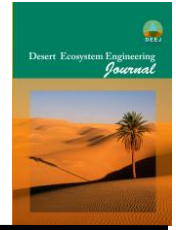




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Desert Ecosystem Engineering Journal

Journal homepage: <http://deej.kashanu.ac.ir>

Investigating Agricultural Drought Changes Using Remote Sensing and Meteorological Indicators: A Case study of North Khorasan Province

Karim Solaimani¹ Shadman. Darvishi², Fatemeh Shokrian^{3*}

Received: 13/06/2021

Accepted: 04/12/2021

Extended Abstract

Introduction: As a natural phenomenon that characterizes the climate system, drought exerts devastating effects on agricultural products, including reducing cultivation levels, decreasing crop yield, and changing cropping patterns, thus threatening the food security of humans and other creatures. Moreover, it brings about some social and environmental consequences such as threatening human health security, spreading diseases, increasing malnutrition, increasing the migration of rural residents, influencing the moisture, health, soil erosion, and vegetation, developing desertification, decreasing the water resources quality, increasing air pollution, and affecting groundwater reserves, wildlife, and biodiversity. These disastrous effects have turned drought into the subject of different investigations worldwide. On the other hand, as Iran is located in arid and semi-arid regions of Asia and suffers from inappropriate rainfall distribution, it faces some problems in terms of cultivating agricultural lands. Located in eastern Iran, North Khorasan province is not an exception in this regard, being considered as a region susceptible to different types of droughts, especially agricultural ones, due to its geographical location. Furthermore, recent droughts in the province have led to reduced water reservoirs' volume, severe groundwater depletion, reduced discharge of wells' water, damages to rainfed crops, and reduced irrigated crops in the province. Therefore, this study sought to investigate the relationship between drought and meteorological conditions in North Khorasan province throughout a 19-year period using remote sensing indices.

Materials and Methods: This study used the data collected from synoptic stations in North Khorasan province, and MODIS imagery data including 16-day MOD13A1 V6 products (500 m spatial resolution) to measure the NDVI index and 8-day MOD11A2 V6 products (500 m spatial resolution) to measure ground surface temperature (LST). Extracted from MODIS images in ARC GIS software, a set of remote sensing indices including NDVI, VCI, LST, VSWI, TCI, VDI, and VHI were also used to monitor the drought. Then, SPI, PNI, MCZI, and ZSI were measured to investigate the relationship between meteorological and remote sensing indices. Finally, Pearson correlations were measured between SPI, PNI, MCZI, and ZSI, and VCI, VSWI, TCI, VDI, and VHI using the SPSS software.

Results: The results of analyzing the Pearson correlation coefficients indicated a strong correlation between SPI, ZSI and MCZI, and VCI, VHI, VDI, and VSWI in Maneh and Samolghan, Shirvan, Esfarayen, Garmeh, and Farouj stations, moderate correlations between the indices in Raz, Jirgalan, and Bojnourd stations, and no significant correlation between the indices in Jajrum station. As for the status of vegetation in North Khorasan province, it was found that the northern, eastern, northeastern, western, and northwestern parts of the province had favorable vegetation, while the province's southern, southeastern, and southwestern regions were covered with sparse vegetation. The results also showed that sparse vegetation played a major role in drought occurrence, with many of the severe and very severe droughts occurring in the southern part of the province according to the

1. Professor, Dept. of Watershed Management, Sari University of Agric. & Natural Resources, Sari-Iran

2. M.Sc. in Remote Sensing & GIS, Aban Haraz Institute of Higher Education, Amol-Iran

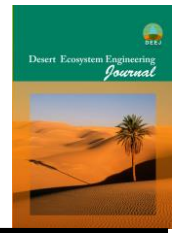
3 . Assistant Professor, Dept. of Watershed Management, Sari University of Agric. & Natural Resources, Sari-Iran, Corresponding author; f.shokrian@sanru.ac.ir

DOI: 10.22052/deej.2021.10.33.51



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Desert Ecosystem Engineering Journal

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TCI index, while the north, west, northwest, east, and northeast regions of the province were in the favorable condition in terms of drought where most of the droughts were of the mild type. Furthermore, based on VCI and VHI, north, northwest, northeast, east, and west parts of North Khorasan province possessed the highest areas with mild drought, with the mild drought, persisted during the 19-year period throughout the province, where the highest area affected by the drought belonged to Shirvan, and Maneh and Samalqan cities in 2000 and 2013, respectively. However, most areas in the south, southeast, and southwest of the province were found to have experienced moderate drought during the study period. According to the VHI (used to displays the combined effects of vegetation and land temperature surface when monitoring the drought), most areas of the North Khorasan province were found to be affected by moderate and mild droughts, with merely the southern regions of the province (Esfarayen and Jajarum counties) experiencing severe droughts. It was also revealed that Farooj, Shirvan, Bojnord, and Raz and Jorgelan were in favorable conditions in terms of drought, VSWI, and VDI. However, the south, southeast, and southwest parts of the province were covered by the most drought areas based on VSWI, and VDI throughout the study period, while normal and optimal conditions were mostly observed in the north, northwest, northeast, west, and east regions of the province.

Conclusion: It could generally be argued that applying various indicators can provide a better understanding of the drought situation, as each indicator examines the drought status based on a specific parameter (such as TCI and VCI) or a combination of several parameters (such as the VHI index). Moreover, evaluation of the correlation coefficients of indicators could be very effective in providing accurate results, considering the fact that some satellite-driven indicators such as the meteorological ones have a direct relationship with the drought status, whose accuracy can better be determined if their relationship with remote sensing indices is investigated. Therefore, considering this study's results regarding the Pearson correlation coefficients between meteorological and satellite drought indices, it is recommended that future relevant studies use VCI, VHI, VSWI, and VDI to monitor the status of drought.

Keywords: Agricultural Drought, VHI, VDI, North Khorasan Province.