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Miyawaki Micro forests for Urban Heat–Health Mitigation: Mechanisms, Evidence Gaps, and Implications for Dense Cities

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Abstract

The urban heat is a growing climate and public health problem, but many cities do not have sufficient space to implement large parks or continuous networks of trees. The Miyawaki method of reforestation, also called dense urban micro forests, has been touted as a miniaturized and fast method of ecological restoration and adaptation to climate change. The ability of these to be used as urban heat-mitigation and heat-health infrastructure is assessed here based on available evidence. It brings together the basic literature in the field of Miyawaki plantations, plantation studies conducted in the field, urban microclimate studies, thermal comfort studies, and studies on the health impacts of heat. There is still limited evidence available for the Miyawaki method, and the evidence is methodologically diverse. Field and geospatial studies reveal reductions in air/land surface temperature, increase in humidity, and better soil/land surface conditions, whereas spacing and ecophysiological studies suggest that performance is related to planting density, species traits, and water availability. There is greater evidence from the wider urban-climate literature that indicates that shading, evapotranspiration, leaf-area distribution, surface characteristics, urban morphology, and airflow all are relevant to cooling performance. There is a plausible relationship between the health benefits of a more green environment and urban-health studies, but no strong study has been found to show a health benefit specific to Miyawaki. Concluding a word of caution, the evidence points to the potential for Miyawaki microforests to be used as a plot-scale thermal refuge and neighborhood- or city-scale thermal mitigation measure, but it cannot yet be considered as a stand-alone approach to neighborhood- or city-scale heat-island mitigation. Replicated comparisons, complete diurnal monitoring, validated thermal-comfort indices, longitudinal assessment, and direct health-relevant outcomes should be used for future research.

Keywords: Miyawaki method; urban microforests; urban heat island; thermal comfort; urban forestry; heat-health; and nature-based solutions.

Introduction

The causes of urban overheating are impervious surfaces, decrease in evapotranspiration, anthropogenic heat inputs, modification of the flow field, and the storage of heat by buildings and pavement surfaces, followed by its release (Oke et al. 1989). The impacts of this process are not only physical; extreme heat exposure has been linked to cardiovascular, respiratory, and other health impacts, and some are more likely to be at risk than others, such as older adults and socially vulnerable populations (Burkart et al., 2015; Nazish et al., 2024). Urban greening is thus considered more than an amenity or ecological measure; it is also a part of public health policy and climate adaptation (Kumar et al., 2024; Santamouris & Osmond, 2020). In highly developed districts, land constrained for large parks or continuous canopy programs is a great challenge to the need for compact interventions. Previous studies have shown that small green spaces can enhance thermal comfort during the day, even when they do not have significant impacts on the urban environment (Quadros & Mizgier, 2023; Sun et al., 2023; Sun et al., 2024). The attention on Miyawaki plantations in this context is due to its practices of close planting, multi-layered vegetation, use of native species, soil preparation and intensive early establishment to speed up the development of forest-like vegetation (Miyawaki, 2004). Since then, this method has been successfully transferred to municipal greening projects, school grounds, riverfronts and urban tiny-forests initiatives in Europe, Asia and the UK (Cambria et al., 2024; Qi et al., 2024; Rauf et al., 2024; Schirone et al., 2025). The claims of this method have been broadened from ecological restoration to biodiversity enhancement and carbon sequestration, self-sustaining and urban cooling, and protection of climate health (Akram et al., 2025). These claims, however, are not empirically sound since a systematic review of 51 documents revealed that only 21 papers included quantitative assessments, seven of which with a control, and only three with replications (Morales et al., 2025). The same review concluded that there was weak or null evidence for several key claims, such as quick maturation, self-sustaining, cost-saving, increased long-term tree density and better biodiversity. These results do not prove the failure of Miyawaki plantations, they simply provide evidence to support the distinction of claims based on the quality and quantity of supporting evidence. It is important to specify it for cooling. A plantation can lower the air temperature within the plantation footprint, decrease land surface temperature in remotely sensed information, decrease mean radiant temperature under the canopy, or help to make cool air move around the outside of the plantation. While related, these outcomes are not synonymous. It has been found that a decrease in the radiant heat load can lead to a better human thermal comfort, without significant reduction in air temperature (Kusaka et al., 2022). In contrast, high density of vegetation can help to mitigate the daytime radiation effect, impacting ventilation or night-time long-wave exchange in urban settings (Li et al., 2024; Meili et al., 2020; Oshio et al., 2021). This review considers the potential of Miyawaki plantations to be urban heat-health infrastructure. It seeks answers to four related questions: 1) What direct evidence is there for their effects on microclimate and heat exposure; 2) which physical and ecological mechanisms are the most relevant; 3) how plot-scale findings can be transferred up to the neighborhood or city scale; and 4) what health related conclusions can be drawn without extending the indirect evidence beyond its scope. Specific studies from India as Miyawaki forests and Japan as small green spaces, park cooling and thermal comfort studies in other countries are discussed to evaluate the plausibility of the pathway from cooling due to vegetation to decreased heat-related health risk. Thus, the aim of this review is to critically collate evidence base across the disciplines—from direct plantation studies, to urban microclimate mechanisms, to heat-health epidemiology—to establish how well the Miyawaki microforest approach is supported as an evidence-based approach to heat mitigation and heat-health in dense urban area contexts.

Methodology

A. Review Design and Evidence Sources

A focused narrative review was carried out and presented in the format of Introduction – Methods – Results – Discussion – Conclusion (IMRDC). The available studies varied significantly in terms of planting configuration, climatic context, spatial scale, comparator, length of monitoring, and definition of the outcome; such variations made it inappropriate to pool them to estimate a single Miyawaki cooling effect. The review is based on literature searches completed around the subjects of Miyawaki forests, urban cooling mechanisms, and the impacts of heat on health and the environment. The inclusion criteria were as follows: (i) directly studied a Miyawaki or tiny forest intervention; (ii) measured or modelled the urban microclimate or thermal comfort; (iii) analyzed a mechanism including shading, evapotranspiration, canopy structure, surface energy balance, or airflow; or (iv) studied relationships between urban vegetation and heat-related morbidity or mortality.

B. **Analytical Framework**

The evidence was grouped into three analysis layers. The first was direct evidence of the Miyawaki method (from Neyveli, Coimbatore, Lucknow, Punjab and Budapest), and the second consisted of studies showing the application of the method in Singapore, Italy, the United Kingdom, the urban areas of the Mediterranean and elsewhere. (Cambria et al., 2024; Qi et al., 2024; Rauf et al., 2024; Schirone et al., 2025; Sugumaran et al., 2026; A. Kumar & Singh, 2026; Goveanthan et al., 2025; Mallesh et al., 2025; Szabó et al., 2025). The second was made up of mechanistic urban-climate evidence from field studies, numerical models, meta-analysis, and reviews of trees, parks, pocket parks, street canyons, and urban morphology (Kusaka et al., 2022; Li et al., 2024; Meili et al., 2020; Oshio et al., 2021; Zhou et al., 2025; Tan et al., 2018; Winbourne et al., 2020; Rahman, Stratópoulos, et al., 2020; Rahman, Hartmann, et al., 2020; Ueyama & Ando, 2020; Irie, 2022; Narita et al., 2004; Sugawara et al., 2021). The third included health-pathway evidence from epidemiological studies, systematic reviews, health-impact assessment, and mortality modelling (Burkart et al., 2015; Nazish et al., 2024; Song et al., 2024; Iungman et al., 2023; Sadeghi et al., 2021; Pascal et al., 2021; Taylor et al., 2024; Wu et al., 2025). The analysis identified four levels of space and cause: in the planted area, across the plot edge and/or neighboring plots, at the neighborhood scale, and at the population level. It also identified the categories of outcome as air temperature, land-surface temperature, radiant temperature, thermal-comfort indices, and health outcomes. Studies that included one or more of the following were given greater weight in interpretation: controls, replication, repeated measurements, validated models, and discussion of uncertainty or limitations.

Direct Evidence from Miyawaki and Tiny-Forest Studies

Direct evidence suggests that Miyawaki plantations can change the environmental conditions in their areas; however, the extent and applicability of this impact is unclear. The most recent field evidence was from Neyveli in Tamil Nadu, with 4,992 saplings of 50 species planted in 2,624 m² at a spacing of 0.6 x 0.6 m (Sugumaran et al., 2026). Measurements were taken at hourly intervals from 06:00 to 18:00 for 1 week, in each season (rainy, winter, and summer). In comparison, the maximum temperature of air inside the plantation area was 31.25 °C, while the soil temperature was slightly lower, 48.79%, in the surrounding areas during the rainy season. The results are consistent with the local effects of shading, surface protection, and evapotranspiration, but were measured from a single site and only during daylight hours, and the open-area comparator was subject to local differences of soil, vegetation, and exposure. Thus, it offers a proof of local microclimate alteration rather than a generalized measurement of the cooling efficiency of Miyawakis. Another study focused on another outcome and scale – Lucknow (A. Kumar & Singh, 2026). The study found an increase in NDVI from 0.22 to 0.40 at a mini-forest site in the period of 2019-2024, and the local land surface temperature dropped by approximately 0.5–1.0 °C, as well as a negative correlation between NDVI and land surface temperature. However, the authors concluded that the lack of significant reduction in neighborhood heat stress was due to the small size, sparse planting, and immaturity of the planted patches, and to using secondary data to make causal inferences. This study therefore helps to confirm a local response to cool the surface, but cannot define a local surface-cooling response that would lead to a reduction in walkable heat exposure or in population health risk. Other supporting evidence on the ecology and physiology of cooling is from Coimbatore (Goveanthan et al., 2025). The species composition may have an impact on canopy development and evaporative potential, as Spathodea campanulata and Cassia siamea showed strong results on several measures while other species showed more moderate results. The present study, however, did not directly measure air temperature, mean radiant temperature, physiological equivalent temperature (PET), universal thermal climate index (UTCI), and heat-related health outcomes and should only be used to provide a mechanistic interpretation and to support the estimate of urban thermal benefit. Comparatively strong evidence was available for planting density in the case of a factorial spacing experiment conducted in Punjab (Mallesh et al., 2025). A randomized block design with three replications, two spacing treatments, 15 native species, and an open control was utilized in the study and microclimate measurements were taken twice daily (08:30 and 14:30) at 15 day intervals. The mean air temperature showed a similar trend (18.84 °C, 19.24 °C, and 20.13 °C, respectively) as did the mean soil temperature (19.73 °C, 21.53 °C, and 21.89 °C, respectively), and the relative humidity was highest in the dense treatment. The findings indicate that a reduced distance between trees and plants is beneficial to the local microclimate, under the conditions tested, but the experiment was carried out on a forestry research facility rather than in an urban environment; conclusions regarding the urban heat island mitigation are thus restricted.

Additional studies provide ecological and implementation contexts. A four-year-old urban Miyawaki forest in Budapest exhibited seasonal variations in photosynthesis and water vapor emission (Szabó et al., 2025), while studies from Singapore, Italy, the United Kingdom, and Mediterranean urban areas documented the expansion of the method into biodiversity, education, restoration, and urban-adaptation programs (Cambria et al., 2024; Qi et al., 2024; Rauf et al., 2024; Schirone et al., 2025). Taken together, these studies demonstrate growing implementation diversity but do not provide a sufficiently consistent comparative basis for estimating heat-health effects.

Mechanisms of Urban Cooling

A broader literature on urban climate exists, and there is more evidence about the mechanisms by which Miyawaki plantations might affect the urban climate. Shading is the most popular and supported mechanism. Street trees decreased the UTCI by 5.9 °C and the WBGT by 1.9 °C from the direct sunlight on a hot summer day in a field comparison conducted in Japan (Kusaka et al., 2022). The results from modelling and measurements conducted in some small green spaces in Tokyo indicated that the maximum air-temperature reductions ranged from 1.17–2.67 °C with PET improvement of 4.75–9.99 °C at different green spaces (Sun et al., 2023); other studies suggested that vertical canopy configuration may significantly affect thermal comfort in small parks (Sun et al., 2024; Zhou et al., 2025). The results of these studies indicate that, for human heat exposure, radiant load changes are more significant than small ambient air temp changes. The second is the process of evapotranspiration. The partitioning of the air temperature reduction due to vegetation cooling shows that evapotranspiration can be a significant fraction of the reduction in within-canopy air temperature, while the shading effect is also important, although it is less significant than the evapotranspiration effect (Tan et al., 2018). The air temperature reduction from well-watered trees was estimated as 3.1–5.8 °C in the city of Phoenix, Singapore, Melbourne and Zurich, respectively, by mechanistic modelling (Meili et al., 2020), but further cooling is limited by stomatal closure due to high VPD. Water availability, hydraulic strategy, species traits, soil volume, irrigation and heat stress are also key controls for urban tree transpiration, identified in a broader synthesis (Winbourne et al., 2020), an important consideration for Miyawaki plantations as close planting can lead to increased water needs in early life, while urban soils may be compacted and limit water access. The cooling performance is also affected by species' characteristics. Leaf area index, leaf area density, crown form, leaf traits, climate and urban morphology were identified as important factors in determining tree cooling through a meta-analysis (Rahman, Stratópoulos, et al., 2020). Rahman, Hartmann, et al. (2020) compared the two species, Tilia cordata and Robinia pseudoacacia, and found that T. cordata transpired about four times more, lowered the air temperature within the canopy by up to 2.8 °C instead of 1.9 °C, and lowered PET by up to 11 °C, instead of 4 °C. The implication for the Miyawaki design is that while high stem density may be a good indicator of thermal performance, it is not enough because the functional characteristics, canopy architecture, rooting conditions and water availability must also be taken into consideration. The third mechanism is through changing the surface energy balance and flow. Trees provide shade to asphalt and soil, decrease the short-wave radiation absorption, change the aerodynamic roughness, and have an effect on turbulent exchange (Li et al. 2024). The major factor for daytime surface cooling in a large Japanese urban park was enhanced heat transport efficiency while anthropogenic heat and heat storage were the key factors for nighttime surface cooling (Ueyama & Ando, 2020). In the urban street-canyon, trees can enhance thermal comfort, and can also diminish the ventilation or raise humidity depending on canopy geometry, wind conditions, building density, background climate and surface materials (Li et al., 2024; Meili et al., 2020). There is special concern for nighttime processes because they are an essential component of claims related to cumulative heat exposure. It has been confirmed in Tokyo that large parks can create a cooler ambient temperature compared to that of adjacent built-up areas, and can induce cold-air seepage up to several hundred meters from the park boundary (Irie, 2022; Narita et al., 2004; Sugawara et al., 2021). Numerical modelling also suggests that the distribution of Leaf Area Density affects the radiative cooling, crown drag and the formation and/or removal of cooled air (Oshio et al., 2021). Dense foliage can influence the exchange of cooled air by decreasing air velocity, but can also decrease the sky-view factor and change the long-wave exchange. Thus, the magnitude and extent of night time cooling in large parks cannot be directly applied to small Miyawaki plantations and the magnitude of cooling is likely to be related to site design and urban morphology.

Evidence Concerning Heat-Related Health Outcomes

Evidence of the benefits of urban vegetation on health outcomes related to heat is much more robust than for Miyawaki plantations. In the most least green areas in Lisbon, a 1 °C increase in UTCI above the 99th percentile was linked to a 14.7% rise in older adults mortality rates, whilst a UTCI increase 99th percentile in the most green areas resulted in a 3.0% increase (Burkart et al., 2015). In a systematic review of 12 studies, it was revealed that higher levels of green space availability were associated with lower heat-related morbidity and mortality, albeit geographically limited to high-income and upper-middle income countries (Nazish et al., 2024). Forest cover, unlike grasslands, substantially altered the heat-mortality relationships in Hong Kong, and had the greatest influence at an exposure distance of ~1 km (Song et al., 2024). Health-impact modelling shows the potential of the importance of urban greening, but does not validate any particular planting method. The number of premature summer deaths attributable to urban heat islands (UHI) ranged from about 6,700 deaths across 93 European cities, whereas urban forest cover of 30% was estimated to reduce the premature summer deaths by ~2,644 (Iungman et al., 2023). Other reviews and modelling studies also highlight the benefits of green infrastructure, tree planting, and blue-green systems, and the fact that outcomes are driven by two factors: distribution of interventions and climate, as well as socio-economic conditions and local design (P Kumar et al., 2024; Santamouris & Osmond, 2020; Sadeghi et al., 2021; Taylor et al., 2024; Wu et al., 2025). Other studies on natural experiments and adaptation-strategies also indicate that greening and urban design could have an impact on the mortality or heat vulnerability, but in a way that is difficult to substantiate as causal (Pascal et al., 2021). There is a plausible causal sequence in the health literature, and exposure to vegetation can lessen exposure to radiant heat and ambient heat, exposure to reduced heat can lessen physiological stress, and reduced heat can consequently result in reduced heat-related morbidity and mortality. However, this sequence is not direct proof of there being any health effects at all from the Miyawaki approach. None of the studies found in this review have shown benefits of a Miyawaki plantation in regards of reduction in heat illness, cardiovascular stress, emergency attendance, hospitalization or mortality.

Table I. Evidence Strength for Principal Claims

Claim	Evidence Strength	Main Evidence	Principal Limitation
Miyawaki plots modify local microclimate	Moderate	(Sugumaran et al., 2026; A. Kumar & Singh, 2026; Mallesh et al., 2025)	Short monitoring periods, limited sites, heterogeneous comparators
Shade improves human thermal comfort	Strong	(Sun et al., 2023; Sun et al., 2024; Kusaka et al., 2022; Zhou et al., 2025)	Most studies are not Miyawaki-specific
Evapotranspiration contributes to cooling	Moderate to strong	(Meili et al., 2020; Tan et al., 2018; Winbourne et al., 2020; Rahman, Hartmann, et al., 2020)	Strongly dependent on water availability, species, and heat stress
Density alone determines cooling	Weak	(Oshio et al., 2021; Mallesh et al., 2025)	Density interacts with morphology, wind, and sky-view factor
Small plots cool surrounding neighborhoods	Limited	(A. Kumar & Singh, 2026; Irie, 2022; Narita et al., 2004; Sugawara et al., 2021)	Strongest spillover evidence derives from large parks
Urban vegetation reduces heat-related health risk	Moderate to strong	(Burkart et al., 2015; Nazish et al., 2024; Song et al., 2024; Iungman et al., 2023)	Evidence is largely indirect for Miyawaki plantations
Miyawaki plantations reduce heat-related illness or mortality	Weak	No robust direct intervention evidence	Requires health-linked comparative studies

Table II. Scale-Dependent Interpretation of Miyawaki Cooling Evidence

Spatial Scale	Appropriate Outcome Measures	Current Evidence	Literature-Supported Interpretation
Within the plantation	Air temperature, soil temperature, relative humidity, surface temperature, leaf-area index	Moderate	Miyawaki plantations can modify local microclimate through shade, surface protection, and evapotranspiration
Plantation edge and adjacent block	Mean radiant temperature, PET or UTCI, wind speed, air-temperature gradients	Limited to moderate	Local thermal-comfort benefits may extend beyond the planted area, but distance and direction are site-dependent
Neighborhood	Distributed air-temperature observations, LST trends, cooling-radius analysis, ventilation pathways	Limited	Small, dispersed plantations may produce localized cooling without substantially reducing neighborhood-wide heat stress
City or population level	Heat exposure, hospitalization, emergency attendance, mortality, attributable-risk estimates	Weak for Miyawaki-specific interventions	Wider urban-greening evidence supports a plausible health pathway, but cannot yet establish a Miyawaki-specific population-health effect

Discussion

A. Plot-Scale Thermal Relief versus Urban Heat-Island Mitigation

The evidence undermines the discourse of most marketing and policy advocates on Miyawaki plantations, which is too simplistic. These plantations can generate local thermal effects by shading, protecting the soil surface, enhancing humidity, and through evapotranspiration; studies in Neyveli and Punjab have shown that the plantations are capable of modifying the local microclimate, and studies in Coimbatore and Budapest have provided physiological evidence that agree with the proposed mechanisms of local microclimate modification (Sugumaran et al., 2026; Goveanthan et al., 2025; Mallesh et al., 2025; Szabó et al., 2025). The Lucknow study introduces a new spatial dimension: "surface cooling" may be reflected in remotely sensed information, but "neighborhood heat stress" is largely unaffected (A. Kumar & Singh, 2026). Therefore, the main difference between thermal relief on a plot scale and urban heat island mitigation is that one is a relief and the other is an attempt to prevent the heat island. Even for small land parcels, it is a likely effect; in Tokyo, where the scale of the green spaces ranged between 0.1 and 1.1 ha, research was conducted to determine the effect on air temperature and PET during the hot daytime period, and the results showed that this effect is plausible (Sun et al., 2023). A Miyawaki plantation can therefore be beneficial alongside schools, clinics, transport corridors, paved courtyards, industrial complexes, and housing developments and heat-sensitive areas, and offer tangible benefits to those who use or pass by, even if the cooling effect is not large beyond the site's boundaries. Claims on the neighborhood scale must be taken more seriously. The cooling effectiveness of large parks is influenced by the characteristics of the park, surrounding edge conditions, wind direction, topography, building configuration, and the ability of the cooled air to enter surrounding streets (Irie, 2022; Narita et al., 2004; Sugawara et al., 2021). Small-scale distributed Miyawaki plots can be connected to create a network of small thermal refuges; however, the benefits of these small plots depend on their spatial arrangements, connectivity, ventilation corridors, and distribution of heat exposure. Small green spaces can be successfully linked together; however, the study of blue-green systems also points out that dense vegetation can block air circulation in the absence of space adaptations to urban form (Probst et al., 2022). Miyawaki plantations should thus be seen as part of a wider urban canopy and heat management plan, not an alternative to parks, street trees, and urban planning.

B. Density, Species, and Context

Planting density is not necessarily a good value to be maximized. Close spacing may enhance the growth of the canopy and improve local shading (Punjab experiment: Mallesh et al, 2025) but may also result in lower wind speed, lower SVF, higher humidity, and changes in radiative exchange at night (Oshio et al, 2021). The benefits of a dense plantation can be greater in an urban context with small morphology in one area and lesser in other areas, for some cases negative. Therefore, there is not a simple rule that says "the higher the density, the better it will be, " and the question becomes "what can be done with density, crown structure, species selection, root zone, irrigation, and surrounding construction to achieve the desired thermal effect? This is the same for species choice. Tree species studies in Coimbatore and comparative studies have proven that there is significant variation among the species in terms of transpiration, canopy development, and thermal performance of trees (Goveanthan et al., 2025; Rahman, Hartmann, et al., 2020). The primary focus of a Miyawaki planting is native species composition; however, the selection of species should also consider the species' water requirements, canopy shape, leaf fall, hydraulic characteristics, and the desired thermal goals (Li et al., 2024; Rahman, Stratópoulos, et al., 2020; Winbourne et al., 2020).

C. Implications for Heat-Health Policy

There is also health evidence that supports considering heat exposure as an important policy pathway and investing in urban greening, especially for vulnerable groups (Burkart et al., 2015; Nazish et al., 2024; Iungman et al., 2023). However, it does not show that all planting forms are equal in terms of health benefits. NDVI, total green-space area, and tree-cover metrics are not perfect measures of canopy height, tree quality, access to trees, ventilation, tree species, or human exposure to trees (Burkart et al., 2015; Song et al., 2024). Besides temperature reduction, the benefits of clean air, physical activity, social interaction, stress mitigation, and better neighborhood conditions are also realized through the positive impacts of heat mitigation (Nazish et al., 2024). Claims of Miyawaki plantations should therefore be seen in the context of their potential contribution to adaptation in the context of heat and not their proven health benefits. The outline policy rationale is that while Miyawaki plantations cannot eliminate exposure of people living in the vicinity of the plantation, they may be able to offer other ecological and social benefits that need to be quantified; the contribution of the plantations to people's health has yet to be determined. This framing is less bold but not as easily disputed as it might be to claim the method as a proven heat-health intervention.

D. Geographic and Methodological Limitations

There are geographical inconsistencies in the evidence base. Although a considerable amount of the direct literature on Miyawaki comes from India, detailed studies of thermal comfort in parks, urban airflow, and park cooling are more likely to be found in other high-income countries, such as Japan and Europe (Burkart et al., 2015; Sun et al., 2023; Goveanthan et al., 2025; Mallesh et al., 2025). Such a disparity is significant; cities in India face high temperatures, water scarcity, high density of development, disparities in access to shade, and lack of monitoring capabilities: it is the mechanisms that explain performance in a city such as Tokyo, and not in Lucknow, Coimbatore, Neyveli or Punjab. Comparative studies of the different tropical, subtropical, arid, and humid climates are thus needed (P. Kumar et al., 2024; Li et al., 2024). In addition, methodological constraints are relevant. Many Miyawaki studies do not have any untreated controls, or the studies are not replicated, or they are not monitored throughout the day, or they do not measure thermal comfort, or they do not measure heat exposure and use a physiological, or remote sensing, proxy instead. A systematic evidence review verifies that this is the case in the larger literature on Miyawaki (Morales et al., 2025). So far, the available evidence is more convincing for the biophysical plausibility than for effects estimates of interventions.

E. Research Priorities

A more robust research protocol would require a comparative design in which a Miyawaki plot is compared with a control site planted as a conventional mixed plantation, a sparse plantation of trees, a lawn or shrub plantation, and a control site that is not vegetated and either paved or open under comparable climatic and morphological conditions. Monitoring parameters should include air temperature, land-surface temperature, mean radiant temperature, relative humidity, wind speed, soil moisture, leaf-area index, and a validated thermal-comfort index (e.g., PET or UTCI) throughout the day–night cycle, wet/dry seasons, early establishment and maturity, and extreme heat times. To determine the relative impacts of shading and evapotranspiration (ET) on physiological measurements such as sap flow, the following can be used (Tan et al., 2018; Winbourne et al., 2020). In addition, thermal measures should be correlated with the presence of any pedestrian activity, user's perceived comfort, reported heat symptoms, cardiovascular responses, emergency attendance, and/or use of health services, if available (Sadeghi et al., 2021). These studies would help move the field from a claims to evidence approach of exposure reduction and health relevance based on vegetation presence or NDVI. Although thermal benefits are only a small part of the benefit of the Miyawaki approach, spatial and institutional benefits could be the most important. Small-scale plantings can be used in situations where traditional parks cannot be implemented, and dense plantings can include additional functions such as shade, wildlife habitat, soil restoration, educational, and local amenity (Qi et al., 2024; Rauf et al., 2024; Schirone et al., 2025). Although these multiple benefits are important, they should not be allowed to cloud the lack of evidence for any single benefit, and the method will gain scientific and policy credibility when benefits and limitations are assessed in the same methodological way.

F. Conclusion

The use of Miyawaki plantations to provide local cooling in urban areas is plausible from a mechanistic perspective. Evidence of modest plot-scale reductions in air and surface temperature, as well as increases in humidity and soil and surface conditions, is currently available. These effects are understood by the broader urban climate literature, which includes shading, evapotranspiration, canopy structure, species traits, surface energy balance, and context-dependent airflow. There is currently limited evidence of spillover effects at the neighborhood level, and less evidence on the health outcomes of Miyawaki. While more general research suggests that improving the urban environment to be "green" can lower morbidity and mortality from heat-related conditions, the results of these studies cannot be directly applied to a specific design of a microforest. In this sense, Miyawaki microforests can be considered as having the potential to represent useful, widely spread, plot-level heat-mitigating infrastructure. While they might offer beneficial thermal refuges and help diversify adaptation networks, they should not be offered as viable 'one size fits all' urban heat island solutions or established heat-health interventions, especially in land-constrained urban settings. Advances in understanding the effects of heat stress on human health and wellness will rely on controlled comparisons, ongoing monitoring, explicit consideration of day–night trade-offs, and direct measurements of human heat exposure and health-relevant outcomes.

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