Peer Reviewed International Research Journal of Geography
Maharashtra Bhugolshastra Sanshodhan Patrika
ISSN : 0971-6785 {Impact Factor 4.567 Renew (IIFS)} Vol. 37, No.1, Jan-Jun. 2020. pp 19-31

Geographical assessment of Vegetation Cover pattern and Temperature and its trends 2001 to 2019: A case study of Nashik City, Maharashtra.

Bharat L. Gadakh[1] Ravindra G. Jaybhaye[2]

Abstract

The climate is one of the most important factors affecting vegetation type and health condition. Thus, evaluation of the quantitative relationship between vegetation patterns and climate is an important area of remote sensing applications at regional and global scales. Such studies may help in design planning for afforestation activity for different purposes. The present paper emphasizes on the spatial relationship between vegetation patterns and temperature as well as its trend over the period 2001-2019. The data sources for using Normalized Difference Vegetation Index (NDVI) techniques used satellite images of one decade for 2001 and 2011 derived from the Land Sat TM data and the climatic data of temperature from weather station installed in the study region. The vegetation health of different seasons for the selected years was examined using NDVI Classification techniques and its relationship calculated with temperature data by using regression analysis. The correlation trend in obtained vegetation cover and temperature data over the 10 years has been determined to observe a Spatio-temporal change in the study area. The study may conclude that the results of the relationship between vegetation cover and temperature data to represent inverse relationship alike areas under vegetation cover decreasing concerning increasing the temperature rate.

Key Words: *NDVI, Land Sat TM, Regression Analysis.*

Introduction:

The climate is one of the most important factors affecting vegetation type and health condition. The climatic elements are including Temperature, Humidity, Rainfall, Wind speed, Air pressure, etc. Most of the temperature is one of the key parameters that control the physical, chemical, and biological processes on the earth surface (Pu.et al.; 2006). Vegetation covers a considerable portion of the earth and affects weather and climate. Vegetation influences both albedo of the earth and the amount of water vapor and carbon dioxide in the air. The dynamic monitoring of vegetation cover change has important implications for the understanding of vegetation responses to climate change and human activities and the evolution of the regional ecological environment (Mao et al. 2011). Temperature and energy balance can be affected by vegetation which influences the land–air exchange of energy and water (Kumar and Shekher, 2015). Vegetation indices retrieved from satellite data have been using to estimate the vegetation quantitatively. NDVI is the most effective and broadly utilized index to estimate vegetation quality (health and growth) and quantity (spread area) (Miura et al., 2006). Temperature is important indicators of the land use and vegetation, vegetation indices(Vis), Including the Normalized Vegetation Index(NDVI), Ratio Vegetation Index(RVI), and Soil-adjusted vegetation index(SAVI) have been used widely to investigate the vegetation and temperature relationship (Yue et al.,2007, Wei and Zhou,2011)

Different kinds of vegetation indices are available bur normalized difference vegetation index (NDVI) is the simplest, efficient and commonly used one. NDVI was 1st suggested by Tucker in 1979 as an Index of vegetation health and density (Liu and Huete, 1995).using the NDVI data of the region the changes in vegetation cover present in the area and also the trend in the increase of temperature.NDVI is not free from defects such as data error during rainy season, saturation effects on dense vegetation etc.(Sruthi and Aslam,2014).so it always better to merge it with other parameters to ensure more accuracy. It is seen that there exists a strong correlation between temperature and NDVI. Temperature is a good indicator of the energy balance at the earth's surface which can provide important information about the surface physical properties and climate. The negative correlation between temperature and NDVI(Goetz,1997), The observed at several scales was largely due to changes in vegetation cover and soil moisture and indicated that the temperature can rise rapidly with water stress (Zhengming et al.,2004). It can be noticed that the ratio of temperature and NDVI increases during times summer season or less of water.

Study area:

The Nashik city is located between 20°02'00" North latitude and 73°50'00" East Longitude at Northwest part of the Maharashtra, at 529.5 meters above sea level. Nashik city has an area of 259.5 square kilometers. Nashik is located 180 km from Mumbai and 206 km from Pune (Gadakh and Jaybhaye, 2015, 2014). Nashik is the administrative headquarter of the Nashik District and Nashik Division. Nashik, which has been referred to as the "Wine Capital of India", is located in the Western Ghats, on the western edge of the Deccan peninsula on the banks of the Godavari. It is claimed to be the fastest-growing city in Maharashtra (Gadakh and Jaybhaye, 2016, 2018, 2020).

❖ **Methodology :**
Methodology is one of the important parts of analysis. The output or result of analysis highly depends on the methodology has used for the data processing or analysis purpose. To achieve the above objective following methodology has adopted:-

❖ **Step -1** Primary data has collected; an exhaustive literature survey of the topic of investigation is to be undertaken. Published literature, reports were collected from various libraries, Institutes and government departments etc. Besides this relevant literature wills also reference books, bulletins, reviews will also be etc.be obtained through the Internet.

❖ **Step -II** to Calculation of Normalized Difference Vegetation Index (NDVI) with the help of ARC GIS software tools.

❖ **Step –III** to classified images for different class like as highly dense vegetation.

❖ **Step –IV** to analysis Temperature Data of year wise

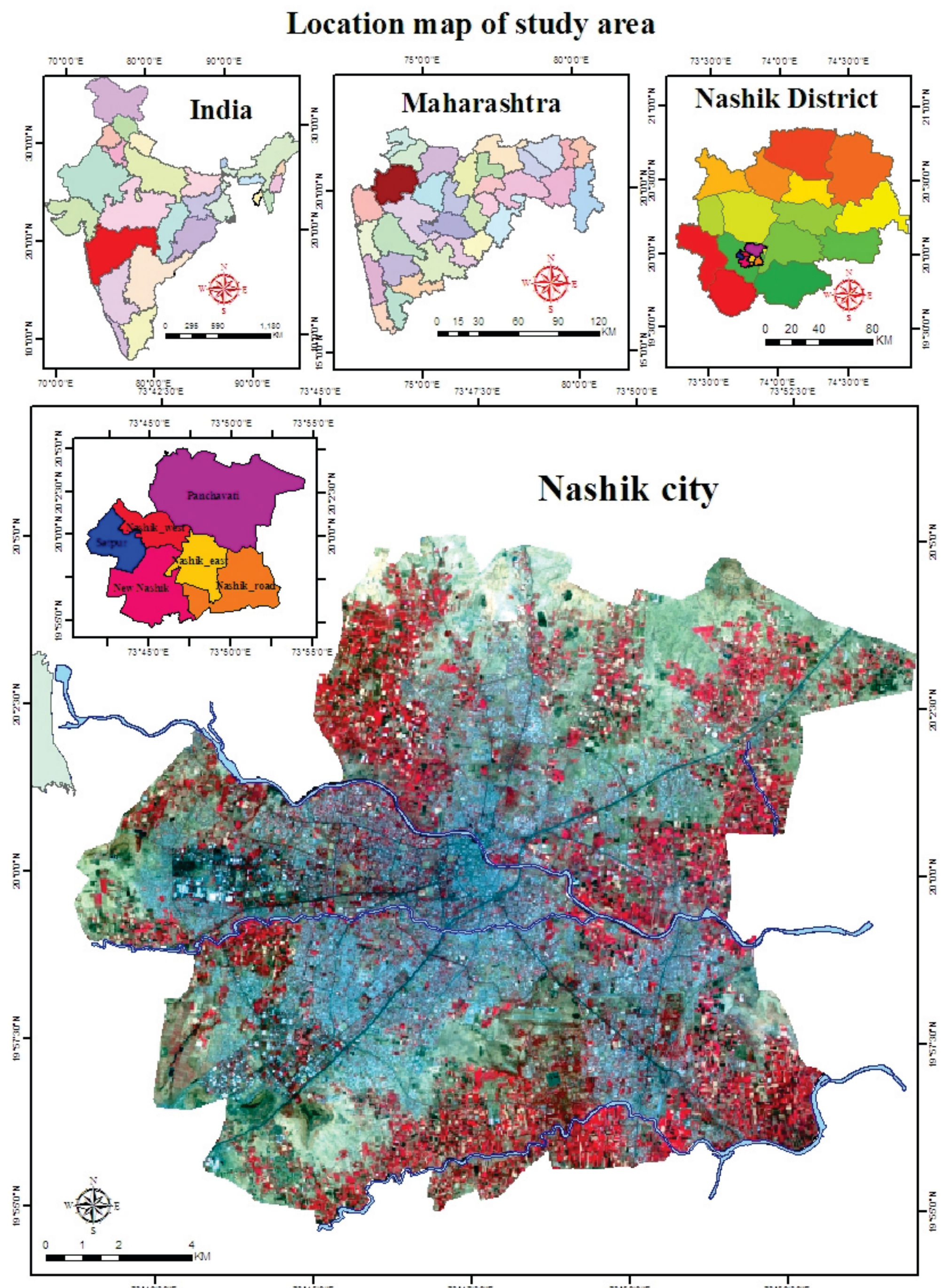
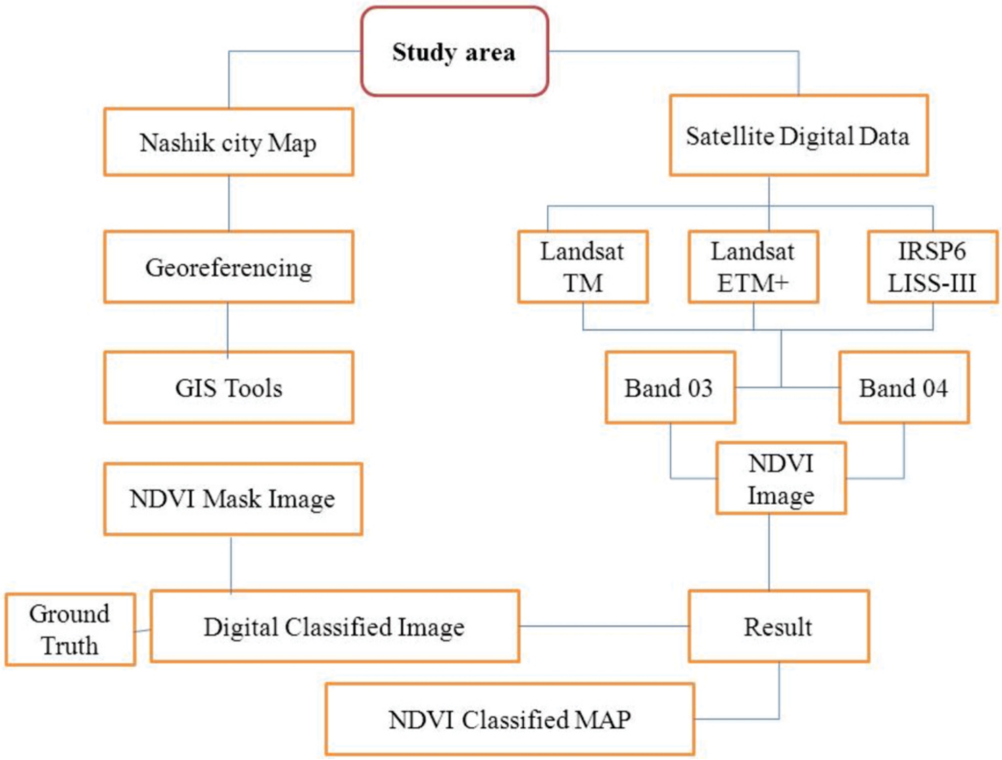


Fig.No:01 Loaction map of study area(Gadakh&Jaybhaye,2016,2018,2020)

❖ **FLOW DIAGRAM:**

Showing Methodology for Analysis of Normalized Difference Vegetation Index.



Result and discussion:

❖ **Analysis of the Remote sensing data:**

The Remote Sensing (RS) and GIS technology is the best tool in the hands of researchers of various disciplines of recent generation. The remote sensing provides the Spectral data from the satellites without any physical contact to the object in the digital form. This digital data is converted into visual images in the form of imagery. The imagery is the best and reliable source of data of the earth's surface in various contexts like topography, biodiversity; land use cultural aspects, etc. Geographic Information System (GIS) is a very recent technology in the hand of geographers. It is the computer-based system for collecting, storing, checking, integrating, retrieving, manipulating processes, analyzing, and displaying data, which are spatially referenced to the earth (Burrow 1986).

The NDVI is one of the most successful of many attempts to simply and quickly identify vegetated areas and their "condition" and it remains the most well-known and used index to detect live green plant canopies in multispectral remote sensing data. NDVI not only detects the vegetation but also demonstrates the quantification of the photosynthetic capacity of forest canopies. The Normalized Difference Vegetation Index (NDVI) is a standardized index allowing you, was generating an image displaying greenness. This index takings advantage of the contrast of the characteristics of two bands from a multispectral raster dataset the chlorophyll pigment absorptions in the red band and the high reflectivity of plant materials in the near-infrared (NIR) band. An NDVI is often used worldwide phenomena to monitor and predict agricultural production and to monitor drought, to assist in predicting hazardous fire zone of any area, and map desert encroachment. The NDVI was preferred for global vegetation monitoring because it helps to compensate for changing illumination conditions, aspect, surface slope, and other in essential factors (Lillesand, 2004).

The differential reflection in the red and infrared R) bands enables you to monitor the density and intensity of green vegetation growth using the spectral reflectivity of the solar radiation. Green leaves generally show better reflection in the near-infrared wavelength range than in visible wavelength ranges. When leaves are water-stressed, diseased, or dead, then after becoming more yellow and reflect significantly less in the range of near-infrared. Clouds, water, and snow show better reflection in the visible range than in the near-infrared range, although the difference is almost zero for rock and bare soil. The NDVI process generates a single-band dataset that mainly represents greenery. The negative values represent clouds, water, and snow, and values near zero represent rock and bare soil. The Normalized Difference Vegetation Index (NDVI) is a numerical indicator that uses the visible and near-infrared bands of the electromagnetic spectrum and adopted to investigate remote sensing measurements and assess whether the target being observed contains live green vegetation. 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 surface water, percent of ground cover, photosynthetic activity of the plant, leaf area index, and the amount of biomass. NDVI was first used in 1973 by Rouse et al. the Remote Sensing Centre of Texas A & M University. Generally, healthy vegetation will absorb most of the visible light that falls on it, and reflects a large portion of the near-infrared light. Unhealthy or sparse vegetation reflects more visible light and less near-infrared light. Bare soils on the other hand reflect moderately in both the red and infrared portion of the electromagnetic spectrum (Holme et al,1987). Since we know the behavior of plants across the electromagnetic spectrum, we can derive NDVI information by focusing on the satellite bands that are most sensitive to vegetation information (near-infrared and red). The bigger the difference, therefore, between the near-infrared and the red reflectance, the more vegetation there has to be. The Normalized Difference Vegetation Index (NDVI) is an index of plant "greenness" or photosynthetic activity. It is one of the most commonly used vegetation cover indices. Vegetation cover indices are based on the observation that different surfaces reflect different types of light differently. Photosynthetically active vegetation, in particular, absorbs most of the red light that hits it while reflecting much of the near-infrared light. Vegetation that is dead or stressed reflects more red lights and less near-infrared light. As well, non-vegetated surfaces have a much more even reflectance across the light spectrum (Congalton, 1999). By taking the ratio of red and near-infrared bands from a remotely-sensed image, an index of vegetation "greenness" can be defined. The (NDVI) is probably the most common of these ratio indices for vegetation. The NDVI is calculated on a per-pixel basis as the normalized difference between the Red and near-infrared bands from an image. The Normalized Difference Vegetation Index (NDVI) is a simple numerical indicator that can be used to analyze remote sensing measurements. Typically, but not necessarily from a space platform and evaluate whether the target being observed contains live green vegetation or not. NDVI = (Near IR - Red) / (Near IR + Red) the sub-scene bands 2 and 3 for each were used to create an NDVI image for each year and then differencing of the images was carried out to detect change (Rai, 2010).

The Normal Difference Vegetation Index transformation is calculated as the ratio of the measured intensities in the red (R) and near-infrared (NIR) spectral bands using the following formula :(Ray, 1991, Dumping, 1978)

NDVI= (Near Infra-Red –Red) / (Near Infra-Red+ Red)

The resulting index value is sensitive to the presence of vegetation on the Earth's land surface and can be used to address issues of vegetation type, amount, and condition. Many satellites have sensors that measure the red and near-infrared spectral bands and many variations on the NDVI exist. The thematic Mapper (TM bands 3 and 4) provides measurements and therefore used to generate NDVI data sets with the following formula

NDVI= (Band 4-band3) / (Band 4+ Band3)

The Red and NIR images are obtained and used to calculate NDVI value for each pixel. The NDVI equation produces values in the range of -1.0 to 1.0, where vegetated areas will typically have values greater than zero and negative values indicate non-vegetated surface features such as water, barren, ice, snow or cloud. The Land sat NDVI is produced at a resolution of 30 m, which offers far greater details, though it can provide less aerial extent.

❖ Calculation of Normalized Difference Vegetation Index (NDVI)

Calculation of NDVI for giving pixel always results in a number that ranges from minus one (-1) two plus one (+1) however, no green leaves give a value close to zero. A zero means no vegetation and close to +1 (0.8 to 0.9) indicates the highest possible density of green leaves. The NDVI values calculated from pixel values of NIR (Band-4) and R (band-3) are also tabulated to find out the extent and the area under different NDVI class intervals.

Normalized Difference Vegetation Index (NDVI) will be computed temporally to understand the change of land cover during the study period. The NDVI is the most common measurement used for measuring vegetation cover. It ranges from values -1 to +1. Very low values of NDVI (-0.1 and below) correspond to barren areas of rock, sand, or urban/built-up. Zero indicates the water cover. Moderate values represent low density of vegetation (0.1 to 0.3), while high values indicate vegetation (0.6 to 0.8) (Bharath, 2012).

❖ Normalized Difference Vegetation Index (NDVI), 1991

Table1: Normalized Difference Vegetation Index (NDVI) Area Statistics.1991

Year	**1991**			
Class	**NDVI Range**	**Area (km2)**	**Percentage**	**Class**
1	0.12-0.23	57.04	21.16	High-Density Vegetation
2	0.9-0.12	74.47	27.64	Moderate Density Vegetation
3	0.06-0.09	68.68	25.48	Low-Density Vegetation
4	-0.01-0.06	50.45	18.72	Fallow Land
5	-0.01--0.15	18.85	7.00	Scrub Land
	TOTAL	**269.48**	**100.00**	

In 1991, the Nashik city Normalized Difference Vegetation Index (NDVI) has computed temporally to understand the change of land cover during the study period. The NDVI is the most common measurement used for measuring vegetation cover. It ranges from values -1 to +1. In the Nashik city Very low values of NDVI (-0.01to -0.15) correspond to barren areas of rock, sand, or urban/built-up. Most of the part of Nashik city Moderate value represents a density of vegetation (0.01 to 0.23) (Gadakh and Jaybhaye,2015)

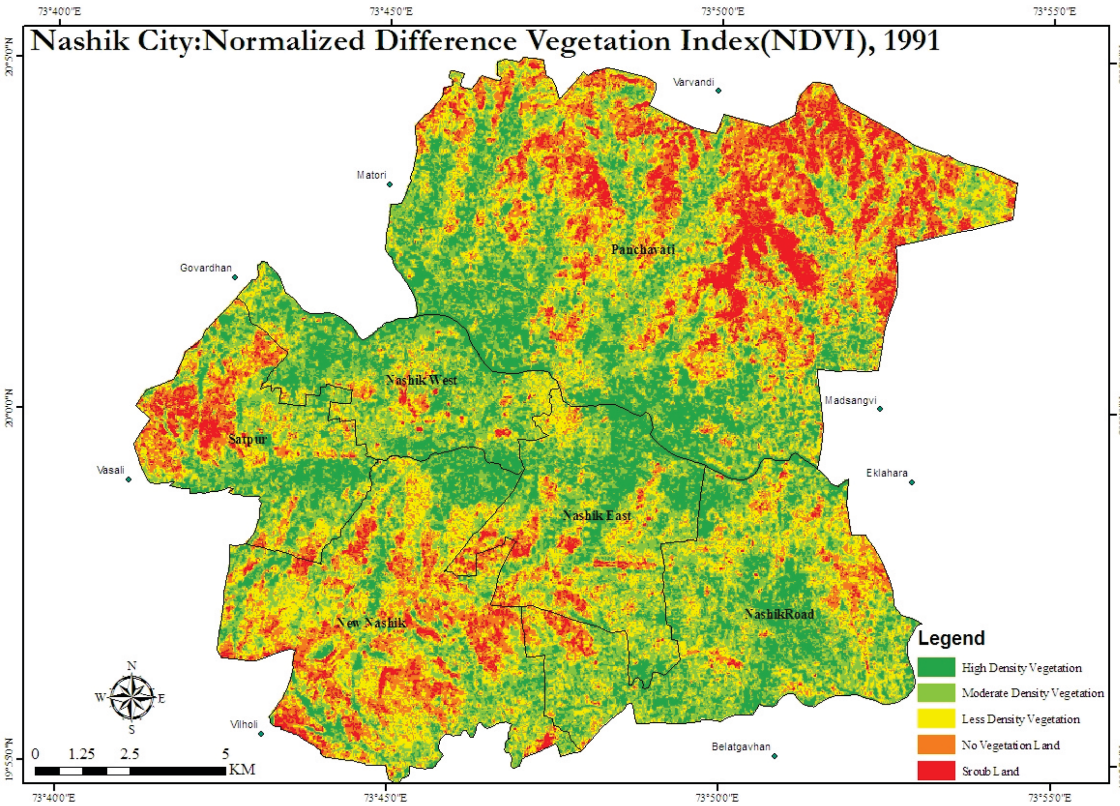


Figure No 2: Normalized Difference Vegetation Index map, 1991

❖ **Normalized Difference Vegetation Index (NDVI), 2001**

Table 2: Normalized Difference Vegetation Index (NDVI) Area Statistics.2001

Year	2001			
Class	NDVI Range	Area (km2)	Percentage	Class
1	0.12-0.23	46.11	17.11	High-Density Vegetation
2	0.9-0.12	72.28	26.82	Moderate Density Vegetation
3	0.06-0.09	63.12	23.42	Low-Density Vegetation
4	-0.01-0.06	52.85	19.61	Fallow Land
5	-0.01--0.15	35.1	13.03	Scrub Land
	TOTAL	**269.46**	**100.00**	

During 2001, the Nashik city Normalized Difference Vegetation Index (NDVI) has computed temporally to understand the change of land cover during the study period. The NDVI is the most common measurement used for measuring vegetation cover. It ranges from values -1 to +1. In the Nashik city Very low values of NDVI (-0.00to -0.26) correspond to barren areas of rock, sand, or urban/built-up. Most of the part of Nashik city moderate value represents a density of vegetation (0.00 to 0.26) (Gadakh and Jaybhaye,2015)

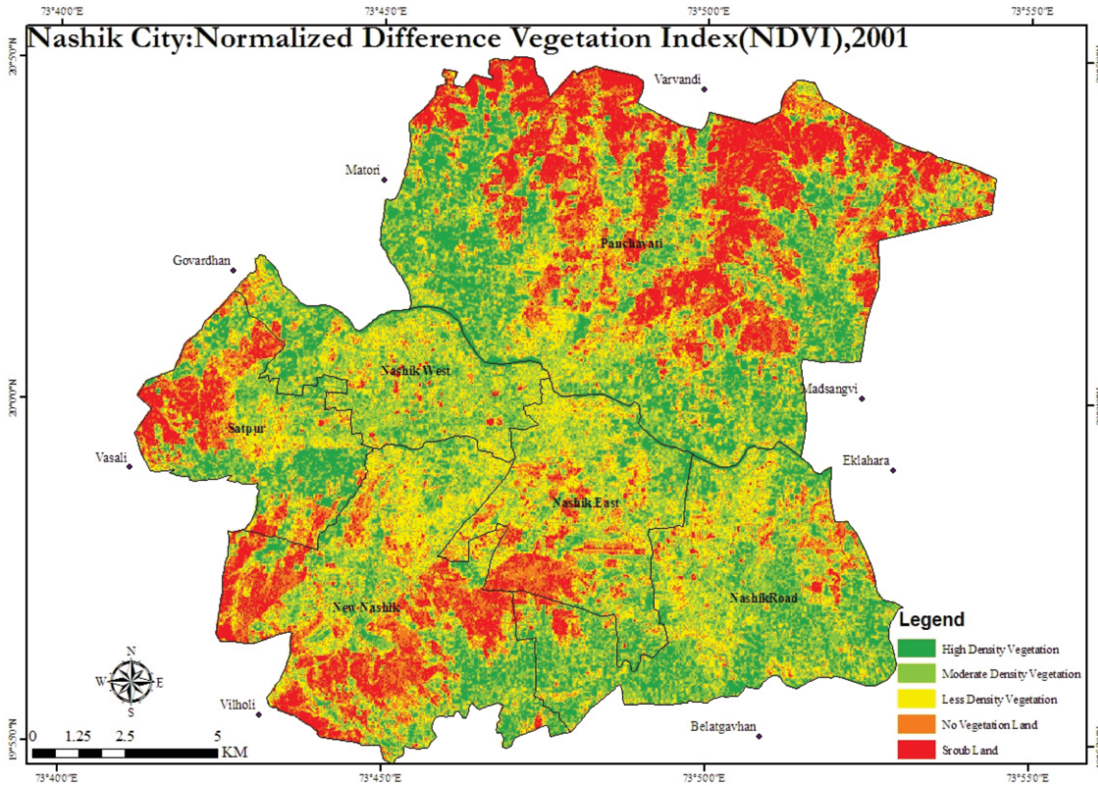


Figure No.03: Normalized Difference Vegetation Index map, 2001

❖ **Normalized Difference Vegetation Index (NDVI), 2011**

Table 3: Normalized Difference Vegetation Index (NDVI) Area Statistics, 2011

Year	**2011**			
Class	NDVI Range	Area (km2)	Percentage	Class
1	0.12-0.23	29.89	9.6	High-Density Vegetation
2	0.9-0.12	59.68	21.04	Moderate Density Veg etation
3	0.06-0.09	62.74	32.18	Low-Density Vegetation
4	-0.01-0.06	65.14	23.42	Fallow Land
5	-0.01--0.15	52.01	13.74	Scrub Land
	TOTAL	269.46	100.00	

During 2011, the Nashik city Normalized Difference Vegetation Index (NDVI) has understood the change of land cover during the study period. The NDVI is the most common measurement used for measuring vegetation cover. It ranges from values -1 to +1. In the Nashik city Very low values of NDVI (-0.00 to -0.35) correspond to barren areas of rock, sand, or urban/built-up. Most of the part of Nashik city Moderate value represents a density of vegetation (0.00 to 0.23) (Gadakh and Jaybhaye,2015)

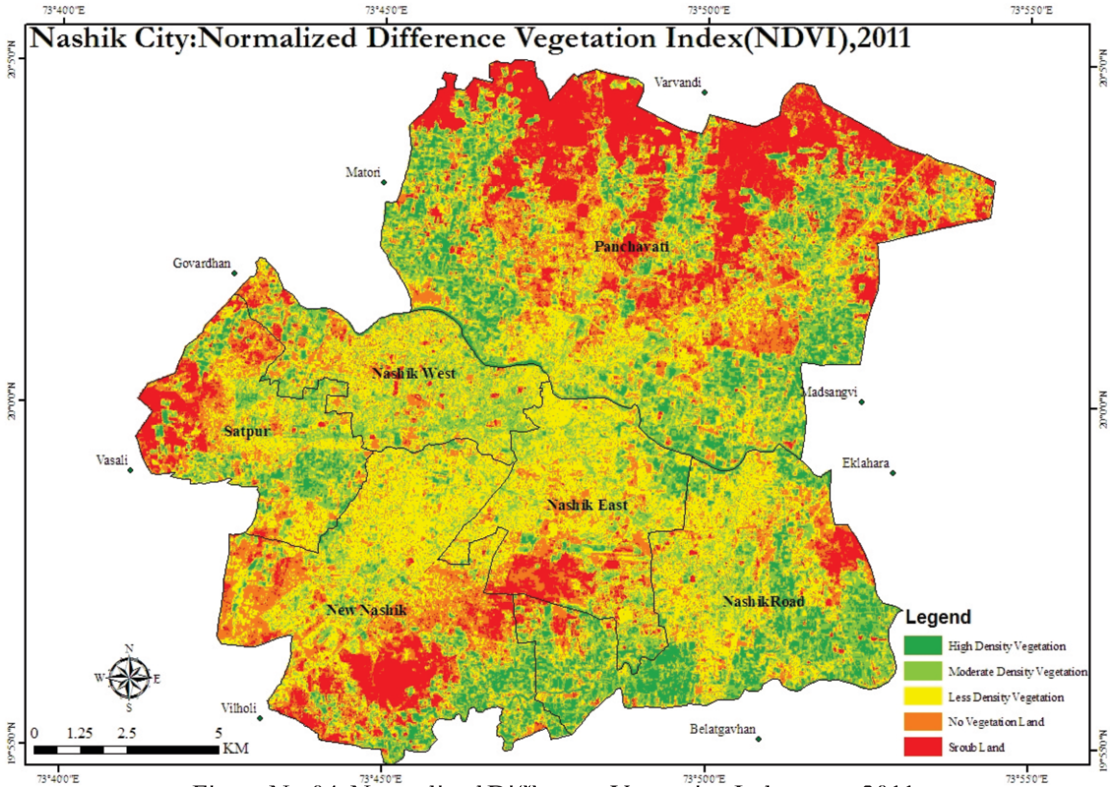


Figure No.04: Normalized Difference Vegetation Index map, 2011

❖ **Normalized Difference Vegetation Index (NDVI), 2019**

Table 3: Normalized Difference Vegetation Index (NDVI) Area Statistics, 2019

Year	**2019**			
Class	NDVI Range	Area (km2)	Percentage	Class
1	0.12-0.23	15.19	10.26	High-Density Vegetation
2	0.9-0.12	56.74	28.81	Moderate Density Vegetation
3	0.06-0.09	92.27	34.24	Low-Density Vegetation
4	-0.01-0.06	77.63	21.05	Fallow Land
5	-0.01--0.15	27.66	5.64	Scrub Land
	TOTAL	269.46	100.00	

During in the 2019, the Nashik city Normalized Difference Vegetation Index (NDVI) has understood the change of land cover during the study period. The NDVI is the most common measurement used for measuring vegetation cover. It ranges from values -1 to +1. In the Nashik city Very low values of NDVI (-0.00 to -0.35) correspond to barren areas of rock, sand, or urban/built-up. Most of the part of Nashik city low value represents a density of vegetation (0.00 to 0.23)

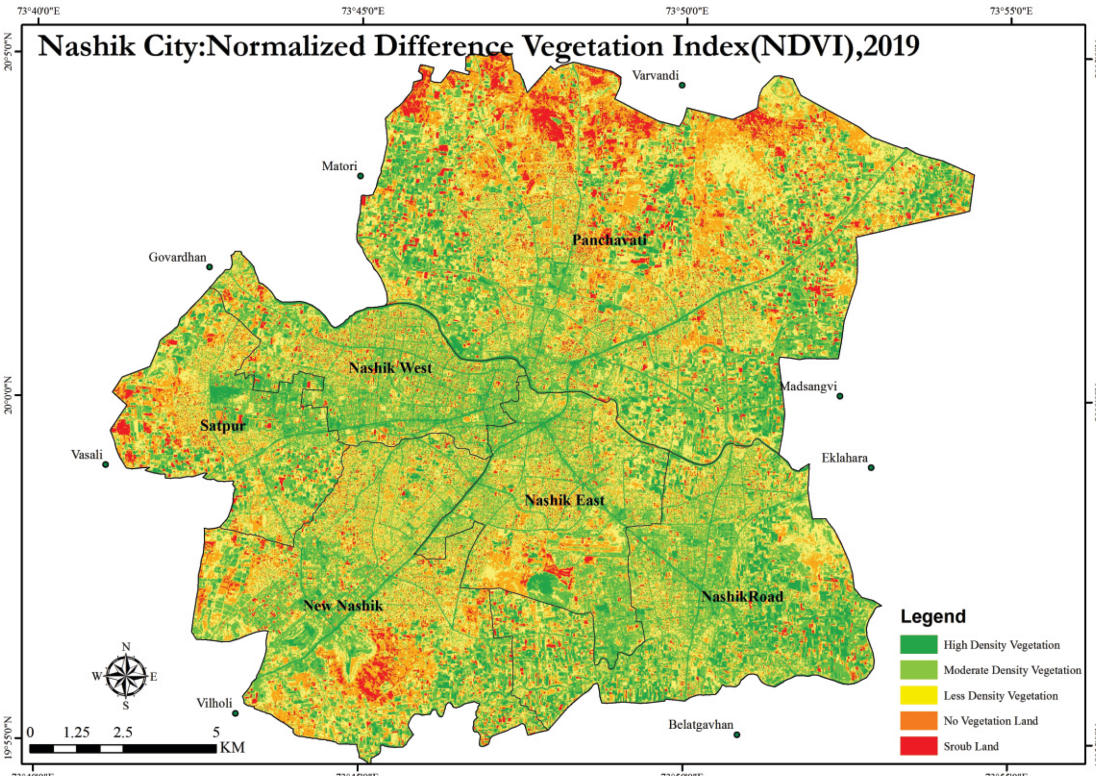


Figure no:05: Normalized Difference Vegetation Index map,2019

Normalize difference vegetation index is the method used to determine the actual vegetation cover of the study area. For the study of NDVI for Nashik city, five second-level classification was followed. High-density vegetation, moderate density vegetation, low-density vegetation, fallow land and scrubland etc., was used for the NDVI study. During 1991 highly dense area 57.04 sq.km, moderately dense area 74.47 sq.km. and 68.68 sq.km low-density areas were observed in NDVI classification for Nashik city. During 2001 the highly-dense area decreased slightly up to 46.11 sq.km area; the same trend has been observed with moderate and low-density vegetation areas. 71.28 sq.km moderately dense vegetation and 63.12 sq.km low-density vegetation observed during 2001 in Nashik city. During 2011, most of the highly-dense vegetation covers converts into other classes and only 29.89 sq.km. Highly dense vegetation was reminded in Nashik city. 56.68 sq.km. Moderately dense and 62.74 sq.km. Low-density vegetation cover remained in 2011. During 2019 Most of the vegetation around 73.21 % percentage as compared last year 2011 silently increase vegetation cover in Nashik city

Temperature of Nashik city from 1981 to 2019

Month	Jan	Feb	Mar	Apr	May	June	July	August	Sept	Oct	Nov	Dec
Avg. Temp (°C)	20.4	21.8	25.3	28.3	29.5	27.6	25.1	24.7	24.6	25	22.7	20.8
Min. Temp (°C)	12.5	13.6	17.4	21.1	23.2	23.1	22	21.5	20.7	19.2	15.5	12.9
Max. Temp (°C)	28.3	30.1	33.3	35.5	35.9	32.1	28.2	28	28.6	30.9	29.9	28.7

Data: 1981 to 2019\ (Ref: climatic data website)

Over all the temperature data from 1981 to 2019, Temperature is silently increasers.

- **Correlation between temperature and NDVI:**

It is closely correlation of normalized difference vegetation index and temperature in any region. Temperature variation not vegetation covers effect but also other factors also affects like as urban area, industrial area, Road density etc. NDVI correlated quite differently with temperature and precipitation, with obvious seasonal differences.

❖ **Conclusion:**

The change of the NDVI is the most common measurement used for measuring vegetation cover. It ranges from values -1 to +1. In 1991 The NDVI value 0.009 to 0.23 range area was decreased from 74.28 % to 62.82%.over the period of 1991 to2018. The expansion of Nashik city concerning agricultural land, settlements, industrial area, transportation etc., was tremendously increased during these decades and vegetation cover was replaced by built up and agricultural land.

❖ **Reference:**

- ArcGIS Resource center, Help from ArcGIS Desktop 10.0 software, ESRI.
- Burrough, P. A., (1986): "Principles of Geographic Information Systems for Land Resources Assessment", Clarendon Press, Oxford.
- CDP of Nashik Municipal Corporation under JNNURM
- Congalton, K., Green, A., (1999): Assessing the Accuracy of Remotely Sensed Data: Principles and Practices, Lewis Publisher New York.
- F. Yianna and P. Poulicos, “GIS Contribution for the Evaluation and Planning of Tourism: A Sustainable Tourism Perspective”,
- Gadakh, B. L., & Jaybhaye, R. G. (2015). An analysis of Normalized Vegetation Cover Index: A case study of Nashik city, Maharashtra. Journal of Basic Sciences, 4(1), 6-14.
- Gadakh, B. L., & Jaybhaye, R. G. (2015). Land resource impact indicators of urban sprawl: A case study of Nashik city, Maharashtra. Journal of Basic Sciences
- Gadakh, B. L., & Jaybhaye, R. G. (2016) AN IDENTIFICATION OF URBAN PATTERN ON 1981 TO 2011 OF THE NASHIK CITY, MAHARASHTRA.
- Gadakh, B. L., & Jaybhaye, R. G. (2017) AN ASSESSMENT OF CORRELATION SEX RATIO AND LITERACY ON 1981 TO 2011 OF THE NASHIK CITY, MAHARASHTRA.
- Gadakh, B. L., & Jaybhaye, R. G. (2017) an assessment of population distribution from 1981 to 2011 of the Nashik city, Maharashtra.
- Gadakh, B. L., & Jaybhaye, R. G. (2018) Land use change detection and monitoring urban growth with Geoinformatics techniques: A case study of Nashik city.
- Gadakh, B. L., & Jaybhaye, R. G. (2018) Scholars Bulletin (Geography).
- Gadakh, B., Jaybhaye, R., & Nalawade, P. (2015). An Assessment of Tourism Potential: A Case Study of Nashik City, Maharashtra. International Journal of Research in Geography,
- Goetz, S. J., 1997.Multi-sensor analysis of NDVI, surface temperature, and biophysical variables at a mixed grassland site. International Journal of Remote Sensing, 18, 71–94.
- H. Effat and M.N.Hegazy, "Cartographic Modeling and Multi-Criteria Evaluation for Exploring the Potentials for Tourism Development in the Suez Governorate, Egypt", Environmental Issues, Sustainable Development, Millennium Development Goals, pp-11-18
- Holme, A.McR., Burnside, D.G. and Mitchell, A.A. (1987): The development of a system for monitoring trend in range condition in the arid shrublands of Western Australia Australian Rangeland Journal 9:14-20.
- Kumar D, Shekhar S (2015). Statistical analysis of land surface temperature–vegetation indexes relationship through thermal remote sensing. Ecotoxicol Environ Saf, 121: 39–44.

- Lillesand, T. M., Kiefer, R.W., Chipman, J. W., (2004): "Remote sensing and Image interpretation", Fifth edition. John and Sons, Inc. New York. 828 p.
- Liu, H.Q.; Huete, A.R., (1995). A feedback based modification of the NDV I to minimize canopy background and atmospheric noise. IEEE Transactions on Geoscience and Remote Sensing 1995, 33, 457-465.
- M. Constantin, C. Daniela-Luminia, G. Mihaela (2009) "Tourism Potential and the Diminishing of Regional Disparities in Romania", economy-and-business-administration volume /2009 /v2- pp-151-155.
- Mao DH, Wang ZM, Song KS et al (2011) The vegetation NDVI variation and its responses to climate change and LUCC from 1982 to 2006 year in northeast permafrost region. Chin Environ Sci 31(2):283–292
- Mao, D., Wang, Z., Song, K., Liu, D., Zhang, B., Zhang, S., & Zhang, C. (2011). The vegetation NDVI variation and its responses to climate change and LUCC from 1982 to 2006 year in northeast permafrost region. China Environmental Science, 31(2), 283-292.
- Miura, T., Huete, A. R., & Yoshioka, H. (2006). An empirical investigation of cross-sensor relationships of NDVI and red/near-infrared reflectance using EO-1 Hyperion data. Remote Sensing of Environment, 100, 223−236
- Pu R, Gong P, Michishita R, Sasagawa T (2006). Assessment of multi-resolution and multi-sensor data for urban surface temperature retrieval. Remote Sens Environ, 104(2): 211–225.
- Ray D.Jackson, Alfredo R.Huete (1991): Interpreting vegetation indices, preventive veterinary Medicine,11 page 185-200.
- Roderick, M., R. C. G. Smith, and G. Ludwick. (1996): Calibrating long term AVHRR derived NDVI imagery. Remote Sensing of Environment 58: 1-12.
- Rouse, J. W., R. H. Haas, J. A. Schell, and D. W. Deering (1973): Monitoring vegetation systems in the Great Plains with ERTS, Third ERTS Symposium, NASA SP-351 I, 309-317.
- S. Formica(2000) "Destination Attractiveness As A Function Of Supply And Demand Interaction", A Ph.D. Dissertation Submitted to the Faculty of the Virginia Polytechnic Institute
- Sruthi.S, and Mohammed Aslam .M.A., (2014) Vegetation Stress Analysis Using Ndvi at Drought Prone Raichur District, Karnataka. IWRM International Symposium. (IWRM2014).
- Verma, A. K., Garg, P. K., Hari Prasad, K. S., & Dadhwal, V. K. (2016). CLASSIFICATION OF LISS IV IMAGERY USING DECISION TREE METHODS. International Archives of the Photogrammetry, Remote Sensing & Spatial Information Sciences, 41.
- Wei M A, Zhou J (2011). Quantitative analysis of land surface temperature–vegetation indexes relationship based on remote sensing. The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences. Vol. XXXVII. Part B6b.Beijing.
- Yin He, Thomas Udelhoven, Rasmus Fensholt, Dirk Pflugmacher and Patrick Hostert(2012): How Normalized Difference Vegetation Index (NDVI) Trends from Advanced Very High-Resolution Radiometer (AVHRR) and Système Probatoire observation de la Terre VEGETATION (SPOT VGT) Time-Series Differ in Agricultural Areas: An Inner Mongolian Case Study, Remote Sensing, Vol-4, page no. 3364-3389.
- Yue W, Xu J, Tan W, Xu L (2007). The relationship between land surface temperature and NDVI with remote sensing: application to Shanghai Landsat 7 ETM+ data. Int J Remote Sens, 28(15): 3205–3226
- Yves Julien, Jose A. Sobrino, Cristian Mattar, Ana B. Ruescas, Juan C. Jime´Nez-Mun˜ Oz,

Guillem So` Ria, Victoria Hidalgo, Mariam Atitar, Belen Franch And Juan Cuenca (2011) Temporal analysis of normalized difference vegetation index (NDVI) and land surface temperature (LST) parameters to detect changes in the Iberian land cover between 1981 and 2001., International Journal of Remote Sensing Vol. 32, No. 7, 10 April, Page No. 2057–2068.

- Zhengming Wan, Pengxin Wang, and Xiaowen Li, (2004).Using MODIS Land Surface Temperature and Normalized Difference Vegetation Index Products for Monitoring Drought in the Southern Great Plains, USA. International Journal of Remote Sensing; 25:61-72.

*** Bharat L. Gadakh[1]**
Department of Geography,
KTHM College, Nashik-02

****Ravindra G. Jaybhaye[2]**
Department of Geography,
Savitribai Phule Pune University, Pune-07