



VEGETATION ANALYSIS USING NORMALIZED DIFFERENCE VEGETATION INDEX (NDVI): A CASE STUDY OF SHERGARH WILD LIFE SANCTUARY

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Abstract: The objective of this work is to identify the changing pattern of existing vegetation and the decreasing trend of green plants coverage in a temporal scale of view in the study area using **NORMALIZED DIFFERENCE VEGETATION INDEX (NDVI)** technique based on Remote Sensing (RS) and Geographical Information System (GIS). The vegetation cover and its spatial distribution have significant effects on the framework and function of the ecosystem and so vegetation plays an important role in climate change, it is also a dominating factor in maintaining the functions of the Earth's ecosystem. The Shergarh sanctuary is located in Shergarh village, about 65 km from the Baran district in Rajasthan. It is located in the Baran district and is spread across 97 sq km near the Shergarh town. For developing NDVI of the study area, two images of sentinel- 2 (2015-2021) have been collected from the USGS (United States Geological Survey) earth explorer website. To investigate NDVI values, it is categorized into three different classes like areas with low (0.2-0.4), medium (0.4-0.6), and high (>0.6) vegetation density based on NDVI ranges of both 2015 and 2021 images. The study reveals that there is a decline in low-density vegetation in recent years while medium and high-density vegetation has increased during the period. 11.7 percent of total vegetation was reduced in six years.

Keywords: NDVI; Remote Sensing; vegetation; Shergarh wildlife sanctuary; sentinel- 2; climate change

1. INTRODUCTION

"The **NORMALIZED DIFFERENCE VEGETATION INDEX (NDVI)** is a dimensionless index that defines the change between observable and near-infrared reflectance of vegetation cover and can be used to estimate the density of green on an area of land" (Weier and Herring, 2000). NDVI is an extensively used technique to detect a change in Vegetation; it enumerates Vegetation by measuring the difference between near-infrared (which Vegetation strongly reflects) and red light (which Vegetation absorbs). Due to the increase in spatial and spectral resolution of remote sensing data, it is possible to work at the micro-level. Satellite images are the base to prepare NDVI in the GIS software, and forest eradication is measured through the NDVI technique. Noticing changes within a remotely sensed time series and classifying their driving mechanisms can help policymakers, natural resource administrators, and scientists to address many issues facing the planet, such as carbon budgets, global climate change, drought, and wildfires. Vegetation cover is a significant issue in a country like India, where growth is in process, and so much of the burden is on natural resources.

India's entire forest cover (TFC) is 7,12,249 square kilometers (km²), According to the 2019 "State of India Forest Report" (ISFR 2019) issued on December 30, 2019, Tree and forest cover comprises 24.56% (8,07,276 sq km) of India's total land area. In the last valuation, it was 24.39%. Where open and very dense forests

have amplified since the latest estimate and abstemiously dense forests have reduced. Based on the IRS Resourcesat-2 LISS III satellite data of the period October to December 2017, the State forest cover is 16,629.51 sq. km, representing 4.86% of the State's geographical area. The State has 77.81 sq km area under Very Dense Forest (VDF), 4,341.90 sq km area under Moderately Dense Forest (MDF), and 12,209.80 sq km area under Open Forest (OF) in terms of forest canopy density classes. The state's forest cover is 57.51 sq km greater than the previous valuation published in ISFR 2017. Overall, forest cover has amplified in recent years, but moderately dense forests have been in a decreasing position in some areas. This study also focuses on a moderately dense forest in the Shergarh wildlife sanctuary. The Shergarh sanctuary is situated in Shergarh village, about 65 km from the Baran district in Rajasthan. The main problem of this research work is environmental degradation, basically the elimination of trees in the protected forest areas. This work aims to recognize the changing pattern of existing Vegetation and the declining trend of green plants coverage in a temporal scale of view in the study area using the NDVI technique based on Remote Sensing (RS) and Geographical Information System (GIS). The vegetation cover and its spatial dispersal have essential effects on the framework and function of the ecosystem, and so Vegetation plays a significant role in climate change, it is also a controlling factor in maintaining the functions of the Earth's ecosystem.

2. THE STUDY AREA

One of the lesser-known wildlife destinations in Rajasthan, Shergarh, has located about 65 km from the Baran. It is situated in the Baran district and extends across 97 sq km close the Shergarh town (latitudes 24.61 degrees and 24.75 degrees, north and longitudes 76.44 and 76.56 degrees east). The sanctuary is recognized for its rich flora & fauna. Its major attractions are tigers, sloth bears, hyenas, deer species like chinkara (Indian gazelle), sambar, chital (spotted deer), and leopards. It was recognized as a protected area in 1983. Fort Shergarh borders the sanctuary, an ancient fort dating back to 790 A.D. Pilgrims pay homage to the fort every year, which has several Jain and Brahman shrines. Parban/Parvan River splits this sanctuary into two parts. The River has its foundation in Madhya Pradesh and crosses through Rajasthan. This is an tributery of Kali Sindh. Parvan originates from the Sehore district of Madhya Pradesh and in Rajasthan; it runs through the districts of Jhalawar, Kota, Baran of Rajasthan. It meets Kali Sindh in the Baran district of Rajasthan state.

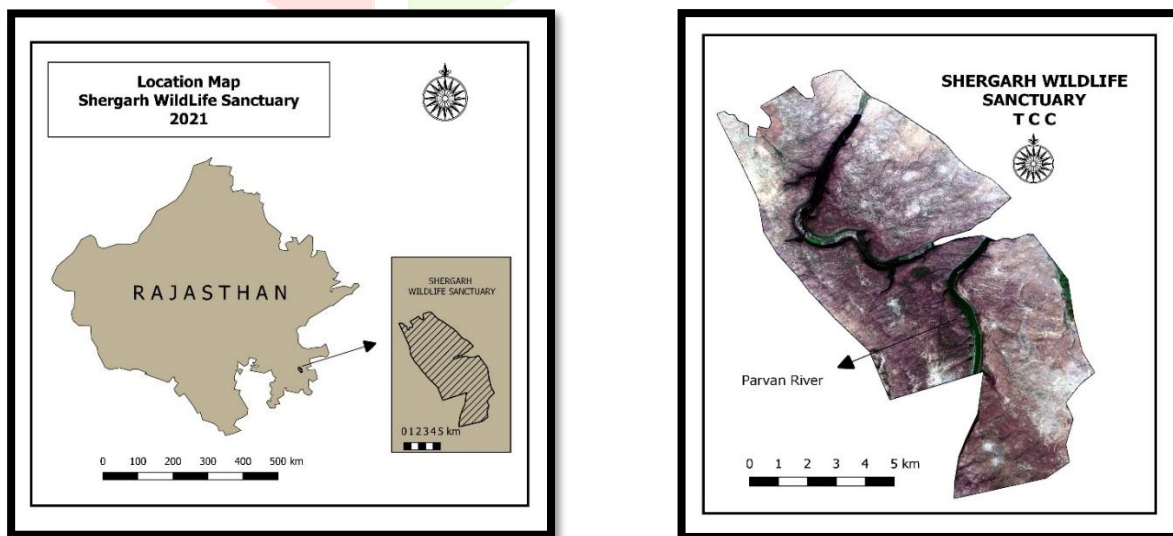


Figure 1.1 & 1.2 (Left and Right) Location map & TCC image of the study area.

3. OBJECTIVE

1. To find change in natural Vegetation of the Shergarh wildlife sanctuary using sentinel-2 data with the help of NDVI (**Normalized difference vegetation index**)(2015-2021).

4. DATA SOURCES AND RESEARCH METHODOLOGY

For developing NDVI, two images of sentinel- 2 have been downloaded from the USGS (United States Geological Survey) earth explorer webpage. With a resolution of 20m, the first image is from sentinel-2a taken on December 7 2015 with Zero percent cloud cover. The second image is from sentinel-2b taken on October 11 2021 with Zero percent cloud cover. Both images have been captured after the Monsoonal period. Both imageries have 10, 20, and 60 m resolution for different band sets. To understand the change in vegetation cover, NDVI has been prepared in Q-GIS open-source software. In pre-processing of the image geometric refinement or image registration, radiometric calibration and atmospheric correction have been applied. Normalized Difference Vegetation Index (NDVI) is an index of vegetation greenness or photosynthetic action. It is a generally used and easily calculated satellite image-based proxy for vegetation efficiency (Kunkel, 2011 and Scanlon, 2002). The NDVI is a simple arithmetical indicator (Demirel et al., 2010; Ricotta et al., 1999; Zhang et al., 2009) which is linked to Photosynthetically Active Radiation (PAR) and measures the ability of leaves (Malo et al., 1990) and gives a amount of the vegetative cover on the land surface over wide areas. This index shows a positive correlation with photosynthetic activity, vegetation cover, biomass, and Leaf Area Index (LAI) (Schmidt et al., 2000). The NDVI algorithm is computed by subtracting the red reflectance values from the near-infrared and dividing them by the sum of near-infrared and red bands. The function used such follow (Tucker, 1979) -

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

(Whereas NIR represents the spectral reflectance in a near-infrared band while RED represents the red band).

NDVI standards range from -1 to 1. The very low value of NDVI corresponds to barren parts of rock, sand, snow, cloud, etc. Moderate values signify shrub and grassland, while high values indicate temperate and tropical forest. Bare soil is illustrated with NDVI values near 0 and water bodies are represented with negative NDVI values (Karaburun, 2010; Chouhan and Rao, 2011; Ramchandra and Kumar, 2004; Xie et al., 2010). The objects designated by different NDVI values are given in table 1.

Table 1.1 NDVI range and concerned objects

Range of NDVI Value	Name of the Objects
Water Body	-1-0
Bare Soil, Rock, Sand and Snow, Cloud	0-0.2
Shrub and Grassland	0.2-0.4
Sparse and Unhealthy Forest	0.4-0.6
Dense and Healthy Forest	0.6-1

The NDVI method is easy to implement and simple to interpret, but it has many flaws. Satellite-based NDVI is influenced by several non-vegetation factors: atmospheric conditions (e.g., clouds and atmospheric path-specific variables, aerosols, water vapor), satellite geometry and calibration (view and solar angles), as well as soil backgrounds and crop canopy (Holben, 1986; Soufflet et al., 1991; Justice et al., 1991). Similarly, cloud shadows affect NDVI values and lead to misinterpretation of the result. Finally, to investigate NDVI values, it is categorized into three different classes like areas with low (0.2-0.4), medium (0.4-0.6), and high (>0.6) vegetation density based on NDVI ranges of both 2015 and 2021 images. 0.2-0.4 NDVI value

represents shrub and grassland, 0.4-0.6 indicates sparse and unhealthy forest, whereas >0.6 NDVI value represents healthy and dense Vegetation.

5. RESULT AND DISCUSSION

False-color composites of the study area are shown in figure (1.3); Image A reflects the vegetation cover in 2015 while Image B of the 2021 time period. These two Images very much clarify the scenario, as one can see the difference of Vegetation in both the images. Dense Vegetation near the river increases significantly but as we go far from the river and near the protective boundaries of the sanctuary, Vegetation is being reduced during the time.

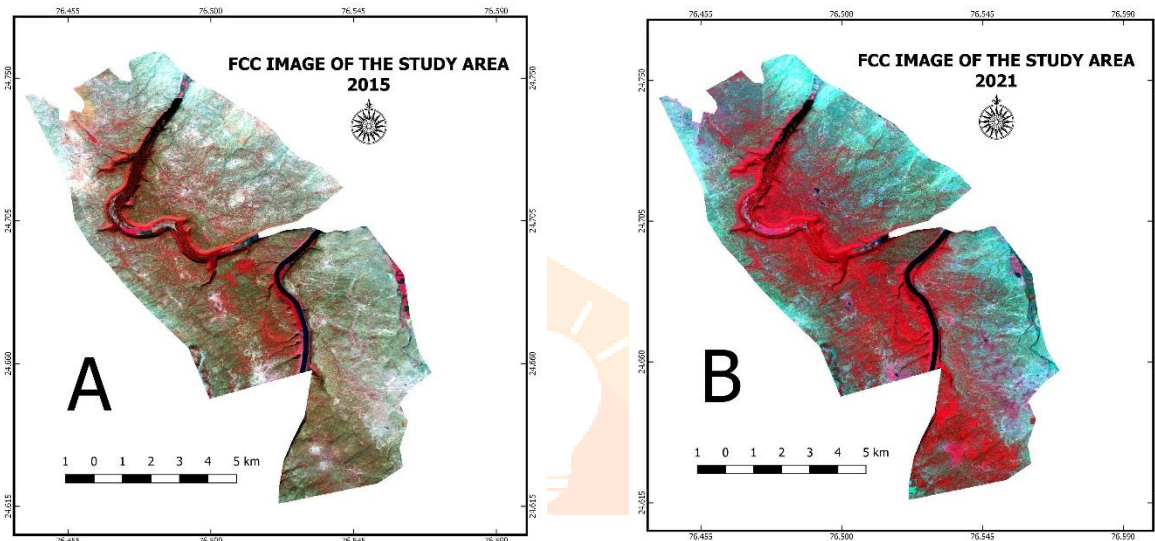


Figure 1.3 (False-color composites of Shergarh wildlife sanctuary A. (2015) B. (2021))

The range of NDVI values in the 2015 image from -0.14 to 0.77 and in the 2021 image from -0.08 to 0.73. A high NDVI value indicates the high vegetation density, while a lower NDVI value shows the low density of Vegetation. The change of vegetation pattern is shown in table 1.2 and figure 1.4. The area covered by Vegetation was 93.20 km^2 in 2015 and 81.93 km^2 in 2021 which indicates the removal of 11.26 km^2 vegetation cover within a span of six years. In 2015 low-density vegetation cover was 68.54 km^2 , and it has 71.23 % share of the total Vegetation of the area. In 2021 this type of Vegetation rapidly decreased more than half times, and the present coverage area is 27.95 km^2 which means 40.5 km^2 vegetation-covered area is abolished within six years only at the rate of 6.76 km^2 per year. The medium density vegetation-covered area was 18.67 km^2 in 2015, and it is increased to 37.74 km^2 in 2021, which shows more

than double growth from the earlier time. The high-density Vegetation also shows growth as it is enriched with an area of 10.26 km², in 2015 it was spread in 5.98 km² area only but in 2021 it increases to 16.24 km².

Figure 1.4 (Vegetation cover change in NDVI image during years 2015(A)-2021(B) in Shergarh wildlife sanctuary)

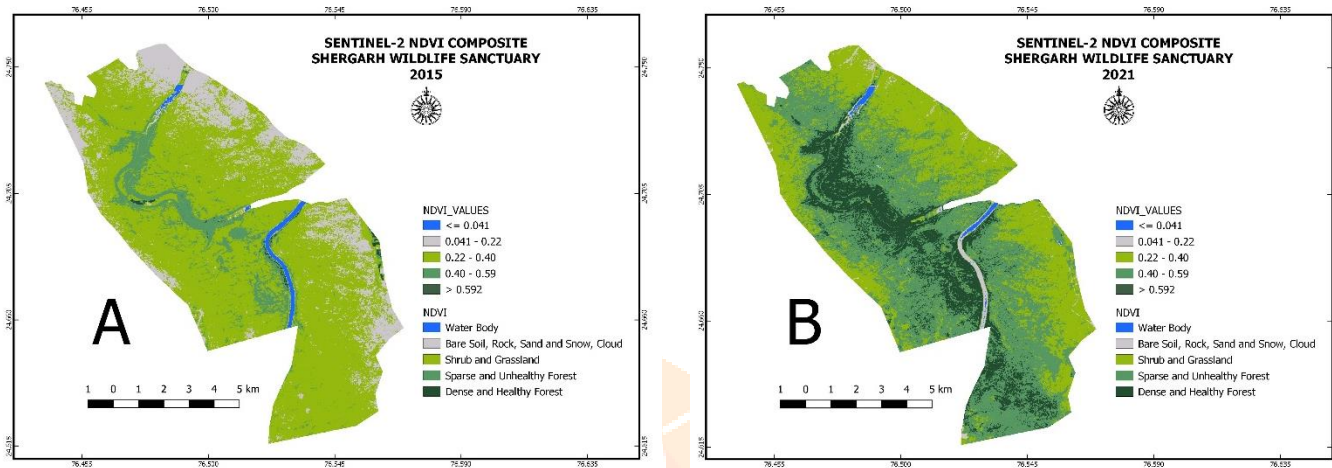


Table 1.2 Change of Vegetation from 2015 to 2021

NDVI Density Class (Vegetation Cover)	2015 NDVI Classes Area km ²	2021 NDVI Classes Area km ²	Change Between 2015 and 2021 km ²	Average Rate of Change %
Low(0.2-0.4)(Shrub and Grassland)	68.54	27.95	-40.58	-59.21
Medium(0.4-0.6)(Sparse and Unhealthy Forest)	18.67	37.74	19.06	102.05
High(>0.6)(Dense and Healthy Forest)	5.98	16.24	10.26	171.56
Total	96.22	96.22	-11.26	-11.70

Results show that In the classified NDVI image, overall Vegetation has decreased as the area under Vegetation reduced to 81.9 km²(2021) from 93.2 km² in 2015. Still, medium and high-density Vegetation increased during the period. The change can be seen clearly in figure 1.4, wherein the 2021 image green area in the middle of the sanctuary is much higher than the 2015 image. In the center of the sanctuary or near the river area, vegetation is increased but near the boundary of the sanctuary, Vegetation had some interference, which resulted in Lapse of Vegetation. The total area calculated under both the images was 96.22 km². Accuracy assessment of both imageries has been also done, in which overall accuracy was found 95.39 percent in 2015 imagery classification and for 2021 imagery classification overall accuracy was found 96.21 percent.

6. CONCLUSION

This study analyzed the change in Vegetation during 2015-2021 in the Shergarh Wildlife Sanctuary using sentinel-2 data. The study reveals that there is a decline in low-density Vegetation in recent years while medium and high-density Vegetation has increased during the period. 11.7 percent of total Vegetation was reduced in six years. NDVI is a significant technique to measure the evolution of land use land cover (LULC) especially change detection of vegetation pattern and its area. So it can be said that this technique is very effective and useful for the decision-making process and future planning concerned with vegetation change.

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