

P-ISSN: 2706-7483
 E-ISSN: 2706-7491
 NAAS Rating (2025): 4.5
 IJGGE 2025; 7(10): 55-58
www.geojournal.net
 Received: 25-07-2025
 Accepted: 29-08-2025

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Assessment of forest cover in Hoshiarpur tehsil: A study based on remote sensing techniques

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DOI: <https://www.doi.org/10.22271/27067483.2025.v7.i10a.429>

Abstract

Forests known as Lungs of planet Earth remain under pressure due to rapid deforestation across the globe. The quantification of forest land change lags behind even after its ecological importance. The present study makes an effort to detect, discuss, and define the transformation in forest cover in Hoshiarpur Tehsil of Hoshiarpur District, located in Punjab, State of India. There is a vast difference in Forest cover among the States of India, and Punjab is one of the least forested states of the Country. Hoshiarpur District, due to its location in foothills of Shiwalik Range of Himalaya, contains most forest cover of the State. Among the four Tehsils of the district, Hoshiarpur being the largest is selected for research to examine and analyze the Forest cover change between the period of 1990 to 2025. Landsat imagery with 30 meter resolution is explored to detect existing variation between two periods. The images are preprocessed, and False Colour Composition (FCC) is created for the better detection of Vegetation cover in supervised classification. To exemplify the preceding notion, the band combination of band 5, band 4, and band 3 is exploited to generate FCC that represent the vegetation in multiple shades of red colour for better detection and observation.

Keywords: Forest, landsat, change detection, altitude, net forest change, check dam

Introduction

Forest Cover change is driven by the combination of demographic, natural, social, economic, biophysical, and political processes (Steven Vanonckelen and Anton Van Rompaey). Net Forest Change (variation between afforestation and deforestation) was estimated 5.2 million hectare per year in 2000-2010, 7.8 million hectare per year in 1990-2000, and 4.7 million hectare per year in 2010-2020 (FAO. 2024) ^[5]. The expansion of agriculture, increasing requirement of timber and wildfires are some major causes of deforestation. Due to lack of data repositories on worldwide forest cover change, the satellite-based earth observation has its importance in Time and Space because it provides visible information to analyze world against forest dynamics (Hansen, Matthew C., *et al.* 2010) ^[3]. The U.S. Landsat mission launched on July 23, 1972, carrying Remote Sensing observation instruments, delivers scientifically important images of Earth surface (NASA). A number of image processing software are available to extract valuable information out of these satellite images. Notable among these are Google Earth Engine (GEE) and ArcGIS. Therefore, the Landsat data is used to analyze long term changes in forest cover of study area (1990-2025) through Google Earth Engine (GEE) and ArcGIS.

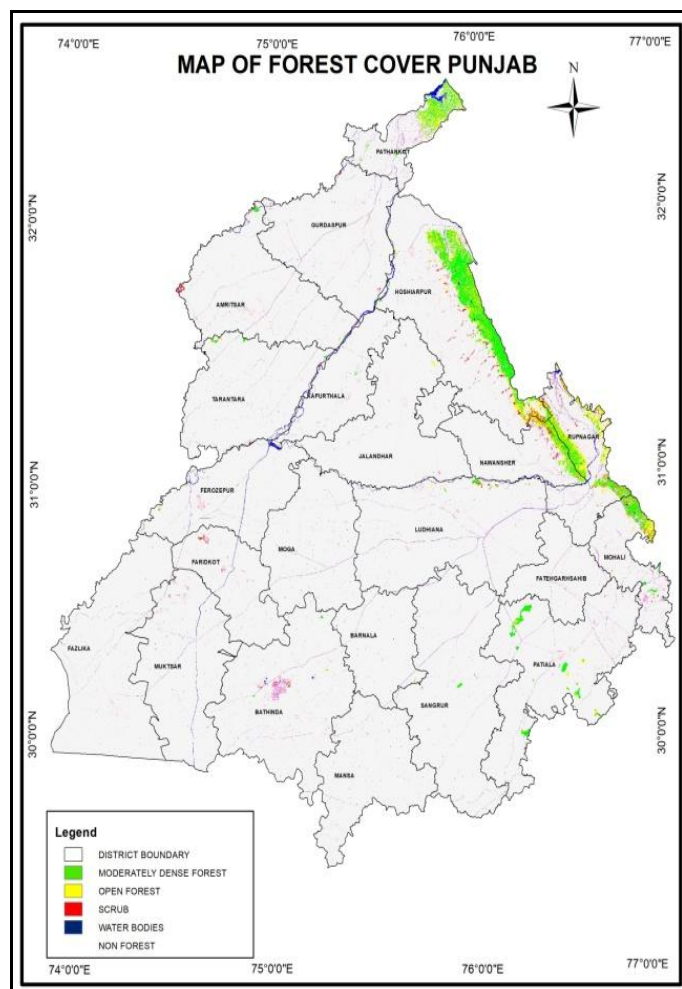
Study Area

The present Study Area is Hoshiarpur tehsil of Hoshiarpur District of Punjab. Having an area of 50362 KM² Punjab is known for its agriculture-based economy as Net Sown area in the State was 81.72% in 2021-22. According to the Department of Forest and Wildlife Preservation (Government of Punjab) the legally notified area under Forests in State is 6.1% (3058 KM²). The area under forest in Punjab as calculated by SoI in 2023 was 3.67% and additional area under Scrubs was 0.08% (Forest Survey of India). The major portion of forest lies in foothill districts of Hoshiarpur, SAS Nagar, Rupnagar, Pathankot and SBS Nagar. 32% Geographical area of Hoshiarpur district under Forest is the highest among all districts of Punjab. The district is divided into four Tehsils, Hoshiarpur, Dasuya, Garhshankar and Mukerian respectively.

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Among these four, Hoshiarpur Tehsil is the largest in terms of area and Population. A total 111801 Hectare area of the Tehsil is explored in research analysis to assess Net Forest Change for aforementioned.

Located in the Foothills of Shiwalik, Hoshiarpur has mild climate as compared to the South-Western districts of State. There are a number of Seasonal Streams (Choe) which flow through Kandi belt of the district. The geographical location of study area is 31.830° N, 31.349° S, 76.106° E, and 75.679° W, respectively. Due to Foothill location, most part contains hilly soil which is less suitable for agriculture.



Source: Department of Forest and Wildlife Preservation, Government of Punjab.

Fig 1: Forest Cover in Punjab

Research Methodology

The study is primarily based on the images of Landsat 5(TM) and Landsat 8 (OLI). Surface Reflectance (SR) images are taken from USGS. Landsat 5 image is exploited to the analysis of year 1990 and Landsat 8 for year 2025. First, all images are filtered for Cloud cover with 'maskL457sr' and 'maskL8sr' functions to remove cloudy pixels and cloud shadows. Second, annual Median Composition is taken. Third, False Colour Composite (FCC) is taken by different band combination that is assigned to all channels (Red, Blue, and Green). As depicted, the FCC images are quite useful in the detection of Vegetation. Fourth, a Supervised Classification is employed through collecting samples of Forested and Non-Forested areas. Finally, 'Random Forest' classifier is used in GEE to train and test data.

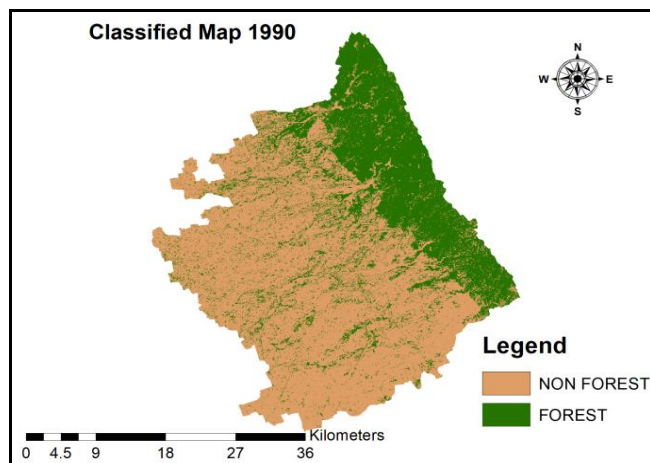


Fig 2: Forest/Non-Forest-1990

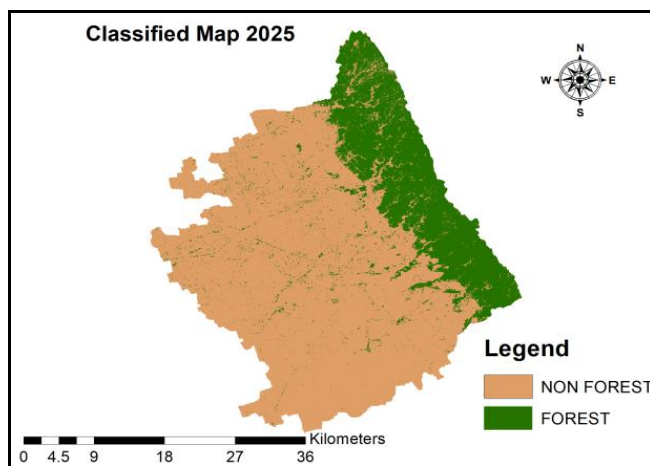


Fig 3: Forest/Non-Forest-2025

Discussion and Results

Punjab as located in North-Western side of the country is part of vast Indo-Gangetic plains. With fertile alluvial soil capacity, state has well-developed agriculture sector, for instance, 98% of its agricultural area is under irrigation. So, the receding forest is a final outcome of the preceding effect. Most of the forest cover in state is concentrated in Shiwalik foothills (Figure 1) because the undulating terrain of these areas is not suitable for agriculture.

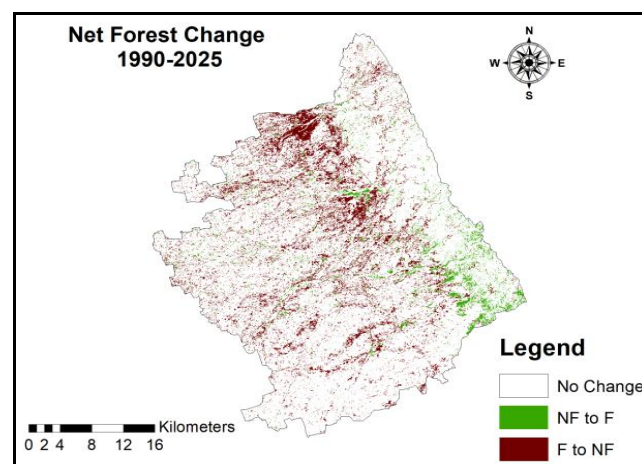


Fig 4: Change between Forest/Non-Forest (1990-2025)

Dry Deciduous is a major forest type found in the State. As reported by Forest Survey of India, there is a decline of-

0.45% forest cover in the state from 2021 to 2023. The attribute tables of Forest and Non-Forest areas are prepared from classified images to analyze forest area in Hoshiarpur Tehsil since 1990 to 2025. The change matrix is also prepared to assess net forest change between two time periods. The study demonstrates that the area under Forest in 1990 was 37155 Hectare that declined to 27674 Hectare in 2025. Forest cover occupied 33.23% of the Geographical area of the tehsil in 1990 which reduced to 24.75% in 2025. One can witness a net loss of 9481 Hectare forest area between two time periods.

Table 1: Area under Forest/Non-Forest

Years	Forest (in Ha.)	Non-Forest (in Ha)	Total Area (in Ha)	Forest%
1990	37155	74646	111801	33.23
2025	27674	84127	111801	24.75

The Change matrix shows 13503 Hectare of Forest area is converted into Non-Forest land use while only 4022 Hectare of new land comes under forest (Net loss 9481Ha) during study period.

Table 2: Change Matrix

	2025	
1990	Forest (in Ha.)	Non Forest (in Ha)
Forest (in Ha.)	23652	13503
Non-Forest (in Ha)	4022	70624

Table 3: Change in Forest area (1990-2025)

Forest-1990 (in Ha.)	Forest-2025 (in Ha.)	Net Change in Forest Area (1990-2025)	Change Percentage
37155	27674	-9481	-25.52

There are a number of seasonal streams in the study area which are called 'Choe' in local dialect. During Monsoon season these Choe overflow and cause siltation and flooding in downstream areas. The whole belt of this undulating foothill topography, which have fragile soil and seasonal streams, is known as Kandi Belt—'an island of poverty amidst the ocean of development' covering about 9% geographical area of Punjab (Karam Singh, *et al.* 2018) ^[1]. The Government in order to improve the situation of the area launched 'Kandi Watershed and Area Development Project' appraised by World Bank in 1978 which became effective in 1980 (Karam Singh, *et al.* 2018) ^[1]. The construction of Check Dams began in the area to control floods and to improve irrigation facilities. The most notable among these Check Dams in the study area is Dholbaha Dam. Other notables Dams are Janauri Dam, Damsal Dam, Chohal Dam, Saleran Dam, Nara Dam, and Patiari Dam. The construction of these Dams improved irrigation and helped to organise agriculture in lower Watershed areas. The construction of Dholbaha Dam, which was completed in 1987, signified great improvement in agriculture and settlements downstream area. The progressive agriculture development in lower flood prone areas however leads to tree cutting and rapid decline in forest cover (figure 5, A1). The downstream areas of Janauri and Damsal Dam too witnessed such kind of second decline (figure 5, A2). In addition, most of the area below 300 m height from sea level is now converted into agriculture land.

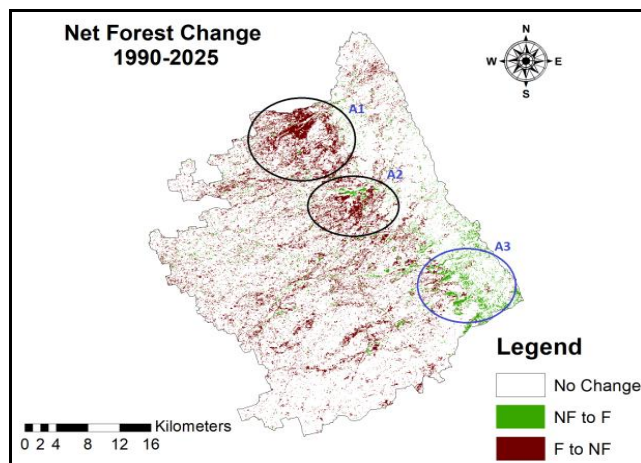


Fig 5: Major Change Locations

Forest fires are also a concern in the study area. As per Forest Survey of India, 271 forest fire incidents detected in Hoshiarpur district during 2023-24. A significant area of the district falls in highly fire prone area to extremely fire prone area. A slight increase of forest cover observed in South-Eastern side (figure 5, A3) of the study area is more or less an open forest instead of dense forest.

Conclusion

The importance of forests is immense for the World. These are vital for various types of life on planet. Forests provide clean air, food, support biodiversity, and absorb Carbon dioxide. But intense human activities, for example, agriculture expansion, urbanisation, mining and forest fires cause rapid decline in forest cover area across world. The given time span (1990 to 2020) observes an estimated loss of 420 million hectares forest covers across the globe. The aforementioned pattern secures a suitable space in the present study. Sharp decline in forest cover in Hoshiarpur Tehsil is a worrisome situation. Most of the decline is associated with gentle slope area which is suitable for agriculture. In contrast, forest cover in hilly part of the tehsil spreads day by day that appears less affected by human activities. Government of Punjab also launched 'The Green Punjab Mission (GPM)' in order to increase tree cover in state by tree plantation drive.

Limitations of the study

The study is based on Landsat Images. These have a resolution of 30x30 meters that seems less suitable for small area study because ample chances of a merger between neighbouring pixels of Forest with Non-Forest can occur.

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