

The Miyawaki technique: Afforestation solution for mitigating Urban Heat Island effects by increasing native Green cover

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Abstract

In recent times, speedy growth in urbanization has been the significant anthropogenic activity across the globe leading to climatic changes. Urban Heat Island (UHI) is being experienced in developing cities due to loss in green cover and increased concretization. It is predicted that with high rise-high density development, the magnitude of Urban Heat Island will further intensify. The Miyawaki technique of afforestation is coming up as a new method in improving the green cover, especially in urban context. It is an afforestation method first developed by a plant ecology expert from Japan, Dr. Akira Miyawaki, which results in forests that have better carbon-dioxide absorption ability, higher reduction of dust and noise, denser green cover in much lesser time and area as compared to monoculture (traditional) plantations. The aim of this paper is to study the Miyawaki technique, its potentiality and usefulness in increasing the native green cover in urban context. The objective of this research is to promote conscious urban growth with the focus being on growing sufficient urban green cover to curb the ill effects of urbanization on environment.

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I. INTRODUCTION

Today, the world is experiencing urbanization at a pace like never before. It is predicted that almost two third of the world's population will be settled in urban region by the year 2025 (Schell and Ulijaszek,1999). Today, the population of Indians living in urban India is highest ever, thus making India to be the second highest urban populated country in the world. India's urban population was 286 million as reported in the 2001 Census which grew to an estimated 377 million in 2011. As per estimates, 14% of the world's urban population will

be residing in India by 2025. (McKinsey & Company [2010](#)).

For a nation's progress, urbanization has become an inevitable yet favoured phenomenon. On the other hand, upsurge of urban population has severely threatened the green cover in urban India. Cities of India- Mumbai and Chennai have a meager 0.12 sq.m. (Srivathsan 2013) and 0.46 sq.m. (FAO 1998) of green space per capita, respectively, Whereas, as per the UN standards, recommended value is 9 sq.m. of green space per capita. The reduction in spaces such as residential gardens further increases the degradation of environment. During the decade

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2000-2010, significant reduction in the areas covered with residential gardens have been visible in Kozhikode, Kerala. This observed modification in life style in exchange of green space explains the negligence towards green cover in urban scenario.

Green cover is an important aspect of urban landscape, lending the urban areas and its people the many benefits which are both tangible and intangible in nature. Ironically, regardless of realizing this, vegetation in urban regions is undergoing severe destruction and degradation due to fast and haphazard urbanization in developing countries. This is ensuing in city settlements being foremost contributors of greenhouse gas emissions and in turn making them more prone to the ill effects of climate change worldwide. As per a report of 2014 by Indian Institute of Science(IISc), Bangalore, the recommended tree-human ratio should be seven trees for every person. Environmentalists have raised their concern at the alarming tree-human ratio in the Indian cities- Gandhinagar in Gujarat has four trees per person, Hyderabad has four trees per person, Nashik in Maharashtra has two trees per person, Delhi has one tree for every 3 person, Bengaluru has one tree for every 7 persons, Mumbai has one tree for every 4 persons.

II. AIM OF THE STUDY

To study the Miyawaki method of plantation for increasing the urban green cover, its potentiality and usefulness in mitigating Urban Heat Island effects.

III. OBJECTIVES OF THE STUDY

- To study the urbanization trends in recent times and its impact on urban green cover.
- To understand Urban Heat Island and its relation to Urban Green cover.
- To study the Miyawaki afforestation method and its usefulness in mitigating Urban Heat Island effects.

IV. URBAN HEAT ISLAND AND ITS RELATION TO URBAN GREEN COVER

In cities, due to concretization, the natural land cover is replaced by thick concentrations of constructions such as pavements, buildings and other elements and surfaces that causes absorption and retention of heat within. This gives rise to Urban Heat Islands (UHIs).The outcomes of this is an increase in energy consumption (e.g. for air conditioning).It also increases air pollution levels. Health damages include heat-related illness, mortality, etc.

Urban expansion due to population outburst and the consequent increase in anthropogenic emissions, decreased potential for evaporative cooling cause an increase in net heat stored in urban areas and result in Urban Heat Islands.

A drastic modification in land-use land-cover by turning natural green spaces into impermeable concrete and paved surfaces continue to occur due to urbanization today. The widely experienced increase in urban temperature is the very outcome of Urban Heat Islands developed across globe.

As compared to temperature in rural areas, the urban temperatures are usually 1-2°C higher. Green cover reduce the Urban Heat Island effect by providing shade and deflecting the sun's radiations. Roots of trees absorb water from the soil. This absorbed water is released into the atmosphere in the form of water vapour through aerial parts of plants such as leaves, stems, flowers. This process which is known as transpiration, leads to cooling of air in the surrounding. Almost 97-99.5% of absorbed water is given out through transpiration by plants. Thus, green cover cools the surrounding. This cooling effect can extend beyond the green space into its surrounding urban areas.

V. MIYAWAKI METHOD FOR URBAN GREENERY

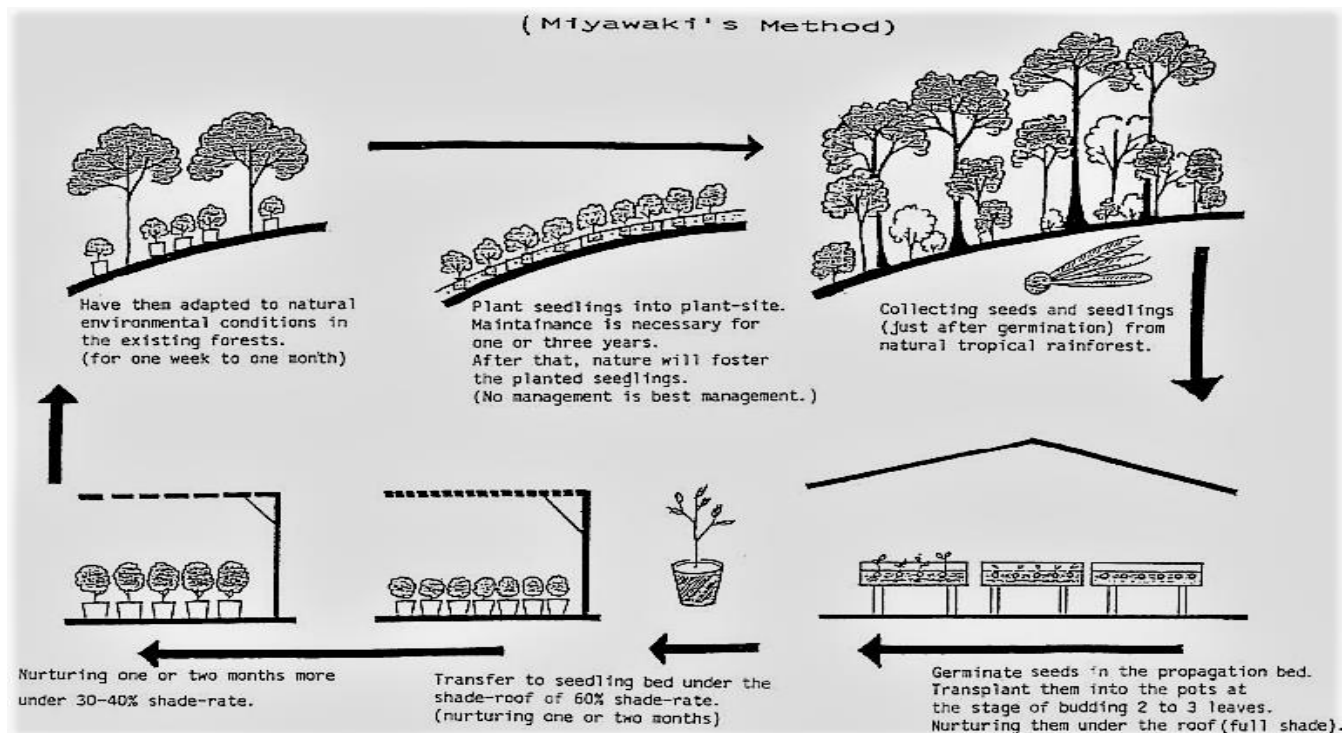


Figure 1. The figure demonstrates the steps to be performed from the collection of propagules through their handling in the nursery until the young plants can be put into their later habitat. This procedure is described as "Miyawaki's method"

Source: Lieth, H. & Lohmann, M. (eds) 1993, "Restoration of Tropical Forest Ecosystems," Proceedings of the Symposium held on October 7-10, 1991, Kluwer Academic Publishers, Dordrecht, The Netherlands.

VI. CASE STUDIES REPORTS

A case study from Yadadri district, Telangana:

Telangana State has come up with a flagship programme under the name, 'TelanganakuHaritha haram' programme. Its objective is to create awareness among people to plant and take care of the saplings planted under this initiative. They aim to create a dense forest instead of mere plantation.

As a part of their first venture, Telangana state forest officials have created a Miyawaki forest in Yadadri district of Telangana between the year 2018-19. The plot which measured one acre had less than 0.1 green cover initially. Applying the Miyawaki method and utilizing local practices and materials, a

dense multi-layered forest was developed cost-effectively. Today, the plot houses 4,000 plants. Named as Yadadri Natural Model Forest (YNF), this forest consists of plants such as Maddi, Maredu, Seethaphal, Red Sandal, NereduRela, Rose Wood, Bamboo, Neem, Narepa, Jeedi, Ippa, and more. A high density plantation was developed using Miyawaki technique in small areas of land using diverse local species of plants. The project cost was around 2 lakh per acre.



Figure 2 Yadadri Model Natural Forest using Miyawaki method



Figure 3 Soil layer and its Composition



Figure 4 Fruiting at Yadadri Forest using Miyawaki method



Figure 5 Fruiting at Yadadri Forest using Miyawaki method



Figure 6 Yadadri Forest green cover growth using Miyawaki method

Sources: <https://www.examrace.com/Current-Affairs/NEWS-Yojana-December-2019-Urbanisation-Developing-Natural-Forest-Cover.htm>

<https://newsmeter.in/a-man-made-forest-grown-in-yadadri-of-telangana-miyawaki-technique-applied/>

VII. OUTCOMES OF THE MODEL

(The outcomes were noted after observing records and results of an year old plantation.)

- A drop in temperature(2°C-4°C) across the plantation area compared to the surrounding temperature of the region since these plantations act as good carbon sinks, thereby reduce temperature.
- The plantation grew high in density in small piece of land accommodating the region's native species.
- The biodiversity was higher in this Miyawaki plantation compared to a traditional plantation in a unit area.
- Fruiting had started in just 1 year after the plantation.
- It housed various wildlife like birds,squirrels,reptiles,butterflies,etc. within one year.
- The plantation was in multi-layer as per the Miyawaki method which gave it natural look of forests.
- More carbon sequestration observed per unit area than before.
- The plantation would be self-sustainable forest after next 2 years.

A case study of Aurangabad division, Maharashtra:

Aurangabad Division (also called as Marathwada Region) covers an area of about 65000 sq km. The geography of Aurangabad is highly deficient of green cover, failing to reach the global/national Green Cover standards.

Table 1. Global standards for Green Cover

Sr. No	Source	Standard
1	World Health Organisation	Each person should be made available an access to green open space within a walking distance of quarterly hour (15 minutes).
2	National Forest Policy	33% of geographical land in a country should consist of forests and green cover, as emphasized and aimed by the National Forest Policy.
3	Urban Development Plans Formulation and Implementation (UDPFI)	<p>% of land to be allotted for recreational areas out of total developed area are as follows-</p> <p>For Metropolitan cities(million plus population) - 20-25%</p> <p>For medium towns/large cities- 18-20%</p> <p>For small towns- 12-14%</p> <p>(As per Master Plan of Indian cities, areas that contain parks, botanical gardens, playgrounds, open spaces, etc. are considered</p>

		under land for recreational usage/open spaces)
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Source:<https://grindmaster.co.in/wp-content/uploads/2019/11/GAM-Report.pdf>

Marathwada holds roughly 6% of forest area, while the remaining 94% of the land area is devoid of green cover. For a region that is already dry and has high risk of droughts owing to dry climatic conditions, a step towards increasing the green cover on fallow urban land can aid in combating various problems like temperature control by mitigating Urban Heat Island effects, apart from combating other environmental problems like air quality, water retention, etc. However, care need to be taken in retaining the original local ecology. After many consultations with field experts, the officials undertook a greening approach using Miyawaki method under the ‘Green Aurangabad Mission’ which would retain the local grassland along with thorny scrub ecology that exists there while still tackling the modern time challenges and fulfilling the standards of green cover.

Table 2. Key Interventions undertaken under the Green Aurangabad Mission and the Rationale behind choosing them:

INITIATIVES	ADVANTAGES
A. <u>Miyawaki Native Dense Forest on Private land</u> 1.Satara, Aurangabad 2.Grind Master Machines Pvt. Ltd., Waluj 3.Can Pack India	An efficient way of utilizing the land and water resources of urban region through economical means Housing the native plant species and wildlife, thereby conserving biodiversity of the

Pvt. Ltd., Waluj	region.
4.MIT College, Aurangabad	30 times more dense plantation compared to monoculture plantation(traditional) and is 30 times more capable of carbon sequestration.
5.Sai Mandir, Aurangabad	
6.Astha Foundation Senior's Home, Jadgaon	
B. <u>Miyawaki Native Dense Forest on Government land</u>	Grows faster and shows fast results in decreased noise and dust pollution.
1.Public Health Centre, Verul	Has low maintenance cost as it grows out to be self-sustainable after 3 years, shows better sustainability
2.Office of Commissioner of Police, Aurangabad	
3. Aurangabad Green School Mission-100 forests	To be applied on barren/fallow urban land, or land which once had forest.

Source-<https://grindmaster.co.in/wp-content/uploads/2019/11/GAM-Report.pdf>

The following features proved Dense foresting using Miyawaki method an excellent option for increasing the green cover of urban regions of Marathwada:

- A drop in temperature (2°C-3°C) in the region with Miyawaki plantation.
- Helps in the percolation of ground water, thereby increasing ground water table.

- Gautala Wildlife Sanctuary and local publications act as a reference resource for forest species of the region.
- Minimal land is needed which results in efficient use of even small pieces of land having high value in urban region.(minimum land area needed is 100 sq.m.)
- Helps in retaining the local biodiversity as it includes a mix of atleast 50-100 different local species, resulting in an increased species diversity that is native to the region.
- All the required resources to grow the forest is readily available nearby site area as the method is adaptable in nature.To tackle the water scarce condition of Marathwada, this method of plantation proves suitable as it gets maintenance free after 3 years of planting.
- When compared with traditional plantation(monoculture),the Miyawaki Forest grow 30 times denser and 10 times faster, are multi fold more rich in biodiversity.
- In urban spaces which are mostly congested, they serve as a sound and dust barrier.
- They act as a natural sink for conserving water and the soil which otherwise would get eroded with the water run off.
- They act as micro-sanctuaries for birds and fauna surviving in urban region.
- They help in preserving the native flora and fauna, thereby easing harvest and storage of seeds having medicinal and other benefits in the area.
- Easy and low maintenance cost, less labour and water requirement per sapling.



Figure 7Miyawaki Forest at GM Waluj, Aurangabad



Figure 8. Miyawaki Forest at Verul Dense Forest, Aurangabad

VIII. CONCLUSION

- Due to urbanization, cities are turning into a concrete jungle. This in turn is resulting in decreased urban green cover and giving rise to Urban Heat islands.
- Urban areas have many small patches of vacant land but not big ones. Hence, there arises the need to create dense forests in such patches in order to restore the balance.
- Miyawaki method of afforestation holds great potential in fulfilling above said need.
- Suitable for any type of soil and climatic condition, Miyawaki method is the way forward in bringing about a big change in small area.

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