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Assessment of vegetation cover of Palghar taluka using NDVI technique

Deepali Mhapsekar[a], Dnyaneshwar Bombe[b]* & Smrity Prabha[c]

[a]Department of Botany, Parle Tilak Vidyalaya Association's Sathaye College (Autonomous), Vile Parle (East), Mumbai, Maharashtra, India

[b]Department of Geography, Parle Tilak Vidyalaya Association's Sathaye College (Autonomous), Vile Parle (East), Mumbai, Maharashtra, India

[c]University Department of Botany, Ranchi University, Ranchi, Jharkhand, India

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Abstract- Forest is a part of an ecosystem to maintain the ecological balance, regularize the climate, conserve the soil, etc. Natural vegetation is getting degraded over a period of time due to anthropogenic activities such as expansion of agriculture, urbanization, developmental projects etc. Over exploitation of forest resources leads to shrinking of the forest land which pose a great threat to biodiversity and environment. Thus, there is an urgent need of action to be taken on these vital issues and rapid action for its conservation. The present investigation aims to study the presence of vegetation cover in Palghar Tehsil with the help of remote sensing data and geoinformatics. The investigation applies NDVI (Normalized Difference Vegetation Index) technique to analyze density of vegetation cover using Landsat 8 RESOURCESAT data. The study depicts NDVI differences according to the density of vegetation cover in the last decade. Further the investigation assured the change in vegetation density with the implementation of change detection technique. Majority of area in Palghar Tehsil comes under Less dense vegetation in the decade. Maximum change detection is observed from moderate density vegetation area to less density vegetation area. The present study will help in the implementation and conservation of vegetation conservation strategies in Palghar region. Remote sensing technology and Geoinformatics softwares for data analysis propagate very precise real time information very accurately and are useful for vegetation assessment, management and conservation of flora and fauna.

Key words: vegetation density, FCC, satellite image and interpretation, NDVI, change detection

INTRODUCTION

Vegetation cover is the crown of vegetation to ground surface expressed as fraction or percent. It may be defined as the green vegetation area which is directly detected by the remote sensing sensor.[1] Reduction of natural vegetation cover in tropical countries over the decades of the 21st century is one of the biggest challenges leading to many environmental problems. The spatio-temporal change in vegetation cover is mainly caused by extension of land utilization due to human activities. Over exploitation has a negative impact upon the natural environment especially the vegetation cover. It is a difficult task to assess the real time spatio-temporal change in vegetation by conventional methods. Observing the earth from space is gaining importance to study the effect of human activities on the natural resources over space and time.[2,3] A rapid urbanization, industrialization and expansion of agriculture as well as developmental projects like dams and transport

*Corresponding author :
Phone : 9960876105
E-mail : dnyaneshwar.bombe.pimpri@gmail.com

caused the disturbance of natural vegetation and habitat of a region of Palghar tehsil. The vegetation plays a vital role in sustenance and regularization of natural environment for the human survival. Thus, there is urgent need to study the vegetation characteristics and distribution patterns. The present investigation is an effort to understand the characteristics, distribution and change in vegetation cover in Palghar tehsil in last decade with the support of remote sensing data. Mapping of earth surface, managing natural resources and studying environmental change has become easier, precise and real-time analysis with the advent of Geospatial Technology especially the third eye like remote sensing. In the recent times, Geospatial Technologies can significantly assist in data collection and analysis of natural resources at low cost and timely manner.[2,3] The research is helpful to the researchers, forest officers and government to identify the problems related to natural environment and plan and implement the programs and policies for the improvement and recovery of natural forest resources. The present study is limited to Palghar tehsil which is influenced by industrialization and urban expansion as well as change in agricultural patterns having impact on natural environment due to which the investigator felt a need of investigation related to the change in vegetation cover.

REVIEW OF LITERATURE

The review of related literature gives an insight to understand the spatiotemporal assessment of vegetation cover using NDVI in Vasai tehsil of Palghar district in research article by Dongre *et al.* (2019)[4]. Further, NDVI and vegetation change detection using remote sensing and GIS - A case study of Vellore district is research article published by Gandhi *et al.* (2015)[5]. Change detection of vegetation cover by NDVI technique on catchment area of the Panchet Hill Dam, India recommends the use of remote sensing for vegetation cover is published by Sumanta *et al.* (2016)[6]. Assessment of spatiotemporal changes in vegetation cover using NDVI in SAGA and QGIS - tutorial credits to Dr. Shital Shukla, Mr. Yogesh Pawar, Ms. Jolly Desai, Ms. Manisha Patil and Mr. S. R. Patil (https://dst-iget.in/) recommends NDVI products and methods for analysis of vegetation existence and density in the area.[7]

AIMS & OBJECTIVES

Assessment of Vegetation Cover of Palghar Taluka Using NDVI Technique:

- To identify the areas of vegetation cover from remote sensing data.
- To assess the vegetation density by using NDVI technique in Palghar Tehsil.
- To evaluate the change in density of vegetation cover in Palghar Tehsil.

MATERIALS & METHODS

Landsat 8 multi spectral remote sensing data with spatial resolution 30 m was used to assess the spatiotemporal change of vegetation cover in the Palghar Tehsil downloaded from earthexplorer.usgs.gov.[8] The downloaded images with Band 3 (Visible green) - 0.525 to 0.600 µm; Band 4 (visible red) - 0.630 to 0.680 µm; Band 5 (Near-infrared) - 0.845 to 0.885 µm and Band 6 (Short wavelength infrared) - 1.56 to 1.66 µm were mosaicked, subset or merged and clipped in QGIS and SAGA softwares.[9-11] (Fig. 1).

FCC and true colour composites were prepared to recognize the vegetation areas in Palghar Tehsil. Colour

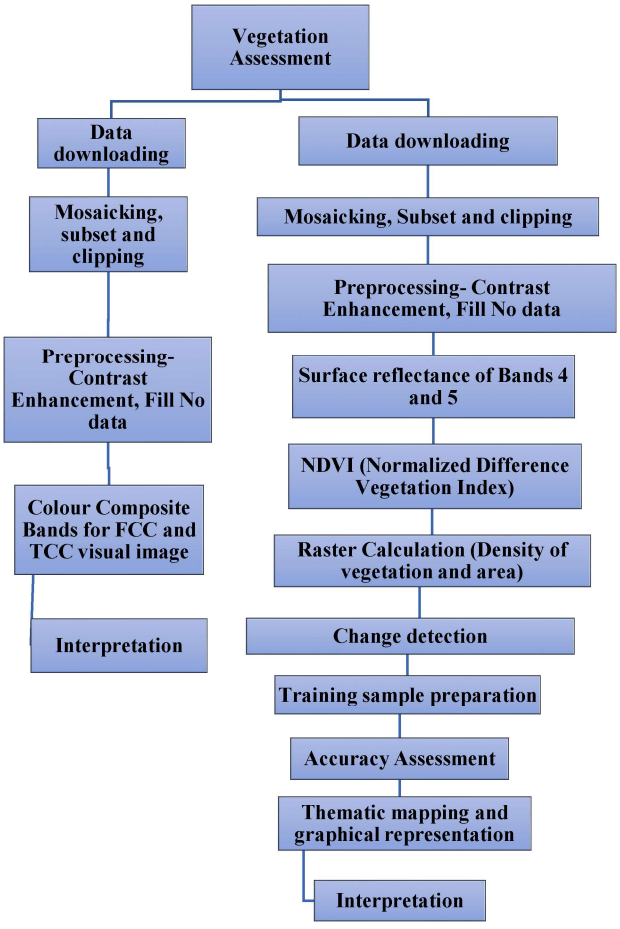


Fig. 1- Flowchart for Vegetation assessment

Infrared band combination (5, 4, 3) is also known as the near-infrared (NIR) composite. It utilizes near-infrared (5), red (4), and green (3). Because chlorophyll reflects near-infrared light, this band composition is useful for analyzing vegetation. In particular, areas in red have better vegetation health. Dark areas depict water and urban areas indicate bluish-white in standard false colour composite image.[9] In true colour composite image, the vegetation is visualized in green colour.

One of the most important biophysical indicators derived from the Satellite images is Vegetation cover. Vegetation indices are of immense help in explaining the distribution of vegetation and soil based on the characteristic of energy reflectance or absorption patterns of green vegetation.[12] The electromagnetic responses of green, healthy vegetation are within the green visible and near-infrared wavelengths. Healthy leaves of plants absorb 70-90% of incident visible radiation, particularly in the blue and red wavelengths, however, the green light is reflected back by the chlorophyll pigment within the chloroplasts in the palisade cells, hence, leaves appear green to the human eye. Blue and red light are absorbed and used in the process of photosynthesis by the chlorophyll pigment. However, wavelengths in the NIR region are mostly reflected and transmitted through the leaves; the cell interfaces in the mesophyll tissue being responsible for their scattering.[13] (Fig. 2).

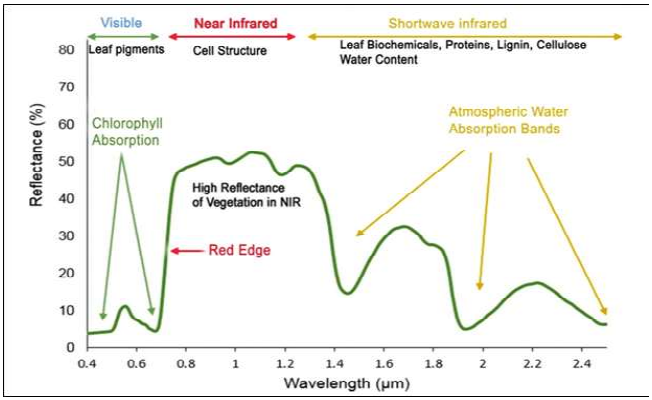


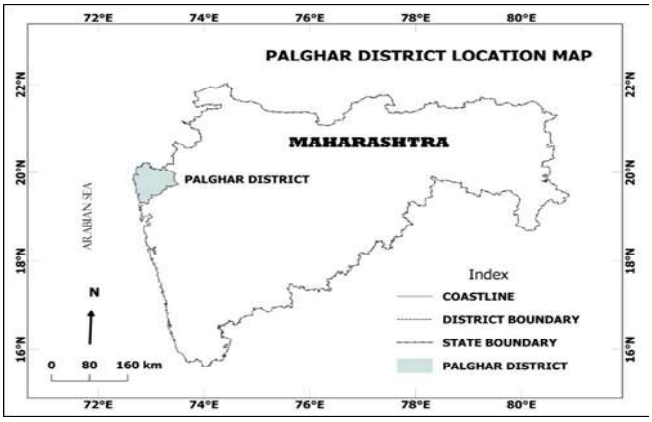
Fig 2- The spectral reflectance curve of vegetation
Source: https://www.researchgate.net/publication/315770910_Landscape_archaeology_on_the_northern_frontier_of_the_Roman_Empire_at_Poroliss vm_An_interdisciplinary_approach/link/5aa8f0000f7e9b0ea3084182/download

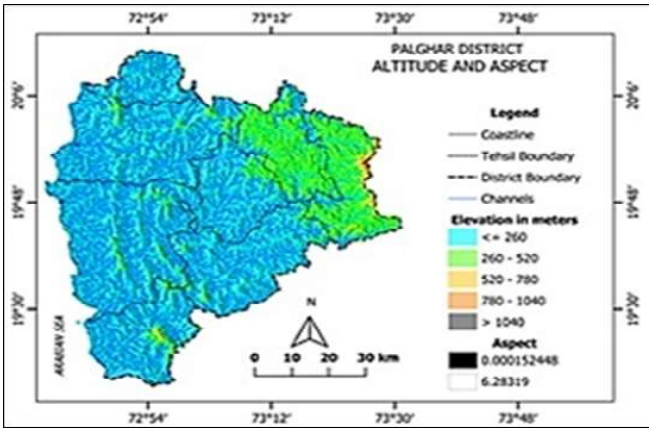
The NDVI is a simple numerical indicator to assess whether the target or object being observed contains live green vegetation or not.[14,15] NDVI is calculated by using SAGA software. It is an index of plant greenness and density existing in a particular area, calculated by formula: NDVI = (Band 5 - Band 4) / (Band 5 + Band 4).[6,16] The NDVI technique is used for extracting the vegetation characteristics presented in the Band 4 and Band 5 (Landsat 8) satellite image. Barren areas or rock, sand, or snow are represented by very low value of NDVI (0.1 and below). Moderate values indicate shrub and grassland (0.2 to 0.3), while high value corresponds to temperate and tropical rainforests (0.6 to 0.8). NDVI values closest to 0 indicate bare soil and those with negative values represent water bodies.[6,17] The degree of greenness in plants is equal to the chlorophyll concentration. The absorption of red light by chlorophyll pigment and the reflection of infrared radiation by water-filled leaf cells leads to the variation in NDVI values.[5,12,18] All visible ranges are captured by the Satellite camera in form of bands through which features can be extracted after applying the NDVI method for different characteristics. The bands are expressed in terms of wavelengths and only three visible bands are used (near infrared, visible red and visible green) in this work for the feature extraction.[12]

NDVI process needs to separate each and every band, for the detection of the vegetation index from a multi spectral remote sensing image. After the separation of different bands, NDVI method is applied according to its characteristic like vegetation at different NDVI threshold values such as below 0.1, 0.2, 0.3, 0.4 and above 0.4. Various NDVI threshold values are used to extract best result from Satellite image of Palghar taluka.[5,19]

Study Area:

Palghar tehsil is the part of the Palghar District located between Arabian coast and Western Ghats (Map 1). It experiences the seasonal hot and humid and mild climate. The district has total of 8 talukas Jawhar, Mokhada, Talasari, Vasai, Vikramgad, Palghar, Dahanu and Wada in the Konkan division of Maharashtra state in India.[20] It is in the Mumbai Metropolitan Region.[21] Forest occupies 48,827 hectares of area out of 1,07,577 hectares of geographic area of Palghar tehsil. Subtropical semi-evergreen, mangrove and deciduous forests exist in the Palghar district. The plantation farming, fodder cultivation and vegetable gardening is also popular agricultural practices in Palghar tehsil.[22]



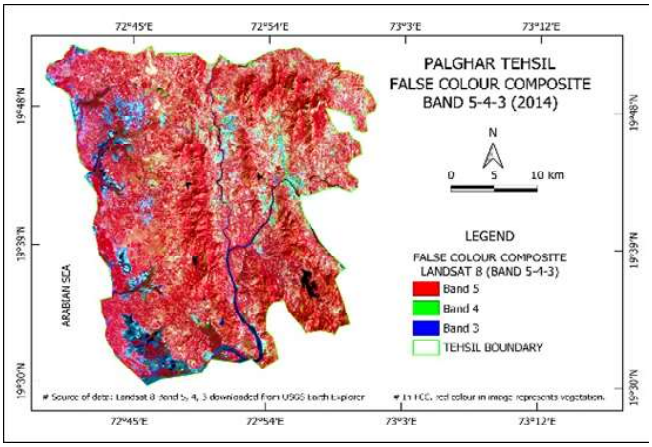


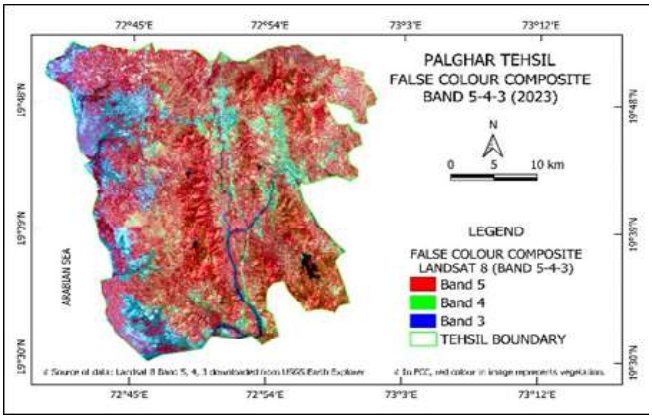
Map 1: Location of palghar district and altitude

RESULTS & DISCUSSIONS

Data Analysis and Findings:

1. False Colour Composite Images: The band combination is also called the near-infrared (NIR) composite. It uses near-infrared (5), red (4), and green (3) as chlorophyll reflects near-infrared light. This band composition is useful for analyzing vegetation as red indicates vegetation, dark blue or black represents water bodies and buildup areas are whitish-blue. The LULC (Land Use Land Cover) identification is possible from the images.



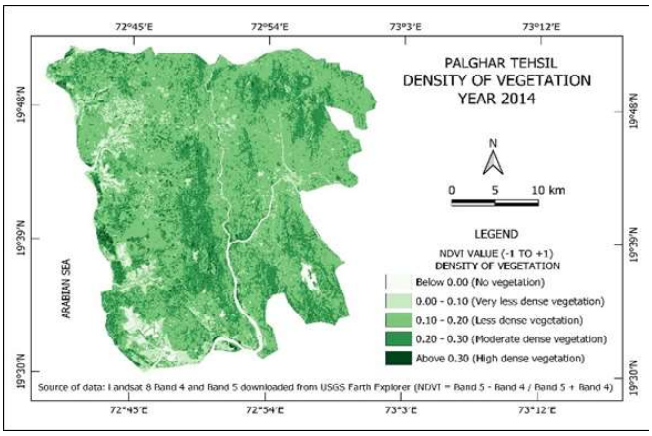


Map 2: FCC images

Visual image interpretation helps to identify the vegetation areas in Palghar tehsil. The FCC image of Palghar tehsil having larger area covered by red compared to other colors means that larger area is under forest cover especially hilly areas and slope land of Asawa fort, Kokaner, Shelwadi, Chahade etc. Coastal plains and river bank areas are under whitish-blue means either buildup urban or rural areas along with transport network especially Palghar town and areas along the western railway and western express highway as well as Surya River. Water bodies in dark blue or black are also present in Palghar tehsil as a river, creeks and dams or lakes. Few patches of barren land or waste land is also observed in Palghar tehsil. Coastal wetlands and low-lying areas are also observed at Kharekuran and Satpati in Palghar tehsil. The comparative observation of FCC images of the year 2014 and 2023 shows that it is very much changed over a period of time. The red colour areas are reduced and whitish-blue colour increased along transport route and surroundings of Palghar town indicating that area under forest or vegetation is reduced due to expansion of urbanization or increasing the size of rural settlements (Map 2).

2. Normalized Difference Vegetation Index (NDVI): The vegetation index is the properties of the red (which vegetation absorbs) and near-infrared bands (which vegetation strongly reflects) to monitor vegetation health and vigor. NDVI always ranges from -1 to +1. Negative values are indicative of water and moisture. Low NDVI values represent barren land or buildup areas and high NDVI values suggest a dense vegetation canopy. The Density of vegetation is relative to low, moderate and high depend on the scale of highest to lowest greenery in the study area. In the present study, the areas having greater than 0.3 NDVI values are considered as high dense

vegetation areas, 0.2 to 0.3 NDVI values indicate moderate dense and below 0.2 NDVI values are considered as a less dense vegetation areas.



Map 3: Palghar Tehsil: Density of vegetation - Year 2014

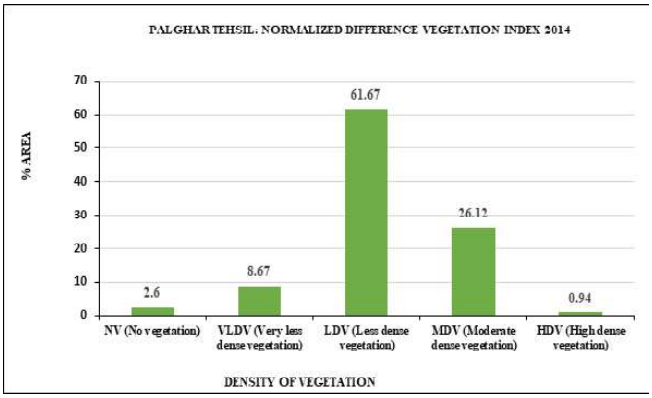
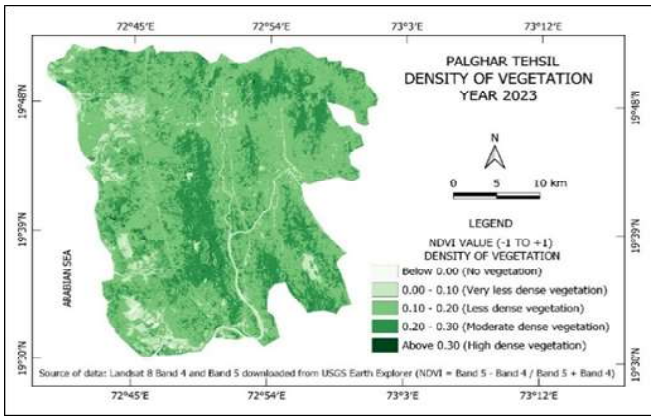


Fig 3- Palghar Tehsil: Normalized Difference Vegetation Index 2014

Table 1- Palghar Tehsil: Normalized Difference Vegetation Index 2014

Sl. No	Class	NDVI Min	NDVI Max	Area in Sq. Km.	Percentage Area
1	NV (No vegetation)	-0.17	0.00	18.53	2.60
2	VLDV (Very less dense vegetation)	0.00	0.10	61.88	8.67
3	LDV (Less dense vegetation)	0.10	0.20	440.26	61.67
4	MDV (Moderate dense vegetation)	0.20	0.30	186.47	26.12
5	HDV (High dense vegetation)	0.30	1.00	6.71	0.94

The area under high dense vegetation is 6.71 sq. km which is around 0.94 % of total area in 2014. In map no. 3, we could observe 8 to 10 patches of high dense vegetation, most probably in the hilly and protected or reserved forest areas of villages in the year 2014. The area under moderate dense vegetation cover is 186.47 sq. km. which is around 26.12 %. The areas with moderate dense vegetation are more or less located at the foothill area which is moderate slope area, represented by NDVI value 0.2 to 0.3. The area under less dense vegetation is 440.26 sq. km which is approximately 61.67 % and that of under very less dense vegetation cover is 61.88 sq. km. which is approximately 8.67 %. The areas of very less dense vegetation cover are found along the coastal plains due to the settlements, industries, transport and agriculture, NDVI value represented between 0 to 0.1. The area under no vegetation is 18.53 sq. km which is approximately 2.60 % (Map 3, Fig. 3, Table 1).



Map 4: Palghar Tehsil: Density of vegetation - Year 2023

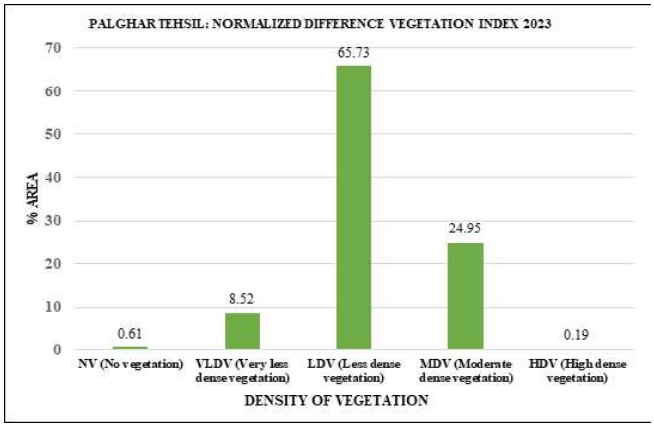


Fig. 4- Palghar Tehsil: Normalized Difference Vegetation Index 2023

Table 2- Palghar Tehsil: Normalized Difference Vegetation Index 2023

Sl. No	Class	NDVI Min	NDVI Max	Area in Sq. Km.	Percentage Area
1	NV (No vegetation)	-0.10	0.00	4.35	0.61
2	VLDV (Very less dense vegetation)	0.00	0.10	60.80	8.52
3	LDV (Less dense vegetation)	0.10	0.20	469.25	65.73
4	MDV (Moderate dense vegetation)	0.20	0.30	178.09	24.95
5	HDV (High dense vegetation)	0.30	1.00	1.36	0.19

The area under very high dense vegetation is 1.36 sq. km which is around 0.19 % of total area in 2023. We could observe 6 to 8 patches of high dense vegetation, most probably in the hilly and protected or reserved forest areas of villages like Asawa, Kokaner, Shelwadi, Chahade etc. which are represented by NDVI value greater than 0.3. The area under moderate dense vegetation cover is 178.09 sq. km. which is around 24.95 %. The areas with moderate dense vegetation are more or less located at the foothill area which is moderate slope area, represented by NDVI value from 0.2 to 0.3. The area under less dense vegetation cover is 469.25 sq. km which is approximately 65.73 % and that of very less dense vegetation cover is 60.80 sq. km. which is approximately 8.52 %. The areas of very less dense vegetation cover are found along the coastal plains due to the settlements, industries, transport and agriculture; represented by NDVI value between 0 to 0.1. The area under no vegetation cover is 4.35 sq. km which is around 0.61 % (Map 4, Fig. 4, Table 2).

Very negligible change in very less dense vegetation area is found from the year 2014 to 2023. Less dense vegetation area increased from 61.67 % to 65.73 %. Moderate dense vegetation area decreased at a considerable extent from 26.12 % to 24.95 %. HDV also decreased from 0.94 % to 0.19 %. Only hilly area patches are left with high dense vegetation (Table 3, Fig. 5).

Table 3- Palghar Tehsil: Normalized Difference Vegetation Index 2014 and 2023

Type of vegetation	% Area in 2014	% Area in 2023
NV (No vegetation)	2.60	0.61
VLDV (Very less dense vegetation)	8.67	8.52
LDV (Less dense vegetation)	61.67	65.73
MDV (Moderate dense vegetation)	26.12	24.95
HDV (High dense vegetation)	0.94	0.19

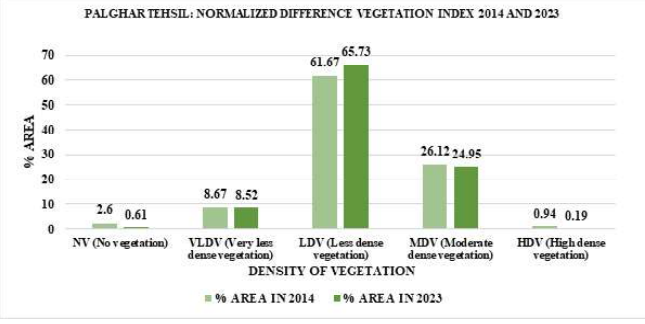


Fig. 5- Palghar Tehsil: Normalized Difference Vegetation Index 2014 and 2023

High dense vegetation areas decreased due to deforestation which is caused by growth of population, rise in built up areas, agricultural expansion and developmental projects like roads, railways, dams, etc. The investigation shows that the vegetation cover gets reduced over a period of time very effectively assessed by using remote sensing data and compilations and analysis with the support of geospatial technology.

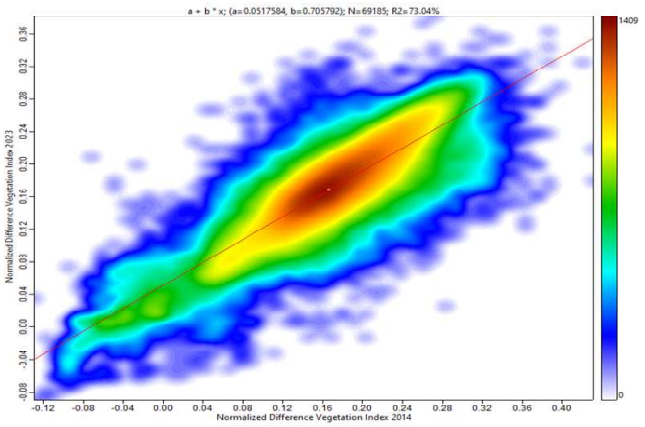
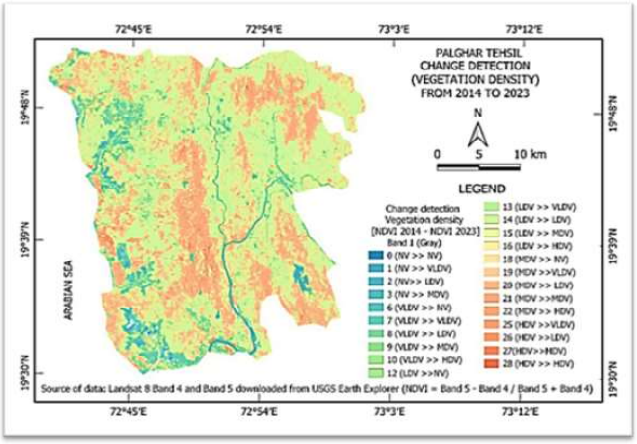


Fig. 6- Palghar Tehsil: Scatterplot (Raster image of NDVI)

The scatterplot is a technique to find the linear relationship of two raster images indicating correlation of DN values of image pixels describing feature (vegetation) characteristics. The scatterplot represents that 73.04 % DN values of NDVI image pixels are correlating with the NDVI classes and the remaining do not correlate. It means only 26.96 % area of NDVI classes changed from high dense to low dense vegetation areas or vice versa (Fig. 6).

3. Change Detection: Change detection is an innovative application of remote sensing image interpretation. It aids to compare and analyze two (or more) remote sensing images taken at different times of the same region and obtain spatio-temporal change information about the ground object especially the LULC.[23] The vegetation change is an important parameter and helpful to the researcher and planners for the conservation of green areas and biodiversity. We can derive change detection using the classified NDVI values of different time period images.

54.25 % of less dense vegetation area, 18.33 % of moderate dense vegetation area and 4.92 % of very less dense vegetation area remained same from 2014 to 2023. 7.67 % of moderate dense vegetation area was converted to less dense vegetation area. 5.92% and 1.45% of less dense vegetation area was converted to moderate dense vegetation and very less dense vegetation areas respectively.



Map 5: Palghar tehsil- Change Detection (Vegetation Density) from 2014 to 2023

Table 4- Palghar Tehsil- Change Detection (Vegetation Density) From 2014 To 2023

Change category	% Change
NV>>NV	0.5040
NV>>VLDV	2.0583
NV>> LDV	0.0287
NV>>MDV	0.0007
VLDV>>NV	0.0964
VLDV>>VLDV	4.9163
VLDV>>LDV	3.5907
VLDV>>MDV	0.0732
VLDV>>HDV	0.0025
LDV>>NV	0.0054
LDV>>VLDV	1.4533
LDV>>LDV	54.2491
LDV>>MDV	5.9213
LDV>>HDV	0.0271
MDV>>NV	0.0014
MDV>>VLDV	0.0737
MDV>>LDV	7.6704
MDV>>MDV	18.3274
MDV>>HDV	0.0610
HDV>>VLDV	0.0022
HDV>>LDV	0.1967
HDV>>MDV	0.6401
HDV>>HDV	0.0999

3.59 % very less dense vegetation area was converted to less dense vegetation area while, 2.06 % of no vegetation area was converted to very less dense vegetation area (Map 5, Fig. 7, Table 4).

Accuracy Assessment:

The accuracy assessment of raster data of NDVI was carried out with the help of training sample areas by observing the topographical maps, Google images and Google Earth Pro, FCC images and NDVI Bhuvan map as well as field survey for high dense, moderate dense and less dense vegetation areas by using the semi-automatic

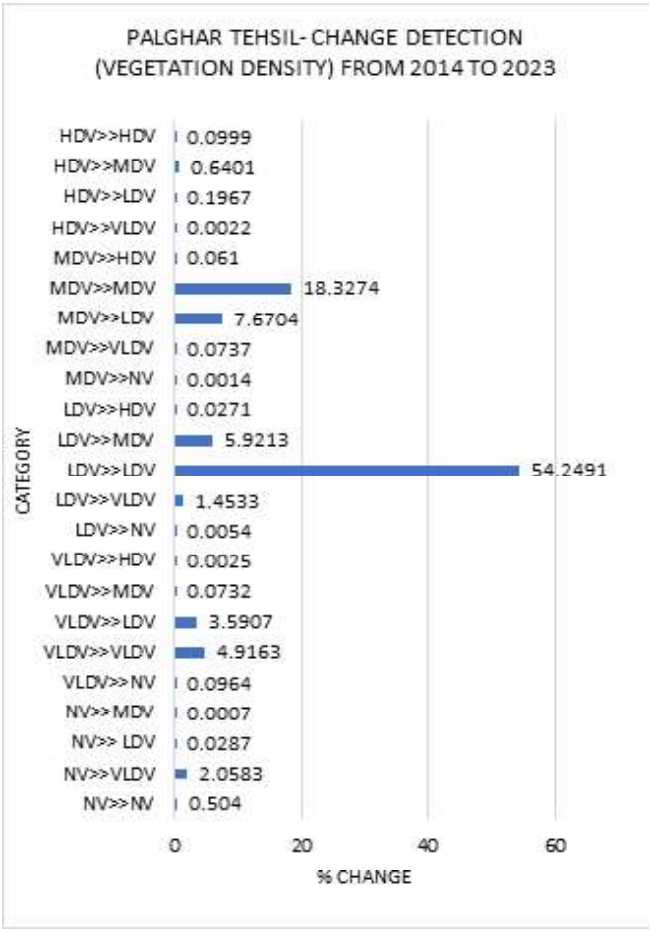


Fig. 7- Palghar Tehsil- Change Detection (Vegetation Density) From 2014 To 2023

classification plugin in QGIS software. The value of accuracy assessment is 82.83 which means approximately 83 % area of actual assessment from images and training samples correlated. It indicates high probability of correct assessment. Also, the accuracy assessment carried out during change detection (Confusion Matrix) as Kappa coefficient which is 0.78 and Overall Accuracy is 0.85 in SAGA software and that too depicts the high probability of correct assessment.

FINDINGS & CONCLUSIONS

- FCC images are useful to identify the LULC and detect the vegetation areas which are represented by red colour in standard FCC image. Few patches of hilly areas and fruit farming areas of coastal plains are covered by dense vegetation. The area around the Palghar town and along the rivers and transport lines is reduced in the vegetation cover and increased in the buildup area.

- The areas under high dense vegetation situated most probably in the hilly and protected or reserved forest areas are represented by NDVI value of greater than 0.3 in 2014 and 2023. The areas with moderate dense vegetation are more or less located at the foothill area which is moderate slope area and represented by NDVI value 0.2 to 0.3. The areas of very less dense vegetation cover are found along the coastal plains due to the settlements, industries, transport and agriculture which are represented by NDVI value between 0 to 0.1. Maximum area is covered by less dense vegetation and minimum or negligible area is under very dense vegetation in Palghar tehsil.
- Area under very less dense vegetation decreased due to the growth of settlements, road, railways, etc. from 2014 to 2023. However, area under less dense vegetation increased while moderate dense vegetation area decreased at a considerable extent. As agricultural and industrial activities increased intensively, high dense vegetation area converts into moderate dense vegetation and less dense vegetation areas. Hence, high dense vegetation area has decreased. Only hilly area patches are left with high dense vegetation area which decreased due to deforestation which is caused by growth of population, rise in built up areas, agricultural expansion and developmental projects like roads, railways, dams, etc.
- Very less dense vegetation areas, less dense vegetation areas and moderate dense vegetation areas remained same from 2014 to 2023. Maximum change detection was observed from moderate dense vegetation area to less dense vegetation area in the same period.
- Industrialization, urban growth, expansion of agricultural land and change in agricultural practices as well as development of transport, dams and other assets are responsible for reduction of forest land in Palghar tehsil. Vegetable Gardening, Plantation Agriculture and Fodder Cultivation are observed as positive signs to increase the area under vegetation in coastal plains. Even tree plantation activities of Government and NGOs are also responsible to increase in vegetation in limited pockets of Palghar tehsil. 8000 trees are planted around 16 km. along the road under the social forestry programme.[22] Agroforestry and conservation of Vanrai-Devrai (Sacred groves) are responsible to conserve the forest in Palghar Tehsil.[24]
- Geospatial Technology platforms helped to detect change in vegetation characteristics of the Palghar tehsil very precisely.

Suggestions for future research:

Afforestation, efficient use of resources, implementation of environmental laws and public awareness on biodiversity conservation should be undertaken in order to conserve existing natural vegetation. Local level research should be undertaken for better understanding of density of vegetation.

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