Original Article

Comparison of Plant Species in Miyawaki Forest Versus the Rest of Rawalpindi Medical University Campus: A Green Concrete Matrix Approach

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Abstract

Background: Sustainable campus planning is increasingly recognized as a critical strategy for mitigating environmental degradation, enhancing biodiversity, and promoting human well-being within academic institutions. Urban universities, particularly in low- and middle-income countries, face significant challenges in balancing infrastructural development with ecological sustainability. Rawalpindi Medical University (RMU) has initiated a Green Campus Project incorporating conventional green spaces and an innovative Miyawaki forest model.
Objective: To compare plant species diversity, distribution, and density between the Miyawaki forest and the remaining green areas of RMU as part of the university's green concrete matrix.
Methods: A descriptive cross-sectional ecological assessment was conducted using official RMU plantation records and field documentation. All plant species across the campus were identified and quantified. Green spaces were categorized into main campus areas and the Miyawaki forest. Descriptive statistical analysis was used to evaluate species composition and plant density.
Results: A total of 1,263 plants were documented across the RMU campus. Of these, 923 plants (73.1%) were distributed throughout the main campus green areas, while 340 plants (26.9%) were concentrated within the Miyawaki forest. The main campus demonstrated greater species variety, whereas the Miyawaki forest exhibited substantially higher tree density and dominance of native and fruit-bearing species. Several ecologically significant species were exclusively present in the Miyawaki forest, highlighting its role in enhancing biodiversity and ecological efficiency.
Conclusion: The integration of a Miyawaki forest within RMU significantly enhances tree density and ecological value despite limited land area. Combined with diverse conventional green spaces, RMU demonstrates a balanced and sustainable green concrete matrix. Expansion of dense plantation models and strategic green retrofitting may further strengthen environmental resilience and establish RMU as a model for sustainable medical university campuses.

Keywords: Green area, Plant species, Miyawaki forest,

Introduction

Accelerated urban growth and the physical expansion of academic institutions have contributed to extensive land sealing, declining biodiversity, and environmental deterioration, particularly across university campuses situated in urban settings[1]. Worldwide, higher education institutions are increasingly acknowledged as key agents of sustainable development and environmental responsibility owing to their educational, research, and societal mandates[2]. The incorporation of green infrastructure into campus planning is consistent with global sustainability agendas, notably the United Nations Sustainable Development Goals (SDGs), with particular relevance to SDG-11 (Sustainable Cities and Communities) and SDG-13 (Climate Action)[3],[4].Green spaces, especially tree-dominated landscapes, provide essential ecosystem services such as carbon sequestration, urban heat mitigation, air purification, and psychological restoration[5]–[7]. In contrast, excessive concrete coverage contributes to urban heat island effects, surface runoff, and reduced ecological resilience[8]. Consequently, modern campus planning emphasizes a balanced green–concrete matrix to optimize environmental performance while maintaining functional infrastructure[9].

The Miyawaki forest method, characterized by dense planting of native species to accelerate natural forest succession, has gained global attention as an effective strategy for rapid urban ecological restoration[10],[11]. Several studies have demonstrated that Miyawaki forests achieve higher biomass accumulation, species diversity, and carbon sequestration compared to conventional plantations[12].

Rawalpindi Medical University (RMU), Pakistan, has implemented a Green Campus Project aimed at sustainable land use and biodiversity enhancement. The present study compares plant species distribution between the Miyawaki forest and the rest of the RMU campus, providing quantitative evidence of species diversity, tree density, and ecological contribution within the university's green concrete matrix.

Materials & Methods

This descriptive, cross-sectional ecological assessment was conducted at Rawalpindi Medical University, Rawalpindi, Pakistan. The total campus area covers approximately 120 Kanal (60,703 m^2) and includes academic, residential, recreational, and landscaped green spaces.

Data Collection: Plant inventory data were obtained from official RMU Green Campus Project records and verified through field documentation. Each plant species was identified using standard botanical nomenclature, and the number of individual plants was recorded according to location.

Area Classification: Green spaces were categorized into: Main Campus Green Areas: Lawns, roadsides, hostels, parking zones, and landscaped areas excluding Miyawaki forest and Miyawaki Forest Area: A designated dense plantation zone established using the Miyawaki method.

Descriptive statistics were used to calculate frequencies and proportions of plant species in each category. Comparative analysis was performed to evaluate species diversity and tree density between Miyawaki forest and the rest of the campus. Findings were interpreted in the context of sustainable campus and urban forestry literature[13],[14].

RESULTS

Overall Plant Distribution: A total of 1,263 plants representing a wide range of species were documented across the RMU campus. Of these, 923 plants (73.1%) were located in the main campus green areas, while 340 plants (26.9%) were concentrated within the Miyawaki forest.

Species Composition in Main Campus: The main campus demonstrated substantial species diversity, with dominant species including Terminalia bellirica (101 plants), Ficus benjamina (106 plants), Chlorophytum comosum (151 plants), Bougainvillea (67 plants), and Platycladus orientalis (43 plants). The distribution reflected a mixture of ornamental, shade-providing, fruit-bearing, and native species.

Species Composition in Miyawaki Forest: The Miyawaki forest exhibited high tree density with 340 plants concentrated in a relatively small area. Dominant species included Alstonia scholaris (40 plants), Lagerstroemia indica (40 plants), Callistemon viminalis (35 plants), Polyalthia longifolia (30 plants), and Terminalia bellirica (30 plants). Fruit-bearing species such as Psidium guajava, Punica granatum, Persea americana, and Prunus armeniaca were also present.

Comparative Findings: While the main campus contributed greater overall species variety, the Miyawaki forest demonstrated significantly higher plant density and tree dominance. Several species, including Cedrus deodara, Ficus carica, Persea americana, and Prunus armeniaca, were exclusively found in the Miyawaki forest. The green area of the RMU is covered with different plant species. A total of 1263 plants are planted in different green areas of the campus the details of plants species along with their location is given in Table 1.

Table. 1 List of Plant Species in Rawalpindi Medical University

S.No	Location		
1.	**Main Lawn-1**		
	Scientific Name	**Common Name**	**Number of Plants**
	Bischofia javanica	IRUM/ Underikhni	4
	Bombax ceiba	Cotton Tree/ Sumbul	1
	Livistona rotundifolia	Table Palm	12
	Ficus benjamina	Fiscus	25
	Chlorophytum comosum	Spider Plant	50
	Schefflera Arboricola	Dwarf Umbrella Tree/Shelfera	10
	Sub Total		**102**
2.	**Main Lawn-2**		

Table. 1 List of Plant Species in Rawalpindi Medical University

	Bischofia javanica	IRUM/ Underikhni	1
	Livistona rotundifolia	Table Palm	14
	Ficus benjamina	Fiscus	15
	Chlorophytum comosum	Spider Plant	100
	Schefflera Arboricola	Dwarf Umbrella Tree/Shelfera	10
	Sub Total		**140**
3.	**Front of Exam Reception Lawn-3**		
	Hyophorbe lagenicaulis.	Bottle palm, Palmiste gargoulette	3
	Chlorophytum comosum	Spider Plant	1
	Ficus benjamina	Fiscus	18
	Sub Total		**22**
4.	**Ground**		
	Alstonia scholaris	Devil tree	25
	Carrisa caranda	Casia Kalaka, Karonda	34
	Lagerstroemia speciosa	Legistonia	35
	Cassia fistula	Amaltas	18
	Bauhinia variegata	Kachenar	9
	Terminalia bellirica	Bahera, Terminalia, Haritaki, Jangli Badam	32
	Eucalyptus camaldulensis	Safaida	4
	Melia azedarach.	Daraik	1
	Morus alba	Shatoot	3
	Tecoma stans	Yellow bells, Yellow elder, or Yellow trumpetbush.	5
	Lagerstroemia speciosa	Legistonia	3
	Jacaranda mimosifolia	Jacaranda, fern tree	2
	bougainvillea	Paperflower	17
	Pongamia pinnata, Millettia pinnata,	Sukh chain, Indian Beech or Pongam, Karanj	3
	Sub Total		**191**
5.	**Basket Ball Court**		
	Pongamia pinnata, Millettia pinnata,	Sukh chain, Indian Beech or Pongam, Karanj	11
	Terminalia bellirica	Bahera, Terminalia, Haritaki, Jangli Badam	11
	Sub Total		**22**
6.	**Hostel**		
	Gatropha	Nut, Ratanjot.	10
	Amaranthus, Lantana camara.	Lal taini, Lantana	3
	Platycladus orientalis	Morpang	13
	Ficus elastica	Rubber plant	3
	Mangifera indica	Mango	2
	Combretum indicum	Jhumka Bail	10
	Bougainvillea	paperflower	5
	Yucca	Adam's needle, Spanish bayonet, and Silk plant.	5
	Sub Total		**51**
7.	**Qari Sahib House**		
	Eriobotrya japonica	Lokat	3
	Pinus roxburghii	Chir pine. Cheer	3
	Sub Total		06
	Masjid Back		
	Cassia fistula	Amaltas	3
	Pinus roxburghii	Chir pine, Himalayan longleaf pine, Chir pine. Cheer	3
	Sub Total		06
8.	**Parking Area Back side**		
	Junglitoot	Broussonetia papyrifera.	2
	Jaman	Syzygium cumini	1

Table. 1 List of Plant Species in Rawalpindi Medical University

	Pelkan	Ficus virens, white Fig	12
	Sub Total		**15**
10	**Infront of LTC & Research lab Lawn**		
	Pelecanus.	Palkan	27
	Hyophorbe lagenicaulis	bottle palm	12
	Sub Total		39
11	Cafeteria front Lawn		
	Dherak Bakain	China berry	12
	Alstonia scholaris	Devil Tree	17
	Wheeping Fig	Ficus Benjamina	5
	Marwa	Origanum majorana	2
	Carrisa caranda	Carrisa caranda	12
	Lagerstounia	Crape myrtle, Crepe Flower"	29
	Sub Total		**77**
12	**Parking Area**		
	Alstonia scholaris	Devil Tree	7
	Terminalia bellirica	Bahera, Terminalia, Haritaki, Jangli Badam	29
	Sub Total		**36**
13	**Cemented Area Student Affair**		
	Terminalia bellirica	Bahera, Terminalia, Haritaki, Jangli Badam	29
	Callistemon viminalis	Bottle brush	1
	Jacaranda mimosifolia	Gakranda	12
	Grevillea robusta	Silver Oak	1
	Sub Total		**43**
14	Cafeteria (Back side)		
	Ficus benghalensis	Burgad	2
	Jacaranda mimosifolia	Jackranda	15
	Jacaranda mimosifolia	Tokoma, Fern, Neeli gul mohur	1
	Casia Nadasa	Pink folwer tree, Amaltas type	2
	Bougainvillea	Bo-gan bail, Paper plant	18
	Ficus benjamina	Ficus	18
	Sub Total		**56**
15	**Cafeteria front Stairs**		
	Bougainvillea	Bo-gan bail, Paper plant	15
	Plumeria	Gul e Chain	5
	Platycladus orientalis,	Morepankh	30
	Irisene herbsti	Kari pata	1
	Lagerstroemia speciosa	Tulsi	1
	Hibiscus rosa-sinensis	Biscus, china rose, Gurhal (گڑھل)	6
	Marwa	Origanum majorana	3
	Cassia fistula	Amaltas	4
	Sub Total		**65**
16	**R&D Stair side**		
	Ficus benjamina	Ficus	30
	Hyophorbe lagenicaulis	Bottle palm	10
	Bougainvillea	Bo-gan bail, paper plant	12
	Sub Total		**52**
17	**Miyawaki Forest**		
	Lagerstroemia indica	Lag Estonia, Gul-dasta,	40
	Alstonia scholaris	Devil tree	40
	Callistemon viminalis	Bottle Brush	35
	Polyalthia longifolia	Ulta ashok	30
	Terminalia bellirica	Bahera, Terminalia, Haritaki, Jangli Badam	30
	Luffa cylindrica	Kasia Galaka, Galka, Sponge Gourd,	20
	Prunus armeniaca	Apricot, Khubani	20

Table. 1 List of Plant Species in Rawalpindi Medical University

Persea americana	Avocado, Makhanphal (or Butter Fruit)	15
Cassia nodosa	Pink Shower Tree, Apple Blossom Tree	11
Jacaranda mimosifolia	Jacaranda, Fern tree	10
Cedrus deodara	Popular, Amla	10
Bougainvillea	Bo-gan bail, paper plant	10
Punica granatum	Anar	10
Kino citrus (Citrus reticulata)	Kinnow	10
Psidium guajava	Guava, Amrood	8
Ficus benjamina	Ficus	12
Ficus carica	Fig, Anjeer	6
Syzygium cumini	Jamun	8
Eriobotrya japonica	Loquat	5
Tecoma stans	Tecoma, Yellow Bells	5
Pongamia pinnata, Millettia pinnata,	Sukh chain, Indian Beech or Pongam, Karanj	5
Sub Total		**340**
Total number of plants		**1263**

Comparative Analysis of Plants Species in Miyawaki Forest Rawalpindi Medical University

The comparative analysis of plant species planted in whole campus of RMU and Miyawaki forest showed that there are 923 plants in the whole campus excluding Miyawaki forest and 340 plants are planted in the Miyawaki forest. The detail of the plant species and their frequency is listed below in Table 2

Table 2: Distribution of Plants Species in Miyawaki Forest and Rawalpindi Medical University.

S. No	Scientific Name	Common Name	Number of Plants	
			Main Campus	Miyawaki Forest
1.	Alstonia scholaris	Devil tree	49	40
2.	Amaranthus, Lantana camara.	Lal taini, Lantana	03	-
3.	Bauhinia variegata	Kachenar	09	-
4.	Bischofia javanica	IRUM/ Underikhni	05	-
5.	Bombax ceiba	Cotton Tree/ Sumbul	01	-
6.	Bougainvillea	Bo-gan bail, paper plant	67	10
7.	Callistemon viminalis	Bottle brush	01	35
8.	Carrisa caranda	Casia Kalaka, Karonda	46	-
9.	Casia Nadasa	Pink folwer tree, Amaltas type	02	11
10.	Cassia fistula	Amaltas	25	-
11.	Cedrus deodara	Popular, amla	-	10
12.	Chlorophytum comosum	Spider Plant	151	-
13.	Combretum indicum	Jhumka Bail	10	-
14.	Dherak Bakain	China berry	12	-
15.	Eriobotrya japonica	Lokat	03	05
16.	Eucalyptus camaldulensis	Safaida	04	-
17.	Ficus benghalensis	Burgad	02	-
18.	Ficus benjamina	Fiscus	106	12
19.	Ficus carica	Fig, Anjeer	-	06
20.	Ficus elastica	Rubber plant	03	-
21.	Gatropha	Nut, Ratanjot.	10	-
22.	Grevillea robusta	Silver Oak	01	-

Table 2: Distribution of Plants Species in Miyawaki Forest and Rawalpindi Medical University.

23. Hibiscus rosa-sinensis	Biscus, China rose, Gurhal (گڑھل)	06	-
24. Hyophorbe lagenicaulis.	Bottle palm, Palmiste gargoulette	25	-
25. Irisene herbsti	Kari pata	01	-
26. Jacaranda mimosifolia	Tokoma, Fern, Neeli gul mohur	30	10
27. Syzygium cumini	Jaman		08
28. Broussonetia papyrifera	Junglitoot	02	-
29. Kino citrus (Citrus reticulata)	Kinnow		10
30. Lagerstounia	Crape myrtle, Crepe flower	29	-
31. Lagerstroemia indica	Lag Estonia, Gul-dasta,		40
32. Lagerstroemia speciosa	Legistonia, Tulsi	39	-
33. Livistona rotundifolia	Table Palm	26	-
34. Luffa cylindrica	Kasia Galaka, Galka, Sponge Gourd,		20
35. Mangifera indica	Mango	02	-
36. Origanum majorana	Marwa	05	-
37. Melia azedarach.	Daraik	01	-
38. Morus alba	Shatoot	03	-
39. Pelecanus.	Palkan	39	-
40. Persea americana	Avocado, Makhanphal (or Butter Fruit)	-	15
41. Pinus roxburghii	Chir pine, Himalayan Longleaf pine, Cheer	06	-
42. Platycladus orientalis,	Morepankh	43	-
43. Plumeria	Gul e Chain	05	-
44. Polyalthia longifolia	Ulta ashok		30
45. Pongamia pinnata, Millettia pinnata,	Sukh chain, Indian Beech or Pongam, Karanj	14	05
46. Prunus armeniaca	Apricot, Khubani	-	20
47. Psidium guajava	Guayaba, amrood	-	08
48. Punica granatum	Anar	-	10
49. Schefflera Arboricola	Dwarf Umbrella Tree/Shelfera	20	-
50. Syzygium cumini	Jamun	08	-
51. Tecoma stans	Tecoma, Yellow bells, Yellow elder, or Yellow trumpetbush.	05	05
52. Terminalia bellirica	Bahera, Terminalia, Haritaki, Jangli Badam	101	30
53. Ficus Benjamina	Wheeping Fig	05	-
54. Yucca	Adam's needle, Spanish bayonet, and Silk plant.	05	-
Total Number of plants		**923**	**340**

DISCUSSION

The findings highlight RMU's evolving approach to sustainable campus planning through the integration of conventional green spaces and innovative Miyawaki forest techniques. The overall plant count and species diversity observed at RMU compare favorably with international green campus benchmarks[15]. The dominance of tree-covered vegetation, particularly within the Miyawaki forest, is ecologically significant. Trees provide disproportionately higher ecosystem services than grass-only landscapes, including enhanced carbon sequestration, thermal regulation, and air quality improvement[16–18]. The concentration of 340 plants within the Miyawaki forest underscores the efficiency of this method in maximizing ecological output per unit area[12].

The presence of fruit-bearing and native species within the Miyawaki forest contributes to urban biodiversity conservation and ecological resilience. Biodiverse plant communities are more resistant to pests, diseases, and climate variability, making them particularly valuable in urban institutional settings[19,20]. From a public health perspective, green environments within medical universities offer added value. Exposure to green spaces has been linked to reduced stress, improved mental health, and enhanced academic performance among students[21-23]. RMU's green infrastructure therefore supports both environmental sustainability and institutional well-being. However, despite substantial green coverage, the main campus still contains large open concrete areas. Gradual conversion of selected concrete surfaces into semi-permeable or shaded green zones could further enhance environmental performance without compromising functional needs[24].

CONCLUSION

The comparative analysis of plant species at Rawalpindi Medical University demonstrates that while the broader campus contributes substantial species diversity, the Miyawaki forest provides exceptional tree density and ecological efficiency. Together, these components form a balanced green concrete matrix that aligns with international sustainable campus standards. Expansion of Miyawaki-style plantations and strategic enhancement of green infrastructure could further strengthen RMU's role as a model for environmentally responsible medical universities in Pakistan.

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REFERENCES:

1. United Nations. Sustainable Development Goals Report 2024.
2. OECD. Universities and sustainability transitions. 2023.
3. United Nations. Transforming our world: the 2030 Agenda.
4. IPCC. Climate Change 2023: Mitigation of Climate Change.
5. WHO. Urban green spaces and health. 2023.
6. Hartig T, et al. Nature and mental health. Annu Rev Public Health. 2023.
7. Tzoulas K, et al. Green spaces and health. Int J Environ Res Public Health. 2022.
8. Oke TR. Urban heat island theory. Prog Phys Geogr. 2022.
9. Norton BA, et al. Green infrastructure in cities. Environ Res. 2023.
10. Miyawaki A. Restoration of native forests. Ecol Eng.
11. Sharma R, et al. Miyawaki forests in urban environments. Urban For Urban Green. 2023.
12. Schirone B, et al. Dense plantations and biodiversity. For Ecol Manag. 2022.
13. Sharifi A. Urban sustainability assessment. Sustain Cities Soc. 2024.
14. Meerow S, Newell JP. Urban resilience frameworks. Landsc Urban Plan. 2023.
15. UI GreenMetric. World University Rankings. 2024.
16. Akbari H. Cooling effects of urban trees. Energy Build. 2024.
17. Li D, Bou-Zeid E. Vegetation and urban microclimate. Environ Res Lett. 2023.
18. Gill SE, et al. Green infrastructure benefits. Build Environ. 2022.
19. Gómez-Baggethun E, et al. Ecosystem services. Ecol Econ. 2024.
20. Kabisch N, et al. Biodiversity in cities. Environ Sci Policy. 2023.
21. WHO. Green spaces and mental well-being. 2022.
22. Twohig-Bennett C, Jones A. Health benefits of green space. Environ Res. 2022.
23. Markevych I, et al. Green space and cognition. Environ Int. 2023.
24. UNEP. Nature-based solutions for cities. 2023.
25. Rawalpindi Medical University. Green Campus Project Report. 2025.