Spatial and Temporal Variation of NDVI in Nagpur District, India Using LANDSAT Images

Wael Albawwab[1], Tauseef Ahmad Ansari[2]

Assistant Professor[1], University of Buraimi, Oman
Assistant Professor[2], University of Buraimi, Oman

Abstract:

Normalized Difference Vegetation Index (NDVI) is a parameter of finding the vegetation on the earth surface. It is used to monitor the climatic changes, occurs in the vegetation, forest health, indicate water stress in vegetation. In this research, NDVI from 2000 to 2011 generated to analyzed the changes occurred in vegetation cover. It is found that the overall NDVI value was in the range of -0.20 to 0.94 from year 2000 to 2011. It is also observed that the NDVI value is in the range of 0.75 to 0.94 in north part of the district. While the central and south part shows range of -0.20 to 0.45 and remaining areas in the range of 0.45 to 0.75. In the 11 years, most of the green spaces has been reduced in the Nagpur District from last 19 years. Hence, there is a need of proper planning and management for maintaining the ecosystem, and there must be the rules for sustainable development.

Key Words: Normalized Difference Vegetation Index (NDVI), Landsat, Land Use (LS) / Land Cover (LC), Rainfall, Arc GIS etc.

Introduction:

The NDVI is a remotely sensed measure of vegetation greenness and is related to various properties of vegetation including its growth and productivity (Gamon et al. 1995). NDVI has found a wide application in vegetative studies as it has been used to estimate crop yields, pasture performance, and rangeland carrying capacities among others. It is often directly related to other ground parameters such as percent of ground cover, photosynthetic activity of the plant, surface water, leaf area index and the amount of biomass. NDVI is reliable indicator of vegetation changes at both global (Kawabata et al., 2001). The possibility of expressing the relationship between precipitation and vegetation has been greatly improved upon by the development of meteorological instruments and the collection of systematic climatic observations. (Areola M. et al., 2018). In India, the climate is dominated by the monsoon, although monsoonal precipitation is not uniform throughout the country; it varies with place and time (Diwan 2002). NDVI has higher sensitivity corresponding with crown density change than other vegetation index. Therefore, information on degree of forest degradation including forest fragmentation need to be defined to formulate a strategy for habitat and ecosystem management (Priatna D. et al. 2012). Bhandari and Kumar (2012), used multi-spectral remote sensing data to find spectral signature of vegetation index, land cover, concrete road structure, urban areas, rocky areas. Yang. and Gong (2013), highlighted some important discoveries about the climate system that have not been detected by climate models and conventional observations; Bothale and Katpatal (2014), studied the variability of rainfall with El Niño Southern Oscillation (ENSO) events at the watershed level to determine the pattern of water available for agricultural planning and water and soil conservation. study area was analyzed in combination with NDVI data from the Moderate Resolution Imaging Spectro radiometer (MODIS) sensor. They found the correlations between ENSO events, rainfall, and vegetation. Rainfall and vegetation shows a positive variance during La Niña events and a negative variance during El Niño events. The impacts of moderate to severe ENSO events (in 2009 and 2010) can be mainly observed on rainfall and vegetation. The sensitivity of vegetation cover with changes in precipitation patterns and that reduction in rainfall and vegetation greenness across large parts of Amazonia (Hilker and Sellers, 2014; There are various scientists (Kinthada.N.R, and Gurram.M.K, 2014; Bothale.R.V and Katpatal.Y.B, 2015; Jiao.N.Z,et.al, 2015; Gandhi.M.et.al 2015; Mazzarino. M and Finn. J.T, 2015; Rishma.C and Katpatal.Y.B, 2016; Kumara.N and Tischbeinb.B, 2017; Zaitunah A., et.al. 2018) evaluated the spatial and temporal pattern in the sensitivity of vegetation to rainfall.

Study Area:

The Nagpur city is located at 21° North and 79° East. Nagpur is Maharashtra's third largest city and is in fact located on the geographical center of India. Also known as the Orange City, After Indian Independence, Nagpur was selected as Maharashtra's second capital. Sites have rich soil with high quantities of clay in Nagpur. Nagpur is surrounded by

Metamorphic rock, Clay, and Sand stone. The city itself is rich with greenery, contains multiple natural as well as artificial lakes, and was even awarded the title of being the second greenest city in India. Nagpur has tropical wet and dry climate. The city experiences extreme temperatures of 49.7° C in summer season from March to June. While minimum temperatures recorded 3.9° C. The average annual rainfall is 1055 mm. The general surface slope is from west to east and the highest elevation level is 358.25 m while lowest elevation is 284.79 m. (Ansari, et al. 2016).

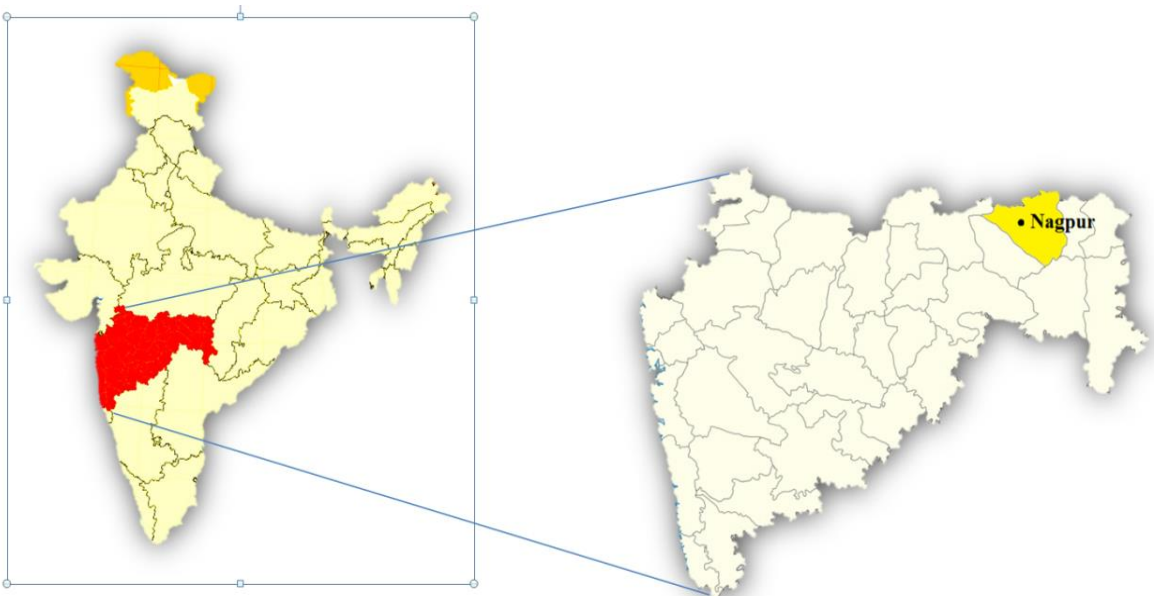

Figure 1: Nagpur District as area of research situated in Maharashtra State

Software Used:

ArcGIS software has been used for the image processing, where the satellite images are opened. ArcGIS is a Geographic information system (GIS) for working with maps and Geographic Information. It is used for creating and using maps, compiling geographic data, analysing mapped information, sharing and discovering geographic information, using maps and geographic information in a range of applications, and managing Geographic Information in a database. The system provides an infrastructure for making maps and geographic information available throughout an organization, across a community, and openly on the Web.

Methodology:

In the first step, data is collection from USGS Earth Explorer website. The USGS Earth Explorer (EE) tool provides users the ability to query, search, and order satellite images, aerial photographs, and cartographic products from several sources. In addition to data from the Landsat missions and a variety of other data providers, EE now provides access to MODIS land data products from the NASA Terra and Aqua missions, and ASTER level-1 B data products over the U.S. and Territories from the NASA ASTER mission. The MODIS image of code MOD13Q1 V6 is selected from MODIS Vegetation Indices- V6 from the year 2000 to 2018 for the month of July for every year. In second step, satellite images reprojected in the WGS-UTM 1984 - 44N zone projection system in the Arc GIS software which suits to India. Third, the images clipped for Nagpur District using clip command. In fourth step, analyses are performed in Arc Map module from add data option. NDVI thematic maps were generated using NIR and red band using equation 1.

NDVI = NIR - Red / NIR + Red (1)

Table 1 shows the range of NDVI values for various types of vegetation.

Table1 Range of NDVI values used for classification of land

S. No.	Vegetation Type	Range of NDVI values
1	Dense Vegetation	>0.45
2	Medium Vegetation	0.25-0.45
3	Sparse Vegetation	0.15-0.25
4	No Vegetation	0.1-0.15
5	Water bodies	<0.1

Results:

The NDVI values were observed for the month of July from 2000 to 2011. The NDVI value more than 0.45 (green colour) shows dense vegetation in north east part in Nagpur district, which is very distinct, whereas in the peripheral areas of city, values observed between 0.25-0.45 (yellow colour) shows medium vegetation. In central part, NDVI value observed between 0.1-0.15 (red colour) shows there is no vegetation. The reason is, Nagpur city is situated in central part based on high dense urban land. NDVI value from 0.25-0.45 (medium dense) is reduced to 0.15-0.25 (sparse vegetation) and 0.15-0.25 (sparse vegetation) has been converted into (no vegetation) urban areas (Figure 2). The highest and lowest value from the year 2000 to 2011 is given in below Table 2.

Table 2: The highest values of NDVI values from year 2000 to 2011.

Sr. No.	Year	Highest NDVI Value	Lowest NDVI value
1	2000	0.75	- 0.2
2	2001	0.77	- 0.2
3	2002	0.80	- 0.2
4	2003	0.82	- 0.2
5	2004	0.84	- 0.2
6	2005	0.84	- 0.2
7	2006	0.93	- 0.2
8	2007	0.94	- 0.2
9	2008	0.78	- 0.2
10	2009	0.83	-0.2
11	2010	0.85	- 0.2
12	2011	0.81	- 0.2

Discussion:

Based on the analysis of the Normalized Difference Vegetation Index (NDVI) results from 2000 to 2011, it can be concluded that the vegetation cover in Nagpur District has undergone significant changes over this period. The overall NDVI values ranged from -0.20 to 0.94, indicating variations in vegetation density and health across different parts of the district. Specifically, the northern part of the district exhibited higher NDVI values (0.75 to 0.94), signifying denser and healthier vegetation. In contrast, the central and southern parts showed lower NDVI values, ranging from -0.20 to 0.45 and 0.45 to 0.75, respectively, indicating less dense and potentially stressed vegetation. Using Remote sensing and GIS a larger area can be cover for the research purpose and number of analyses can be done. The analyses can be used for proper urban planning and management.

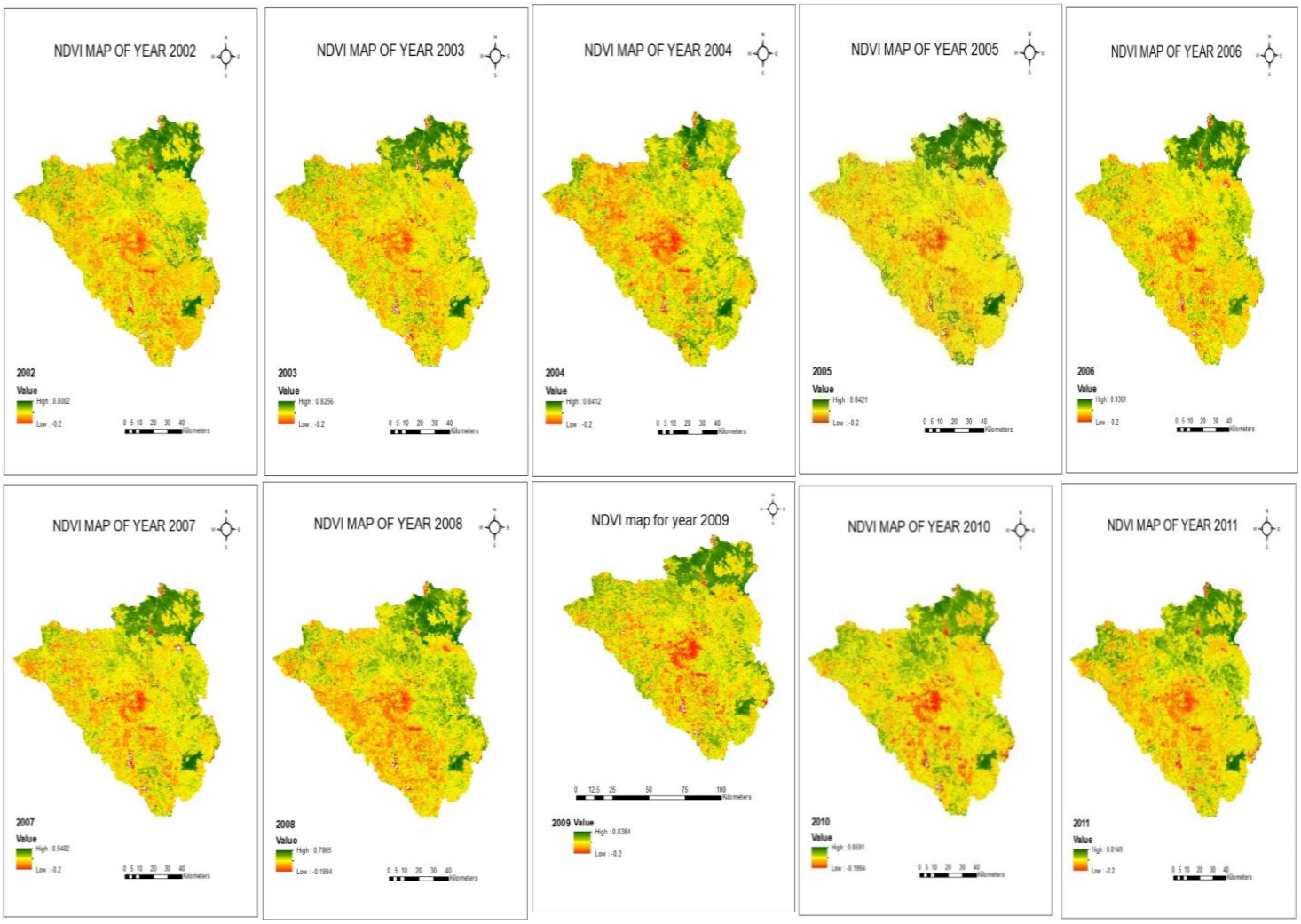

Figure 2: The spatial and temporal pattern of NDVI values of Nagpur District from the year 2000 to 2011

References:

1. AreolaM and Fasona.M, (2018), "Sensitivity of Vegetation to Annual Rainfall Variations over Nigeria.",Remote Sensing Applications: Society and Environment, S2352-9385,(17),30073-3.
2. Bhandari.A.K and Kumar.A, (2012), "Feature Extraction using Normalized Difference Vegetation Index (NDVI): a Case Study of Jabalpur City.", Procedia Technology, 6, 612 – 621.
3. Bothale.R.V and Katpatal.Y.B, (2014), **"Response** of Rainfall and Vegetation to ENSOEvents during 2001–2011 in Upper Wardha Watershed, Maharashtra, India.", Journal Of Hydrologic Engineering, 2014, 19(3): 583-592.
4. Bothale.R.V and Katpatal.Y.B, (2015), "Trends and Anomalies in Extreme Climate Indices and Influence of El Ni ˜no and La Ni ˜na over Pranhita Catchment in Godavari Basin, India.", Journal Of Hydrologic Engineering, 2016, 21(2): 05015023.
5. Gandhi.M.,Parthiban.S., et.al, (2015). "NDVI: Vegetation change detection using remote sensing and gis – A case study of Vellore District.", Procedia Computer Science, 57, 1199 – 1210.
6. Hilker.T and Sellers.P, (2014). "Vegetation dynamics and rainfall sensitivity ofthe Amazon.",.PNAS , vol. 111,no. 45 , November 11,16043.

7. Jiao.N.Z,Chen.D.K ,et.al ,(2015). "Climate change and anthropogenic impacts on marine ecosystems and counter measures in China.", Advances in Climate Change Research, 6,118-125.

8. Kinthada.N.R, Gurram.M.K ,et.al ,(2014)"Land Use/Land Cover and NDVI Analysis for Monitoring the Health of Micro-watersheds of Sarada River Basin, Visakhapatnam District, India.", Journal of Geology & Geosciences, 3: 146. doi: 10.4172/2329-6755.1000146.

9. Kumara.Nand Tischbeinb.B ,(2017). "Impact of climate change on water resources of upper Kharuncatchment in Chhattisgarh, India.",Journal of Hydrology: Regional Studies, 13, 189–207.

10. Rishma.C and Katpatal.Y.B, (2016). "Footprints of El Ni ˜no Southern Oscillation on Rainfall and NDVI-Based Vegetation Parameters in River Basin in Central India.", Journal of Hydrology Engineering, 21(12): 05016030.

11. Rishma.C and Katpatal.Y.B, (2016). "Variability in rainfall and vegetation density as a response to ENSO events: A case study in Venna river basin of central India.",Journal of Agrometeorology 18 (2) : 300-305.

12. Mazzarino.M and Finn.J.T , (2015). "An NDVI analysis of vegetation trends in an Andean watershed.",Wetlands EcolManage,DOI 10.1007/s11273-016-9492-0.

13. Yang.J and Gong.P , (2013). "The role of satellite remote sensing in climatechange studies.",Nature Climate Change, Vol 3.

14. Zaitunah.A, Ahmad.A.G , et.al ,(2018). "Normalized difference vegetation index (ndvi) analysis for land cover types using landsat 8 oli in besitang watershed, Indonesia.", Earth and Environmental Science, 126, 012112.

15. Gamon, J. A., et al. (1995). "Relationships between NDVI, canopy structure,and photosynthesis in three Californian vegetation types." Ecol.Appl., 5(1), 28–41.

16. Kawabata, A., Ichii, K. and Yamaguchi, Y. (2001). "Globalmonitoring of interannual changes in vegetationactivities using NDVI and its relationships totemperature andprecipitation. Inter.J. Remote Sens., 22(7), 1377-1382.

17. Diwan, P. L. (2002), "Vagaries of monsoon: Water crisis and its management. New Delhi, India: Government of India", Press Information Bureau.

18. Priatna D, Santosa Y, Prasetyo L B and Kartono A P. (2012), "Habitat selection and activity patternof gaps collared Sumateran Tigers Jurnal Manajemen Hutan Tropika 18 (3) pp 155-163.

19. Ansari, T.A., Yashwant B. Katpatal and A. D. Vasudeo., (2016), "Integrated approach of geospatial visualization and modeling for groundwater management in hard rock terrains in Nagpur Urban Area, India". Arab J Geosci, 9: 325, DOI 10.1007/s12517-016-2357-2