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Original Article

# A Mini Forest of Heritage: Assessing the Mango (*Mangifera indica L.*) Field Gene Bank at Gurudas College in the Context of the Miyawaki Model

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**Abstract**

Educational campuses, when managed as green open spaces, not only enhance the learning environment but also act as crucial ecological nodes within the urban landscape. The Mango Field Gene Bank established at Gurudas College, Kolkata, represents an innovative model for ex situ conservation of traditional mango (Mangifera indica L.) varieties from Malda and Murshidabad districts of West Bengal. Designed as a dense orchard resembling a "mini forest," this initiative combines genetic conservation with ecological restoration. The study explores whether the mango orchard aligns with the Miyawaki model of afforestation, an approach that promotes rapid, multilayered native forest development. Through conceptual and ecological analysis, the article highlights how this living repository embodies principles of biodiversity preservation, microclimate regulation and educational engagement, while suggesting ways to strengthen its resemblance to a Miyawaki-type forest ecosystem.

***Keywords:*** *Ex Situ Conservation; Goals (SDGS); Miyawaki Model, Mango Field Gene Bank, Sustainable Development Gurudas College; Traditional Mango Varieties*

## Introduction

Many universities and colleges are now adopting "green campus initiatives", emphasizing energy-efficient infrastructure, waste management, water harvesting, and biodiversity conservation. Such initiatives align with the Sustainable Development Goals (SDGs), particularly SDG 11 (Sustainable Cities and Communities) and SDG 13 (Climate Action). Thus, educational campuses, when managed as green open spaces, not only enhance the learning environment but also act as crucial ecological nodes within the urban landscape.

### *Educational Institution Campuses as Green Open Spaces*

Educational institution campuses play a vital role in maintaining urban ecological balance by serving as green open spaces that provide environmental, educational, and social benefits. In densely populated cities, where green cover is often limited, campuses act as microhabitats supporting local biodiversity, mitigating heat islands, and improving air quality (Liu *et al*., 2021). The presence of trees, gardens, and water bodies within these spaces contributes to carbon sequestration and enhances the aesthetic and psychological well-being of students and staff (Edeigba *et al*., 2024). These days research workers are designing educational campuses which can become models for integrating biodiversity into urban

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spaces, showcasing the benefits of such integration on mental health, cognitive function, and community engagement (Marium, 2025).

From an educational standpoint, campus greenery serves as a living laboratory where students engage in experiential learning related to botany, ecology, and environmental management (De *et al*., 2019). It fosters ecological literacy, sustainability values, and environmental stewardship among the younger generation. Furthermore, green campuses contribute to climate resilience by reducing surface runoff, supporting pollinators, and moderating local temperatures (Tzoulas *et al*., 2007).

*Educational Campuses as Sites for Conservation of Plant Genetic Diversity*

Educational institution campuses can play a significant role in the conservation of plant genetic diversity by serving as ex situ conservation sites for native, traditional, and endangered plant species. With careful planning, campuses can maintain botanical gardens, herbal gardens, and field gene banks that preserve local flora and traditional crop varieties, acting as living repositories of genetic resources (Heywood, 2019). Such initiatives provide opportunities for students and researchers to engage directly with conservation practices while ensuring the survival of species that might otherwise be lost due to urbanization and habitat destruction. By cultivating rare or region-specific plants, educational campuses contribute to maintaining genetic variability, which is crucial for adaptation to changing climates and future breeding programs (Hammer & Teklu, 2008). Additionally, integrating plant diversity conservation into academic and extracurricular activities fosters environmental awareness and supports sustainability education (De *et al*., 2019). Thus, educational campuses not only enhance biodiversity within their premises but also act as microcosms of conservation, linking education, ecology, and community engagement. Field gene banks of an educational institution is an ideal example of ex situ conservation within the campus (De, 2017).

Conservation of plant genetic resources is fundamental for ensuring biodiversity, food security, and cultural sustainability (Maxted *et al*., 2020). The disappearance of many plants species due to human activities is depleting the world's genetic resources and is putting man's heritage of biodiversity under serious threat (Soladoye *et al*., 2005). International efforts aimed at collecting and conservation of plant genetic resources have been coordinated since 1974 by the International Board for Plant Genetic Resources (IBPGR) (Konopka & Hanson 1985).

*The Miyawaki Model of Afforestation*

Developed by Japanese botanist Dr. Akira Miyawaki, the Miyawaki method is a reforestation approach that accelerates natural succession by planting dense clusters of native species (Miyawaki, 1999). The model's essential features include:

- Exclusive use of **native species** suited to the local ecology.
- **High-density planting**, typically 3–5 saplings per square meter.
- **Multilayered vegetation**, with canopy, understory, and ground flora.
- **Soil enrichment** through organic matter and microbial activity.
- **Minimal maintenance** after initial establishment.
- **Rapid growth and ecological restoration**, achieving mature forest conditions within 20–30 years.

Globally, the Miyawaki method has been recognized for urban greening and biodiversity enhancement. The Miyawaki method of restoration of forest ecosystems and the establishment of small new forests within urban settings emerged as promising solutions to augment ecosystem sustainability (Akram *et al*., 2025). In India, several urban Miyawaki forests, have demonstrated improved microclimatic regulation, soil stability, and species diversity within compact spaces (Roy *et al*., 2025).

*Diversity of Mango (Mangifera indica L.)*

Mango (Mangifera indica L.) belongs to plant family Anacardiaceae. Literature review reveals that there are about 1000 varieties of mango. (Mukherjee, 1972; Rathour, 2023). India is rich in mango diversity (Mukherjee, 1972). Mango (Mangifera indica L.) is known as the 'king of fruits'

for its rich taste, flavor, color, production volume and diverse end usage (Singh *et al*., 2016). The Mango is the national fruit of India, Pakistan and the Philippines. It is also the national tree of Bangladesh (Singh *et al*, 2019).

In West Bengal, traditional mango (Mangifera indica L.) varieties, particularly those from Malda and Murshidabad, constitute a significant part of agricultural and cultural heritage However, the increasing preference for high-yield commercial mango cultivars (Rajan & Yadav, 2021) and shrinking orchard spaces have endangered this rich genetic legacy.

## Materials and Methods

**Study site:** Gurudas College is located near Jewish Cemetery, the postal address is 1/1, Suren Sarkar Road, Phoolbagan, Narkeldanga, Kolkata 700054, West Bengal, India. The coordinates are 22.5711869°N 88.3899065°E.

### Objective

To address this concern, a Mango Field Gene Bank was established at Gurudas College, Kolkata, as part of a long-term academic and conservation initiative led by first author in 2016. The gene bank serves as both a repository of traditional mango germplasm and an urban green space contributing to biodiversity enrichment.

*Research Hypothesis*

The present research hypothesis guiding the ongoing study is whether this developing orchard demonstrates characteristics consistent with the Miyawaki Model of ecological restoration. According to Miyawaki principles, a forest is considered successful when it exhibits structural complexity, multi-layered vegetation, rapid biomass accumulation, and increasing autonomy from human intervention. Early observations, including canopy stratification, self-sustaining soil development, natural regeneration of flora, and the steady rise in biodiversity, suggest emerging parallels with the Miyawaki framework. This article examines the ecological structure of this mango orchard and evaluates whether it reflects the principles of the Miyawaki model of afforestation, thereby combining ex situ conservation with ecological restoration.

*The Genesis of the Mango Field Gene Bank*

The Mango Field Gene Bank was conceived as a living laboratory and conservation site within the Gurudas College campus in Kolkata, West Bengal, India. Traditional mango varieties were collected directly from farmers and orchardists of Malda and Murshidabad, districts historically known as the "mango belt" of Bengal. Notable varieties include Alapati, Anaras, Badsabhog, Bimbli, Champa, Chinichampa, Chotolaksman, Dudhkamal, Golachoka, Gopalbhog, Golapkhas, Kachamitha, Khirsapati, Madhuchuski, Madhugulguli, Misrikanta, Molamjam, Nawab Bhog, Rakhalbhog, Rani Pasand, Shadulla, Sinduria, Vabani and many others, each representing unique taste profiles, flowering times, and resilience to climatic variations (De *et al*., 2014).

In 2016, twenty-five traditional mango (Mangifera indica L.) varieties sourced from Malda and Murshidabad districts were planted as part of a conservation effort. Nearly a decade later, these trees have matured into a dense, layered green space that now resembles a mini forest rather than a conventional plantation. The once open area is now characterized by a closed canopy, enriched understorey, leaf-litter accumulation, and the gradual return of birds, insects, soil fauna, and wild undergrowth; features typical of a natural forest ecosystem. This orchard is more than just a collection of trees; it represents a living archive of Bengal's mango heritage, safeguarding rare, region-specific landraces that carry centuries-old cultural, agricultural, and ecological significance. It also serves as a living repository of genetic material that can be used for different areas of interest. First author has investigated the variation in flowering and fruit set among the different varieties of mango varieties (De *et al*, 2019) and carried on some case studies on the utility of such field gene bank (De, 2022).

These 25 (twenty-five) mango varieties, many of which were traditional mango varieties of Malda and Murshidabad districts of West Bengal along with some commercial varieties (as checks) were planted at the far end of the Gurudas College Library campus also known as the Golden Jubilee campus. The list of mango varieties that are now conserved as Mango Field Gene Bank of Gurudas College is given in Table I.

***Table 1:*** *List of Mango Varieties Now Conserved in The Mango Gene Bank of Gurudas College*

| Sl. No. | Mango Variety Name |
|---|---|
| 1 | Aswina |
| 2 | Amrapalli |
| 3 | Bara Sahi |
| 4 | Begam Fuli, |
| 5 | Bel kusum, |
| 6 | Bimli, |
| 7 | Bombai, |
| 8 | Champa, |
| 9 | Chousa, |
| 10 | Churmur, |
| 11 | Dobani, |
| 12 | Do Phala, |
| 13 | Golap Bhog, |
| 14 | Golap Khas, |
| 15 | Himsagar, |
| 16 | Kishen Bhog, |
| 17 | Lakhna, |
| 18 | Langra, |
| 19 | Molam Jam, |
| 20 | Motichur, |
| 21 | Rani Pasand, |
| 22 | Sadullah, |
| 23 | Sahi, |
| 24 | Saranga, |
| 25 | Surma Fazli |

## Result and Discussion

*A Growing Heritage: The Emergence of a Mini Mango Forest (2016–2025)*

In 2016, twenty-five heritage mango (Mangifera indica L.) varieties from the mango belts of Malda and Murshidabad were planted with the vision of conservation, research, and living documentation of Bengal's mango biodiversity. Initially appearing as a small plantation with young saplings, the site has undergone remarkable ecological transformation over the years. Today, these trees stand tall, their crowns overlapping to form a cohesive canopy that resembles a self-sustaining mini forest. Fig 1 & 2 show the location of the Mango Field Gene Bank of Gurudas college. Fig. 3 & 4 depict the photographs taken on the inauguration day in 2016.

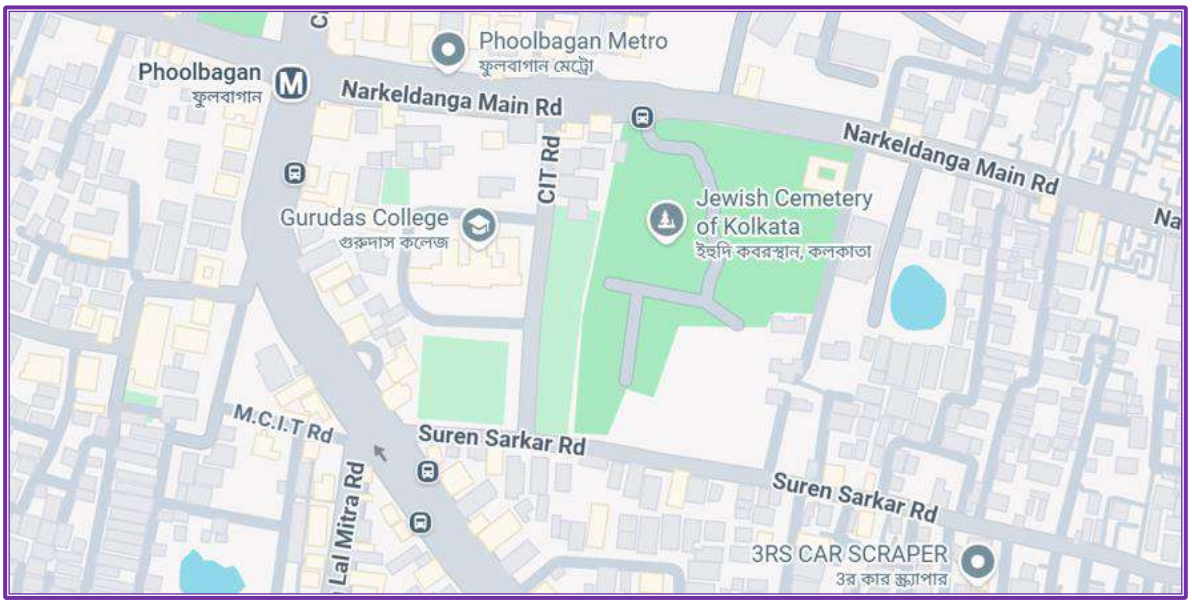


***Figure 1:*** *Google Map location of Gurudas College, Kolkata 700054. The Golden Jubilee campus has the Jewish Cemetery on its right, CIT Road on the left and below Suren Sarkar Road*

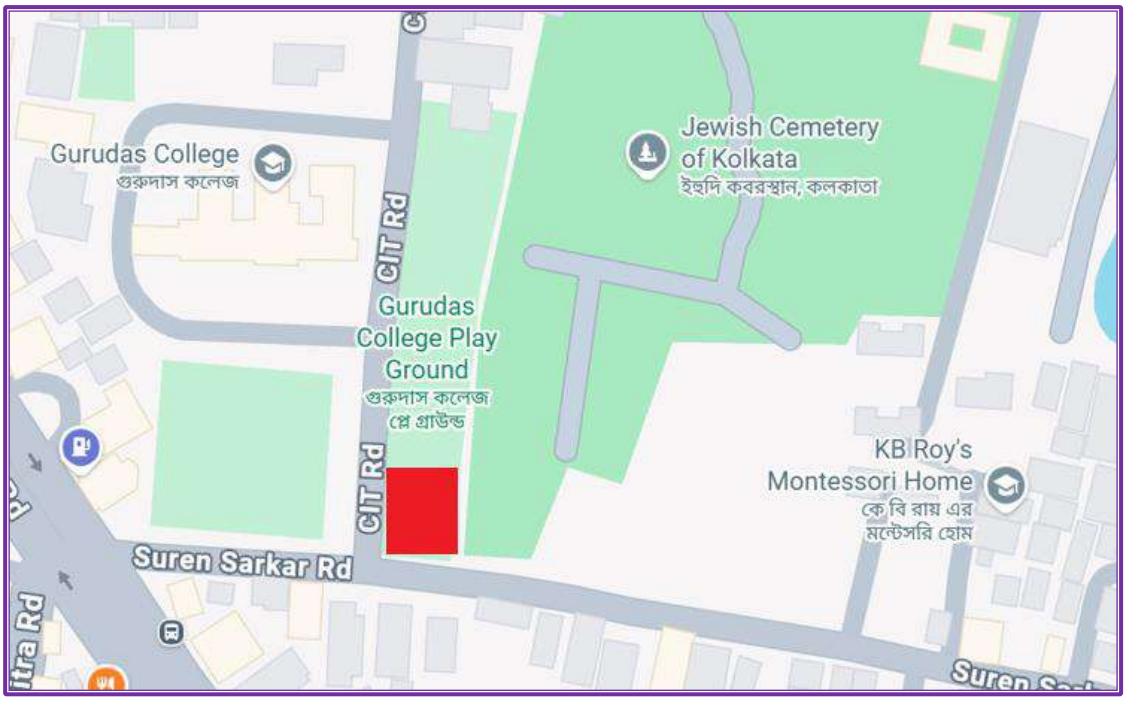


***Figure 2:*** *Google Map Showing the Location of The Mango Gene Bank of Gurudas College, Marked as A Red Rectangle*


***Figure 3:*** *Field Gene Bank set up in 2016*


***Figure 4:*** *Inauguration of the Mango Field Gene Bank, Named as Amrakunja by Gurudas College Authorities*

As the trees matured, the space beneath them began to change. Leaf litter accumulated over the years, enriching the soil with organic matter and creating a cool, humid forest floor. Earthworms, insects, amphibians and small birds returned, using the orchard as habitat and feeding ground, a sign of positive ecological succession. Changes in the structure of the mango field gene bank in Gurudas College are shown as photographs of the same site in 2016, 2019 and 2015 (Fig. 5 & 6).

| | |
|---|---|
|  | The Mango Field gene bank in 2016. |
|  | The Mango Field gene bank 2019. |
|  | The Mango Field gene bank in 2025. |

***Figure 5:*** *Portion of the Mango Field Gene bank in in 2016, 2019 and 2025*

| | |
|---|---|
|  | The Mango Field gene bank in 2016. |
|  | The Mango Field gene bank 2019. |
|  | The Mango Field gene bank in 2025. |

***Figure 6:*** *Portion of the Mango Field Gene Bank in 2016, 2019 and 2025*

With time, the mango orchard developed vertical structure: A dense upper canopy of foliage and branches of mango varieties which are comparatively fast growing and/or taller than other varieties (Fig. 7 & 8).

***Figure 7:*** *Dense Upper Canopy of Foliage Formed by The Tall Mango Varieties*

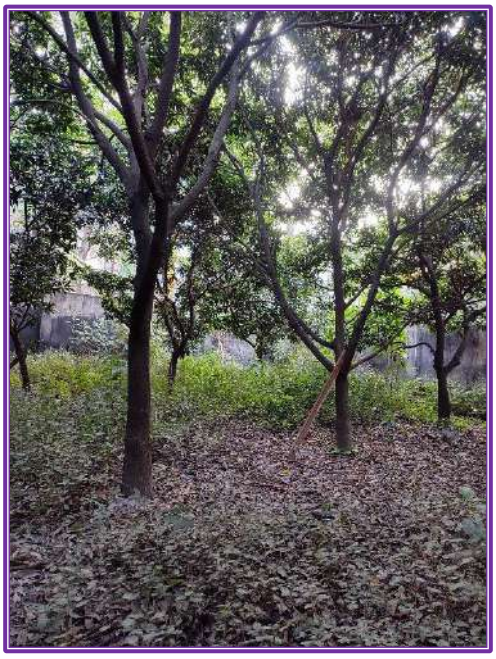

***Figure 8****: Dense Upper Canopy of Foliage Formed by The Tall Mango Varieties*

A middle layer of mango varieties that instead of growing taller spread their branches to form a sort of mid layer (Fig. 9. & 10).

***Figure 9:*** *Middle Layer of Mango Varieties That Spread Horizontally*

***Figure 10:*** *Middle Layer of Mango Varieties That Spread Horizontally*

A developing undergrowth of grasses, wild herbs and fallen leaves. Though this growth varies with season and not very dense as light penetration is quite low due to the dense canopy of the tall mango varieties. Together, these elements give the space the visual and ecological character of a young forest, rich in microhabitats, biodiversity, and environmental function (Fig, 11).

***Figure 11:*** *A Developing Undergrowth of Grasses, Wild Herbs and Fallen Leaves. The Mango Gene Bank In 2025 Resembling A Mini Forest*

The Google Map images show that indeed the far end of the Gurudas College Golden Jubilee campus, labelled as Gurudas College Playground. The Mango Field Gene bank is beside Suren Sarkar Road and the dense canopy layer is clearly visible in Fig. 12 with a close-up view as Fig. 13.


***Figure 12:*** The Mango Field Gene bank is beside Suren Sarkar Road


***Figure 13:*** *Close-up View of The Dense Canopy to The Left of Baba Buro Shiv Mandir (A Local Temple)*

*E*valuating the Mango Field Gene Bank Against Miyawaki Parameters

Although originally designed as a gene bank rather than a forest restoration project, the Gurudas College mango orchard exhibits several features comparable to the Miyawaki model (Table 2).

***Table 2:*** *Comparison between Miyawaki Model Features and the Mango Field Gene Bank*

| Miyawaki Principle | Observation in Mango Field Gene Bank | Interpretation |
|---|---|---|
| Use of Native Species | Traditional mango varieties indigenous to Bengal's alluvial plains | Fully consistent |
| Density of Planting | Trees planted at closer spacing than conventional orchards | Partially consistent; promotes canopy overlap |
| Multilayered Structure | Mango canopy with spontaneous shrubs, herbs, and grasses beneath | Ecologically comparable to Miyawaki layering |
| Soil Health and Mulching | Natural leaf litter accumulation and organic matter recycling | Strong alignment |
| Maintenance | Low-maintenance, minimal pruning or chemical inputs | Sustainable management |
| Ecological Services | Shading, bird and pollinator attraction, microclimate regulation | Functionally similar outcomes |

Today, the site stands as a living demonstration of how ex-situ conservation efforts, when nurtured patiently, can evolve beyond an orchard into a functioning ecosystem. This miniature mango forest preserves genetic diversity of traditional mango varieties, some rare and on the verge of disappearing. This Mango Gene Bank at Gurudas College, Kolkata 700054, serves as a model for sustainable conservation, carbon sequestration, pollinator support, and climate resilience. What began as twenty-five plants has now become a thriving green legacy, one rooted in culture, biodiversity, and ecological restoration.

Further longitudinal monitoring of soil health, carbon sequestration, biodiversity indices and resilience under climatic variability will be critical to validating this hypothesis and defining whether such heritage orchards can serve as culturally rooted, biologically meaningful models of micro-forest restoration in eastern India.

The orchard thus embodies many functional characteristics of a Miyawaki forest: native species selection, organic soil health, biodiversity support, and minimal intervention. Unlike a strict Miyawaki plantation (which uses high-density, mixed native species), this orchard is composed of a single species with multiple genetically distinct traditional cultivars. Thus, the working hypothesis proposes that while the mango orchard may not fully conform to the classic Miyawaki methodology, it may represent a unique, cultivar-based variant of a Miyawaki-like model, one where intraspecific diversity and ecological

succession together promote forest-like dynamics. However, it lacks the species stratification typical of a mixed-species Miyawaki system, as it is dominated by Mangifera indica.

*Ex Situ Conservation and Genetic Heritage*

The Mango Field Gene Bank contributes significantly to ex situ conservation of traditional cultivars, maintaining living collections ensures long-term availability of genetic resources for crop improvement, climate adaptation, and research (De, 2022).

This initiative also safeguards local cultural heritage, many traditional mango names and stories are tied to community identity in Bengal. The gene bank preserves not only biological diversity but also the ethnobotanical knowledge associated with these varieties. Students and researchers can observe flowering, fruiting, and pest resistance patterns, contributing to future conservation and breeding programs (De *et al*., 2019).

*Ecological and Educational Significance*

The mango orchard, now resembling a mini forest, performs essential ecosystem services within an urban academic landscape:

- **Carbon sequestration and temperature moderation.**
- **Soil stabilization** through organic litter and microbial activity.
- **Biodiversity support**, offering habitat for birds, pollinators, and small fauna.
- **Environmental education**, providing experiential learning opportunities for botany and environmental science students.

As noted by several researchers that green spaces within academic campuses serve as vital models for integrating conservation, sustainability, and pedagogy (Liu et. al., 2021; Edeigba *et al*., 2024; (Marium, 2025). The Gurudas College orchard thus serves dual functions, as a Field gene bank and as an urban ecological microhabitat.

*Challenges and Future Directions*

To strengthen alignment with the Miyawaki framework, the following strategies may be implemented:

1. **Introducing understory and shrub layers** with native flora (e.g., Clerodendrum, Justicia, Crotalaria).
2. **Creating biodiversity monitoring protocols** to assess faunal diversity and soil quality.
3. **Integrating rainwater harvesting and compost systems** to enhance sustainability.
4. **Community outreach** for awareness on traditional mango conservation and propagation.

Such actions would transform the orchard into a hybrid conservation forest, advancing both germplasm preservation and urban rewilding goals.

## Conclusion

The Mango Field Gene Bank at Gurudas College exemplifies how a small-scale academic initiative can merge scientific conservation and ecological restoration. By preserving traditional mango varieties from Malda and Murshidabad, it safeguards a genetic and cultural legacy under threat. Structurally and functionally, the orchard aligns with key elements of the Miyawaki model, native species selection, dense plantation, and self-sustaining growth, though with a single-species focus.

This living laboratory stands as a model for integrating ex situ conservation with the Miyawaki philosophy, offering a replicable framework for educational institutions seeking to promote biodiversity, sustainability, and heritage conservation within urban spaces.

## Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this work.

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