

BALANCING ECOLOGICAL FUNCTIONALITY AND SAFETY: ASSESSING MIYAWAKI FORESTS IN THE CONTEXT OF RECREATION

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Abstract

The integration of nature into urban environments must carefully balance requirements of public recreation with long-term landscape protection. Recently, the Miyawaki "micro-forest" method has gained immense popularity as a rapid urban greening solution. However, this study critically assesses the functional and ecological realities of such densely planted structures against their promotional narratives. By applying conceptual modeling based on tree biomechanics, we demonstrate that the extreme planting density inherent to the Miyawaki method results in intense competition for light from the juvenile phase onward. This developmental trajectory results in spindly, pole-like tree habits characterized by high height-to-diameter (H/D) ratios, small crowns, and compromised mechanical stability. This structural vulnerability notably increases the risk of stem breakage and windthrow, posing direct safety hazards to park visitors. Consequently, these plantings fail to provide long-term microclimatic benefits - such as effective shading and transpiration cooling - essential for comfortable recreational spaces. Furthermore, their impenetrable, thicket-like structure limits spatial readability and safe accessibility, severely restricting their utility for public recreation. We conclude that while micro-forests offer a short-term visual greening effect, they cannot substitute traditional, thoughtfully spaced group plantings that ensure long-term landscape resilience, functional ecological services, and safe public use.

Key words: dense plantings, height-to-diameter ratio, landscape architecture, tree biomechanics, urban greening

Introduction

The sustainable development of contemporary urban agglomerations necessitates the integration of multifunctional green infrastructure. This often leads to a strong collision between the needs associated with mass public recreation and the long-term goals of landscape protection. In recent years, a rapid greening technology commonly referred to as Miyawaki "micro-forests" has gained immense popularity. This technique aims to rapidly restore degraded urban spaces into thriving ecosystems, yet its broader application remains controversial due to complex spatial, financial, and social dynamics in dense city environments [Qi et al. 2024, 2025; Zeybek 2025]. A thorough semantic and methodological analysis proves that this concept often blurs the rigorous definitional boundaries adopted in landscape ecology and forest sciences. Small, isolated patches of greenery created using the Miyawaki method constitute an experimental dense plantation rather than a fully-fledged, self-regulating forest ecosystem.

The widespread acceptance of this method by city administrations frequently stems from a fundamental temporal error in the planning process: favoring investments that provide a rapid visual effect while ignoring the long biological time required to develop stable tree structures. Nevertheless, recent literature emphasizes the significant social and cultural dimensions of these plantings. Barns et al. [2025] observe that the cultivation of Miyawaki forests can enliven values of human-nature care, functioning as sites of multi-species gathering and environmental stewardship. Similarly, Narraway et al. [2025] emphasize that new, participatory tree planting initiatives can nurture cultural value and build community resilience by strengthening the bonds between people and local landscapes. However, while these social and educational benefits are highly valuable, they must be rigorously weighed against the ecological and biomechanical realities these dense structures impose on the public.

Material and methods

The study was conducted using conceptual modeling based on the synthesis of tree biomechanics, urban forestry literature, and landscape architecture principles. A critical review of peer-reviewed literature concerning the height-to-diameter (H/D) ratio and tree stability under static loads, particularly drawing on the biomechanical mechanisms established by Peltola [2006] and the *Static-Integrated-Assessment* (SIA) method [Sinn & Wessolly 1989], was performed to evaluate the physical resilience of densely planted trees. Furthermore, to assess the impact of such dense structures on pedestrian

safety, the study integrated principles from *Crime Prevention Through Environmental Design* (CPTED) audits, as explored and developed by Cozens et al. [2022]. A comparative matrix was developed to contrast the morphological evolution and structural stability of extremely dense plantings (the Miyawaki method) with traditional, moderately spaced group plantings. Visual and schematic models were created to illustrate the biological versus functional trajectories over a multi-decadal timeline.

Results

Deconstructing the myths of rapid greening evaluating the actual value of dense plantings requires a deconstruction of the promotional promises surrounding the Miyawaki method. The premise of creating "biodiversity oases" is challenged by the fact that rigorous competitive pressure rapidly leads to the dominance of a few aggressive taxa, limiting the formation of multilayered biological diversity. Furthermore, while Schirone et al. [2010] highlight that the Miyawaki method aims to simulate natural processes of ecological succession by densely planting intermediate and late successional species simultaneously, the rapid elongation of the main axis is fundamentally a pathological stress reaction to severe light deficit, not a physiological indicator of ecosystem maturity. Schirone et al. [2025] demonstrate that tiny forests in Italy offer strong pedagogical value and can reconnect people with natural rhythms. However, true bioclimate parameters - such as effective urban cooling and human thermal comfort - depend heavily on specific tree traits, spatial arrangements, and the contrasting interactions between species and sites [Rahman et al. 2020]. These advanced climatic functions cannot be fully replicated by the overcrowded, unventilated structures characteristic of juvenile micro-forests. The critical aspect of evaluating the Miyawaki method in recreational areas remains the rigorous analysis of tree structural mechanics. The planting density of 3 to 7 seedlings per square meter forces immediate, ruthless spatial competition for light. This forced allocation of carbon assimilates results in apical dominance at the expense of necessary *secondary* radial growth and the development of lateral branches. This trajectory produces spindly, pole-like morphological forms with critically impaired statics.

The scientific and engineering indicator used to valorize this phenomenon is the *height-to-diameter* ratio (HDR). According to Sharma et al. [2019], HDR is an important tree and stand stability measure that is significantly affected by stand density, inter-tree spacing, and competition. Stable, free-growing trees are characterized by appropriate trunk taper and a safe, low H/D ratio, ensuring stress distribution to an extensive root system. In contrast, in dense plantings, the H/D ratio reaches critical warning values, and the bending moment generated by aerodynamic loads in the upper parts of vestigial crowns translates into massive stresses in the weakened basal zone [Peltola 2006]. These mechanisms are explicitly contrasted in the comparative matrix [Figure 1], highlighting the differences between the slender, fracture-prone habit in the Miyawaki system and the resilient, balanced crowns of group plantings.

The deficit of extensive, spatial crowns in overcrowded trees results in an extremely low *Leaf Area Index* (LAI) in the upper canopy. This parameter is directly proportional to the tree's capacity for transpiration cooling and shading efficiency, both of which are essential for thermal comfort in pedestrian zones. Moreover, the physical thicket of trunks blocks natural ventilation.

In parallel with climatic dysfunction, micro-forests pose significant challenges for environmental criminology and pedestrian safety. Extremely dense undergrowth forms a solid optical barrier that drastically limits the spatial readability of urban parks. CPTED audits emphasize that natural surveillance and visual clarity are crucial for deterring crime and enhancing perceived safety [Cozens et al. 2022]. The reduction of sightlines and spatial transparency significantly increases the psychological sense of threat. In areas of active pedestrian mobility, the presence of such visual screens can lead to potentially tragic collisions, as research on pedestrian-crossing configurations has shown that restricted visibility is a primary contributing factor to accidents [Gitelman et al. 2017]. This raises questions about the safety of the Miyawaki technique when implemented for recreational purposes near high-traffic paths.

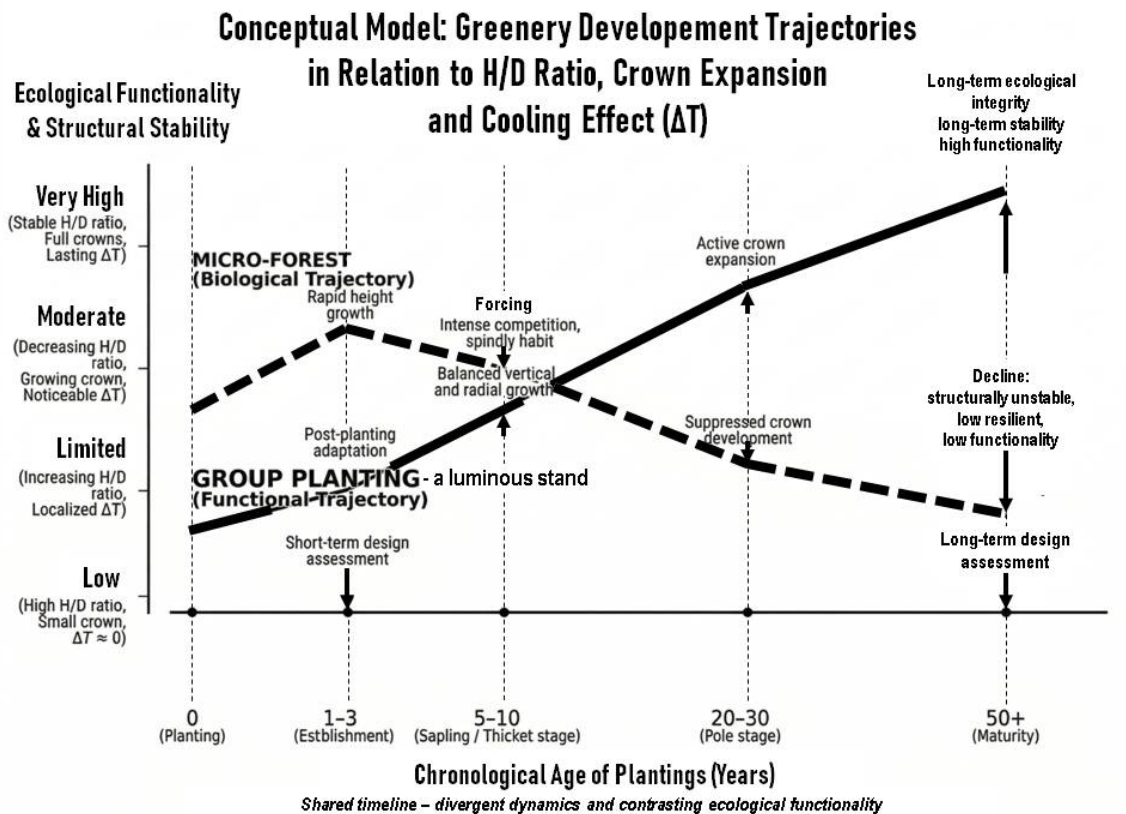


Fig. 1: Comparative matrix contrasting the morphological traits, mechanical stability, and long-term climatic functions of extreme-density Miyawaki micro-forests with moderately spaced group plantings.

Discussion

The widespread adoption of the Miyawaki method often overlooks long-term ecological consequences in favor of short-term biomass accumulation. The evolution of a micro-forest is characterized by an early, rapid growth spike that falsely elevates the project assessment [Schirone et al. 2010]. However, as intraspecific competition escalates, this is followed by a drastic decline in ecological and functional value, as trees with critically high height-to-diameter (H/D) ratios become biomechanically unstable and prone to windthrow [Peltola 2006; Sharma et al. 2019]. Conversely, a traditionally designed park planting matures sustainably, increasing its value. While the technique holds promise for enhancing urban sustainability, its integration into planning policies requires careful consideration of spatial, financial, and social dynamics, as its broader application in diverse urban environments remains controversial [Zeybek 2025].

Professionals note that its feasibility in temperate urban climates is hindered by high tree mortality due to competition and the need for further longitudinal research [Qi et al. 2024]. These authors exploring perceptions among UK landscape professionals, found that, despite support for the method in specific landscapes, major concerns remain regarding high initial costs, maintenance intensity, and the public perception of untamed green spaces [Qi et al. 2025]. Furthermore, the requirement for substantial soil preparation raises concerns regarding cost and feasibility in dense urban environments [Zeybek 2025].

Despite these ecological and financial challenges, the method's popularity is largely driven by its social dimensions. The cultivation of Miyawaki forests enlivens values of human-nature care and functions as a catalyst for community gathering [Barns et al. 2025]. Participatory tree-planting initiatives nurture the cultural value of new urban green spaces, building community resilience and strengthening local bonds [Narraway et al. 2025]. However, this social enthusiasm must be reconciled with environmental criminology; unmanaged, thicket-like green spaces can quickly become perceived safety hazards, requiring ongoing audits to prevent crime and disorder [Cozens et al. 2022]. Ultimately, while the method attempts to bypass the earliest stages of ecological succession and offers strong pedagogical value [Schirone et al. 2025], these findings underscore the necessity of prioritizing functional longevity, mechanical stability, and safe public use over short-term visual impacts in urban forestry.

Conclusion

A synthetic assessment of the Miyawaki method reveals serious limitations for creating safe and ecologically efficient recreational spaces:

- extreme planting density triggers intense light competition, resulting in trees with critically high height-to-diameter (H/D) ratios and compromised biomechanical stability, which significantly elevates the risk of windthrow and stem breakage in public areas;
- despite providing a rapid short-term visual effect, the suppressed crown development in micro-forests severely limits their long-term capacity to deliver essential microclimatic ecosystem services, such as effective transpirational cooling and shading;
- the impenetrable, thicket-like structure of dense plantings restricts spatial readability and natural surveillance; in accordance with Crime Prevention Through Environmental Design (CPTED) principles, this lack of visibility diminishes perceived pedestrian safety and increases collision risks in active recreational zones.

In the conclusion, achieving rational landscape architecture requires a methodical **return to thoughtfully spaced group plantings**, which provide young trees with balanced developmental space, preventing an uncontrolled vegetative race and allowing them to form statically stable trunks and durable crowns.

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Souhrn

Tento článek kriticky hodnotí Miyawakiho metodu „mikrolese“ v kontextu městské rekreace a bezpečnosti. Pomocí koncepčního modelování založeného na biomechanice stromů dokazujeme, že extrémní hustota výsadby vede k intenzivnímu soupeření o světlo, což má za následek vysoký poměr výšky k průměru (H/D) a sníženou strukturální stabilitu. Tyto vytáhlé stromy představují bezpečnostní riziko kvůli zvýšenému nebezpečí vyvrácení větrem a zlomení kmene. Kromě toho hustá, houštinovitá struktura omezuje viditelnost chodců a neposkytuje dostatečné mikroklimatické výhody, jako je stín a ochlazení. Studie dospěla k závěru, že tradiční, rozptýlené skupinové výsadby nabízejí lepší dlouhodobou ekologickou funkčnost, odolnost a veřejnou bezpečnost ve srovnání s krátkodobými vizuálními efekty metody Miyawaki.

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