



MINISTERIO
DE AGRICULTURA Y PESCA,
ALIMENTACIÓN Y MEDIO AMBIENTE

Drought management in Spain



Directorate General for Water
SPANISH MINISTRY OF AGRICULTURE, FISHERIES, FOOD AND ENVIRONMENT



DROUGHT MANAGEMENT IN SPAIN

- From "*crisis management*" (emergency) to "*risk management*" (planning)
- Trigger: drought 1991-1995
 - Economic impact in irrigation: Alicante 34 M€; Valencia 19 M€; Murcia 18 M€; Castellón 8 M€.
 - Employment impact: more than 2 million lost wages, 84 M€.
 - Restrictions in Guadalquivir River Basin: Sevilla.
- Law 10/2001 of the National Hydrological Plan. Drought management.
 - Establishing a comprehensive global system of indicators (Ministry of Environment).
 - Development of Drought Management Plans (River Basin Management Authorities).



DROUGHT MANAGEMENT PLANS (DMP)

- **Objective: to reduce the frequency and intensity of droughts, and minimize their negative impacts (environmental, social and economic) as much as possible.**
- **Articulate and coordinate all issues related to: control, monitoring, follow-up system, risk assessment, decision making, implementation of measures.**

Questions that the Plan should answer:

When? How? Who?



Development of Drought Management Plans

- Analysis of water resources.
- Analysis of water uses and water demands.
- Characterization and analysis of historical droughts.
- Proposed drought indicators.
- Thresholding.
- Mitigation measures



- Definition of "*unidades de demanda*" (demand units).
- Selection of the best indicator representing the evolution of the available resources for each "*unidad de demanda*": most appropriate hydro-meteorological parameter (or a combination) .
 - Reservoirs storage, reservoirs inflows, streamflows (gauging stations), groundwater levels, rainfall, snow reserves.



CHARACTERISTICS OF A SYSTEM OF HYDROLOGIC INDICATORS

- It should allow to objectively characterize and assess the level and situation of the drought.
- It should be fast and easy to obtain and easy to verify for the public.
- It should be easy to interpret. Normalization.
- It should be specific for each system.
- It should be helpful to decision-making: early and progressive implementation of the most appropriate measures at every time (associated with thresholds).



SELECTED INDICATORS

RELACIÓN DE LAS ZONAS E INDICADORES SELECCIONADOS

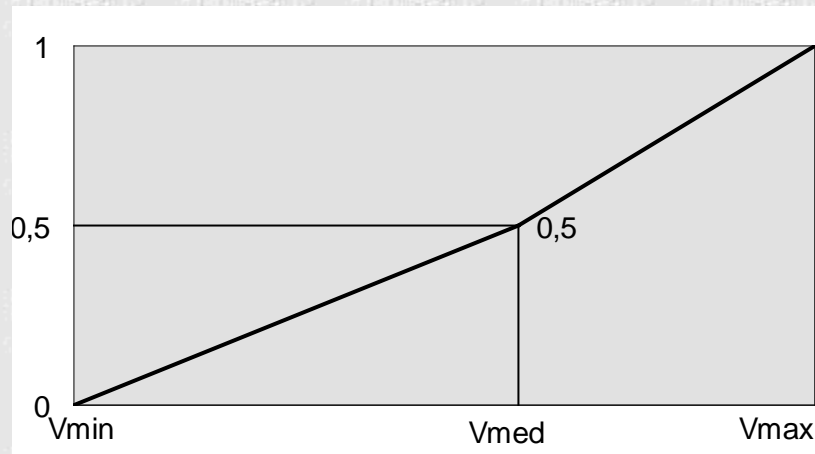
CÓD	ZONA	INDICADOR
1	Recursos superficiales del sistema del río Cenia	Volumen mensual embalse de Ulldecona
2	Recursos subterráneos franja costera Cenia-Maestrazgo	Piezómetro 08.11.004. Cabanes
3	Rec. superficiales Interior Cenia-Maestrazgo	Pluviómetros areales Zona Interior C-M
4	Recursos alto y medio Mijares	Entradas a Arenós
5	Recursos superficiales regulados por Arenós y Sichar	Volumen embalsado en Arenós y Sichar
6	Recursos subterráneos Plana de Castellón	Piezómetro 08.12.017. Xilxes/Chilches
7	Recursos Alto Palancia	Entradas al Regajo
8	Recursos superficiales regulados por el Regajo	Volumen embalsado en el Regajo
9	Recursos subterráneos Plana de Sagunto	Piezómetro 08.21.005. Sagunto
10	Recursos regulados por el Arquillo de San Blas	Volumen embalsado en el Arquillo de San Blas
11	Recursos río Alfambra	Estación foronómica 08028. Villalba Alta.
12	Recursos fluyentes río Guadalaviar	Entradas al Arquillo de San Blas
13	Recursos medio Turia	Estación foronómica 08018. Zagra.
14	Recursos regulados por Benageber y Loriguilla	Volumen embalsado en Benageber y Loriguilla
15	Recursos subterráneos Liria-Casinos/Buñol-Chestre	Piezómetro 08.23.005. Turia
16	Recursos subterráneos Plana de Valencia	Piezómetro 08.26.019. Alginet
17	Recursos alto Júcar	Estación foronómica 08032. Cuenca.
18	Recursos alto Cabriel	Estación foronómica 08090. Pajaroncillo.
19	Recursos subterráneos Utiel-Requena	Piezómetro 08.24.005. Utiel
20	Recursos ríos Jardín y Lezusa	Estación foronómica 08138. Balazote
21	Recursos fluyentes Mancha Oriental	Estaciones foronómicas 08144 y 08036
22	Recursos fluyentes medio Cabriel	Pluviómetros areales Zona Medio Cabriel
23	Recursos subterráneos Mancha Oriental	Piezómetro 08.29.053. Cenizate
24	Recursos regulados por el embalse de Forata	Volumen embalsado en Forata
25	Recursos fluyentes Embarcaderos-Tous	Pluviómetros areales Embalse de Tous
26	Recursos regulados por Alarcón Contreras y Tous	Suma de volumen en Alarcón, Contreras y Tous
27	Recursos subterráneos Caroeh	Piezómetro 08.28.007. Montesa
28	Recursos fluyentes del Albaidda y Cañoles	Pluviómetros areales Zona L'Ollería
29	Recursos subterráneos Sierra Grossa, Sierra de las Agujas y Plana de Gandía	Piezómetro 08.38.019. Gandía
30	Recursos del sistema Serpis	Volumen embalsado en Beniarrés
31	Recursos sistema Marina Alta	Pluviómetros areales Marina Alta
32	Recursos sistema Marina Baja	Volumen almacenado en Amadorio y Guadalest
33	Recursos Alto Vinalopó	Pluviómetros areales alto Vinalopó
34	Recursos Medio Vinalopó-Alacanti	Pluviómetros areales medio Vinalopó





NORMALIZATION OF INDICATORS

- All the indicators are normalized to values from 0 to 1, which allows the combination of different indicators by weighted additions.



$$- Si V_i \geq V_{med} \Rightarrow I_e = \frac{1}{2} \left[1 + \frac{V_i - V_{med}}{V_{max} - V_{med}} \right]$$

$$- Si V_i < V_{med} \Rightarrow I_e = \frac{V_i - V_{min}}{2(V_{med} - V_{min})}$$



ESTABLISHING THRESHOLDS

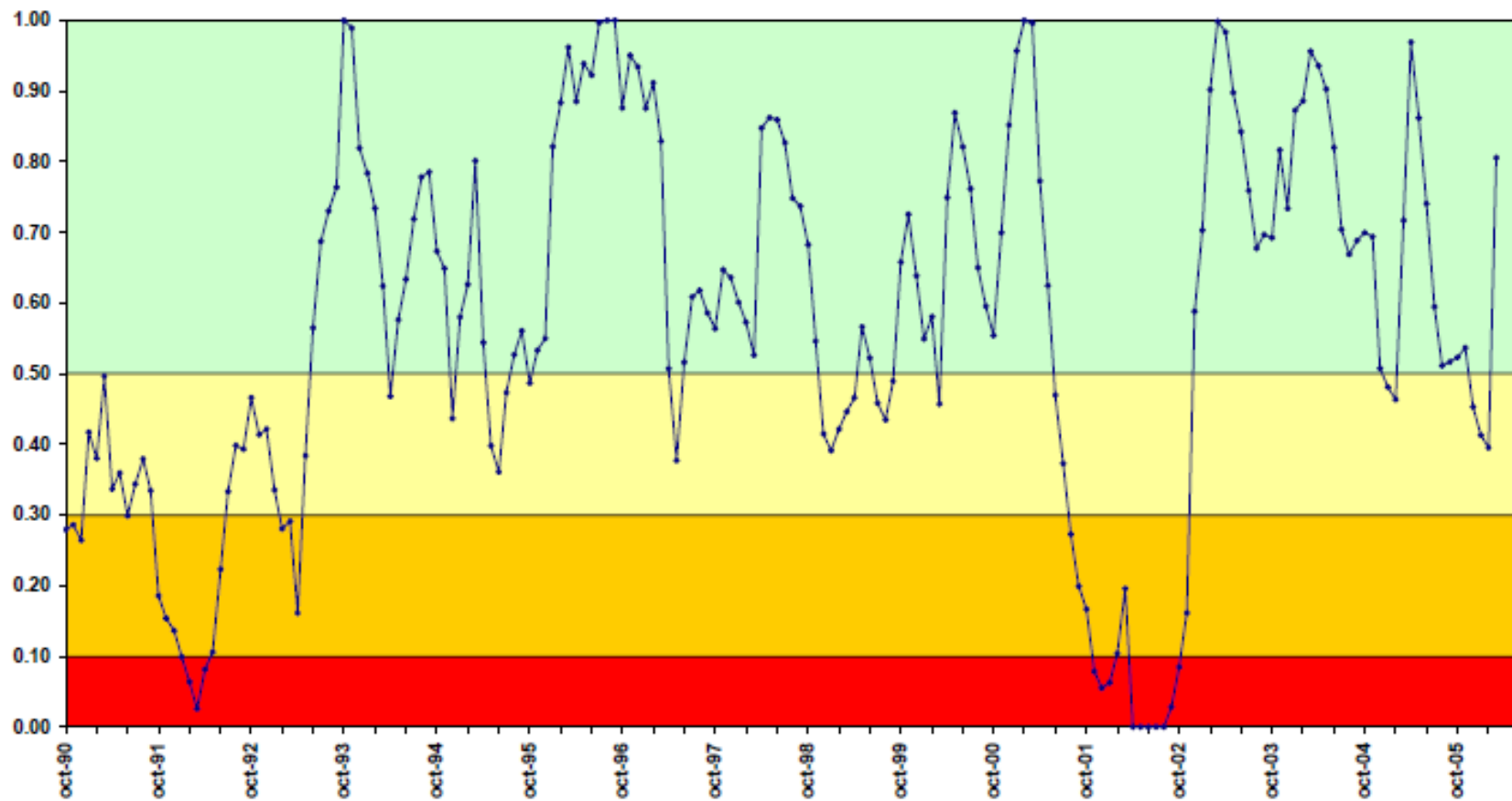
Clasificación de los estados hidrológicos	
Riesgo de restricciones	Estado hidrológico
Muy bajo	Normalidad
Bajo	Prealerta
Medio	Alerta
Alto – Muy alto	Emergencia

Level of hydrological drought and risk of restrictions corresponding to each level

- **Objective:** To progressively activate and implement the measures to be applied in order to avoid the negative impacts of the most severe stages of droughts.



DROUGHT INDICATOR EVOLUTION OF THE S.E. ESLA-VALDERADUEY (DUERO R.B.)



Normalidad

Prealerta

Alerta

Emergencia

le ponderado



TYPES OF MITIGATION MEASURES

TYPES OF MITIGATION MEASURES				
Status	Normal	Pre-alert	Alert	Emergency
Objective	Planning	Information-control	Conservation	Restrictions
Type of measure	Strategic	Tactics		Emergency

- Strategic measures → long term actions, included in the River Basin Management Plan.
- Tactic measures → planned short term actions.
- Emergency measures → extraordinary actions adapted to the extension, affected areas and gravity of the situation.



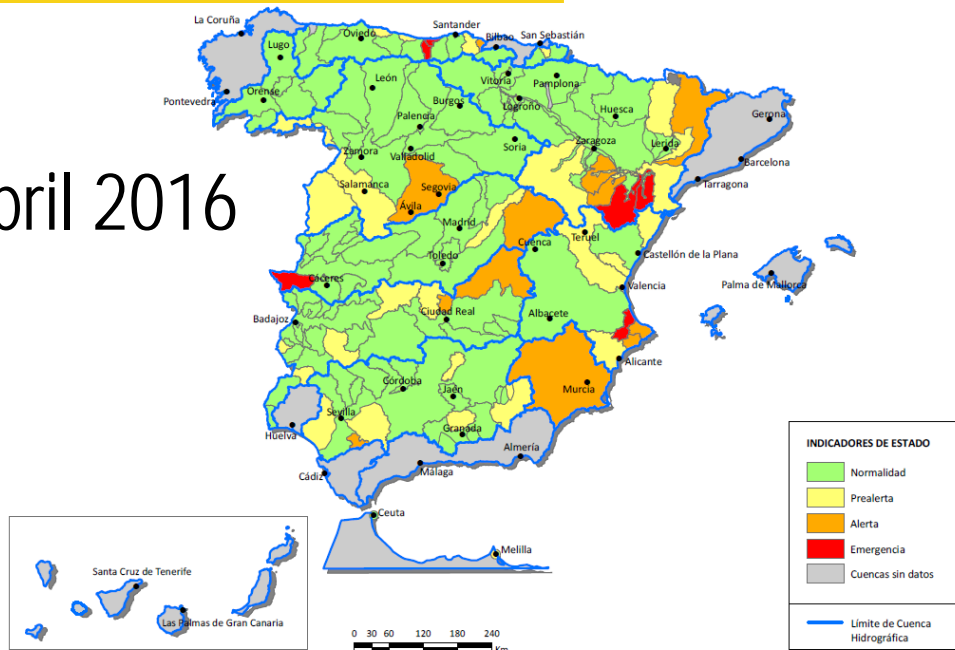
SOME RESULTS OF THE NEW STRATEGY AGAINST DROUGHTS

- **Drought 2005–2008.** Impacts highly attenuated compared to the period 1992-1995.
 - Using drought indicators.
 - Demand management: moderation in urban and industrial consumption, reduced supplies for irrigation (moderate abstractions of reservoirs, modernization and greater efficiency in irrigation, less water demanding crops, tax exemption).
 - Water use rights exchange or acquisition: farmers don't irrigate their land in exchange of an economic compensation.
 - Alternative resources: increased use of groundwater (drought wells), increased water reuse and desalination.
 - Increased attention to environmental problems and measures (monitoring and quality control of water body status, ecological flows, etc.).
 - Rationality and moderation in the execution of emergency infrastructures.



MAPS OF DROUGHT LEVEL INDICATORS

April 2016

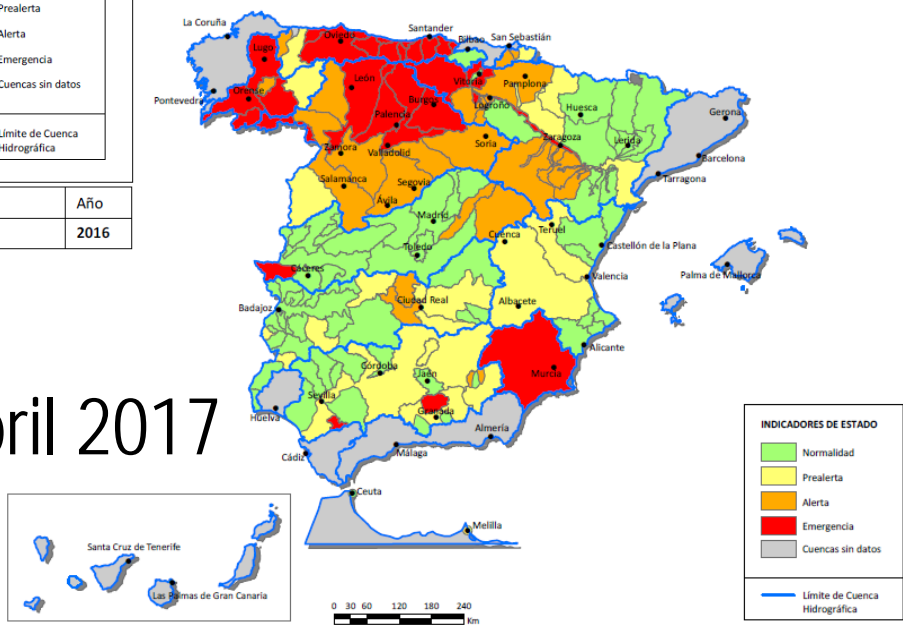


INDICADORES DE ESTADO

- Normalidad
- Prealerta
- Alerta
- Emergencia
- Cuencas sin datos

— Límite de Cuenca Hidrográfica

April 2017



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- Emergencia
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— Límite de Cuenca Hidrográfica



NEXT STEPS RELATED TO DROUGHT MANAGEMENT PLANS

- A new *Drought Management Plan*, for each River Basin District, should be approved before 31 December 2017, adapted to the new situation of each basin, according to the River Basin Management Plans, and especially in relation to:
 - Water resources.
 - Water demands.
 - Experiences obtained during the last sequences of drought.
 - Protected areas.
 - Ecological flows and other environmental requirements.
- The new DMPs will establish a clear difference between drought (related to a natural situation due to a reduction of rainfall and hydrological flows) and scarcity (related to anthropic effects).



How drought can affect health

Drought can have many harsh effects on plants, animals, and the environment. This can contribute to increased risk to human health. Here are only a few examples of what drought can do:



Cause stress, anxiety, and depression. Drought causes economic losses to businesses that rely on water (for example, farms and landscape companies) and job loss for people who work in these areas.



Change the amount and patterns of certain diseases. For example, mosquitoes carrying West Nile virus can move into new areas when stagnant bodies of water create new breeding grounds. Also, dry and dusty soil conditions can increase the risk of Valley Fever, a lung infection caused by a fungus in the soil.



Intensify wildfires and dust storms, thus increasing the number of particulates in the air. This can worsen asthma and other heart and lung diseases.



Intensify heatwaves causing increased risk of injury and death from heat exhaustion or heat stroke.



Stress city- or county-wide water systems that supply water not only to households but also at-risk populations such as people in hospitals and nursing homes.

Source: U.S. National Center for Environmental Health <http://www.cdc.gov/nceh/drought/>





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Thank you for your
attention