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An analysis of Normalized Vegetation Cover Index: A case study of Nashik city, Maharashtra

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Abstract:

The Normalized Difference Vegetation Index gives a measure of the vegetative cover on the land surface over wide areas. The Normalized Difference Vegetation Index is a standardized index allowing you to generate an image displaying greenness. The Remote Sensing and GIS technology is the best tool used for vegetation monitoring. The NDVI values always ranges between -1 and +1 because of high reflectance in the NIR of EMS. Non-vegetation area has NDVI value less than zero and 0 - 1 value indicates a wide variety of vegetation from the bare surface of the dense forest canopy. The city of Nashik is situated in in the northwest of Maharashtra. It has been used the Landsat TM (1991), land sat ETM+ (2001) and IRS P6-LISS-III (2011) data. 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. It has resulted 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 to2011. The expansion of Nashik city in respect to agricultural land, settlements, industrial area, transportation etc., was tremendously increased during these decades and vegetation cover was replaced by built up and agricultural land.

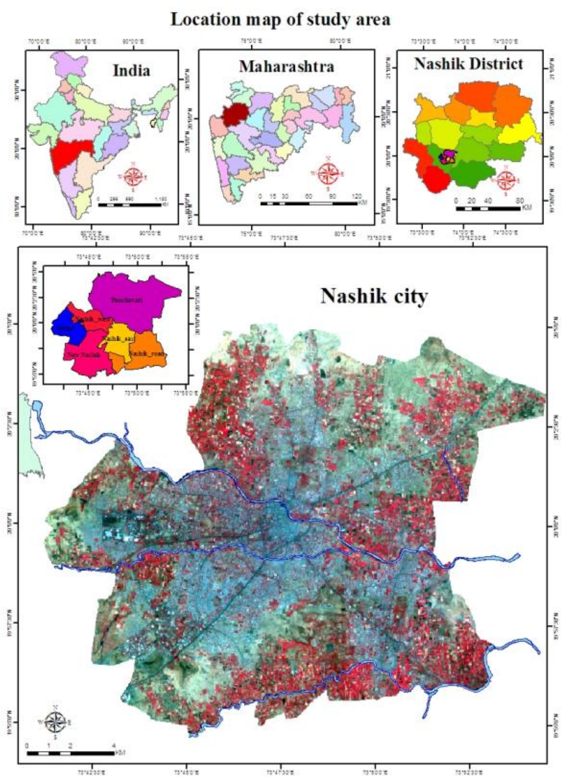
Keywords: *Normalized Difference Vegetation Index, Remote Sensing, Digitization, Digital Classification*

1 Introduction

The Normalized Difference Vegetation Index (NDVI) is a standardized index allowing you to generate an image displaying greenness. An NDVI is often used worldwide to monitor drought, monitor and predict agricultural production, assist in predicting hazardous fire zones, and map desert encroachment. The NDVI is preferred for global vegetation monitoring because it helps to compensate for changing illumination conditions, surface slope, aspect, and other extraneous factors (*Lillesand 2004*). The Normalized Difference Vegetation Index (NDVI) gives a measure of the vegetative cover on the land surface over wide areas. Remote sensing data can be used for vegetation monitoring. The various remote sensing-based vegetation measures utilized in agricultural monitoring, the Normalized Difference Vegetation Index (NDVI) is the most widely used proxy for vegetation cover and production (*Yin, 2012*). The Remote Sensing (RS) and GIS technology is the best tool in the hands of researchers of various disciplines of recent generation. The NDVI values always ranges between -1 and +1 because of high reflectance in the NIR of EMS. Non-vegetation area has NDVI value less than zero and 0 - 1 value indicates a wide variety of vegetation from the bare surface of the dense forest canopy. The Normalized Difference Vegetation Index (NDVI) is a measure of the difference in reflectance between these wavelength ranges. NDVI takes values between -1 and 1, with values 0.5 indicating dense vegetation and values <0 indicating no vegetation.

2 Materials and Methods

Study area:



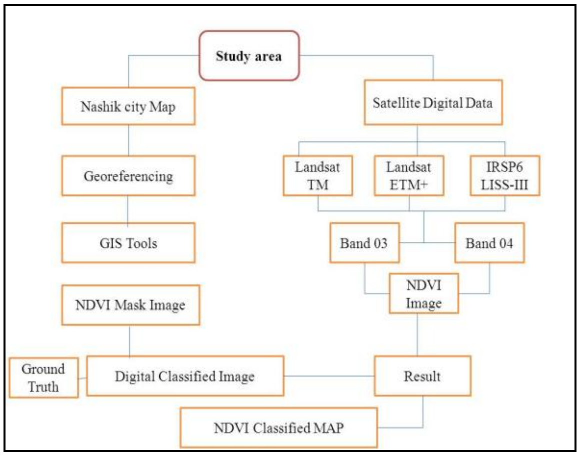
The city of Nashik is situated in the State of Maharashtra, in the northwest of Maharashtra, on between 19° 54'40" North latitude to 20° 05'08" North latitude and between 73° 41'08"East longitude to 73° 54'22" East longitude. It is connected by road to Mumbai (185 kms.) and to Pune (220kms.). Nashik is one of the most important cities of Northern Maharashtra. The city has become the center of attraction because of its beautiful surroundings and cool and pleasant climate. Nashik has a personality of its own due to its mythological, historical, social and cultural importance. The city, vibrant and active on the industrial, political, social and cultural fronts, has influenced the lives of many great personalities. The river Godavari flows through the city. Temples and Ghats on the banks of Godavari have made Nashik one of the holiest places for Hindus all over the World. Nashik city is one of the five places in India where the famous Kumbh Mela is held once in 12 years.

Methodology

Methodology is one of the important parts of analysis. Output or result of analysis highly depends on the methodology will be used for the data processing or analysis purpose. To achieve the above objective following methodology will be adopted:-

- ❖ **Step -1** Primary data will be collected; exhaustive literature survey of the topic of investigation is to be undertaken. Published literature, reports will be collected from various libraries, Institutes and government departments etc. Besides this relevant literature wills also reference books, bulletins, reviews will also be etc.by obtained through Internet.
- ❖ **Step -II** to Calculation of Normalized Difference Vegetation Index (NDVI) with help of ARC GIS software tools.
- ❖ **Step –III** to classified image for different class like as highly dense vegetation.

- ❖ FLOW DIAGRAM: Showing Methodology for Analysis of Normalized difference Vegetation Index.



❖ **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 geographer. 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 the 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 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. Photo synthetically 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 measurement. 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 is able to 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 interval.

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*).

3 Results and Discussion

- **Normalized Difference Vegetation Index (NDVI), 1991**

During in the 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)

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**	

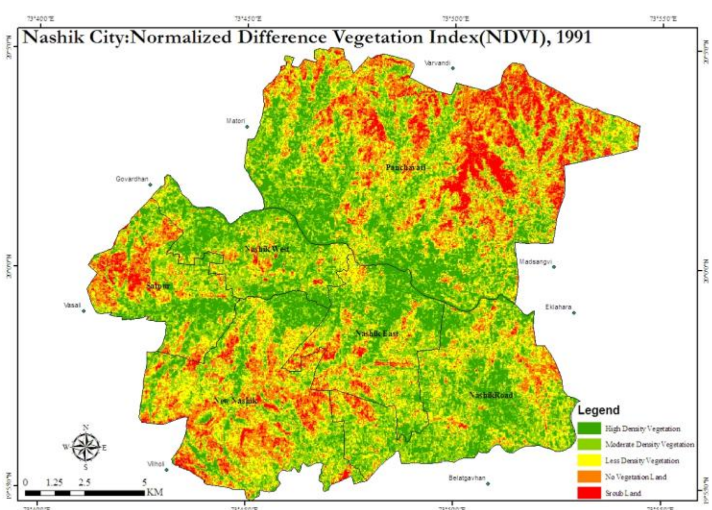


Figure 2: Normalized Difference Vegetation Index map, 1991

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

During in the 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).

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	

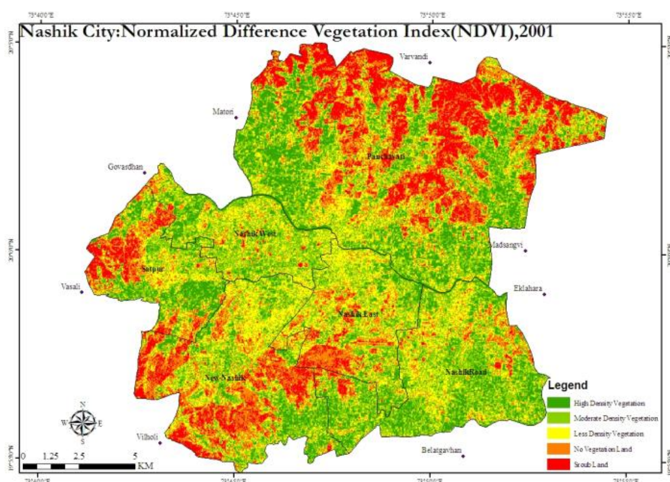


Figure 4.23: Normalized Difference Vegetation Index map, 2001

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 Vegetation
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**	

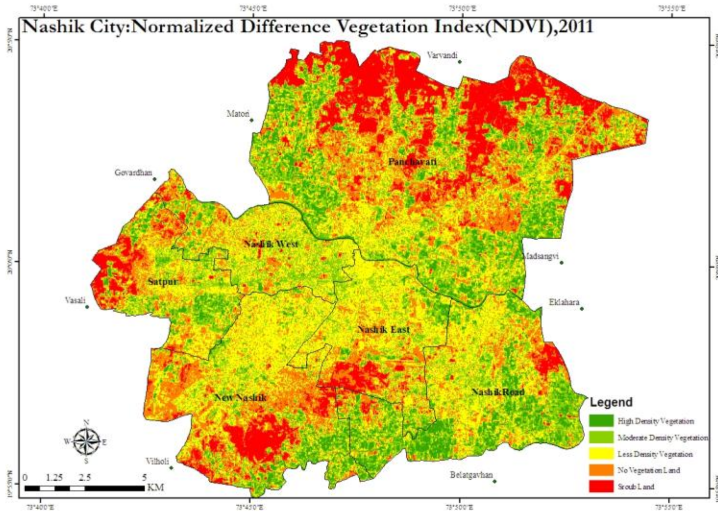
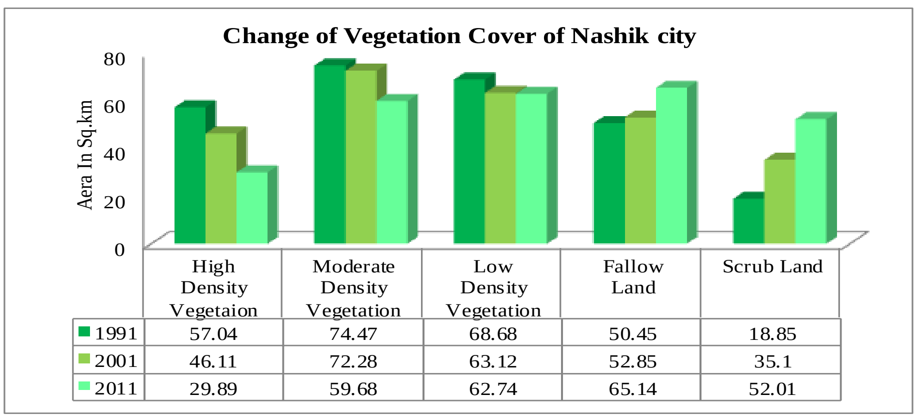


Figure 4.24: Normalized Difference Vegetation Index map, 2011

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

During in the 2011, the Nashik city Normalized Difference Vegetation index (NDVI) has 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 (-0.00 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)



	High Density Vegetaion	Moderate Density Vegetation	Low Density Vegetation	Fallow Land	Scrub Land
1991	57.04	74.47	68.68	50.45	18.85
2001	46.11	72.28	63.12	52.85	35.1
2011	29.89	59.68	62.74	65.14	52.01

Figure 4.25: change of Vegetation cover of Nashik city

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 scrub land 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 was observed in NDVI classification for Nashik city. During 2001 the highly dense area decreased slightly up to 46.11 sq.km area; same trend has been observed with moderate and low density vegetation area. 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 cover converts in to another 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 was remaining in 2011.

4 Conclusions

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 to2011. The expansion of Nashik city in respect to agricultural land, settlements, industrial area, transportation etc., was tremendously increased during these decades and vegetation cover was replaced by built up and agricultural land

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