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Land Use Dynamics in Beed District, Maharashtra: Spatial Patterns, Drivers, and Implications

Archana Shivaji Waghmare

Assistant Professor, Department of Geography, Saraswati Mahavidyalaya Kaij, Dist-Beed 43112 (M.S.), India.
Email- archanawaghmare2012@gmail.com
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ABSTRACT :

Beed District, located in Maharashtra's semi-arid Marathwada region, has experienced significant land use changes in recent decades due to factors like increased farming, urbanization, infrastructure growth, and environmental issues like changing rainfall patterns and a lack of water. This study synthesizes research conducted from 2023 to 2025, examining spatial and temporal patterns of land use and land cover (LULC) in Beed District. Changes in agricultural, urban, forest, and fallow land were measured using Geographic Information Systems (GIS), Remote Sensing (RS), and statistical analyses. These changes were also linked to their social, economic, and ecological causes. The results highlight the immediate necessity for sustainable land management strategies that reconcile developmental ambitions with environmental preservation.

Keywords: Beed District, Land Use Change, GIS, Remote Sensing, Semi-arid Region, Urbanization, Agricultural Intensification, Sustainable Land Management

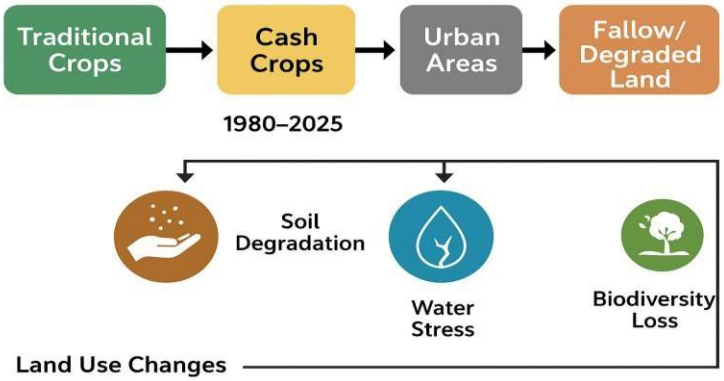
Introduction

Land use change is a key topic in human-environment geography because it shows how human activities and natural systems interact in a dynamic way. The Marathwada region, especially Beed District, has a semi-arid climate, relies on monsoon rains, and farming is the main way people make a living. The district has changed a lot in the last few decades because of population growth, urbanization, changes in farming practices, and improvements to infrastructure, such as roads and irrigation projects.

For long-term land use, protecting the environment, and planning for the future, it is important to understand these changes. Recent improvements in GIS and RS make it possible to accurately measure changes in LULC over time. Research in Maharashtra's semi-arid regions indicates that transitions from multi-cropping systems to monoculture, urban encroachment, and expanded fallow land can lead to soil degradation, biodiversity decline, and modified hydrological cycles (Gaikwad et al., 2018; Saraf, 2024).

These changes not only make ecosystems less resilient, but they also change how therapeutically important plants are grown. Recent research on AM fungi colonization in regional flora, such as Capparis zeylanica and Ricinus communis (Sarwade et al., 2024), demonstrates a significant correlation between soil microbial health and agricultural patterns as well as land management practices. Consequently, the preservation of agro-biodiversity is essential for ecological sustainability and the conservation of medicinal plants (Sarwade et al., 2025). This paper combines the trends, causes, and effects of land use change in Beed District and suggests possible policy changes.

Figure 1: land use changes



Methodology

Data for this study were collected from multiple sources:

- *Satellite Imagery:* Landsat TM/ETM+ (1980–2015) and Sentinel-2 (2015–2025) were used for LULC classification.
- *Historical Maps:* Survey of India maps provided baseline data.
- *Government Records:* Revenue and agricultural department records offered insights into land tenure, crop patterns, and irrigation infrastructure.
- *Field Surveys:* Selected villages were surveyed to validate RS interpretations and gather socio-economic data.

We used ArcGIS and QGIS to do GIS and RS analyses. We used supervised classification and NDVI to find changes in vegetation and land use. Post-classification comparison and overlay techniques quantified temporal LULC transitions. Statistical techniques, such as descriptive statistics, correlation analysis, and Mann-Kendall trend tests, investigated the associations between land use change and environmental or socio-economic variables.

Land Use Trends in Beed District

About 60–65% of Beed's land is used for farming (Table 1). In the past, it was common to grow more than one type of crop at a time, like millets, pulses, and oilseeds. Recent studies show that market demand and government incentives are pushing farmers to grow only one crop, especially soybeans, cotton, and maize. While better irrigation and high-yield varieties have made farming more productive, these methods have led to soil nutrient depletion, over-extraction of groundwater, and less crop diversity (Kharbikar et al., 2024; Gaikwad et al., 2018).

Urban areas, especially the city of Beed and the taluka centers, have grown and taken over fertile farmland along highways and infrastructure corridors. Beed city grew by almost 35% between 2000 and 2023. This caused agricultural landscapes to become more fragmented, more impervious surfaces to be created, and more stress on water and energy resources (Times of India, 2023).

Forest cover is still low, at only 8–10% of the total area. This is because land is being converted and fuelwood is being taken from the forest. Fallow land changes depending on the weather, crop failures, and whether or not it is economically viable. For example, drought-prone talukas like Kaij and Beed have more abandoned land, while irrigated areas reclaim fallow plots for farming (Saraf, 2024).

Table 1: Land Use/Land Cover Area and Changes in Beed District (1980–2025)

LULC Category	1980 (km²)	2000 (km²)	2015 (km²)	2025 (km²)	Change 1980–2025 (%)	Key Drivers
Agricultural Land	7,820	8,100	8,450	8,600	+10%	Market demand, irrigation, cash crops (soybean, cotton)
Urban Area	320	450	580	650	+103%	Population growth, infrastructure, industrial development
Forest Cover	1,100	1,050	1,000	950	-14%	Fuelwood extraction, land conversion
Fallow Land	1,200	1,300	1,400	1,500	+25%	Rainfall variability, drought, crop failure
Water Bodies	180	175	170	165	-8%	Water extraction, sedimentation

Sources: Kharbikar et al., 2024; Mahalkar, 2024; Saraf, 2024.

Taluka-Level Crop Pattern Shifts

Table 2 highlights crop shifts in key talukas, indicating a move from traditional millets to high-value cash crops.

Taluka	Dominant Crops (1980s)	Dominant Crops (2020s)	Key Changes	Implications
Georai	Sorghum, Bajra, Pulses	Cotton, Soybean	Monoculture expansion	Soil nutrient depletion, biodiversity loss
Ashti	Millets, Oilseeds	Cotton, Maize	Shift to cash crops	Increased irrigation demand, groundwater stress
Kaij	Sorghum, Pulses	Maize, Soybean	Partial monoculture	Fallow land increase in drought years
Beed	Millets, Pulses	Soybean, Cotton	Urban encroachment	Fragmented agriculture, pressure on resources

Sources: Gaikwad et al., 2018; Kharbikar et al., 2024.

Figure 2: land use showing agricultural land conversion to urban, fallow, or monoculture crops, emphasizing forest loss.

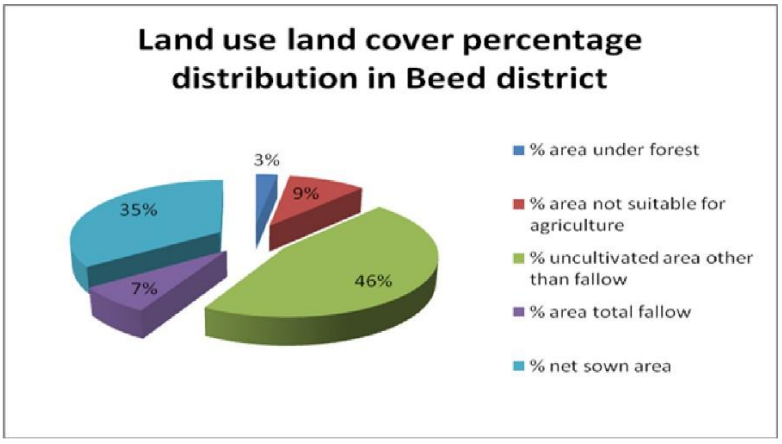
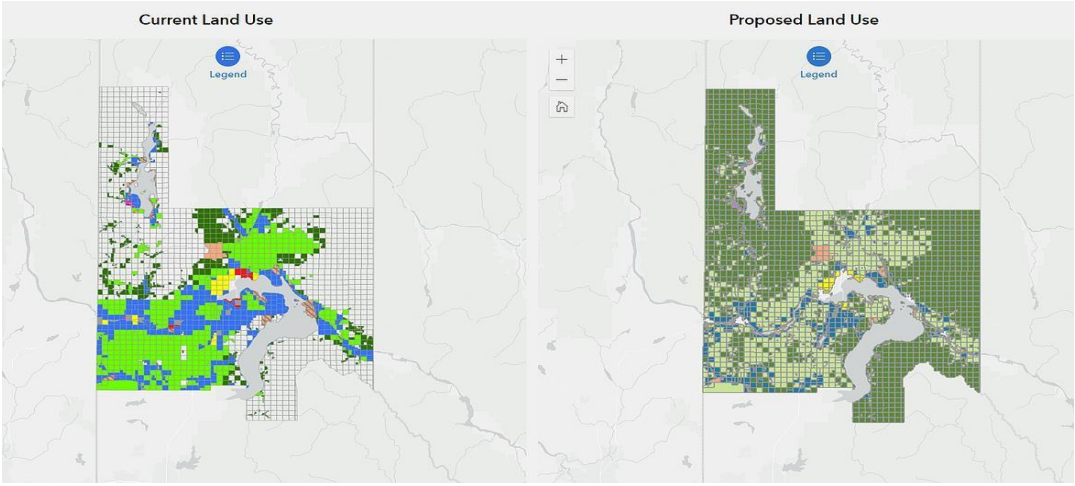


Figure 3: Map showing spatial growth along highways and infrastructure corridors.



Drivers of Land Use Change

Land use change in Beed District is influenced by multiple socio-economic and environmental factors:

1. ***Socio-Economic Drivers*:**

   More people means that there is more need for services, infrastructure, and housing.
   Economic incentives like subsidies and MSP programs encourage people to grow cash crops.
   Seasonal migration leading to land abandonment or intensification (Mahalkar, 2024).

2. ***Environmental Drivers*:**

   The amount of rain and dryness affects how crops grow.
   When there isn't enough water, less food can be grown. This means that crops that can survive drought are more likely to be grown or that land will be left alone (Masroor, 2022).

3. ***Policy and Governance Drivers*:**

When you buy land for roads, highways, and industrial zones, you turn farmland into urban or industrial land.
The government also changes how land is used by promoting cash crops and new irrigation methods (Times of India, 2023).
These factors also change where and how well medicinal plants like Allium sativum, Ocimum sanctum, Moringa oleifera, and Aloe barbadensis grow. To grow these plants and make their secondary metabolites, the soil needs to be healthy and the land needs to be managed well (Mishra et al., 2024; Otia et al., 2024; Sarwade et al., 2024–2025).

Ecological and Socio-Economic Implications

Land use changes have several ecological and socio-economic consequences:

- ***Ecological Impacts*:**
- Changes in how land is used can have a lot of effects on both the economy and the environment:
  Effects on the environment: Monoculture reduces habitat diversity, putting native plants and animals at risk, and has an impact on underground microbial communities, such as AM fungi (Sarwade et al., 2024).

- ***Socio-Economic Impacts*:**

  Farmers in places that are likely to have droughts lose money when their crops fail and their land gets worse.

  Urban sprawl takes away fertile land, which makes it harder for people to get enough food.
  *Medicinal Plant Potential:*Changing the land could put plants with medicinal properties at risk, like Curcuma longa (for neurological and renal uses) and Pyrimidine derivatives for cancer treatment (Sarwade et al., 2024, 2025).

Policy Recommendations

To mitigate negative consequences, integrated land use planning is essential:

- Promote *sustainable agriculture* through crop diversification, organic farming, and water-efficient irrigation (drip irrigation, check dams).
- Improve *governance and land tenure systems*, ensuring participatory land management policies align development with ecological sustainability.
- Engage communities to reflect local socio-economic realities, ensuring effective adoption of sustainable practices.
- Leverage biotechnological tools, including green-synthesized nanoparticles and plant genomics, to enhance secondary metabolite production while conserving native biodiversity (Kumar et al., 2024; Sarwade et al., 2024).

Conclusion

A complicated mix of social, economic, environmental, and policy factors is what has caused changes in land use in Beed District. Urban growth, more intensive farming, and building more infrastructure can all make jobs, but they can also hurt the environment and society. To keep this semi-arid area strong for a long time, it is important to use land management methods that protect the environment while also helping the economy grow.

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