Assessment of Multi-Scale Drought Datasets for Multi-Disciplinary Applications

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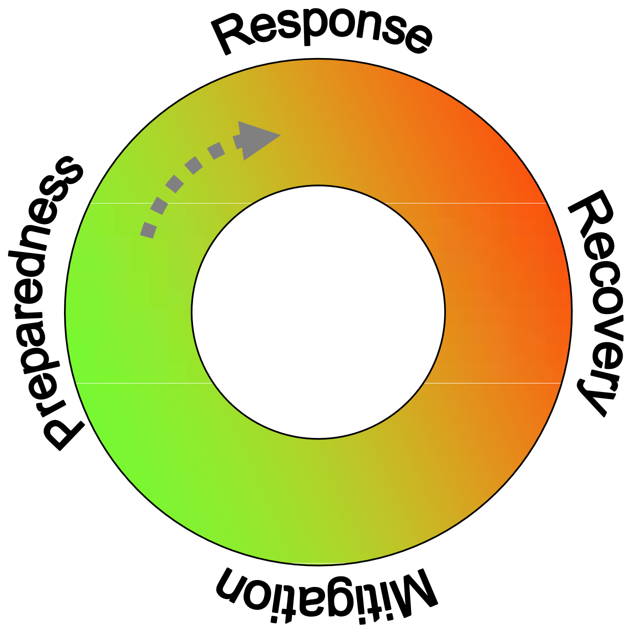
Introduction:

Drought is a period of deficient precipitation with high impacts on agriculture, water resources and on the natural ecosystems. Thus, drought is the natural hazard that affects large sectors with very negative consequences.

Nevertheless, most of the actions conducted to mitigate the negative effects of droughts belong to the response and recovery phases of the disaster management cycle, i.e. they are focused on alleviating the immediate effects of drought once the phenomenon has occurred and restoring the affected areas to their previous state.



Introduction:

These measures are very necessary, but are of limited effect in the long term since they can only cope with specific catastrophes; i.e., they hardly contribute to reducing the vulnerability of the affected societies to drought. In order to reduce the drought vulnerability of the affected societies, it is necessary to promote an integral conception of drought risk management. Hence, event-oriented actions need to be complemented by other measures focused on promoting drought risk mitigation and preparedness.

Two fundamental requisites for **reinforcing drought mitigation** and preparedness in the long term are:

i) an accurate drought risk assessment quantifying the degree of hazard and the vulnerability of the different regions;

ii) **real-time information** informing on the development of drought conditions and providing forecasts of the likely evolution of the drought.

Introduction:

New technologies are available for developing monitoring and early warning systems based on real-time information to support decision making. At present the different drought monitoring systems developed worldwide have the problems of accessing to high quality climate information on a real time.

In Europe there is a lack of a common net of meteorological observatories to have access to the information on real time. On the contrary, the competences for collecting information correspond to the different states and commonly most of the available meteorological information is not open and available on real time.

This makes necessary to use the open available information to develop the real time drought information and commonly the available information has much **lower spatial resolution that the really available datasets**.

We have analyzed the **capability of these low resolution climatic datasets to quantify drought severity and drought impacts** in the Ebro basin (Northeast Spain) and to determine the application of drought information to assess vulnerability and impacts.

General methods:

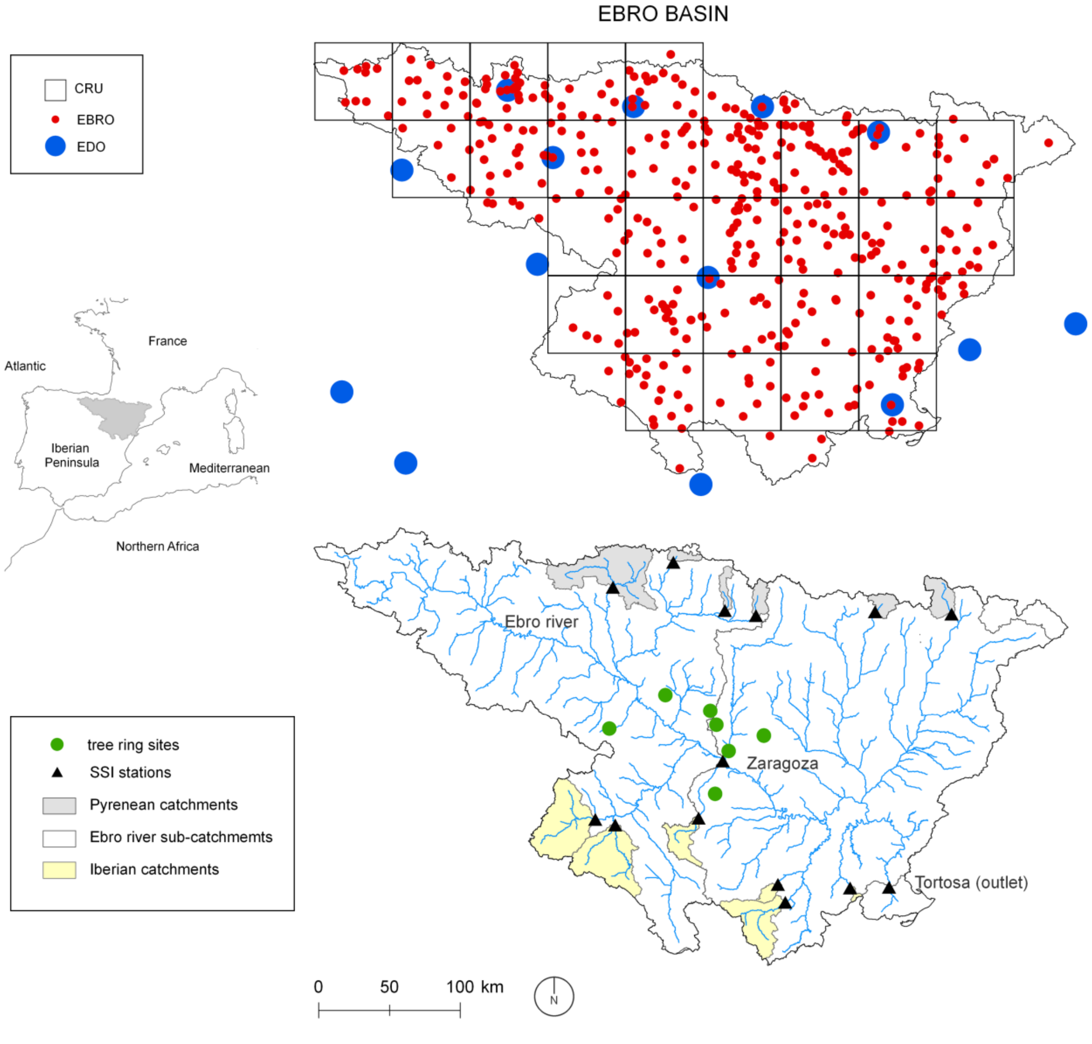
Given the difficulties to objectively identify the onset and end of a drought, and to quantify drought severity in terms of its duration, magnitude, and spatial extent, much effort has been devoted to developing drought indicators for risk analysis and drought monitoring.

Drought indicators are the most essential element for drought analysis and monitoring since they allow identifying and quantifying droughts. Although there is not a general consensus to select any specific drought index for drought monitoring, among the different existing drought indices here we have selected the **Standardized Precipitation Index (SPI)** since it has been accepted by the World Meteorological Organization as the reference drought index. In the "Lincoln Declaration on Drought Indices" it was a consensus agreement that the Standardized Precipitation Index (SPI) should be used by national meteorological and hydrological services worldwide to characterize meteorological droughts.

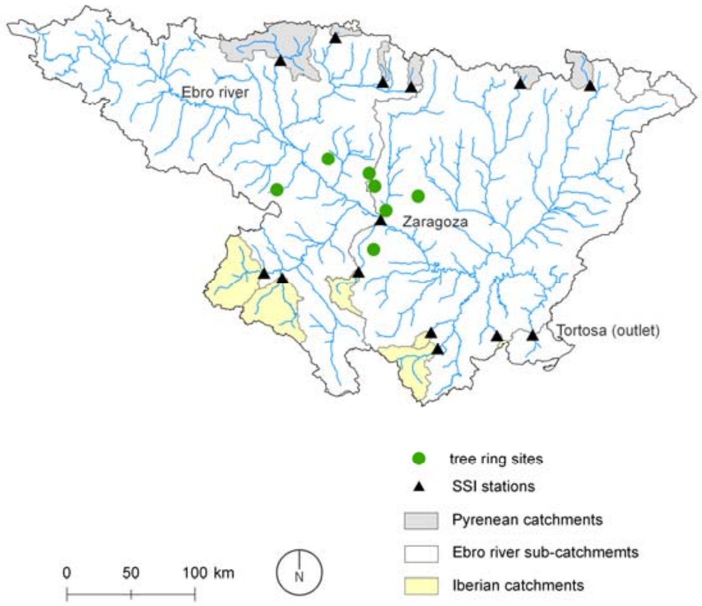
The SPI is being used in different drought monitoring systems (e.g., Svoboda et al., 2002), including the **European Drought Observatory (EDO)**. This index is obtained using exclusively **precipitation data**. Therefore, the quality of the SPI outputs and the quantification of the severity and spatial extent of droughts will depend on the quality of the precipitation inputs to be included in the analysis.

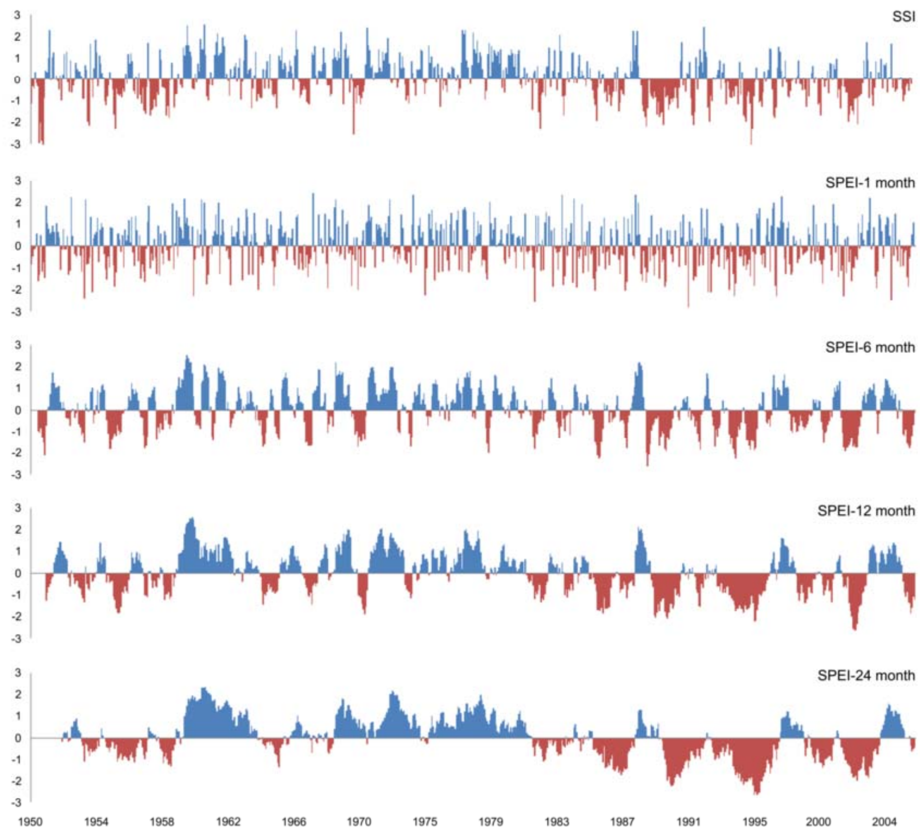
General methods:

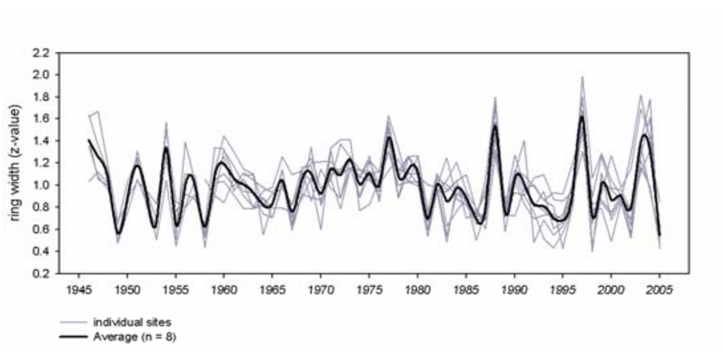
Three different precipitation datasets have been used to calculate the SPI in the Ebro basin.



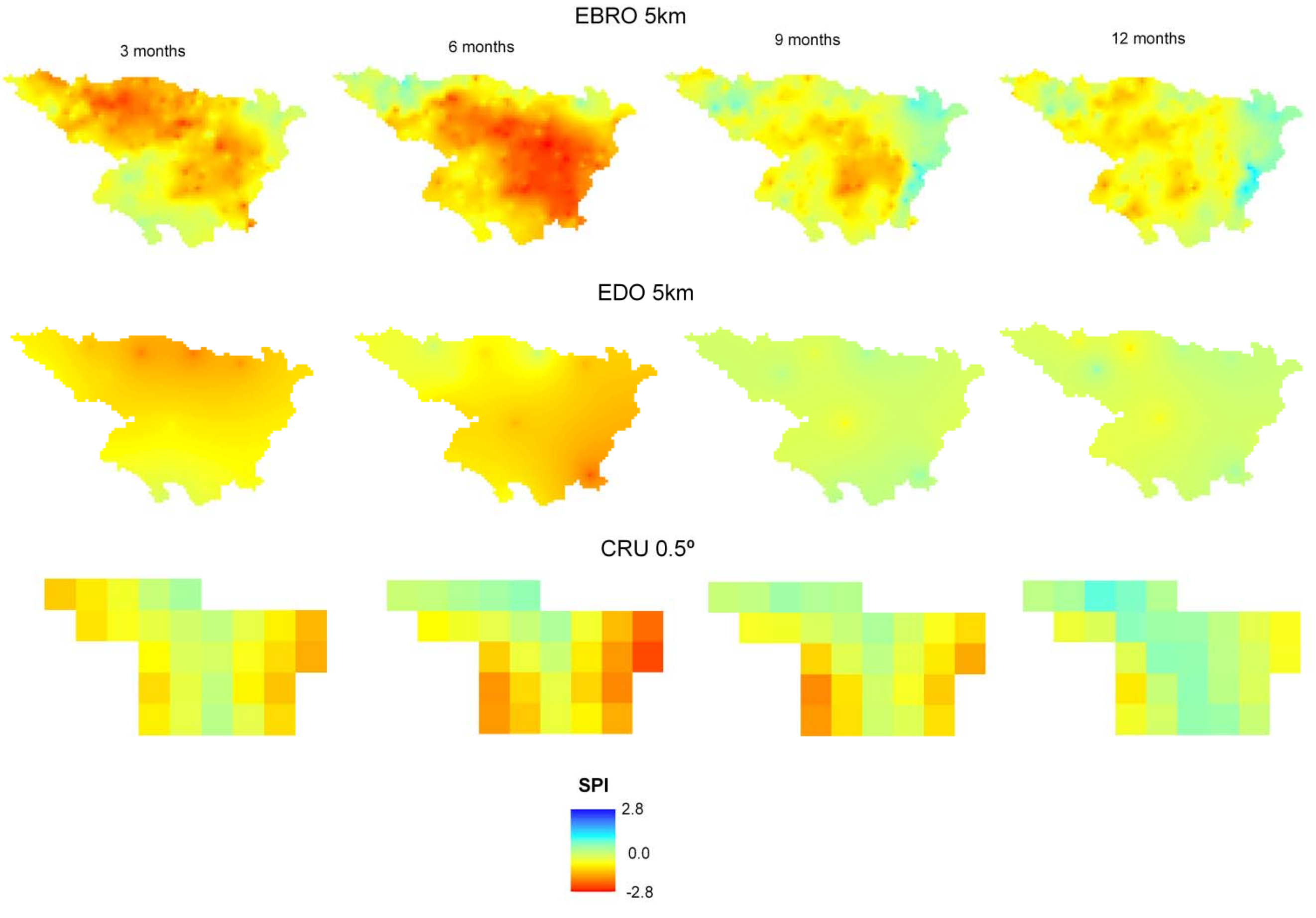
Datasets


Ebro river
Zaragoza
Tortosa (outlet)
tree ring sites
SSI stations
Pyrenean catchments
Ebro river sub-catchmemts
Iberian catchments
0 50 100 km
N


SSI
SPEI-1 month
SPEI-6 month
SPEI-12 month
SPEI-24 month
1950 1954 1958 1962 1966 1970 1975 1979 1983 1987 1991 1995 2000 2004

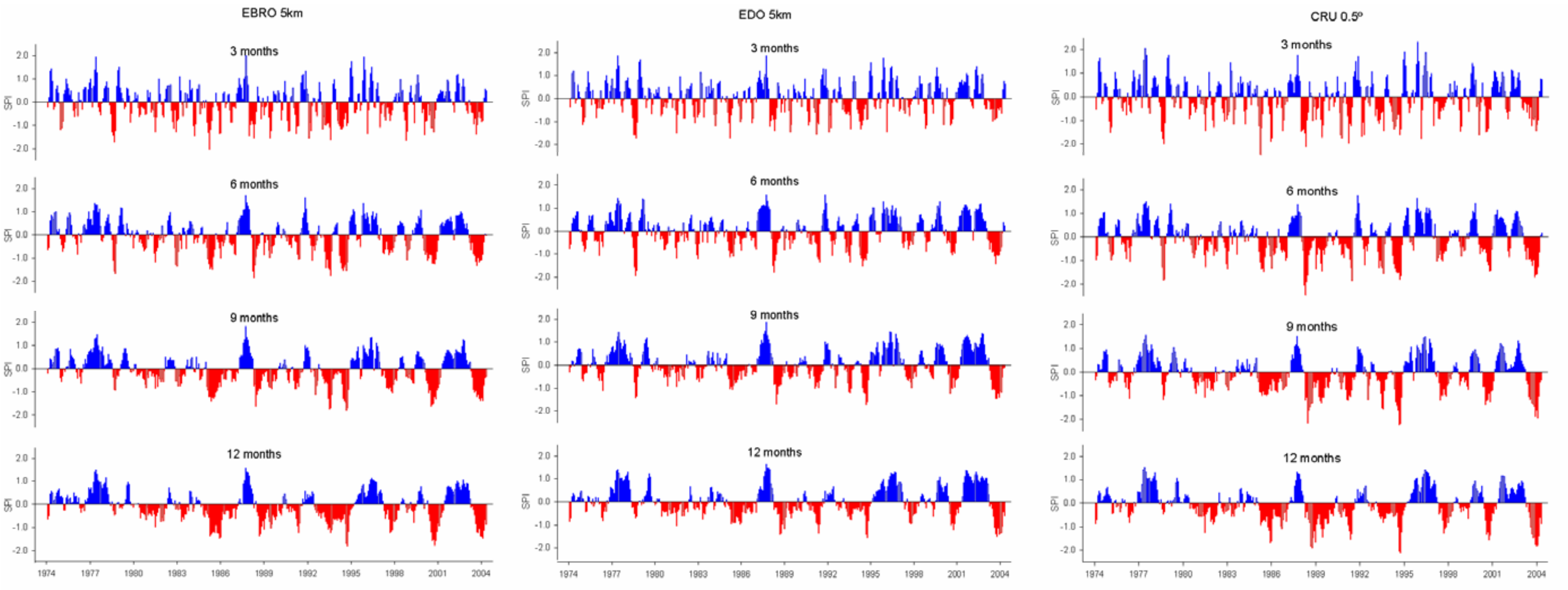

ring width (z-value)
1945 1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005
individual sites
Average (n = 8)

Comparison of drought indices from different datasets and spatial resolutions



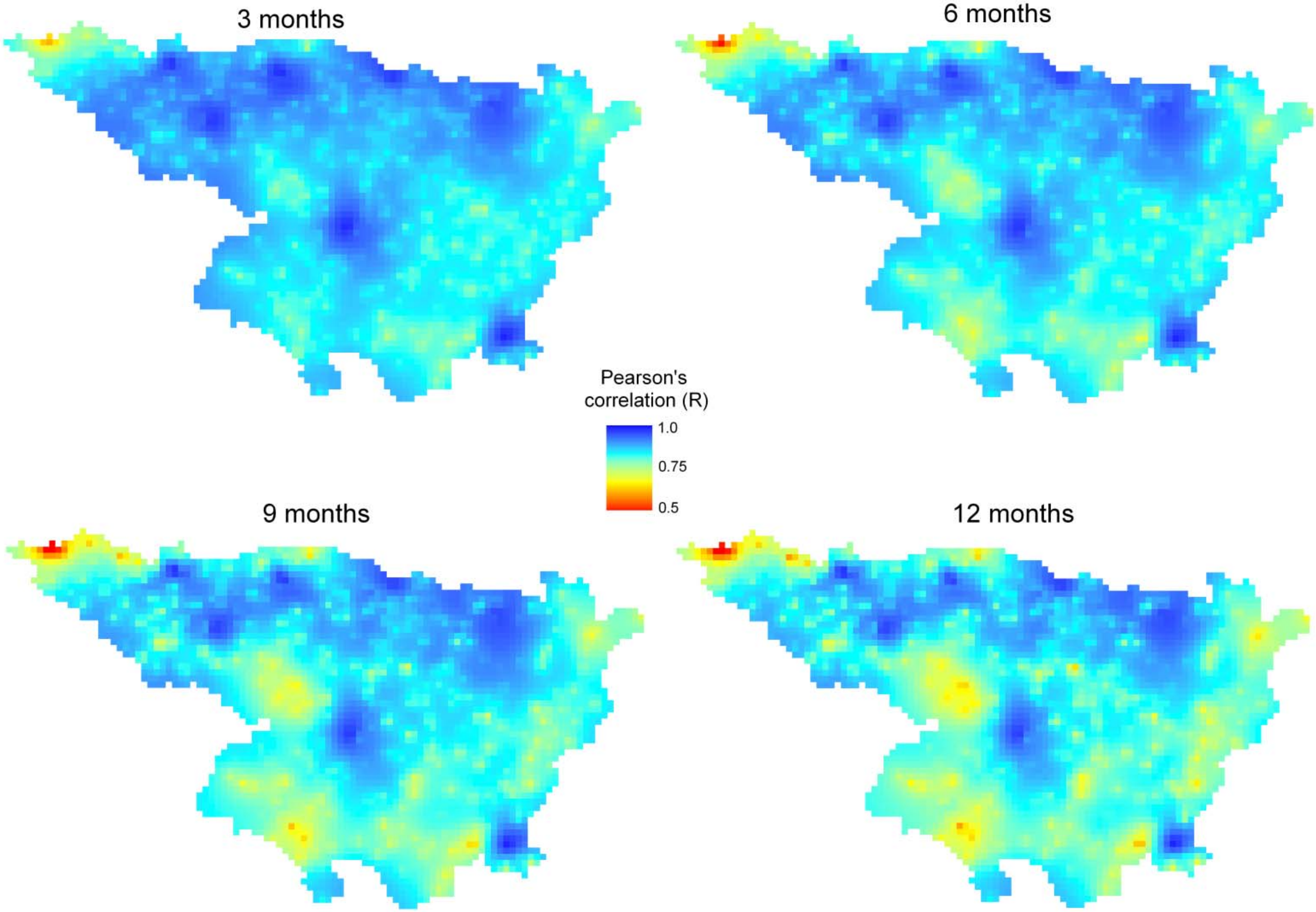
Example of the SPI datasets from the EBRO, EDO and CRU data. The maps correspond to June 1995, in which strong drought conditions affected the Ebro basin.

Comparison of drought indices from different datasets and spatial resolutions



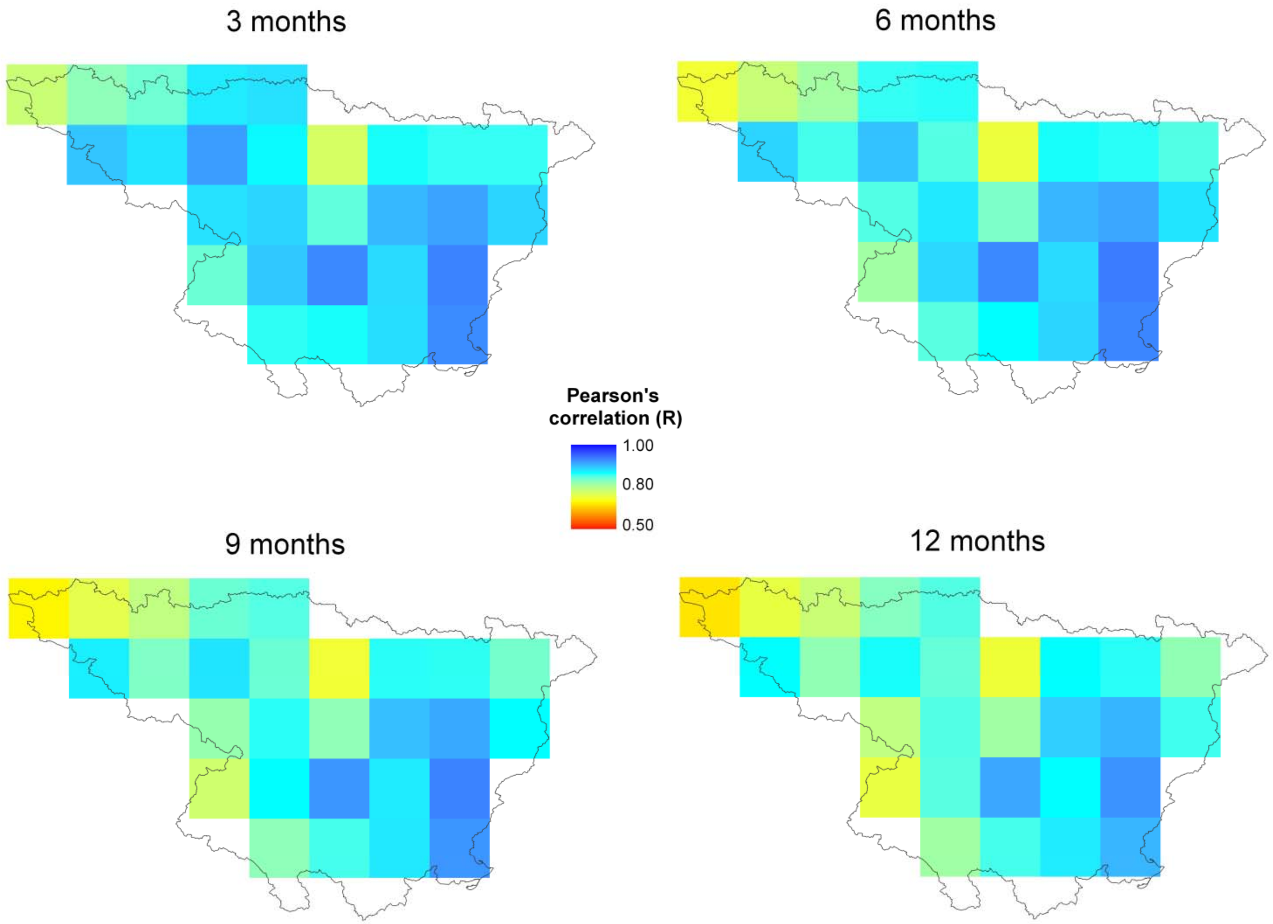
Average 3-, 6-, 9- and 12-month SPI for the entire Ebro basin from the EBRO, EDO and CRU datasets (1974-2005).

Comparison of drought indices from different datasets and spatial resolutions



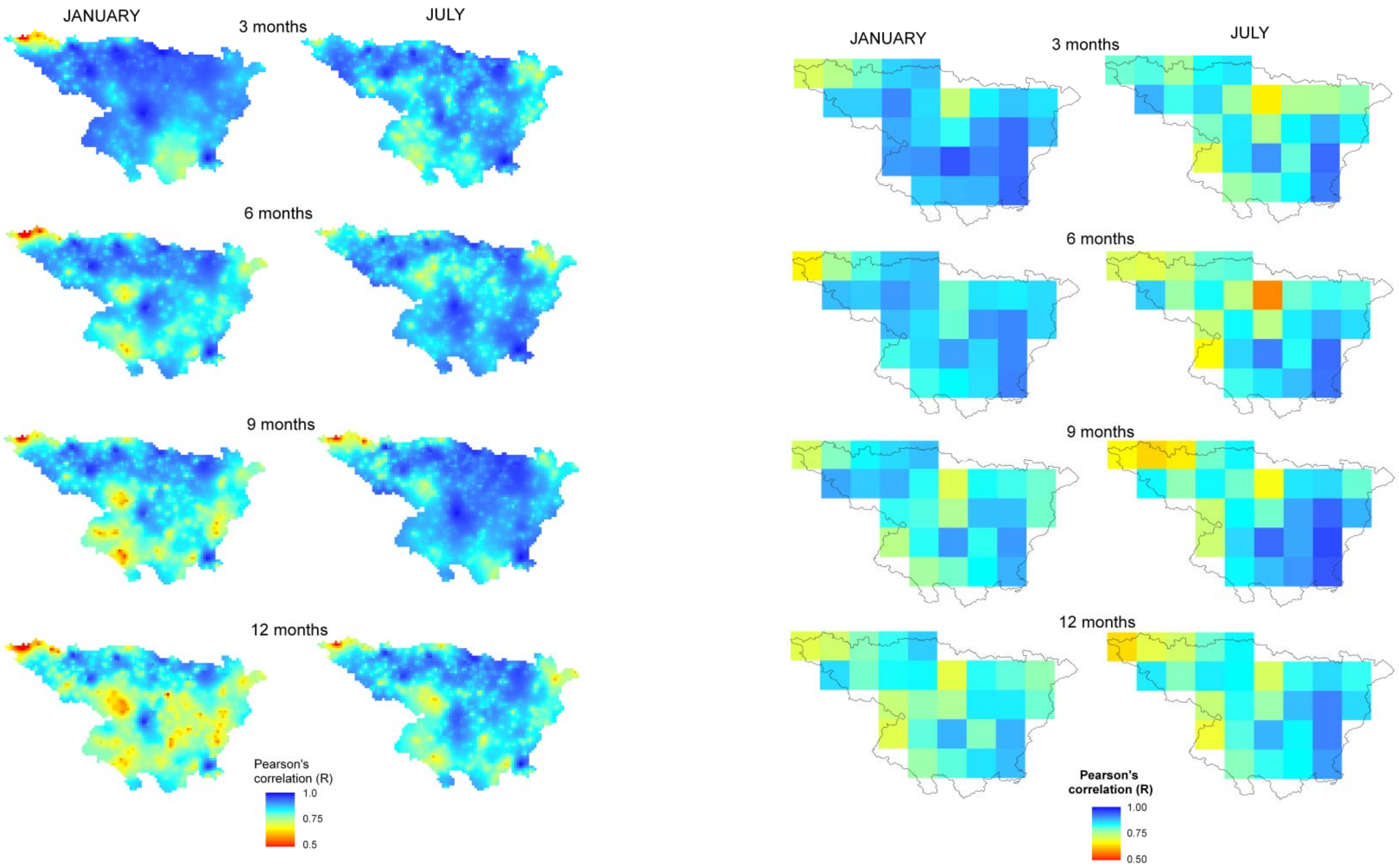
Correlations between the EBRO SPI and the EDO SPI on different time scales (1974-2005)

Comparison of drought indices from different datasets and spatial resolutions



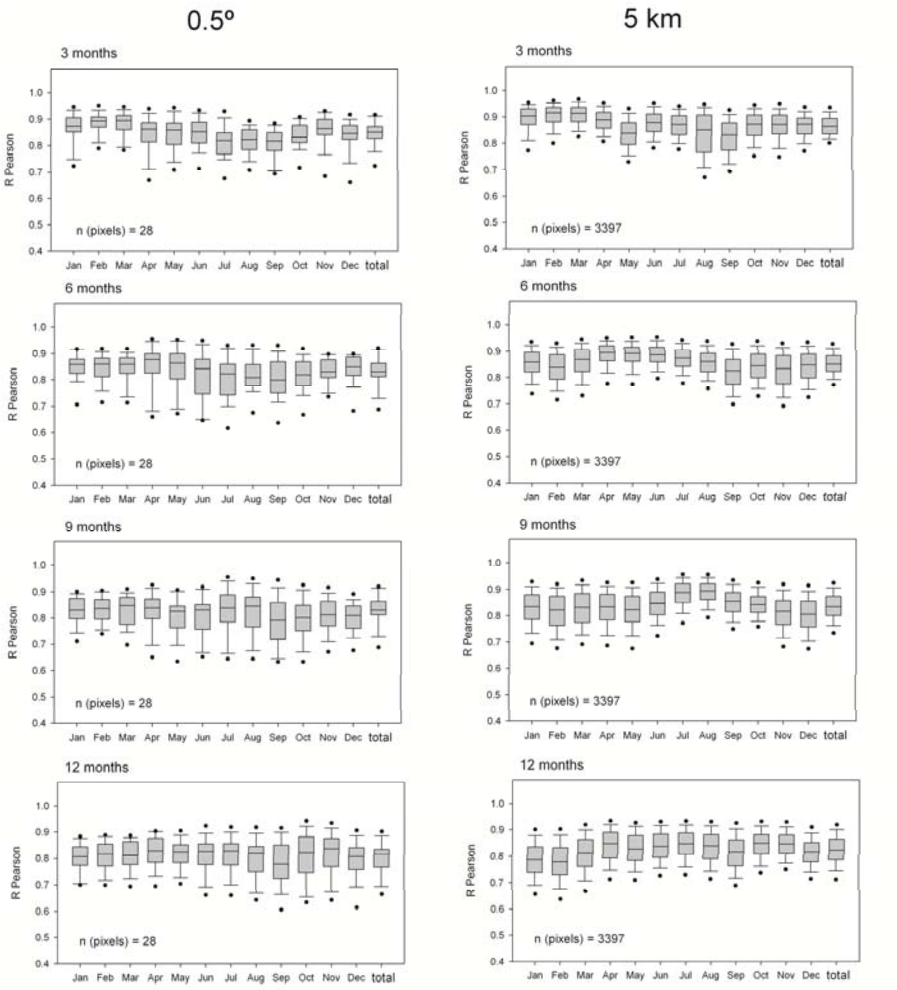
Correlations between the EBRO SPI and the CRU SPI on different time scales (1946-2005).

Comparison of drought indices from different datasets and spatial resolutions



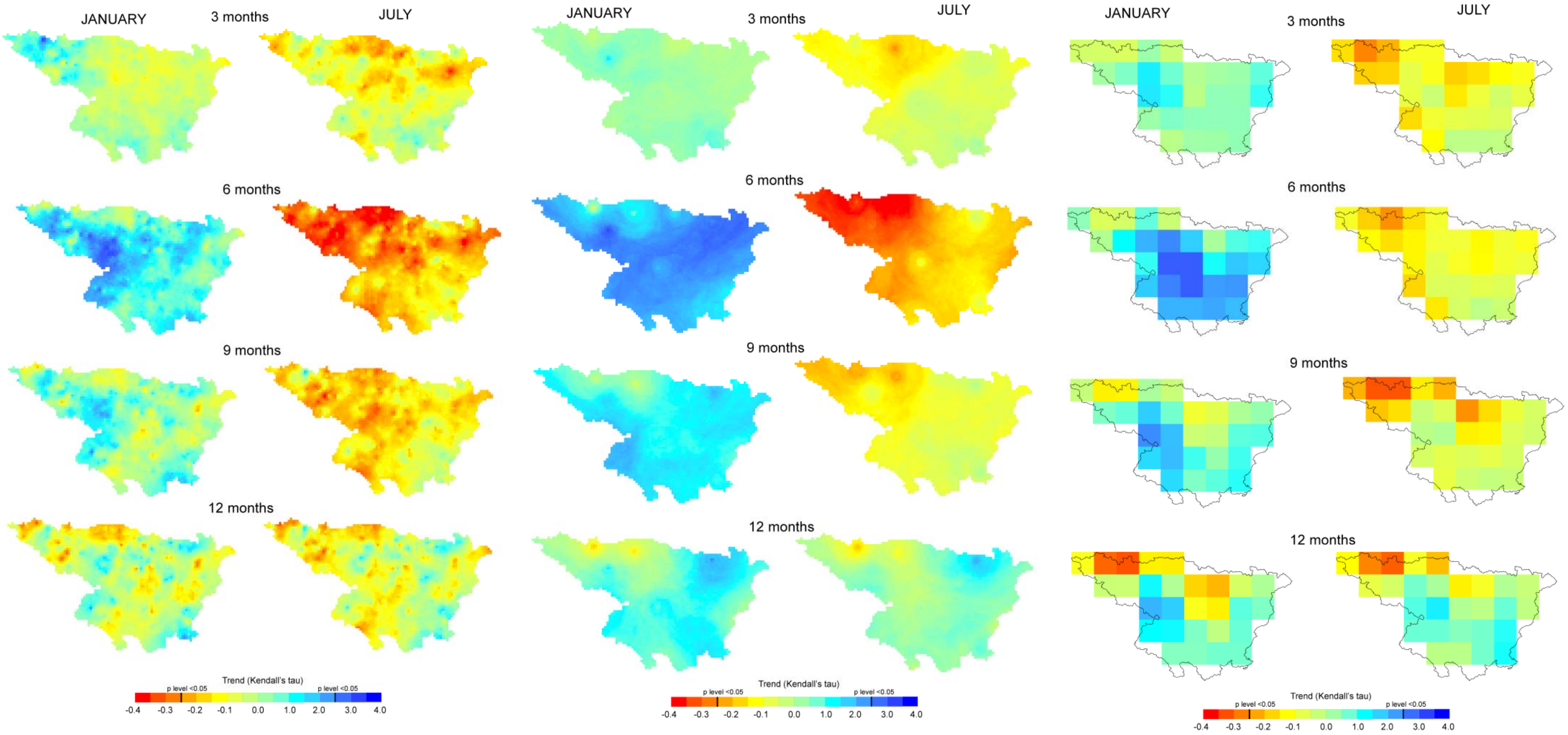
Correlations between the EBRO SPI and the EDO and CRU SPI on different time scales for the January and July monthly series (1974-2005).

Comparison of drought indices from different datasets and spatial resolutions



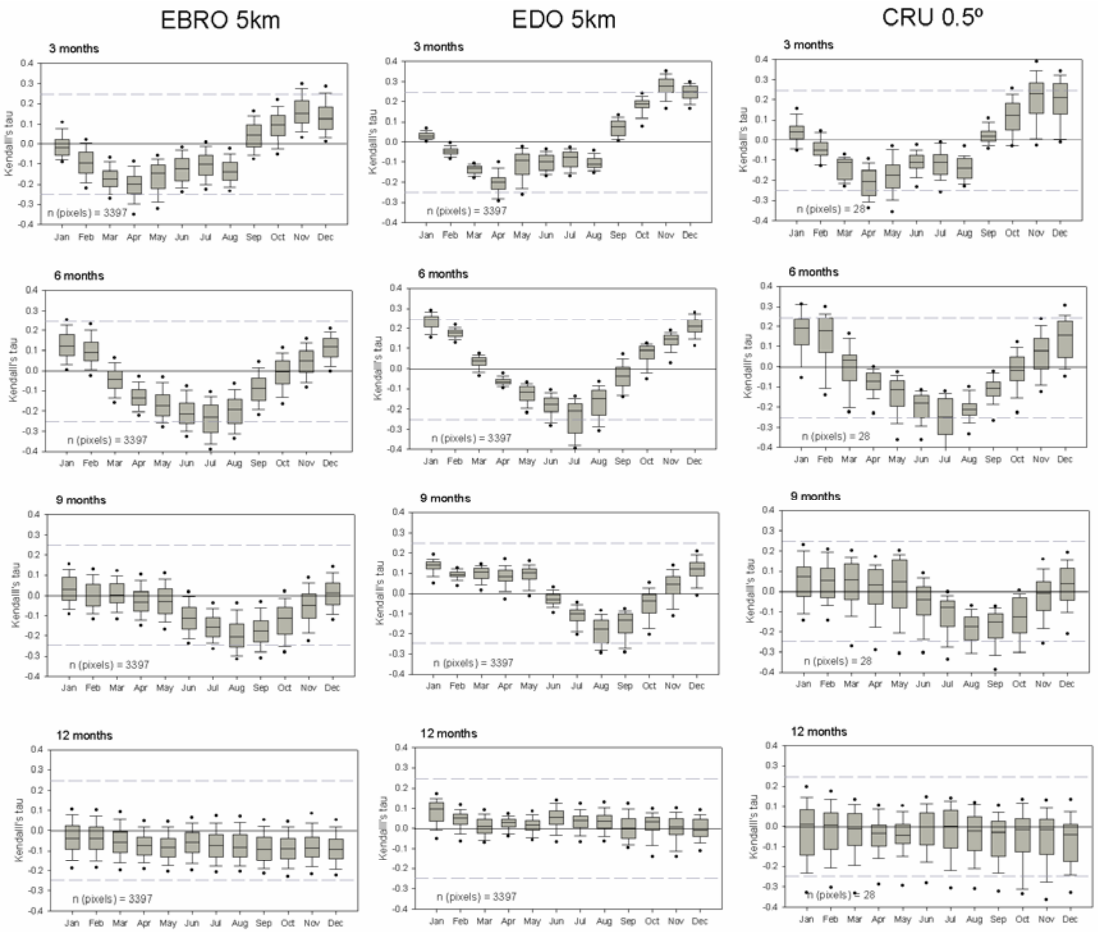
Box-plot of correlations between the EBRO SPI and the EDO and CRU SPIs at the time scales of 3, 6, 9 and 12 months. Each bar summarises the correlations for the complete set of 5 km or 0.5º for the corresponding month and time-scale. The plot "total" corresponds to the correlations from the complete series without distinguish between months.

Comparison of drought indices from different datasets and spatial resolutions



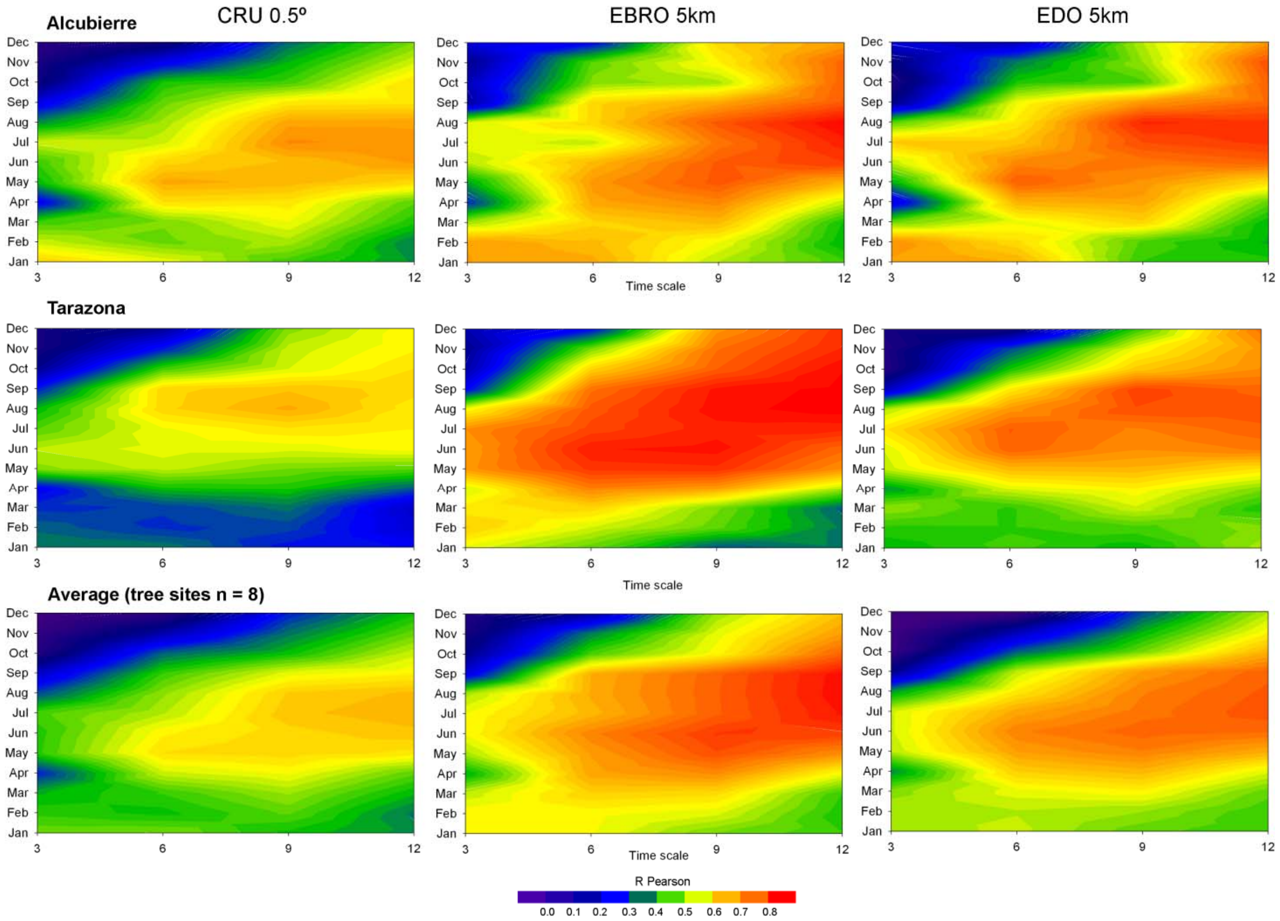
Evolution (1974-2005) of the surface area affected by droughts considering two SPI thresholds (-0.84 and -1.65) at the time-scales of 3 and 12 months for the EBRO, EDO and CRU datasets.

Comparison of drought indices from different datasets and spatial resolutions



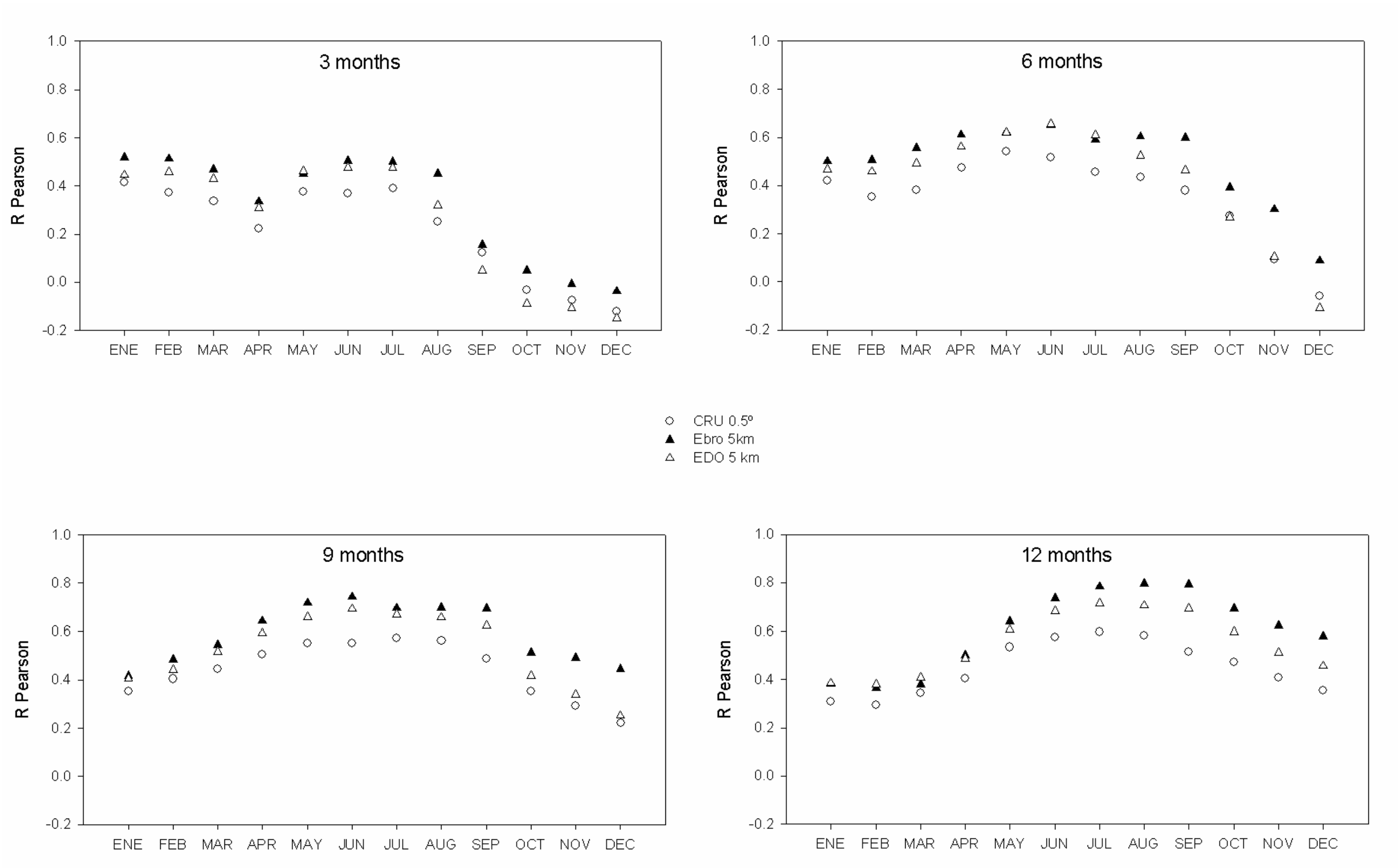
Box-plot of Tau coefficient for the EBRO SPI and the EDO and CRU SPIs at the time scales of 3, 6, 9 and 12 months. 1974-2005. Dotted lines indicate the threshold for statistical signification.

Assessment of the capability of different drought data sets to monitor drought impacts on forest growth



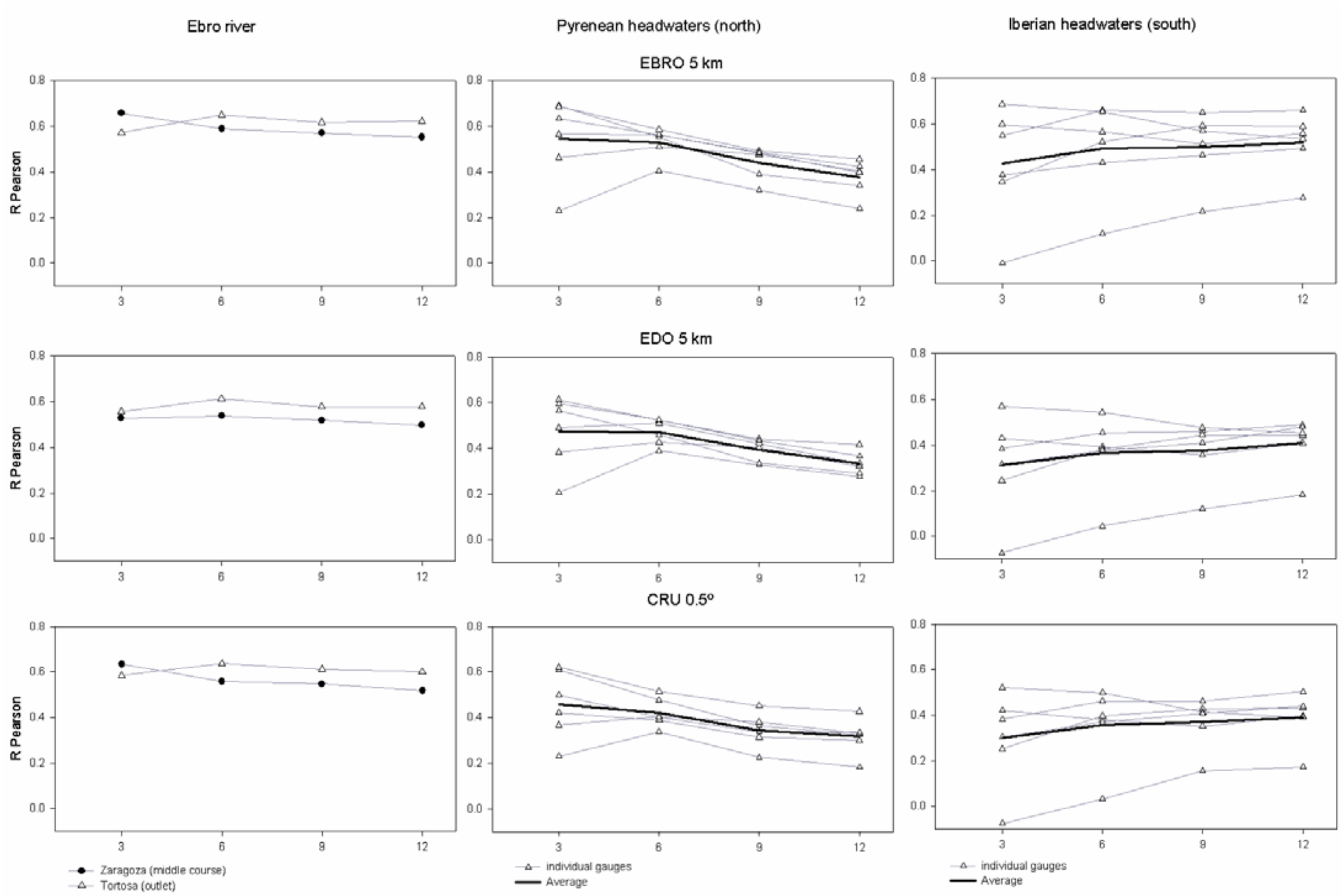
Correlations between the monthly series of SPI at the time-scales of 3, 6, 9 and 12 months and the annual growth of the *P. halepensis* forests obtained from tree-ring records. Correlations were obtained from the EBRO, EDO and CRU SPI datasets

Assessment of the capability of different drought data sets to monitor drought impacts on forest growth



Average correlations between the different monthly series of the EBRO, EDO and CRU SPI and the tree-ring growth for the 8 forest sites.

Assessment of the capability of different drought data sets to monitor water resources



Correlations between the series of SPI at the time-scales of 3, 6, 9 and 12 months and the SSI series in different sub-basins of the Ebro river basin. Correlations were obtained from the EBRO, EDO and CRU SPI datasets.

Summary and conclusions

- Fine climate datasets are preferable to identify better drought impacts and to determine differences in the drought vulnerability.

- The low resolution datasets reproduce quite well the general drought temporal variability, mainly at short time-scales, and can the main features of the drought changes.

- Low resolution datasets also provide reliable outputs in terms of knowing a variety of multi-source impacts.

- **Drought monitoring systems must provide drought information based on the available climatic information, independently of the spatial scale at which the data is available.**

- **Efforts must be conducted to improve the access to the available climatic information at real time in Europe to have better monitoring systems that allow taking better decisions and more efficient drought preparedness and mitigation of the drought impacts.**