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Zoning droughts by standardized precipitation index in Esfahan province (IRAN)

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ABSTRACT

The Standardized Precipitation Index (SPI) has become a popular measure of drought across the globe. In this study, Standardized Precipitation Index (SPI) was used in annual period of time to survey on drought. Also, in order to zonation frequency of drought, geographic information system (GIS) software and Kriging method used for extracting dry areas. The zoning maps show most severe drought is in eastern areas of the province.

Key words: drought analysis, Standardized Precipitation Index, GIS, Kriging method

INTRODUCTION

Drought is not only the world's costliest natural event, collectively affecting more people than any other form of natural hazard (Wilhite, 2000), but it is also one of the most difficult phenomena to define. For drought monitoring and warning, meteorologists and hydrologists have developed indices, which depend on hydro- meteorological parameters or rely on probabilities of drought occurrence (Vogt and Somma, 2000). Drought indices based on one or more variables are commonly used to identify and monitor drought at different time scales. During the recent years various indices have been developed to detect and monitor drought (Palmer, 1965; McKee *et al*., 1993; Meyer *et al*., 1993). The SPI was developed by McKee et al. (1993, 1995). The SPI was designed to be flexible to location and suitable for droughts at different hydrological levels. SPI is based on fitting a probability distribution to precipitation data, followed by a transformation to a standard normal distribution. The SPI values are based on the precipitation for the past several months, with common scales of 1, 3, 6, 12, 24 and 48 month(s). Guttman (1998) demonstrated that SPI compares favorably to the more prominent Palmer Index (Palmer, 1965; Palmer, 1968). SPI has been used for studying different aspects of droughts, for

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example, forecasting (Mishra et al., 2007), frequency analysis (Mishra et al., 2009), spatio temporal analysis (Mishra and Singh, 2009; Shahid, 2008; Loukas and Vasiliades, 2004; Bastini, 2011) and climate impact studies (Mishra and Singh, 2009; Loukas et al., 2008), monitoring ground water drought (Shahid and Hazarika, 2010) assessing drought risk (Shahid and Behrawn, 2008). The aim of this study is zoning droughts by standardized precipitation index in Esfahan province.

Site of study, Data used, SPI and drought classes

Esfahan province is located in Iran. With geographical 30′ 42˚ to 34′ 30˚ North and 49′ 36˚ to 55′ 32˚ East. Input data to this study consists of SPI Annually values for the period September 1979 to September 2009, for 25 rainfall sites, these sites are identified in Fig. 1, in Esfahan. In this research, data of climatological stations of General Administration of Aerology and Regional Water Authority of Esfahan Province which support maximum area of the region were selected. These stations were included statistical period at least for 30 years. After completion, amendment and assimilation, they transformed to a common time scale. Then the SPI was used identify dry and wet periods of rainfall. SPI could be used to compute monthly rainfall or analysis total rainfall in each delight intervals (3 to 6-month). In this research, the annual timeframe and the following formula were used:

$$SPI = \frac{p - \bar{P}}{Q} \quad (1)$$

Where SPI is standard index, P is the normalized amount of precipitation of the current annual, P is the average of rainfall in timeframe for each station, and Q is the standard deviation of each station in timeframe.

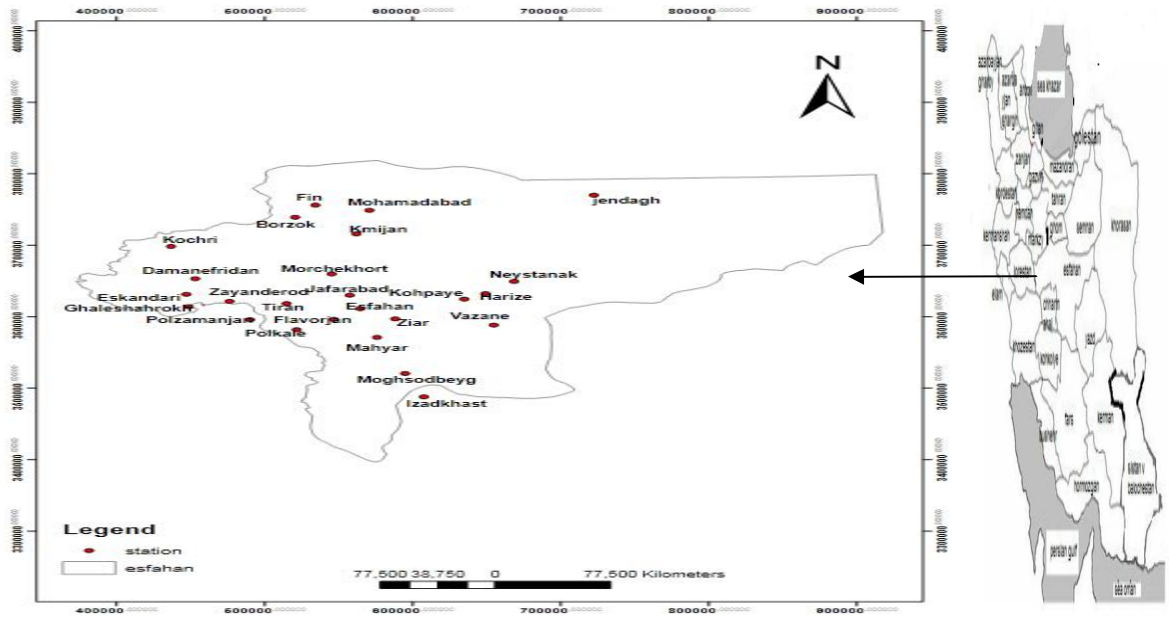

Figure 1. The Esfahan province with identification of the rainfall sites utilized in the study.

DISCUSSION AND CONCLUSION

At first, precipitation data were transferred to the Excel software, and then SPI method was used for evaluation. SPI diagrams for selected stations in the study area are shown in figure2. Obtained values were transformed to GIS and after organizing data base for each station. Zoning map was based on SPI values for each statistical year. In this study, Ordinary Kriging of Geostatistics tools has been used for mapping the spatial extent of meteorological and droughts(figure3) because it is a quick deterministic interpolator that is accurate. Moreover there is a very diminutive decision to make regarding model parameter. Furthermore, Geostatistics is based on the theory of regionalized variables are increasingly preferred because it allows the capitalization of spatial correlation between neighboring observations to predict attribute values at not sampled locations (Goovaerts, 2000).

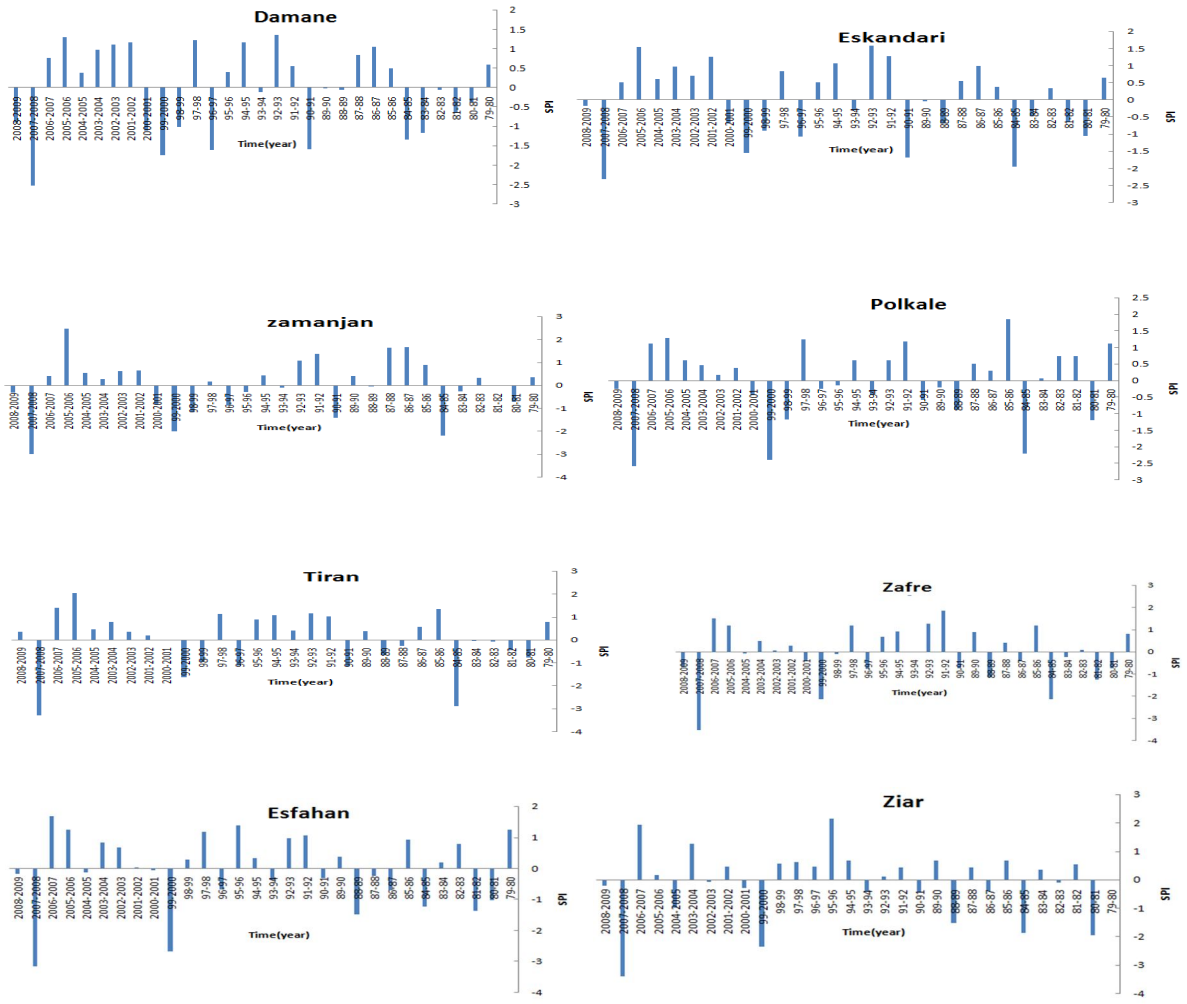

Figure2: SPI diagrams for selected stations in the study area

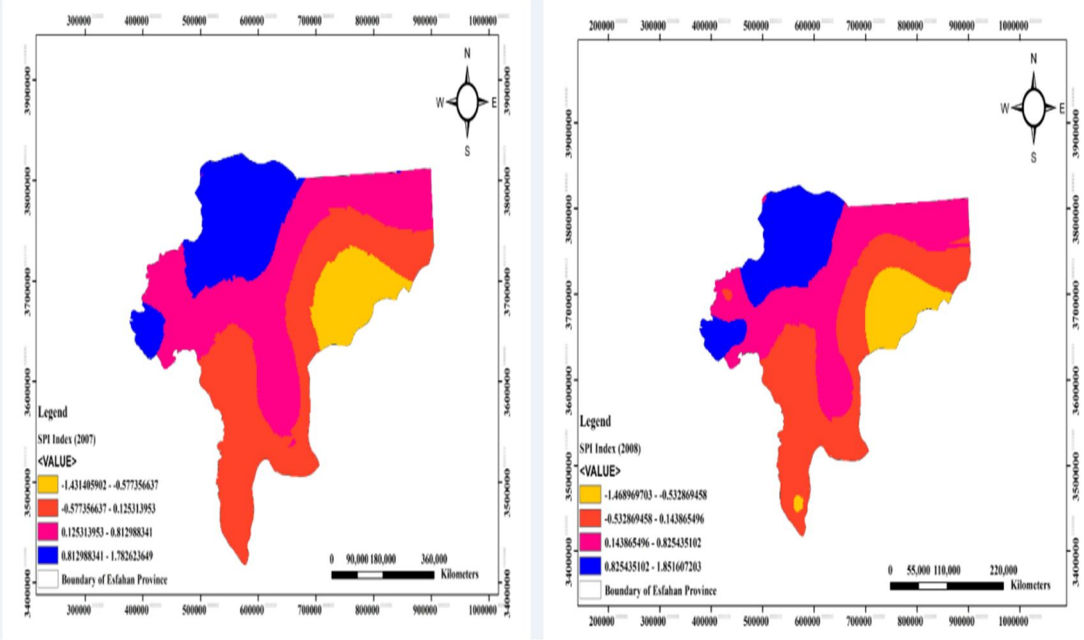

Figure3: Zoning droughts in the study area for 2007-2008 and 2008-2009.

RESULT

In this study, Attempts to zoning drought aim, analyzed and classified the drought year with SPI method. And the end used the kriging method to zoning drought in Isfahan province. The zoning maps show most severe drought is in eastern areas of the province. In this research, to the Annual value of SPI, driest year is year 2007-2008.

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