Climate Change Impact and Adaptive Measures for Green Cover Assessment at District Level

Amol Dhokchaule, Anita Morkar, Santosh Wagh, and Makarand Kulkarni

Abstract Green cover maps are critical for a variety of water resource and environmental applications. Green space distribution is critical in urban planning because it significantly improves the ecological quality of metropolitan areas. It improves air quality, urban health, biodiversity conservation, noise reduction and so on. One of the most negative effects of urbanization is the loss of vegetation cover. As a result, proper distribution of green spaces in urban environments is becoming increasingly important for sustainable development and healthy living. The goal of this research is to identify and map green cover using remote sensing technology. This paper proposes a supervised classification methodology for district-level green cover mapping. This study made use of the Resourcesat-II satellite's LISS-III sensor (23.5 m) resolution. Nashik district has received post-monsoon and pre-monsoon statistics for the water year 2019–2020. About 580 ground truthing sets in the form of point, line and polygon data collected with handheld GPS instruments from various tahasils in Nashik district for analysis and validation. The method's accuracy is evaluated using ground truthing data. The proposed method yields accurate results. Nashik district has a land area of 1,551,489 Ha. The estimated post-monsoon green cover area is 739876 ha, or around 47.68 percent of the geographical area, and the estimated pre-monsoon green cover area is 537909 ha, or around 34.67 percent of the geographical area. The findings discussed in this paper will provide critical information to state and local governments for the protection and restoration of green covers and the conservation of natural ecosystems in the Nashik district. The study also finds its utility for biogeochemical models where the type and extent of cover is the major input to monitor and sustain the ecological balance.

Keywords Green cover · Supervise classification · Pre-monsoon · Post-monsoon · Ground truthing

A. Dhokchaule (✉) · A. Morkar · S. Wagh · M. Kulkarni
Resources Engineering Centre, Maharashtra Engineering Research Institute, Nashik 422004, India
e-mail: dhokchauleamol14@gmail.com

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1 Introduction

Nature has been bountiful to us providing the substance which has been the basis of all our material and cultural progress. Green space distribution plays an imperative role in climate change [1]. The importance of forests and forest resources in the economy of the state/country is really very important as they perform productive, protective and aesthetic functions and confer other advantages to the community. The forests conserve and enrich soil, helping in maintaining geographical, geological and climatic conditions. The natural resources are now depleting very fast causing serious environmental problem. Natural and human-induced environmental changes in an urban environment are of concern today due to deterioration of the environment and human health [2]. Monitoring the world's remaining forests is now an important component of a number of global initiatives relating to sustainability, the environment and climate change [3]. The study of changes in green cover is critical for proper planning, utilization and management of natural resources. Traditional methods for gathering demographic data, censuses and environmental sample analysis are insufficient for multi-complex environmental studies, as many problems are frequently presented in environmental issues. Several studies have been conducted to improve classification accuracy using various remote sensing and/or GIS-based ancillary data at various stages of classification.

Due to unevenness of rainfall, development activities, rapid expansion of population, urbanization, industries, climate change, etc. in various areas, green cover mapping at district level is becoming most important [4]. Remote sensing technique proves to be cost-effective and accurate for doing spatially large area. The remote sensing technique for assessing green cover is primarily based on mapping of vegetation-spread areas during satellite overpasses. The primary source of spatial information about the Earth's surface cover and contribution is remote sensing [5]. Different sensors collect a wealth of information about the Earth, which can be used by scientists who want to monitor spatial data in real time. The following are the goals of this paper: (1) to investigate the impact of climate change on green cover at the district level, (2) to generate Taluka-wise green cover statistics for the Nashik district for the post- and pre-monsoon seasons in 2019 and (3) conduct spatial and temporal analysis of green cover data from Indian remote sensing satellites.

2 Study Area and Data Source

2.1 Study Area

Nashik district is included in the study area. Nashik is located in the north-west corner of Maharashtra, between 19° 35′ and 20° 52′ North latitude and 73° 15′ to 74° 56′ East longitude. It is located 565 m above mean sea level. Several rivers drain

the western slope of the Ghats, including the Daman-Ganga River, which flows west to the Arabian Sea.

The majority of the Nashik district's eastern portion, which is located on the Deccan Plateau, is open, fertile and well cultivated. The Godavari River rises in the district and flows eastwards to the Bay of Bengal. Godavari tributaries include the Kadwa and Darna. The Girna River and its tributaries flow eastwards into the Tapi River through fertile valleys. The index map of Nashik district is shown in Fig. 1.

Fig. 1 Index map of Nashik district, Maharashtra [5]

Table 1 Dates of pass for satellite data

Satellite	Sensor	Path	Row	Date of pass for pre-monsoon	Date of pass for post-monsoon
Resourcesat-II	LISS-III	94	58	06/05/2019	08/12/2019
Resourcesat-II	LISS-III	95	58	11/05/2019	13/12/2019
Resourcesat-II	LISS-III	95	59	11/05/2019	13/12/2019
Resourcesat-II	LISS-III	96	58	16/05/2019	24/11/2019

Table 2 Details of SOI toposheet used

S. No.	Toposheets	Number
1	46H5 to 46H15	11
2	46L1 to 46L15	11
3	46I10 to 46I13	3

2.2 Data Used

Satellite Data National Remote Sensing Centre, Hyderabad, website has been browsed to prepare a list of dates of satellite pass over the Nashik district for the year 2019. The list of cloud-free satellite images have been prepared for the both pre-monsoon and post-monsoon period. Resource sat II satellite data have been finalized and used for the analysis. These images cover the total area of interest. The details of satellite pass are given in Table 1.

SOI toposheet. Survey of India (SOI) toposheets of 1:50,000 scales have been used for georeferencing of satellite images for study area. These details are as given in Table 2.

3 Results and Discussions

3.1 Ground Truthing

Remote sensing techniques require certain amount of field observation called "ground truth" in order to convert pixel data into meaningful information. Such work involves visiting number of sites. The green cover data dictionary was created for recording the field information such as barren land, fallow land, water, vegetation, forest, scrub, crop, urban and crop waste, etc. The location of the features is recorded using the handheld GPS. The standard pro forma was used to record the field data. Field photographs are also taken during the field visit.

GPS readings were taken with the help of Trimble Juno Handheld GPS device, and simultaneously, latitude/longitude values have been recorded during the visit. In above all field visits, almost 315 point features, 162 line features and 103

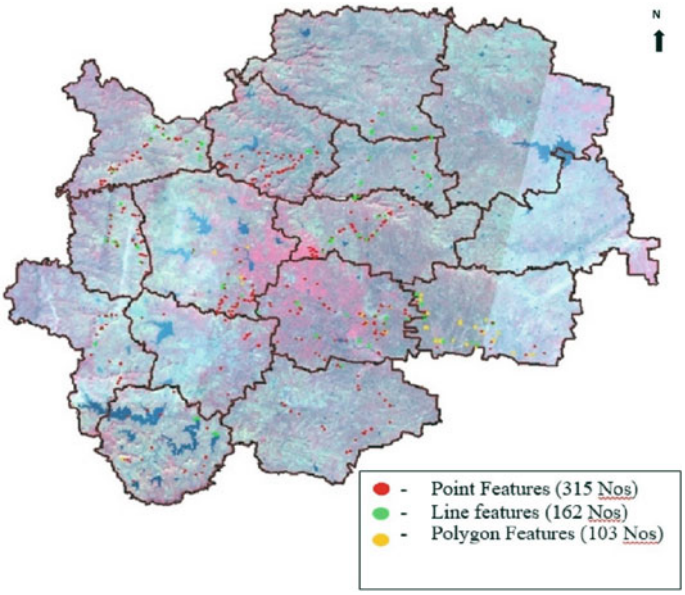

Fig. 2 Ground truth features of Nashik district

polygon features, total 580 features from 13 talukas, i.e., Nashik, Dindori, Niphad, Yeola, Sinnar, Igatpuri, Chadwad, Peth, Surgana, Kalwan, Trimbakeshwar, Deola and Baglan of Nashik district have been collected. The collected ground truth features of Nashik district are shown in Fig. 2.

3.2 Taluka-Wise Green Cover Statistics and Maps

Green cover statistics followed by green cover map for each taluka in pre-monsoon and post-monsoon is given to have a fairly good idea about the distribution pattern and density of green cover in the taluka. Following Tables 3 and 4 give the statistics of green cover in pre-monsoon and post-monsoon, respectively. Similarly, Figs. 3 and 4 show the green cover maps in pre-monsoon and post-monsoon of Nashik district for the year 2019. A bar chart is prepared to show the comparison of green cover area in pre-monsoon and post-monsoon in the year 2019 for Nashik district. Figure 5 shows the comparative bar chart of pre- and post-monsoon green cover area in Nashik district for the year 2019.

Table 3 Taluka-wise green cover area (pre-monsoon)

Taluka	Geographic area (Ha)	Green cover area (Ha)	% of total green cover Area	% of taluka geographic area
Baglan	145,910	59,567	11.07	40.82
Chandwad	95,558	14,599	4.38	24.66
Deola	57,112	13,597	2.53	23.81
Dindori	132,049	59,107	10.99	44.76
Igatpuri	86,180	39,986	5.77	36.00
Kalwan	85,464	48,440	8.50	53.53
Malegaon	179,408	40,421	7.51	22.53
Nandgaon	109,813	25,628	4.76	23.34
Nashik	89,295	31,634	5.53	33.31
Niphad	104,979	55,142	10.25	52.53
Peth	55,675	26,227	4.88	47.11
Sinnar	133,819	26,786	4.98	20.02
Surgana	81,368	34,716	6.45	42.67
Trimbakeshwar	89,287	48,185	8.96	53.97
Yeola	105,570	13,875	3.43	17.49
Total	1,551,489	537,909	100.00	

Table 4 Taluka-wise green cover area (post-monsoon)

Taluka	Geographic area (Ha)	Green cover area (Ha)	% of total green cover area	% of taluka geographic area
Baglan	145,910	74,023	10.00	50.73
Chandwad	95,558	47,867	5.26	40.71
Deola	57,112	24,876	3.36	43.56
Dindori	132,049	63,221	8.54	47.88
Igatpuri	86,180	31,024	5.40	46.40
Kalwan	85,464	45,747	6.55	56.68
Malegaon	179,408	87,101	11.77	48.55
Nandgaon	109,813	46,664	6.31	42.49
Nashik	89,295	29,741	4.28	35.43
Niphad	104,979	60,753	8.21	57.87
Peth	55,675	27,479	3.71	49.36
Sinnar	133,819	56,533	7.64	42.25
Surgana	81,368	50,171	6.78	61.66
Trimbakeshwar	89,287	50,988	6.89	57.11
Yeola	105,570	43,687	5.28	37.04
Total	1,551,489	739,876	100.00	

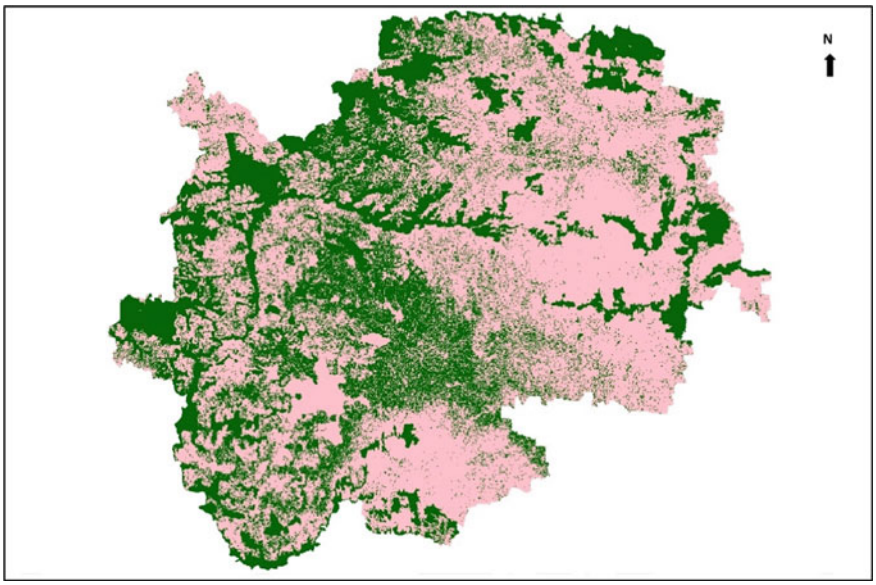

Fig. 3 Green cover maps of Nashik district (pre-monsoon) year 2019

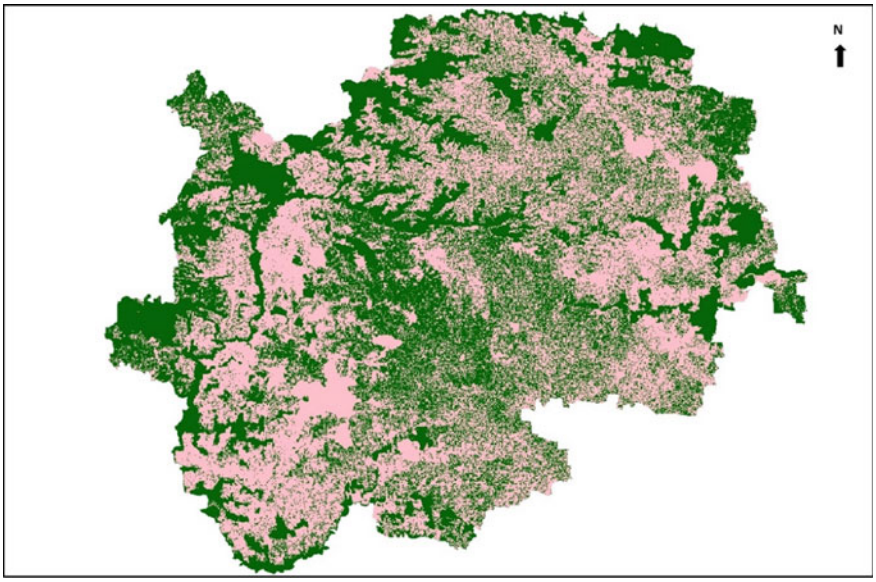

Fig. 4 Green cover maps of Nashik district (post-monsoon) year 2019

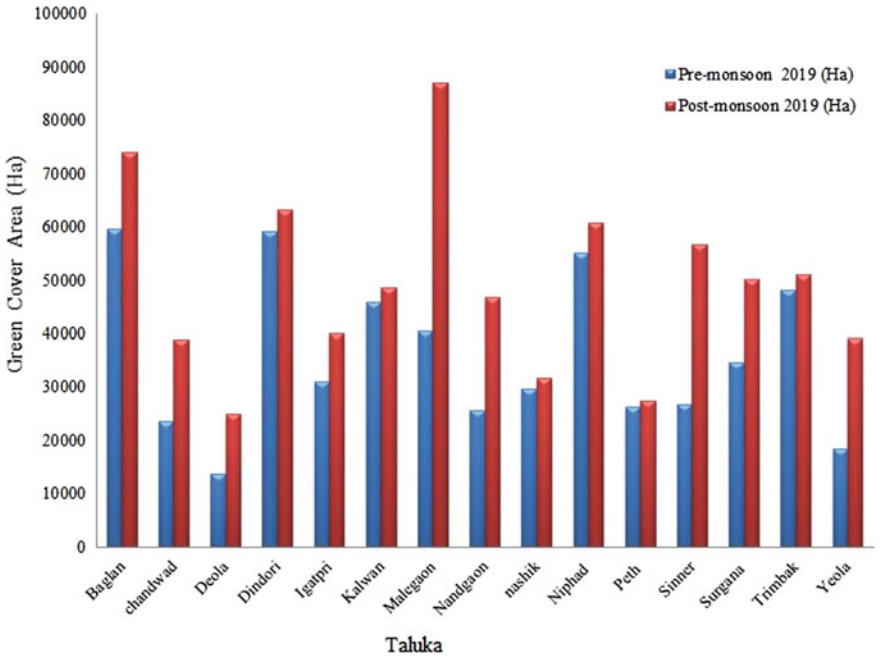

Fig. 5 Pre-monsoon and post-monsoon taluka-wise distribution of green cover in Nashik district, year 2019

4 Conclusions

The following conclusions are derived from the foregoing study:

- Green cover area in Nashik district as per geographical area in post-monsoon is 47.69% and in pre-monsoon it is 34.67%.
- In pre-monsoon, the green cover in each taluka as per percent of total district Green cover area ranged from as 2.53% to 11.07%.
- In post-monsoon the green cover in each taluka as per percent of total district green cover area ranged from as 3.36% to 11.77%.
- Nine talukas in Nashik district are rich talukas contributing green cover more than 5 percent of total green cover area in pre-monsoon. Similarly, 12 talukas in Nashik district are rich talukas contributing green cover more than 5 percent of total green cover area in post-monsoon.
- Two talukas in Nashik district contributing less than 5 percent green cover area in both pre-monsoon and post-monsoon.
- The result of this study will provide fundamental information to state as well as local authorities for the protection and restoration of green covers and conservation of natural ecosystem in Nashik district.

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