Revista Internacional de Ciencia y Tecnología de la Información Geográfica
International Review of Geographical Information Science and Technology

Domingo, C. (2016): "Contributions to the knowledge of the multitemporal spatial patterns of the Iberian Peninsula droughts from a Geographic Information Science perspective", GeoFocus (Tesis), nº17, p. 163-165. ISSN: 1578-5157

CONTRIBUTIONS TO THE KNOWLEDGE OF THE MULTITEMPORAL SPATIAL PATTERNS OF THE IBERIAN PENINSULA DROUGHTS FROM A GEOGRAPHIC INFORMATION SCIENCE PERSPECTIVE

CRISTINA DOMINGO-MARIMON[1, 2]
cristina.domingo@uab.cat
[1]Grumets Research Group, Dep Geografia, Edifici B, Universitat Autònoma de Barcelona, 08193 Bellaterra, Catalonia, Spain
[2] CREAF, Campus UAB. Edificio C, Bellaterra (España)

Directores: Dr. Xavier Pons, Dr. Miquel Ninyerola y Dr. Jordi Cristóbal
Lugar de defensa: Departament de Geografia, Facultat de Filosofia i Lletres, Universitat Autònoma de Barcelona
Fecha: 25/01/2016
Calificación: Sobresaliente Cum Laude y Doctor Europeus

Disponible: http://hdl.handle.net/10803/379829

ABSTRACT

Drought, an insidious natural hazard, is a complex phenomenon involving climate processes that has large environmental and socioeconomic impacts. In recent years there has been an increasing interest in droughts effects and monitoring due to the current situations of extreme climatic events. Such drought events have implications on many of the Societal Benefit Areas (SBAs) that GEOSS (Global Earth Observation System of Systems) addresses; and this phenomenon set up an interconnection between different fields, such as agriculture sustainability, food security, ecosystem functions and services, biodiversity, carbon stocks, water resources, and wildfires, among others. According to the recently published IPCC 5th Assessment Report, a decrease in precipitation coupled with warmer temperatures associated to drought events is projected especially in the Mediterranean Basin, which will result in reductions on water availability for natural and agricultural systems and human needs.

Although research on drought is progressing, the phenomenon is still not well understood, and this fact makes difficult to adequately manage this type of events and their derived consequences. For instance, in the Spanish Iberian Peninsula droughts are recurring phenomena which in recent decades have led to major natural and socioeconomic impacts. Moreover, the Spanish Iberian Peninsula is an interesting case study due to its situation in the Mediterranean Basin and its

Recibido: 01/04/2016
Aceptada versión definitiva: 27/06/2016

Domingo, C. (2016): Ccontributions to the knowledge of the multitemporal spatial patterns of the Iberian Peninsula droughts from a Geographic Information Science perspective", GeoFocus (Tesis), nº17, p. 163-165. ISSN: 1578-5157

heterogeneous complex territory. With around 90 % of its land surface (35 % agriculture and 55 % forest areas) highly threatened by droughts, understanding the spatial and temporal characteristics of drought in this area is essential for monitoring, forecasting and managing of its consequences.

Both climate and remote-sensing data are the core of this thesis that wants to contribute to the knowledge of the multitemporal spatial patterns of droughts in the Iberian Peninsula and their effects, especially on forests, from a Geographic Information Science perspective. This thesis addresses drought identification and characterization at different spatiotemporal scales and demonstrates the need for a new conceptual framework where forest drought has its own recognition. A better understanding of past droughts events affecting the Spanish Iberian Peninsula and their possible drivers has been achieved through the development of a monthly climate (precipitation and temperature) and drought (Standardized Precipitation Index- SPI and Standardized Precipitation Evapotranspiration Index- SPEI) cartographic Big Data base for the period 1950-2012 at 8 different timescales, which includes more than 14 000 continuous maps at a detailed spatial resolution of 100 m.

The analyses of spatiotemporally continuous SPEI maps offers an innovative spatial vision of drought, identifies the spatial distribution of most affected areas, and quantifies the intensity and time extent of drought events, often unveiling areas more affected than previously expected and suggesting new future climatic units for the area. This multidimensional approach has enabled monitoring the spatiotemporal dynamics evolution of droughts, the so-called drought moving waves, which facilitates the identification of several simultaneous present and long-term drought events. Trends of SPEI time-series at different timescales identifies an abrupt regime shift between 1979 and 1981 affecting the central-eastern part of the Iberian Peninsula, which was consistently anticipated by early warning signals. The analysis indicates that the Atlantic Multidecadal Oscillation (AMO) is the strongest predictor of the shift. The evaluation of potential impacts of drought regime shifts in forest carbon sequestration of Mediterranean *Pinus halepensis* forests has also resulted in reduction in carbon stock accumulation rates in most of the evaluated areas.

However, climate-based patterns do not entirely explain the real state of vegetation. Instead, satellite observations potentially provide a complementary view with greater spatial and temporal coverage of drought conditions. Therefore, vegetation indices derived from MODIS (MODerate-resolution Imaging Spectoradiometer) sensor has been calculated as possible indicators of physiological forest parameters. An exploratory analysis based on time-series of climate and MODIS data has been carried out showing the capabilities of integrated climate and remote-sensing data to identify and characterize drought patterns on forests at different timescales. For instance, remote-sensing temperature indices exhibit R^2~0.56 with SPEI at the shortest timescales, while when examining timescales of about 1 year, the higher correlations are found with water and vegetation indices (R^2~0.38). These results show both the robustness of SPEI and remote-sensing data working together, and the sense of using SPEI for pre-remote sensing drought studies.

Finally, a new methodology for generating MODIS 8-day surface reflectance products based on a topographic correction and a geostatistical analysis approach has been developed in order to address several issues related to the spatial heterogeneity of current MODIS 8-day composites (MOD09A1). Results show that this new product not only greatly improves the current product, but also presents

Domingo, C. (2016): Ccontributions to the knowledge of the multitemporal spatial patterns of the Iberian Peninsula droughts from a Geographic Information Science perspective", GeoFocus (Tesis), nº17, p. 163-165. ISSN: 1578-5157

a high monthly correlation with products obtained by the compilation of the daily product (MOD09GA), being a possible substitute of high processing time analysis of daily products.

In summary, the research carried out in this thesis covers many aspects of drought studies, meteorological studies and forest studies, consolidating progress in the investigation of the drought phenomenon.

Keywords: Remote-sensing, Climate, Drought, Spatial temporal analysis