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Application of NDVI in Vegetation Monitoring using Sentinel -2 Data for Shrirampur Region of Maharashtra

P. Ubale Sonali[1*], Jakku Prasanna[2], A. A. Atre[3], C. Pande[3] and S. D. Gorantiwar[3]

[1]Department of Botany, [2]Division of Agronomy, College of Agriculture, Pune College of Agriculture, Pune, India
[3]M. P. K. V. Rahuri, India

**Corresponding author*

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A B S T R A C T

Vegetation is a key component of ecosystem and its plays most important role for stabilizing global environmental. Normalized Difference Vegetation Index (NDVI) and Soil Adjusted Vegetation Index(SAVI) known as a remote sensing techniques which are used to quantifying and classify vegetation cover over land. Hence the major objective of this paper is assessment of vegetation monitoring with the help of indices like NDVI and SAVI using Sentinel-2 time series image data for November 2019 and December 2019in the Arc GIS 10.1 software. In this study, NDVI analysis for classify vegetation cover and detect change using November, 2019 to December, 2019 satellite images was analysed. Minimum, Average and maximum value of NDVI and SAVI was calculated for month Nov and Dec, 2019. Accordingly vegetation cover is classified as dead, stressful and healthy vegetation. In addition, the Spearman's correlation coefficients between the VIs values in healthy stressful and dead vegetation between SAVI and NDVI were 0.870 and 0.957 for month November and December respectively. Area for all three vegetation classes was calculated by doing supervised classification of NDVI of both month. The result showed that the average vegetation cover was decreased in the month of December and healthy vegetation was found more in month of November as compare to December. This shows that NDVI and SAVI indices forSentinel-2 images can be used for vegetation monitoring.

Introduction

Vegetation is an assemblage of plant species and the ground cover or land cover they provide.(Burrows, 1990). Vegetation cover plays a key role in terrestrial biophysical process and is related to a number of ways to the dynamics of global climate. Changes in land cover induced by human activity have profound implications on climate (Dickinson *et al.,* 1986, Lean and Warrilow, 1989). Vegetation monitoring is one of the most important applications of remote sensing usually it provides information by dividing the land cover into different classes based on its land resources (Munawar, 2013). Vegetation plays an important role in providing different ecosystem services and goods so as to adapt and mitigate the global climate change. If the name of the economy comes to India, then it has the most important role of agriculture sector. The whole economy of India is dependents upon agriculture. Therefore, if agriculture is called a back bone of India, it will not be exaggerated. Agriculture is the primary source of livelihood for about 58 per cent of India's population and India is the world's largest producer of wheat, pulses, rice, spices. Where India is growing steadily in the field of agriculture there is also an increasing demand for vegetation monitoring in agriculture sector. In such a way Vegetation indices plays an important role for vegetation monitoring.

The concept of normalized difference vegetation index (NDVI) lies with the fact that plants have evolved to reflect near-infrared light, where visible light is strongly absorbed by almost all plants in photosynthesis. The measure is thus an index of these two aspects, helping to show how vigorous plant growth is happening in regions. (Marks Altaweel, 2017) Calibrated results can then be used to estimate vegetation growth and overall biomass, as more vegetation growth will affect the ratio of visible light absorbed and near-infrared light reflected. (Shunlin Liang 2008). Overall, it is the simplicity of the NDVI technique and its applicability to vegetation-base studies that have helped to make it perhaps the most extensively used in categories of remote sensing techniques used to monitor agriculture and plant growth.

The interaction of electromagnetic radiation with vegetation forms the basis of one of the most widespread applications of remote sensing in natural resource management. Green vegetation reflects different amounts of incident radiation in different portions of the electromagnetic spectrum. The most widely used portions of the electromagnetic spectrum for vegetation analysis are the red and near-infrared (NIR) ranges. Vegetation response (i.e. the amount of light reflected) in the red band is very low due to high absorption of incident radiation (by chlorophyll – the pigment in plant leaves). On the other hand, response in the NIR is very high due to high reflection of incident radiation. In-between these two bands is the red-edge channel/range, which is equally useful in vegetation analysis. Together, these spectral ranges give a measure of the chlorophyll content in vegetation.

Spectral vegetation index data have been used to investigate the interactions between climate and landscape ecosystems, monitor the effects of floods, drought, fire and desertification, aid with land management and sustainability, investigate climate change and carbon sequestration, and assess natural resources, agricultural production and food aid (Myneni *et al.,* 1997, Nemani *et al.,* 2003, Seelan *et al.,* 2003, Yang *et al.,* 1998).Global, regional and local natural resource survey and assessment strategies are increasingly incorporating remotely sensed imagery to monitor current and historical vegetation dynamics and often rely on the combined use of multi-sensor vegetation data. Various studies have shown the effectiveness of satellite imagery in classifying heterogeneous vegetation cover (Joshi *et al.,* 2006) A rising number of national, regional and local users and applications are employing geospatial tools that incorporate time series of spectral vegetation index data and other reference data such as roads, rivers and soil information for spatially and temporally explicit natural resource and agricultural monitoring.

A vegetation index is a vegetation indices or indicator that make apparent or make clear the greenness, the relative density and health of vegetation for each pixel or picture element or in a satellite image. Vegetation indices (VIs) are mathematical combination of ratios of mainly red, green and infrared spectral bands. Although, several vegetation indices are being used but the most widely used vegetation indices is Normalized Difference Vegetation Index (NDVI) which has been used for the last 20 years or more for monitor vegetation stress. The normalized difference vegetation index (NDVI) is a simple graphical indicator that is used to analyse remote sensing measurements. The main objective to calculate NDVI is to quantifying the healthy green vegetation (Green Cover, Grassland, vegetation) on the basis of satellite images. It takes advantage of the differential reflection of green vegetation in the visible and near-infrared (NIR) portions of the spectrum and provides information on the vegetation condition.

Present study were done with objectives that 1.To determine dead, stressful and healthy vegetation over particular area.2. To determine usefulness of vegetation indices like NDVI and SAVI for vegetation monitoring.

Materials and Methods

Study area

The study is conducted for Shrirampur taluka in Ahmednagar district in the Indian state of Maharashtra situated at 19.62 N, 74.66 E in western Maharashtra. (Fig.1)Total area of Shrirampur taluka is 569.87KM^{2}.Main water resources of the district are the rivers, dam and groundwater.

Climate

Shrirampur has a tropical wet and dry climate with average temperatures ranging between 20 to 42 °C (68 to 108 °F).Shrirampur experiences three distinct seasons: Summer, Monsoon and Winter. Typical summer months are from March to May, with maximum temperatures ranging from 30 to 40 °C (86 to 104 °F). Arid dry climate and well established irrigation system makes Sugarcane an ideal cash crop. Shrirampur is considered as one of the major producers of sugarcane in the sugarcane belt in the state of Maharashtra.

2-3 used data

To achieve the objective of this study, Sentinel 2 data is downloaded from the USGS (United State Geological Survey) Earth explorer website (earthexplorer.usgs.gov) for month November and December, 2019both raster and vector data was used. The Sentinel-2collects high-resolution multispectral imagery useful for a broad range of applications, including monitoring of vegetation, soil and water cover, land cover change, as well as humanitarian and disaster risk. Resolution is about 10 m. Sentinel 2 was used to prepare NDVI and SAVI map for given study area.

2-4 Vegetation indices

Firstly, Sentinel 2 data for month November and December, 2019 was downloaded from USGS (United state geological survey) and processed in Arc map 10.2 software. The data is processed under NDVI and SAVI to extract the vegetation information.

NDVI (Normalized Difference Vegetation Index)

The NDVI is a simple numerical indicator that can be used to analyse the remote sensing measurements, from a remote platform and assess whether the target or object being observed contains live green vegetation or not. NDVI Stands for Normal Difference Vegetative Index, which gives the vegetative proportions in an area. In other words, on a pixel by pixel basis subtracts the value of red band from the value of NIR band and divides by their sum. The formula to calculate NDVI is shown below.

NDVI= (NIR-Red) / (NIR+Red)

Where RED is visible red reflectance, and NIR is near infrared reflectance. The wavelength range of NIR band is (750-1300 nm), Red band is (600-700 nm). The NDVI is motivated by the observation vegetation, which is the difference between the NIR and red band. It should be larger for greater chlorophyll density. The value of NDVI ranges from -1 to +1. Very low value of NDVI (0.1 and below) correspond to barren areas of rock, building, sand, snow or non-cropped area were represented as dead vegetation. Moderate values (0.2 to 0.3) correspond to shrub and grassland were represented as stressful vegetation while high value (0.6 to 0.8) indicates temperate and tropical rainforests, agricultural crop land represented as healthy vegetation. In other words, the degree of greenness is equal to the chlorophyll concentration. NDVI values vary with the absorption of red light by plant chlorophyll and the reflection of infrared radiation by water-filled leaf cells. All visible ranges are captured by the Satellite camera in form of bands through which features can be extracted after applying the NDVI method for different characteristics.

SAVI (Soil Adjusted Vegetation Index)

Generally vegetation indices derived from NDVI have shown that they are unstable in areas with different values of soil color, soil moisture and suffer from saturation effects by dense vegetation cover (Huete 1988; Wan *et al.,* 2004). For the first time the SAVI has been introduced by Huete (1988) to decrease the instability values by soil different colors which was based on simple radiative transfer. The SAVI results follow from this equation:

SAVI = ((1+L)*(NIR-Red)/(NIR+Red+L)

Where L is a canopy background adjustment factor which ranges from 0 for very high vegetation cover to 1 for very low vegetation cover. The most typically used value is 0.5 which is for intermediate vegetation cover and in present study we have used 0.5 for L.

The data is recoded in Arc map software and supervised classification of extracted NDVI of both month was done for three classes i.e. dead vegetation, stressful vegetation and healthy vegetation by taking training sets. Area for all three classes is calculated by converting supervised classified image from raster to polygon.

Statistical analysis

In the present study we have extracted two vegetation indices for all point samples by Arc GIS 10.1 software of which the values were analysed statistically based on Spearman correlation for 10 sample points from each classand comparison was done between both indices i.e.SAVI and NDVI.

Results and Discussion

The results of present study show that the average NDVI values of November month for dead, stress full and healthy vegetation are 0.22, 0.31 and 0.74 respectively. In addition, the average values of SAVI for same month for dead stress full and healthy vegetation are. 0.32, 0.478 and 0.825, respectively.

The results of present study show that the average NDVI values of December month for dead, stress full and healthy vegetation are 0.19, 0.28 and 0.56 respectively. In addition, the average values of SAVI for same month for dead stress full and healthy vegetation are

0.27, 0.43 and 0.79, respectively. All VIs in present study have used Red or Infrared bands in their equations, which represent the greenness conditions of aboveground biomass and vegetation cover. Area under healthy stress full and dead vegetation for both month was calculated and it were as follows:

Table.1 Area calculated by Supervised Classification NDVI image for month of November

S.N.	Classes	Area(Sq.Km)
1.	Dead vegetation	232.28
2.	Stress full vegetation	271.04
3.	Healthy Vegetation	291.74

Table.2 Area calculated by Supervised Classification NDVI image for month of December

S. N.	Classes	Area(Sq.Km)
1.	Dead vegetation	242.17
2.	Stress full vegetation	271.04
3.	Healthy Vegetation	319.62

Fig.1 Location of study area (Shrirampur)

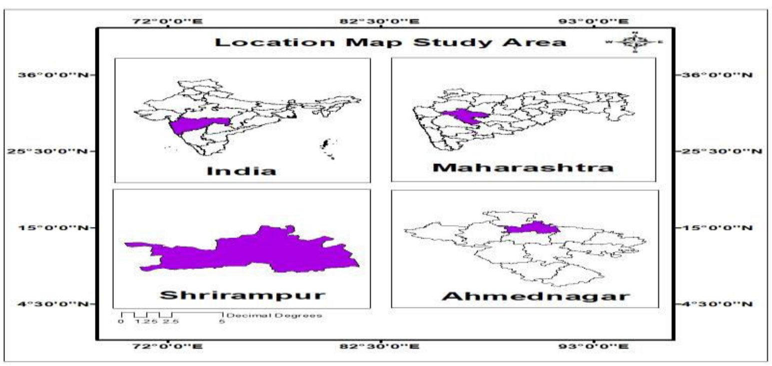


Fig.2 NDVI map for November, 2019

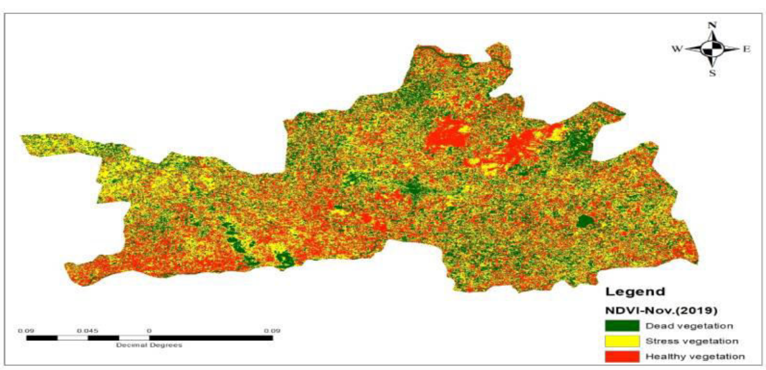


Fig.3 NDVI map for December, 2019

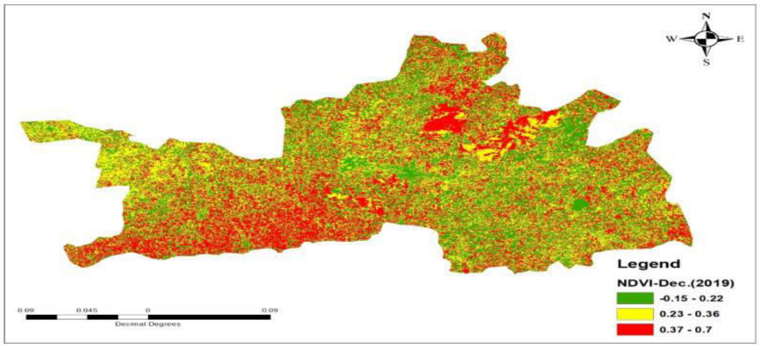


Fig.4 SAVI map for November, 2019

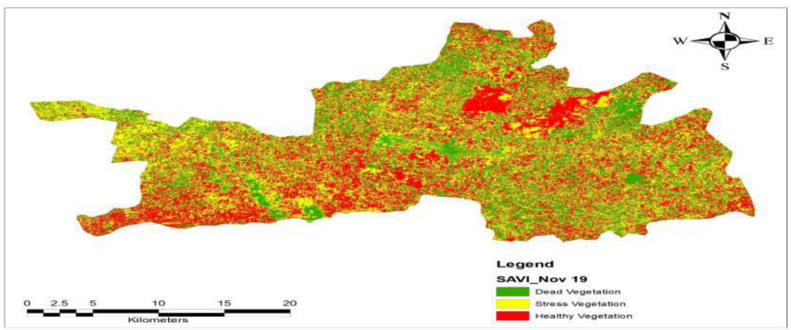


Fig.5 SAVI map for December, 2019

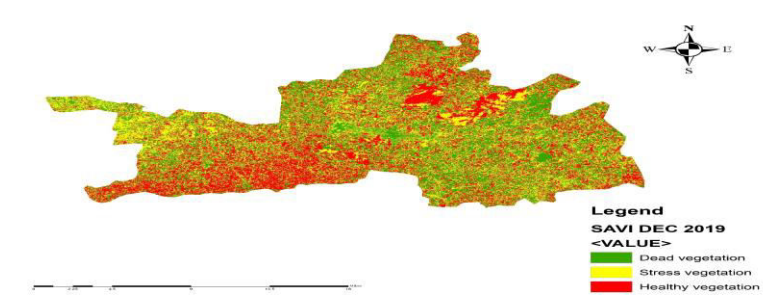


Fig.6 Supervised Classification map for November, 2019

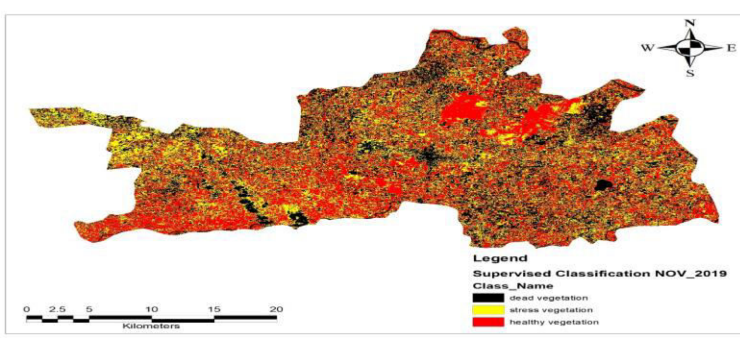


Fig.7 Supervised Classification map for December, 2019

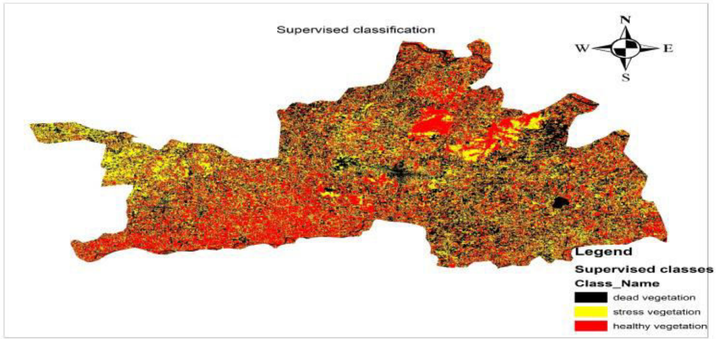


Fig.8 Correlation between SAVI and NDVI NOV 2019

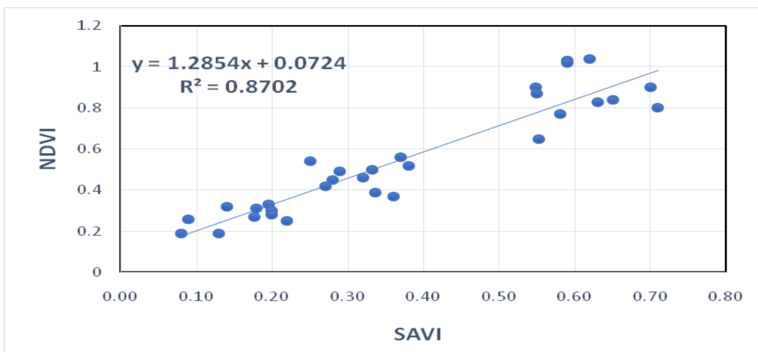
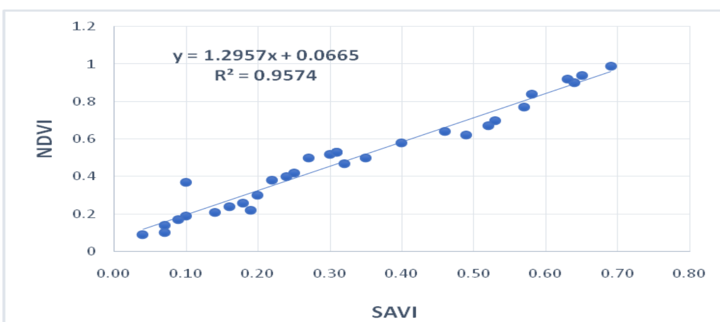


Fig.9 Correlation between SAVI and NDVI NOV 2019



In conclusion the study was focused on detecting vegetation condition with the help of satellite base vegetation indices. The study is conducted for Shrirampur taluka in Ahmednagar district in the Indian state of Maharashtra. From this study the following conclusion were made.

Range of NDVI (0.19 to 0.24) and SAVI (0.28 to 0.37) values for dead vegetation for month of November was low as compare to stress full and healthy vegetation. Values of NDVI for stress full vegetation was in range of 0.24 to 0.39 and SAVI values are in range of 0.37 to 0.58.Values of NDVI(0.39 to 0.71) and SAVI(0.58 to 1.07) for healthy vegetation was higher as healthy vegetation shows more reflectance.

Similarly, range of NDVI (-0.15 to 0.23) and SAVI (-0.22 to 0.32) values for dead vegetation for month of December was low as compare to stress full and healthy vegetation. Values of NDVI for stress full vegetation was in range of 0.22 to 0.36 and SAVI values are in range of 0.32 to 0.54..Values of NDVI(0.36 to0.70) and SAVI(0.54 to 1.04) for healthy vegetation was higher as healthy vegetation shows more reflectance.

NDVI and SAVI values for December month was lower as compare to November for healthy vegetation.

Area under healthy vegetation for December reduces by 12.68% as compare to area under healthy vegetation for month of November.

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