Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2020; 9(5): 1716-1721
Received: 16-07-2020
Accepted: 18-08-2020

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Spatial and temporal variation of normalized difference vegetation index (NDVI) in the Uben river basin of Gujarat

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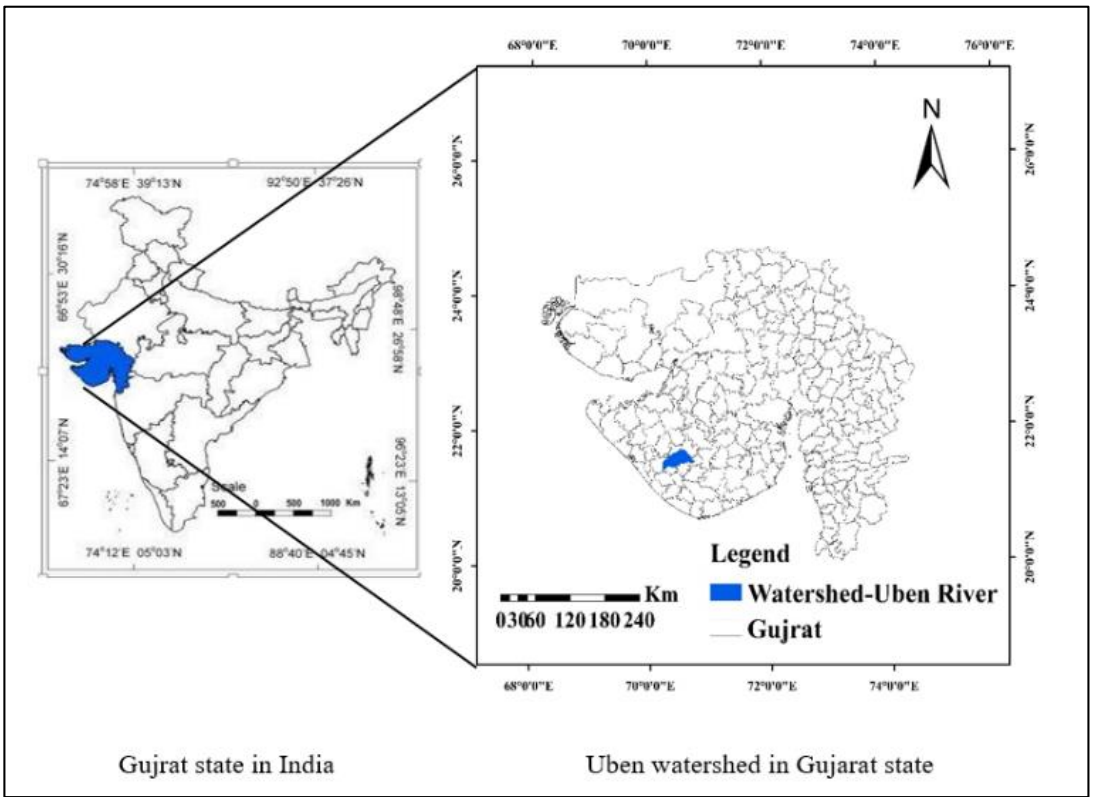
DOI: https://doi.org/10.22271/phyto.2020.v9.i5x.12588

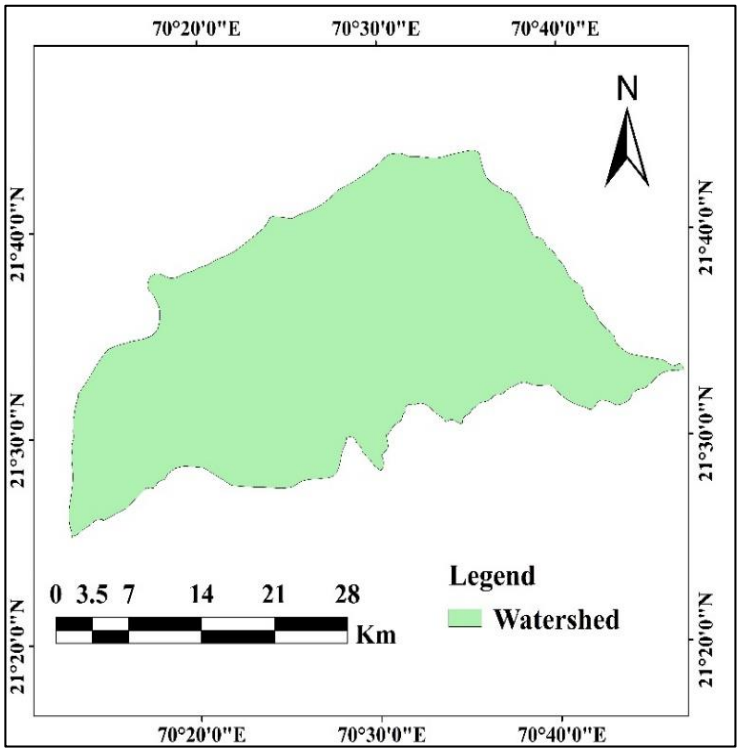
Abstract
The Normalized Difference Vegetation Index (NDVI) is important indicators for monitoring of vegetation status. The remote sensing based bio-physical variable maps were used to estimate NDVI in Uben river catchment and command area of Gujarat state, India. Multi date satellite images of Landsat-8 for Rabi season, year 2018-19 were used in the ArcGIS 10.3 software to derive the Normalized Difference Vegetation Index (NDVI). The maximum NDVI in the study area was 0.566 on February 19, 2019.The minimum NDVI in the study area was -0.327 on February 19, 2019. The average NDVI value ranges from -0.132 to 0.368 for wheat crop, 0.092 to 0.294 for coriander crop, 0.098 to 0.204 for cotton crop and 0.083 to 0.103 for waste land.The average NDVI value for wheat and coriander crop was increase from Initial stage to Mid-crop growth stage and then decreased during End season stage. The cotton crop shows higher NDVI value in December *i.e.* 0.204 then decreased due to harvesting of cotton. The average NDVI values in waste land were less as compared to agricultural land with crop and forest area due to no vegetation and exposed soil.

Keywords: Spatial and temporal variation, NDVI

Introduction
The Multi Spectral Remote Sensing images are very efficient for obtaining a better understanding of the earth environment (Ahmadi and Nusrath, 2012) [1]. It is the Science and Art of acquiring information and extracting the features in form of Spectral, Spatial and Temporal about some objects, area or phenomenon, such as agriculture land, urban area, vegetation and water resources without coming into physical contact of these objects (Karaburun and Bhandari (2010) [5]. The Normalized Difference Vegetation Index (NDVI) are considered indicators of plant growth and can be employed in the determination of correlated biophysical variables, such as the leaf area index (LAI), biomass, photosynthetic activity and grain yields. The NDVI can monitor vegetation status and stress, specifically in relation to water stress and the surface temperature (T_s) will rise rapidly with water stress. The potential for obtaining soil moisture by using the relationship between remotely-sensed T_s and NDVI has been investigated by several authors in their studies (Goetz, 1997; Goward *et al.*, 2002; Sandholt *et al.*, 2002) [3, 4, 9]. The present study was undertaken in the Uben river catchment and command area located in Junagadh district of Gujarat, India. In the study the vegetation status was estimated using remote sensing.

Study area and data collection
The experiment was conducted in the Uben river catchment and command area of Gujarat state (Fig. 1). The latitude and longitude of the study area are 21°25'31" N to 21°44'36" N (North latitude) and 70°12'32" E to 70°47'25" E (East longitude).





Uben catchment and dam command area

Fig 1: Location map of study area

Data Collection

The temporal satellite images of Landsat 8 were downloaded from USGS website (www.earthexplorer.usgs.gov) of Path 150 and Row 045for study area.The Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS) are instruments on board the Landsat 8 satellite, which was launched in February 2013.The satellite collects images of the Earth with a 16-day repeat cycle, referenced to the WRS-2. The approximate scene size is 170 km north-south by 183 km east-west. Landsat 8 provides spectral band files in GeoTIFF format. The Remote sensing and GIS software used for the study was ESRI's ArcGIS-ArcMap 10.3. The detail of different resolutions of Landsat-8 is given in Table 1.

Table 1: Band Designation in Landsat Data

Landsat-8							
Sr. No.	**Band**	**Wave- length (micr-ometer)**	**Spatial Resolution (meter)**	**Sr. No.**	**Band**	**Wave-length (micr-ometer)**	**Spatial Reso-lution (meter)**
1.	Band 1-costal Aerosol	0.43- 0.45	30	7.	Band 7 –SWIR 2	2.11- 2.29	30
2.	Band 2-Blue	0.45- 0.51	30	8.	Band 8 –Panchromatic	0.50 - 0.68	15
3.	Band 3-Green	0.53- 0.59	30	9.	Band 9 – Cirrus	1.363-1.384	30
4.	Band 4-Red	0.64- 0.67	30	10.	Band 10 - Thermal Infrared (TIRS) 1	10.60- 11.19	100× (30)
5.	Band 5-Near Infrared (NIR)	0.85- 0.88	30	11.	Band 11 - Thermal Infrared (TIRS) 2	11.50-12.51	100× (30)
6.	Band 6-SWIR 1	1.57- 1.65	30				

(www.earthexplorer.usgs.gov)

Methodology

Normalized Difference Vegetation Index (NDVI) calculated from reflectance measured in the visible and near infrared channels. NDVI uses the visible and near-infrared bands to measure the density and vigor of green vegetation by comparing the amount of visible light reflected to the amount of near-infrared light reflected. The principle of applying NDVI in vegetation mapping is that vegetation is highly reflective in the near infrared and highly absorptive in the visible red. The contrast between these channels can be used as an indicator of the status of the vegetation. In addition to providing an indication of the 'greenness' of the vegetation, these two spectral bands are chosen because they are most affected by the absorption of chlorophyll in leafy green vegetation and by the density of green vegetation on the surface. Also, in red and near-infrared bands, thecontrast between vegetation and soil is at the maximum. The Normalized Difference Vegetation Index (NDVI) was introduced by Rouse *et al.* (1973) [8]. The NDVI was computed using the following formula.

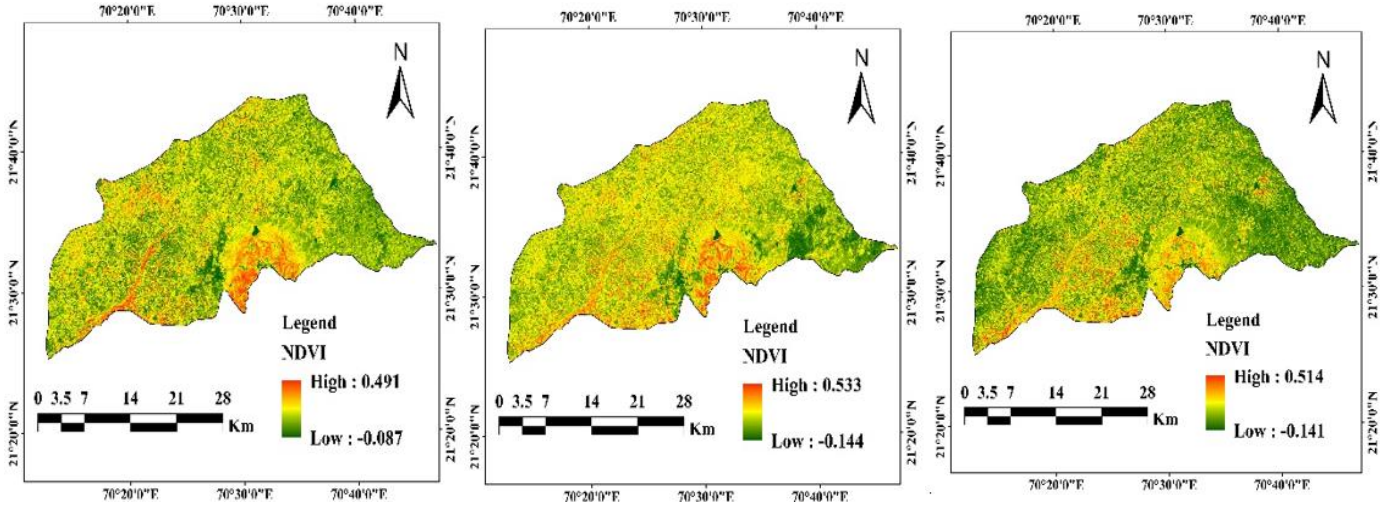
$$NDVI=\frac{(NIR-R)}{(NIR+R)} \quad \ldots (1.0)$$

Where,
NIR=Reflectance in the near-infrared band
R=Reflectance in the red visible band.

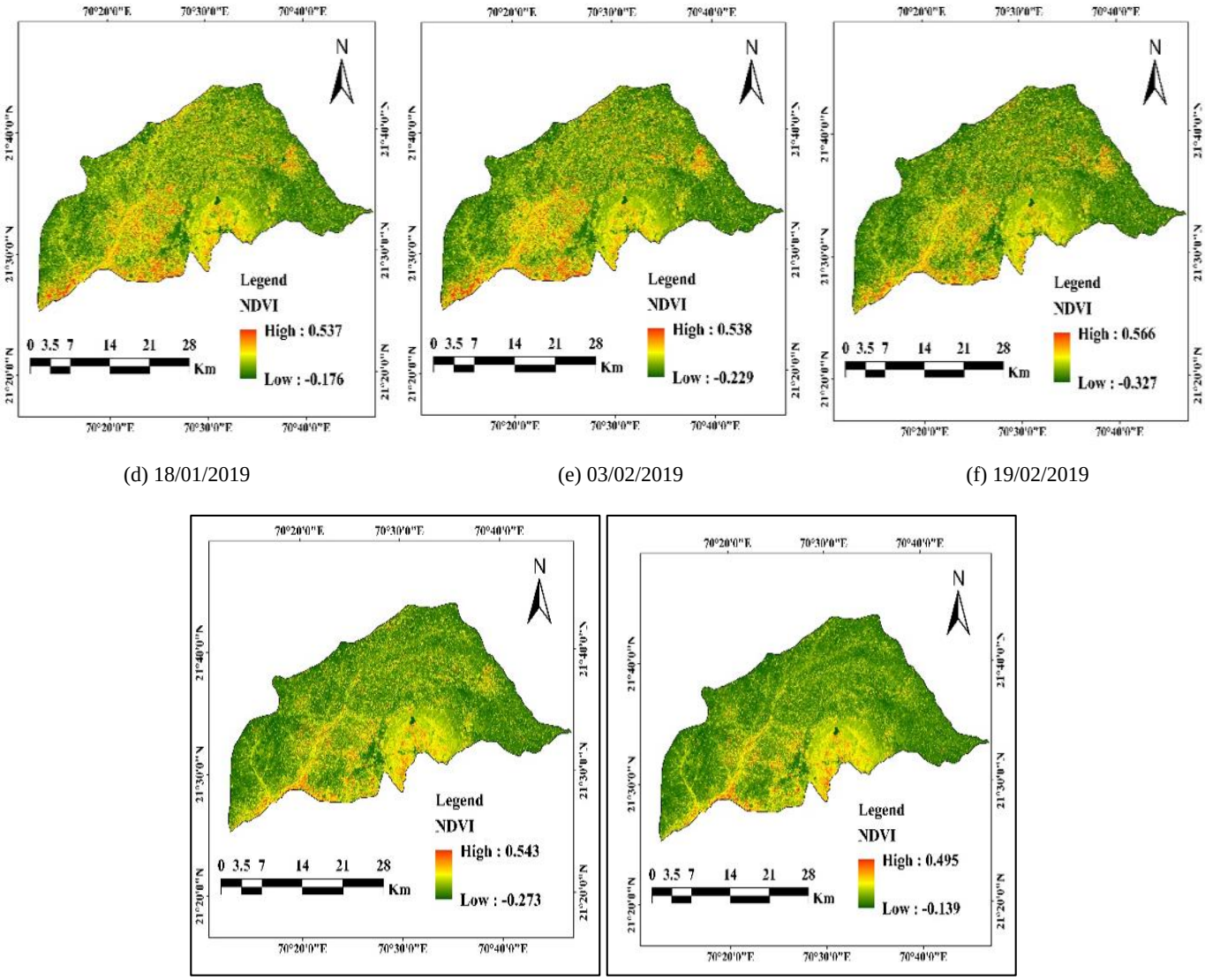
The chlorophyll (green pigment) absorbs incoming radiation in the visible band, while the leaf structure and water content is responsible for a very high reflectance in the near-infrared region of the spectrum. NDVI has been correlated to a variety of vegetation parameters, including quantity, productivity, biomass, etc. NDVI ranges from −1 to +1, with +1 indicating healthy vegetation cover, lower values representing stressed vegetation, negative values representing open water or high moisture content, and 0.1 value, indicating bare soil (Ghebrezgabher *et al.*, 2016) [2]. Thus, the valid data used in the analysis was from 0.1 to 1.0. The raster calculator of ArcGIS 10.3 was used to prepare the NDVI map for Landsat images.

Results and Discussion

The Normalized Difference Vegetation Index (NDVI) was used to examine the relation between spectral vegetation variability and the changes in vegetation growth rate. Higher values of NDVI indicate good and healthier vegetation. Lower values were found the less vegetated soils and presumably because reflection from the soil was high and produce low values in near infra-red band and high values in red band; hence the NDVI values were low. The NDVI maps were prepared for acquired Landsat-8 images for different dates i.e. December 01, 2018; December 17, 2018; January 02, 2019; January 18, 2019; February 03, 2019; February 19, 2019; March 07, 2019; March 23, 2019.



(a) 01/12/2018 (b) 17/12/2018 (c) 02/01/2019



(d) 18/01/2019 (e) 03/02/2019 (f) 19/02/2019

(g) 07/03/2019 (h) 23/03/2019

Fig 2: (a to h) NDVI maps of study area using Landsat images

The values of NDVI in the study area for Rabi season, 2018-19 were ranged from -0.087 to 0.491, -0.144to 0.533, -0.141 to 0.514, -0.176 to 0.537, -0.229 to 0.538, -0.327 to 0.566, -0.273 to 0.543 and -0.139 to 0.495 for the December 01, 2018; December 17, 2018; January 02, 2019; January 18, 2019; February 03, 2019; February 19, 2019; March 07, 2019 and March 23, 2019 respectively. The maximum NDVI in the study area was 0.566 on February 19, 2019.The minimum NDVI in the study area was -0.327 on February 19, 2019. The highest value of NDVI *i.e.* 0.566 was observed (red color in map) on February 19, 2019 and after that the values decreased. The highest value of NDVI was observed in forest areas as compared to other land use (Rizvi *et al*., 2009) [7]. The NDVI values in wheat and coriander crop i.e. 0.368 and 0.294 respectively from December to January 18, 2019 and February 03, 2019 respectively due to crop growth stage and then after it was decreased.Koppada and Janagoudarb (2017) [6] reported that NDVI value for cropped land varies between 0.14-0.37. This decrease in the NDVI value was due to the harvesting stage of crop. NDVI map was also shows that in month of December maximum area was under crop and then after area under crop decreased due to harvesting of cotton crop. Theriver basin area and Girnar forest (southern part of the study area) shows higher NDVI values. The minimum area under higher value of NDVI was observed during month of March, 2019.

Temporal Variability of Normalized Difference Vegetation Index (NDVI) for Different Land Use

There are total nineteenlocations were selectedfrom study area; from which nine location indicate wheat crop, three location indicate coriander crop, three location indicate cotton crop and other four location indicate waste land. The NDVI for different land uses and temporal variability of NDVI for period of December 1, 2018 to March 23, 2019 is given in Table 2. The trends of NDVI for different land use are shown in Fig. 3.

Table 2: Normalized Difference Vegetation Index (NDVI) values for different land use

Date	NDVI				Average NDVI value
	Wheat crop	Coriander crop	Cotton crop	Waste land	
01/12/2018	0.132	0.134	0.186	0.103	0.135
17/12/2018	0.269	0.183	0.204	0.093	0.208
02/01/2019	0.333	0.219	0.151	0.083	0.234
18/01/2019	0.368	0.287	0.131	0.085	0.258
03/02/2019	0.309	0.294	0.105	0.091	0.228
19/02/2019	0.257	0.254	0.115	0.102	0.202
07/03/2019	0.166	0.103	0.105	0.092	0.131
23/03/2019	0.147	0.092	0.098	0.094	0.119

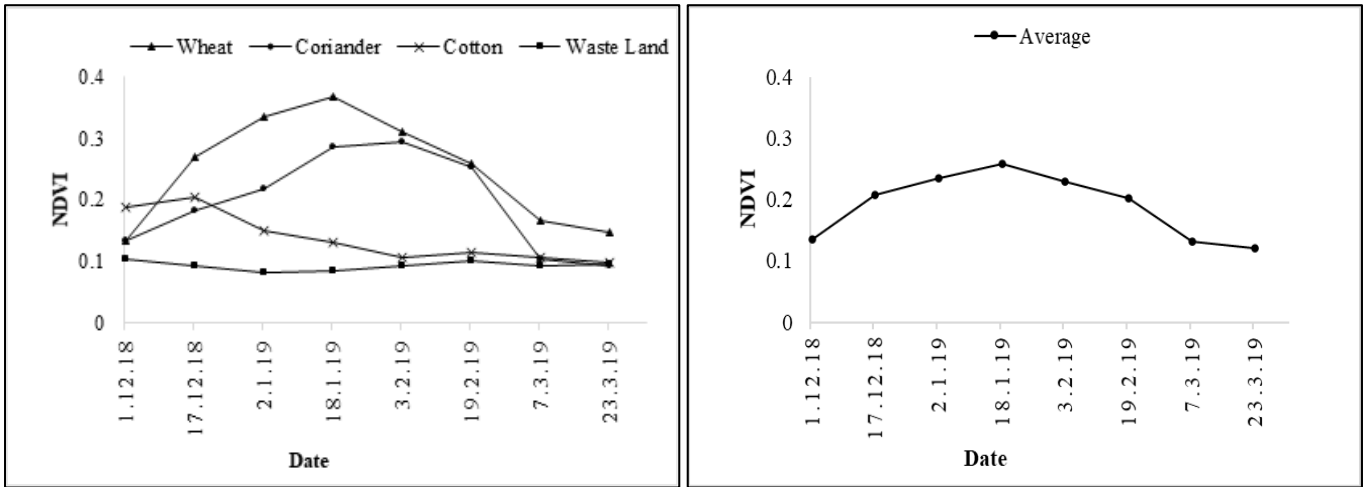


Fig 3: Temporal Variability of average NDVI for different Land Use

Conclusions

The average NDVI value ranges from -0.132 to 0.368 for wheat crop, 0.092 to 0.294 for coriander crop, 0.098 to 0.204 for cotton crop and 0.083 to 0.103 for waste land.In wheat and coriander crop NDVI increases up to 0.368 and 0.294 respectively from December 1, 2018 to January 18, 2019 and February 03, 2019 respectively and then after NDVI decreases towards the end crop season. Koppada and Janagoudarb (2017) [6] reported that NDVI value for cropped land varies 0.14-0.37. The average NDVI values remain almost same as the behavior of NDVI values for particular locations. The higher values of NDVI were observed in wheat and coriander crop as compare to cotton crop and waste land. From the December to last week of January NDVI values increases in wheat and coriander crop which shows higher crop growth soil moisture after that the NDVI values decreased *i.e.* during harvesting stage of the crop. In cotton crop NDVI was higher in December and then it was decreased due to harvesting of cotton in January month. The NDVI value of cotton and waste land became same after harvesting of cotton crop. The NDVI value of waste land area shows uniform trend.

Abbreviation and symbol

et. al.	:	and others
etc.	:	and other things
Eq.	:	Equation
Fig.	:	Figure
GIS	:	Geographic Information System
i.e.	:	That is
J.	:	Journal
NDVI	:	Normalized Difference Vegetation Index
NIR	:	Near Infrared
OLI	:	Operational Land Imager
Ta	:	Atmospheric Temperature
Ts	:	Surface Temperature
TIRS	:	Thermal Infrared Sensor
USGS	:	United States Geological Survey
VI	:	Vegetation Index
WSN	:	Wireless Sensor Network

Application of Research

The NDVI shows status of crop vegetation. Therefore, from NDVI crop growth stage can be finding. Remote sensing based NDVI is very useful for drought monitoring in large scale area. Also from NDVI land use map are prepared.

Research Category: Remote sensing

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