



Instituto de Ingeniería del Agua y Medio Ambiente

I. I. A. M. A.



1st Pan-EU Drought Dialogue Forum

30-31 October 2012, Cyprus

Nicosia-Cyprus

Actions taken by science to support implementation of policy. The Júcar River Basin case of study

by **J. Andreu, A. Solera & J. Paredes**

Water Resources Engineering Research Group,
Institute for Water and Environmental Engineering (IIAMA)
Universidad Politécnica de Valencia (SPAIN)

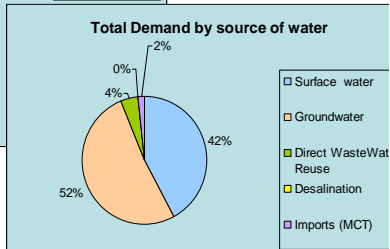
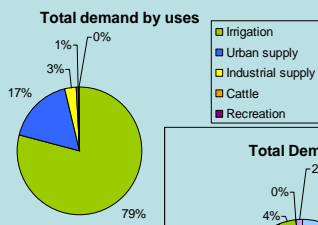
e-mail: ximoand@upv.es

www.upv.es/aquatool/

Júcar River Basin Authority (CHJ)

And Water Resource Systems

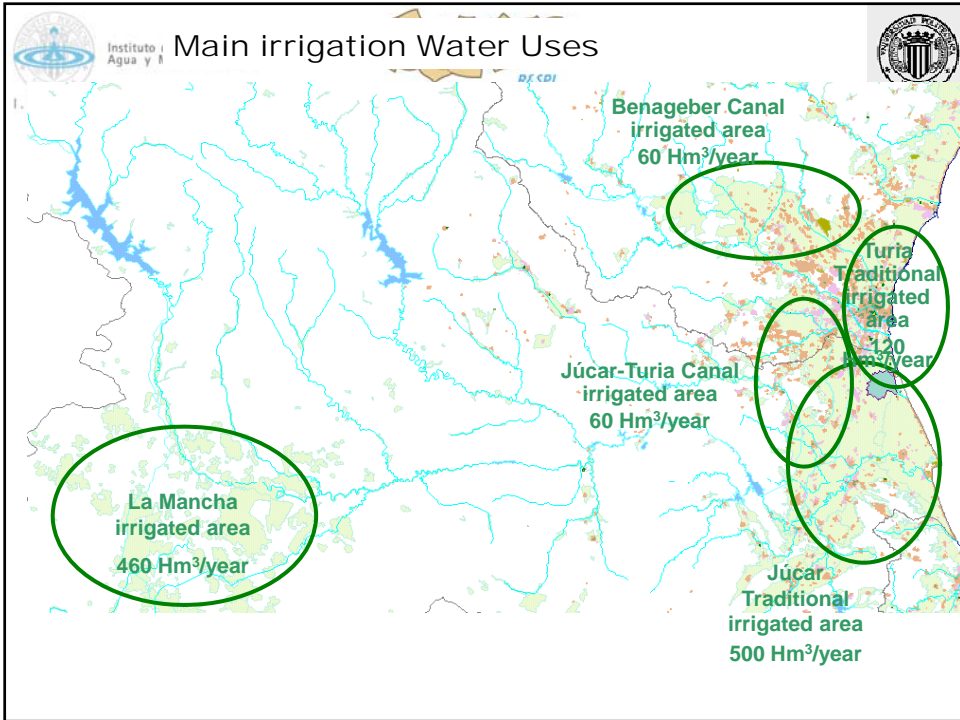
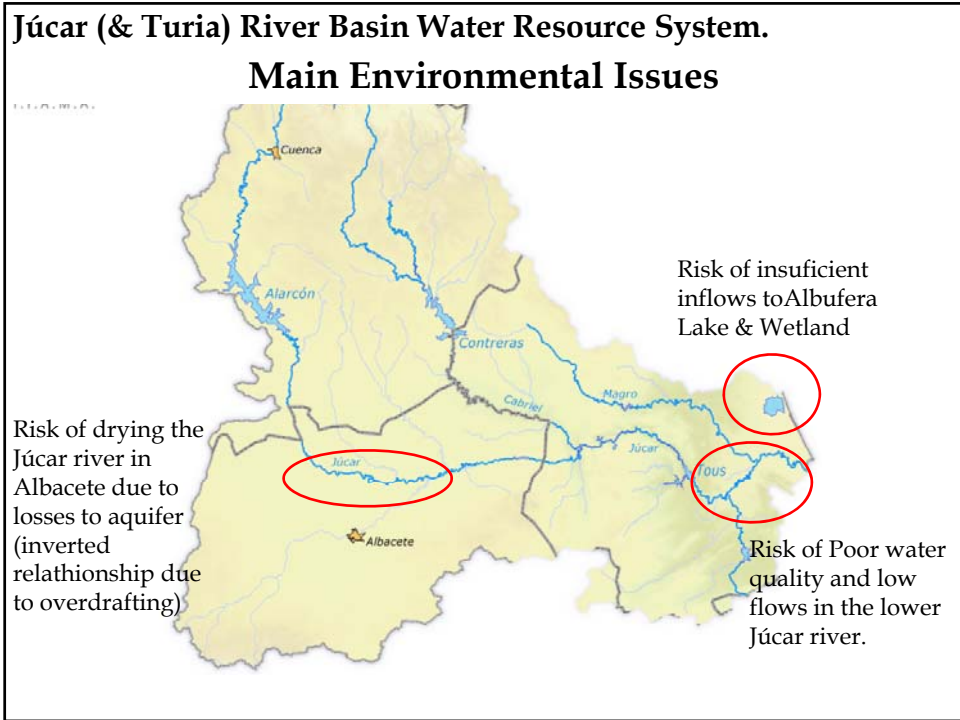
Surface (km ²)	43.000
Permanent population	4.792.528
Equivalent population due to tourism	367.322
Irrigation surface (ha)	347.275
Water demand (hm ³ /year) (Hm ³ /year = Gigaliters/year)	3.172

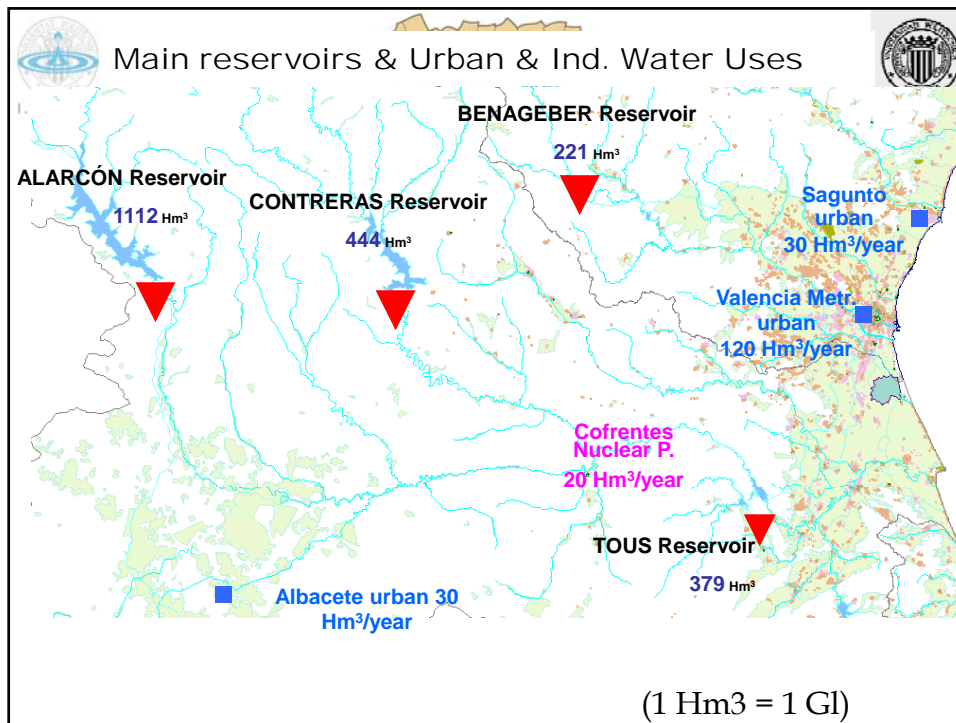


HALF OF THE AREA IS SEMIARID

+HIGHEST VARIABILITY IN EUROPE (IN SPACE AND TIME)







- Semi-Aridity (climate)
- Scarcity (Human needs)

SISTEMA	DEMANDA 2015	RECURSO EN RÉGIMEN NATURAL	DEMANDA / RECURSO
CENIA-MAESTRAZGO	117	312	0,38
MIJARES	300	531	0,56
PALANCIA	101	117	0,87
TURIA	666	496	1,34
JÚCAR	1.546	1.671	0,93
SERPIS	125	190	0,66
MARINA ALTA	94	222	0,42
MARINA BAJA	75	74	1,01
VINALOPÓ - ALACANTÍ	256	97	2,64
TOTAL DHJ	3.280	3.711	0,88

In Eastern & SE Spanish River Basin Plans for WFD,
-water licenses (or water right allocation) and
-ecological flows
are key issues

- Semi-Aridity (climate)
- Scarcity (Human needs)
- High Space & Time hidrological variability: **Droughts** (scale of years in WRS): long, intense and high magnitude
- Climate change¿?

SISTEMA	DEMANDA 2015	RECURSO EN RÉGIMEN NATURAL	DEMANDA / RECURSO
CENIA-MAESTRAZGO	117	312	0,38
MIJARES	300	531	0,56
PALANCIA	101	117	0,87
TURIA	666	496	1,34
JÚCAR	1.546	1.671	0,93
SERPIS	125	190	0,66
MARINA ALTA	94	222	0,42
MARINA BAJA	75	74	1,01
VINALOPÓ - ALACANTÍ	256	97	2,64
TOTAL DHJ	3.280	3.711	0,88

In Eastern & SE Spanish River Basin Plans for WFD, water licenses (or water right allocation) and ecological flows are key issues

Long tradition of

- Water Resources Planning** : 80's, 90's, 2000's
- Adaptation to drought**

But, until recent times:

- Drought: CRISIS MANAGEMENT** (reactive approach)

Since 2001 (after big drought 1992-1995):

- Big effort to pass from reactive approach to PROACTIVE approach:**
- Special Drought Management Plans** (finished in 2007)

High interaction between Research & Science and Policy Makers

RESEARCH & SCIENCE CONTRIBUTION TO POLICY MAKING

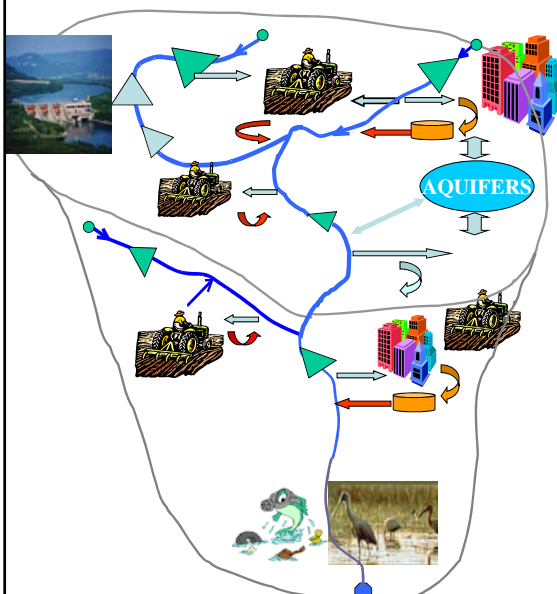
Water Resources Planning : 80's, 90's, 2000's:

- Improvement of knowledge** about the WRS:
 - >All kind of **Models** (since 80's)
- Closing the gap** between R&S and PM:
 - >**Decision Support Systems (DSS)** (since 90's)
 - >...

WR Systems INTEGRATE at the BASIN SCALE: WaterBodies, W.Uses (Demands), Infrastructures




I. I. A. M. A.




Complex relationships that affect water availability both in SPACE & TIME

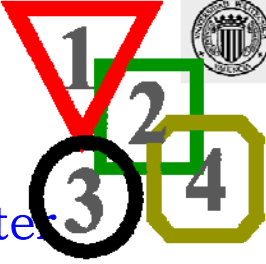
Implications on all aspects (w. quality, environment, economy, ...) **can only be captured by means of adequate integrated modeling**



Instituto de Ingeniería del Agua y Medio Ambiente
I. I. A. M. A.



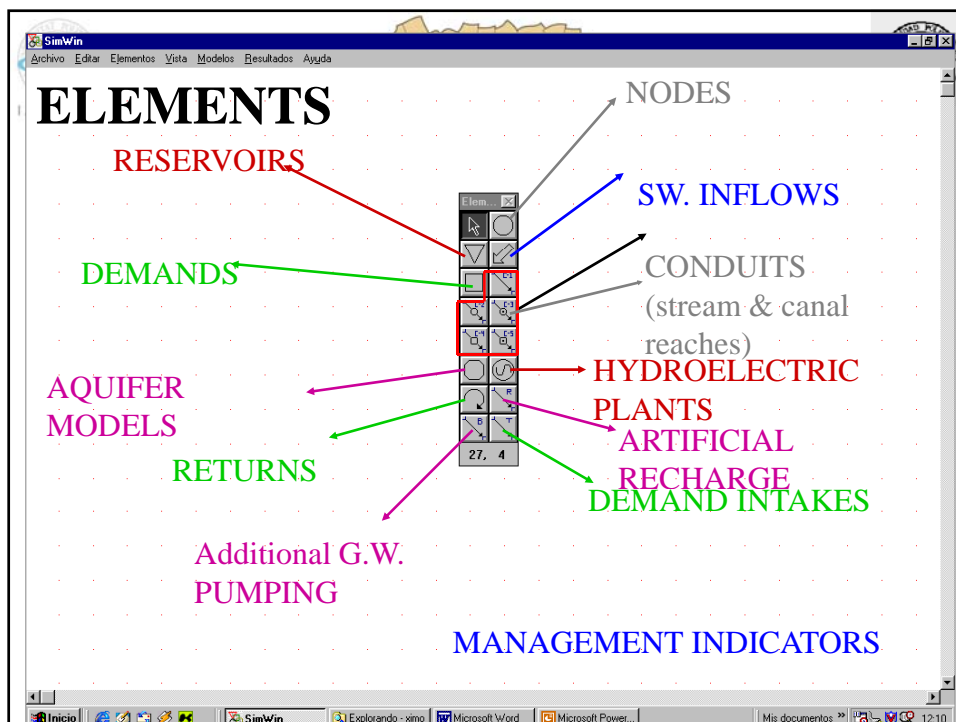
DROUGHT
R&SPI

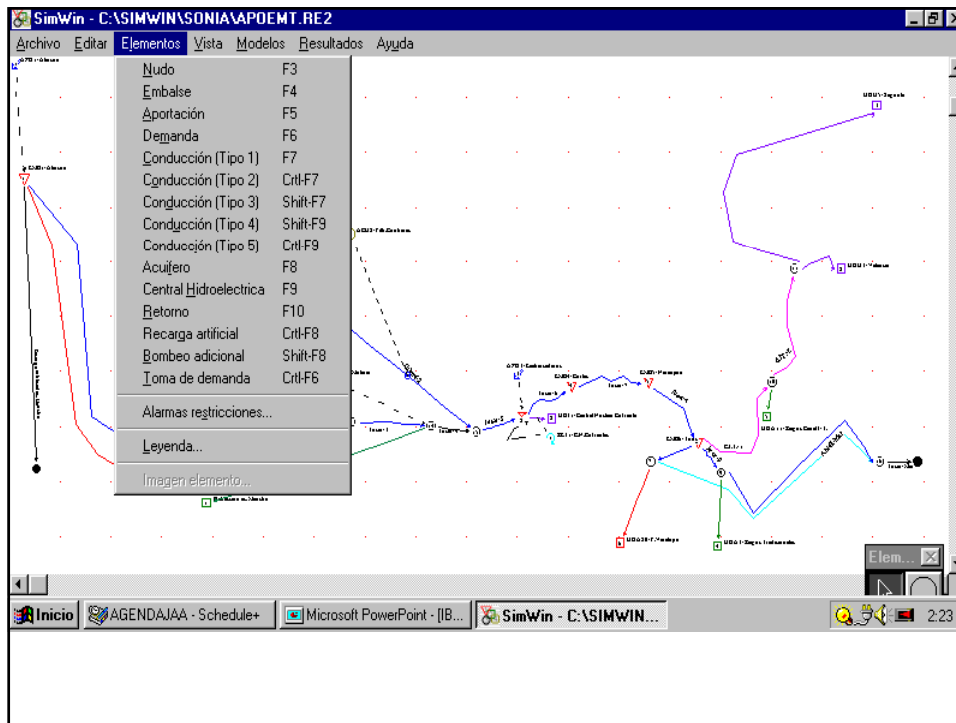



AQUATOOL:


DSSS designed for integrated management of complex water resource systems


J. Andreu, J. Capilla, y E. Sanchis, “Generalized decision support system for water resources planning and management including conjunctive water use”, *Journal of Hydrology*, Vol. 177, pp. 269-291, 1996.





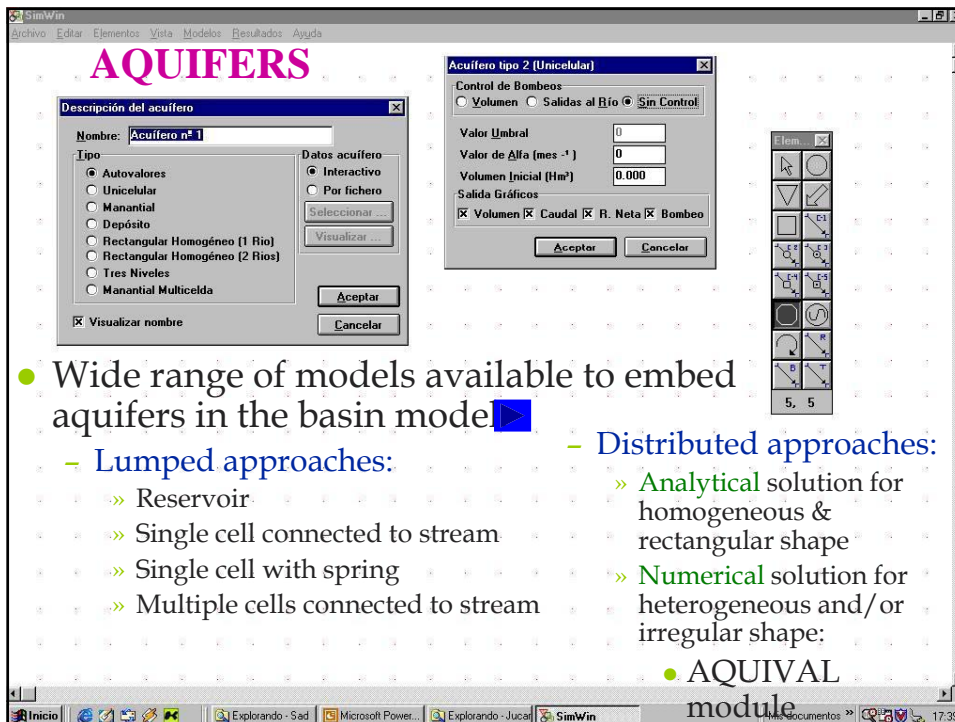
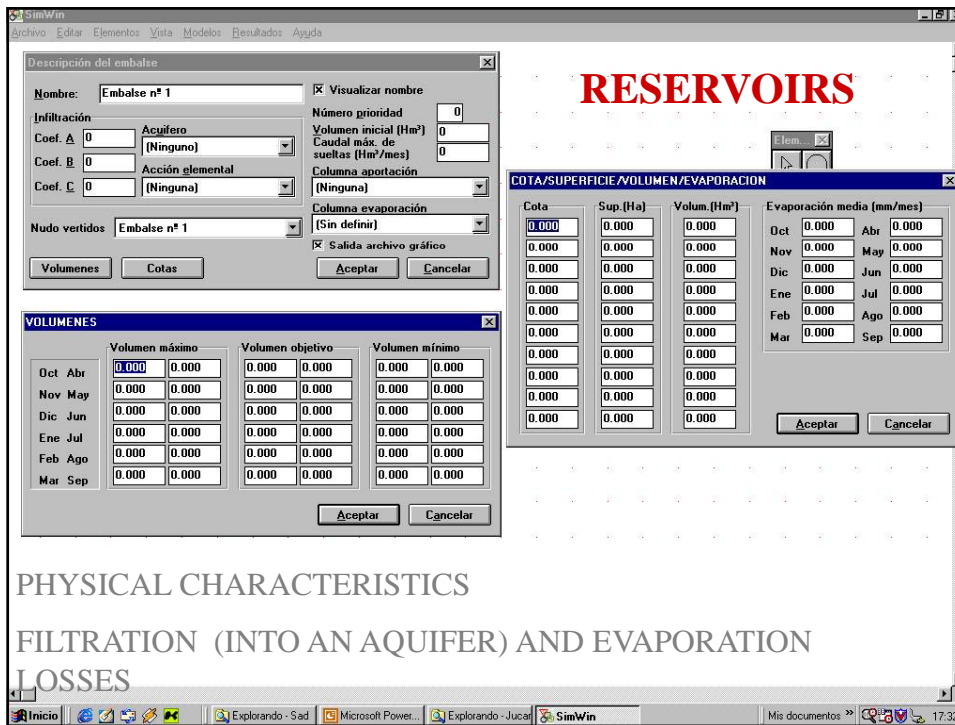




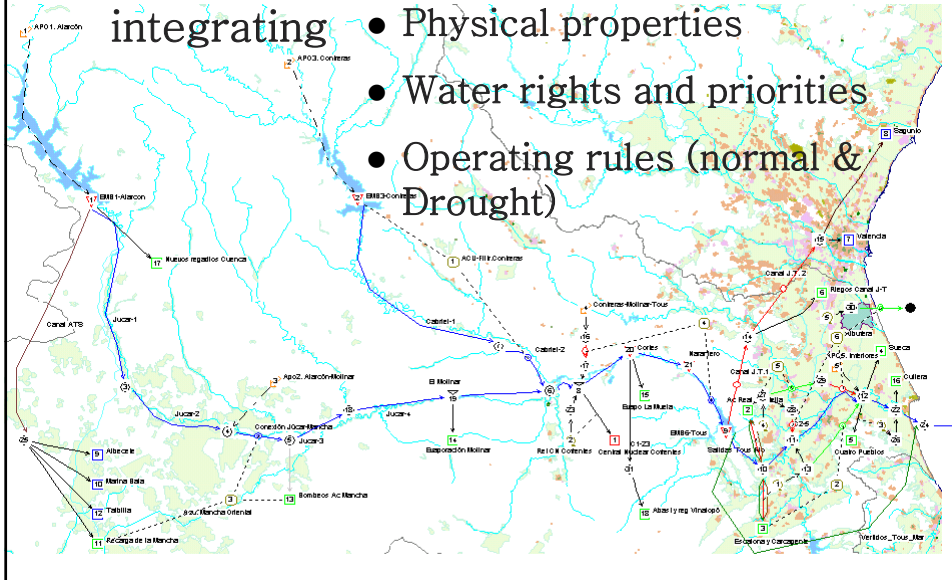


The DSS allows the user to:

- Input and modify the space configuration of a water resource system
- **Edit and manage geo-referenced data bases containing physical characteristics, management characteristics**



Integrated Basin model: Jucar Basin



- integrating
- Physical properties
 - Water rights and priorities
 - Operating rules (normal & Drought)

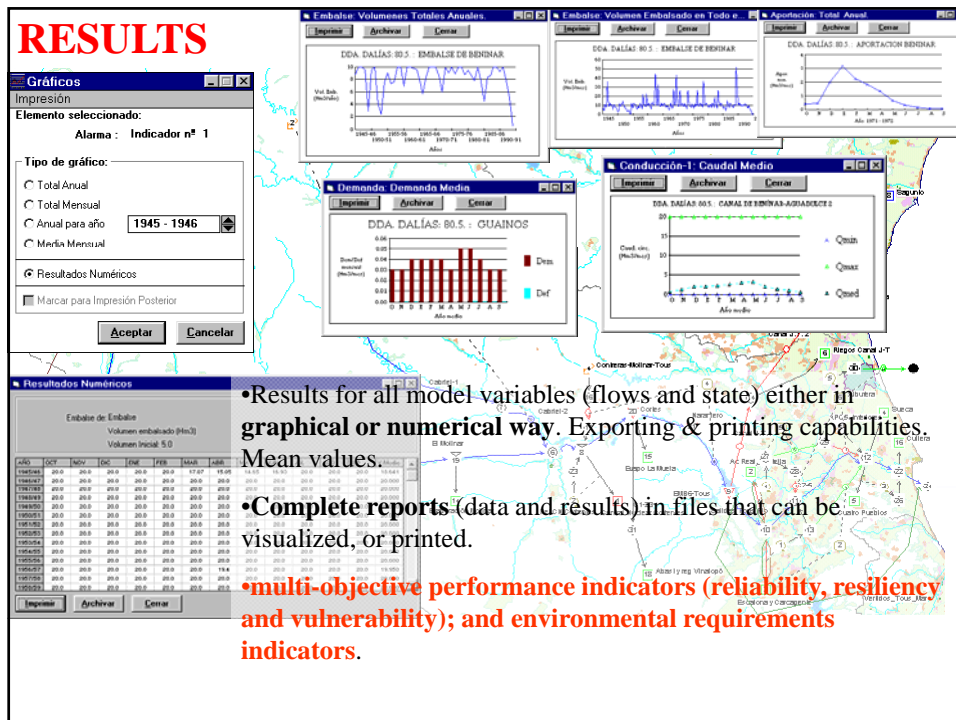
SIMULATION

for given hydrologic inflows scenarios^{SPI}

INTERNAL

In every month, a network flow optimization algorithm (Out-of-kilter) finds a flow solution which is compatible with the physical restrictions, and tries to minimize weighted deviations from operating rules (Target supplies, flows, and reservoir storage); respecting priorities.

Iteration is needed to take into account non-linearities and surface-groundwater relationships.



- Results for all model variables (flows and state) either in graphical or numerical way. Exporting & printing capabilities.
- Complete reports (data and results) in files that can be visualized, or printed.
- multi-objective performance indicators (reliability, resiliency and vulnerability); and environmental requirements indicators.

VARIABLES RELATED TO FAILURE & DROUGHT

- **Failure (operative drought):** When supply < demand
 - Intensity, duration, magnitude
- **Reliability:** Probability of satisfactory supply (not in failure).
- **Risk** es la probability of failure.
- **Resiliency:** Average probability of system recovering when in failure. (Related to the inverse of time to get back to satisfaction situation after a failure).
- **Vulnerability:** Expected value of the deficits (or of the costs associated) (average deficit or average cost).

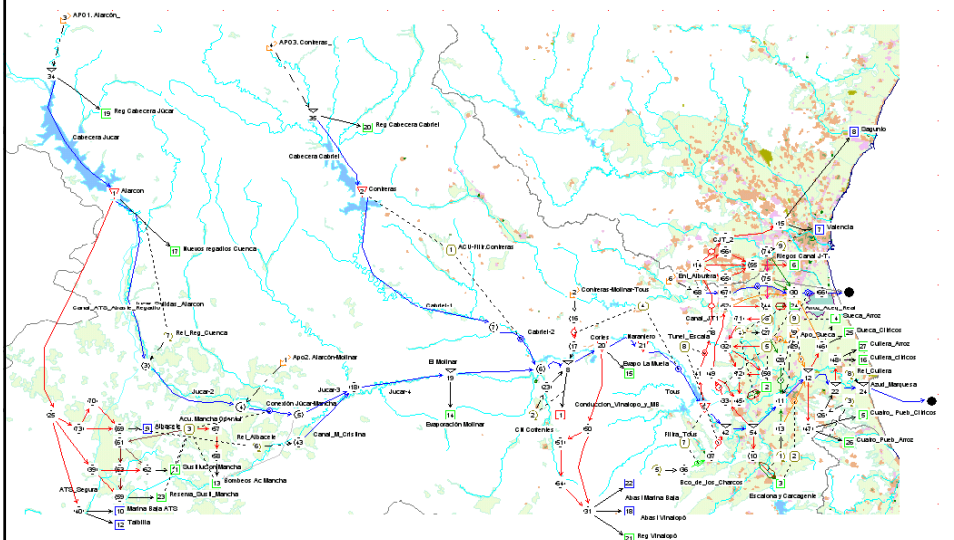
DSS in Planning Phase of IRBP&M

- transparency, participation, negotiation, and conflict resolution are essential factors
- use of Integrative DSS, for evaluation of alternatives, as **shared vision** of the system, generally as a result of **joint model and DSS building**, enhances very much this process: **Jucar-Vinalopó participatory water conflict solution** (CHJ, 2005b)



JOINT DSS DEVELOPMENT AND USE

DSS including a Simulation model of Júcar RB management



RESEARCH & SCIENCE CONTRIBUTION TO POLICY MAKING

Water Resources Planning : 80's, 90's, 2000's:

- Improvement of knowledge about the WRS:
 - >All kind of Models (since 80's)
- Closing the gap between R&S and PM:
 - >Decision Support Systems (DSS) (since 90's)
 - >**KNOWLEDGE BROKERING** (since 2000's)

Contribution to Special Drought Management Plans:

-



DROUGHT MANAGEMENT PLANS



Entities in charge: River Basin Authorities (**All Spanish River Basins have Drought Man. Plans since 2007**)

Objective: minimize environmental, social and economic impacts of drought situations

Contents: includes diagnosis of situation (historical droughts, vulnerability of basin), indicators system (precipitation, river inflows in natural regime, stored volume in surface reservoirs, water levels in aquifers), programme of measures to be applied in each drought phase according to the drought status, management and follow-up system.

.

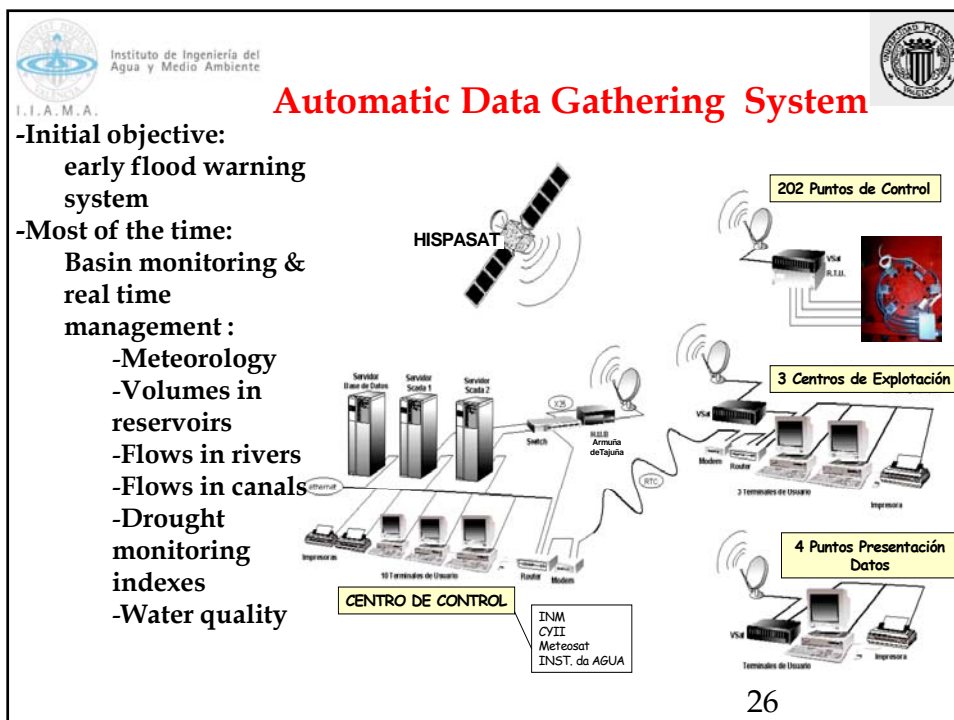
RESEARCH & SCIENCE CONTRIBUTION TO POLICY MAKING

Water Resources Planning : 80's, 90's, 2000's:

- Improvement of knowledge about the WRS:
 - >All kind of Models (since 80's)
- Closing the gap between R&S and PM:
 - >Decision Support Systems (DSS) (since 90's)
 - >KNOWLEDGE BROKERING (since 2000's)

Contribution to **Special Drought Management Plans:**

- Design of **Drought Monitoring Indicators** for WRS
- Definition of states (Abundance, normality, pre-alert, alert and emergency)
- Design of operating rules





Instituto de Ingeniería del Agua y Medio Ambiente



DROUGHT MONITORING:

Use of different traditional types of indicators:

- 1) Meteorological drought (SPI)
- 2) Agricultural drought (Palmer)
- 3) Hydrological drought (historical position)
- 4)

And use of institutional indicators:

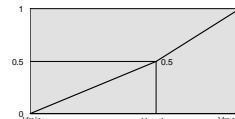
CHJ Operative Drought Indicators

Indicator Evaluation and Threshold Definition

Weighted combinations of standardized values of key variables related to water availability:

34 individual indicators:

- 9 reservoir volume
- 9 piezometric level
- 9 fluvial networks
- 7 pluviometers



Status Index	Status
0,75 – 1,00	NORMAL
0,50 – 0,75	PRE-ALERT
0,30 – 0,50	ALERT
0,15 – 0,30	EMERG.
0,00 – 0,15	EMERG.

SISTEMA EXPLOTACIÓN	Ind Estado 31/03/2008	ÍNDICE SIST. EXPLOTACIÓN
1	0,99	0,66
2	0,52	
3	0,74	
4	0,39	0,67
5	0,82	
6	0,66	
7	0,35	0,57
8	0,70	
9	0,61	
10	0,32	0,33
11	0,10	
12	0,04	
13	0,19	
14	0,39	
15	0,45	
16	0,53	
17	0,00	0,14
18	0,00	
19	0,35	
20	0,14	
21	0,20	
22	0,58	
23	0,16	
24	0,18	
25	0,73	
26	0,14	
27	0,58	
28	0,82	
29	0,53	0,72
30	0,80	
31	0,82	0,82
32	0,88	
33	0,79	0,73
34	0,70	

Drought indicators JRBA (31 March 2008).

Continuous monitoring
(Published in web page)



SCENARIOS

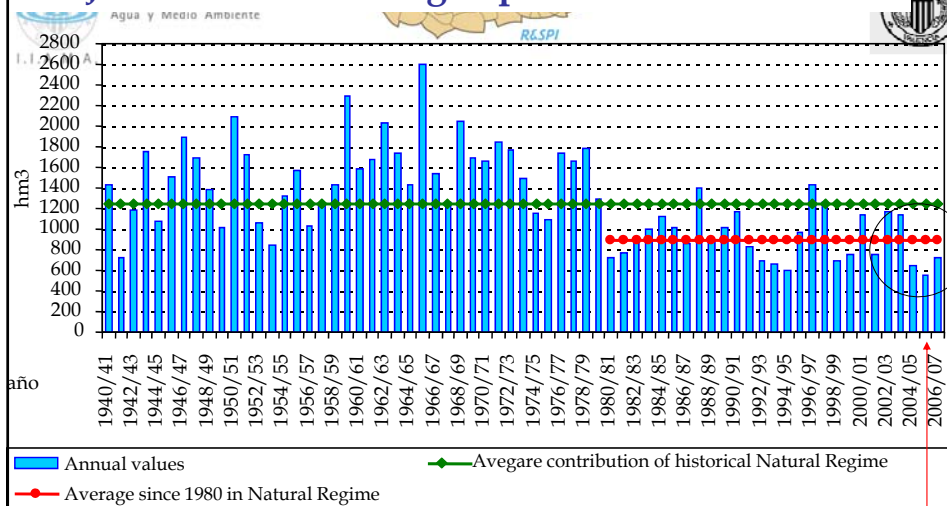
Sistema	Jun	Jul	Ago	Sep	Oct	Nov	Dic	Ene	Feb	Mar	System	Risk Valuation	Scenario
Cenia-Maestrazgo	0.67	0.63	0.61	0.64	0.7	0.59	0.74	0.69	0.66	0.66	Cenia-Maestrazgo	LOW	NORMAL
Mijares-Plana de Castellón	0.66	0.66	0.65	0.72	0.73	0.66	0.68	0.67	0.66	0.67	Mijares-Plana de Castellón	LOW	NORMAL
Palancia-Los Valles	0.66	0.61	0.55	0.64	0.67	0.59	0.68	0.61	0.58	0.57	Palancia-Los Valles	LOW	NORMAL
Turia	0.44	0.39	0.38	0.4	0.44	0.45	0.43	0.39	0.37	0.34	Turia	MEDIUM	PRE-ALERT
Júcar	0.29	0.26	0.23	0.23	0.22	0.19	0.16	0.14	0.14	0.14	Júcar	VERY HIGH	EMERGENCY
Serpis	0.41	0.43	0.45	0.5	0.69	0.63	0.78	0.70	0.67	0.72	Serpis	LOW	NORMAL
Marina Alta	0.51	0.51	0.55	0.69	1.00	0.92	0.96	0.89	0.90	0.82	Marina Alta	VERY LOW	NORMAL
Marina Baja	0.80	0.80	0.80	0.85	1.00	1.00	1.00	0.92	0.92	0.88	Marina Baja	VERY LOW	NORMAL
Vinalopó-Alacantí	0.74	0.73	0.83	0.95	1.00	0.86	0.87	0.80	0.82	0.73	Vinalopó-Alacantí	VERY LOW	NORMAL

Drought status indicator per exploitation system

	Status Index Values			
	Scenario Inputs		Scenario outputs	
	During	Condition	Condition	Output Scenario
Normal	-	≥ 0.50	-	-
Pre-alert	3 months in a row	$[0.5 - 0.30]$	3 consecutive months $\leq \geq 0.50$	Normal
Alert	2 months in a row	$[0.3 - 0.15]$	2 consecutive months $\leq \geq 0.50$ 6 consecutive months $\leq [0.5 - 0.30]$	Pre-alert
Emergency	2 months in a row	< 0.15	2 consecutive months $\leq [0.5 - 0.30]$ 6 consecutive months $\leq [0.3 - 0.15]$	Alert



JRB Natural discharge up to Tous Reservoir



Four consecutive years of intense drought

2005/06: Worse in rec. history

2006/07: third lower

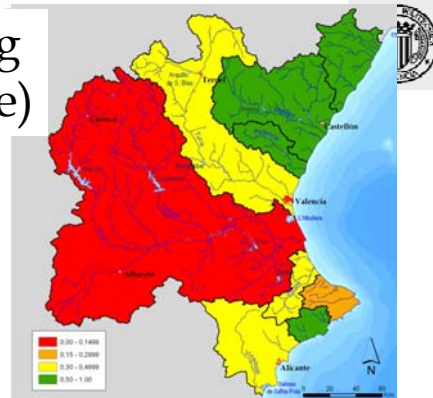


Continuous monitoring
(Published in web page)

Drought indicators CHJ
(31 January 2006)

Júcar => emergency

Marina Alta => alert



System	Valuation risk	State Index	State
Cenia-Maestrazgo	LOW	0.55	STABLE
Mijares-Plana de Castellón	LOW	0.51	STABLE
Palancia-Los Valles	LOW	0.52	STABLE
Turia	MEDIUM	0.38	INITIAL ALERT
Júcar	VERY HIGH	0.13	EMERGENCY
Serpis	MEDIUM	0.32	INITIAL ALERT
Marina Alta	HIGH	0.28	ALERT
Marina Baja	LOW	0.58	STABLE
Vinalopó-Alacantí	MEDIUM	0.49	INITIAL ALERT

RESEARCH & SCIENCE CONTRIBUTION TO POLICY MAKING

Water Resources Planning : 80's, 90's, 2000's:

- Improvement of knowledge about the WRS:
 - >All kind of Models (since 80's)
- Closing the gap between R&S and PM:
 - >Decision Support Systems (DSS) (since 90's)
 - >KNOWLEDGE BROKERING (since 2000's)

Contribution to Special Drought Management Plans:

- Design of Drought Monitoring Indicators for WRS
- Definition of states (Abundance, normality, pre-alert, alert and emergency)
- Design of operating rules



Instituto de Ingenieros
Agua y Medio Ambiente

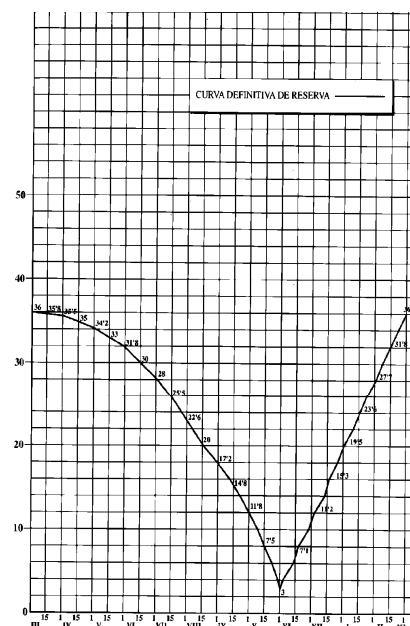
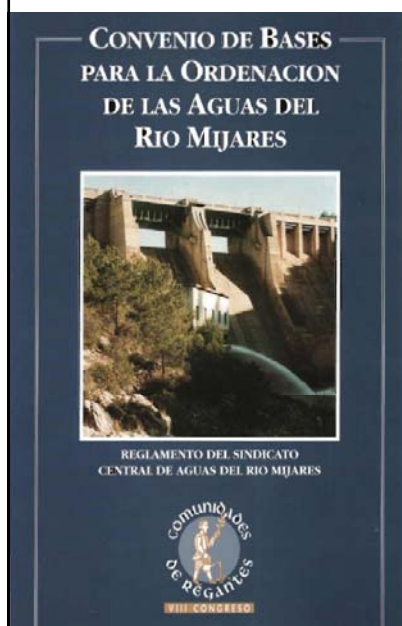
I. I. A. M. A.

WATER ALLOCATION IN REAL TIME: OPERATING RULES



- Water allocation committee (WAC)
- Operating rules designed and “optimized” using DSS and indicators
- Negotiated among stakeholders, desirable consensus.
- Include different situations
- Orientative values, adapted to circumstances by the WAC

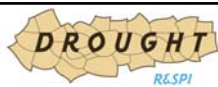
CHJ tradition of using Operating Rules: MIJARES RIVER OPERATING RULES & USER'S ORGANIZATION





Instituto de Ingeniería del Agua y Medio Ambiente

I. I. A. M. A.



ESCAMENARIO 2015		P. SEQUIA SOLO BAJO ALERTA-2 (C. ALARCON)				
	ABUNDANCIA	NORMALIDAD	PREALERTA	ALERTA-1	ALERTA-2 (C. ALARCON)	EMERGENCIA
no	100	86	84	81	78	75
Escalona	22.9	19.7	19.2	18.5	17.9	17.2
Carcaixent	13.7	11.8	11.5	11.1	10.7	10.3
ARJyAntella	212.0	182.3	178.1	171.7	165.4	159.0
	ABUNDANCIA	NORMALIDAD	PREALERTA	ALERTA-1	ALERTA-2 (C. ALARCON)	EMERGENCIA
R-ALTA-Tota	248.6	213.8	208.8	201.4	193.9	186.5
RA-Pozos se	0	0	0	0	25	30
RA-Superfici	248.6	213.8	208.8	201.4	168.9	156.5
R-BAJA My-A	236.0	203.0	198.2	191.2	184.1	177.0
RB-Rebombe	0	0	0	0	30	60
RB-Superfici	236.0	203.0	198.2	191.2	154.1	117.0
(inv. R.B.)	76	76	76	76	76	76
TOTAL RIBER	560.6	492.8	483.1	468.5	454.0	439.5
TOTAL PS+R	0	0	0	0	55	90
TOTAL RIB-S	560.6	492.8	483.1	468.5	399.0	349.5
al			85	65	45	33.33
MO-Total	396.0	340.6	332.6	320.8	308.9	297.0
MO-Superf	93.0	80.0	68.0	52.0	36.0	26.7
MO-Subt	303.0	260.6	264.7	268.8	272.9	270.3
CJT-Total	70.0	60.2	58.8	56.7	54.6	52.5
CJT-Superf	70.0	43.0	36.6	28.0	19.4	14.3
CJT-Pozos Se	0	0	0	8	12	12
CJT-RESTOSu	0.0	17.2	22.3	20.8	23.3	26.2
CJT-Subt.tot	0.0	17.2	22.3	28.8	35.3	38.2

RESEARCH & SCIENCE CONTRIBUTION TO POLICY MAKING (Cont.)

Contribution to **Real Time Drought Management:**
 -Support to **Permanent Drought Committee & Technical Drought Office.**

Composition of the Commission: RD 1265/2005

Delegate board from the Governing Board of CHJ (JRBA)

Entitled to vote (13):

- President of JRBA
- JRBA (3) : Commissary, Technical Director, Head of Planning Office.
- Spanish Ministries (2): Industry (IGME) and Environment
- Autonomous Regional Governments (4)
 - Urban users representative (Valencia Metr. Area W. Supply)
 - Agricultural users representative (Real del Júcar Ditch).
 - Industrial users representative (Iberdrola, S.A.)

In advisory capacity (4)

- Environmental Interest Defence: Agró
- Entrepreneurial Representation: AVA
- Labor Unions representation: CCOO
- Local Entities representative: Albacete municipality

Numerous “guests”



Instituto de Ingeniería del Agua y Medio Ambiente



Meeting Calendar



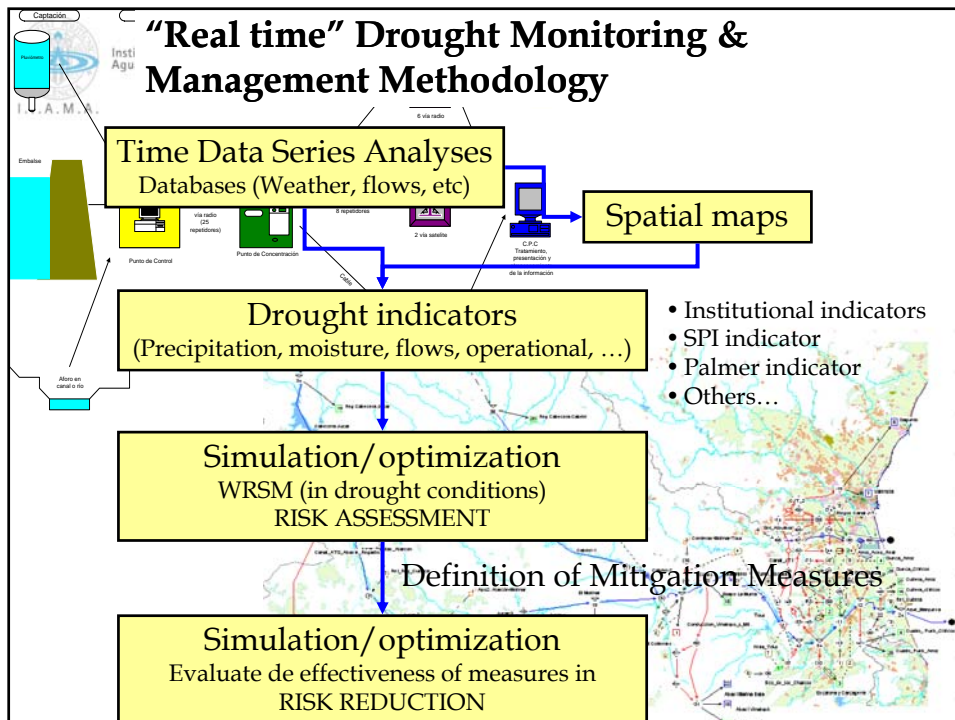


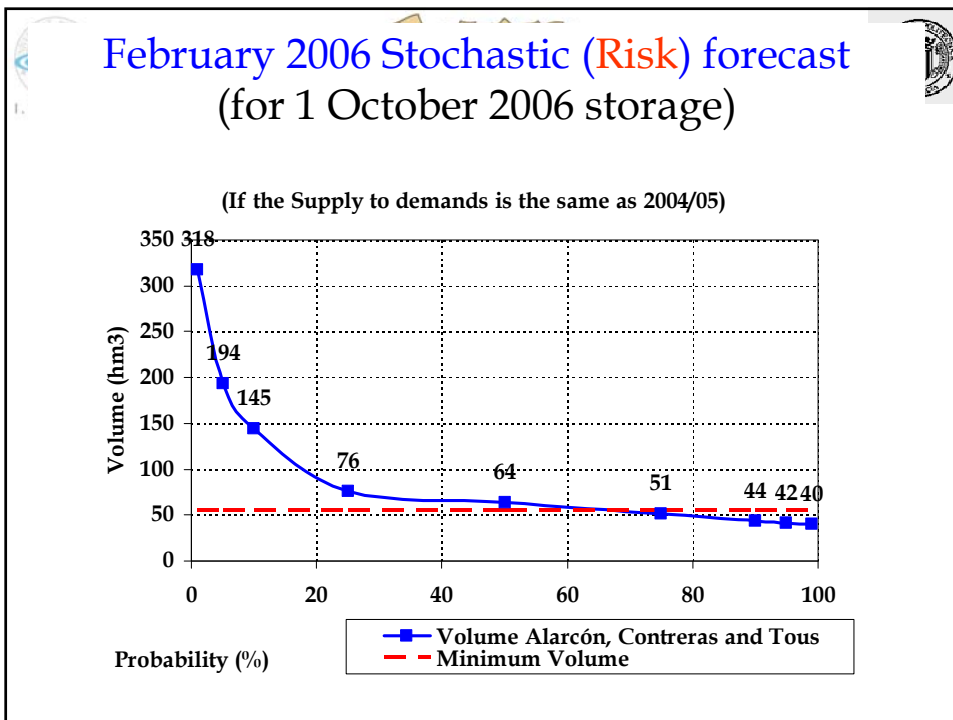
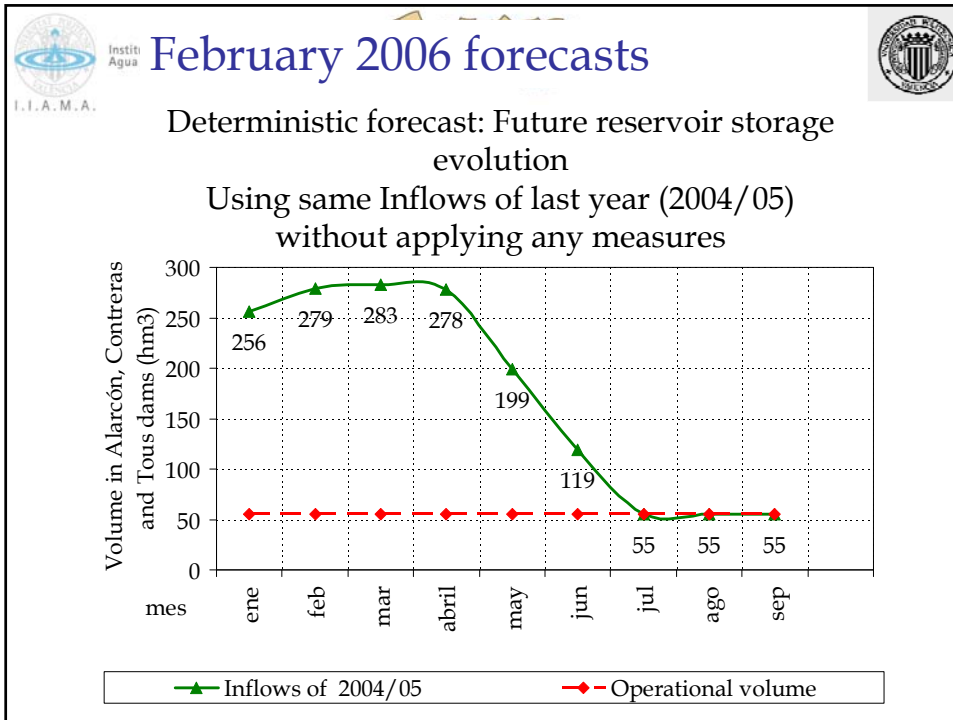

- 1) 1st December 2005
- 2) 21st December 2005
- 3) 21st January 2006
- 4) 13th February 2006
- 5) 15th March 2006
- 6) 18th April 2006
- 7) 22nd May 2006
- 8) 27th June 2006
- 9) 19th July 2006
- 10) 24th August 2006
- 11) 12th September 2006
- 12) 28th September 2006
- 13) 15th November 2006
- 14) 15th December 2006
- 15) 15th February 2007
- 16) 20th April 2007
- 17) 18th July 2007
- 18) 17th September 2007
- 19) 31st October 2007
- 20) 12th December 2007
- 21) 15th February 2008
- 22) 14th March 2008
- 23) 18th April 2008
- 24) 12th June 2008
- 25) 16th September 2008
- 26) 17th October 2008
- 27) 22nd December 2008
- 28) 12th March 2009

RESEARCH & SCIENCE CONTRIBUTION TO POLICY MAKING (Cont.)

Contribution to **Real Time Drought Management:**

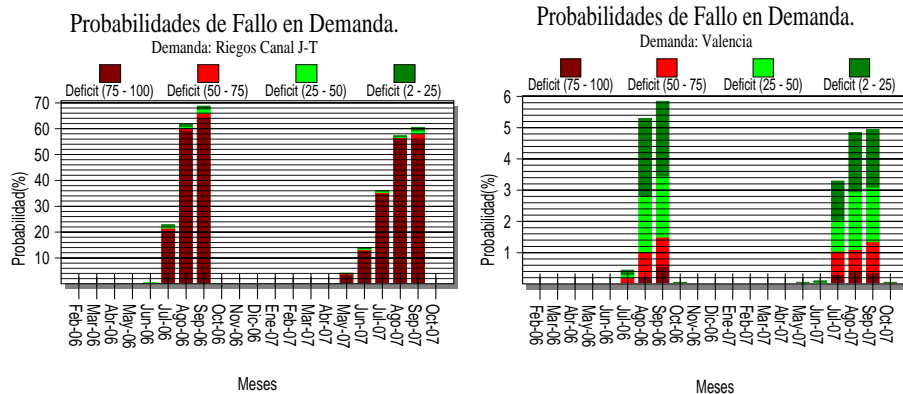
- Support to **Permanent Drought Committee & Technical Drought Office. Use of DSS for**
 - >**Drought Risk assessment** in WRS
 - >Forecasting of WRS evolution during the near future
 - >Design of measures
 - >







Probability of failure in urban and agricultural areas



Measures



- Use of drought wells (Conjunctive use)
- Reuse of waste water
- Water rights purchase to increment environmental flows
- Application of measures to save water: irrigation reduction, and alternative urban supply
- Conjunctive management of Turia and Jucar Basins
- Public education trough media (Newspapers, ...) in order to reduce urban consumption
- Intensive monitoring and surveillance
- Other ...

RESEARCH & SCIENCE CONTRIBUTION TO POLICY MAKING (Cont.)

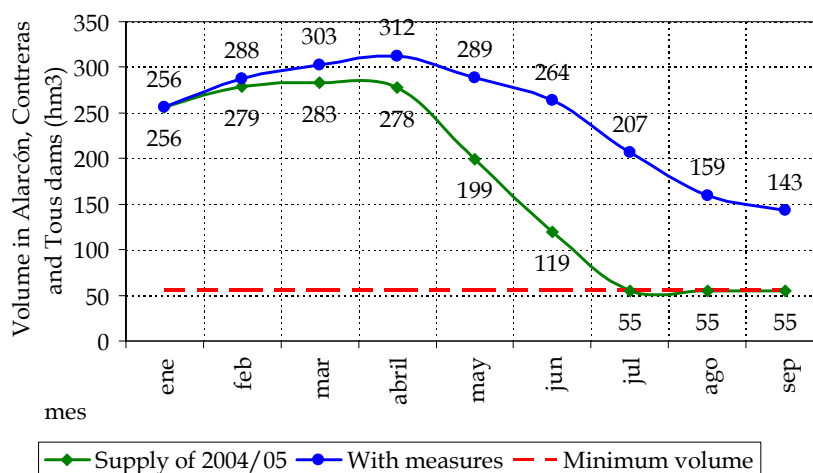
Contribution to Real Time Drought Management:

- Support to Permanent Drought Committee & Technical Drought Office. Use of DSS for
 - >Drought Risk assessment in WRS
 - >Forecasting of WRS evolution during the near future
 - >Design of measures
 - >Assess the effectiveness of measures
 - >Providing grounds for conflict negotiation and consensus achievement
 - >KNOWLEDGE BROKERING

Effectiveness of the measures

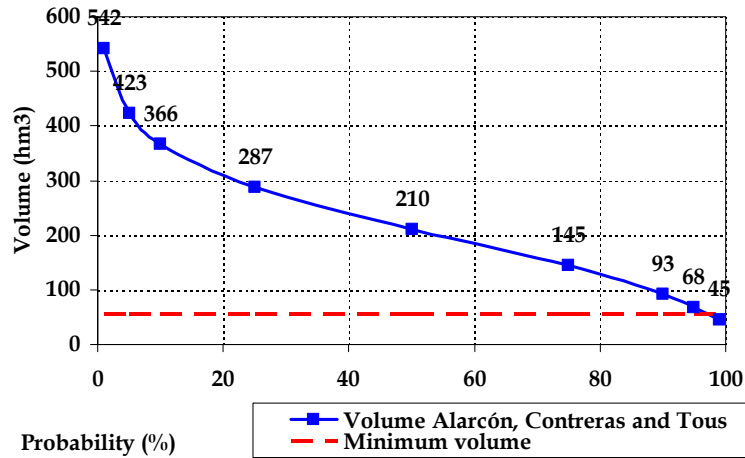
February forecasts (if measures are applied)

Deterministic forecast: Future volume reservoir evolution
Using same Inflows as last year (2004/05)



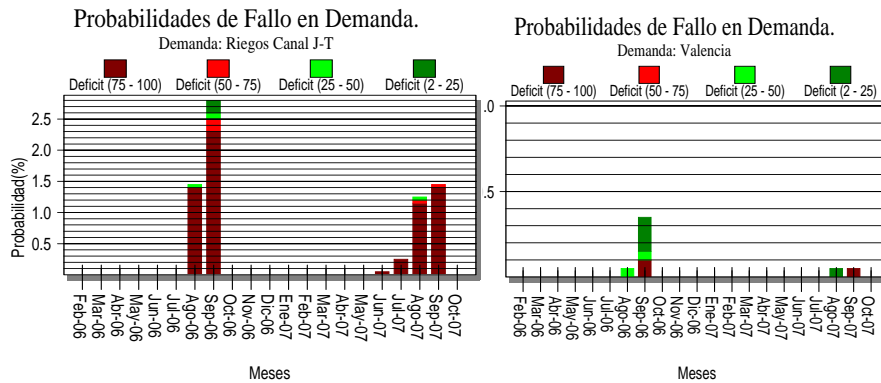
New February Stochastic forecast for 1 October 2006 (if measures are applied)

Final state of dams at 1 october of 2006

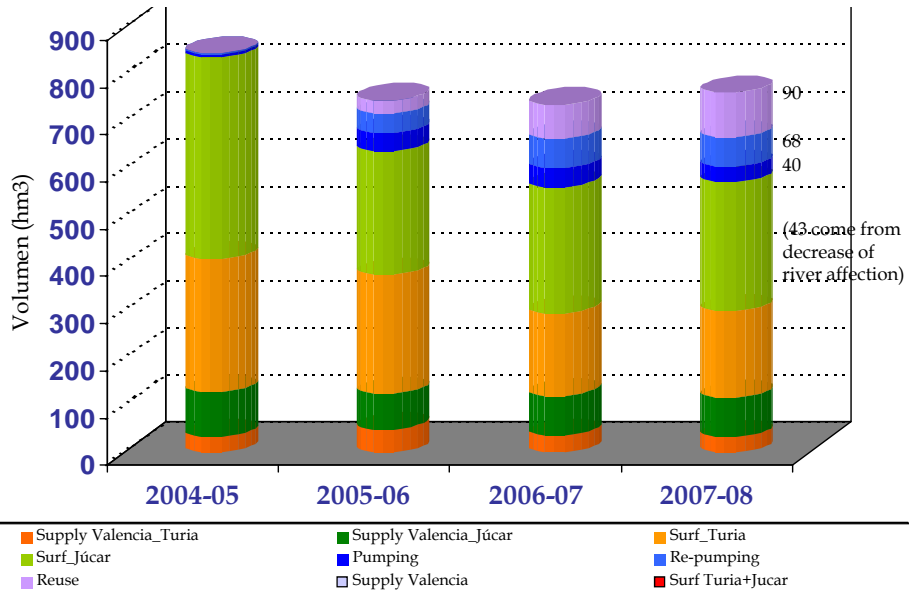


New values for Risk of failures in demands

Probability of failure in urban and agricultural areas



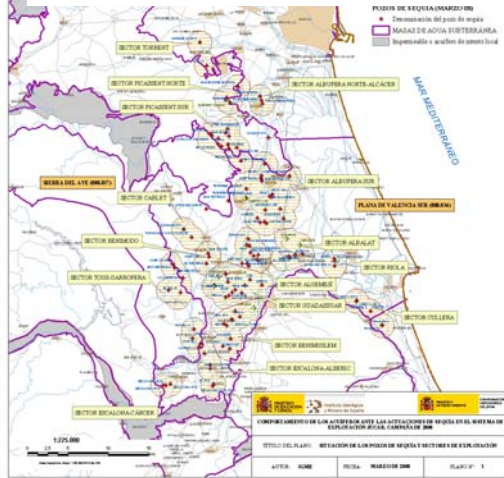
Total annual supplies by origins and destinations



CONJUNCTIVE USE OF SURFACE AND GROUND WATER (Aларcon's agreement + Drought wells) and RECYCLING in the irrigation system

Farmers in the coastal plane, who are entitled to surface water, pumped from the aquifer and recycled sludge water, giving up an equal amount from their surface water allocation to be used by the upstream farmers and urban suppliers. The later paid for the costs of pumping (5 cents of euro/m³)

2008	Wells	Recycl. pumps
Real del Júcar Ditch	66	2
Real de Escalona Ditch	7	
Real de Carcaixent Ditch	3	
Sueca irrigation union		8
Cullera irrigation union	6	8
Mayor de la Villa and Honor de Corbera Ditch	4	1
General Community from Canal Júcar-Turia	40	
Total	126	19

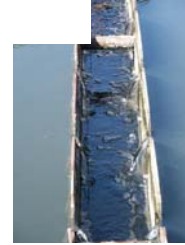




Instituto de Ingeniería del Agua y Medio Ambiente

I. I. A. M. A.

DIRECT REUSE OF RECLAIMED (TREATED) WASTEWATER



Volumes of Direct re-use of treated wastewater during drought

EDAR	Finedo II. Extension		Quart-Benatger	Carraixet	Paterna-Fte. del Jarro		TOTAL
UDA	Iradi. I. Vega de Valencia. Rest of Ditches	Del Oro Ditch	Iradi. I. Vega de Valencia. Rest of Ditches	Iradi. I. Vega de Valencia. Rest of Ditches	Iradi. I. Vega de Valencia. Rest of Ditches	Iradi. I. Vega de Valencia. Real Ac de Moncada	
User	Favara Ditch (B)	Del Oro Ditch (G)	Ditches of Andarella (B), Xirivella (B), Benager (B), Faitanar (B) y Favara (C)	Rascanya Ditch (B)	Tormos Ditch (G)	Real de Moncada Ditch (B)	(Hm ³)
	(Hm ³)	(Hm ³)	(Hm ³)	(Hm ³)	(Hm ³)	(Hm ³)	
2005/06	6.015	22.156	0	0	0	0	28.171
2006/07	6.781	50.153	9.008	3.791	0.603	0.829	71.165
2007/08	9.946	66.857	12.782	3.444	0.214	0.913	94.157



Instituto de Ingeniería del Agua y Medio Ambiente

I. I. A. M. A.



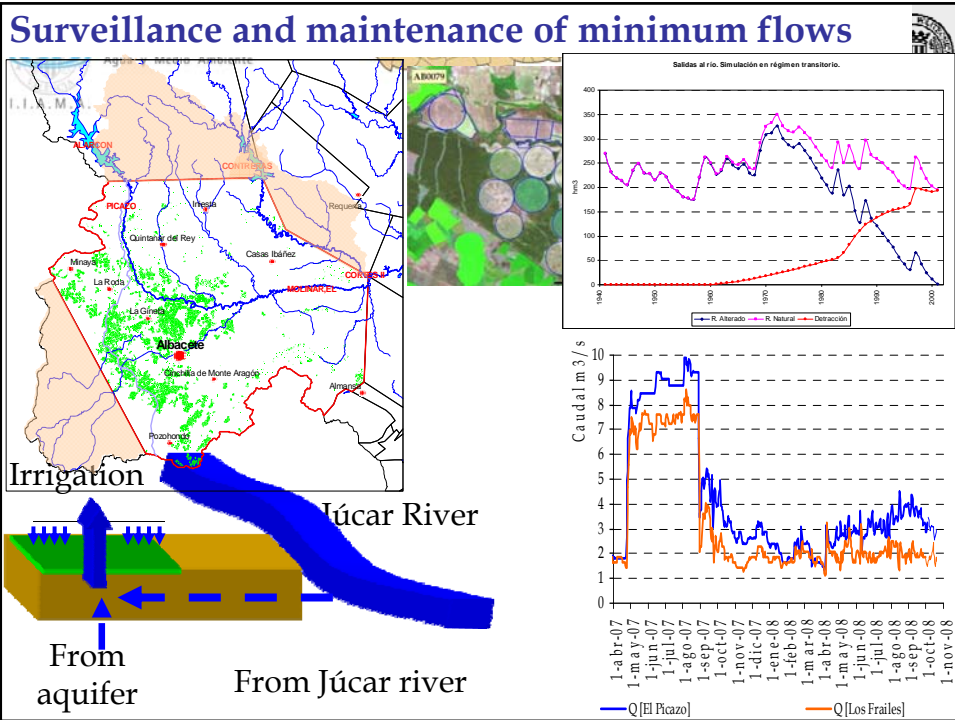
Environmental measures

Albufera Lake
Ramsar Wetland

Monitoring network:

- Lake level
- Outflow in the 5 canals
- Inflow in some ditches





La Mancha Aquifer Use Reduction 2007-08

Public offer agreement for **water rights acquisition** in the middle section of the Júcar basin due to **environmental reasons**

Objective: Reducing extractions in the middle section of the Júcar river, both in surface water and in the area of the aquifer with a greater effect on the river flow.

2007 Rights acquisition and **adaptation** through **reduction of irrigated surface**.

2008 Rights acquisition and **adaptation** by using less water-consuming crops (spring crops) (**Changes in crop patterns**)

Selection criteria (model based):

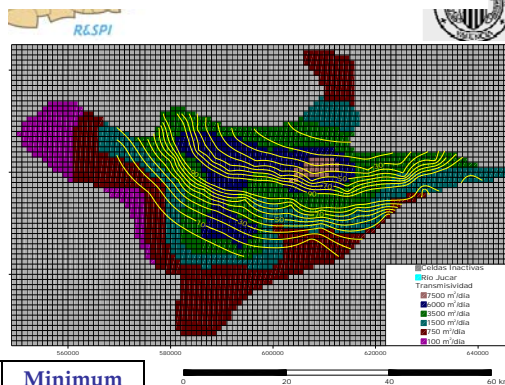
1. Effects on river (0-20 points)
2. Offered price (0-20 points)

Extension: 28.000 has

W. Rights volume: 148 hm³

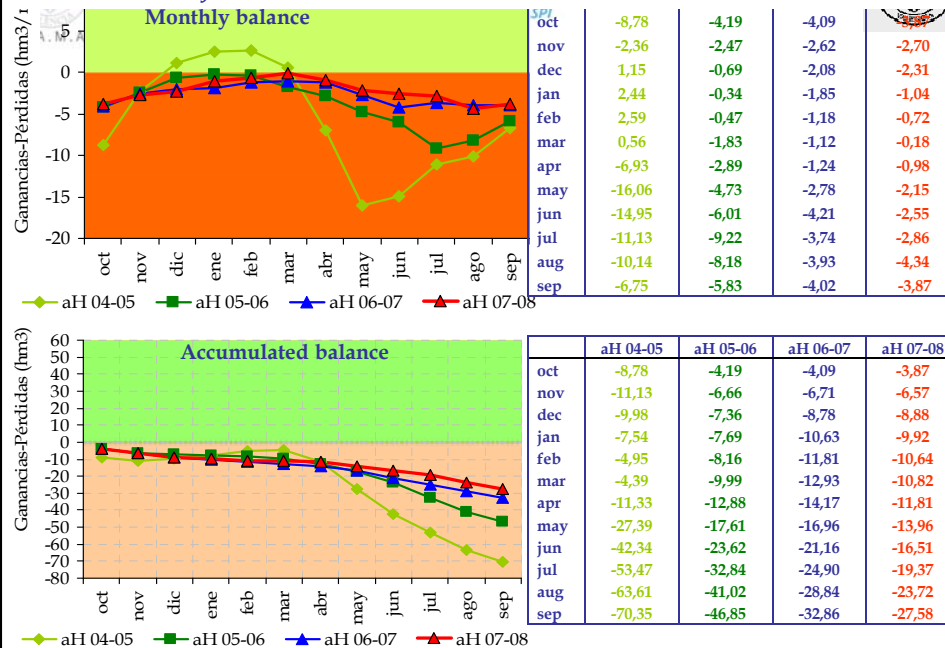
Time frame: seasons 2007-08

Uses reduction 2007&2008



Maximum amount 07	Minimum amount 07	Maximum amount 08	Minimum amount 08	2007	2008
0,1957 €/m ³	0,13 (€/m ³)	0.25 €/m ³	0.20 (€/m ³)		
				Total	Total
HGU Presented requests:				119	234
Right volume (hm³)				56,8	109,6
Renounced volume (no economic compensation) (hm ³)				22,9	12,5
Offered volume (hm ³)				27,3	50,6
Materialised budget (million€)				5,5	12,7
Reserved volume (hm ³)				6,6	46,5

Monitoring the effectiveness of the measure: Balance for the Picazo-Los Frailes reach of Júcar River





Instituto de Ingeniería del Agua y Medio Ambiente



Surveillance middle section of Júcar river

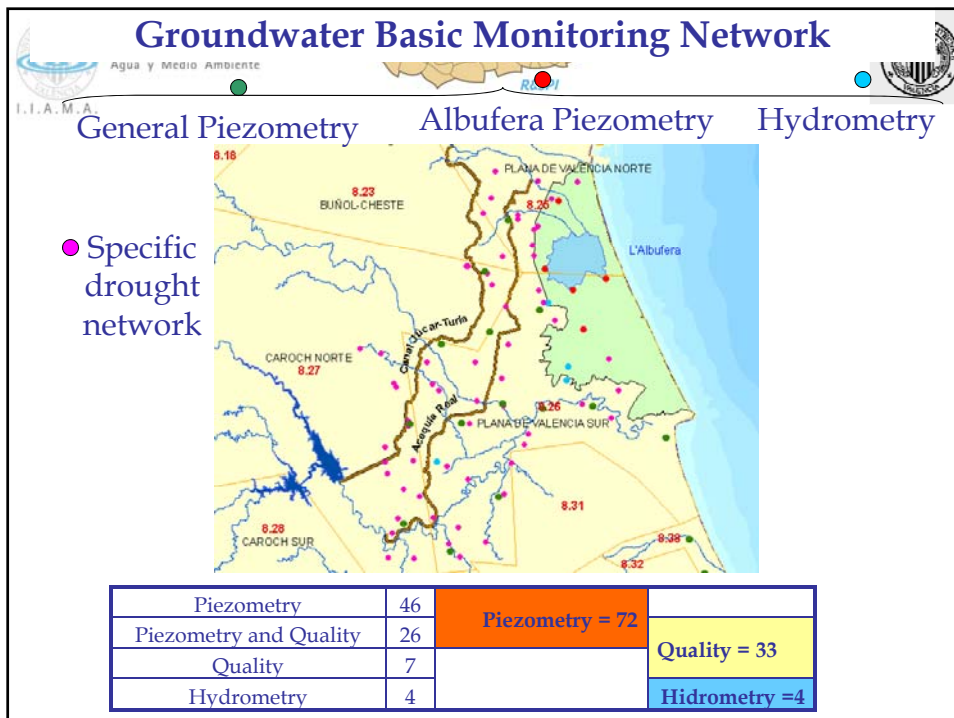
Objective: flow maintenance downstream from Alarcón reservoir



Júcar river in summer 1995

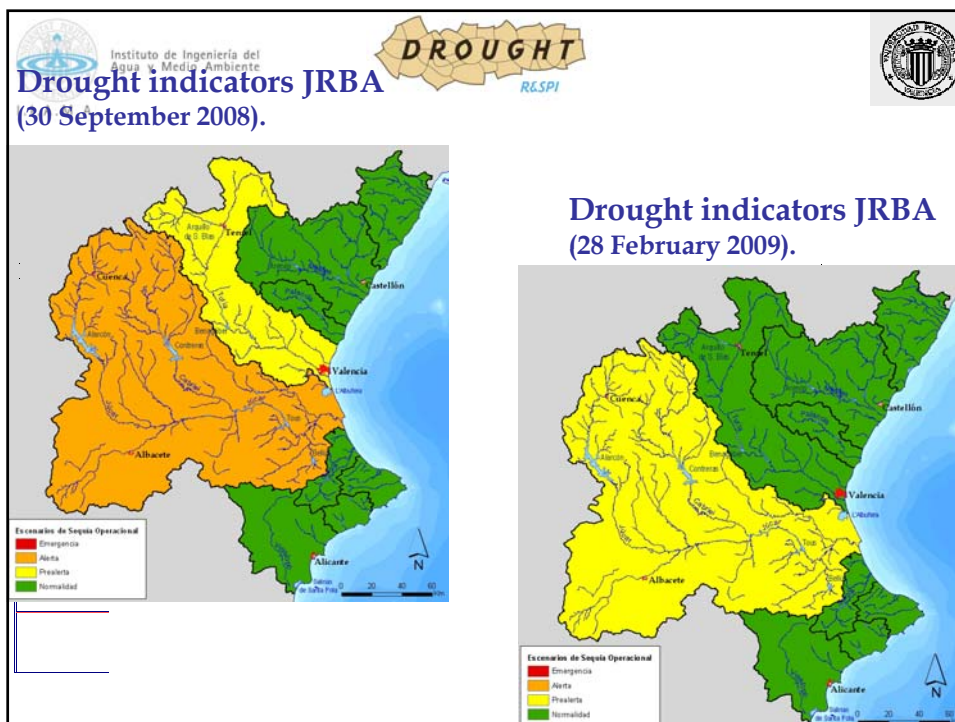
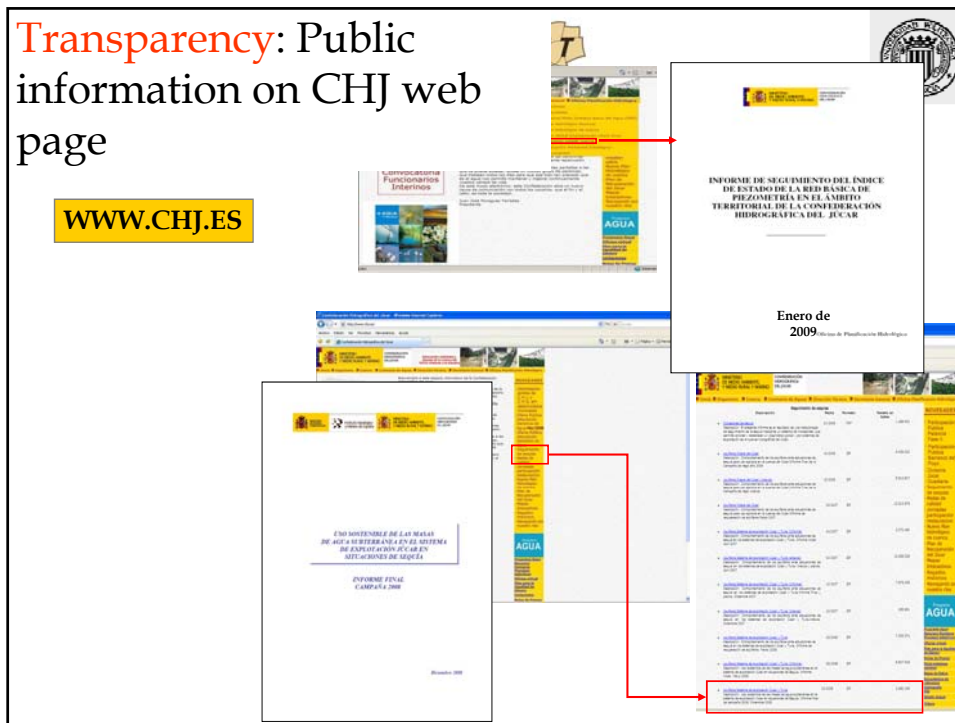


Júcar river in summers 2006 and 2007



Transparency: Public information on CHJ web page

WWW.CHJ.ES





SUMMARY AND CONCLUSIONS



DROUGHTS:

- Permanently prepared for droughts.
- New drought management policy:
 - Planning and proactive vs. Emergency and reactive
 - Special Drought Plans
- Continuous monitoring and risk assessment (Anticipation)
- Permanent Conservation measures
- Drought = conflict: participation, negotiation, transparency, tools and knowledge available to the stakeholders, ...
- Thrust atmosphere, cooperation, consensus, ...



DSS



- **DSS are essential** for the purpose of providing
 - Integration,
 - Transparency
 - easiness of use by PMA and
 - shared vision for conflict resolution.
- They are also very valuable for
 - sensitivity analysis
 - risk assessment
 - Trade-off assessment



DSS USE DURING NEGOTIATIONS PROVIDES MANY ADVANTAGES:

- ◆ **Development of MODELS, SHARED by the technicians, stakeholders, and policy makers: SHARED VISION OF the SYSTEM**
- ◆ **OBJECTIVE FRAMEWORK AND REFERENCE** that allows each group to evaluate the consequences of the alternatives that are proposed by them and by the others.
- ◆ **TOOL FOR the RATIONAL ANALYSIS OF MANAGEMENT AND OPERATION POLICIES** of resulting systems (CRUCIAL FOR REACHING AGREEMENTS AND TO AVOID FUTURE CONFRONTATIONS)
- ◆ **OBJETIVITY OF TECHNICAL ASPECTS** that allows negotiations to be developed IN SOCIAL AND POLITICAL TERMS THAT ALLOW **EQUITABLE AGREEMENTS.**

RESEARCH & SCIENCE CONTRIBUTION TO POLICY MAKING

Water Resources Planning : 80's, 90's, 2000's:

- Improvement of knowledge** about the WRS:
 - >All kind of **Models** (since 80's)
- Closing the gap** between R&S and PM:
 - >**Decision Support Systems (DSS)** (since 90's)
 - >**KNOWLEDGE BROKERING** (since 2000's)

Contribution to Special Drought Management Plans:

- Design of **Drought Monitoring Indicators** for WRS
- Definition of states (Abundance, normality, pre-alert, alert and emergency)
- Design of operating rules

RESEARCH & SCIENCE CONTRIBUTION TO POLICY MAKING (Cont.)

Contribution to Real Time Drought Management:

- Support to **Permanent Drought Committee & Technical Drought Office. Use of DSS** for
 - >**Drought Risk assessment** in WRS
 - >Forecasting of WRS evolution during the near future
 - >Design of measures
 - >**Assess the effectiveness of measures**
 - >Providing grounds for **conflict negotiation and consensus achievement**
 - >**KNOWLEDGE BROKERING**

RESEARCH & SCIENCE CONTRIBUTION TO POLICY MAKING (Cont.)

Contribution to POST-DROUGHT ANALYSIS:

- Indicators for performance of measures
- Updating the Special Plans for Drought
- Modification of the Special Plans for Drought
- >

About KNOWLEDGE BROKERING:

- Link between Research & Science and Policy Makers
- Central component of Knowledge transfer
- Encourages the use of
 - >Research inPlanning & Implementation
 - >Evaluation activities to identify successes or improvements

INDIVIDUALS serving as Knowledge Brokers:

- Must understand:
 - >Research process
 - >Decision making process
 - >Stakeholders behavior and needs
- must anticipate research needs for PM
- they are the ones to jump from Science to the train of P Making, and viceversa.



GHT
R&PI



Thank you for
your
attention!

