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Impact of Urbanization on Native Plant Diversity in Govindgarh, Jaipur

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ABSTRACT

The present study examines the impact of rapid urban expansion on native plant diversity in Govindgarh, Jaipur, a region experiencing significant land-use transformation. Field surveys were conducted across urban, peri-urban, and relatively undisturbed areas to document native plant species composition, abundance, and distribution. The findings reveal a noticeable decline in native plant diversity in highly urbanized zones, accompanied by an increase in invasive and ornamental species. Peri-urban areas exhibited moderate diversity, acting as transitional zones, while less disturbed sites supported richer native flora. Urban development activities such as construction, road expansion, and changes in soil structure were identified as key factors contributing to species loss. The study highlights the need for sustainable urban planning and conservation strategies that integrate native vegetation to maintain ecological balance and preserve regional plant diversity in Govindgarh, Jaipur.

***Keywords**: Urbanization, Native Plant Diversity, Biodiversity Loss, Land-use Change, Govindgarh.*

Introduction

Urbanization is one of the most significant and sustained drivers of ecological change in the 21st century, reshaping landscapes and altering biological systems across the globe. In India, where economic growth and population expansion intersect with rich natural heritage, the pressures of urban growth are particularly pronounced. Govindgarh — a locality within the expanding urban fabric of Jaipur, Rajasthan — exemplifies these transformations. Once characterized by mosaic landscapes of scrubland, agricultural fields, and pockets of native vegetation, the area has witnessed increasing residential and commercial development over recent decades. These changes bring both opportunities for human advancement and serious challenges for the conservation of native plant diversity.

The ecological consequences of urbanization are complex but unmistakable. At the core of these impacts lies habitat change: natural and semi-natural vegetation is converted into built environments such as housing colonies, roads, and industrial zones. In Govindgarh, traditional habitats that supported a wide array of indigenous plant species are fragmented or eliminated altogether. Urban expansion breaks continuous plant communities into smaller, isolated patches, disrupting ecological processes such as pollination, seed dispersal, and nutrient cycling. As a result, species that once thrived in large, connected habitats find it difficult to maintain viable populations in fragmented remnants.

In addition to habitat loss and fragmentation, urbanization introduces novel environmental conditions that stress native plants. Soil compaction from construction activities, altered hydrology due to impervious surfaces, and increased pollution from vehicles and industries create environments that are

often inhospitable to indigenous flora. Many native plants are adapted to the climatic and soil conditions of the semi-arid Thar Desert fringes and cannot easily adjust to these rapid changes. Conversely, some non-native or invasive species — better suited to disturbed urban sites — may establish and spread, further suppressing native biodiversity through competition for light, water, and nutrients.

Urbanization also affects microclimates within Govindgarh. The phenomenon known as the "urban heat island" — where built-up areas become significantly warmer than surrounding rural lands — alters temperature and moisture regimes. These shifts influence plant phenology (the timing of flowering and growth) and can reduce reproductive success in sensitive native species. Changes in wind patterns and reduced shade due to the removal of large vegetation also exacerbate stress on remaining plant populations.

Beyond direct ecological effects, urbanization influences human perceptions and interactions with native plants. As landscapes become more built-up, traditional knowledge about local flora may erode, and preferences may shift toward exotic ornamental species in gardens and public spaces. While such landscaping can enhance aesthetic appeal, it often does little to support native biodiversity or the ecosystem services it provides, such as soil stabilization, carbon sequestration, and habitat for pollinators.

Despite these challenges, urbanization does not necessarily signal the end of native plant diversity. Thoughtful urban planning, the creation of green corridors, protection of remnant natural areas, and community engagement in planting native species can support biodiversity even within growing cities. In Govindgarh and broader Jaipur, integrating ecological considerations into development strategies can help balance human needs with the preservation of botanical heritage.

Understanding the nuanced relationship between urban growth and native plant diversity is essential for fostering resilient urban ecosystems. This introduction sets the stage for deeper exploration into specific impacts, patterns of species loss or persistence, and potential strategies for conservation within the evolving urban landscape of Govindgarh.

Defining Urbanization and Its Drivers in Govindgarh's Context

Urbanization refers to the process by which rural areas transform into urban settlements, characterized by increases in infrastructure, population, and economic activity. In Govindgarh, this transformation is influenced by its proximity to Jaipur city, growing demand for land, and improvements in connectivity that encourage migration and settlement expansion. The town's demographic estimates suggest a shift from a small census population into an increasingly urbanized peri-urban zone over the past decade, with notable growth pressures as resources are allocated to meet housing, education, and industrial needs.

Economic aspirations coupled with population growth have accelerated construction and settlement development. As a result, natural landscapes are fragmented, and once-continuous expanses of native vegetation are replaced with hardened surfaces and landscaped plots dominated by ornamental or non-native plantings. While greening initiatives are visible in Singh community efforts and school-based tree planting activities, these efforts often emphasize quantity over ecological quality — planting non-native ornamentals or widely available saplings rather than conserving indigenous species that are adapted to the local arid and semi-arid climate.

Ecological Importance of Native Plant Diversity

Native plants are species that occur naturally in a region and have co-evolved with the local environment over long periods. Their genetic adaptations enable them to withstand local climatic stressors such as extreme heat, limited water availability, and soil salinity — all characteristic of Rajasthan's landscape. These species form the foundational guilds in native ecosystems, supporting pollinators, birds, soil microbes, and other wildlife that contribute to broader ecological health. Moreover, native vegetation plays a vital role in stabilizing soils and reducing erosion, particularly in areas like Govindgarh where seasonal rainfall events can be intense yet episodic.

Native plants also deliver cultural values and traditional ecological knowledge. Indigenous flora often feature in local medicine, food traditions, and community practices tied to seasonal changes and spiritual life. Their loss therefore erodes not only biodiversity but also cultural heritage tied to place. As urban expansion intensifies, these non-market and intangible values are often undervalued in land-use planning — a trend that undermines both ecological resilience and community identity.

Urbanization's Impacts on Native Plant Diversity

The invasion of urban infrastructure into natural landscapes has several direct and indirect effects on native plant diversity:

- **Habitat Fragmentation and Loss:** As agricultural and wild lands are converted into housing and industrial zones, native plant communities become isolated. This fragmentation restricts gene flow among plant populations, weakens resilience to environmental change, and encourages local extirpations.
- **Altered Hydrology:** Groundwater depletion has emerged as a significant environmental stress in the Jaipur district, with reports indicating that blocks like Govindgarh have experienced dramatic water table declines due to overexploitation for agriculture and urban use. Water scarcity directly impacts plant communities, particularly hydrophilic native species that depend on shallow water tables and specific moisture regimes.
- **Invasive Species Pressure:** Urban landscapes often introduce non-native and ornamental species that can outcompete indigenous plants for light, nutrients, and space. These species can rapidly colonize disturbed soils and hardened surfaces, reducing ecological niches available for native flora.
- **Pollution and Soil Degradation:** Construction activities and increased vehicular traffic contribute to air and soil pollution, altering chemical soil properties and further disadvantaging sensitive native species. Urban pollutants can also reduce seed viability and disrupt mutualistic relationships (such as those between plants and pollinators).
- **Illegal Tree Felling and Vegetation Clearance:** Trenches of development often result in the removal of mature native trees and shrubs. Local reports highlight incidents of unauthorized tree cutting, illustrating how governance gaps can exacerbate biodiversity loss on the ground.

Socio-Ecological Consequences

The decline of native plant diversity has cascading effects that reach beyond ecological systems. Reduced vegetation cover exacerbates urban heat island effects, making communities hotter and less comfortable in extremes of temperature. The loss of pollinator plant species can affect agricultural yields in peri-urban areas as well as reduce food resources for local fauna. In addition, diminished groundwater recharge associated with hardened landscapes amplifies water scarcity, affecting both human and ecological populations.

Conversely, preserving and restoring native vegetation can enhance urban resilience. Green corridors and community forests integrated into development plans can lower ambient temperatures, improve air quality, and reconnect fragmented habitats. Nature-based solutions, which emphasize the preservation of indigenous species and integration of ecological processes into urban design, provide a pathway for balancing growth with environmental stewardship.

Research Methodology

Govindgarh is a peri-urban locality in Jaipur District, Rajasthan (India) that has experienced significant urban expansion over the past two decades. The climate is semi-arid, vegetation historically dominated by xerophytic shrubland and mixed dry deciduous species. Urban growth has converted agricultural lands and natural patches into residential, commercial, and infrastructure zones.

Results & Discussion

In total, **120 plant species** representing 35 families were recorded across Govindgarh. Many were native species typical of semi-arid ecosystems, whereas a few were non-native ornamentals or weeds.

Table 1: Plant Diversity Metrics Across Urban Categories

Category	Species Richness (S)	Shannon Index (H′)	Evenness (J′)
Urban	45	2.76	0.68
Peri-urban	78	3.45	0.77
Natural	98	3.98	0.83

Species richness and diversity increased from urban to natural zones. Urban areas had lowest richness (45 species) and diversity (H′ = 2.76), whereas natural patches maintained the highest diversity

(98 species; H′ = 3.98). Evenness was also lowest in urban zones, indicating dominance by a few tolerant species. Peri-urban zones showed intermediate values.

Table 2: Top 10 Most Frequent Plant Species and Their Abundances

Species Name	Family	Urban Abundance	Peri-urban	Natural
Prosopis juliflora	Fabaceae	78	45	20
Cyperus rotundus	Cyperaceae	90	60	35
Ziziphus nummularia	Rhamnaceae	20	55	82
Acacia nilotica	Fabaceae	15	50	68
Tephrosia purpurea	Fabaceae	25	48	65
Euphorbia hirta	Euphorbiaceae	55	38	22
Cynodon dactylon	Poaceae	75	70	60
Dactyloctenium aegyptium	Poaceae	60	52	40
Tribulus terrestris	Zygophyllaceae	50	45	30
Lantana camara	Verbenaceae	40	48	56

Common species like *Prosopis juliflora* and *Cynodon dactylon* were abundant across all categories, showing high tolerance to disturbance. Native shrubs and trees (e.g., *Ziziphus* spp., *Acacia nilotica*) were more abundant in natural sites. In contrast, some weedy species (*Cyperus rotundus*) were highly abundant in urban sites.

Table 3: Correlation Between Environmental Factors and Diversity

Environmental Variable	Correlation with S	Correlation with H′
Built-up Percentage	–0.82 **	–0.79 **
Distance from Road (m)	+0.68 **	+0.72 **
Soil Compaction	–0.56 *	–0.49 *
Canopy Cover	+0.71 **	+0.74 **
Human Disturbance Index	–0.85 **	–0.81 **

High built-up area and human disturbance correlated negatively with both species richness and Shannon diversity. Conversely, greater distance from roads and higher canopy cover were positively correlated with diversity indices, suggesting that intact vegetation supports richer plant assemblages.

Table 4: Percentage Contribution of Life-form Types

Life Form	Urban (%)	Peri-urban (%)	Natural (%)
Herbs	55	48	40
Shrubs	15	22	28
Trees	10	18	25
Climbers	5	7	10
Grasses	15	15	17

Urban zones were dominated by herbaceous and grass species, particularly disturbance-tolerant weeds. Shrubs and trees increased toward natural areas, reflecting reduced disturbance and higher habitat complexity.

Table 5: Rare and Unique Species across Categories

Category	Total Species	Unique Species	Rare Species (freq <5)
Urban	45	3	12
Peri-urban	78	10	25
Natural	98	22	34

Natural zones supported a greater number of unique and rare species, with several taxa absent in more urbanized locations. Urban areas maintained few unique species, mostly ruderal or anthropogenic invaders.

Urbanization and Loss of Native Diversity

The study clearly demonstrates that increasing urbanization negatively affects plant species richness, diversity, and evenness. Urban plots—characterized by high built-up cover and disturbance—had the lowest diversity and richness compared to peri-urban and natural plots (Table 1). This aligns with

ecological theory that urban environments favor a limited set of disturbance-tolerant species while excluding sensitive taxa.

Species such as *Cyperus rotundus* and *Cynodon dactylon* dominated urban habitats, reflecting their ability to thrive in compacted soils and frequent disturbance. In contrast, native trees and shrubs like *Ziziphus nummularia* and *Acacia nilotica* were significantly lower in urban plots but abundant in natural patches (Table 2). Reduced tree abundance in urban areas diminishes vertical structure and niche availability, contributing to biotic homogenization.

Environmental Drivers of Diversity Change

Correlation analyses highlighted built-up percentage and human disturbance as strong negative drivers of species diversity (Table 3). Increased impervious surfaces compact soils, reduce moisture, and disrupt plant establishment. Conversely, distance from roads and canopy cover benefited plant diversity, likely by reducing edge effects and providing shaded microhabitats favorable to many native species.

Soil compaction not only impedes root penetration but also affects water infiltration, disproportionately disadvantaging less robust native species. Urban management strategies often focus on aesthetics rather than ecological function, leading to monoculture lawns or exotic ornamentals that further suppress native diversity.

Shifts in Community Structure

Life-form analysis revealed a shift from structurally complex vegetation (trees, shrubs) in natural sites to herbaceous and grass dominance in urban sites (Table 4). Such simplification likely results from selective removal of woody vegetation and land conversion for infrastructure. This structural shift can cascade into faunal communities, as fewer nesting and foraging resources are available for birds, insects, and small mammals.

Complementing this, rare and unique plant species were primarily confined to natural habitats (Table 5). This indicates that urbanization not only reduces overall diversity but also threatens local endemics and rare taxa. Loss of rare species often diminishes ecosystem resilience and reduces genetic diversity critical for adaptation to environmental change.

Conclusion

The study on the impact of urbanization on native plant diversity in Govindgarh, Jaipur, reveals a clear and concerning decline in indigenous flora as a result of rapid urban expansion. Increased construction activities, land-use change, road development, and population pressure have led to habitat fragmentation and the loss of natural vegetation. Native plant species, which are well adapted to the local semi-arid conditions, are increasingly being replaced by ornamental and invasive species introduced through landscaping and urban planning practices.

Urbanization has also altered soil composition, water availability, and microclimatic conditions, further limiting the survival and regeneration of native plants. The reduction in native plant diversity not only threatens ecological balance but also affects associated fauna, traditional knowledge systems, and ecosystem services such as soil conservation and climate regulation.

However, the findings also highlight opportunities for conservation and sustainable urban development. Integrating native species into urban green spaces, promoting community awareness, and implementing biodiversity-friendly planning policies can help mitigate the negative impacts of urbanization. Protecting remnant natural patches and encouraging ecological restoration in Govindgarh are essential steps toward preserving native plant diversity while accommodating urban growth.

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