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Assessing the Efficiency of Vegetation Indicators for Estimating Agricultural Drought Using *MODIS* Sensor Images (Case Study: Sharghi Azerbaijan Province)

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Abstract

Drought is a natural disaster. Because a significant impact on the agricultural and economy sector, it affects the lives of local residents. With Using of the remote sensing, drought can be studied through its effects on plants and agriculture resulting in more accurate and effective results found for modeling drought. In this study, the efficiency of agricultural drought indicators for estimating vegetation conditions will be examined. The results of *VCI* show that year 2001, 2008, 2000 and 2009 have the most rates of drought, presently and years 2010 and 2003 have been minimal. Used data are satellite images from Terra *MODIS* sensor precipitation data on 2000_2011.Rainfall data is for synoptic climatology station. To obtain the vegetation condition index (*VCI*) was used of the normalized vegetation index (*NDVI*). *NDVI* derived from bands 13 and 16. To evaluate the success, Standardized Precipitation Index (*SPI*) calculated at 9 stations on the time scale of 3 months to 4 years. By *SPI*, 2008 and 2001 with a maximum drought and 2010 and 2003 years have been the lowest. The results shows that for agricultural drought assessment through Remote Sensing, *VCI* would be an excellent model, And in areas where weather stations are Sporadic , or if there is no the model can be used to estimate drought.

Keyword: Agricultural drought, *MODIS*, *NDVI*, Sharghi Azarbijan, *SPI*, *VCI*.

Introduction

The drought is a natural disaster due to a significant impact of on the agricultural sector and the economy, affected the lives of area residents (Mahmoudi Cohen *et al*, 1390). Drought phenomenon, complex phenomenon with different effects. Hence the parameters to determine the severity and extent droughts are used. More indicators in in this field to be applied, Was built Based on criteria the meteorological variables such as the soil moisture, of temperature Especially or rainfall give examined. With providing a different and broader adoption of satellite data, The possibility study droughts using this technology is provided by. Using remote sensing

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techniques can be through the effects of droughts on agricultural plants, Studied and a result the results are more accurate and more effective to achieved modeling droughts (Heim, 2002). Currently satellite images regularly and carefully, spatial resolution, high of ground preparation Regularity conditions and extent, and can provide the space. The benefits of using remote sensing techniques than weather can increase the sampling spots, Wider masking level, the higher resolution and cost less as noted (Wilhite, 2000). So far, many works in conjunction with the drought indices extracted from satellite imagery done seen in all of the chronic type of uncertainty that sometimes causes inefficiency of the drought is forecasting models. More accuracy in image processing to extract the indexes can be more efficient in drought prediction models (Rhee *et al*, 2010). Rahim Zadeh (2005), the AVHRR sensor data to estimate the the drought in NDVI and VCI examined. Results indicate a high correlation between the index and VCI amount in the synoptic station was of rainfall.

Rezaei Moghadam and colleagues (2013) Performance of the MODIS sensor data to estimate the of Lake Urmia watershed droughts Iran with VCI, TCI and SPI were evaluated. The results showed that the TCI is more appropriate VCI because is more correlation with meteorological data.

Thenkabail *et al* (2004) in the southwestern region of Asia, with indices run Dev.NDVI, VCI, TCI and VHI to assess the droughts began.

Karnieli and colleagues (2006) examined the status of VHI indicators in six different ecosystems in Mongolia began. The results showed that the optimum temperature rises activities affects vegetation.

Bhuiyan and Kogan (2006) in the Aravalli region of India, drought indices, using NDVI, VCI, TCI and VHI data obtained NOAA-AVHRR satellite compared with statistical indicators and SWI SPI studied.

Bhuiyan (2008) to estimate the droughts Thar Desert northwestern India and East Pakistan between 1984 and 2003, using NOAA-AVHRR satellite data extraction and utilization indices NDVI, VCI, TCI and VHI payments.

Zhang *et al* (2009) In a study Hvang·hvay full analysis of droughts in China using AVHRR images and meteorological data for the years 1981 to 2008 than they did.

Rhee *et al* (2010) using the NDVI, VCI, TCI, VHI and SPI-arid region of Arizona and New Mexico, and North and South Carolina began in the wet zone.

Roswintiarti *et al* (2010) to estimate the droughts began in the island of Java in Indonesia. They are this purpose to index images from MODIS EVI (improved of vegetation Index) and land surface temperature (LST) was used.

Owrangi *et al* (2011) estimated the drought in Fars province of Iran using sensor imagery AVHRR and SPOT satellite with images began. In this study, the indices VCI, TCI and VHI is applied.

Materials and methods

The study area

The study area is a East Azerbayejan province in Iran. The Province at coordinates 36 degrees 45 minutes and 39 degrees 24 minutes northern latitude and 45 to 48 degree, 20 minutes of eastern longitude is located. Regional extent of 45,120 square kilometers. In Figure 1, the East Azerbayejan province and the position of the meteorological stations are shown.

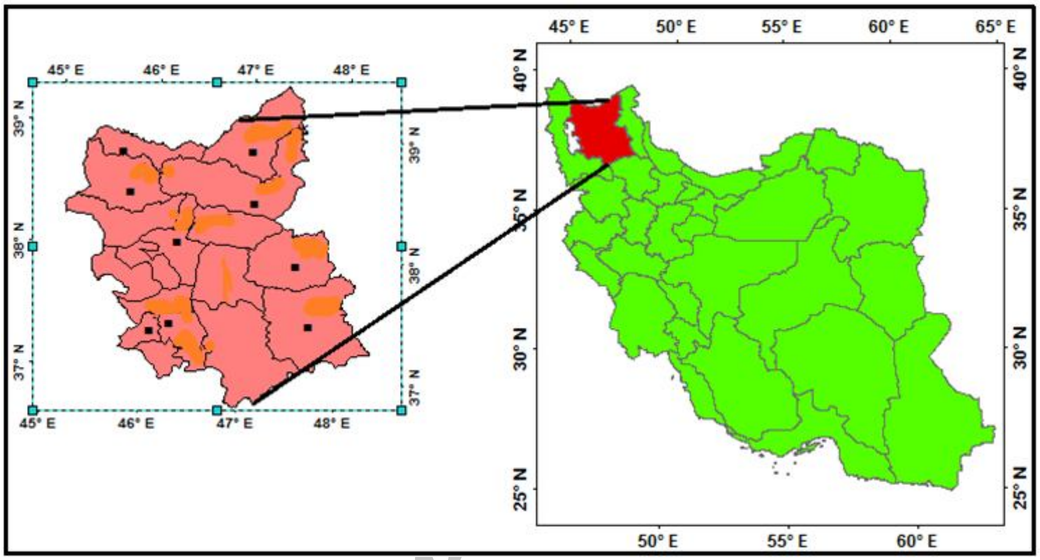

Figure 1: The study area location in Iran.

Most important The topography effects of this region can have of Sahand mountain range Arasbaran and noted mishoo. Plains Tabriz, Sarab, Ahar are the most important areas of altitudinal.

Data

The data used by the MODIS sensor images from 2000 to 2011 for the first of June and rainfall data synoptic stations and Klematolozhy from 2000 to 2011 (March to May) is.

Meanwhile should be noted that due to unavailability of 2007 images, the drought this year has not been estimated.

Indicators

1 - Index NDVI (Normalized Difference Index of vegetation)

NDVI index By Tucker in 1979 for the first time as vegetation cover health index were considered.

$$NDVI = (P\ NIR - P\ R) / (P\ NIR + P\ R)$$

In which P NIR, near infrared band and PR, is a red band. Potential NDVI the vegetation index (Teillet et al, 1997), percentage green cover, vegetation and luxuriant vegetation index reflects percentage leafy areas. This index is the most common vegetation index. The vegetation in health well-reflected waves near-infrared bands. The numerical value of each pixel between 1 + and 1 - are variable, the index for the vegetated areas of 1/0 (thin) to 8/0 (dense) is. (Rasouli, 2008 and Thenkabail et al, 2002). Previous studies indicate that the NDVI index to predict the effect of precipitation on vegetation cover prior to three months of delays.

The latency depends on the climate of the area is completely fed by rainfall or irrigation completely been and have been performed as part of this act. Much depends on the delay time of the delay time is quantitative rainfall (Whang et al, 2002).

2 - Index VCI (The vegetation Status Index)

VCI Index by kogan is proposed for the first time. This indicator shows how NDVI this month NDVI calculated from data recorded near term are:

VCI = (NDVI i – NDVI min) / (NDVI max – NDVI min)*100

Here to NDVI max and NDVI min of data recorded by long-term (eg 10 years) for the month or the week, and i represents the current month is calculated. situation vegetation cover by VCI, is measured as the percentage. VCI is an amount equal 100percent the amount NDVI NDVI max is equal to a month. different levels drought intensity VCI of below 40% is shown. When VCI is close zero percent represents a very dry month when the NDVI amount is close to its maximum value, drought situation improved. values VCI Low for successive time intervals are pointing to increasing droughts (Thenkabail *et al*, 2004).

3 - Index SPI (Standardized Precipitation Index)

The index for quantify of deficient rainfall or drought in multiple time intervals (3, 6, 12, 24 and 48 months) is designed. The time scales different, particularly the effects of drought on the ability to access of water resources explains and enhances precision of the calculations. Index SPI Precipitation deficient in studying the effects on underground water, surface water of reserves and, soil moisture, and the waterways, are useful (Quluzada, 2004).

Based on the study, McKee et al (1993), the series of SPI, periods 1, 3 and 6 months, as short term courses and periods of 12, 24 and 48 months, as long periods have been determined. Series a short reviews of agricultural droughts and long term series in the identification and analysis of hydrological drought are used.

SPI in the time scale quarterly fluctuations is very long term time scale, these fluctuations are reduced and can be interpreted in such a short time that SPI is very sensitive to the moisture conditions and so the slightest change in monthly precipitation, SPI quickly responds, If the change is positive, zero swing, and the SPI to be negative changes, SPI has fluctuated below zero. This feature, SPI constitutes a powerful tool for monitoring moisture conditions and short-term changes (agricultural droughts) shows (Bodagh Jamali et al, 2005).

Table 1: SPI and VCI classification schemes

Classification Schemes / Drought Classes	SPI (McKee et al., 1993)	VCI (Kogan, 1995)
Extreme drought	< -2.0	<10
Severe drought	< -1.5	<20
Moderate drought	< -1.0	<30
Mild drought	< 0.0	<40
No drought	> 0.0	>40

For listed parameters, the software ENVI, geometric and radiometric corrections on the images were performed. After the bands 13 (672/0-662/0 micrometers) and 16 (877/0-862/0 micrometers) NDVI for each year was calculated. The software ERDAS, for each year of VCI was run on images. Then ArcGIS software for the classification the maps and output from them was used. At the end of the meteorological data to calculate the SPI were used.

Results and Discussion

After applying the NDVI and VCI on the classification of images and outputs the results the map to be were obtained. According to these results, the years 2001, 2008, 2000 and 2009 have been the highest droughts. So that 85, 80, 74 and 57 percent range, they are faced with a variety of drought. The years 2010 and 2003, respectively, with the lowest rate it has been droughts. Maps of drought from 2000 to 2011 in Figure 2, is shown.

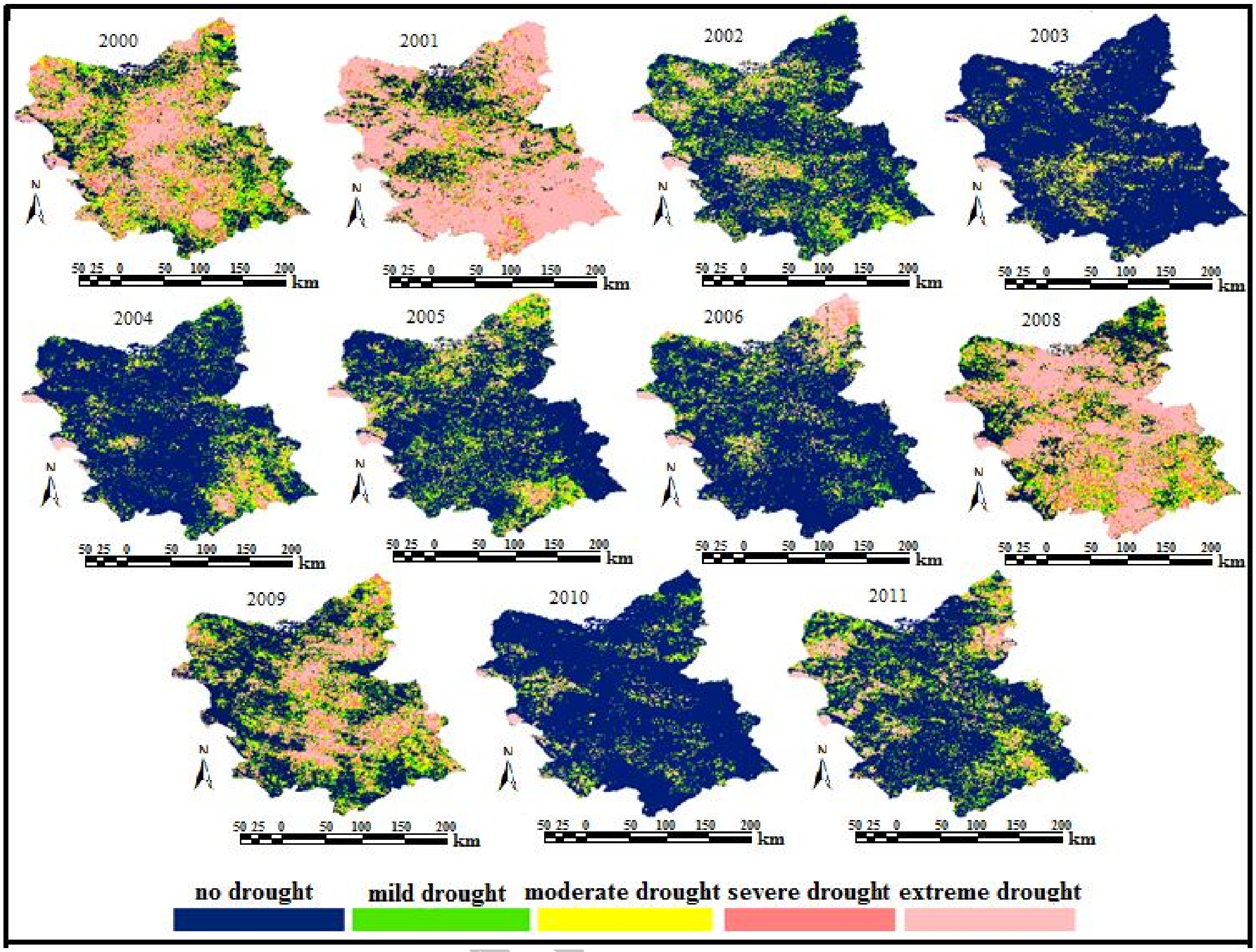

Figure 2 - Map of the VCI from 2000 to 2011.

According to Table 2, in 2001 about 58 percent of the region droughts has been facing severe. The very severe droughts in 2008, the 40 percent area in the covers. In 2001, with around 1/8% and then the in 2003 (2%) had the lowest rates were very severe drought in class. Table 2, and the percentage of area for each VCI droughts index shows.

Table 2: Floors area of drought with VCI.

	Extreme drought (%)	Severe drought (%)	Moderate drought (%)	Mild drought (%)	No drought (%)
2000	24/9	15/9	18	14/7	25/9
2001	58/5	10/1	9	7	14/9
2002	5	4/9	10	14/9	65
2003	2	1/6	1/2	5/2	87/6
2004	3/1	3/7	6/4	9/4	77/3
2005	4/3	4/8	9	12/4	69/4

2006	6/2	3/7	5/5	9	75
2008	40	14/7	14/7	11/2	19/5
2009	14/6	12/3	15	15	43
2010	1/8	1/7	3/2	5/2	88
2011	6/6	5/8	9/6	12/8	65/2

Continue on for 4 years (2001, 2003, 2008 and 2010), SPI 3-month time scale was calculated. In 2001 and 2008, all stations with droughts categories confronted were. Also years 2003 and 2010 with the wet are confronted. Myaneh Station In 2008, the driest Station and Station Bonab 2010 Station was the most humid.

Table 3: SPI index values for stations

In 2010	In 2008	In 2003	in 2001	Station
0/34	-1/6	0/22	-0/73	Tabriz
1/2	-1/3	0/4	-0/8	Ahar
3/5	-2	0/4	-0/95	Bonab
0/66	-2/1	0/3	-0/49	Maraghe
1/3	-2/1	0/73	-0/94	Marand
1/53	-0/8	0/76	-0/27	Jolfa
1/5	-2/24	0/63	-0/9	Myaneh
0/24	-1/9	0/9	-0/98	Sarab
0/18	-0/6	1/4	-0/67	Kalebar

Conclusion

In this research VCI performance in estimating agricultural droughts Eastern Azerbaijan province were examined. Of the data satellite Meteorological from 2000 to 2011 were used. The model examined in this research VCI was that from NDVI is obtained. Droughts maps for each year respectively. Finally to assess VCI the SPI was used. As was observed, the index SPI using meteorological data were obtained the results VCI confirm. Therefore, the use of knowledge remote sensing and VCI is a suitable method for estimating droughts, which can be a viable alternative for weather data. The advantage of using satellite images is that in areas where meteorological stations there is no or only sporadically, can be These images for the estimation of droughts agricultural quickly and efficiently used.

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