Chapter 12
Identification of Dry Periods in the Dobrogea Region

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ABSTRACT

The main objective of this study is to identify different types of drought (moderate, severe and extreme) in the Dobrogea region based on three indicators: the Standardized Precipitation Index (SPI), the Standardized Precipitation and Evapotranspiration Index (SPEI) and the Standardized Flow Index (SFI). The dry periods, from a meteorological point of view, were identified based on a drought index that takes into account only precipitation (SPI) and another one that takes into account both precipitation as well as mean air temperature (SPEI). To highlight the dry periods from a hydrological point of view we applied the procedure for calculating the SPI to monthly discharge time series, through the Standardized Flow Index (SFI).

INTRODUCTION

Drought is one of the most complex phenomena which can have a strong impact on agriculture, society, water resources and ecosystems. One of the reasons for this is the spatial extent of drought and its duration, sometimes reaching continental scales and lasting for many years. Usually drought is defined as a period of deficient precipitation over a long period of time (e.g. a season or more). Typically there are four types of drought: a) *hydrological drought* (occurs when river streamflow and the water storages fall below long-term mean levels), b) *meteorological drought* (characterized by months to years with precipitation deficit), c) *agricultural drought* (this includes the soil drought and soil-atmospheric drought, and is characterized by dry soils as a direct effect of reduced precipitation) and d) *socio-economic drought* (occurs when the demand for an economic good exceeds supply

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as a result of a weather-related shortfall in water supply) (Ped, 1975; WMO, 2012; Wilthie & Glantz, 1985; Farago et al., 1989; Maracchi, 2000).

Because of the complexity of drought, no single index has been able to adequately capture the intensity and severity of drought and its potential impacts on such a diverse group of users. Comparing drought characteristics from region to region or event to event is facilitated by the use of a numerical standard. Unfortunately, the complexity of drought and the multiple drought definitions make it nearly impossible to capture drought intensity and severity in a single index. The most used drought index is the Palmer Drought Severity Index (PDSI) (Palmer, 1965); an index which is based on a supply-and-demand model of soil moisture and it enables the measurement of both wetness and dryness. The index has proven to be most effective in determining long-term drought — a matter of several months — and not as good with conditions over a matter of weeks (Alley, 1984; Weber & Nkemdirim, 1998). One of the main disadvantages of PDSI is that it has a fixed temporal scale and does not allow the identification of different types of drought (e.g. agricultural, hydrological or meteorological). This may act as a drawback because drought is considered a multiscalar phenomenon (McKee et al., 1993, Vicente-Serrano et al, 2010). An improvement was made by McKee et al. (1993) with the development of the Standardized Precipitation Index (SPI), which takes into account the multiscalar nature of droughts. SPI has also a major drawback: it is based just on precipitation data and does not take into account the effect of evapotranspiration, which has a strong impact on drought conditions. Recently, a new drought indicator, the Standardized Precipitation - Evapotranspiration Index (SPEI) (Vicente-Serrano et al., 2010) has been proposed to quantify the drought condition over a given area. SPEI takes into account both precipitation and evapotranspiration and can be computed on time scales from 1 to 48 months. SPEI combines the sensitivity of PDSI to changes in evaporation demand with the multiscalar nature of SPI.

These timescales reflect the impact of drought on the availability of the different water resources. Soil moisture conditions respond to precipitation anomalies on a relatively short scale. Groundwater, streamflow and reservoir storage reflect the longer-term precipitation anomalies (WMO, 2012).

Concerning the Standardized Flow Index (SFI), several research papers approached this index and standardizing method was applied to streamflow for identifying multi-scale hydrological drought. Vidal et al. (2010) consider that it would be relevant to also compute both indices related to meteorological and agricultural droughts (SPI and SSWI - the Standardized Soil Wetness Index) at the catchment scale for a direct comparison with an index related to hydrological drought (SFI). In Chelcea et al. (2013) was applied the theory underlying the calculation of the Standardized Precipitation Index (SPI) to define a Standardized Flow Index (SFI), emphasizing in this way the dry hydrological periods, on the Barlad River in eastern part of Romania. Also, Wen et al. (2011) have demonstrated that the Standardized Flow Index (SFI) was a simple and useful tool to research, monitor and manage hydrologic drought in a highly regulated river system, the Murrumbidgee River in southeast Australia.

Dobrogea region is situated in the south-eastern part of Romania between the lower Danube River and the Black Sea, and includes the Danube Delta, Romanian coast, and the northernmost part of the Bulgarian coast. Dobrogea lies in the temperate continental climatic area; the local climate is determined by the influx of oceanic air from the northwest and northeast and continental air from the East European Plain. The particular climatic features of the Dobrogea region are reflected in the semi-arid character of the Dobrogea plain. The meteorological drought phenomenon is very extended (both in time and space) over Dobrogea