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Research Paper

Assessment the Effect of Drought on Vegetation in Desert Area using Landsat Data ☆

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ABSTRACT

Drought phenomenon is one kind of a disaster that can significantly affect the density of vegetation in any area especially dry regions. This study tries to express the effect of drought on vegetation cover in Yazd-Ardakan plain, central Iran. At first, annual average for SPI index was calculated from 1996 to 2015, and then NDVI was calculated for May in 1998, 2000, 2009, 2010, 2011 and 2015. Afterwards, NDVI maps were classified into three groups including no vegetation, poor vegetation (pastures), and dense vegetation (farmlands and gardens). Based on the results the worst value of drought was −1.92 in year 1999. Besides, the annual SPI of 1996 with value of 2.4 was considered as the wettest year during study period (1996–2015). The highest percentage of dense vegetation and poor vegetation were related to 2010 and 1998 respectively, and the lowest percentage for both classes was related to 2000. There was correlation among the area of poor vegetation class in middle of spring and previous annual SPI at the significant level of 95%. In contract, no correlation was found between dense vegetation class areas in middle spring and previous amount of annual SPI. The study of the correlation between the SPI average and the percentage of vegetation classes indicated that pastures were highly sensitive to SPI changes; however, farming lands showed less sensitivity in short term due to using deep wells.

1. Introduction

As an unpleasant climatic phenomenon that directly affects societies through the limiting access to water resources, drought is also followed by some huge economic, social and environmental costs (Goddard et al., 2003). This phenomenon is affected by rainfall, temperature, evaporation and transpiration, the content of humidity in accessible soil and the condition of underground water (Shahabfar et al., 2012; Montandon and Small, 2008).

Although meteorological information from ground stations has good accuracy and is popular worldwide, the distribution and density of meteorological stations is insufficient for the required spatial information detection (Brown et al., 2008; Unganai and Kogan, 1998; Skandari et al., 2016).

The spatial extent of drought cannot be properly identified unless there is a good distribution of meteorological stations throughout the area. Even then, the requirement of time and cost for the data preparation and chances of error, may hinder the procedures of drought mitigation. In this context, drought monitoring through satellite based information has been popularly accepted in recent years for its low cost, synoptic view, repetition of data acquisition and reliability (Dutta et al., 2015). In addition to the advantages mentioned, the Normalized Difference Vegetation Index (NDVI) and the Vegetation Condition Index (VCI) have been accepted globally for identifying agricultural drought in different regions with varying ecological conditions (Ji and Peter, 2003; Barati et al., 2011; Dutta et al., 2015). Satellite based NDVI is a useful tool for measuring and monitoring environmental conditions such as crop condition simulation, yield estimation, land degradation, dryland studies, etc. (Dutta et al., 2015; Aboelghar et al., 2010; Mondal et al., 2014; Boori et al., 2015).

Drought monitoring projects in USA are of the most interesting projects performed by some great organizations such as USDA, NDMC and NOAA in which drought has been studied across USA, and their up to date results are screened for the public access (Water and Become, 2005).

The research was conducted by Hadian et al. (2013) revealed that NDVI has a strong correlation with vegetation canopy. Therefore, using NDVI in monitoring vegetation cover and its relation to

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meteorological parameters; in particular, precipitation might be applicable.

Ji and Peter (2003) carried out a study on vegetation response to accessible humidity by analyzing SPI and NDVI indices in the vast deserts in the north of America. This study was completed on grass vegetation and farming lands on the basis of three main goals including the study of the relation among Standardized Precipitation Index (SPI) and NDVI indices in various time scales, NDVI response to SPI in various periods of growing season and regional properties, and the relation between NDVI and SPI. They concluded that the best cohesion between NDVI and SPI was three months. Also, the best relation between SPI and NVDI in regions with low capacity in storing water was obtained in soil. Finally, the most important result was that NDVI is an effective index of humidity-vegetation condition, but for monitoring drought with NDVI index, seasonal scheduling should be also taken into consideration.

Yingxin et al. (2007) represented that there was a strong relationship among NDVI, NDWI and drought conditions by analyzing NDVI and NDWI collected from 5-years images of MODIC sensor for assessing drought in meadow of the great plain of America. Bhuiyan et al. (2006) monitored drought dynamism in Arawali in India by applying some meteorological indices and some indices obtained from satellite sensors, from 1984 to 2003. In their study, they utilized the SPI index for determining the rainfall deficit amount and the standardized water level index for assessing shortcoming and drainage of the underground water. Rahimzadeh et al. (2008) studied the possibility of using NDVI and VCI indices, extracted from AVHRR sensor of NOAA satellite, for monitoring drought in west north of Iran. They obtained the best cohesion between NDVI and VCI by 3-month rainfall (current month plus the past months), and in comparison with VCI, they found a better conformity between the NDVI and the rainfall.

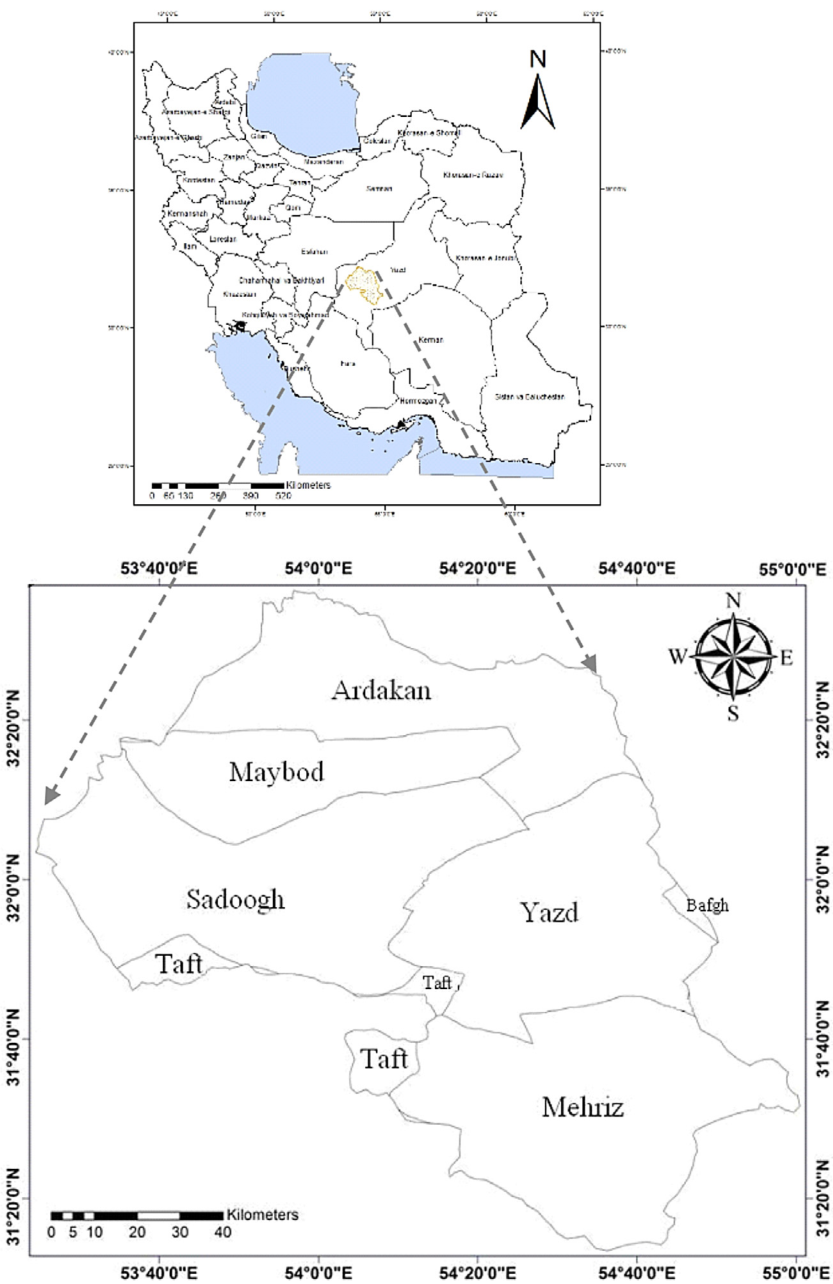

Fig. 1. The location of the study area.