Eco. Env. & Cons. 28 (August Suppl. Issue) : 2022; pp. (S229-S233)
Copyright@ EM International
ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2022.v28i04s.034

Vegetation Change Detection using Remote Sensing and GIS, 2001-2021 – A Case Study of Nashik City, Maharashtra

P. M. Nalawade, B. L. Gadakh and Kadam Amol B.

Department of Environmental Science,
K.R.T. Arts, B.H. Commerce and A.M. Science College, Nashik, Maharashtra, India

(Received 6 November, 2021; Accepted 16 January, 2022)

ABSTRACT

This article provides an improved vegetation change detection technique for the analysis of satellite image based on normalized difference vegetation index (NDVI). The normalized difference vegetation index measures the amount of vegetation on the earth's surface across a large region. Remote sensing delivers spectral data from satellites in digital form without any direct interaction with the item. In the form of imaging, this digital data is transformed into visual images. In different settings such as topography, biodiversity, land use, cultural elements, and so on, imagery is the best and most trustworthy source of data about the earth's surface. In the hands of geographers, the geographic information system (GIS) is a relatively new technology. This index takes use of the disparity features of two bands a multispectral raster dataset: chlorophyll pigment absorptions in the red band (Red) and high reflectivity of plant materials in the near-infrared (NIR) band from a multispectral raster dataset. The NDVI for every pixel always yields a figure between -1 and +1, although no vegetation cover yields a value near to zero. The NDVI value around +1 represents the maximum area under the vegetation cover. The NDVI value near to -1 indicates barren expanses of rock, sand, or built-up areas. In urban area, vegetation plays essential role in enhancing the microclimate. Natural vegetation has declined in many tropical cities as a result of urbanization. The Nashik city is located to northwest region of the Maharashtra in India. The normalized difference vegetation index was analyzed using Landsat satellite imaginary data for the study period 2001-2021. The results showed that the vegetation cover of the Nashik city declined due to urban sprawl. The class, very low density vegetation explains that the area has increased which clearly indicates that the vegetation cover has been decreased from 2001 to 2021, i.e. 25.51% to 55.87% per sq.km area. The class, very high density vegetation explains that the area has decreased from 2001 to 2021, i.e. 11.66% to 5.54%% per sq.km area.

Key words : *Urban sprawl, Normalized difference vegetation index, Remote sensing, Geographical information system, Landsat data.*

Introducation

Natural vegetation has become scarce in many tropical cities as a result of rapid urbanization,, and impervious material such as asphalt and concrete have taken its place. This result in a greater amount of sensible heat flow that latent heat flux (Emmanuel, 2005). In urban areas, vegetation plays as essential role in enhancing the microclimate and outdoor thermal comfort (Spangenberg, 2004). The cooling effects of dense vegetation can be significant. As a result, the impact of vegetation on urban micro-

climate has been recognised as a major component in urban environmental research. The normalized difference vegetation index measure (NDVI) is a standardized index that is used to measure the vegetation cover. Drought monitoring, agricultural production monitoring and forecasting, projection dangerous fire zones, and mapping desert encroachment are few application which can be studied by using the normalized difference vegetation index. The normalized difference vegetation index values are constantly between -1 and +1. The NDVI value of non-vegetation areas is less than zero, whereas the NDVI value 0 to +1 shows board range of vegetation covers. Low vegetation density (0.1to 0.3) is represented by moderate values, whereas high vegetation density (0.6 to 0.8) is represented by high values. The remote sensing and geographic information system (GIS) technologies are the most powerful tools in the hands of today's academics in variety of fields. Remote sensing delivers spectral data from satellites in digital form without any direct interaction with the item. In the form of imaging, this digital data is transformed into visual images. In different settings such as topography, biodiversity, land use, cultural elements, and so on, imagery is the best and most trustworthy source of data about the earth's surface. In the hands of geographers, the geographic information system (GIS) is a relatively new technology. It is a computer-based system that collects, stores, checks, integrates, retrieves, manipulates processes, analysis, and displays data that is geographically related to the earth (Burrow, 1986). The NDVI is the most well-known and widely used index for detecting living green plant canopies in multispectral remote sensing data, and it is one of the most successful of several attempts to simply and rapidly identify vegetated regions. NDVI not only identifies vegetation, but also allows for the measurement of forest canopy photosynthetic potential. The normalized difference vegetation index (NDVI) is a standardized index that allows you to create a green image. This index takes use of the disparity features of two bands a multispectral raster dataset: chlorophyll pigment absorptions in the red band (Red) and high reflectivity of plant materials in the near-infrared (NIR) band from a multispectral raster dataset. An NDVI is frequently used across the world to monitor and anticipate agricultural productivity, drought, and to aid in the prediction of dangerous fire zone, as well as a map of desert encroachment. Using the following formula, the normalized difference vegetation index transformation is determined as the ratio of observed intensities in the red (Red) and near infrared (NIR) spectral bands (Rays, 1991).

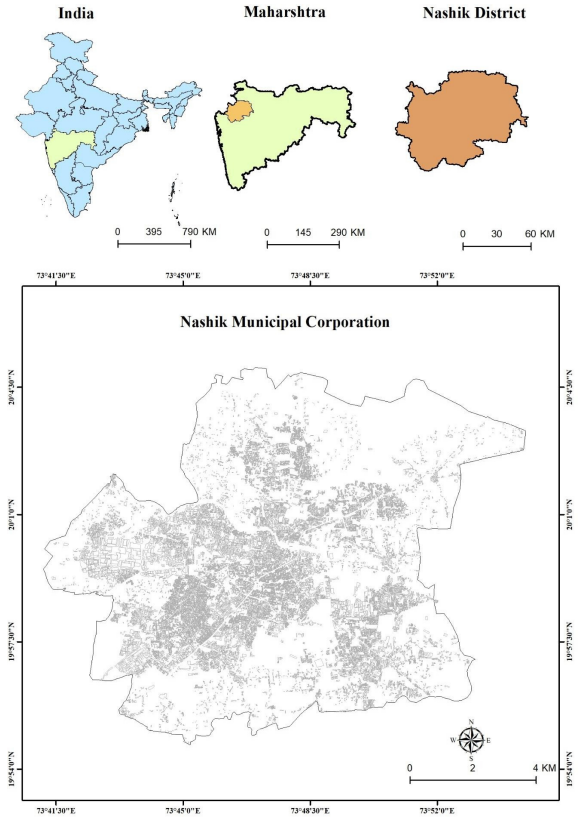
NDVI= (Near Infra-red - Red) / (Near Infra-red + Red)

The Normalized Difference Vegetation Index Calculation (NDVI): The NDVI for every pixel always yields a figure between -1 and +1, although no vegetation cover yields a value near to zero. The NDVI value around +1 represents the maximum area under the vegetation cover. The NDVI value near to -1 indicates barren expanses of rock, sand, or built-up areas.

Materials and Methodology

Study Area

The city of Nashik is situated in the state of Maharashtra, in the northwest of Maharashtra, 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



Location of study area: Nashik city

Mumbai (185 km) and to Pune (220 km). Nashik is one of the most important cities in Northern Maharashtra. The city has become the centre of attraction because of its beautiful surroundings and pleasant atmospheric conditions. 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 the Godavari have made Nashik one of the holiest places for Hindus all over the world.

SATELLITE DATA

Satellite Data				
Satellite	Sensor	Path/Row	Resolution	Dateof Acquisition
LANDSAT-4	ETM+	147/46	30Meter	2001
LANDSAT-5	ETM+	147/46	30Meter	2006
LANDSAT-7	ETM+	147/46	30Meter	2011
LANDSAT-7	OLI-TIRS	147/46	30Meter	2016
LANDSAT-8	OLI-TIRS	147/46	30Meter	2021

SOFTWARE

1. ERDAS 2014
2. ARC GIS 10.5
3. Google Earth Pro

Methodology

One of the most important aspects of analysis is methodology. The technique that will be applied for data processing will have a significant impact on the output of the analysis.

Step 1: Using Landsat satellite images, ARC GIS software tools for the study period the normalized difference vegetation index (NDVI) will be calculated.

Step 2: Classify the image into distinct categories, such as very high dense vegetation.

Step 3: Field analysis will be done to understand the vegetation change detection.

Results and Discussion

From Graph 1 and Table 1 according to considered classes: In the year 2001, the very low density vegetation was 25.51%, low density vegetation was 36.92%, moderate density vegetation was 10.38%, high density vegetation was 15.54% and very high density vegetation was 11.66% per sq.km area respectively for Nashik city. This indicates that the

Methodology flow chart

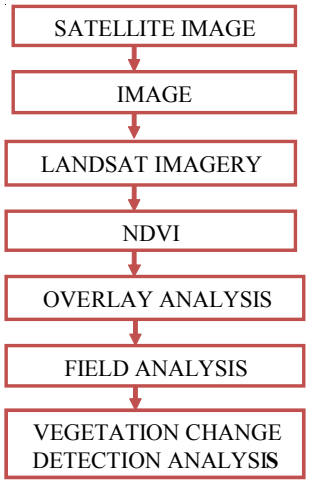
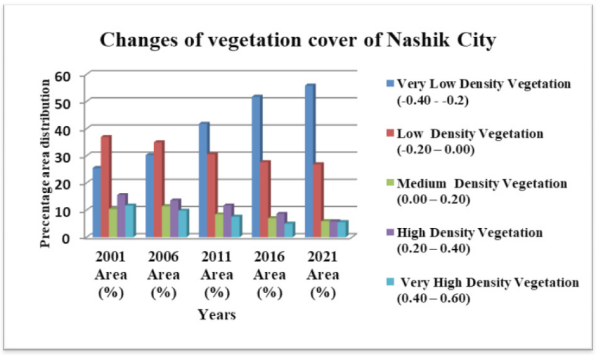


Table 1. The changes in vegetation cover percentage distribution area per sq.km, Nashik City.

NDVI Classes	2001 Area (%)	2006 Area (%)	2011 Area (%)	2016 Area (%)	2021 Area (%)
Very Low Density Vegetation (-0.40 - -0.2)	25.51	30.27	41.76	51.76	55.87
Low Density Vegetation (-0.20 – 0.00)	36.92	34.97	30.58	27.65	26.88
Medium Density Vegetation (0.00 – 0.20)	10.38	11.44	8.41	6.99	5.88
High Density Vegetation (0.20 – 0.40)	15.54	13.54	11.70	8.62	5.83
Very High Density Vegetation (0.40 – 0.60)	11.66	9.77	7.54	4.99	5.54
TOTAL	100	100	100	100	100



Graph 1. The change in vegetation cover percentage distribution area per sq.km, Nashik City.

maximum vegetation cover was 11.66% per sq.km area in the 2001. In the year 2006, the very low density vegetation was 30.27%, low density vegetation was 34.97%, moderate density vegetation was 11.44%, high density vegetation was 13.54% and very high density vegetation was 9.77% per sq.km area respectively for Nashik city. This indicates that the maximum vegetation cover was 9.77% per sq.km area in the 2006. In the year 2011, the very low density vegetation was 41.76%, low density vegetation was 30.58%, moderate density vegetation was 8.41%, high density vegetation was 11.70% and very high density vegetation was 7.54% per sq.km area respectively for Nashik city. This indicates that the maximum vegetation cover was 7.54% per sq.km area in the 2011. In the year 2016, the very low density vegetation was 51.76%, low density vegetation was 27.65%, moderate density vegetation was 6.99%, high density vegetation was 8.62% and very high density vegetation was 4.99% per sq.km area respectively for Nashik city. This indicates that the maximum vegetation cover was 4.99% per sq.km area in the 2016. In the year 2021, the very low density vegetation was 55.87%, low density vegetation was 26.88%, moderate density vegetation was 5.88%, high density vegetation was 5.83% and very high density vegetation was 5.54% per sq.km area respectively for Nashik city. This indicates that the maximum vegetation cover was 5.54% per sq.km area in the 2021. From the graph 1, we can easily identify that the class very low density vegetation has been increased from year 2001 till 2021, i.e. 25.51% to 55.87% per sq.km area which clearly indicates that the vegetation cover under this class had

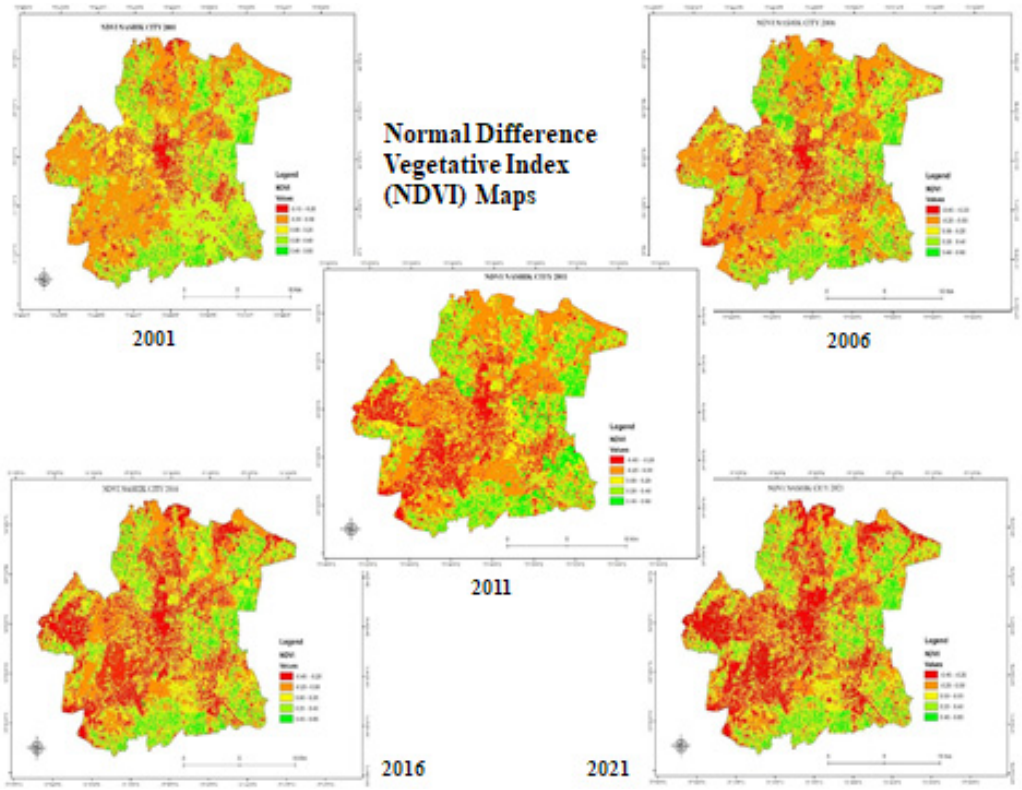


Fig. 1. Normalized Difference Index Map for Years - 2001, 2006, 2011, 2016 and 2021

been increased. Hence the vegetation cover has been decreased up to year 2021. The very high density vegetation class explains the vegetation cover in year 2001 it was 11.66% while in year 2021 it is 5.54% per sq.km area respectively. Hence, this class also explains that the Nashik city vegetation cover had been decreased till year 2021. From Figure 1, we can clearly visualize the vegetation change detection of Nashik city for study period i.e. from year 2001 till 2021 with respective to considered five classes according to NDVI value range from (-0.40 - -0.2) to (0.40 – 0.60) in normalized difference vegetation index maps.

Conclusion

The area under the very low density vegetation class explains that the area has increased which clearly indicates that the vegetation cover has been declined from 2001 to 2021, i.e. 25.51% to 55.87% per sq.km. The class, very high density vegetation explains that the vegetation covered area has declined from 2001 to 2021, i.e. 11.66% to 5.54% per sq.km. The expansion of the Nashik city in respect to agricultural land, settlements, industrial area, transportation etc., has been increased from year 2001 till 2021. Hence, the vegetation cover declined, which is replaced by built up and agricultural land. There is need to protect urban green spaces of Nashik city which maintain urban ecoenvironment. This study helps to assess and detect the vegetation cover of Nashik city for sustainable development and town planning.

References

Arc GIS Resource center, Help from ArcGIS Desktop 10.0 software, ESRI.

Burrough, P.A. 1986. *Principles of Geographical Information Systems for Land Resources Assessment.* Clarendon Press, Oxford.

CDP of Nashik Municipal Corporation under JNNURM.

Congalton, R.G. and Green, K. 2008. *Assessing the Accuracy of Remotely Sensed Data: Principles and Practices.* CRC press.Lewis Publisher New York.

Constantin, M., Daniela-Luminia, C. and Mihaela, G. 2009. Tourism Potential and the Diminishing of Regional Disparities in Romania", economy-and-business administration volume /2009 /v2- pp-151155.

Effat, H. and Hegazy, M. N. 2009. Cartographic modeling and multi criteria evaluation for exploring the potentials for tourism development in the Suez Governorate, Egypt. Stuttgart: Stuttgart University of Applied Sciences. *Environmental Issues, Sustainable Development, Millennium Development Goals*. pp-11-18.

Emmanuel, M. R. 2005. *An Urban Approach to Climate-Sensitive Design – Strategies for the Tropics.* New York, Spon Press, 2005.

Formica, S. 2000. *Destination attractiveness: As a function of supply and demand interaction, hospitality and tourism management* (Doctoral dissertation, Doctoral dissertation, The Virginia Polytechnic Institute and State University).

Holm, A. M., 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 [Range management]. *Australian Rangeland Journal (Australia).* 9 : 14-20.

Jackson, R. D. and Huete, A. R. 1991. Interpreting vegetation indices. *Preventive Veterinary Medicine.* 11(3): 185-200.

Julien, Y., Sobrino, J. A., Mattar, C., Ruescas, A. B., Jimenez-Munoz, J. C., Soria, G. and Cuenca, J. 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*. 32(7) : 2057-2068.

Lillesand, T., Kiefer, R. W. and Chipman, J. 2014. Remote sensing and image interpretation.John Wiley & Sons. Fifth edition. Inc. New York. 828 p.

Roderick, M., Smith, R. and Lodwick, G. 1996. Calibrating long-term AVHRR derived NDVI imagery. *Remote Sensing of Environment.* 58 (1) : 1-12.

Rouse Jr, J., Haas, R. H., Schell, J. A. and Deering, D. W. 1974. Monitoring vegetation systems in the Great Plains with ERTS. *NASA special Publication.* 351: 309.

Spangenberg, J. 2004. Improvement of Urban Climate in Tropical Metropolis – A case study in Rio de Janeiro, University of Applied Sciences, Cologne, Germany.

Yianna, F. and Poulicos, P. 2010. GIS Contribution for the Evaluation and Planning of Tourism: a sustainable tourism perspective. In: *Proceedings of the International Leisure and Tourism Symposium, ESADE, Barcelona.* (Vol. 11).

Yin, H., Udelhoven, T., Fensholt, R., Pflugmacher, D. and Hostert, P. 2012. How normalized difference vegetation index (ndvi) trends from advanced very high resolution radiometer (AVHRR) and systèmeprobatoired'observation de la terre vegetation (spot vgt) time series differ in agricultural areas: An inner mongolian case study. *Remote Sensing.* 4(11): 3364-3389.