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The Geography of Land Utilization Change in Beed District: Implications for Biodiversity and Therapeutic Plant Resources

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ABSTRACT

A lot has changed in the last sixty years about how people use land in semi-arid areas like Beed district in Maharashtra. Changes in society and the economy, better farming, and environmental stressors like drought and the depletion of groundwater have all led to these changes. These changes have a big impact on ecological processes, the number of medicinal plants, and the diversity of plants and animals that live underground. This review combines historical and current land use data, looks at the causes and effects of changes in land use, and links these trends to new research on plant-microbe interactions and natural products that can help people. The review emphasizes the necessity for cohesive land management strategies that preserve soil and biodiversity while facilitating sustainable agriculture and phytomedicine production.

Keywords: Beed District, biodiversity, arbuscular mycorrhizal fungi, medicinal plants, and sustainable agriculture

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1. Introduction

Land use and land cover change (LULCC) represents a dynamic interaction between human society and the environment, profoundly affecting ecological functions and socio-economic structures (FAO, 2020; Turner et al., 2007). In semi-arid areas like Beed, where farming is still the main way to make money, these changes affect not only food security but also ecosystem services, biodiversity, and the availability of medicinal plants (Census of India, 2011; District Gazetteer of Beed, 1975).

2. Literature Review

2.1 Land Utilization Studies

Land use research has evolved from conventional models, such as von Thünen's agricultural location theory, to contemporary GIS-based assessments, enabling spatiotemporal analyses of rural landscapes (Singh, 2002; FAO, 2011). Regional studies highlight the influence of drought, the proliferation of cash crops, and innovations in irrigation technology on alterations in land use in semi-arid Maharashtra (Deshpande & Narayanamoorthy, 2003). .

2.2 Plant–Microbe Interactions

Arbuscular mycorrhizal (AM) fungi are common partners in the soil that help plants get more nutrients and handle stress better. Studies on regional flora reveal that native species such as Capparis zeylanica and Ricinus communis exhibit substantial arbuscular mycorrhizal fungal colonization, thereby improving ecosystem stability in arid conditions (Sarwade et al., 2024). Disrupting the soil, cultivating a singular plant species, and employing chemical fertilizers diminish these interactions, adversely affecting agricultural productivity and natural plant communities.

2.3 Therapeutic Natural Products

Plants that are used in medicine from the area are very important in both traditional and modern medicine. Allium sativum, Ocimum sanctum, and Moringa oleifera exhibit antioxidant, anticancer, hormonal, and antimicrobial properties (Mishra et al., 2024; Otia et al., 2024; Sarwade et al., 2024–2025). Scientists have looked into how curcuma longa affects the brain and kidneys, and pyrimidine derivatives have been shown to help fight cancer. These natural resources are even more useful for translation now that they can be used in new biotechnological ways, such as green-synthesized nanoparticles and plant genomics (Kumar et al., 2024).

3. Study Area: Beed District

The Beed district is in the Marathwada region of Maharashtra (18°59'–19°57' N; 75°30'–76°40' E) and covers an area of about 10,693 km². The district has a semi-arid climate, with an average of 700 mm of rain per year and a lot of droughts (Census, 2011). The most common type of soil is black cotton soil. You can use them to grow crops with or without water. The majority of people in the district depend on farming, and changes in how land is used have a direct effect on ecological processes and biodiversity, including populations of medicinal plants and soil microbial communities.

4. Methodology

This review uses secondary data from the NRSC LULC maps (2019), historical census reports (1961–2011), district gazetteers, and agricultural statistics. We employed GIS mapping and comparative statistical analysis to quantify alterations in land use categories. A synthesis based on literature also links these patterns to the interactions between plants and microbes and the significance of regional plants in medicine

5. Land Utilization in the Past

Beed's farms mostly grew subsistence crops like jowar, bajra, and pulses in the 1960s. There wasn't much cotton grown. There wasn't much irrigation, and the commons and grazing land were still there (District Gazetteer, 1975). AM fungal communities were relatively stable due to diverse cropping patterns and minimal chemical inputs (Sarwade et al., 2024). Forests and common lands housed medicinal plants like Capparis zeylanica and Ricinus communis, supporting ecological and ethnobotanical networks.

6. Present Land Utilization Patterns

People grow cash crops like soybeans, cotton, and sugarcane on their land these days. Groundwater levels have dropped because borewell irrigation and mechanization have made it easier to get water. The amount of forest cover and grazing land has gone down, which has made it harder for medicinal plants to find homes. Monoculture practices have reduced AM fungal diversity and subterranean microbial stability, negatively impacting soil fertility and plant resilience (Sarwade et al., 2025). Urban growth and development in the suburbs have made ecological connectivity even worse.

7. Drivers of Land Use Change

1. Physical factors: erratic rainfall, drought frequency, and soil degradation.
2. Economic factors: profitability of cash crops, Minimum Support Price policies.
3. Technological factors: borewell irrigation, mechanization, high-yielding varieties.
4. Policy factors: cooperative sugar factories, agricultural subsidies.
5. Biological factors: decline in microbial diversity due to monoculture and agrochemical use.

8. Consequences of Land Use Change

1. Agricultural: initial yield increase, but unsustainable groundwater usage.
2. Ecological: loss of AM fungal diversity and medicinal plant populations.
3. Socio-economic: farmer migration and financial distress (GoM, 2014).
4. Pharmacological: decreased availability of medicinal plants limits raw material for traditional and modern therapies.

9. Comparative Analysis: Past vs Present

Indicator	1960s	2020s
Crop Diversity	High (millets, pulses, cotton)	Low (soybean, cotton, sugarcane)
Forest Cover	8–10%	<5%
Irrigation	<5%	>40%
AM Fungal Stability	High	Declining
Medicinal Plant Availability	Widespread	Fragmented

10. Implications for Plant–Microbe Interactions and Therapeutic Resources

Studies show that how we use land affects the biodiversity that lives underground. Plants that are native to the area, like Capparis zeylanica, can handle stress in the soil and not getting enough nutrients (Sarwade et al., 2024). A reduction in habitat heterogeneity leads to diminished microbial diversity, adversely affecting both crop health and the quality of medicinal plants. Phytomedicinal species, such as Allium sativum, Ocimum sanctum, and Moringa oleifera, rely on intact soil–microbe networks for the synthesis of secondary metabolites (Mishra et al., 2024; Otia et al., 2024). The efficacy of Curcuma longa in neurological and renal conditions illustrates the correlation between ecological integrity and pharmacological potential

11. Future Prospects

I. Land Management: watershed development, crop diversification, agroforestry.

II. Biodiversity Conservation: protecting AM fungi and medicinal plant populations.

III. Phytomedicine Development: sustainable sourcing of regional medicinal plants.

IV. Biotechnological Integration: green nanoparticles, genomics, and molecular pharmacology.

V. Holistic Approaches: linking soil health, plant-microbe interactions, and human health for agroecological resilience.

12. Conclusion

The Beed district is a good example of how changes in land use can affect health, the economy, and the environment. Historical land use practices maintained significant crop diversity, forest coverage, AM fungal stability, and the availability of medicinal plants. Modern trends, on the other hand, like monoculture, irrigation, and urban growth, have caused habitats to become fragmented and biodiversity in the soil to decrease. You need to know how these things work in order to manage land in a way that is good for the environment, protect biodiversity, and keep developing therapeutic plant resources. Future research should integrate GIS mapping, soil microbial analysis, and phytochemical studies to enhance evidence-based conservation and agricultural policies.

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