ANALYZING DEM CHARACTERISTICS FOR AREA AFFECTED BY DROUGHT IDENTIFIED USING VHI: A CASE STUDY OF IAŞI COUNTY

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Abstract

In this paper was studied areas affected by drought using TCI, VCI and VHI. These indices are based on LST and NDVI. Drought is one of the most widespread and least understood natural phenomena. The droughts are the phenomena which affect large areas and remote sensing data covering large territory can be used to assess the droughts impact and their extent. In this study was used remote sensing images from the Landsat 8 Operational Land Imager (OLI), taken in April and May 2018. Study area, for this paper, geographically, is situated on latitude 47°32'N to 46°49'N and longitude 26°36'E to 28°05'E. This administrative unit is hit by heavy rains, floods, droughts and at larger periods of time by landslide events and earthquakes. NDVI values indicates that vegetation has been developed between 21st April and 7th May. LST values was about the same for images analyzed for study area. VHI is usually used to detect areas affected by severe drought. For these Landsat images analyzed was noticed that large areas were not affected by drought. Some zones were affected by moderate and mid drought – about the same for April and May. For these areas were made analysis to determine any connections between drought and altitude, gradient of slopes and exposure of slopes. Areas affected by moderate and mid drought have slope between 0^0 and 7.5^0, mostly between 5^0 and 7.5^0. Zones with slopes over 7.5^0 affected by drought is insignificant. Exposure of slopes for areas affected by drought is preponderant east and north-east.

Key words: Drought, VCI, TCI, VHI, DEM analysis

An insidious natural hazard, drought results from a insufficiency of water (precipitation) from expected (meaning "regular") such that when it's extended over a time of year or longer period of time, the volume of precipitation is not enough to meet the demands of the environment (Wilhite, 2000). Drought could be a regional or local phenomenon and its characteristics vary from a climate regime to some other (Iglesias *et al*, 2009). In addition is difficult to determine the severity of drought. This phenomenon is perceived as a hazard with a slowly development and has a prolonged length (Smith, 2000). The most serious outcome of drought, associated with social, economic and political factors, is famine. Its severity thus not only depends on the duration, intensity and geographical extent of water shortage conditions, but also on the degree of vegetation and human activities dependent on water (Murad, 2010).

One of the principale threats in water resources management is the uncertainty of The climatic environment. Drought as environmental phenomenon is an integral part of climatic ariability (Knutson, 1998). Droughts are regional / local events and their appearances are governed by regional climatic parameters such as precipitation, evapotranspiration, temperature etc. So the consequences of this event vary in accord to climatic regimes on all sides the world (Byun, 1991).

Remote sensing (RS) technology can be used to monitor effectively over large areas of drought. Satellite-borne remote sensing data gives a synoptic view of Earth surface, so can be used to evaluate drought occurrence spatially. Have been developed and applied, a few remote-sensed drought indices, which including duration, spatial extent, intensity, and severity (Ji, 2003; Sivakumar, 2004; Sruthi *et al*, 2015). One of this is VCI.

In this study was used VCI to evaluated drought of Iasi and was analyzing characteristics of DEM for zone with different degrees of drought.

MATERIAL AND METHODS

Study Area

Study Area, geographically, is situated on latitude 47°32'N to 46°49'N and longitude 26°36'E to 28°05'E. The local climate is continental with minimal rainfall and with large temperature

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differences between the seasons (www.wikivoyage.org).

Neighborings Iaşi county are Botosani to the North, Neamt to the West, Vaslui to the South and Rep. of Moldova to the East. Iasi County overlay on: Jijia Hills, Suceava Plateau and Central Moldavian Plateau, 3 main subunits of the Moldavian Plateau, and has a area of 5497 km^2. This administrative unit is hit by heavy rains, floods, droughts and at larger periods of time by landslide events and earthquakes (Margarit et al., 2014).

Landsat Data

The Landsat 8 satellite payload consists of 2 science instruments the Operational Land Imager (OLI) and the Thermal Infrared Sensor (TIRS). These 2 sensors provide seasonal coverage of the global landmass at a spatial resolution of 30m (Vis, NIR, SWIR); 100m (thermal) and 15m (panchromatic) (landsat.gsfc.nasa.gov). Landsat 8 was developed as a collaboration between NASA and the USGS.

Landsat data was offered free by USGS and in this paper was used images taken on 21st April and 7th May.

Preprocessing of the Landsat-8 OLI images suppose operations that prepare images for subsequent analysis that try to compensate/ correct for systematic errors. The data are subjected of a few corrections like radiometric or atmospheric (miningeology.blogspot).

Data processing

Land surface temperature (LST)

LST is a key parameter in the physics of land surface processes. That parameter combining the energy fluxes between atmosphere and ground and surface-atmosphere interactions (Mallick et al., 2012).

In this study, the method used for estimating LST was proposed, in 2016, by Advan, Jovanovska and Orhan (Advan, Jovanovska, 2016; Orhan et al., 2016).

Normalized Difference Vegetation Index

NDVI was first suggested by Rouse (1973) and is a numerical indicator that uses the visible (Vis) and near-infrared (NIR) bands of the electromagnetic spectrum. Scientific community adopted to analyze RS measurements and assess whether the aim being observed contains live green vegetation or not (John Rouse, 1973). The formula to calculated NDVI values suppose subtracts the red reflectance values from the near-infrared (NIR) and divides it by the sum of them.

$$NDVI=\frac{(NIR-RED)}{(NIR+RED)}$$

Vegetation Health Index (VHI), Vegetation Condition Index (VCI) & Temperature Condition Index (TCI).

VCI is defined by formula:

$$VCI=\frac{NDVI-NDVI_{min}}{NDVI_{max}-NDVI_{min}}*100$$

where $NDVI_{max}$ and $NDVI_{min}$ represent maximum and minimum values of Rouse's index. The VCI is used, by researchers, to monitor weather related variations, like drought and is one of the most important vegetation indicators (Quiring, 2010). If areas present condition like soil wetness or cloudiness, NDVI, the most popular vegetation index, is improper and for this situation VCI is a better index to interpret a event like the drought. VHI, a combination of VCI and TCI can differentiate droughts from excessive soil wetness or cloudiness (Kogan, 1995; Kogan et al., 2011):

$$TCI=\frac{LST_{max}-LST}{LST_{max}-LST_{min}}*100$$

$$VHI=a*VCI+(1-a)*TCI$$

where the TCI represents the stress of temperature and „a" is a coefficient that quantified the relative contributions of moisture and temperature of the vegetation health. LST_{max} and LST_{min} represent the maximum and minimum of LST map. Because the contributions of moisture and temperature to vegetation health are unknown for a specific location at some periods, the coefficient "a" was often assumed equal for simplicity with 0.5.

VHI range from 0 to 100 with next 5 drought classes: extreme drought (0-10), severe drought (10-20), moderate dought (20-30), mid drought (30-40), no drought (40-100).

Slope aspect and curvature

Formally, slope, can be described by a plane at a tangent to a point on the surface and has two components:

- Gradient - maximum rate of change of the elevation of the plane (angle that the plane makes with a horizontal surface)
- Aspect - direction of the plane with respect to some arbitrary zero (north) (www.geo.uzh.ch).

Curvature represents the rate of change of slope. According to Evans (1980) exists two important components, both of which can be convex, concave or planar (www.geo.uzh.ch).

RESLUTS AND DISCUSSION

Figure 1 shows LST, NDVI, VCI, TCI, VHI maps and DEM analysis.

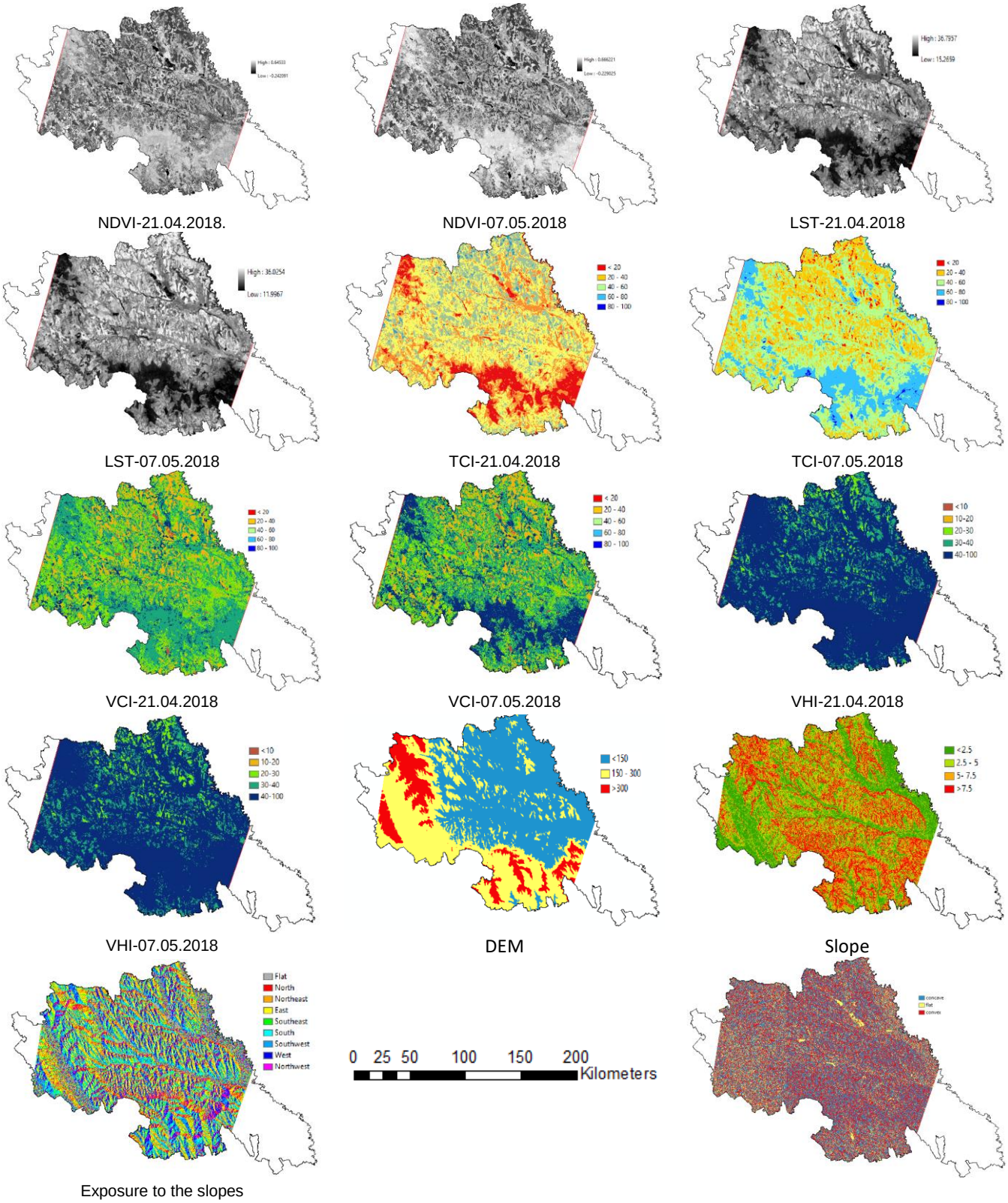

Figure 1. LST, NDVI, TCI, VCI, VHI maps and DEM analysis

NDVI value on 21st April varies between -0.242 and 0.645 with mean value 0.293. That figures indicated that vegetation is not so developed. On 7th May mean value for NDVI is high, 0.348, and it noticed that vegetation has been developed. At this moment NDVI values varies between -0.229 and 0.666.

LST varies between 15.26^0 and 36.79^0 for data taken in April with mean teperature 25.11^0. On 7th May mean temperature is about the same value 24.71^0.

Analyzing areas affected by drought using TCI it was noticed that in April areas affected by drought is larger comparative with May.

VCI indicated that areas affected by drought is about the same in April and May. For areas covered by dense vegetation in May VCI indicates that these zones is more wet as against April.

VHI is usually used to detect areas affected by severe drought. For these Landsat images analyzed was noticed that large areas was not affected by drought. Some zones were affected by moderate and mid drought – about the same for April and May. For these areas were made analysis to determine any conections between drought and altitude, gradient of slopes and exposure of slopes. Areas affected by moderate and mid drought have slope between 0^0 and 7.5^0, mostly between 5^0 and 7.5^0. Zones with slopes over 7.5^0 affected by drought is insignificant. Exposure of slopes for areas affected by drought is preponderant east and north-east.

CONCLUSIONS

In this paper was evaluate drought, for Iasi county, using VCI, TCI and VHI – to determine areas affected by severe drought. These indices is based on NDVI and LST. NDVI values indicates that vegetation has been developed between 21st April and 7th May. LST values was about the same for images analyzed for study area.

Analyzing areas affected by drought using TCI it was noticed that in April areas affected by drought is larger comparative with May. VCI indicated that areas affected by drought is about the same in April and May. For areas covered by dense vegetation in May VCI indicates that these zones are more wet as against April.

Areas affected by moderate and mid drought, determined using VHI, have slope between 0^0 and 7.5^0, mostly between 5^0 and 7.5^0. Zones with slopes over 7.5^0 affected by drought is insignificant. Exposure of slopes for areas affected by drought is preponderant east and north-east.

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