

## The Spatial Monitoring of Drought in Arid Agriculture Geography by Vegetation Temperature Condition Index (VTCI) Using MODIS Remotely Sensed Data (Case Study: Markazi Province)

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### Extended Abstract

#### Introduction

Drought is a natural disaster with a slow-onset and creper nature which cause economic damages especially in arid agricultural and natural resources geography sections. Because of drought harmful impacts on arid areas geography, studying of drought characteristics such as severity, duration, and frequency of area are very important. Because of unsuitable coverage of climatological stations and inaccessibility to update data, drought monitoring and assessment don't have suitable accuracy in developing countries such as Iran. Satellite remote sensing technology using suitable capabilities such as spatial, temporal, spectral and radiometric resolutions; have provided near real time monitoring of land surface phenomena like drought (Zargar et al.2011). Hence, remotely sensed data from Terra's MODIS has been used for drought spatial monitoring since 2000 and application of satellite-based drought indices of vegetation condition (VTCI) in drought identifying, analyzing, evaluating and monitoring has been studied world widely (AghaKouchak 2015, Karnieli et al. 2010, Wang et al. 2001, Wan et al. 2004).

#### Materials and Methods

This research was carried out in Markazi Province with area about 29,127 km<sup>2</sup> which located between 33 °, 23 ' N to 35°, 33 'N and 48°, 51' E to 51°, 05'E. In this research we have been used NDVI and LST products 3/4 level of Terra MODIS data of August in years of 2000 to 2014. The Terra MODIS 16-day composite of NDVI and 8-day LST were selected for this study. The compositing period is from July 28 to August 30, 2000 to 2014 (day 209 and 225 for NDVI and day 209 to 233 for LST of each year). The spatial resolution for the NDVI and LST data is about 250 and 1km in nominal respectively (226m and 855m actually). Also, for climatological data, synoptic stations with records of precipitation for at least 30 years and with fully recorded data have been selected for every month from July 2000to August 2014. This VTCI index has been used as an effective agricultural drought index to monitor spatial pattern of vegetation over a region (Eq. 1). Vegetation temperature condition index is calculated as (Wang et al., 2004, Wan et al., 2004);

$$VTCI = \frac{LST_{NDVIi,max} - LST_{NDVIi}}{LST_{NDVIi,max} - LST_{NDVIi,min}} \quad (1)$$

Where:

$$\begin{aligned} LST_{NDVIi,max} &= a + bNDVI_i \\ LST_{NDVIi,min} &= a' + b' NDVI_i \end{aligned} \quad (2)$$

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In general, the coefficients are estimated from the scatter plot of LST and NDVI in the area. The shape of the scatter plot is normally triangular at a regional scale (Gillies et al., 1997, Wang et al., 2004) if the study area is large enough to provide wide range of NDVI and surface moisture conditions.

### Discussion and Results

In the study area, the main land cover types are rangelands and croplands, other land cover types include salt land and stony land. A method to analyze the wet and dry conditions is to use the scatter plot of LST and NDVI. On the whole, the same 'warm edge' and 'cold edge' are used in calculating VTCI for all land cover types over the whole study area. After estimating, and from the selected 'warm edge' and 'cold edge' for study years (July 2000-2014), the best correlation (Eq. 3) get for year of 2006. Linear relation for this year gets;

$$\begin{aligned}LST_{NDVI_i,max} &= 325.91 - 11.463NDVI_i \\LST_{NDVI_i,min} &= 305.78 + 7.8353 \times NDVI_i\end{aligned}\tag{3}$$

### Conclusions

In this research, the near real time satellite-based drought index (VTCI) which physically interpreted as the ratio of LST differences among the pixels with a specific NDVI values in regional geography scale, have been computed in Markazi Province. This study explored integration of vegetation represented by NDVI and surface temperature measurements (LST) for deriving vegetation temperature condition index (VTCI) based on interpretation of LST-NDVI space. The role of satellite-derived VTCI for monitoring and assessing agricultural drought on a regional geography scale has been assessed by NDVI and LST indices. It was observed that the VTCI is an ideal index to monitor spatial characteristics of agricultural drought. Consequences of this research showed that from August of 2000 to 2014, the highest and lowest drought class belonged to medium, light (more than 84%) and wet (less than 1%) classes, respectively. Also, years of 2013 and 2011 had most area percent of high drought and wet. One issue in applying VTCI approach is how to determine its 'warm edge' and 'cold edge' (Wan et al. 2004). Correlation Analysis of VTCI and LST and NDVI showed that LST had negative and NDVI had positive correlation with VTCI index. The major advantage of VTCI is that it captures information about drought stress condition solely by satellite measurements. The procedures described in this paper can be considered as a good method for real time assessment of agricultural drought.

**Keywords:** Agricultural Drought, Remote Sensing, VTCI, MODIS, LST, NDVI.

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