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In-depth investigation of precipitation-based climate change and cyclic variation in different climatic zones

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Abstract Climate change and cyclic variation are investigated based on station data of 61 years (1951–2011), representing twelve climatic zones in Iran. Climate change is investigated by applying the non-parametric Mann–Kendall test and the three-dimensional loglinear model to the12-month SPI time series, and by applying the likelihood ratio test to precipitation time series. Cyclic variation is studied by applying the three-dimensional loglinear model to the 12-month SPI time series. Analysis included entire data period, two sub-periods [(1951–1981), (1982–2011)] and three sub-periods [(1951–1971), (1972–1991), (1992–2011)]. The Mann–Kendall test results indicated combinations of different trend behaviors, whereby climate change could not be evaluated. The likelihood ratio test did not confirm climate change (at 95 % confidence level), in most of the studied stations. However, the more in-depth analysis by the three-dimensional loglinear model, i.e., detection of significant differences among drought frequencies, did not confirm climate change (at 95 % confidence level), in any of the studied stations. Cyclic variation was not confirmed by the three-dimensional loglinear model (at 95 % confidence level), in any of the studied stations. The findings of this research illustrate the need for meticulous techniques like the three-dimensional loglinear model, as a necessary tool for climate change and cyclic variation studies.

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1 Introduction

Drought is viewed as a natural and re-occurring climatic disaster. As a phenomenon, drought continues to challenge our existing knowledge, which in comparison with other natural hazards can affect the society more than ever before. Quantitative definitions of drought are expressed by drought indices. Among the many previously developed indices, Standardized Precipitation Index (SPI) has been extensively applied worldwide. A relatively large group of researchers have focused their works on application and detailed analysis of SPI, while others have attempted to make analytical comparison among available drought indices. Some of the more recent drought-related researches in Iran include and are not limit to Shahabfar et al. (2012), Khalili et al. (2011), Banimahd and Khalili (2011), Mirabbasi et al. (2011), Tabrizi et al. (2010), Araghinejad (2011), Modarres (2010), Morid et al. (2006), and Raziei et al. (2009, 2011).

Climate change has become a subject of research and discussion in recent years. According to the Intergovernmental Panel on Climate Change (IPCC) report (IPCC 2007), instrumental observations over the recent 160 years showed an increasing of surface temperature with significant regional variations. One of the issues of climate change is the temporal decrease of available water resources with possible links to decreasing trends in precipitation. Then relating the decrease of precipitation to droughts, it is often said that because of climate change the drought events are becoming more frequent and or more severe (Brunetti et al. 2004; Huntington 2006).

It should be noted that variability of drought events are not necessarily a direct result of climate change. For example in a detailed study, Bordi et al. (2009) analyzed the linear and nonlinear trends of drought and wet periods, applying the gridded SPI to two distinct data sets. Their research demonstrated that the time series of drought and wetness area coverage followed a remarkable linear trend towards the end of the twentieth century, which was then reversed in