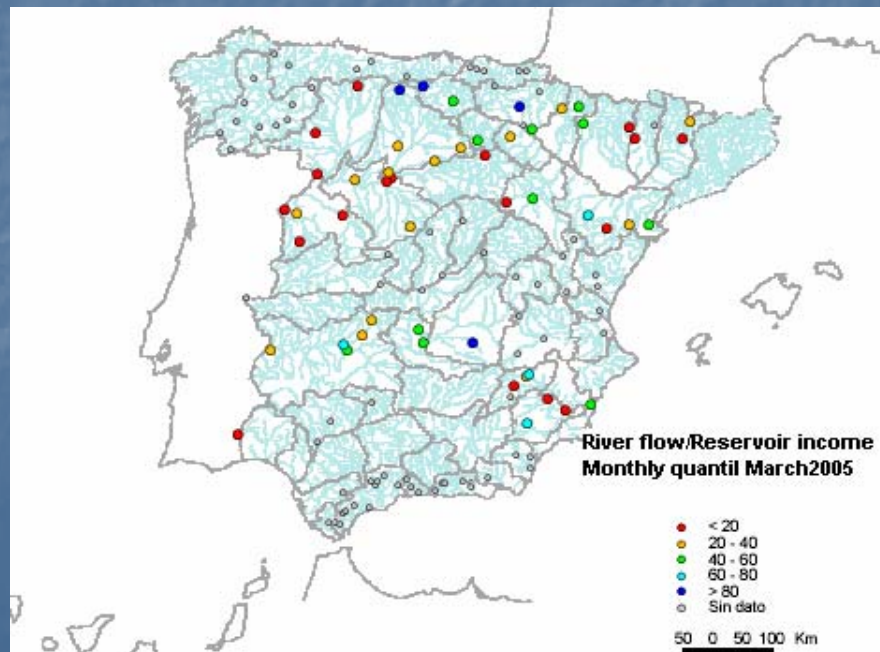
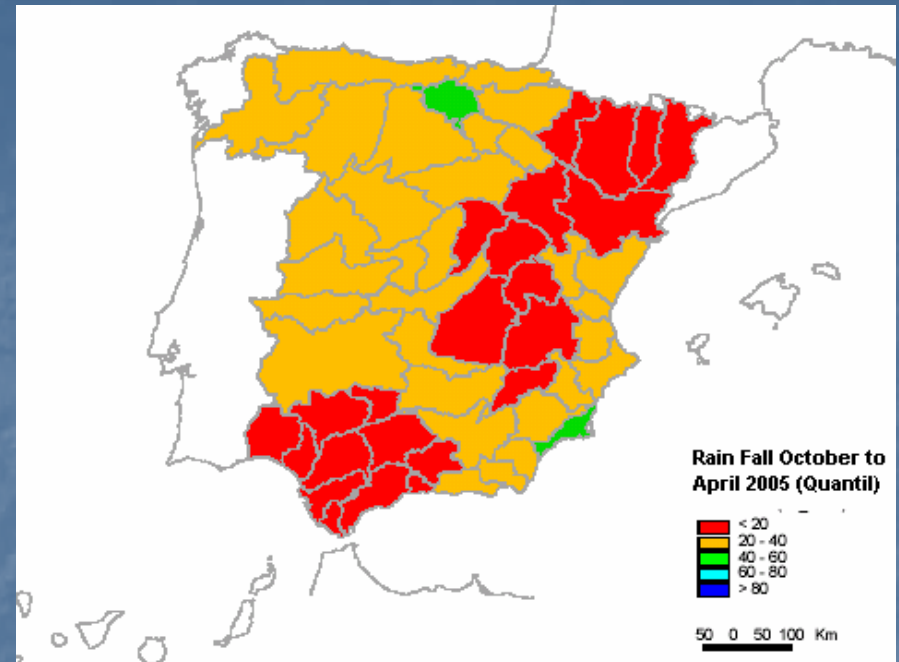
Hydrological Indicator System

- The hydrological situation is monthly monitored by the Environment Ministry, including:
 - Rain-fall
 - Stream flow
 - Reservoir water storage
 - Aquifer piezometric levels
 - Snow stored(in progress)

Hydrological Indicator Network



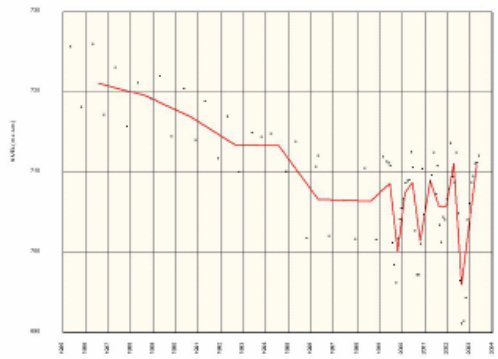
Hydrological Indicator System: monthly monitoring



AQUIFERS

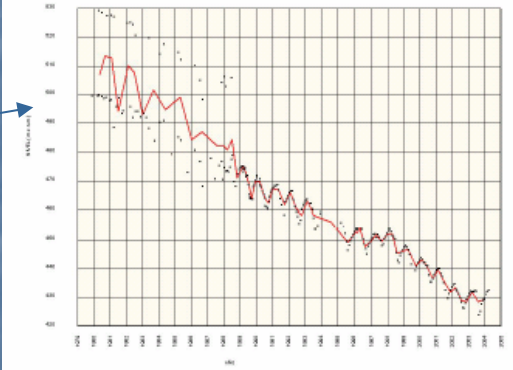
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Central del Duero



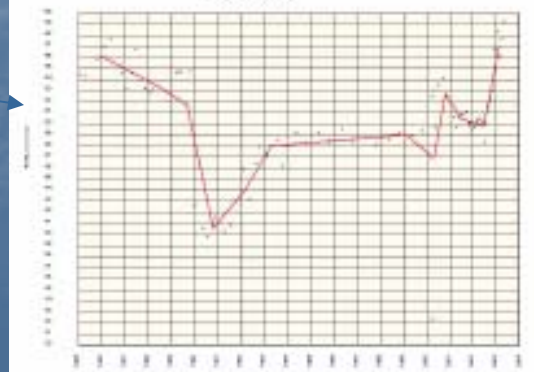
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Virgen de Lagunas



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Chiva





MINISTERIO DE MEDIO AMBIENTE

CONFEDERACIÓN HIDROGRÁFICA DEL EBRO

COMISARIA DE AGUAS HIDROLOGÍA

EVOLUTION of SNOW STORAGE in ARAGÓN RIVER BASIN until YESA RESERVOIR

Period : 01/10/2003 - 27/04/2005

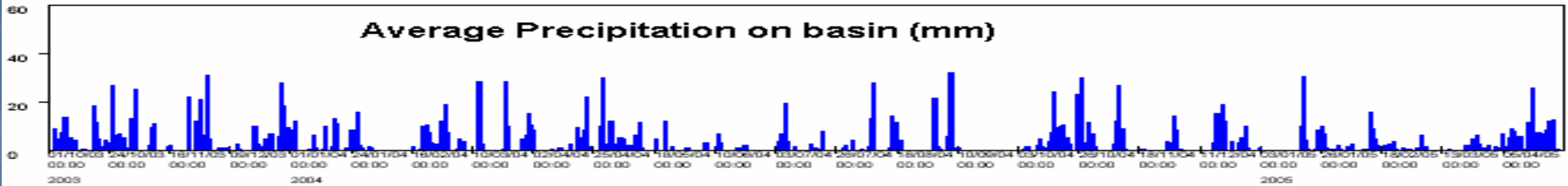


ASTER

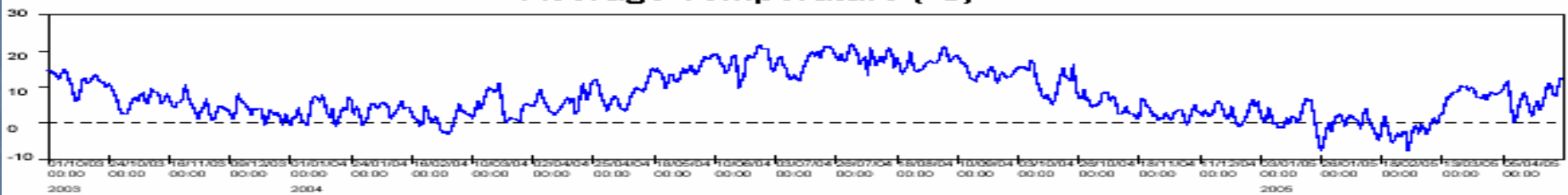
Daily values

28/04/2005

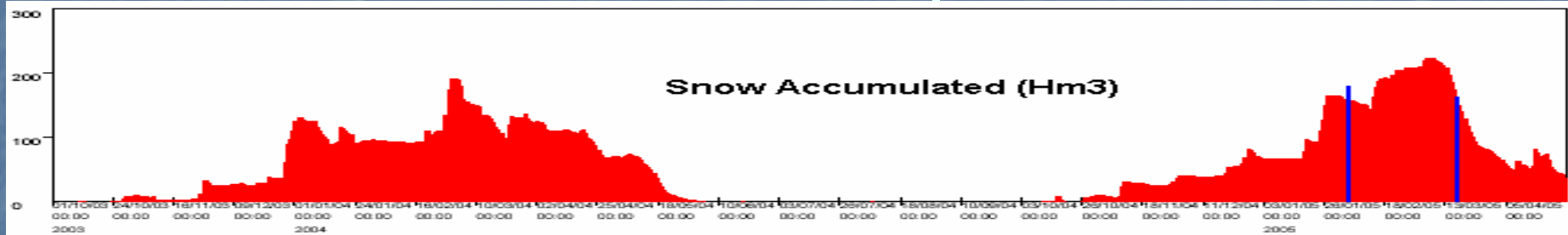
Average Precipitation on basin (mm)



Average Temperature (°C)



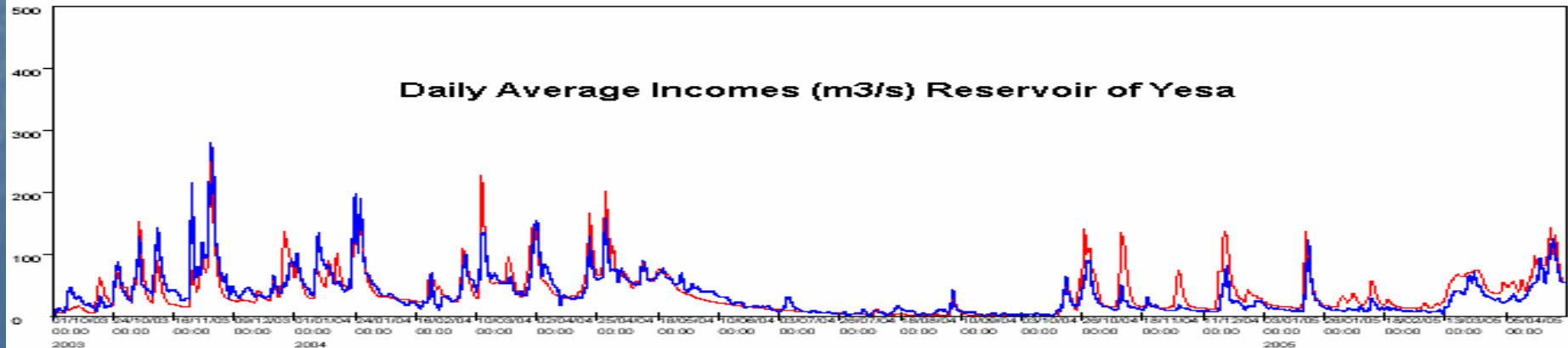
Snow Accumulated (Hm3)



CALCULATED

MEASURED

Daily Average Incomes (m3/s) Reservoir of Yesa



5. Basin Special Plan for Droughts

Drought management

- According with the thresholds, if necessary, the River Basin Authority declares the state of Drought: Pre-Alert, Alert or Emergency and zones affected
- The Special Plan (controlled by the River Authority) and Drought Emergency Plan (by the water supply institution) are initiated. Several measures must be taken with respect to:
 - Public awareness campaigns
 - Alternative sources development
 - Changes in management system rules (priority demands, ecological flows...)
 - Temporarily water supply cuts
 - Others

RESOURCES
ASSESSMENT

WATER
RESOURCE
MANAGEMENT
SYSTEMS

HISTORICAL
DROUGHTS

DESCRIPTIVE
VARIABLES

Drought Special Plan: drawing up Guide (Ministry of Environment)

TERRITORIAL
PARTITION

NETWORK

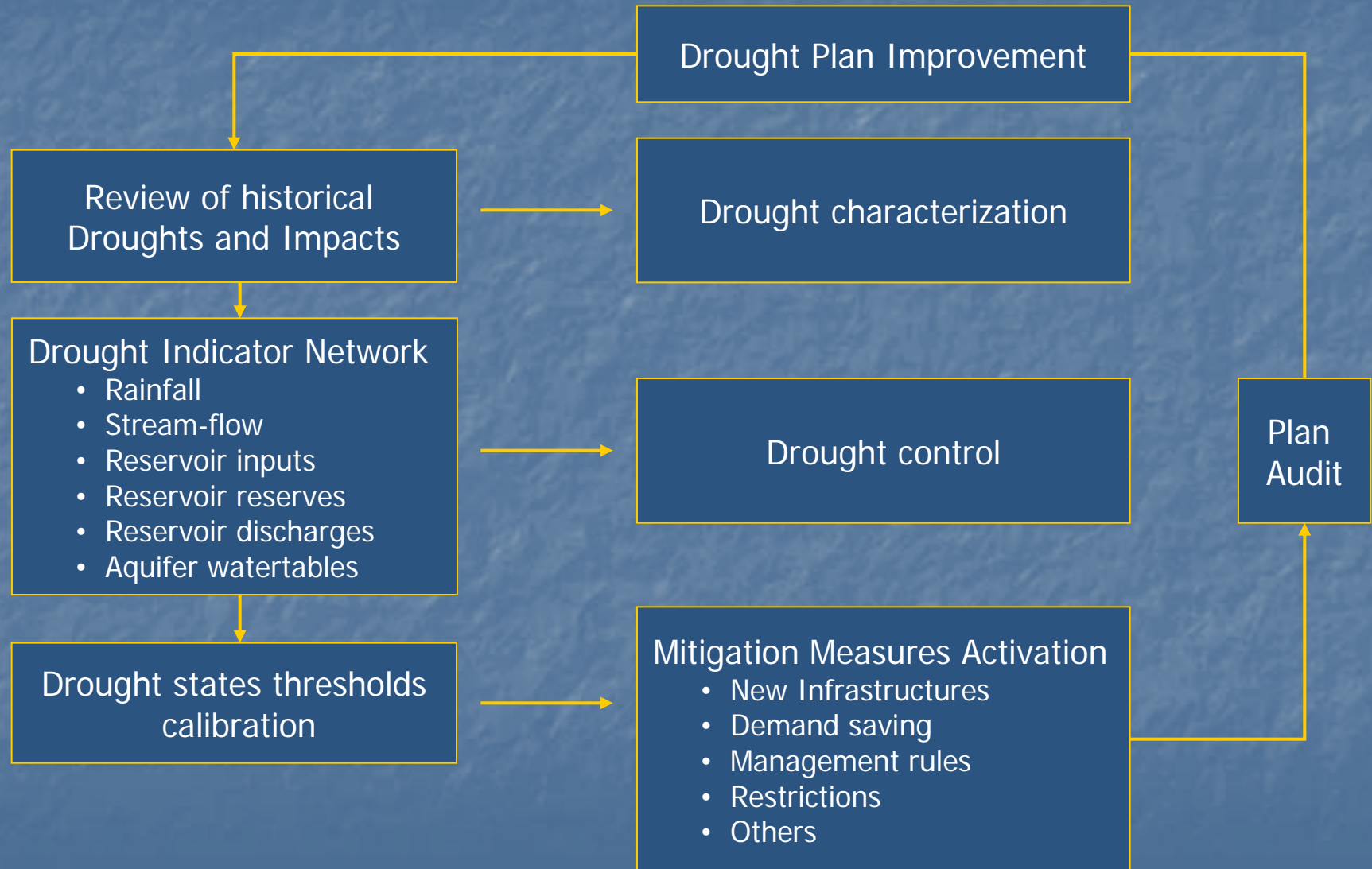
INDICATOR
DEFINITION

TRHESHOLD
Normal Alert
Drought

SPECIAL PLAN
Alert / Drought

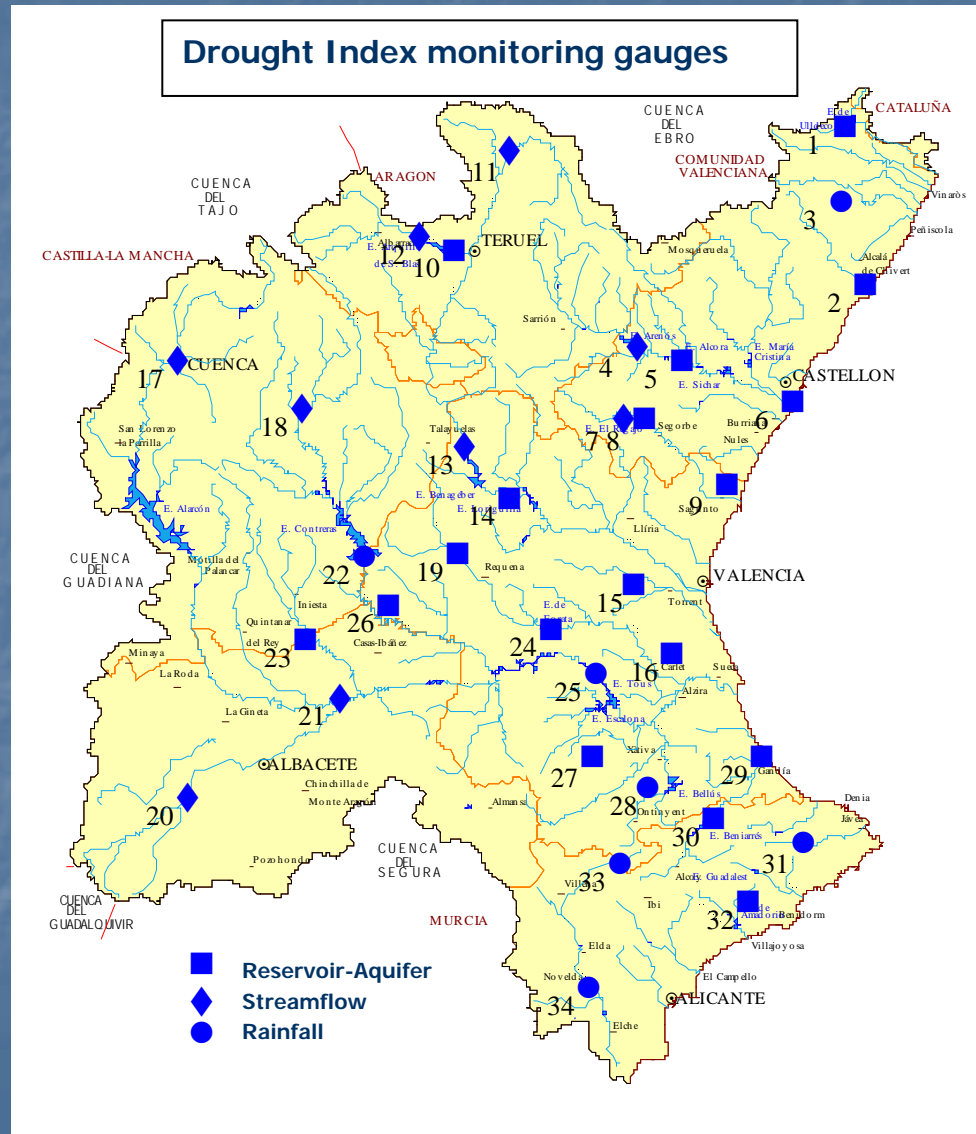
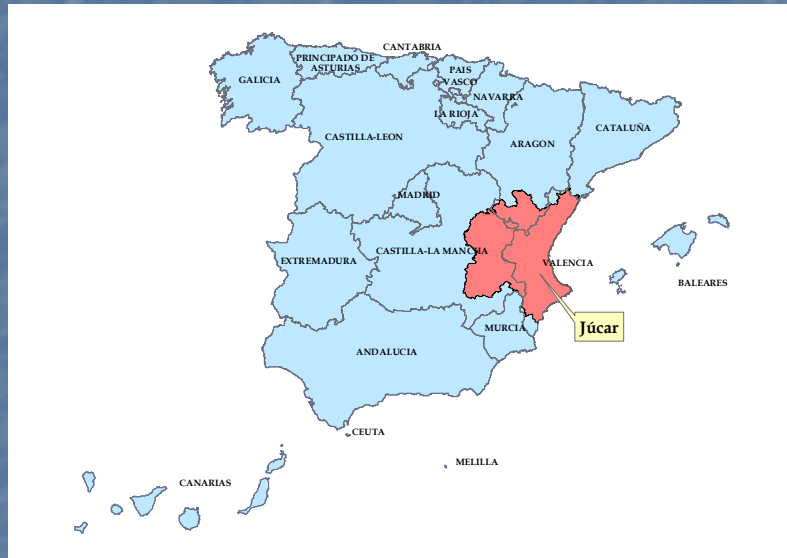
PROGRESSIVE
MEASURES
N / A / D

Drought Special Plan Process



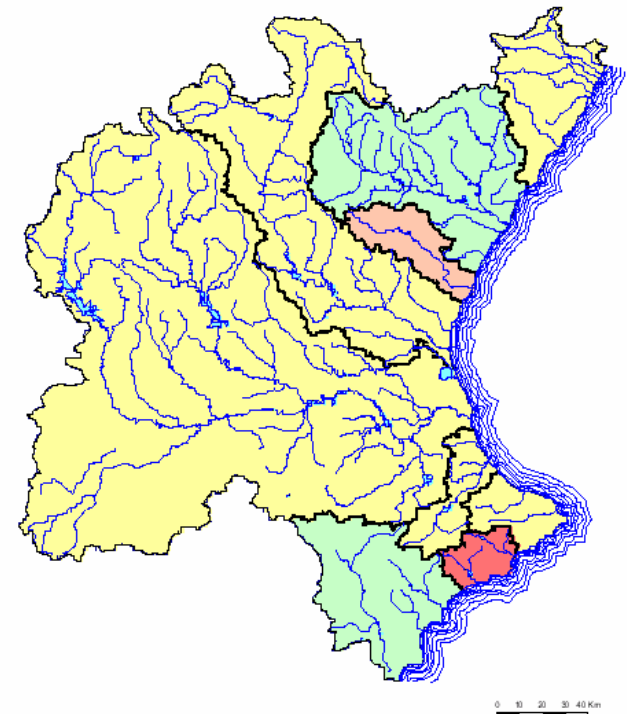
Jucar River Basin Special Plan

Jucar River Basin State Index



Example Júcar Basin situation September 2001

zona	indicador	niveles			
		30-09-2001		30-04-2001	
Recursos superficiales del sistema del río Cenia	Volumen mensual embalse de Uldecona	0,62		0,90	
Recursos subterráneos franja costera Cenia-Maestrazgo	Piezómetro 312360002. Alcalá de Chivert	0,33		0,63	
Recursos subterráneos Interior Cenia-Maestrazgo	Pluviómetro 08511-A. San Mateo H.S.	0,76		0,61	
Recursos alto y medio Mijares	Entradas a Arenós.	0,21		0,08	
Recursos superficiales regulados por Arenós y Sichar	Volumen embalsado en Arenós y Sichar	0,60		0,65	
Recursos subterráneos Plana de Castellón	Piezómetro 302530008. Almazora	0,86		0,22	
Recursos Alto Palancia	Entradas al Regajo	0,10		0,02	
Recursos superficiales regulados por el Regajo	Volumen embalsado en el Regajo	0,50		0,73	
Recursos subterráneos Plana de Sagunto	Piezómetro 29268092. Sagunto	0,15		0,68	
Recursos regulados por el Arquillo de San Blas	Volumen embalsado en el Arquillo de San Blas	0,80		0,84	
Recursos río Alfambra	Estación foronómica 08028	0,61		0,70	
Recursos fluyentes río Guadalaviar	Entradas al Arquillo de San Blas	0,03		1,00	
Recursos medio Turia	Estación foronómica 08018	0,33		0,56	
Recursos regulados por Benageger y Loriguilla	Volumen embalsado en Benageger y Loriguilla	0,31		0,44	
Recursos subterráneos Liria-Casinos/Buñol-Cheste	Piezómetro 282840014. Chiva	0,22		0,53	
Recursos subterráneos Plana de Valencia	Piezómetro 292910008. Alginet	0,27		0,35	
Recursos alto Júcar	Estación foronómica 08032	0,49		1,00	
Recursos alto Cabriel	Estación foronómica 08090	0,36		1,00	
Recursos subterráneos Utiel-Requena	Piezómetro 272750013. Utiel	0,39		0,56	
Recursos ríos Jardín y Lezuza	Estación foronómica 08138	0,15		0,52	
Recursos fluyentes Mancha Oriental	Estaciones foronómicas 08144 y 08036	0,00		0,62	
Recursos fluyentes medio Cabriel	Pluviómetro 08251-E. Embalse de Contreras	0,36		0,29	
Recursos subterráneos Mancha Oriental	Piezómetro 252920006. Cenizate	0,29		0,44	
Recursos regulados por el embalse de Forata	Volumen embalsado en Forata	0,09		0,12	
Recursos fluyentes Embarcaderos-Tous	Control pluviométrico 08269. Salto de Millares	0,46		0,43	
Recursos regulados por Alarcón Contreras y Tous	Suma de volumen en Alarcón, Contreras y Tous	0,46		0,59	
Recursos subterráneos Caroch	Piezómetro 283120003. Enguera	0,00		0,00	
Recursos fluyentes del Albaida y Cañoles	Pluviómetro 08285. L'Ollería	0,44		0,39	
Recursos subterráneos sierras Grossa y de las Agujas	Piezómetro 303110024. Gandía	0,46		0,47	
Recursos del sistema Serpis	Volumen embalsado en Beniarrés	0,46		0,30	
Recursos sistema Marina Alta	Pluviómetro 08045-u. Alcalalí	0,32		0,29	
Recursos sistema Marina Baja	Volumen almacenado en Amadorio y Guadalest	0,14		0,05	
Recursos Alto Vinalopó	Pluviómetro 08002. Bañeres	0,54		0,39	
Recursos Medio Vinalopó-Alacantí	Pluviómetro 08013. Novelda	0,53		0,36	

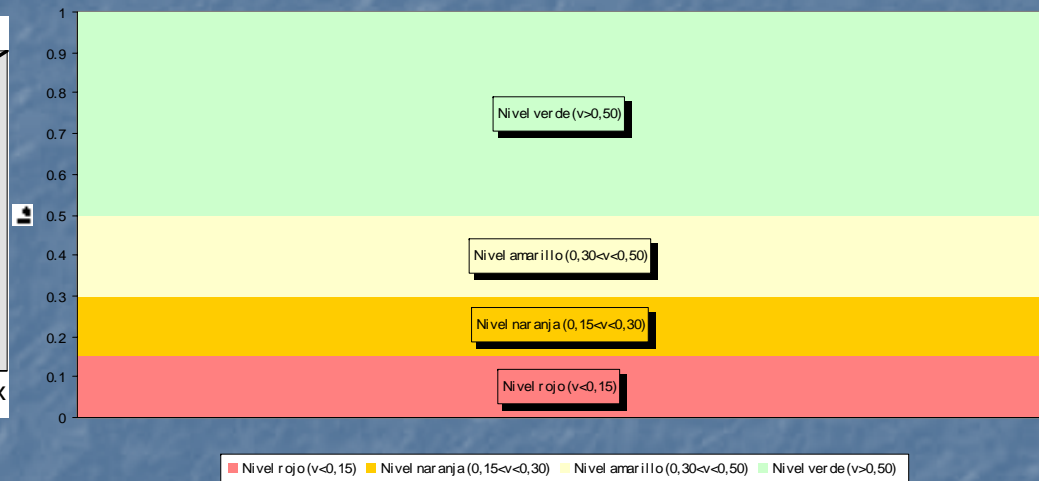
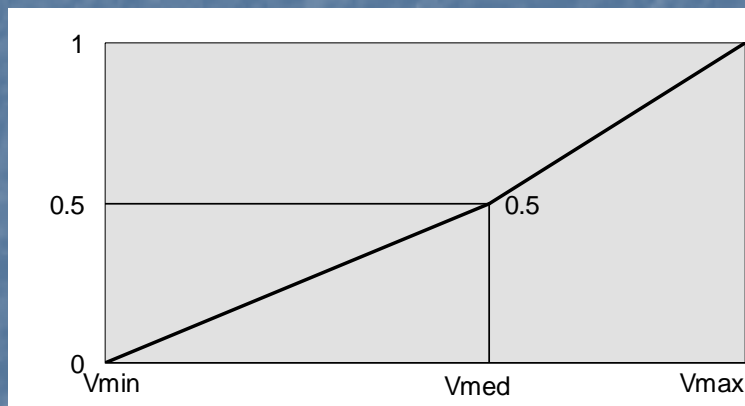


9 Sub-basins

34 Zone Indicators

Jucar River Basin State Index

Linear combination of the following types of gauges in each sub-basin: rainfall, stream-flow, water storage reservoir and aquifer water levels



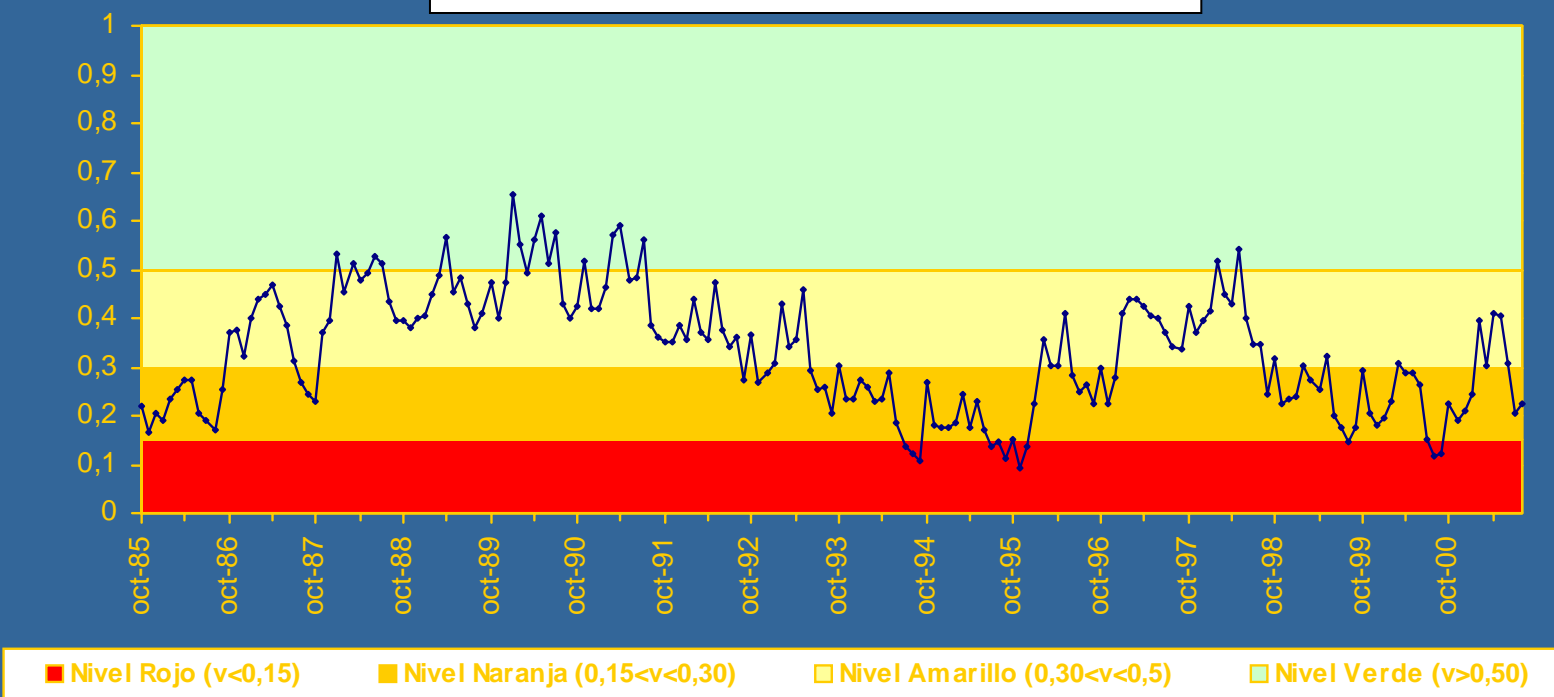
V_{max} , min or med: maximum, minimum or average value of period

green = normality,
orange = alert,

yellow = prealert,
red = emergency

Jucar River Basin State Index

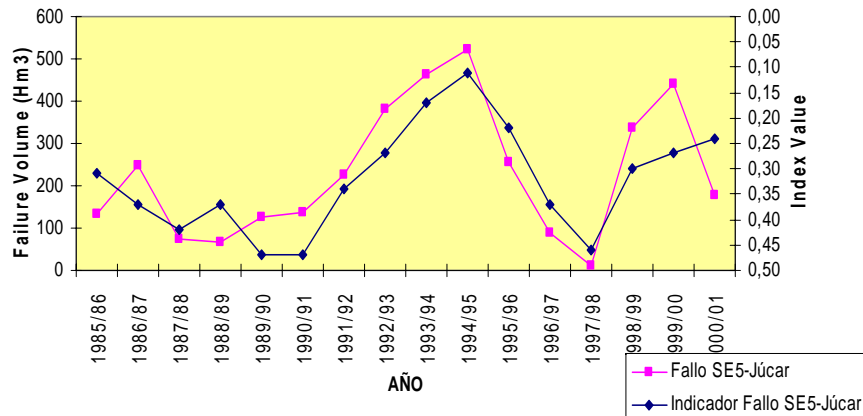
Global Jucar River Basin Index



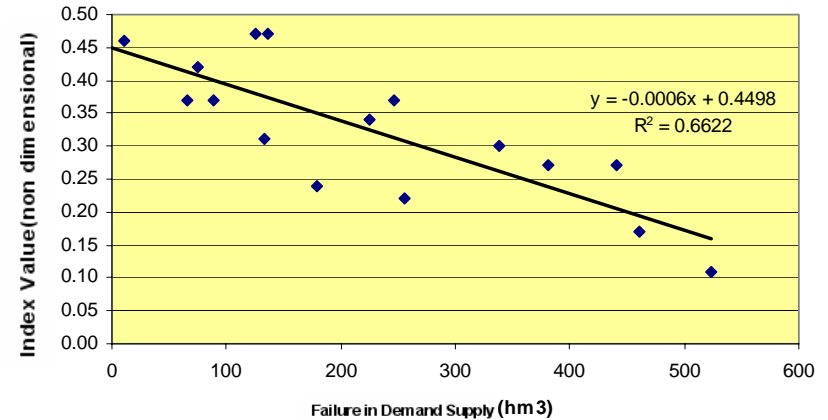
green = normality, yellow = pre-alert, orange = alert, red = emergency

Indicator-Failure supply correlation

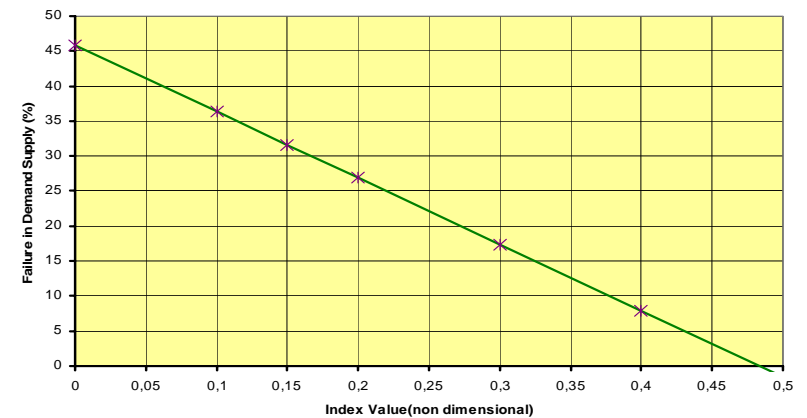
INDICATOR - FAILURE TO SUPPLY DEMAND CORRELATION
SE 5-JÚCAR



RELATIONSHIP BETWEEN FAILURE IN DEMAND SUPPLY- INDICATOR STATE
JUCAR RIVER BASIN



RELATIONSHIP BETWEEN FAILURE IN DEMAND SUPPLY- INDICATOR STATE
JUCAR RIVER BASIN

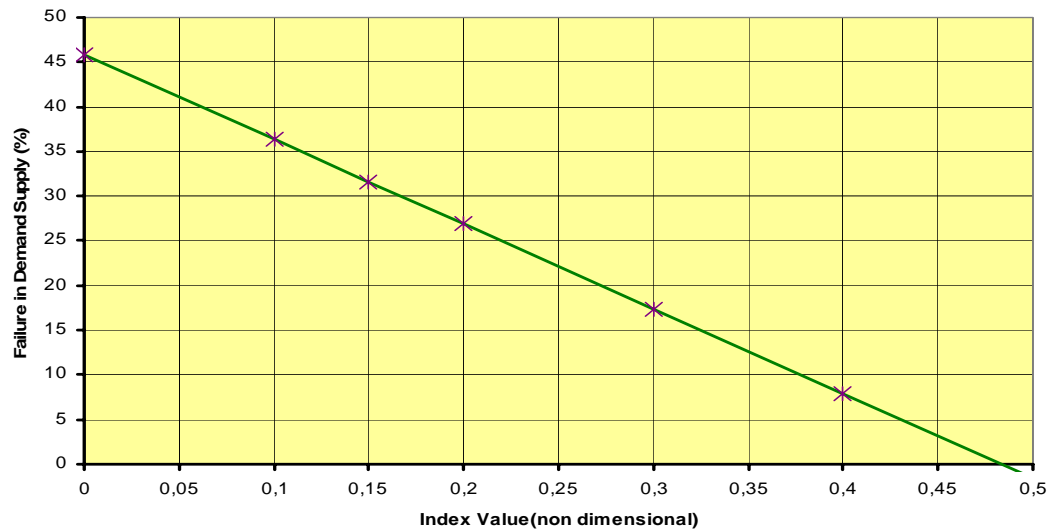


Failure – Drought Index calibrated
using simulation models

Jucar River Basin Special Plan

GLOBAL DROUGHT CHARACTERIZATION PARAMETERS JUCAR RIVER BASIN							
Indicator	1 - 0,5	0,5 - 0,4	0,4 - 0,3	0,3 - 0,2	0,2 - 0,15	0,15 - 0,1	0,1 - 0
State	Normality	Prealert		Alert		Emergency	
Objectives	Planification	Control		Conservation		Restrictions	
Deficit (%)	0	0-8	8-17	17-27	27-32	32-36	36-46
Storage (hm ³)	1604-813	813-667	667-500	500-333	333-250	250-167	167-0

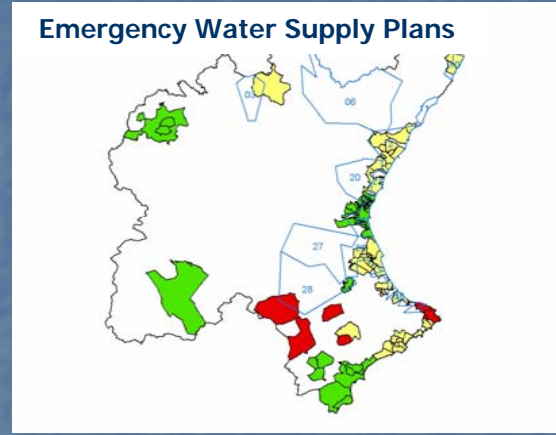
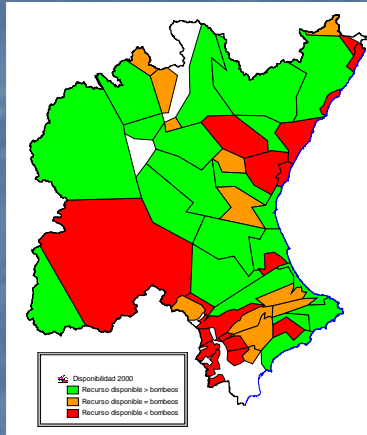
**RELATIONSHIP BETWEEN FAILURE IN DEMAND SUPPLY- INDICATOR STATE
JUCAR RIVER BASIN**



Jucar River Basin Special Plan

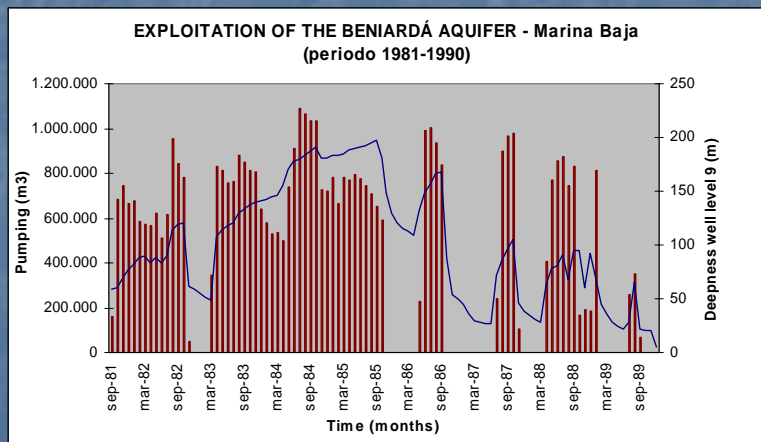
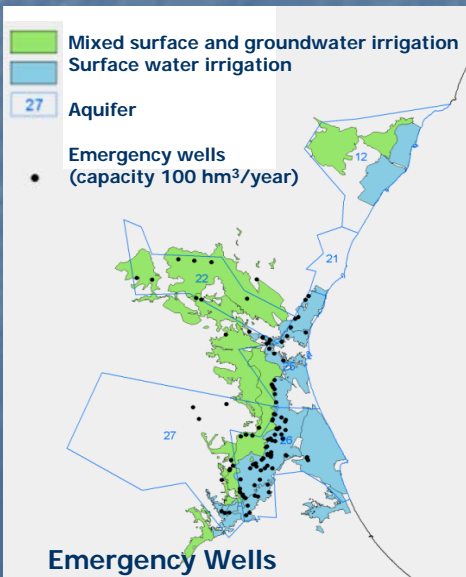
- The planned actions for the Special Plan in Jucar River Basin are the following:
 - Approval of exploitation rules and use restrictions
 - Aquifers of strategic reserve
 - Temporal exploitation of the reserves
 - Emergency wells
 - Desalination
 - Reuse of treated wastewaters
 - Transfers of external resources
 - Furthermore, the Drought Special Plan must activate and serve as boundary condition for water supplying Emergency Plans for towns over 20,000 inhabitants

Jucar River Basin Special Plan

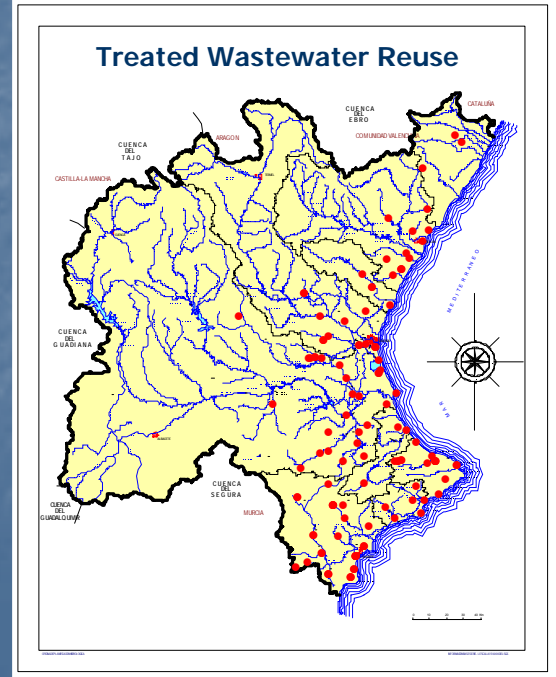


- Available resources > Abstractions
- Available resources = Abstractions
- Available resources < Abstractions

Simulation Model. Management Rules



Drought Special Plan Measures



Jucar River Basin Special Plan

Drought Special Plan Effects

DROUGHT MITIGATION PARAMETERS	% Demand
Urban and Agrary Demand (3 380 hm ³ /year)	100,00
Alert State (I<0.3)	
Initial Deficit	17,00
Water Conservation Measures	5,68
New Available Resources	5,00
Emergency State (I<0.15)	
Initial Deficit	32,00
Water Restrictions	22,37
New Available Resources	5,53
Total New Available Resources (Pre-Alert/Alert/Emergency)	
Wastewater reuse	7,34
Irrigation systems modernization	5,83
Desalination	1,80
Aquifer reserves abstractions	3,40
External transferences	0,15
Total	18,52

Planned conservation resources suppose a delay in the appearance of alert and emergency threshold and the development of new available resources to face drought represent 18.52 % of Jucar River Basin demands, acting as new offer in normality and pre-alert states, and as mitigation resources in alert and emergency states.

6. Conclusions

Conclusions (1/2)

- Drought planning tendencies nowadays drifts towards moving from crisis to risk management.
- Developing comprehensive, **long-term drought preparedness** policies and action plans may significantly reduce the risks and vulnerabilities associated with extreme weather events.
- It should include **prevention** – in order to reduce the risk and effects of uncertainty- and **mitigation** – measures undertaken to limit the adverse impacts of hazards- strategies.
- Drought impact assessment involve, at least, the specific effect on the economy, social life and **environment**, vulnerable to event.
- The problem of drought requires a **proactive management** developing actions planned in advance, which involve modification of infrastructures and laws and institutional agreements and the improvement of public awareness.

Conclusions (2/2)

- The drought management strategy should include sufficient capacity for contingency planning **before** the onset of drought, and appropriate policies to reduce vulnerability and increase resilience to drought
- Basic elements of a drought preparedness and risk management strategies that guide **Drought Special Plans** are the following:
 - Effective information and **early warning systems** are the foundation for effective drought policies and plans, as well as effective network and coordination between central, regional and local levels.
 - Drought management strategy should include sufficient capacity for contingency planning before the onset of drought, and appropriate policies to **reduce vulnerability** and **increase resilience** to drought.
- In Spain the legal framework regarding to drought has evolved from crisis management to risk management. It is desirable strengthen the long term measures of the Special Plans concerning to River Basin Management Plans and enhance the linkages with **Water Framework Directive**.

