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Effective Approach in Urban Forest Growth: A Study on the Miyawaki Method in Gundagarthi Village, Kalaburgi District, Karnataka, India

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Abstract
Forests are dynamic ecosystems essential for maintaining biodiversity, regulating climate, and sustaining life on Earth. In response to increasing deforestation and urbanization, various afforestation techniques have been adopted among them, the Miyawaki method stands out as a promising alternative. Miyawaki forests are known to grow 10 times faster, become 30 times denser, and support significantly greater biodiversity than conventional plantations, often becoming self-sustaining within 3 to 5 years. This study aims to evaluate the growth performance of plant species and assess the environmental impact of Miyawaki afforestation on local ecological parameters. An experimental Miyawaki forest using 50 native species was established in Gundgarthi village, Kalaburgi district, Karnataka, India, covering an area of 1,208 sq. meters. Methodology includes soil preparation, Selection of native species, Procurement of sampling, designing the forest, plantation as designed, organic mulching and regular watering were done to support early-stage growth. Initial results indicate significant plant growth, ranging from 1 to over 3 meters within a short period, with species-specific variations. The emergence of a self-sustaining ecosystem was also observed, demonstrating the potential of the Miyawaki method in restoring biodiversity, enhancing soil fertility, and contributing to climate change mitigation through temperature reduction.

Keywords: Miyawaki forest; Urbanization; Afforestation; Carbon sequestration; Gundagarthi

Introduction

Forests are vital, living ecosystems that support biodiversity, regulate climate, and sustain life on Earth. India's diverse landscape ranging from the dense vegetation of the Western Ghats to the arid Thar Desert, from coastal mangroves to the Himalayan ranges - reflects an extraordinary richness in biodiversity and ecological wealth. This geographical variety makes India a key player in global environmental conservation efforts. In recent decades, the growing threat of climate change has become a pressing global concern. Among its primary drivers is deforestation. Since 1990, the world has lost more than 178 million hectares of forest due to urbanization, agriculture, and other human activities. Alarmingly, in 2023 alone, 6.37 million hectares of forest were lost 45% higher than the target limit set by over 140 countries committed to ending deforestation by 2030. India, too, has faced significant losses, with 2.33 million hectares of tree cover disappearing since 2000. As part of its commitment to the United Nations' Sustainable Development Goals (SDGs), India has pledged to create an additional carbon sink of 2.5 to 3.0 billion tonnes of CO_2 equivalent through increased forest and tree cover by 2030, under the Paris Climate Agreement of 2015. To achieve this, various afforestation techniques have been employed, including natural regeneration, commercial plantations, agroforestry, and the Miyawaki method. However, conventional forest development is a slow process often taking decades or even centuries to reach maturity and ecological stability. In contrast, the urgency of urban environmental restoration calls for faster, scalable solutions.

Miyawaki method

The Miyawaki Method was conceptualized by Dr. Akira Miyawaki, a renowned Japanese botanist and vegetation ecologist. This method is rooted in the concept of Potential Natural Vegetation (PNV) a framework introduced by German vegetation ecologist Reinhold Tuexen in 1956 to better understand natural ecosystems. This technique promotes the rapid growth of dense, native forests in small urban and degraded areas. Initially applied across hundreds of sites in Japan, the method has since demonstrated significant success in other Asian countries such as

Thailand, Malaysia, and India. Unlike natural regeneration, which may take decades to achieve self-sustainability, Miyawaki forests can become self-sustaining in as little as 3 to 5 years. They grow 10 times faster, are 30 times denser, and support far greater biodiversity than traditional plantations. Given the increasing pace of urbanization and environmental degradation, the Miyawaki method stands out as an effective, adaptable, and time-efficient solution particularly in urban and semi-urban settings where land is limited but the need for green cover is critical.
The Miyawaki approach involves the dense planting of a variety of native tree species, those that would naturally exist in the area under undisturbed conditions based on the PNV model. The goal is to recreate a self-sustaining, biodiverse forest in a short span of time. Unlike non-native species, which often require more care, maintenance, and specific environmental conditions to thrive, native species are well-adapted to the local climate and soil. As a result, they grow faster, require fewer resources, and offer greater ecological benefits.

Dr.Miyawaki's first large-scale application of this afforestation technique was initiated in 1971 at the Oita Works of Nippon Steel Corporation, Japan, under the project titled *"Native Forest by Native Trees."* Since its inception, the method has been successfully implemented across several countries, including India, where it is progressively gaining wider acceptance. In recent years, various Indian start-ups and organizations such as Digital Green, Waste Ventures, Banyan Nation, and Say Trees have actively contributed to promoting and scaling the Miyawaki method, with the objective of enhancing its accessibility and affordability for individuals, communities, and institutions engaged in ecological restoration.

In this context, the present study was undertaken with the following objectives: (i) to evaluate the growth performance of plant species established using the Miyawaki method in Kalaburagi District; (ii) to analyse the environmental impacts of Miyawaki forests on local ecological parameters, including biodiversity, soil quality, and microclimatic conditions; and (iii) to identify and examine the key factors influencing the growth and survival of plant species within Miyawaki forest ecosystems.

The Miyawaki method of afforestation represents a sustainable and efficient approach for the development of dense, rapidly growing native forests, suitable for both urban and rural contexts, ranging from small land parcels to extensive landscapes. The present study further examines the ecological and environmental benefits associated with the implementation of the Miyawaki method in the Kalaburagi district. The scope of the study encompasses several key aspects, including the establishment of forests that are significantly denser up to 30 times than conventional plantations, and the promotion of biodiversity through the incorporation of 50 to 100 native species within a single site. Additionally, the study evaluates the method's contribution to climate change mitigation, particularly through the reduction of ambient temperatures and the improvement of air quality. The Miyawaki forests are also recognized for their capacity to substantially reduce noise and dust pollution, with effectiveness reported to be up to 30 times greater than that of traditional plantation approaches. Furthermore, the method enhances carbon sequestration potential, with carbon dioxide absorption rates considerably higher than those observed in monoculture plantations.

The research also considers the rapid growth characteristics of vegetation established through this method, typically exhibiting a minimum annual growth rate of approximately one meter. Over time, these plantations develop into self-sustaining ecosystems that require minimal or no maintenance beyond the initial three-year establishment period. In addition, the method contributes to the improvement of soil fertility and functions as a natural protective barrier against environmental disturbances. Ultimately, the creation of chemical-free, native forests supports local faunal diversity, including insects, birds, and small animal species, thereby strengthening overall ecosystem resilience.

Materials and Methods

Study area

Gundagarthi village is located in the Chittapur taluk of Kalaburagi district, Karnataka, within the Deccan Plateau region. The village lies approximately between 17.2°–17.3° N latitude and 76.8°–76.9° E longitude, near Kalaburagi city. It is characterized by a semi-arid climate, black cotton soils, and predominantly agricultural land use, making it suitable for rural and environmental studies.

Methodology

1. Begin with the soil. Soil preparation plays important role for the success of Miyawaki forest growth, initial analysis of soil parameters like pH, carbon nitrogen like components are essential in order to add the manure and top soil etc.
2. Selection of native species, Determine which species should grow in this soil based on the climate,
3. Procurement of sampling.
4. Design the forest- Plant saplings that are up to 80 cm high, 3 to 5 saplings per square meter, once the soil has been modified to a depth of one meter.
5. Plantation process as per design, supporting plant for initial period watering patterns

6. Protection of the plants are needed, Borders needs to fenced to avoid any intruders (like cow, dog, bull and humans), The first few months require extra care as the trees are small for the first two or three years, the forest has to be watered and weeded, after which it becomes self-sustaining.

Soil analysis and its preparation

Divide the field into different homogenous units based on the visual observation; Remove the surface litter at the sampling spot. Drive soil sample. Collect at least 10 to 15 samples from each sampling unit and place in a bucket or tray. Make a 'V' shaped cut to a depth of 15 cm in the sampling spot using spade. Remove thick slices of soil from top to bottom of exposed face of the 'V' shaped cut and place in a clean container. Sampling at several locations in a zig-zag pattern ensures homogeneity. Mix the soil before sending for the analysis. Soil analysis will provide the information on various parameters like pH, carbon, potassium and nitrogen status which will help us to optimize before sampling, Soil preparation consists of loosening the soil with 1 meter depth digging and addition of components fill it in the hole of one meter through JCB and then the space is ground leveled, by adding the top soil. Soil texture helps determine water conserving capacity, water infiltration, root perforation capacity, nutrient retention and edibility.

- **Perforator**: Perforator substances aid in the improvement of perforation and the rapid development of roots. We can do this by using spongy and dry biomass found in nature. Husk is a by-product that can be used in grain mills and animal feed stores. Rice husk, coir, wheat husk, corn husk, or groundnut shells are some other options.

- **Water retainer:** Comparing to the herbal water retention ability, water retainer helps soil to maintain extra moisture and water. Coco-peat or dry sugarcane stalk may be used as natural materials.

- **Manure:** For nourishment, organic fertilizer is needed. Depending on the environment and availability, different products may be used, such as cow manure, goat manure, or vermicompost. Manure is a nutrient-releasing plant fertilizer that releases nutrients gradually.

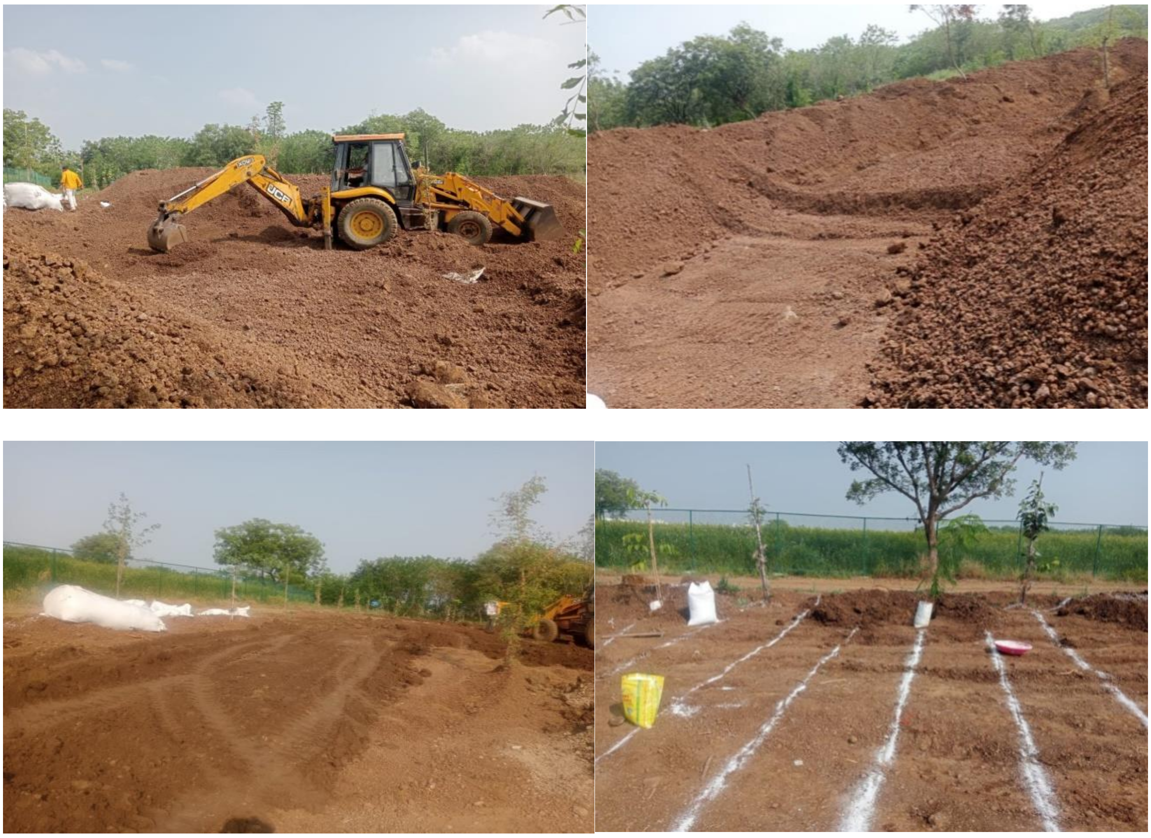

Fig. 1. Land preparation methods

Selection of Native Species

The success of the Miyawaki forest method largely depends on the careful selection of native plant species, as this influences growth rates and adaptability. This step involves creating a comprehensive database of local floral diversity by conducting a quadrant survey in a native forest located within the same agro-climatic zone as the intended Miyawaki forest site. This survey helps identify the Potential Natural Vegetation (PNV). Additionally, secondary resources such as published flora records (e.g., Botanical Survey of India) and forest department guidelines for the zone should be consulted. The native species database must encompass a wide variety of plants, including large and small trees, shrubs, and herbs, ensuring a well-balanced forest composition. The species distribution should include flowering, medicinal, fruit-bearing, and timber plants. Ideally, the top five most dominant species identified through the quadrant survey should make up about 50% of the forest, while the next most abundant native species should constitute 25-40%.

Procurement of Saplings

The preferred method for preparing saplings involves collecting seeds from native plants, germinating them in seedbeds, and then transplanting them into pots once they develop two to three leaves. Alternatively, saplings can be sourced directly from nurseries. It is essential to select nurseries known for providing high-quality saplings of the desired species, ensuring no adulteration occurs. Trusted sources include reputable private nurseries and forest department nurseries. Saplings should ideally be between 60-80 cm in height for optimal transplantation success.

Designing the Forest

The planting area should be demarcated into 1-square-meter grids. Within each grid, plants should be arranged on small mounds to create a dense, multi-layered forest structure comprising shrubs, sub-trees, trees, and canopy species. Each square meter should contain 3 to 5 plants of different species and layers, avoiding clustering of the same species or following predictable patterns. Maintain at least a 60-centimetre gap between saplings to promote healthy growth. The objective is to achieve a random, dense plantation of native species. Proper planning for water supply and storage—such as pipelines, overhead sprinklers, tanks, or borewells—should be established before transplantation to ensure adequate irrigation during the critical initial period.

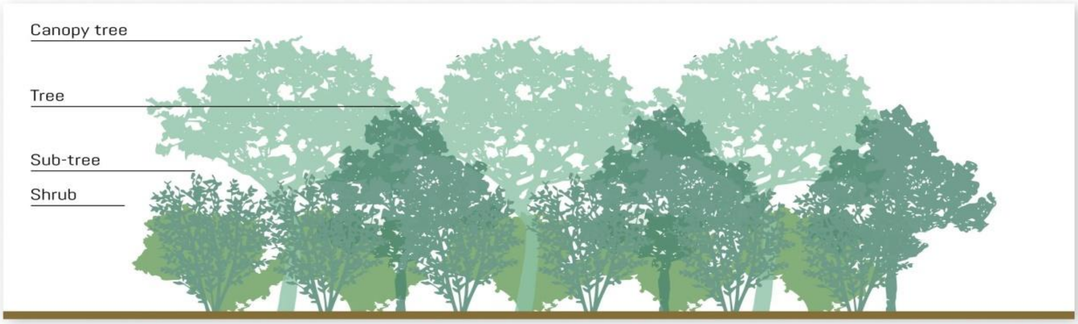

Fig-2: multi layered forest(courtesy: Google images)

Plantation Process

This step is critical to the successful establishment of the Miyawaki forest. Saplings should be planted randomly in a layered manner, mixing different species and plant types.

- In the marked planting area, dig pits approximately 12" x 12" spaced 2-3 feet apart, arranged in a triangular pattern.
- Place the saplings into these pits according to the forest design plan.
- Support each sapling with a 4-5 feet bamboo stake tied loosely to prevent damage.
- Apply mulching immediately after planting to retain moisture.
- Water the saplings thoroughly for at least one hour post-plantation to help settle the soil and mulch.
- Aim for a tree density of around 3 trees per square meter, with 3-5 trees planted per square meter.

Maintenance and Weeding

Post-plantation maintenance is crucial and requires consistent care for 2-3 years. This includes:

- Regular watering and ensuring sufficient water storage, especially during the summer months.
- Periodic removal of weeds to prevent competition for nutrients.
- Monitoring plant health by assessing leaf budding, branching, and overall growth.
- Maintenance typically requires one to two dedicated personnel (gardeners) for effective management.

Materials

The study was conducted in Gundgarthi village, located in the Kalaburgi district of Karnataka. An experimental approach was employed, utilizing over 50 local plant species such as..

Plant types based on height	Noof species	Types based on usefulness	No of species
trees	36	Medicinal	19
shrubs	14	Fruiting	11
		Flowering	12
		Timber/leaves	08
Total	50	Total	50

- Saplings were collected from various plant nurseries and the forest department, then planted in Gundgarthi village where the study was conducted. The total plantation area covers 1,208 square meters, located at Lumbini Park, Gundgarthi.
- Soil analysis was carried out to assess the soil's nature and composition, which guided site preparation. Coir and coco peat were used as perforators and water-retaining materials to enhance moisture retention. Mulching was done using sugarcane leaves and residuals from toor dal plants.
- For irrigation, a combination of sprinkler systems and manual watering was employed to ensure continuous water supply. The height and circumference (girth) of the plants were measured monthly, and the data were recorded systematically in tabular form.

Results and Discussion

Plant Growth Performance

The growth performance of the planted species was assessed through periodic measurements of plant height and girth. Within one year of plantation, all categories of vegetation exhibited substantial growth. Large tree species attained heights ranging from 3.0 m to over 4.0 m, while small tree species reached between 1.5 m and 4.0 m. Shrub species recorded comparatively lower but significant growth, ranging from 0.8 m to 2.5 m. The observed growth rates exceed the standard expectations of the Miyawaki method, which typically ensures a minimum growth of approximately 1 m per year. The enhanced growth in the present study can be attributed to high-density planting, species diversity, effective soil conditioning using organic amendments (coir and coco peat), mulching practices, and consistent irrigation. These findings indicate that the adopted management practices were highly suitable for promoting rapid vegetation establishment under the semi-arid conditions of the study area.

Microclimatic Variation

Microclimatic parameters, including temperature and relative humidity, were monitored both inside and outside the plantation site. A consistent reduction in temperature was observed within the Miyawaki forest, with values ranging from 2°C to 4°C lower than the surrounding open areas. In contrast, relative humidity levels were found to be comparatively higher within the plantation. The reduction in temperature can be attributed to increased canopy cover, which reduces solar radiation penetration and enhances shading. Additionally, higher transpiration rates from dense vegetation contribute to evaporative cooling. The increased humidity within the plantation is likely due to reduced evapotranspiration losses and improved moisture retention facilitated by mulching and soil amendments. These results demonstrate the ability of dense afforestation to create a localized microclimate that is more favorable for plant growth and ecological stability.

Soil Fertility Status

Soil analysis conducted before plantation (November 2025) and after one year (February 2026) revealed marked improvements in soil physicochemical properties. Organic carbon content increased by 0.08%, indicating enhanced organic matter accumulation. Available nitrogen, phosphorus, and potassium showed significant increases of 15.1%, 121.7%, and 14.4%, respectively. Additionally, changes in soil pH and electrical conductivity suggest an overall improvement in soil condition. These improvements can be attributed to continuous organic matter input through mulching and litter deposition, which enhances microbial activity and nutrient cycling. The use of coir and coco peat likely improved soil structure and water-holding capacity, further supporting nutrient availability and plant uptake. The substantial increase in phosphorus may be linked to mineralization processes and improved microbial interactions in the rhizosphere.

Conclusion

The results of the present study highlight the effectiveness of the Miyawaki method in promoting rapid plant growth, improving soil fertility, and modifying microclimatic conditions within a short period. The growth rates recorded (1–4 m within one year) surpass the typical benchmarks reported in earlier Miyawaki studies, indicating that localized adaptations and management interventions can significantly enhance outcomes. The observed reduction in temperature and increase in humidity further demonstrate the ecological benefits of dense plantation systems in mitigating heat stress and improving environmental conditions. Simultaneously, the improvement in soil nutrient status confirms the role of such plantations in restoring degraded soils and enhancing long-term ecosystem productivity. Overall, the findings suggest that the Miyawaki approach is highly effective for ecological restoration in semi-arid regions and can serve as a sustainable model for afforestation, climate regulation, and soil rehabilitation.

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