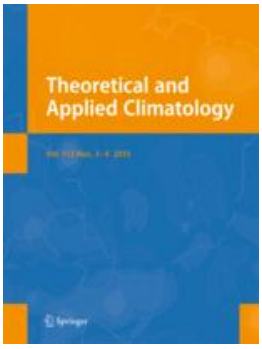

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ORIGINAL PAPER

Probabilistic analysis of extreme regional meteorological droughts by L-moments in a semi-arid environment

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Abstract Regional extreme value analyses of drought characteristics provide information on probabilistic nature of drought occurrence, viewed as an essential tool in drought mitigation and planning. In this paper, L-moments are used to investigate the regional characteristics and probabilistic behavior of drought severity levels, represented by the Standardized Precipitation Index (SPI) annual minima (the minimum monthly SPI value). Rainfall data of 3, 6, 12, and 24 month time scales are investigated. A regional watershed in southwestern Iran is used as a case study area. The semi-arid nature of the study area requires appropriate selection of rainfall data. The boxplot approach is used to select those months with adequate data time series for the SPI analysis. Appropriateness of the suggested data time series is discussed in the context of the research by Wu et al. (2007). Based on the results, all of the suggested time scales are found appropriate for SPI investigations. For each time scale of interest regional homogeneity is evaluated and the best regional/sub-regional probability distribution function is selected. Regional quantiles are estimated for different time scales and their variability with respect to return period is discussed.

1 Introduction

Droughts are categorically defined to be of meteorological, hydrological, agricultural, or socio-economic nature. The meteorological drought concept provides an explanation of precipitation deficits and the hydrological drought deals with low stream flow status and associated water uses. Conceptually in agricultural drought, the consequential influence of decreases of soil moisture on crop failure is evaluated (Dracup et al. 1980; Wilhite and Glantz 1985). The socio-economic aspect of droughts is used to discuss the effects of water shortages on people, their lives, and also the economic impacts of meteorological, hydrological, and agricultural droughts (National Drought Mitigation 2006).

As a common practice, drought indices are used to identify drought characteristics when any one of the drought categories is investigated. Among the more popular indices, one can mention the Palmer Drought Severity Index, introduced by Palmer (1965), Effective Drought Index, by Byun and Wilhite (1996), Standardized Precipitation Index (SPI), by McKee et al. (1993), and Deciles, by Gibbs and Maher (1967). The SPI index has the flexibility to identify, assess, and monitor drought conditions over a range of temporal scales. As a result, the SPI index has been used to evaluate water shortages, monitor dry and wet periods, and evaluate drought on a regional basis (Bonaccorso et al. 2003). In addition, the probabilistic nature of the SPI makes it adequate for investigations on drought risk (Guttman 1998).

Among the many related researches on regional evaluation and spatio-temporal aspects of drought, one can mention Tsakiris et al. (2007), Bordi et al. (2001), Tonkaz (2006), Lana et al. (2001), Lloyd-Hughes and Saunders (2002), Tsakiris and Vangelis (2004), Bordi and Sutera (2001), Paulo et al. (2003), Hayes et al. (1999), Szalai and Szinell (2000), Vicente-Serrano et al. (2004), Rouault and Richard (2003), Domonkos (2003), Bonaccorso et al. (2003a), Ntale and Gan (2003), Min et al. (2003), Kemal Sonmez et al. (2005), Eder et al. (1987), Raziei et al.

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