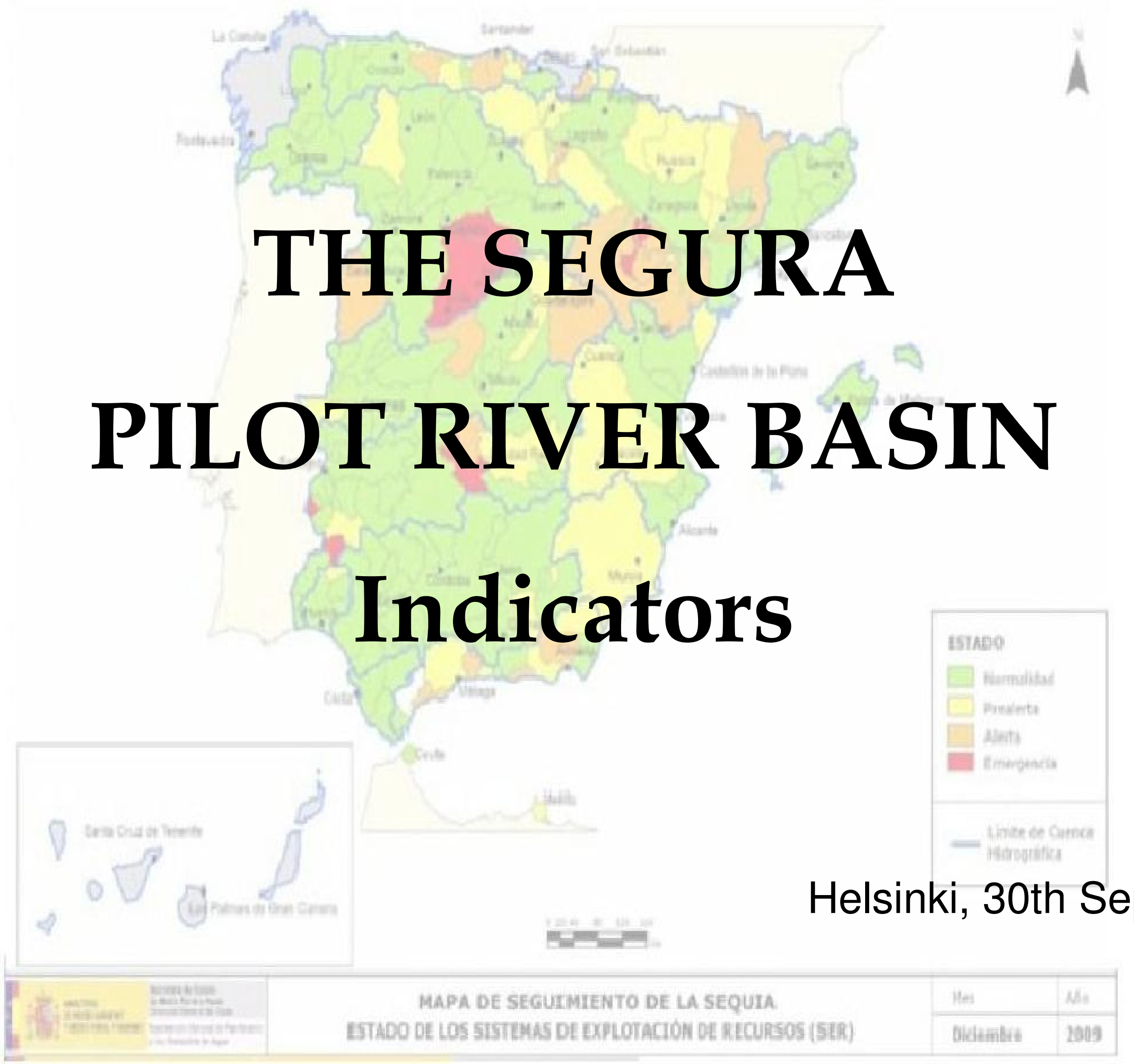
GOBIERNO DE ESPAÑA
MINISTERIO DE MEDIO AMBIENTE Y MEDIO RURAL Y MARINO
CONFEDERACIÓN HIDROGRÁFICA DEL SEGURA

THE SEGURA

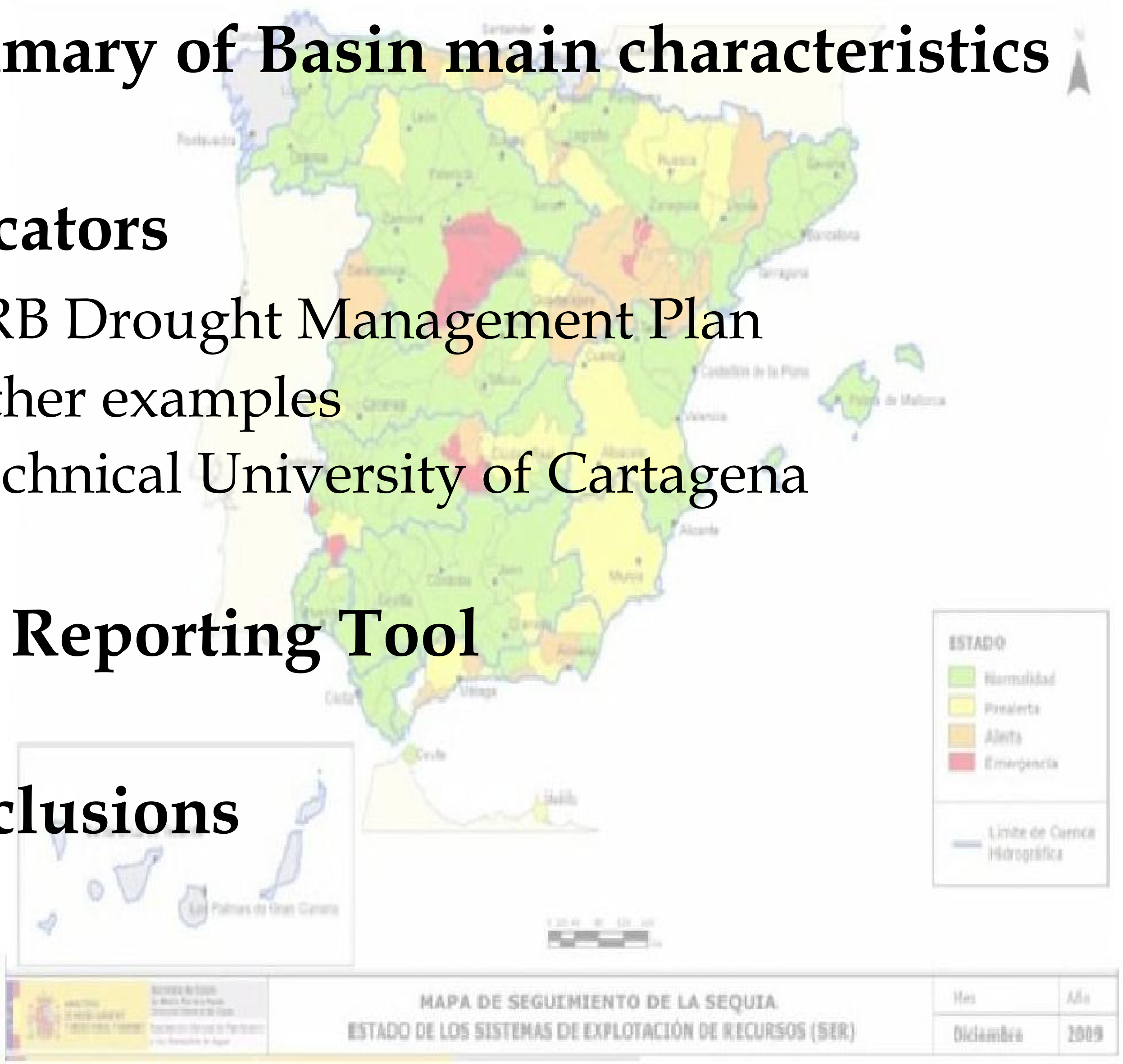
PILOT RIVER BASIN

Indicators

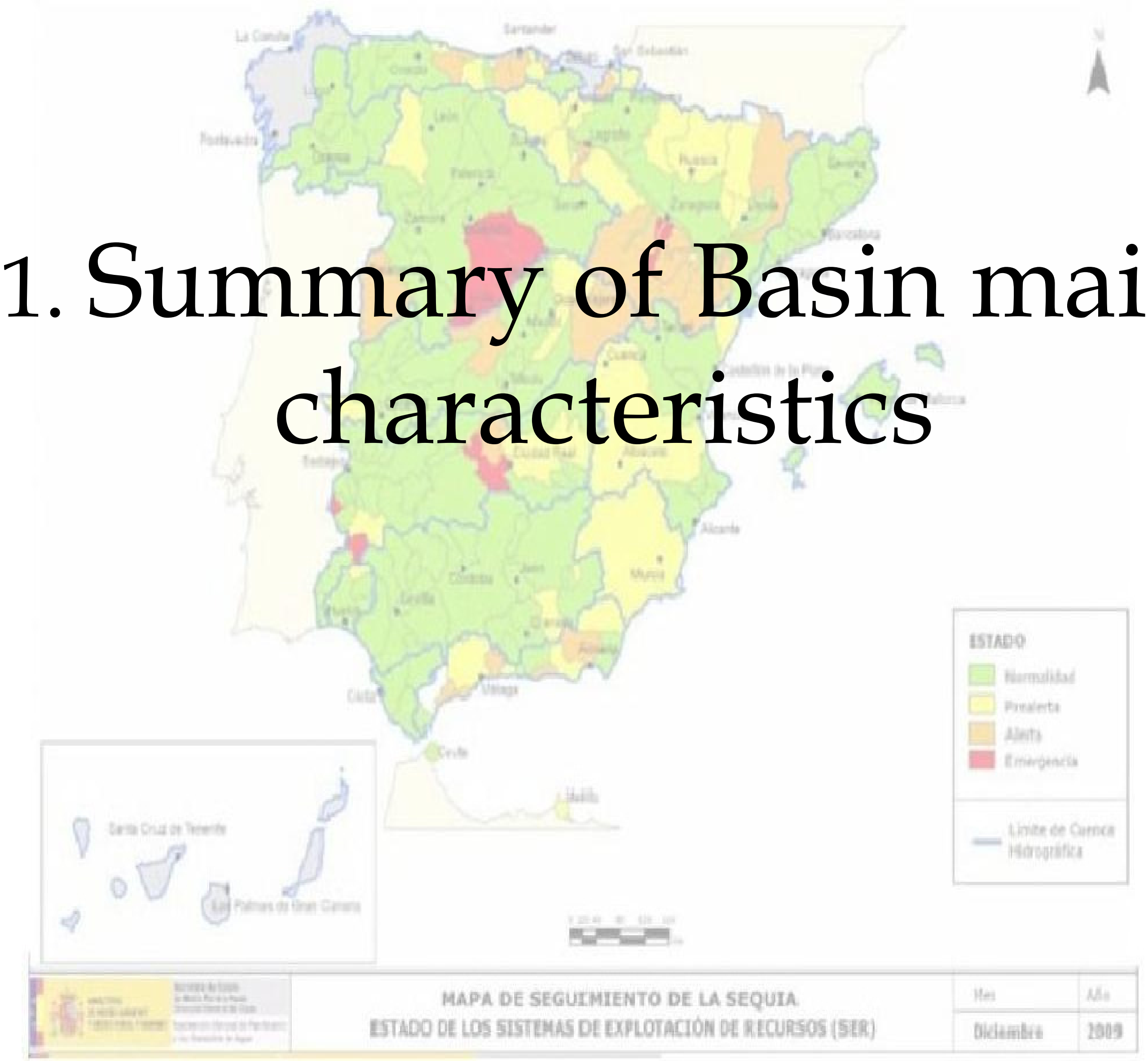


Helsinki, 30th September

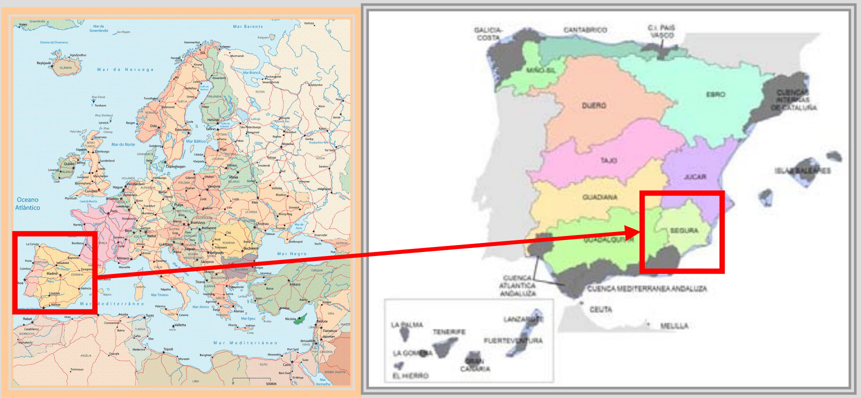
INDEX


ESTADO
Normalidad
Prealerta
Alerta
Emergencia
Límite de Cuenca Hidrográfica
MAPA DE SEGUIMIENTO DE LA SEQUIA
ESTADO DE LOS SISTEMAS DE EXPLOTACIÓN DE RECURSOS (SER)
Mes
Diciembre
Año
2009

1. Summary of Basin main characteristics

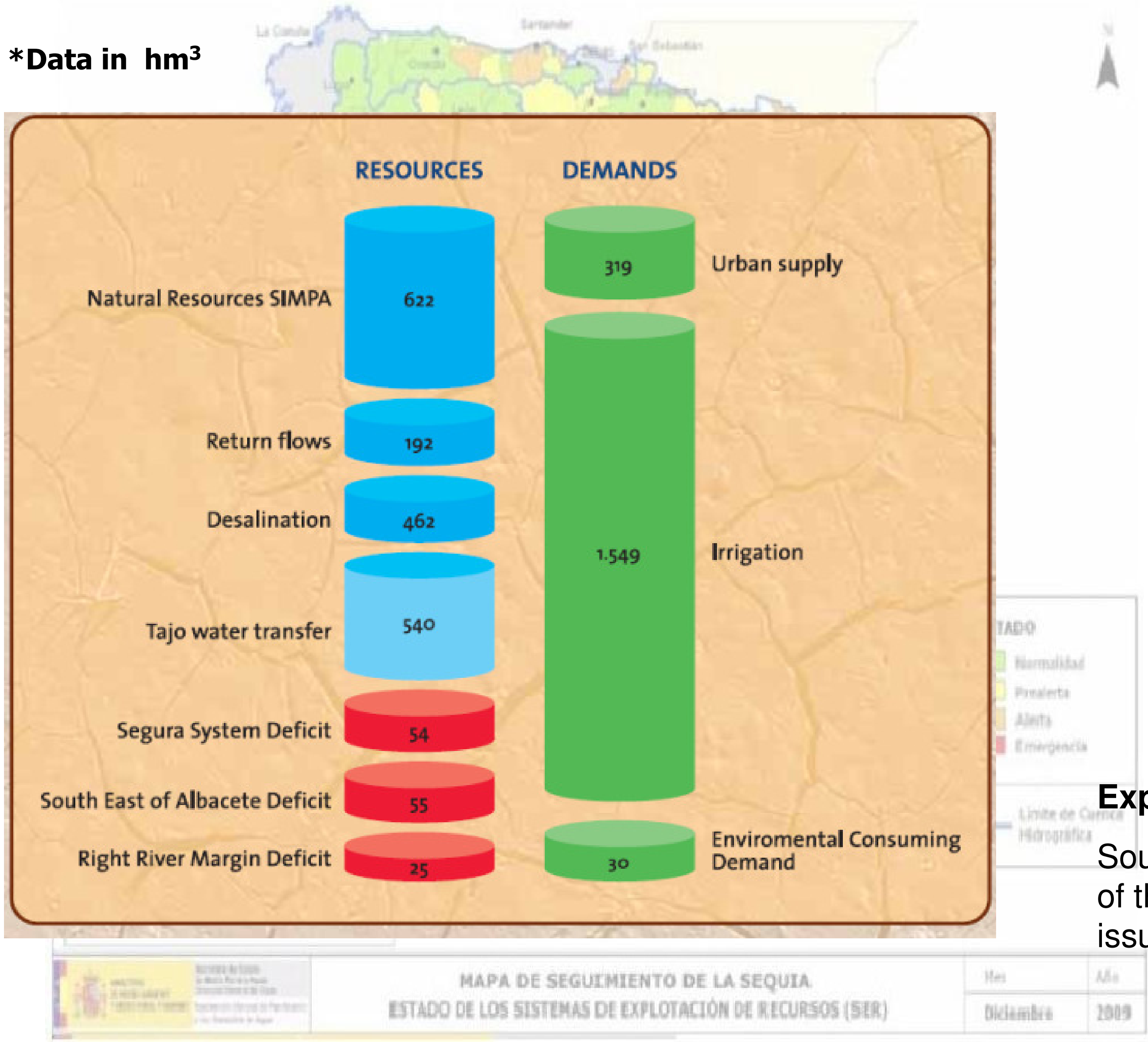


1. Summary of Basin main Characteristics

LOCATION	
SURFACE (Km²)	18,815
POPULATION (Year 2009)	1,969,370 (> 2,500,000 in summer)
TOTAL LENGHT OF CHANNEL NETWORK (Km)	1,470
RESERVOIRS CAPACITY (hm3)	1,141
AVERAGE RAINFALL (mm)	**365** (over the half of the Spanish average)
POTENTIAL EVAPOTRANSPIRATION (mm)	**827**
NATURAL RESOURCES (hm3/year)	**803**
RATIO PER INHABITANT (m3/inh/year)	**442**
IRRIGATION SURFACE (ha)	269,029
GROSS DEMAND VOLUME (hm3/year)	1,662
PRODUCTION VALUE (M€/year)	3,202 (1.93 €/m3)
NET MARGIN (M€/year)	1,202 (0.72 €/m3)

1. Summary of Basin main Characteristics: BALANCE

***Data in hm^3**

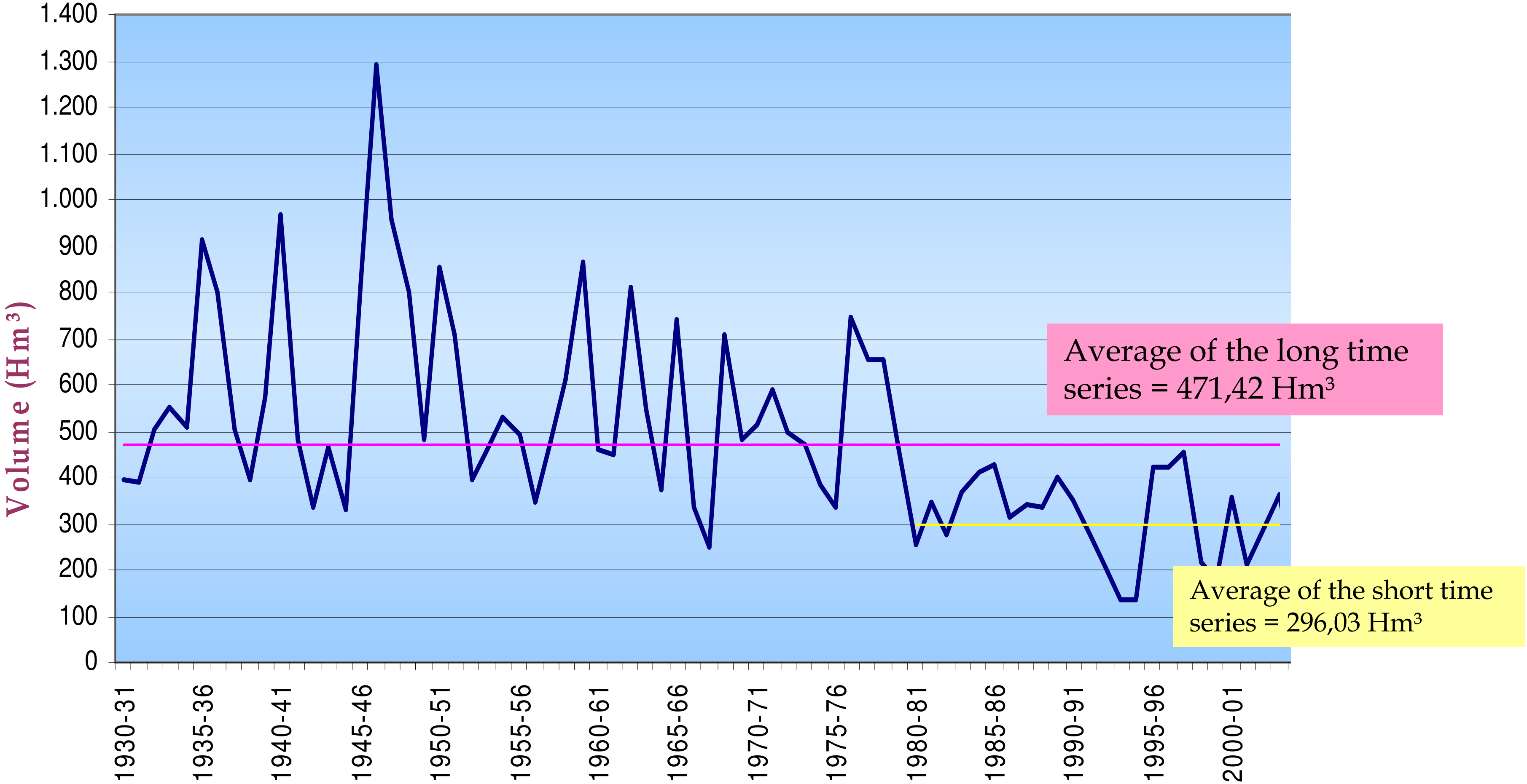


Expected in 2015

Source: Overview of the significant issues

1. Summary of Basin main Characteristics: TRENDS

Interannual acumulated runoff between september 1931 and september 2009



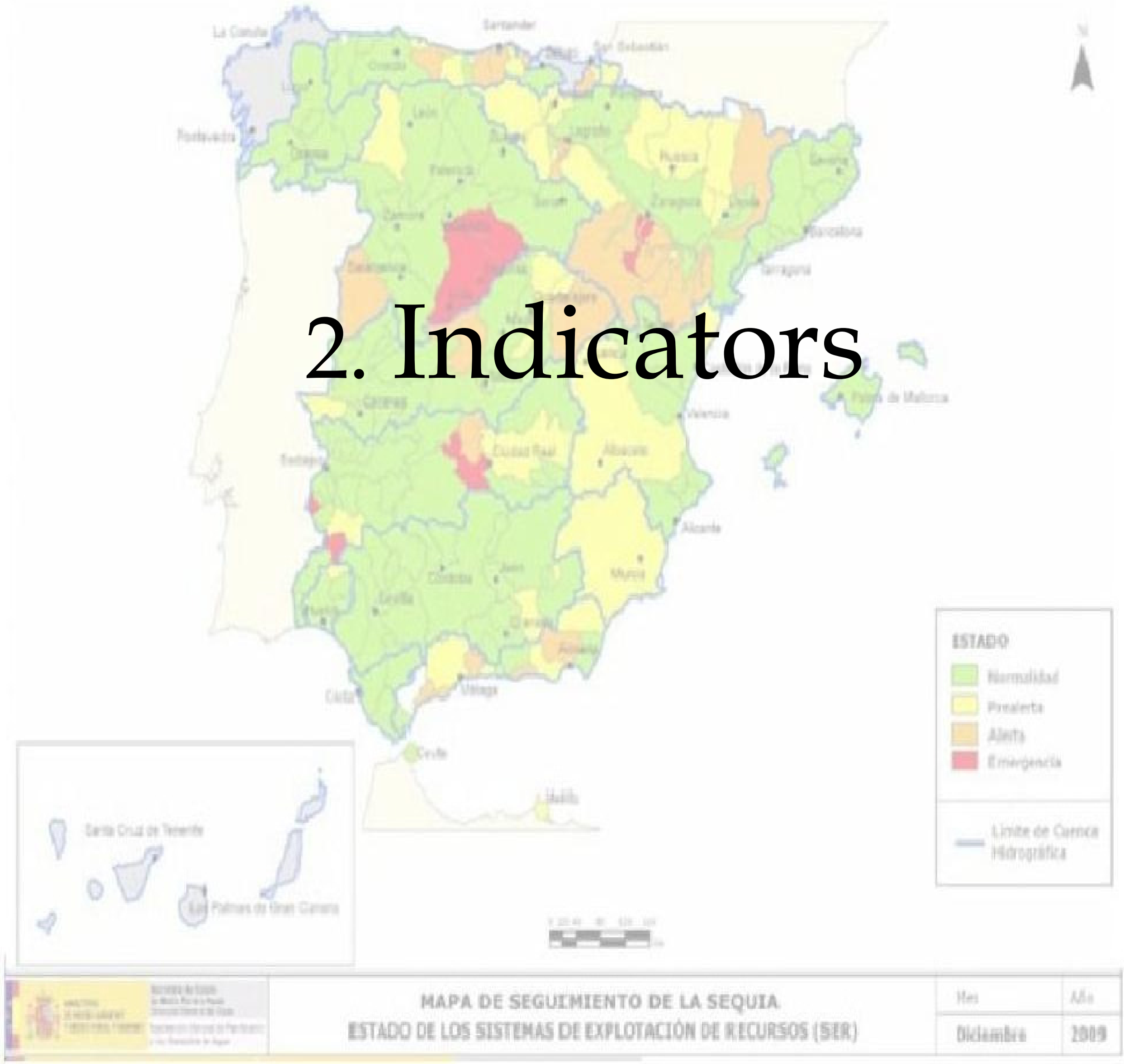
Average of the long time series = 471,42 Hm³

Average of the short time series = 296,03 Hm³

MAPA DE SEGUIMIENTO DE LA SEQUIA
ESTADO DE LOS SISTEMAS DE EXPLOTACIÓN DE RECURSOS (SER)

Mes	Año
Diciembre	2009

2. Indicators



2. Indicators: 2.1 SRB Drought Management Plan

➢**INDICATOR**:

-Basin sub-system:

Ve = 0,66*Run-off(annual)+0,33*water in reservoirs

-Water transfer sub-system:

Ve = 0,33*Run-off(annual)+0,66*water in E+B reservoirs

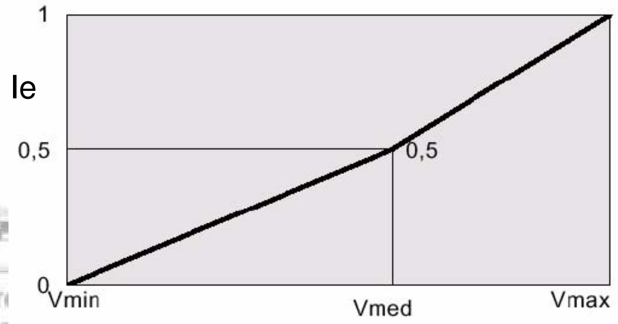
-Global indicator

Ve = a*Ve(basin)+b*Ve(water-transfer)

a, b depend on water rights given in each Sub-system (a=0,48; b=0,52)

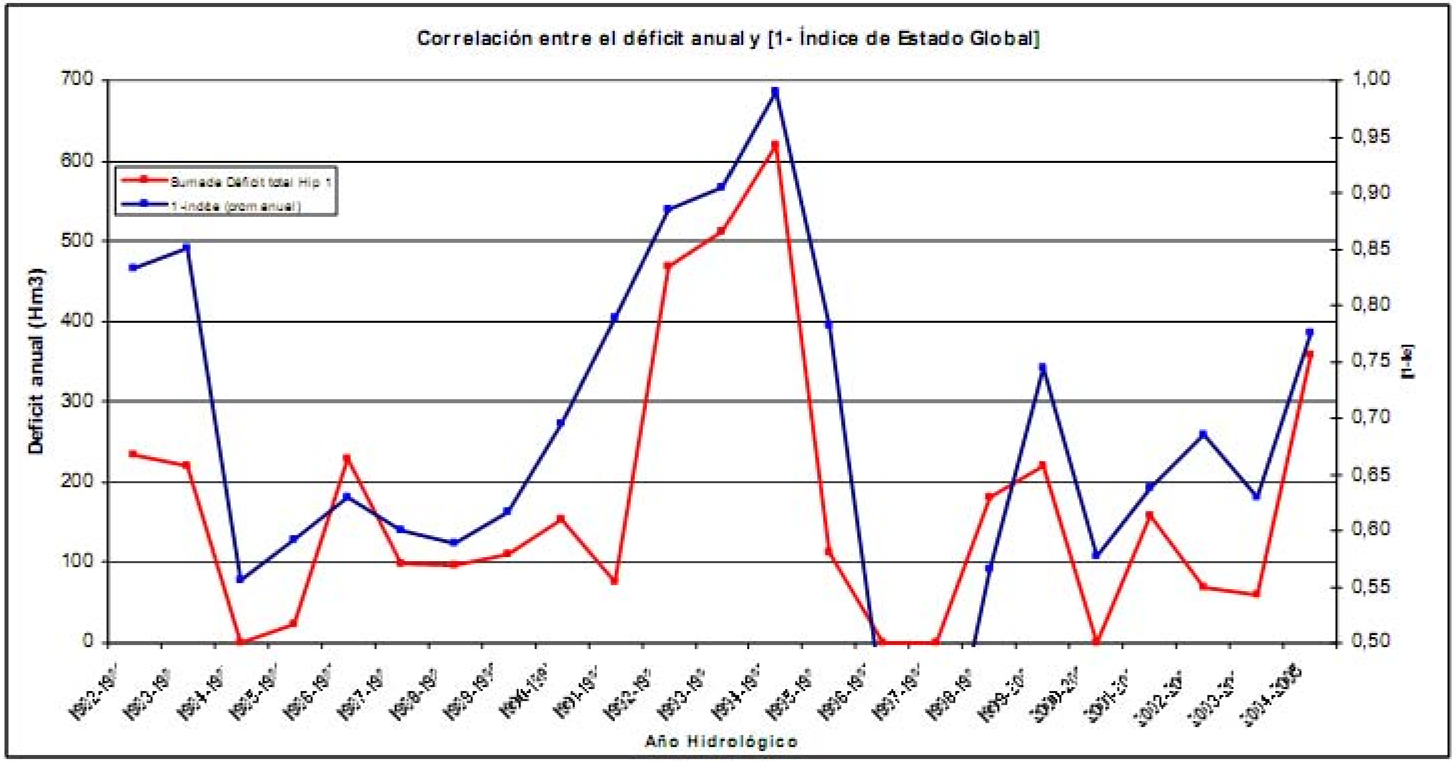
➢ Once the indicator is established, an associated **INDEX** is assessed (monthly) as follows:

Index (Ie) varies between 0,5 and 1 when Ve>Vmed, and between 0 and 0,5 when assessed Ve>Vmed, as shown in the graph.



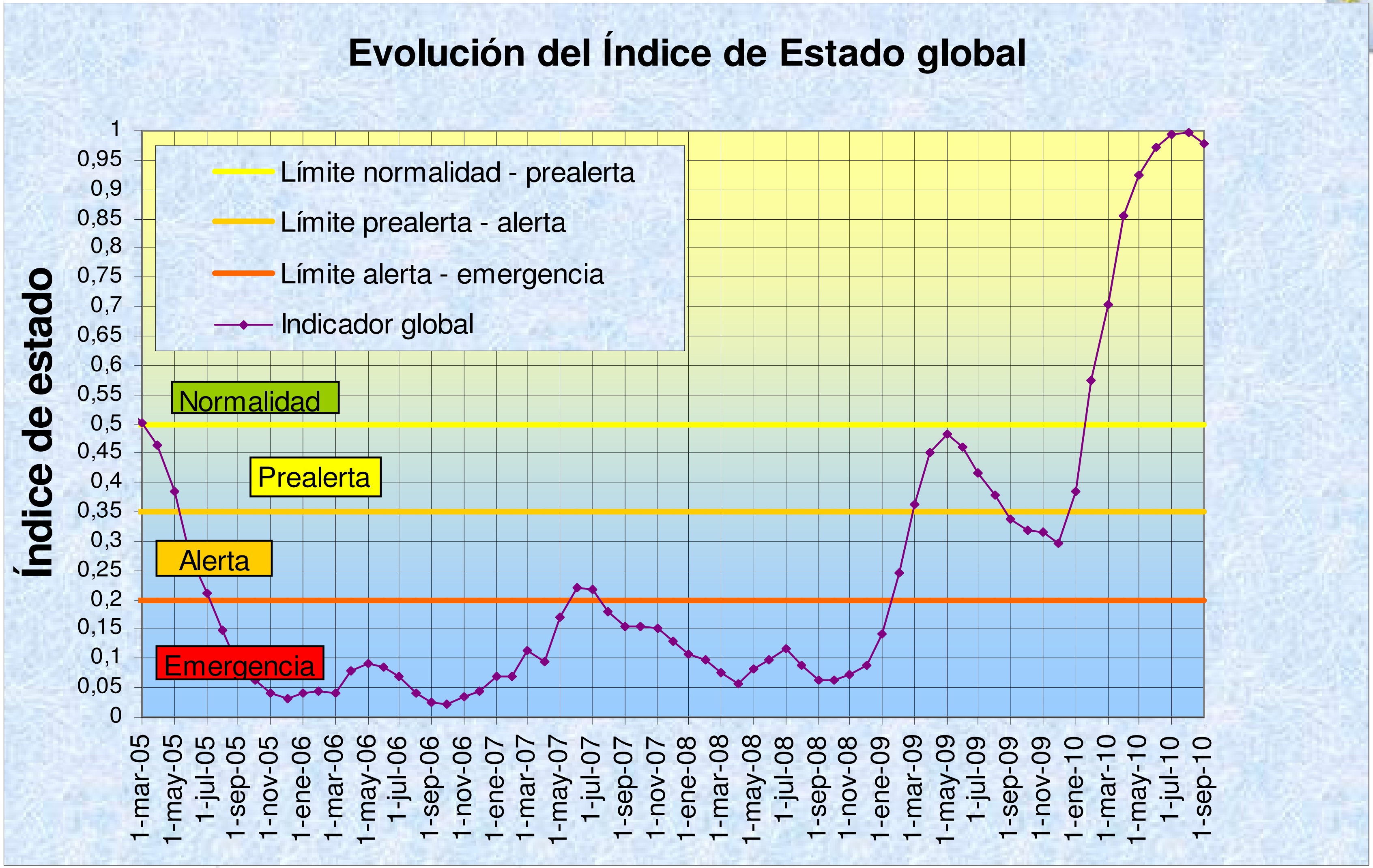
2. Indicators: 2.1 SRB Drought Management Plan

Checking index accuracy:



As we can see in the previous graph, **drought index and deficit series follow the same trend**. Highest deficit periods show lowest index values.

2. Indicators: 2.1 SRB Drought Management Plan

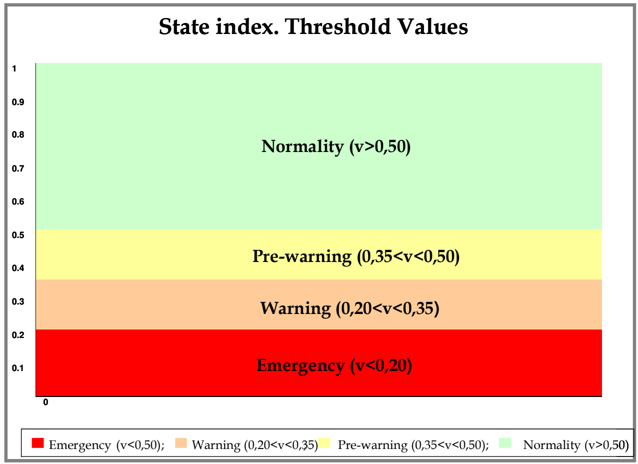

Evolución del Índice de Estado global


MAPA DE SEGUIMIENTO DE LA SEQUIA
ESTADO DE LOS SISTEMAS DE EXPLOTACIÓN DE RECURSOS (SER)

Mes	Año
Diciembre	2009

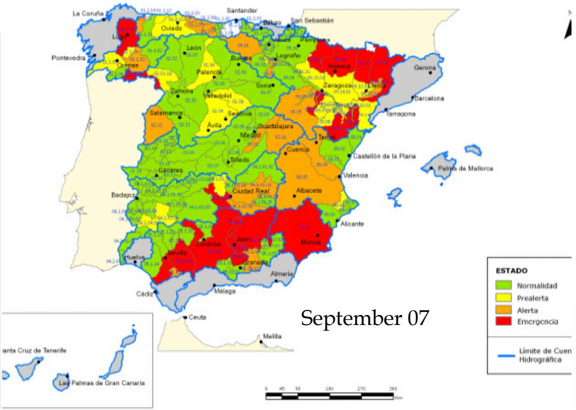
GOBIERNO DE ESPAÑA MINISTERIO DE MEDIO AMBIENTE Y MEDIO RURAL Y MARINO CONFEDERACIÓN HIDROGRÁFICA DEL SEGURA

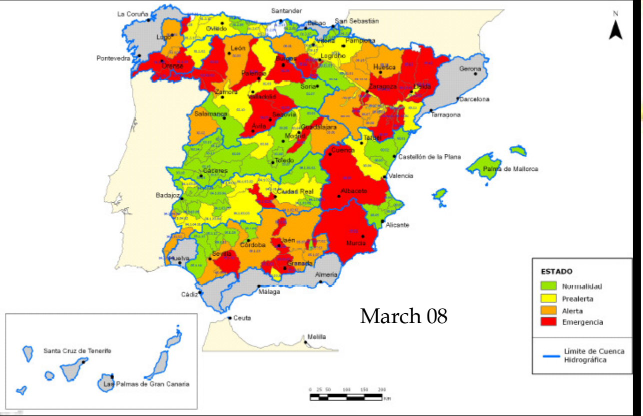
DROUGHT ACTION PLANS-DROUGHT INDICATORS

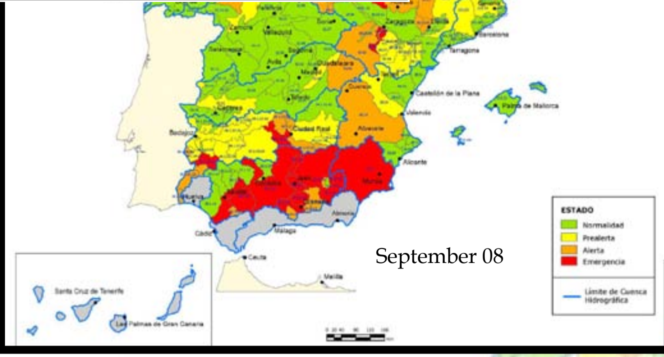

State index. Threshold Values

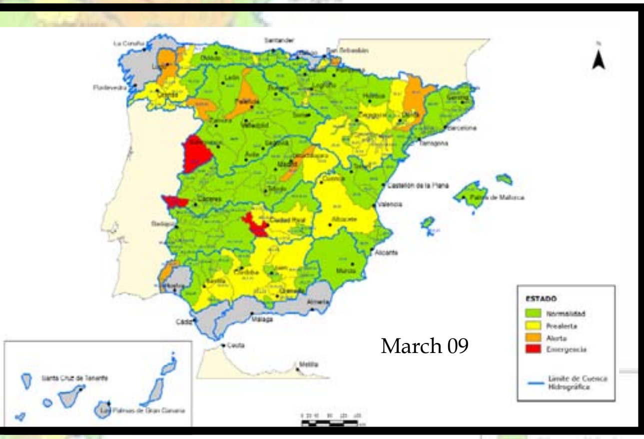
LEYENDA

- 🟩 Normalidad
- 🟨 Prealerta
- 🟧 Alerta
- 🟥 Emergencia

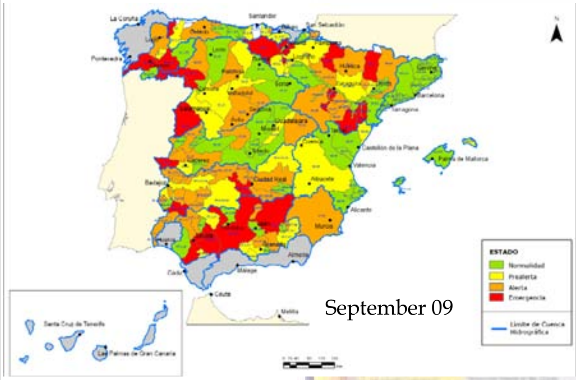

September 07

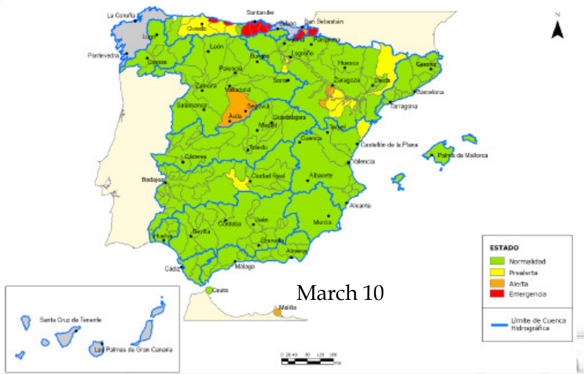

March 08


September 08


March 09

Fuente: http://www.marm.es


September 09


March 10


July 10

2. Indicators: 2.1 SRB Drought Management Plan

After the severe drought period suffered during the last 4 years, the Spanish Government is carrying out a revision of all river basin plans, in order to:

- Evaluate the effectiveness of the measures applied.
- Identify weaknesses and strengths of the Plans.
- Give new guidelines for the revision of the Plans.

GOBIERNO DE ESPAÑA MINISTERIO DE MEDIO AMBIENTE Y MEDIO RURAL Y MARINO DIRECCIÓN GENERAL DEL AGUA

CONFEDERACIÓN HIDROGRÁFICA DEL SEGURA

INFORME DE SEGUIMIENTO DEL PES DE LA CUENCA DEL SEGURA

PERIODO ABRIL DE 2007 A SEPTIEMBRE DE 2009

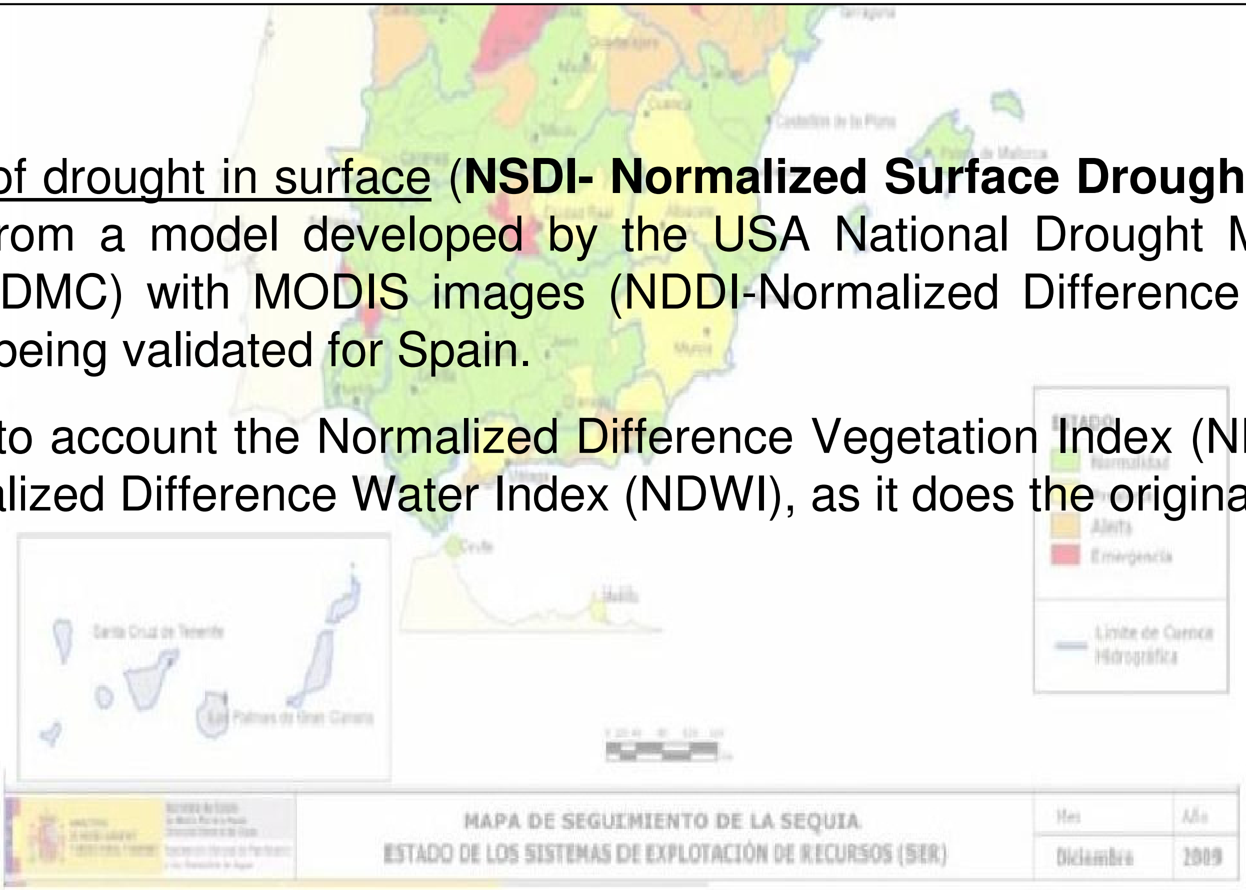
IBERHIDRA, S.L.

Julio 2010.

2. Indicators: 2.2 Other examples- NSDI

General Directorate of Water
Ministry of the Environment and Rural and Marine Affairs

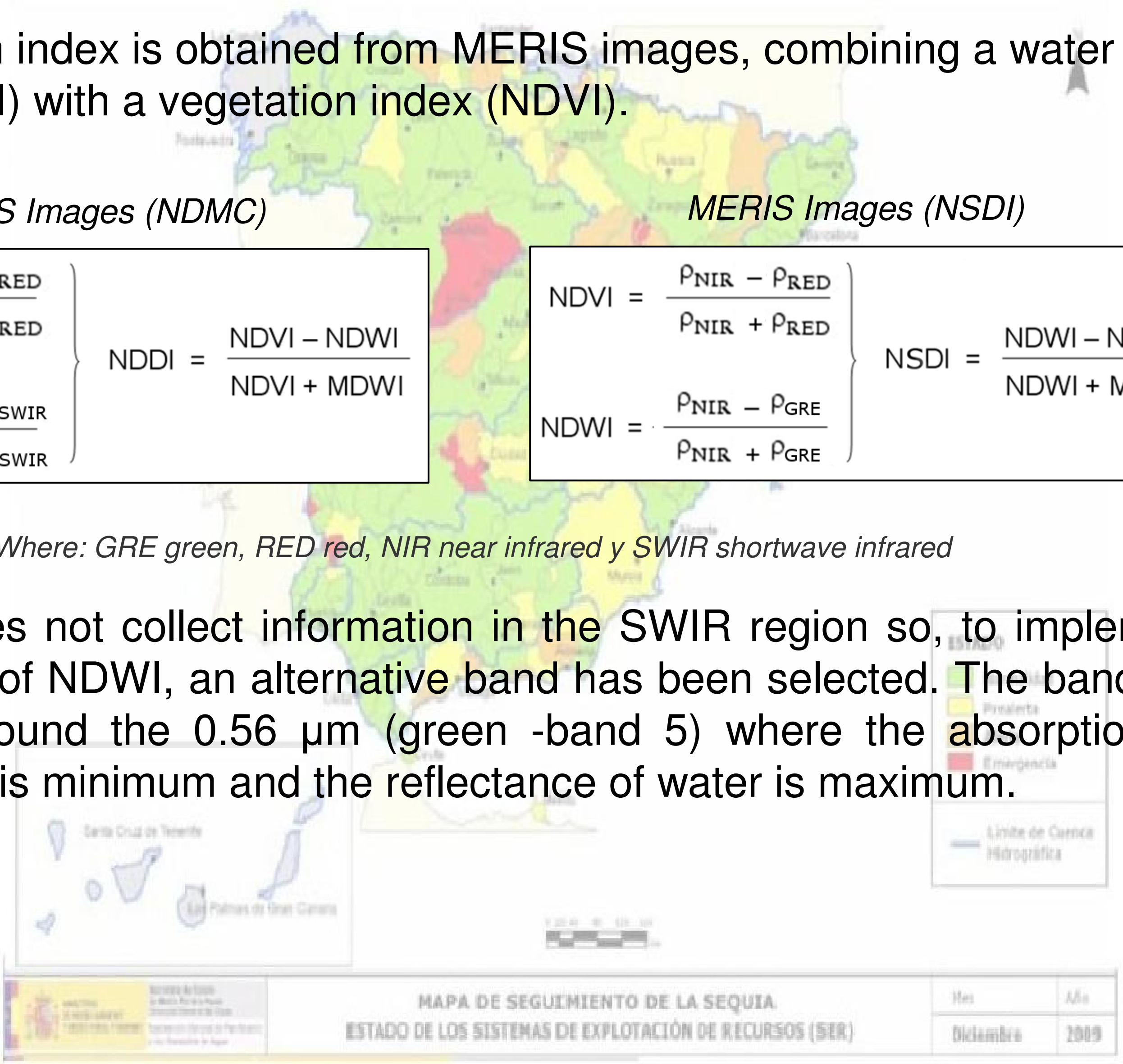
Information obtained from the slides of the presentation of *Alberto Rodriguez Fontal* during the WMO/UNISDR Expert Group Meeting on Agricultural Drought Indices- Murcia 4th-6th June- 2010



An index of drought in surface (**NSDI- Normalized Surface Drought Index**), adapted from a model developed by the USA National Drought Mitigation Center (NDMC) with MODIS images (NDDI-Normalized Difference Drought Index), is being validated for Spain.

It takes into account the Normalized Difference Vegetation Index (NDVI) and the Normalized Difference Water Index (NDWI), as it does the original NDDI.

2. Indicators: 2.2 Other examples - NDSI



The Spanish index is obtained from MERIS images, combining a water content index (NDWI) with a vegetation index (NDVI).

MODIS Images (NDMC)

$$NDVI = \frac{\rho_{NIR} - \rho_{RED}}{\rho_{NIR} + \rho_{RED}} \qquad NDWI = \frac{\rho_{NIR} - \rho_{SWIR}}{\rho_{NIR} + \rho_{SWIR}} \qquad NDDI = \frac{NDVI - NDWI}{NDVI + MDWI}$$

MERIS Images (NSDI)

$$NDVI = \frac{\rho_{NIR} - \rho_{RED}}{\rho_{NIR} + \rho_{RED}} \qquad NDWI = \frac{\rho_{NIR} - \rho_{GRE}}{\rho_{NIR} + \rho_{GRE}} \qquad NSDI = \frac{NDWI - NDVI}{NDWI + MDVI}$$

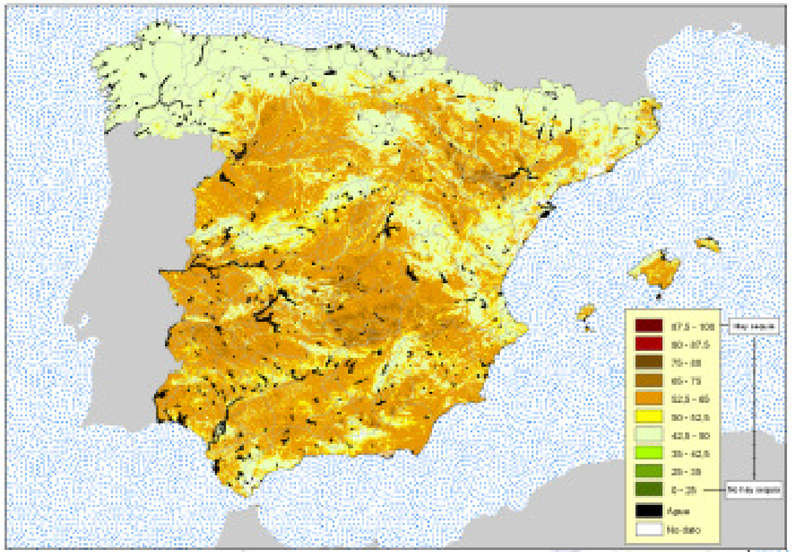
Where: GRE green, RED red, NIR near infrared y SWIR shortwave infrared

MERIS does not collect information in the SWIR region so, to implement the calculation of NDWI, an alternative band has been selected. The band used is situated around the 0.56 µm (green -band 5) where the absorption of the chlorophyll is minimum and the reflectance of water is maximum.

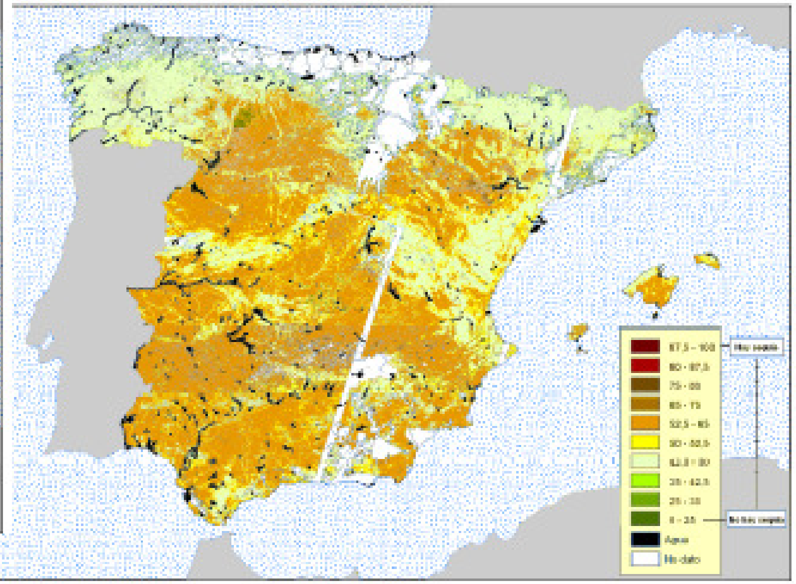
2. Indicators: 2.2 Other examples - NDSI

NDSI maps, at National level, are elaborated and published regularly by the Ministry of the Environment and Rural and Marine Affairs, in a weekly report.

This information is available in the web page: http://www.mma.es/portal/secciones/aguas_continent_zonas_asoc/ons/mapa_informe_ons/informes_cuenca.htm



July, 2010

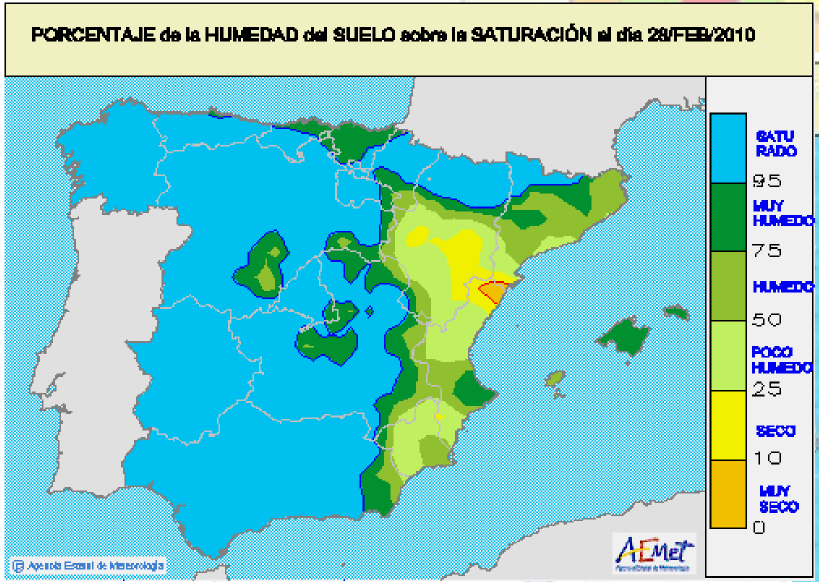


August, 2010

2. Indicators: 2.3 Other examples – Soil Moisture

Like the previous indicator, **Soil Moisture maps**, <u>at National level</u>, are elaborated and published regularly by the Ministry of the Environment and Rural and Marine Affairs in a weekly report.

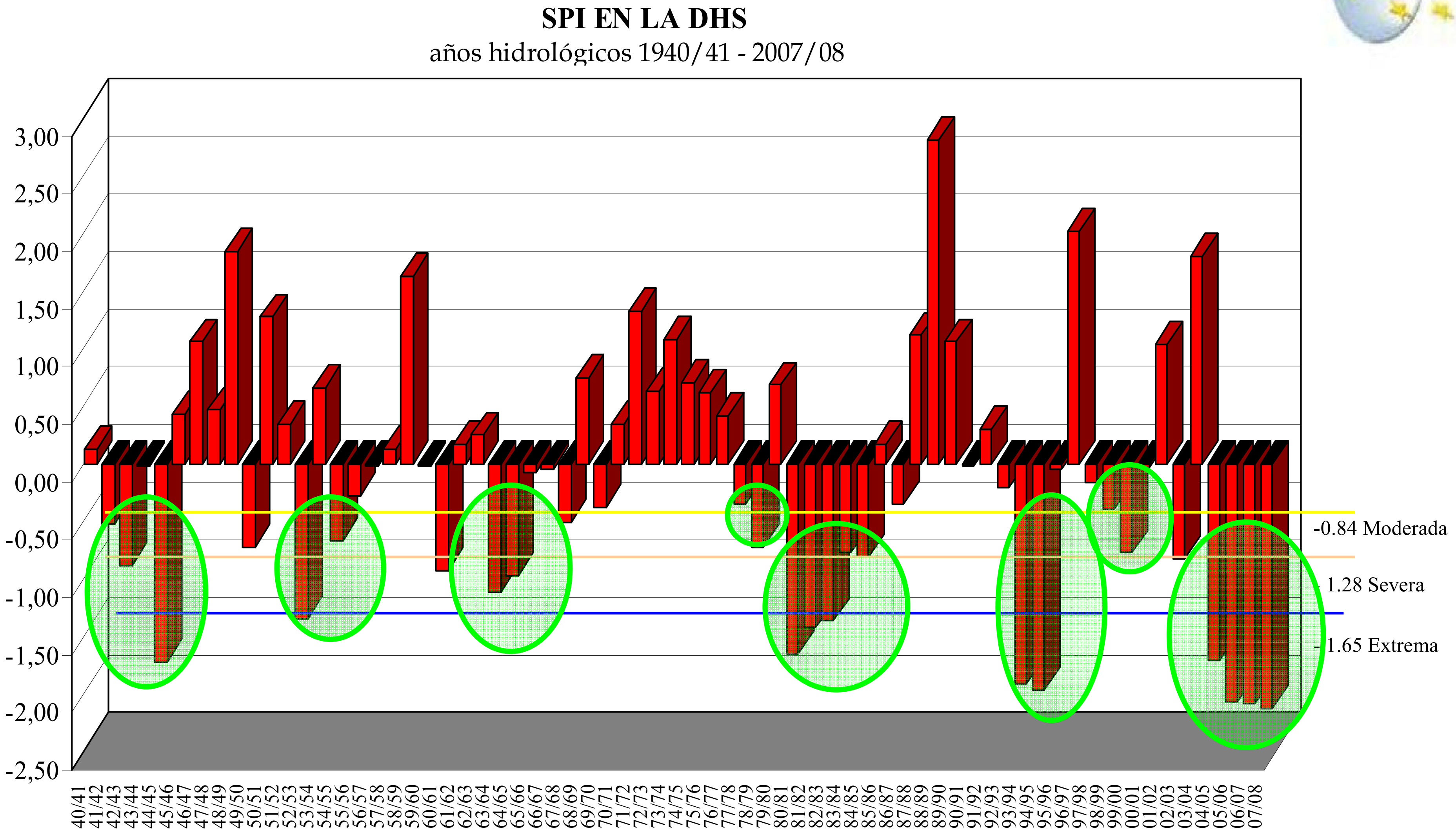
This information is available in the same web page.



February, 2010

August, 2010

2. Indicators: 2.3 Others - SPI



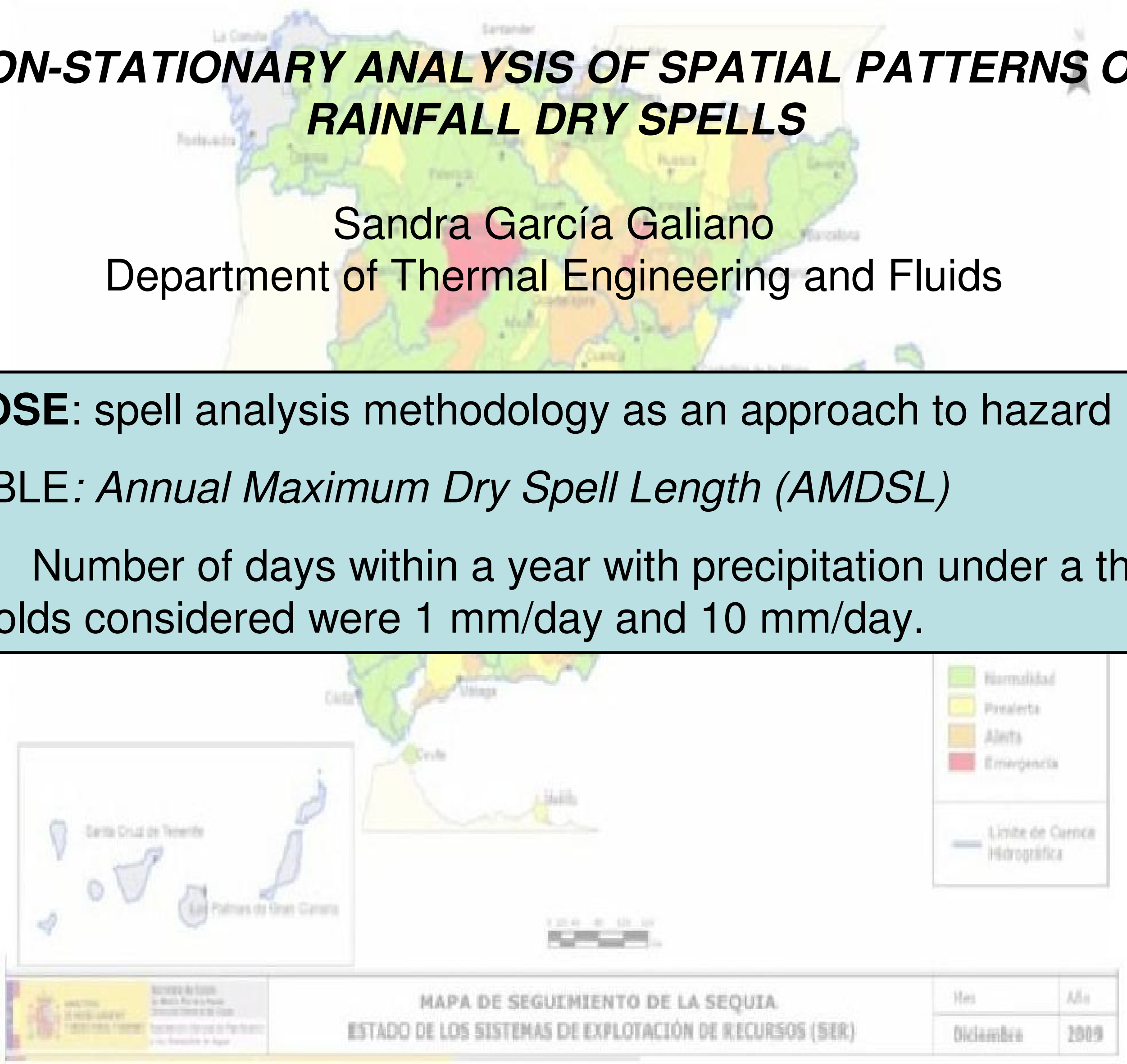
SPI EN LA DHS

años hidrológicos 1940/41 - 2007/08

MAPA DE SEGUIMIENTO DE LA SEQUIA
ESTADO DE LOS SISTEMAS DE EXPLOTACIÓN DE RECURSOS (SER)

Mes	Año
Diciembre	2009

2. Indicators: 2.3 Technical University of Cartagena



NON-STATIONARY ANALYSIS OF SPATIAL PATTERNS OF RAINFALL DRY SPELLS

Sandra García Galiano
Department of Thermal Engineering and Fluids

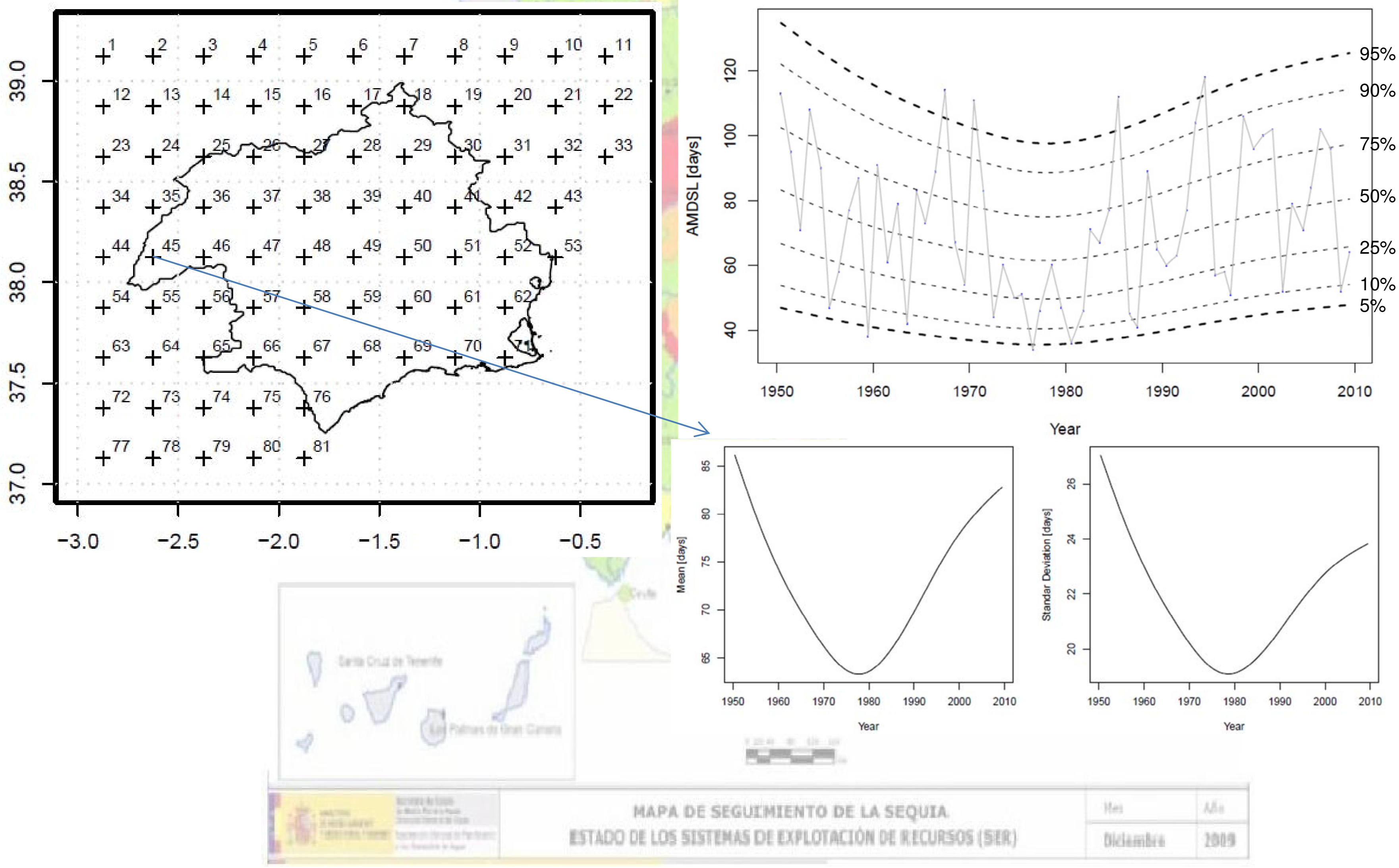
PURPOSE: spell analysis methodology as an approach to hazard maps.

VARIABLE*: Annual Maximum Dry Spell Length (AMDSL)*

Number of days within a year with precipitation under a threshold. Thresholds considered were 1 mm/day and 10 mm/day.

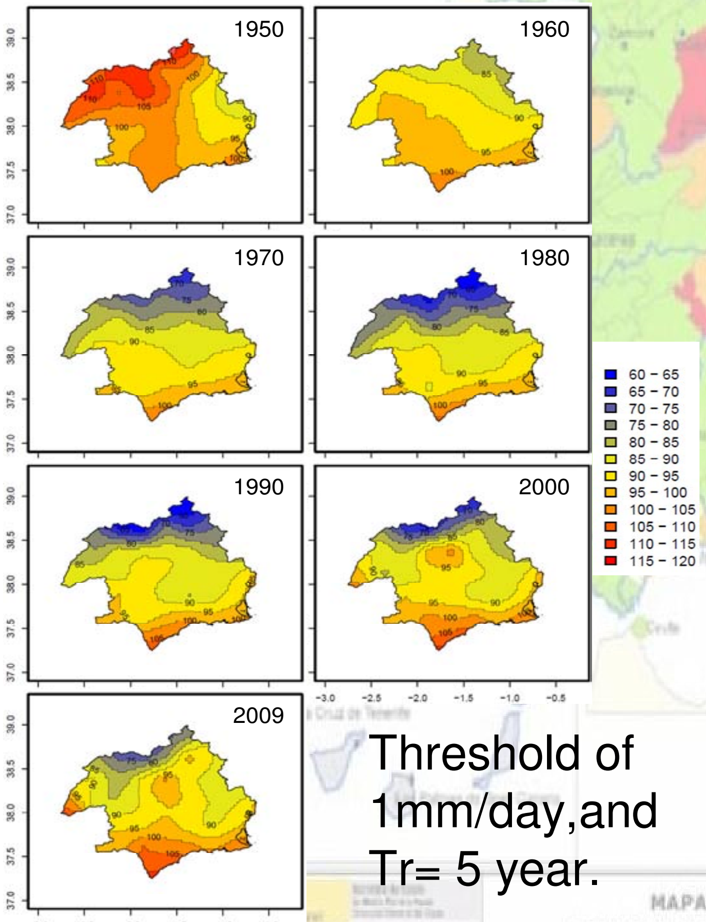
AMDSL analysis

Example of **GAMLSS** applied to AMDSL, on site 45 head-basin of Segura River. Threshold 1 mm/day

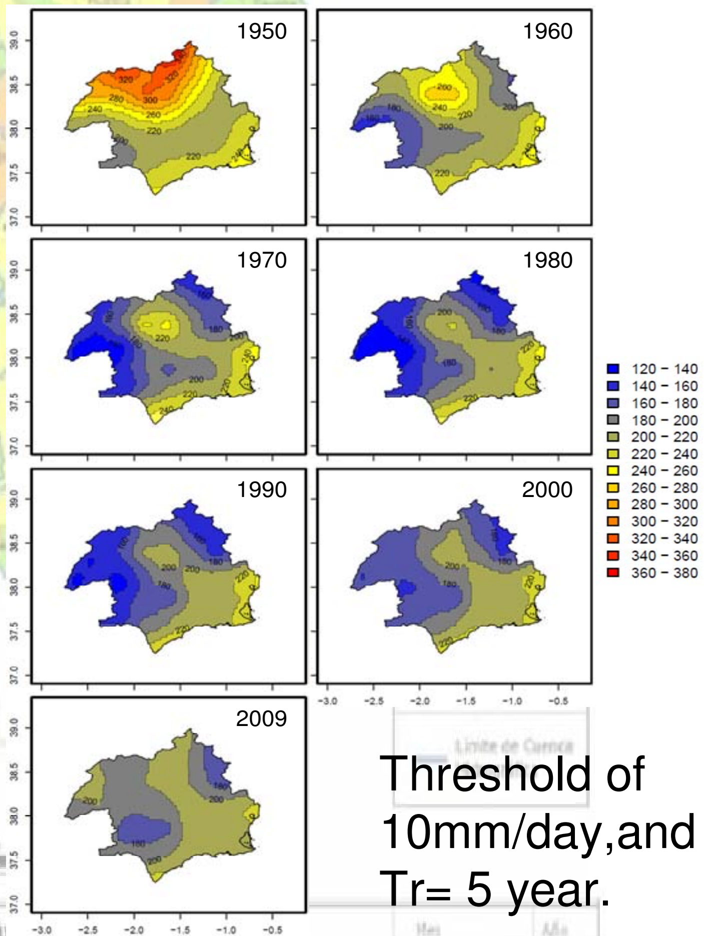


2. Indicators: 2.3 Technical University of Cartagena

From the GAMLSS analysis applied to AMDSL series, it is possible to build maps associated to several *Tr* (return period)= 1/*P* [*X*>*x*], for selected years (or time horizons). Considering threshold of 1mm/day and 10 mm/day, and Tr 2, 5 and 10 years.

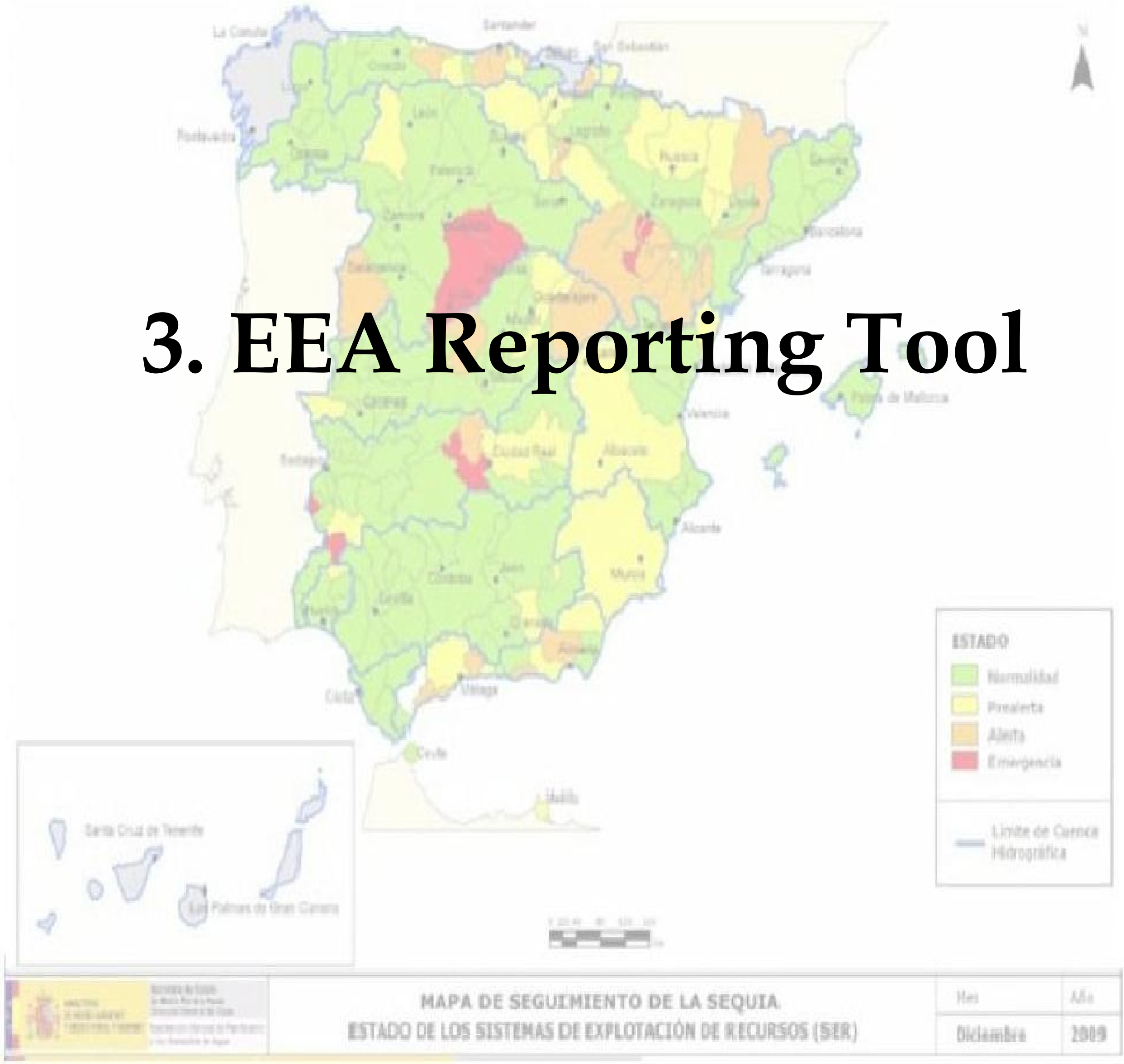


Threshold of 1mm/day,and Tr= 5 year.



Threshold of 10mm/day,and Tr= 5 year.

3. EEA Reporting Tool



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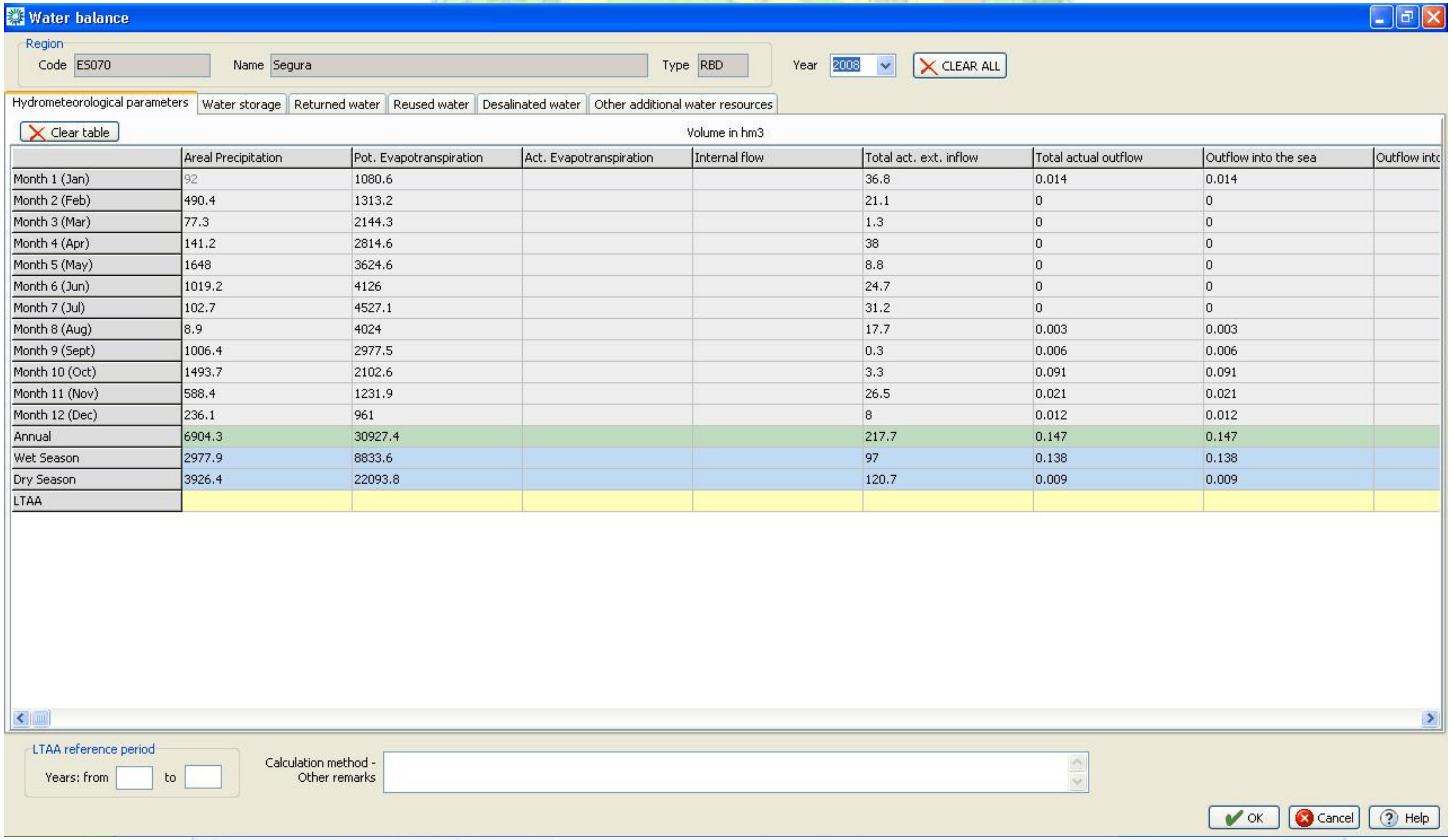
CONFEDERACIÓN HIDROGRÁFICA DEL SEGURA

3. EEA Reporting Tool

The Segura River Basin has provided the information requested by the EEA, although these information might be revised after the WMP approval.



Region

Code: ES070 Name: Segura Type: RBD Year: 2008

Volume in hm3

	Areal Precipitation	Pot. Evapotranspiration	Act. Evapotranspiration	Internal flow	Total act. ext. inflow	Total actual outflow	Outflow into the sea	Outflow int
Month 1 (Jan)	92	1080.6			36.8	0.014	0.014	
Month 2 (Feb)	490.4	1313.2			21.1	0	0	
Month 3 (Mar)	77.3	2144.3			1.3	0	0	
Month 4 (Apr)	141.2	2814.6			38	0	0	
Month 5 (May)	1648	3624.6			8.8	0	0	
Month 6 (Jun)	1019.2	4126			24.7	0	0	
Month 7 (Jul)	102.7	4527.1			31.2	0	0	
Month 8 (Aug)	8.9	4024			17.7	0.003	0.003	
Month 9 (Sept)	1006.4	2977.5			0.3	0.006	0.006	
Month 10 (Oct)	1493.7	2102.6			3.3	0.091	0.091	
Month 11 (Nov)	588.4	1231.9			26.5	0.021	0.021	
Month 12 (Dec)	236.1	961			8	0.012	0.012	
Annual	6904.3	30927.4			217.7	0.147	0.147	
Wet Season	2977.9	8833.6			97	0.138	0.138	
Dry Season	3926.4	22093.8			120.7	0.009	0.009	
LTAA								

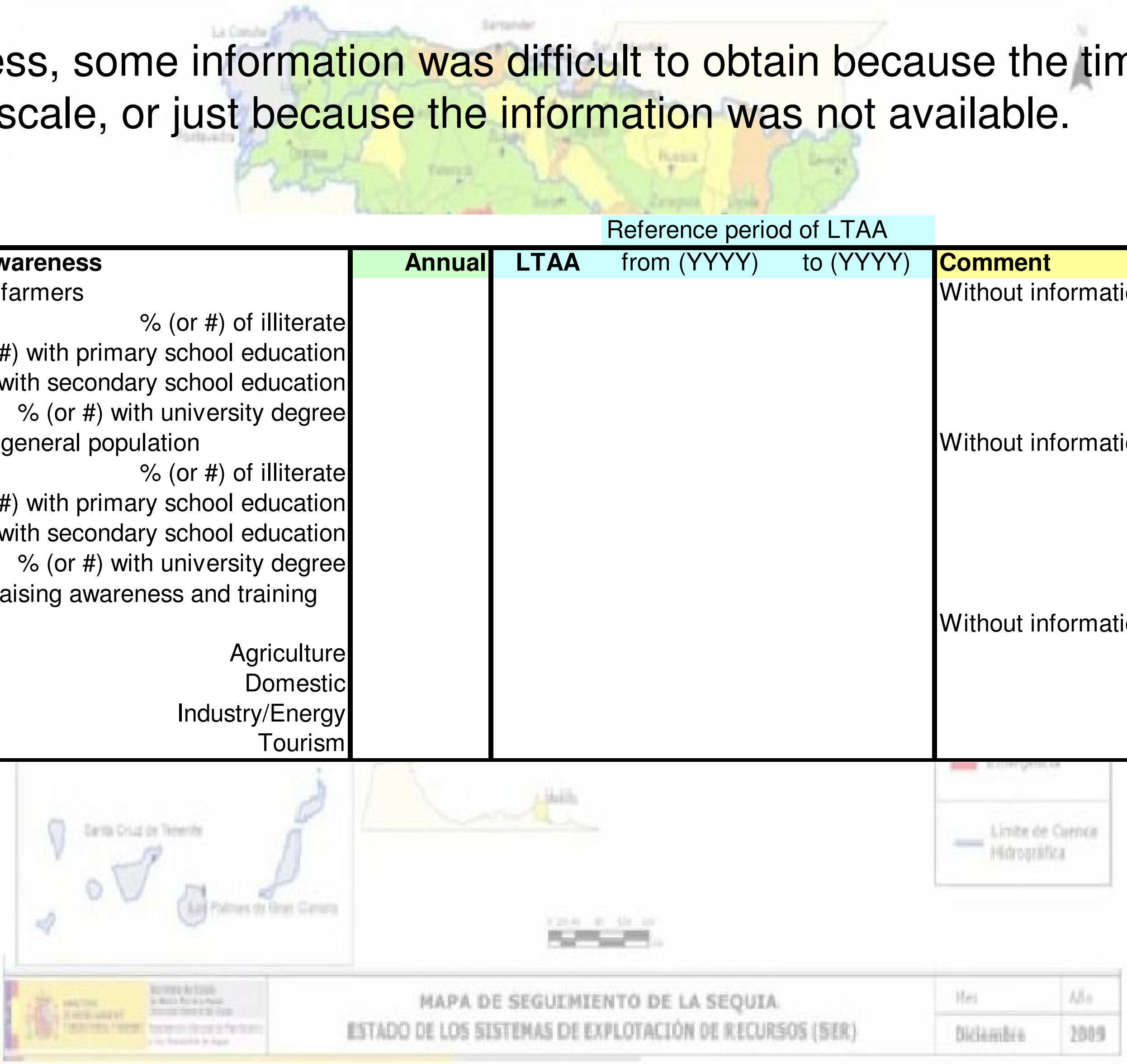
LTAA reference period

Years: from ____ to ____

Calculation method - Other remarks: ____

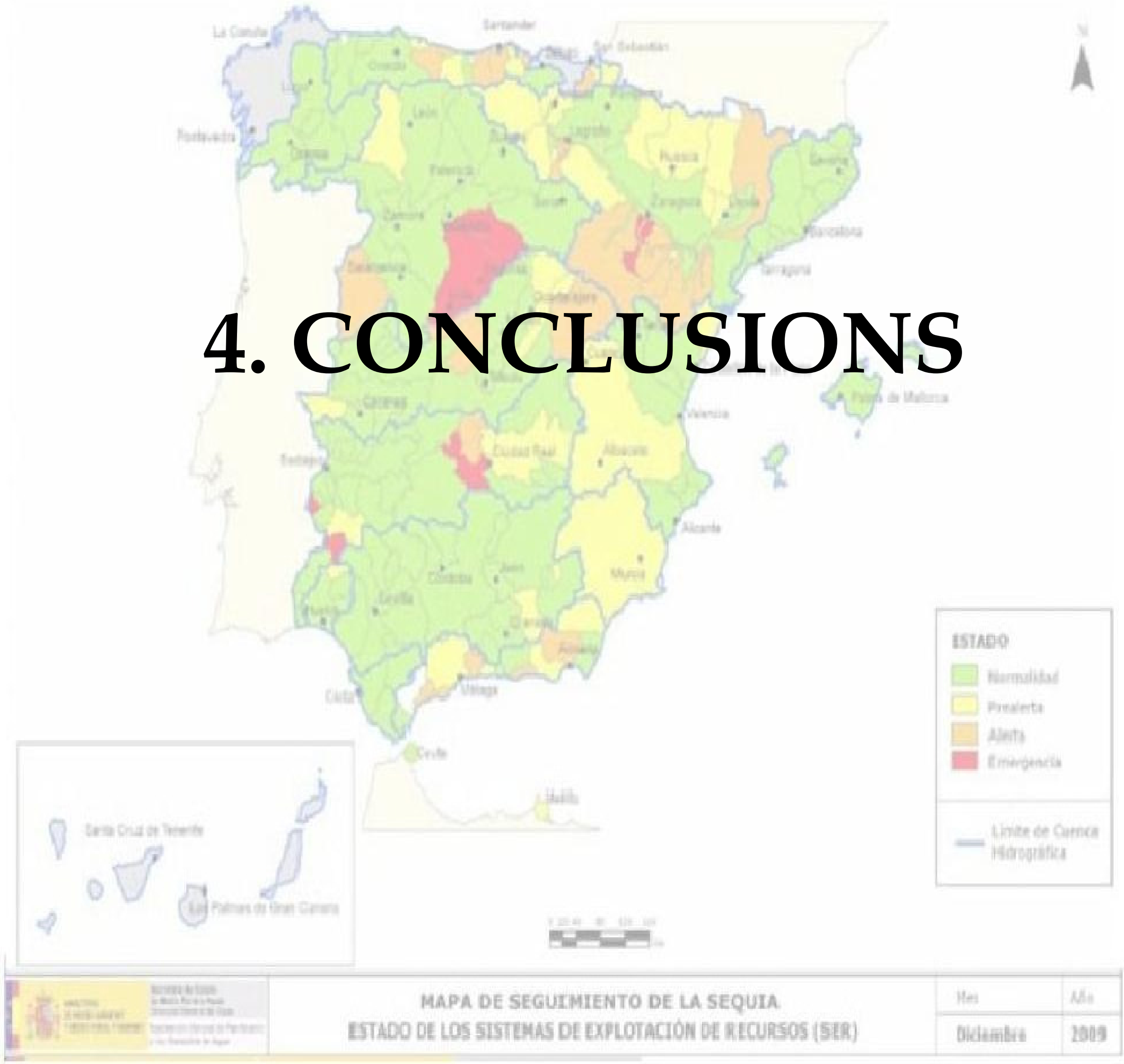
3. EEA Reporting Tool

Nevertheless, some information was difficult to obtain because the time scale, the space scale, or just because the information was not available.

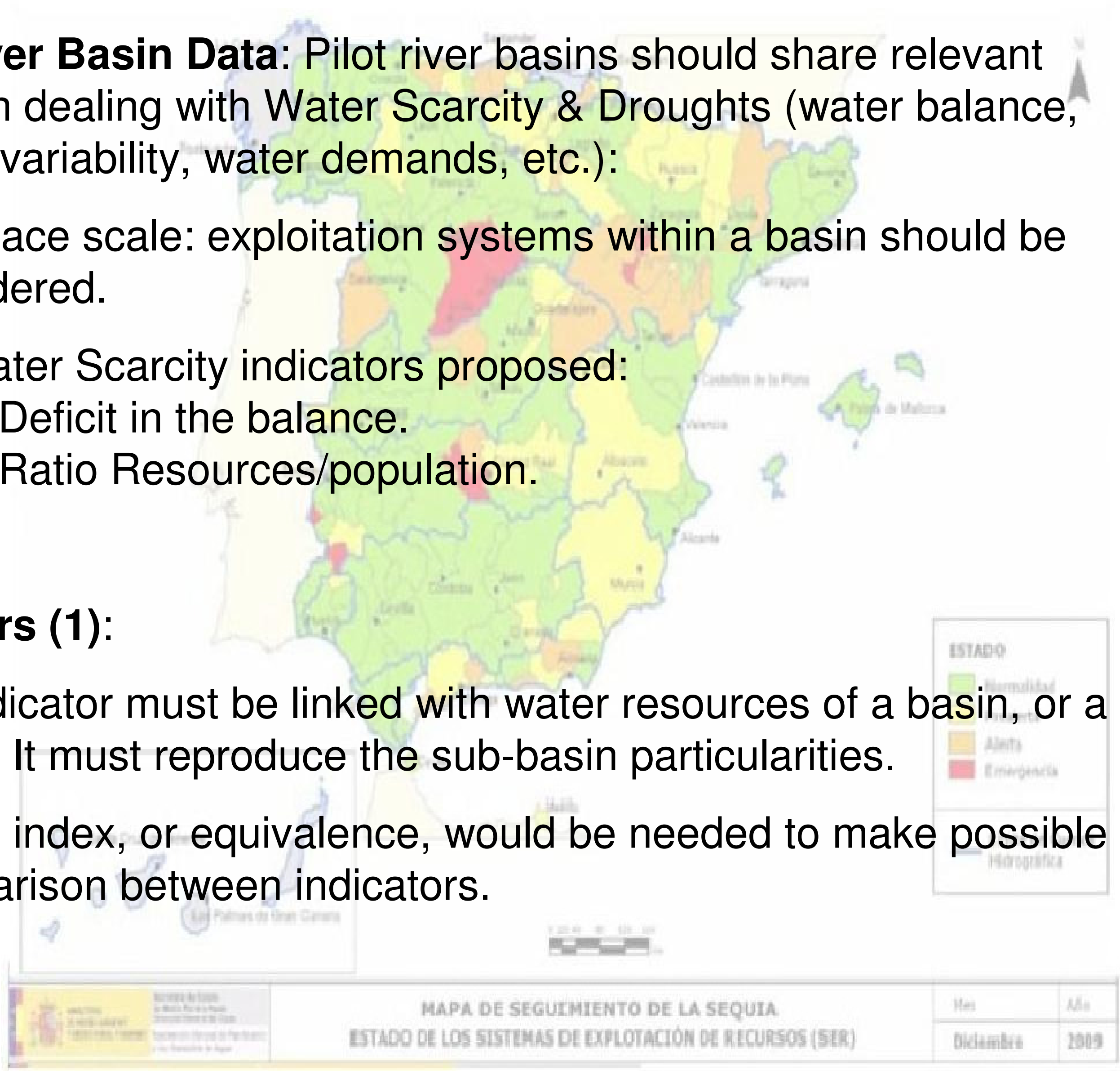


			Reference period of LTAA		
Education and Awareness	**Annual**	**LTAA**	from (YYYY)	to (YYYY)	**Comment**
Education level of farmers					Without information
% (or #) of illiterate					
% (or #) with primary school education					
% (or #) with secondary school education					
% (or #) with university degree					
Education level of general population					Without information at RBD scale
% (or #) of illiterate					
% (or #) with primary school education					
% (or #) with secondary school education					
% (or #) with university degree					
# of programmes raising awareness and training initiatives					Without information at RBD scale
Agriculture					
Domestic					
Industry/Energy					
Tourism					

4. CONCLUSIONS



4. CONCLUSIONS

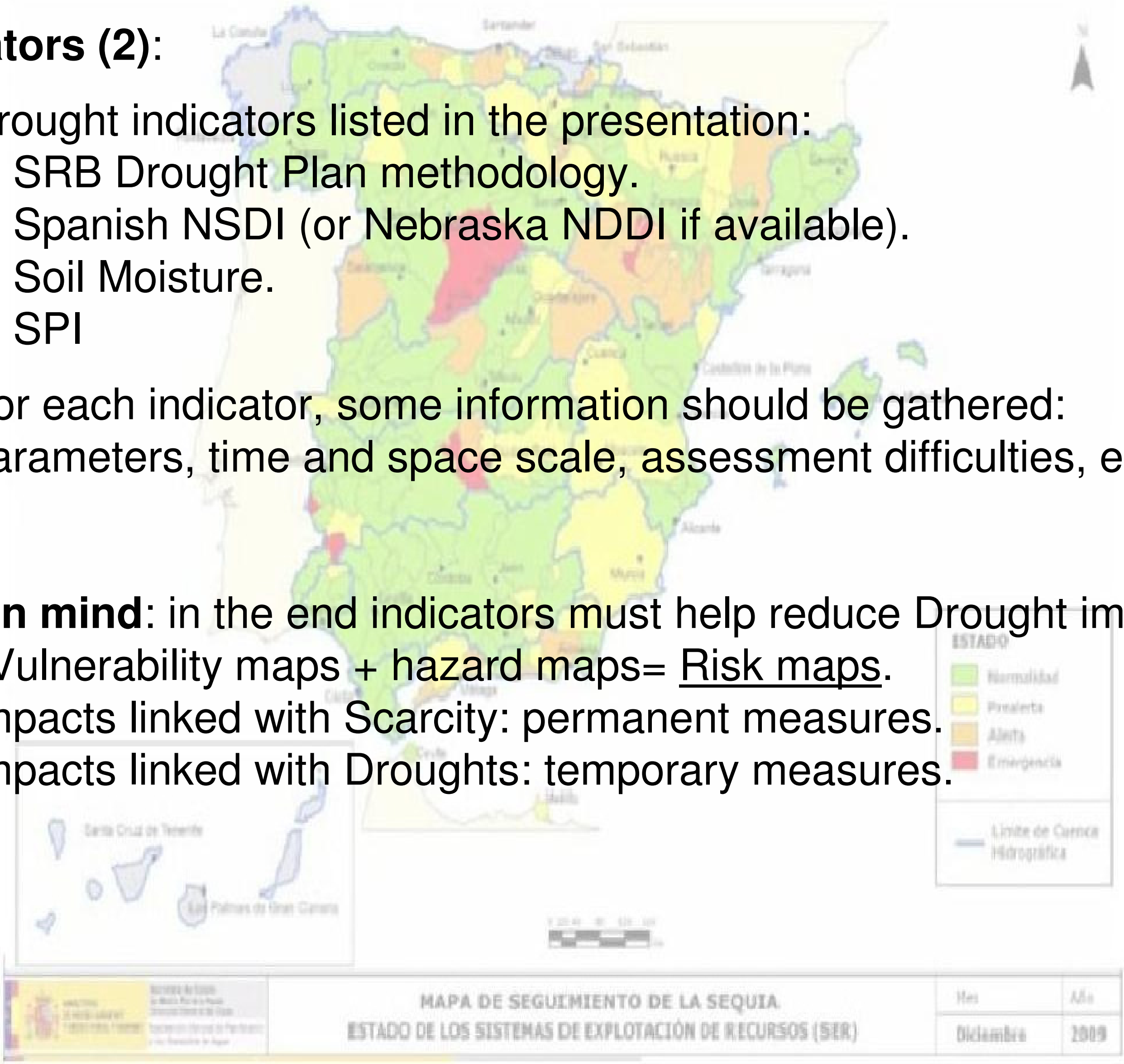


- **Pilot River Basin Data**: Pilot river basins should share relevant information dealing with Water Scarcity & Droughts (water balance, resources variability, water demands, etc.):
  - Space scale: exploitation systems within a basin should be considered.
  - Water Scarcity indicators proposed:
    - Deficit in the balance.
    - Ratio Resources/population.

- **Indicators (1)**:
  - Indicator must be linked with water resources of a basin, or a sub-basin. It must reproduce the sub-basin particularities.
  - An index, or equivalence, would be needed to make possible the comparison between indicators.

- **Indicators (2)**:
  - Drought indicators listed in the presentation:
    - SRB Drought Plan methodology.
    - Spanish NSDI (or Nebraska NDDI if available).
    - Soil Moisture.
    - SPI
  - For each indicator, some information should be gathered: parameters, time and space scale, assessment difficulties, etc.

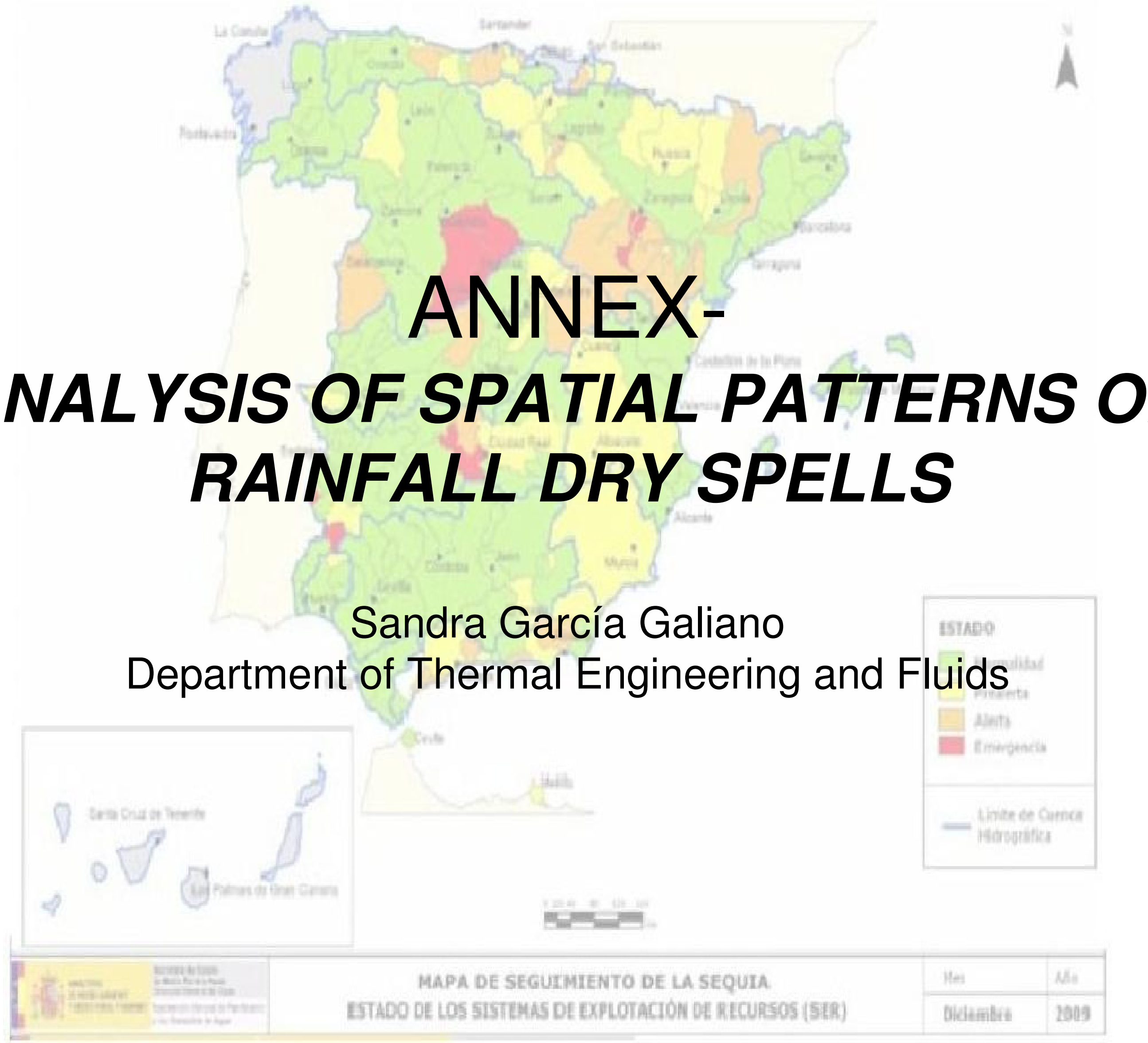
To keep in mind: in the end indicators must help reduce Drought impacts.
Vulnerability maps + hazard maps= <u>Risk maps</u>.
Impacts linked with Scarcity: permanent measures.
Impacts linked with Droughts: temporary measures.



THANKS FOR YOUR ATTENTION

For further information, please visit: http://www.chsegura.es

or contact me: adolfo.merida@chsegura.es



ANNEX-

ANALYSIS OF SPATIAL PATTERNS OF RAINFALL DRY SPELLS

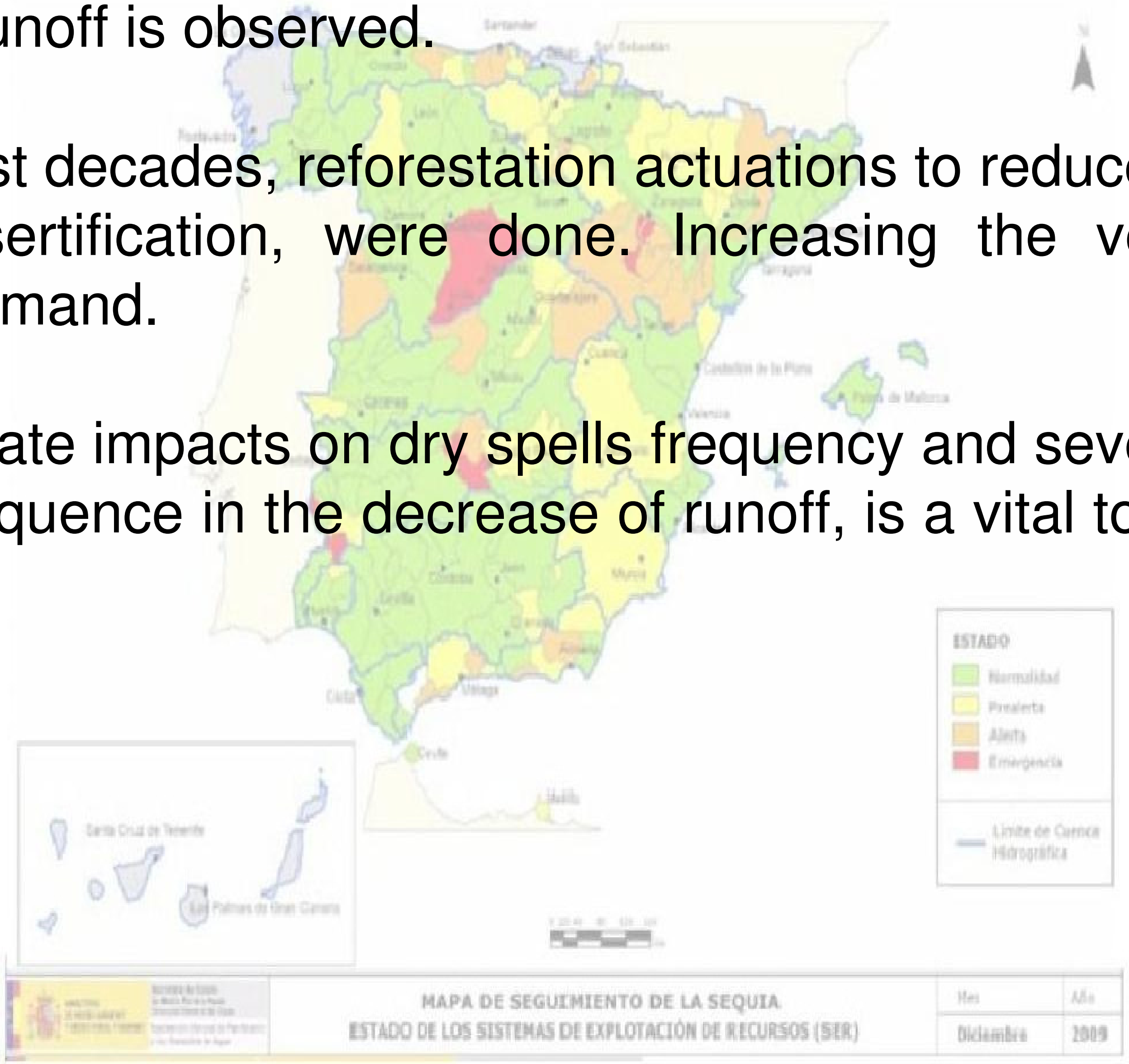
Sandra García Galiano
Department of Thermal Engineering and Fluids

Introduction

In Spanish South-East basins, a decreasing in the head-basins runoff is observed.

In the last decades, reforestation actuations to reduce erosion and desertification, were done. Increasing the vegetation water demand.

The climate impacts on dry spells frequency and severity, and in consequence in the decrease of runoff, is a vital topic to be studied.

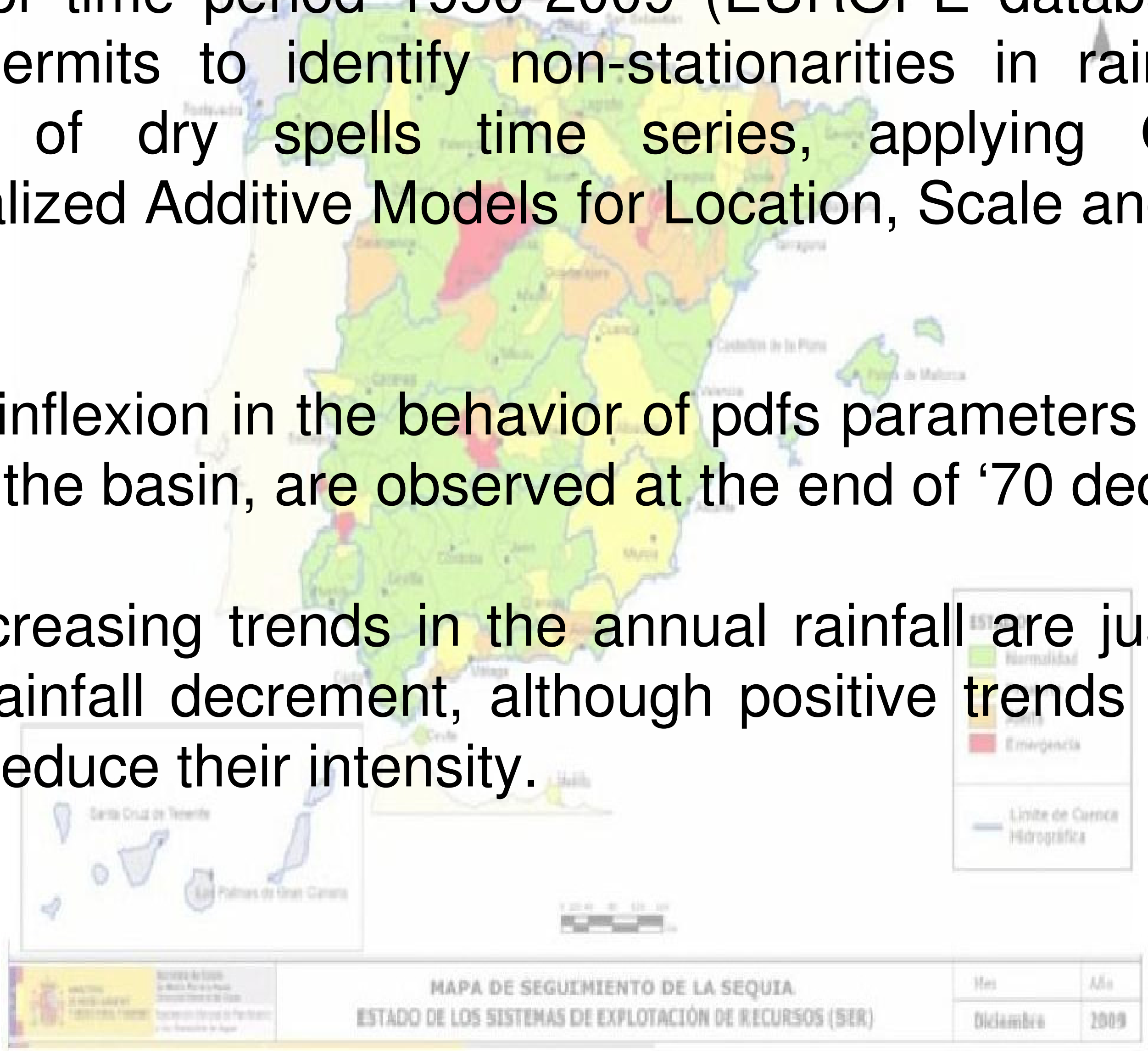


Introduction

In base to observed daily data of rainfall grids (Haylock et al., 2008) for time period 1950-2009 (EUROPE database), the study permits to identify non-stationarities in rainfall and lengths of dry spells time series, applying GAMLSS (Generalized Additive Models for Location, Scale and Shape) models.

A clear inflexion in the behavior of pdfs parameters in some parts of the basin, are observed at the end of '70 decade.

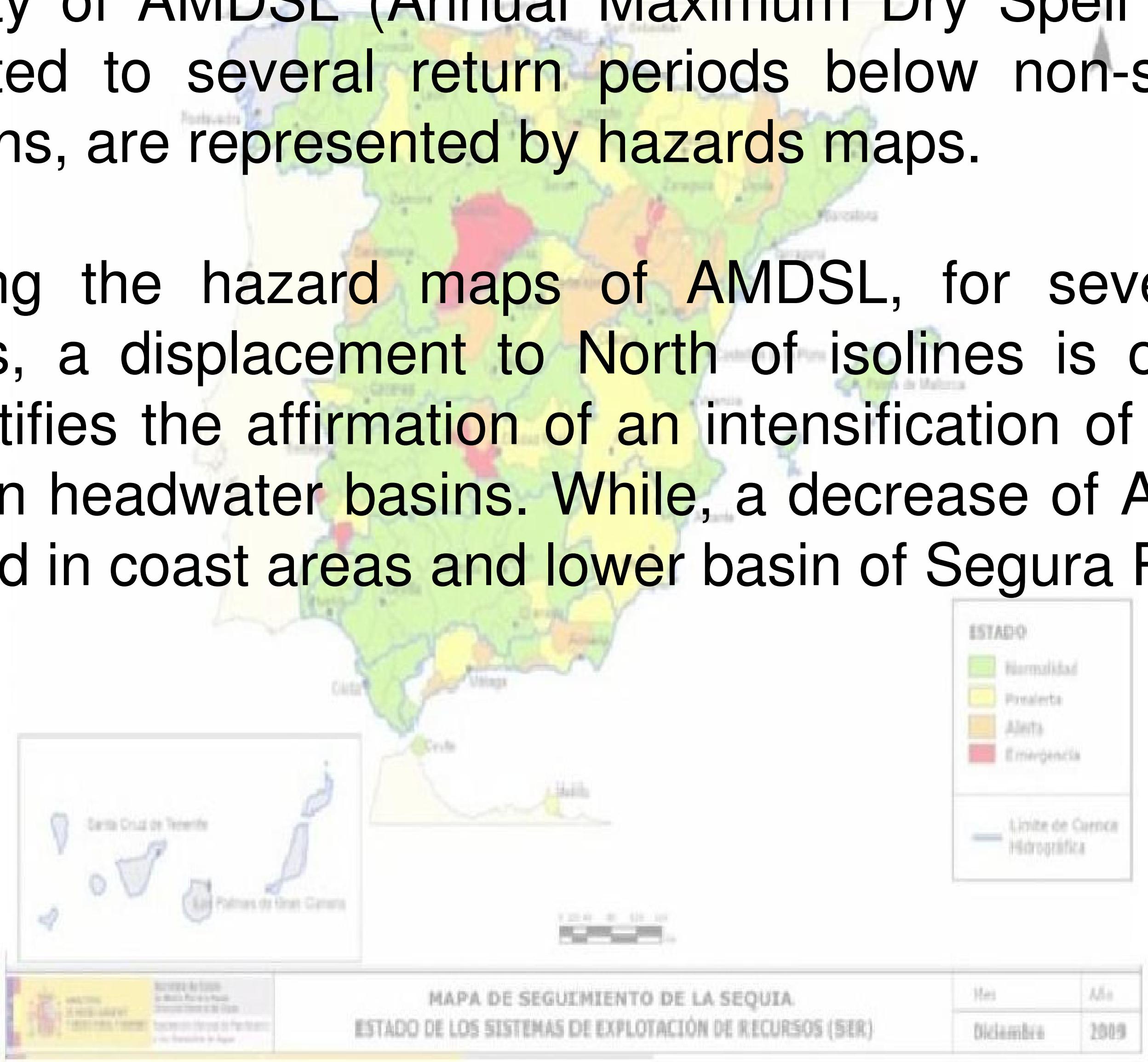
The decreasing trends in the annual rainfall are justified by winter rainfall decrement, although positive trends of spring rainfall reduce their intensity.



Introduction

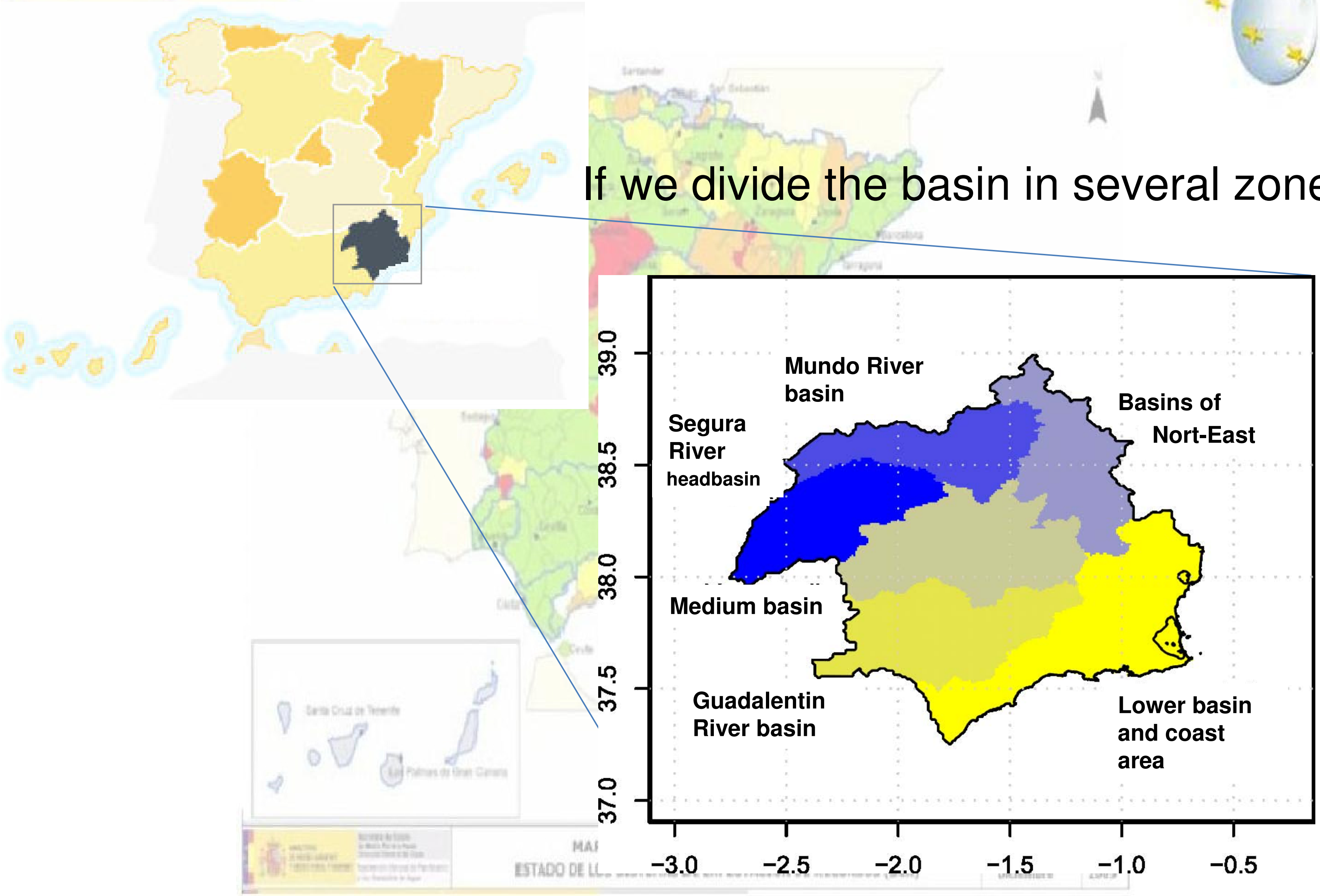
On base of GAMLSS results for selected sites, the spatial variability of AMDSL (Annual Maximum Dry Spell Lengths) associated to several return periods below non-stationary conditions, are represented by hazards maps.

Analyzing the hazard maps of AMDSL, for several time horizons, a displacement to North of isolines is observed. This justifies the affirmation of an intensification of droughts events in headwater basins. While, a decrease of AMDSL is observed in coast areas and lower basin of Segura River.

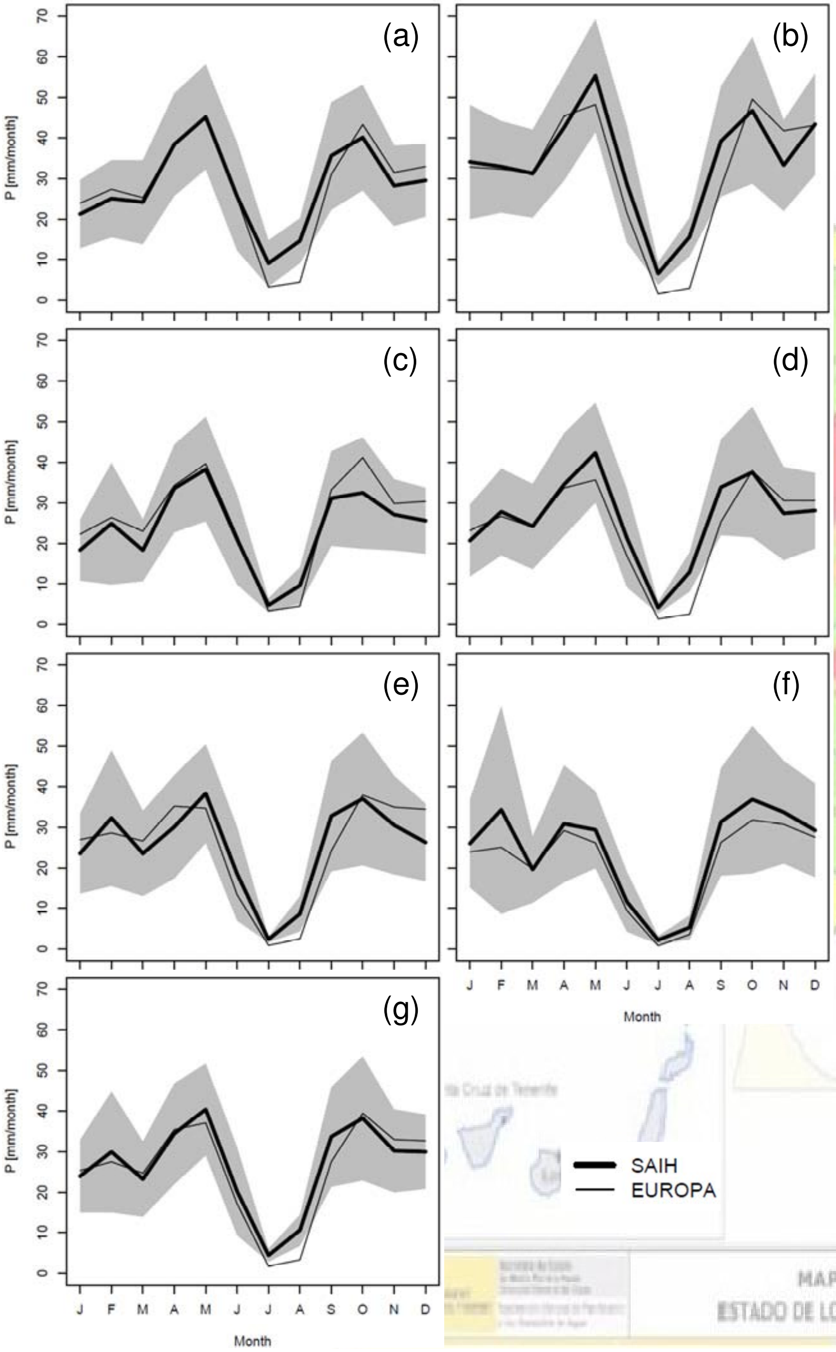


Study region

If we divide the basin in several zones,



Seasonal cycle of rainfall. Time period 1992-2009

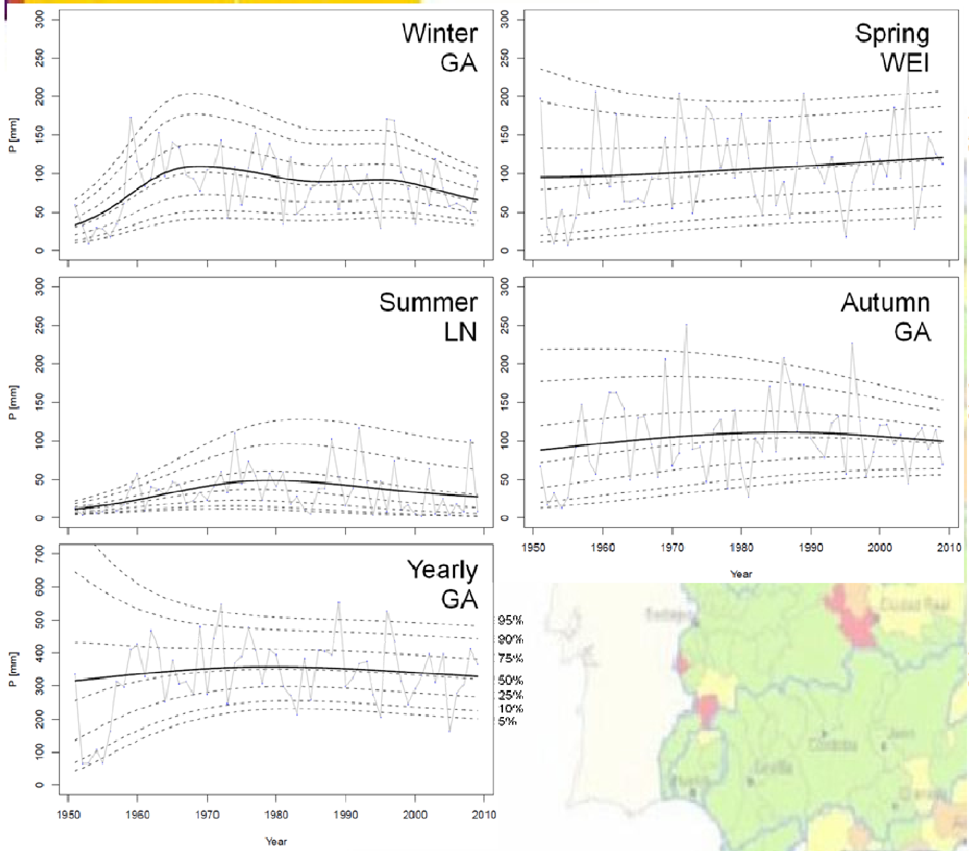


Bimodal behavior of rainfall, with maximum on spring and autumn. On head-basins, important winter precipitation component is observed.

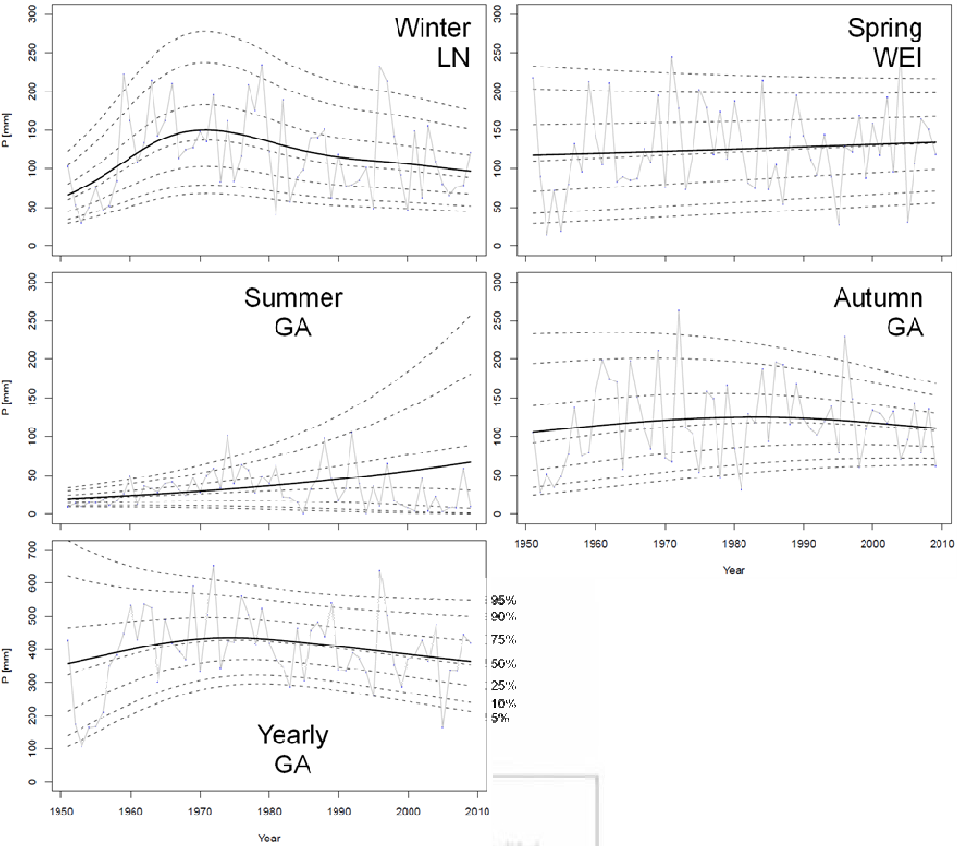
SAIH data and database EUROPE: (a) Segura River head-basin, (b) Mundo River basin, (c) Basins of North-East, (d) Medium basins, (e) Guadalentín River basin, (f) Lower basin and coast areas, and (g) Whole Segura River basin. The grey area represents the confidence interval of 95 % estimated from SAIH data.

GAMLSS analysis of annual and seasonal rainfall. Time period 1950-2009

Segura River head-basin



Mundo River basin

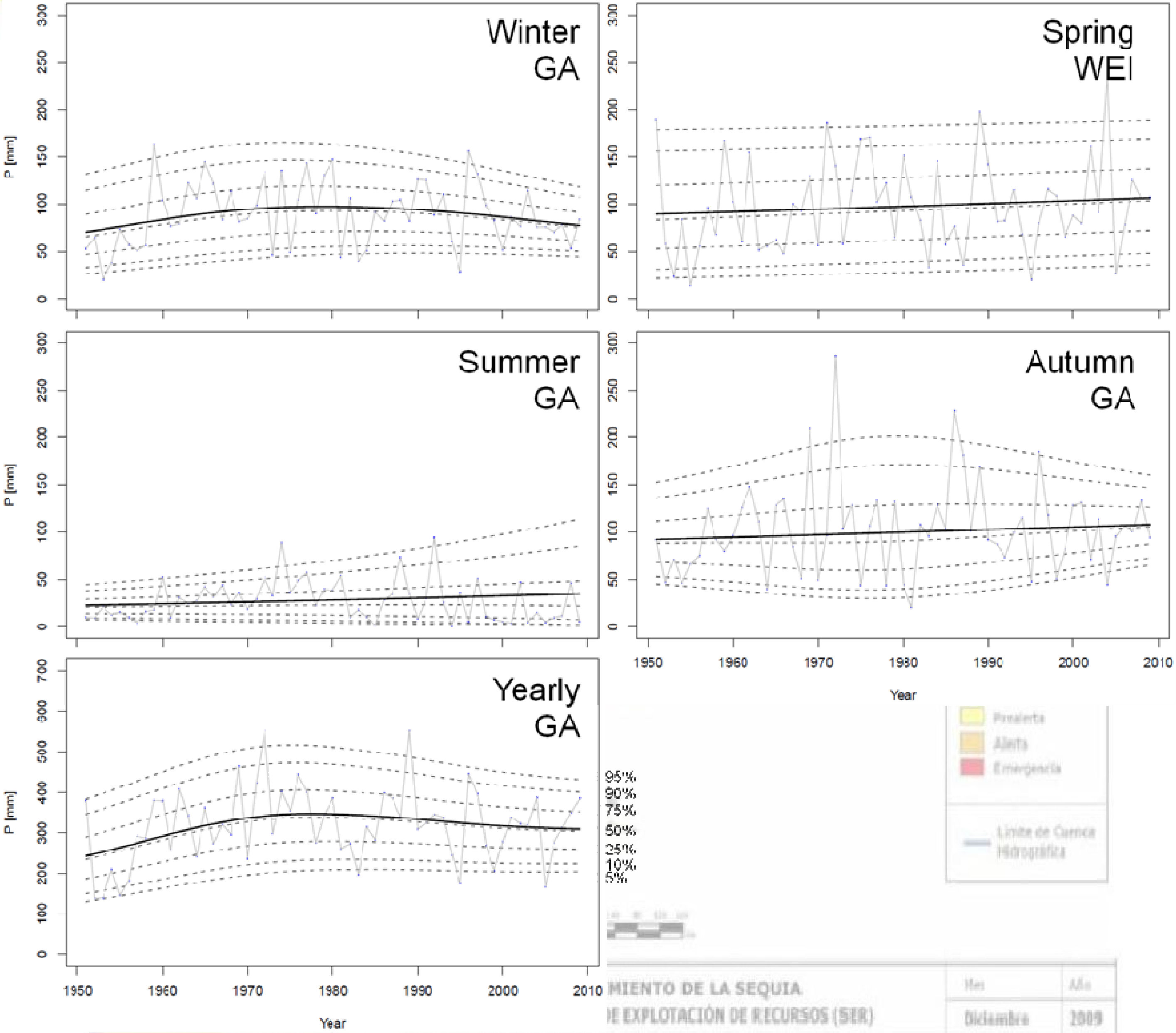


Applying GAMLSS, to EUROPE database for time period 1950-2009,

- Seasonal rainfall. In general, decrease of winter rainfall from ‘80 decade (with exception of North-East basins, Medium basin and Lower basin and coast areas). Spring rainfall denotes slow increasing trend. Autumn rainfall, increasing trend before ‘80 decade, then without significant trend.
- Annual rainfall. Without significant trends from ‘80 decade. On head-basins (Mundo River, Segura River and Guadalentín river), slow decrease trends from ‘80 decade.

GAMLSS analysis of annual and seasonal rainfall. Time period 1950-2009

Whole Segura River Basin



Prealerta
Alerta
Emergencia

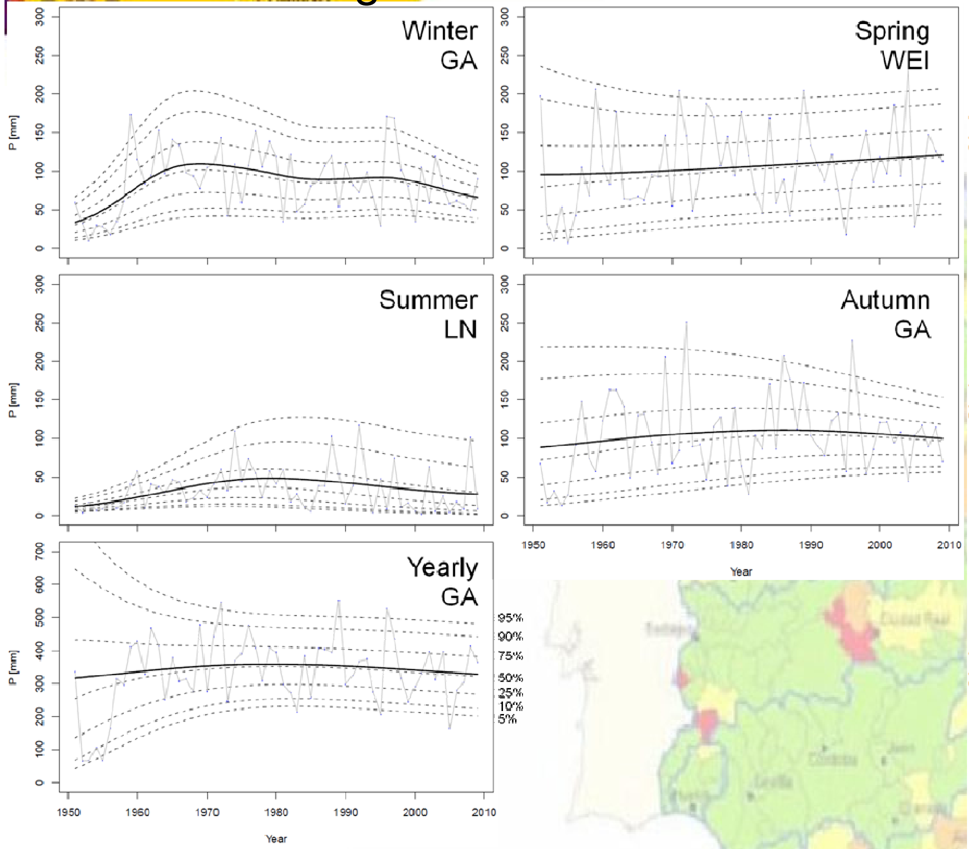
Límite de Cuenca Hidrográfica

MIENTO DE LA SEQUIA
DE EXPLOTACIÓN DE RECURSOS (SER)

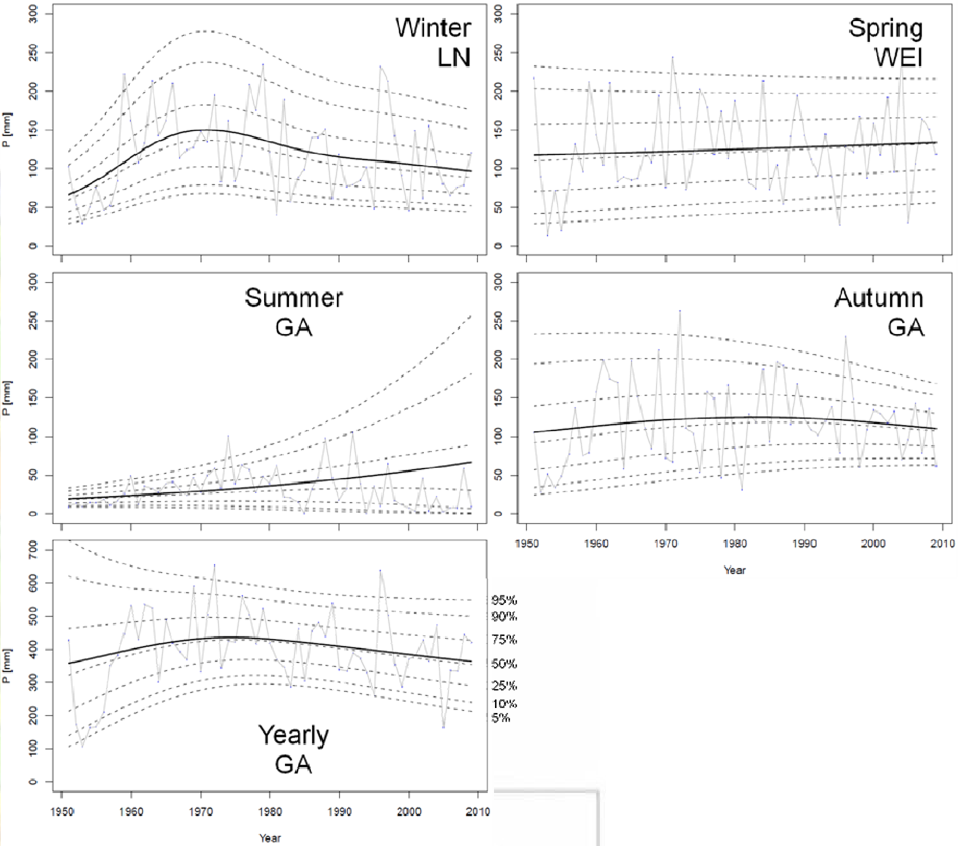
Mes	Año
Diciembre	2009

Analysis of annual and seasonal rainfall. Time period 1950-2009

Segura River Basin



Mundo River Basin



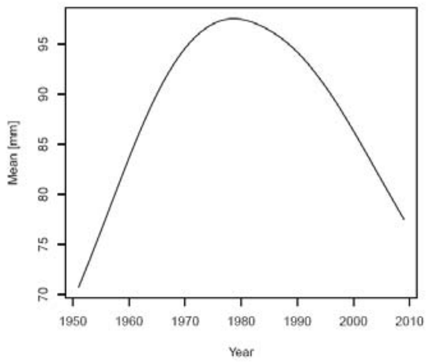
Applying GAMLSS to EUROPE database for time period 1950-2009,

- Seasonal rainfall. In general, decrease of winter rainfall from ‘80 decade (with exception of North-East basins, Medium basin and Lower basin and coast areas). Spring rainfall denotes slow increasing trend. Autumn rainfall, increasing trend before ‘80 decade, then without significant trend.
- Annual rainfall. Without significant trends from ‘80 decade. On head-basins (Mundo River, Segura River and Guadalentín river), slow decrease trends from ‘80 decade.

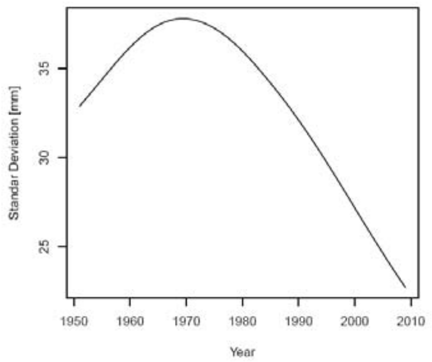
Analysis of time evolution of statistics of pdfs for Whole Segura River. Time period 1950-2009

Winter

Mean

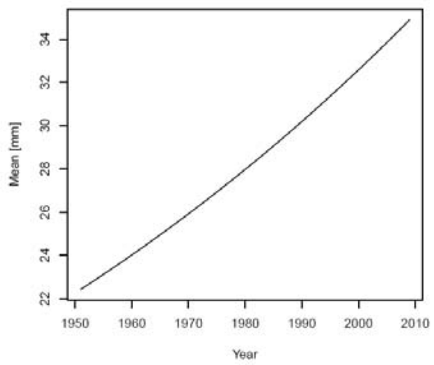


Standard deviation

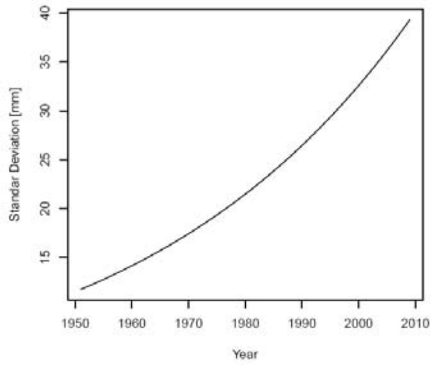


Summer

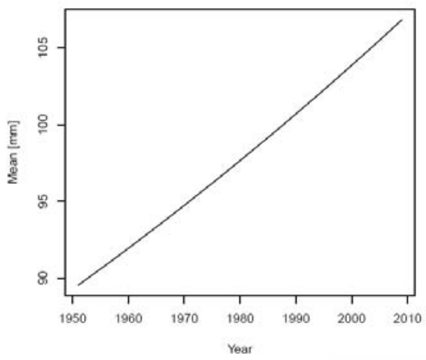
Mean

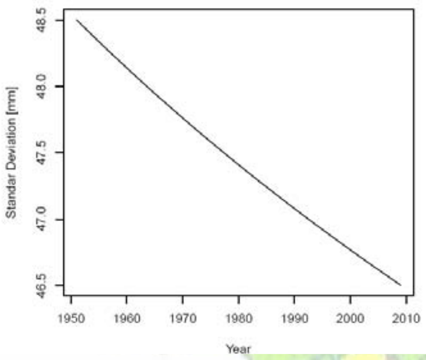


Standard deviation

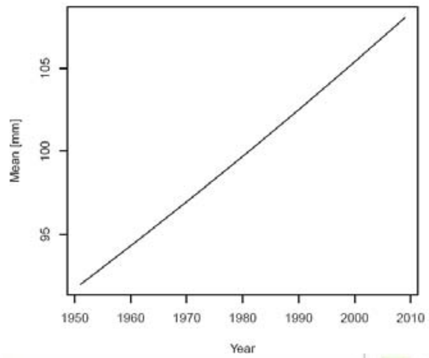


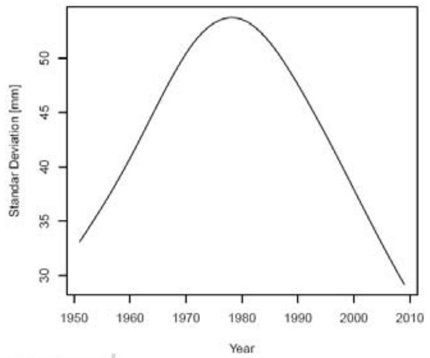
Spring



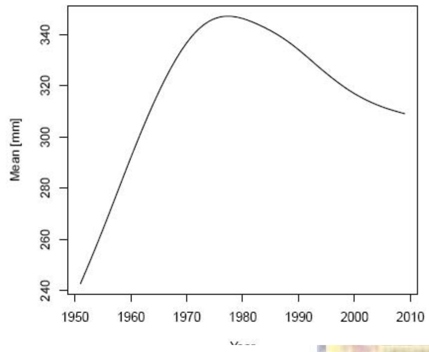


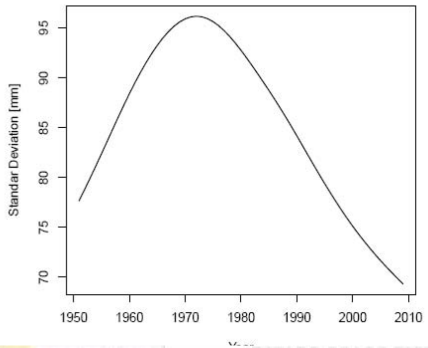
Autumn





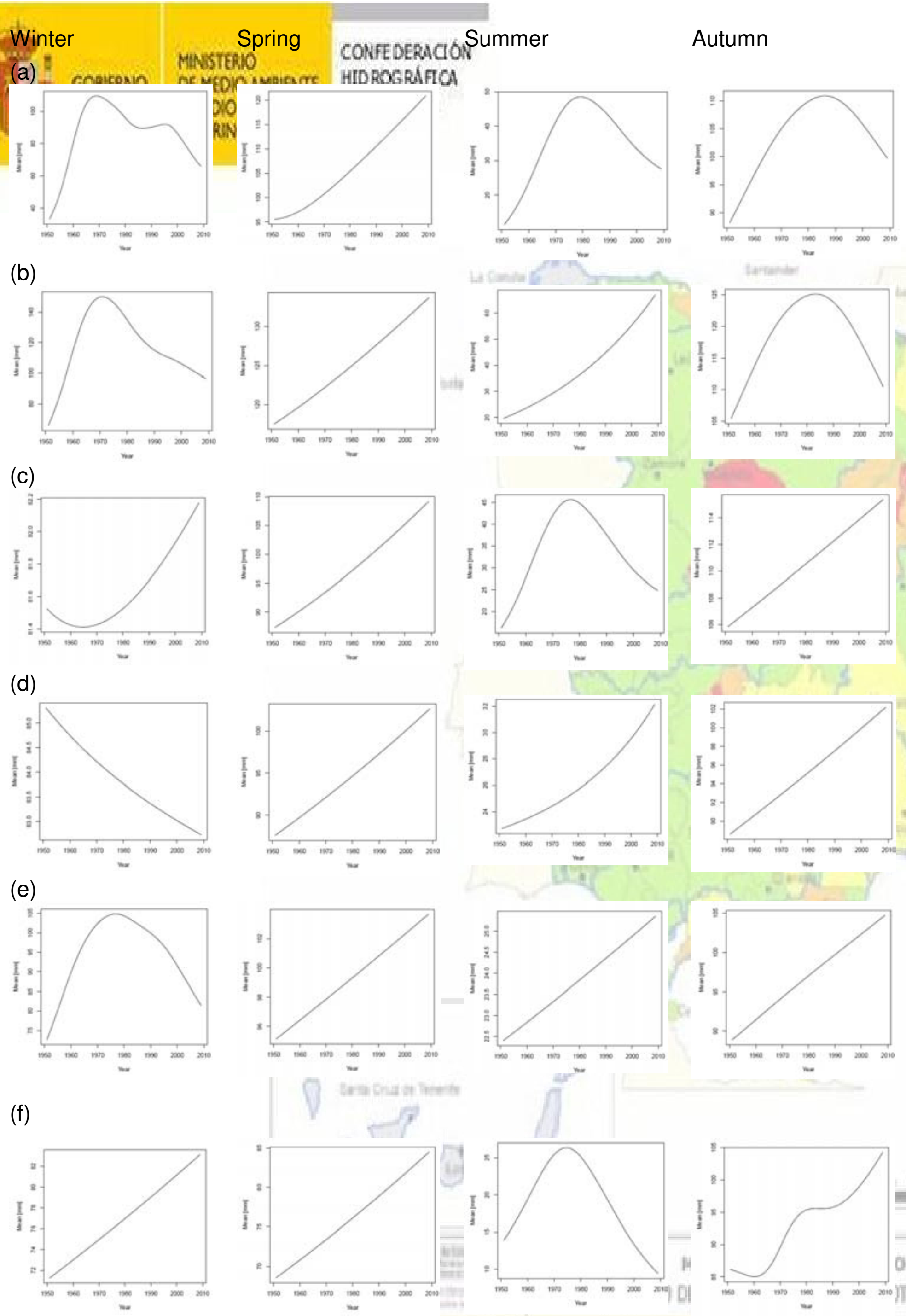
Annual





Applying GAMLSS to EUROPE database for time period 1950-2009, non-stationary behavior of statistics (mean and standard deviation) of pdfs, are observed. A non-lineal behavior of annual mean is clearly justified by the winter mean.

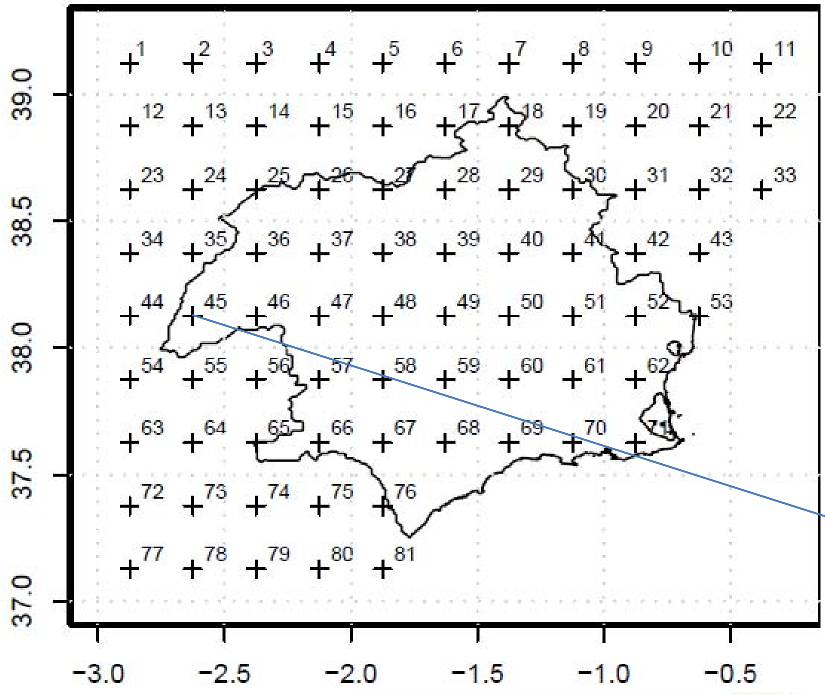
Variation of mean statistic of pdfs



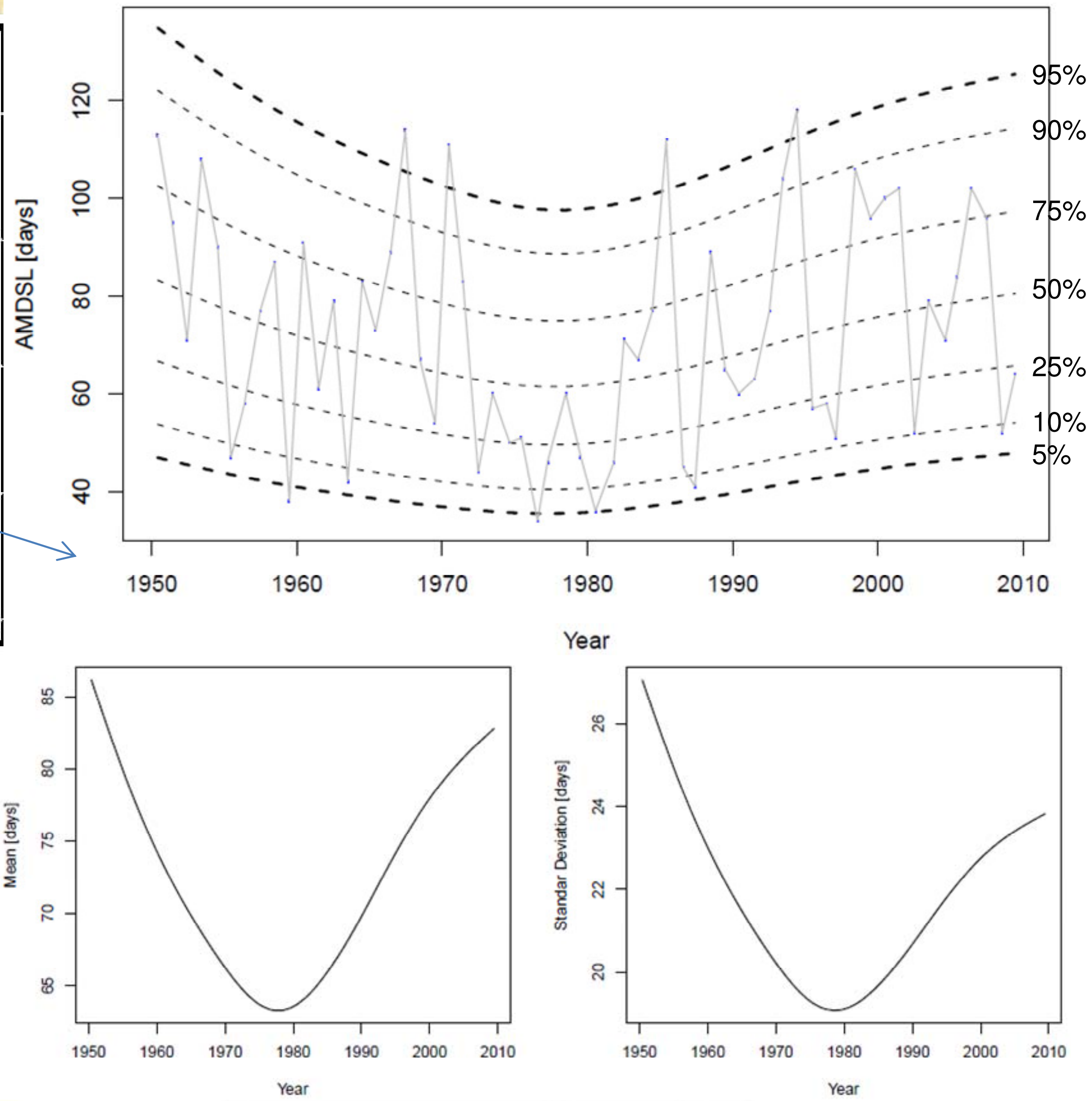
GAMLSS to Europe database, time period 1950-2009: (a) Segura River head-basin, (b) Mundo River basin, (c) Basins of North-East, (d) Medium basins, (e) Guadalentín River basin, (f) Lower basin and coast areas, and (g) Whole Segura River basin.

Analysis of AMDSL by GAMLSS
Europe database, time period 1950-2009,

AMDSL analysis considering thresholds of 1 mm and 10 mm/day

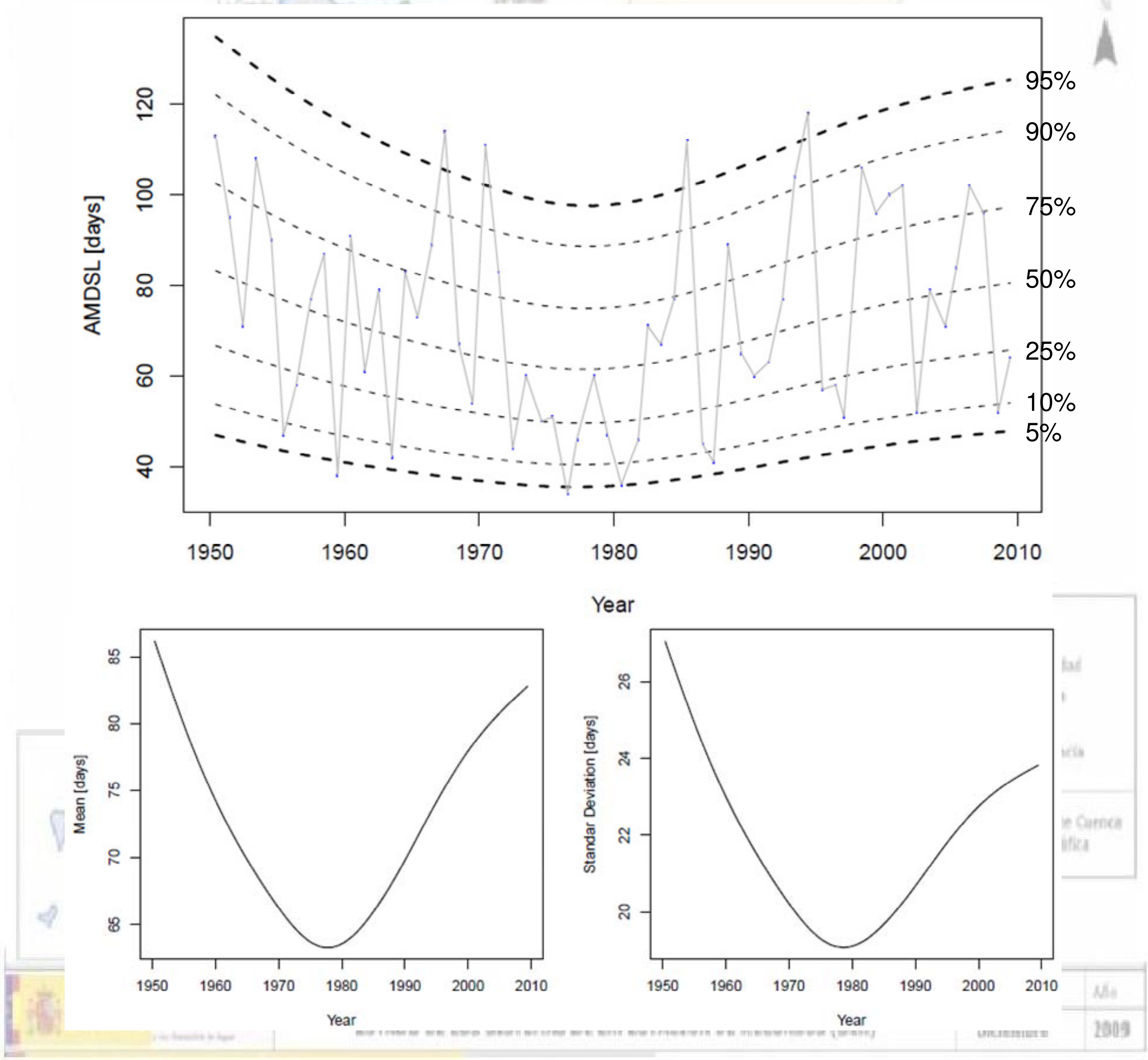


Example of GAMLSS applied to AMDSL, on site 45 head-basin of Segura River. Threshold 1 mm/day



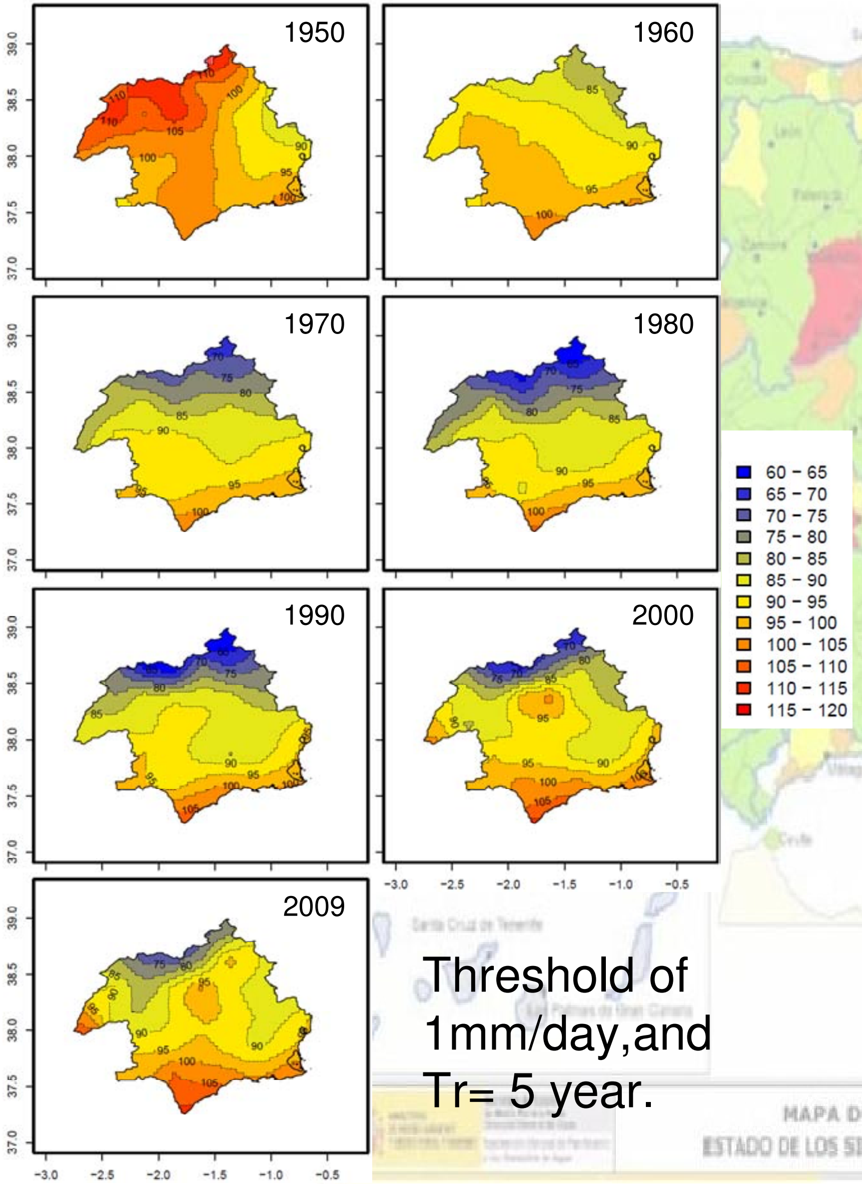
Analysis of AMDSL by GAMLSS
Europe database, time period 1950-2009,

AMDSL analysis considering threshold of 10 mm/day. Example of GAMLSS applied to site 45 head-basin of Segura River.

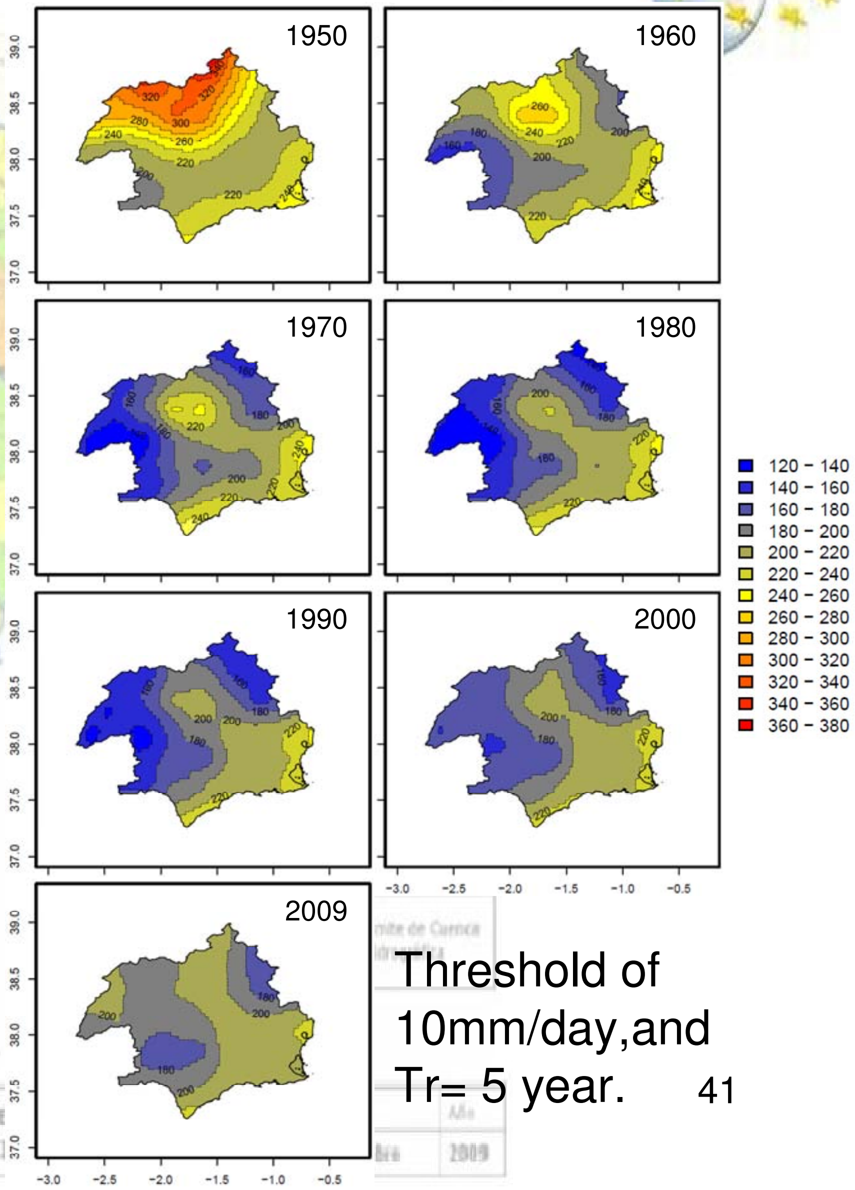


Building hazard maps of AMDSL by GAMLSS. Europe database, period 1950-2009

From the GAMLSS analysis applied to AMDSL series, it is possible to build maps associated to several *Tr* (return period)= 1/*P* [*X*>*x*], for selected years (or time horizons). Considering threshold of 1mm/day and 10 mm/day, and Tr 2, 5 and 10 years.



Threshold of 1mm/day,and Tr= 5 year.



Threshold of 10mm/day,and Tr= 5 year.