The role of Miyawaki forests in school grounds

Children's participation and the development of place ownership

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Abstract

Pocket forests developed with the Miyawaki method present fast succession and reach climax in up to 20 to 30 years. The local community is usually included in the planting, and school grounds are commonly chosen locations for stand establishment. Children's participation in the process from design to planting can stimulate the ownership of places and foster environmentally aware citizens. This observational case study aims to evaluate the development of these aspects through site visits to five Miyawaki forests planted on school grounds in Europe and Brazil. Participating children, school staff, parents and forest designers were interviewed in connection with the visits. Children's engagement in the implementation of Miyawaki forests directly affected the senses of pride, place attachment and ownership of places. Children that participated in the planning and planting processes became stewards of the forests and cared about them. The evaluation of the forests planted in Europe suggests that it is possible to implement Miyawaki pocket forests in school grounds in Southern Sweden as part of a strategy to enhance biodiversity, provide ecosystem services and empower school children.

Keywords: Miyawaki forest, children's participation, children's ownership of place.

“I hope all of the Japanese people plant small saplings with their own hands in order to protect their own lives and those of their loved ones, and to preserve the lush verdure of Japan. I wish to spread the know-how and the results of this ecological reforestation to the whole world”

Akira Miyawaki (2014)

To my parents, friends, and teachers for the basis.

To Artur for the support.

To Alice for the future.

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Abbreviations

Abbreviation	Description
CEU	Unified Educational Center
MM	Miyawaki Method
MF	Miyawaki Forest
NGO	Non-Governmental Organization
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations Children’s Fund

1. Introduction

1.1 The Miyawaki Method

The Miyawaki method (MM) for the development of pocket forests was developed by Akira Miyawaki, a Japanese botanist, who was interested in biodiversity and reforestation inspired by the sacred Japanese forests called *shinju no mori* (Miyawaki, 2023). These temple forests consist of a mixture of only native species, and as all natural forests, need more than two centuries to develop through the conventional successional stages, until reaching their climaxes (Miyawaki, 1999) (Miyawaki, 2023).

Miyawaki began developing his method in the 1970s in Japan, in response to a demand of the Nippon Steel Corporation to implement a reforestation project on the outskirts of a polluted industrial area (Miyawaki, 1999) (Miyawaki, 2023). After the success of this project, other Japanese industries hired Dr. Miyawaki to establish more forests with the same technique. This effort expanded significantly when the Japanese government recruited Dr. Miyawaki for develop a large-scale reforestation project to restore and protect some coastal areas after the Great East Japan Earthquake devastated the eastern coast of Japan in 2011 (Miyawaki, 2023). The reforestation effort was called the Great Forest Wall Project and aimed to create forests that were not only resilient against damage caused by tsunamis that usually follow an earthquake, but also worked like a barrier to protect the coast against water and wind destruction (Miyawaki, 2023).

The MM has some key steps to be followed, starting with a field survey for the identification of the potential natural vegetation and further species selection. After this, a soil survey is conducted, followed by soil preparation and/or improvement using locally produced organic matter or compost, if necessary (Miyawaki, 1999) (Lewis, 2022). The selected specimens must be potted seedlings 30 to 40 cm tall, to be planted in a dense mix of two to three seedlings per square meter in temperate environments (Miyawaki, 2023), to favor competition and further development. The soil must be covered with straw for mulching, which prevents soil erosion and weed development, provides nutrients through decomposition, and regulates moisture (Lewis, 2022). During the first three years after planting, maintenance should focus

primarily on weeding, with the removed material left on-site as mulch. When the trees reach around three meters in height, it is usually enough for blocking sunlight for weeds not to thrive, so no more maintenance is necessary (Miyawaki, 1999). At this point, the Miyawaki forest (MF) is considered self-sustainable.

The densely planted trees compete for light, water, and soil nutrients in a mutualistic and competitive interaction (Lewis, 2022). The battle for sunlight stimulates upwards growth. The expectation is that a multistratal quasi-natural climax forest is reached in 20 to 30 years in temperate environments (Miyawaki, 1999) (Miyawaki, 2023).

1.2 Children's participation and ownership of spaces

Hart (1992) was the pioneer in discussing children's participation in decision-making processes. He adapted Arnstein's (1969) ladder of citizen's participation for use with children (Figure 1). It is comprised of eight steps that conceptualize the degrees in which children are not only involved but also are allowed to participate and take initiative in public governance. This framework can also be applied to urban open space management.

The first three steps of the ladder consist of actions that are sometimes framed as proper inclusion, but in reality, do not involve children in any meaningful way. Proper participation begins from the fourth step on. This framework also stresses the difference between the terms "public involvement" and "participation." The first includes children in decision making, but does not guarantee their impact on the result, while the latter means that access is given during the development process, and they have a degree of power which is enough to affect the outcome (Fors, 2020).

The first paragraph of the 12th article of the United Nations' (UN) Convention on the Rights of the Child (UN, 1989) states that:

> "States Parties shall assure to the child who is capable of forming his or her own views the right to express those views freely in all matters affecting the child, the views of the child being given due weight in accordance with the age and maturity of the child." (UN, 1989)

After a long discussion, Sweden implemented the UN Convention (1989) into law in 2020, but already decades earlier, efforts were made to involve

children and young people in urban spatial planning, particularly through the use of tools by municipalities and the allocation of space for projects targeting this public (Rodela & Norss, 2023).

Starting in the 1970s, the United Nations Educational, Scientific and Cultural Organization (UNESCO) gathered environmental professionals to discuss people-centered solutions to environmental problems (Derr, Chawla & Mintzer, 2018). One branch of this project culminated in the "Growing up in cities" UNESCO program, deriving from Kevin Lynch's studies from 1977 (Moffat, 2002), and was developed since the 1990s, coordinated by Louise Chawla (Varney, 2003). The program aimed to discuss these solutions with the focus on examining the ways in which children and youth use and perceive their everyday environments (Derr, Chawla & Mintzer, 2018). Lynch stated that children could lead to their active participation in community change and used different methods for evaluating their behaviors and participation in urban planning (Derr, Chawla & Mintzer, 2018) (Varney, 2003). The series of eight case studies in the second phase of the "Growing up in cities" initiative, provide a participatory view of the features children and youth would like to be part of their communities (Varney, 2003). In the Australian branch of the study, Malone (1999) identified adolescents' demand to have urban spaces that allow identification and connection with the surrounding natural environment of their community.

Steps		
8	Child-initiated, shared decisions with adults	Degrees of participation
7	Child-initiated and directed	
6	Adult-initiated,shared decisionswith children	
5	Consulted and informed	
4	Assigned but informed	
3	Tokenism	Non-participation
2	Decoration	
1	Manipulation	

Figure 1: The eight steps of Hart's ladder of children's participation (Hart, 1992).

The United Nations Children's Fund's (UNICEF) Child Friendly Cities Initiative aims to implement the UN (1989) Convention on the Rights of the Child at the local level through children participation, facilitating their involvement in decision-making to promote local accountability for children's rights (UNICEF, n.d.).

Korfiatis & Petrou (2021) affirm that children involved in all phases of urban green space development tend to express ownership of these places (e.g. cultivating plots or gardens), and are motivated to maintain and care for the preservation of these spaces. These children tend to develop place attachment to these environments, with the identification of its features as attractive (Kudryavtsev et al., 2012). These bonds linking people and natural places are long-lasting and reflect on future nature preservation.

In the traditional forest planting festivals in Japan, it is common to allow school children to participate (Miyawaki, 2023), and tree planting is part of the regular school curriculum (Miyawaki, 1999). This creates a sense of ownership as the children grow up and witness the forest's development. When they eventually become adults, they tend to be emotionally attached to these natural environments and take their own children to the forests they once planted (Miyawaki, 1999).

1.3 Objectives

This thesis was motivated by the question "Why don't we have MFs in Sweden?". Initial research found no examples of MFs in the country. Specialists in urban open spaces were also informally questioned, and they had no knowledge of any initiatives of planting MFs in Sweden. This realization brought the following question to mind: "Would it be feasible to plant MFs in Southern Sweden?"

To help answer this question, the author decided to visit MFs around the world to dig deeper not only into the feasibility of the technique but also into the forests' relations to the most common public linked to MFs planting approach: the school children.

The goal was to investigate children's participation in planning and implementation of the MF in schoolyards as future green playing environments, through site visits and interviews with different stakeholders.

It was also aimed to evaluate the development of children's place ownership and stewardship to the built forest environments in school grounds and the fostering of environmentally aware individuals.

Since most of the MFs planted by Dr. Miyawaki's disciples are still young, it was not expected to assess climax mature forests, but to check on

the characteristics of the developing ones, with features that could be applicable to children's learning and playing.

2. Methods

2.1 Study design and data collection

This qualitative case study (Baxter & Jack, 2008) was performed from November 2023 to December 2024 as a bachelor's degree project in landscape architecture.

Between November 2023 and November 2024, bibliographic research about Miyawaki forests and playing environments was done.

From November 2023 until August 2024, organizations, companies, and initiatives engaged in planting MFs were searched, explored online, selected, and contacted.

Based on the organizations' available information on their websites and social media, eight forests were selected to visit. The locations of the forests were a main consideration, with travel being feasible for the researcher to visit them. The chosen forests (table 1) had available information on the associated schools', companies', or non-governmental organizations' (NGO) websites, about children participating in the planting process. There was an intensive search on the internet for MFs in Sweden, but none were found. Specialists were also consulted, but to their knowledge, no initiatives were present in the country to this date.

Table 1: Miyawaki school forests chosen for visiting, with inclusion status.

School	City	Country	Company / Organization	Status
CEU Tiquatira	São Paulo	Brazil	Formigas de Embauba	Included
Oakwood Primary	Glasgow	Scotland	Voice for Nature Collective	Excluded
Balornock Primary School	Glasgow	Scotland	Therme One Health	Included
Louise Schroeder Schule (Walter-Möller Park)	Hamburg	Germany	Citizens Forests	Excluded
Louise Schroeder Schule (Louise-Schroeder-Straße)	Hamburg	Germany	Citizens Forests	Excluded
Tinderhøj School	Rødovre	Denmark	By Rum Skole	Included
Rudme Friskole	Rudme	Denmark	Rudme Grønne Nabofællesskaber	Excluded
École Comunale de Barvaux	Durbuy	Belgium	Urban Forests	Included
Ejby Skole	Glostrup	Denmark	By Rum Skole	Included

The companies, organizations, and schools linked to the selected forests were contacted by email, phone calls, social media messages, and website contact forms, asking for more information and for permission for visits. Not all of them answered the contacts, so visits were performed with a

booked appointment or spontaneously on a convenient date chosen by the researcher.

The included Scottish MF was located outside of the school walls, right in front of the main entrance. In this case, it had free access for the community and visitors. The included MFs in Denmark, and the ones in Brazil and Belgium are located within the school grounds, were easily reached and visits were followed by the school staff. The MF visit in Belgium was also accompanied by the forest designer.

From the eight pre-selected MFs, one is located in a tropical region in Brazil, and the others are in the temperate climate zone in Europe, with two in Germany, two in Scotland, two in Denmark, and one in Belgium (table 1).

During the field assessment, the species present at the MF were recorded, the three tallest trees were measured, and design features and plant development were observed. School staff and/or children were interviewed if possible. Photographs were also taken. Some interviews were performed after the visits, depending on the availability of subjects.

When applicable, informed consent was asked for the interviewees or their legal representatives.

Finally, the author was invited by the forest designer of the Tinderhøj school forest, in Denmark, to follow the steps on the implementation of a new MF in a schoolyard in the greater Copenhagen area. This took place in late October 2024.

Each visit was documented as a separate case, and the collected information was later compiled and discussed together.

2.2 Cases

2.2.1 Unified Educational Center (CEU) Tiquatira

CEU Tiquatira is a unified educational center belonging to São Paulo municipality, located in the suburbs of the biggest metropolis of Latin America. This educational center is based on a model that aims to offer not

only education, but also recreation, culture and sports to the community that frequent its premises. The center maintains a municipal school, a library, sporting facilities, a swimming pool, and rooms for courses and workshops designed for the local community (Cidade de São Paulo, n.d.).

The NGO Formigas de Embaúba has been engaged in planting MFs at the schools of suburban São Paulo since 2021, recreating native Atlantic rainforests (Formigas de Embaúba, 2022a). The organization did a massive survey with georeferencing in the city, for assessing the available spaces for the implementation of quasi-natural rainforests (Formigas de Embaúba, 2022b). In 2022 the organization planted more than 8,000 seedlings in 7 mini-forests in CEUs (UN Decade on Restoration, n.d.a), engaging students and teachers in the nature conservation and reforestation efforts. One of these MFs was planted in CEU Tiquatira in October 2022, and was designed by Rafael Ribeiro, the co-funder and planting director of the NGO. According to information provided on a sign installed at the forest, more than one hundred native tree and bush species, like guava (*Psidium guajava*), jaboticaba (*Plinia peruviana*) and ipê (*Handroantus* spp.) were planted. The NGO calls the quasi-natural Atlantic Miyawaki rainforests, like the one in CEU Tiquatira, open-air forest classrooms. Here, the students can be engaged in practical, hands-on lessons in various subjects (Sugi Project, n.d.a) (Cidade de São Paulo, 2022).

2.2.2 Balornock Primary School

The Broomfield Forest was designed by James Godfrey-Faussett, an experienced forest maker from the United Kingdom (Sugi Project, n.d.b). It is located in Broomfield Park in Northern Glasgow, directly opposite from Balornock Primary School's main gate. The park has a vast area of 14.6 hectares, mainly composed of mowed lawn, walking paths and some sparse trees. Even though it characterizes a green space, it lacks biodiversity.

The MF was designed with a Celtic cross shape, which is a symbol with cultural significance to the region and has a central meeting area. The designer's expectation is that once fully grown, this meeting point will figure an open meadow surrounded by a quasi-natural Scottish forest (Sugi Project, n.d.b).

This MF was idealized to support the learning and nature contact of the Balornock Primary pupils, since the school area is mainly composed of hard

pavement, without much greenery. Around 90 students participated on the planting day in November 2021. A total of 1,400 trees of 22 native species were planted in 400 m^2 area (Sugi Project, n.d.b).

2.2.3 Tinderhøj School

The Tinderhøj School is located in Rødovre Municipality, in the greater Copenhagen area and has students from six to 16 years old. It is classified as a "green school," which is a badge given by the municipality to nature-oriented schools (Rødovre Kommune, 2024). The institution focuses are nature and sustainability, under which the environment, climate cycle, and citizenship topics are worked on (Rødovre Kommune, 2024). The school counts on a green coordinator, Inge Hertzum, who followed the author during the visit.

The MF in Tinderhøj School was designed by By Rum Skole, a company from Denmark. The intention of the design was to develop a 100 m^2 Nordic quasi-natural MF in a primary school (By Rum Skole, 2022). Around 40 native species were planted, and most of MM principles were followed (2030 Skov, 2022). The species chosen included fruiting trees like *Malus sylvestris*, flowering and fruiting bushes like *Sambucus sp.* and *Syringa vulgaris*, conifers *Picea abies* and *Pinus sylvestris*, three *Salix* spp. species and many understory species including *Vaccinium myrtillus* and *Gallium odoratum*.

During thematic pre-planting activities, the students from 4th and 6th grades had a crash-course with a team of landscape architects and represented their expectations for the design of the MF by creating handmade models. In the process, there was focus on the form and experience of creating a small forest (By Rum Skole, 2022).

The planting was executed in two phases, engaging around 150 children in November 2022 and March 2023. The area designated for the forest was a former grassland with rich clay soil that did not require extensive soil preparation, according to the forest designer Adam Roigart.

The first phase of implementation included three different spots, separated by walking paths, to allow further contact of the students with the developing environments. There were different experimental approaches in the final step of planting, with soil covered with straws in one of the spots, and

no cover on the other two. The second phase was implemented in spring 2023, with similar species choice. In this area, there was no mulching.

Another experimental effort was to spread native species seeds over the planting sites, but they did not develop according to expectations.

2.2.4 École Communale de Barvaux

The École Communale de Barvaux, is located in the District of Barvaux-sur-Ourthe, belonging to Durbuy municipality in Eastern Belgium. It is a municipal primary school, with students from nursery to the 6th grade (École de Barvaux, 2024). In collaboration with the company Urban Forests, a 100 m^2 was planted on the school grounds in 2018 (RTBF, 2024). Urban Forests is responsible for more than one hundred MFs in Belgium and France (Urban Forests, 2024) and have planted more than 118,000 trees (Restore Forest, 2023). The visited forest was designed by the biologist and founder of Urban Forests, Nicolas de Brabandère, who followed our visit in October 2024. According to him, it was one of the first MFs planted in Europe. He told us that this MF is considered self-sustainable.

Brabandère mentioned that in 2021, when the forest was around two years old, there was a flooding in the school area due to heavy rains and the rise of the Ourthe river level (Dewals et al., 2021). After the event, it was observed that the developing forest was not damaged, as expected by Dr. Miyawaki when designing the Great Forest Wall in Japan (Miyawaki, 2023).

2.2.5 Ejby Skole

The Ejby School is located in Glostrup municipality in Denmark. It accommodates 127 children from grades zero to six and is surrounded by greenery, including a mature forest. Children use the green spaces for outdoor lessons and after-school activities and also have access to a nearby pond. Students can safely cycle to school and are encouraged to practice sports and swimming. The school is proud of the community and family engagement in its activities (Skolerne i Glostrup, n.d.).

The initiative of the implementation of the MF was intended to increase the ecosystem services in an already rich school ground and was financed by Nordea bank.

2.3 Excluded cases

Both forests close to Louise Schroeder Schule in Hamburg, Germany, were excluded from the research after being visited, because they had school children participation in the planting, but were not located close to the involved school. It was observed by the author that children from this school could not have regular access to either MFs.

The Oakwood Primary Forest in Scotland was also excluded because the school did not return the contacts and when arriving at the location, it was found that the school was still on summer break, the forest was fenced at the school ground and could not be reached by the author.

The MF at the Rudme Friskole in Denmark was already two years old and developing well, but the school was on autumn break during the chosen days for field visit. When contacted by phone, the school director said that this forest is still young, and even though the school children were engaged in the planting, they are not yet having on-site activities, but on the nearby cultivating plots and wooden shelter. He said that in the future they are probably going to develop open-air classes there. As a result, this MF was also excluded from this report.

3. Results

3.1 Atlantic Forest Classrooms in CEU Tiquatira, São Paulo, Brazil

This MF was visited in November 2023, 13 months after its planting (Figures 2 and 3). It was observed to be a well-established forest, with some trees measuring more than 3.5 meters in height. According to the planting NGO's co-founder, the expected survival rate for the forest should be around 87%. The educational center's cultural assessor, which followed the visit, Mônica Fróes, was very enthusiastic about the development of the forest. Two weeks after our visit, the NGO staff performed the annual maintenance on the forest, which consisted mostly of weeding and pruning of some species destined for green fertilization, leaving the branches and leaves on site for soil enrichment (Figure 4).

The CEU Tiquatira's Manager, Marta Gomes Barbosa Oliveira, was interviewed about having the MF's project in their facility:

> "The Formigas de Embaúba project has a gigantic impact on our territory, which is a territory of great vulnerability. The CEU Tiquatira is located in the Penha region, in the city of São Paulo. And the NGO is in various CEUs of the city, planting the mini–Atlantic Forests, bringing impacts to the entire ecosystem of our region and schools, raising awareness to climate change and to the need to have this mini forest inside our facility."

> "Children participate in everything, from cultivating the land since the tiny seed. From knowing the seeds, which trees will be planted, which plants will help these baby seedlings grow. When we have the mini forest planted, it is like a nursery, [the seedlings] are babies growing, in need of care. Children learn from the beginning, from the seeds, which plants they belong to, what they will provide, what impact they have on nature, [the children] participate in all of this."

> "The impact [in the educational center] is gigantic, also bringing pedagogical aspects such as teachers' and coordinators' training [...] to work directly in the classroom. [...] The teachers and coordinators, in the pedagogical part, aggregate this knowledge inside the classroom, go there and manage the forest. For us, it is a huge wealth to have this mini-Atlantic forest within our territory."

The mother of one student in CEU Tiquatira's primary school, who immigrated from Haiti, was interviewed by the coordinator while harvesting Andu beans from the mini forest:

"These beans are very good and delicious [...] they have much iron."

Figures 2 and 3: Miyawaki forest planted on CEU Tiquatira in São Paulo, Brazil.

Figure 4: CEU Tiquatira's MF on maintenance day in November 2023. (Courtesy of Marta Gomes Barbosa Oliveira)

3.2 Broomfield Forest, Balornock Primary School, Glasgow, Scotland.

In November 2023, the forest reached two years. According to a Sugi NGO report, after some difficulties with establishment due to wind and rain overexposure, it started to take shape, with decreasing weed pressure. The survival rate was 85%, and the average height of the tallest trees was 1.8 meters (Sugi Project, n.d.b).

The MF was visited for this research in August 2024, with two years and nine months of growing. It was well developed, with the identification of *Tilia* sp., *Betula pubescens*, *Betula pendula*, *Alnus incana*, *Alnus glutinosa*, and *Acer* sp. The understory had, among other species, *Rosa canina* and thistle, the national flower symbol of Scotland.

While performing the visit, which was on a sunny Saturday afternoon, three children that were playing at the park got curious about the activity around the forest and approached the research staff to ask questions about the work being performed. They proudly expressed that they participated in the planting day in 2021, and they referred to the forest as theirs, expressing ownership of the place. While photos were being taken to identify the trees and understory species, they asked to be photographed in front of their forest (Figure 5). Their parents also approached and asked questions about the research project and the author's opinion on the development of the forest. They were surprised about the international importance of this natural area in their neighborhood park.

Figure 5: Young planters in front of the Broomfield Forest. Balornock Primary School is on the background.

In a post on social media, the students involved in the planting expressed their experience in a few words, such as: “We are helping to heal planet Earth,” “We are growing nature,” and “The trees are my new favourite place” (X, 2021).

3.3 Nordic Pocket Forest, Tinderhøj School, Rødovre, Denmark

In our visit, in September 2024, after a hard implementation phase in the first after-planting year, well-developed *Salix* sp. specimens were observed reaching up to 3.2 m in height. The conifers were still struggling to develop and there were plenty of weeds and grass growing in the unmulched plots (Figure 6).

Figure 6: Unmulched plot with plenty of grass and weed cover. At the bottom it can be observed an underdeveloping Picea abies seedling.

Figure 7: Mulched plot, showing small amount of weeds.

According to the school's green coordinator, the sites implemented in the fall developed well and the area with straw mulch thrived better than the others (Figure 7). The plot planted in spring and with no mulching suffered more with the hot dry summer in 2023 and demanded intense irrigation. After the summer, it started to thrive.

The green coordinator was interviewed and reported that the MF still does not attract much of the children's attention, since they have another mature forested area in the school ground. She considers that the most important outcome was the sense of ownership of the MF by the students. The

school staff observed that they care more about the environments where they were involved in the planting, like the MF and the cultivation plots, in contrast to isolated trees planted in the school area by the municipality. The MF was protected by a palisade and a log fence, to delimit the boundaries and prevent children playing nearby from throwing balls into the area (Figure 8). She also mentioned that the aspect that most frequently attracts students around the forest nowadays is the presence of insects, mostly bees during flowering season, on the flowered bushes like *Sambucus nigra* and *Phacelia tanacetifolia*. There was also a bench in front of the forest that children used for socializing, but it unfortunately had to be removed.

Figure 8: MF surrounded by protecting palisades and log fences in Tinderhøj's schoolyard.

3.4 Barvaux Municipal School's MF, Durbuy, Belgium

In our visit in October 2024, we found out that this MF is thriving, despite some broken branches (Figure 9), attributed to the children's play. Trees up to 11.2 meters high were noted. All of the observed species are native to the area, such as *Corylus avellana, Acer campestre*, *Prunus avium* and *Quercus robur*. There was an initiative to evaluate the development of *Ulmus glabra* in a MF. This species is commonly affected by the Dutch elm disease, and unfortunately the planted specimens are already showing signs of the illness.

Figure 9: Broken branch (red arrow) on a developing tree in the École de Barvaux's MF.

The forest has 34% mortality reported in its last evaluation in 2023 (Brabandère & Malengreau, 2023) and supports biodiversity not only in plant and animals presence, but also on soil analysis, which has evidenced fungi, protozoans, nematodes, and bacteria (Brabandère & Malengreau, 2023). The same study also compared the temperature between the forest interior, a nearby lawn, and a concrete playing area on a sunny day. They found that the forest registered 7°C lower temperature than the nearby lawn and 26°C less than the concrete playing area nearby.

According to Grim Jacobs, the director of the school, the children were always allowed to spend time in the forest unsupervised, but since September 2024 it was decided to restrict their access to it because of tree damage. He observed that the children who planted the trees six years ago cared more about them. However, the youngest tree planters are now in the sixth grade, and it is their last year at this school. The younger children that later joined the school do not feel much attachment to the forest.

Six children in the sixth grade were interviewed by the researcher (Figure 10). They mentioned that they gave names to their trees and still knew which ones they had planted six years ago. They said that they always cared for their forest, but the small kids are messy and are not equally careful about it. When asked about the activities that they performed at the forest, they answered that they gathered there for socializing, but also for playing games like hide and seek. They said they enjoy it when the teachers take them to have classes in their forest. The director mentioned that after access was restricted, the children are asking more frequently to have outdoor classes there. The young interviewees said that they studied forest biodiversity on-site and learned to identify the tree species by their leaves and other features. According to Jacobs, after the restriction, birds are already being observed in the forest, and they were scared off by the kids' noise before.

Figure 10: The author interviewing the children involved in planting the MF in the background. The school director and the forest designer were following the visit.

3.5 New forest implementation at Ejby School, Glostrup, Denmark

In October 2024, the company By Rum Skole in Denmark invited the author to follow the planting of a MF at Ejby Skole, a primary school in the municipality of Glostrup, Denmark. The co-founder of the company and landscape architect in charge of the project, Adam Roigart, explained that the students involved in the development of the forest were chosen by the school, so a class of the fifth grade was engaged in the tasks. The first step was to present the project to the school children, and they expressed their own expectations for the new forest. They made models for the expected design (Figures 11 and 12), which were compiled and taken into consideration for the final design developed by the By Rum Skole team. The children asked during the planning process that the forest should have a path crossing it as well as a rounded area in the middle for them to spend time inside and socialize in the future.

Figure 11: Planting area model made by the By Rum Skole landscape architects' team. The models made by the school children fitted like cassettes into the area model.

Figure 12: Models made by Ejby School children expressing their expectations and insights for their MF design.

After a feedback meeting with the presentation of the design (Figure 13), the children were gathered in the planned MF site, which previously had its soil analyzed and prepared by the municipality. The kids were divided into groups and received different tasks, like preparing the fence poles for protecting the planted seedlings and delimitating the paths through the forest with woodchips and tree slash.

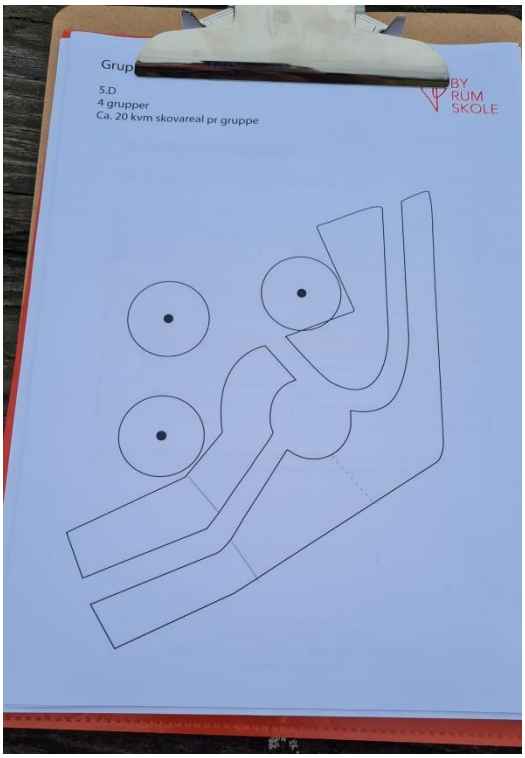

Figure 13: Final design for the Ejby School's MF.

The third day was designated for planting (Figures 14 and 15). The children were divided into small groups of three to four and received a delimited area for planting. They were given instructions about the distance between seedlings and the planting technique. Adults supervised the procedure, but the children performed the task without much intervention. The children were asked to give names to their seedlings, to increase their attachment to the planted trees. Most of them were very enthusiastic about it and were very careful about following the planting instructions. In a modified approach from the original MM, children were also asked to plant perennials between the trees and shrubs seedlings. When questioned about the experience, some children mentioned that they liked it very much and were eager to see the forest developing. This is despite the fact that they were already in the fifth grade, and they would only study at the school until the sixth.

On the last project day, the children prepared a speech for the inauguration of their forest in the presence of the whole school community. They also made signs to identify the tree species planted.

In the future, all school students will have the opportunity to follow the development of the forest. Local associations will be further trained in how citizens can strengthen biodiversity. Association members and after-school

children will also have the opportunity to follow the development of the forests and add new elements (By Rum Skole, 2024).

Figure 14: Children receiving information about the MM planting technique.

Figure 15: Ejby School children planting a seedling at their MF.

4. Discussion

4.1 Children's participation and ownership of spaces

Varied expressions of ownership of spaces were noticed in all study cases. According to Korfiatis and Petrou (2021), ownership is a sense that develops through participation by the involvement of children in all the tasks of a project. It was observed in the Danish Ejby School MF planting process that the landscape architecture company responsible for the project tried to engage children in the process from the idealization of the forest and its design process, gathering and respecting their suggestions and wills. They also engaged the whole class in the different steps of implementation of the plan, from the fencing and delimitation of paths to the planting and the final confection and affixation of signs. In the middle of the forest, a rounded space was created for socializing that could also be used as an open classroom, as requested by the children. This affords students to develop a sense of place and attachment (Shahrad, 2024) by spending more time in a space where they have invested not only physical effort but also mental energy in creating.

The implementation of MFs in schools had varied levels of children participation, according to Hart's schematic ladder (1992). In most but not all of the cases studied, the children had the opportunity to express their wills during the planning and design process. At the very least, they were consulted and informed about their roles in the forest planting. However, most of the cases were adult-initiated assignments with shared decision-making processes. Our sample focused on children up to sixth grade, but there are examples of projects that were developed based on the ladder's eighth and highest participation step. In the Rosborg high school forest in Vejle, Denmark, a MF is planned for establishment in January 2025 under the guidance of the NGO 2030 Skov. The project started with the initiative of three high school students as a science fair project, which won a prize and gained local visibility (2030 Skov, 2024).

The harvest of Andu beans in the forest by a parent in Brazil expresses that the ownership of the MFs belongs not only to the children engaged in the planting, but also extends to their families. In a study conducted in Cyprus, children exhibited similar behavior, claiming the right to take home the

vegetables from the plots they had planted. They believed their efforts in growing the plants meant they owned the harvest (Korfiatis & Petrou, 2021).

The Broomfield Forest in Glasgow instilled a sense of pride and ownership in the children who participated in the MF planting. The three children with their parents at the park during our forest assessment approached the author voluntarily. They were moved by their curiosity about all the activity around the forest and also wanted information about the disturbance in a space that they considered theirs by right. A sense of pride for their ownership of this otherwise public space was present in their speech, notably in the possessive pronoun “our” used to refer to the forest. The noticeable sense of ownership developed by the act of planting a tree, and thus a forest, influences the efforts towards its preservation in the future. As mentioned by Miyawaki (1999) the adults that once planted a MF tend to preserve it and take their future children and partners to the same environment in the future, developing a long-term link to that forested landscape.

Similar behavior was observed in the Tinderhøj Nordic MF in Denmark, where the forest was planted by students in the fourth and sixth grades. The interviewed coordinator observed that these children cared more for the young trees they themselves planted, compared with other students who were not involved in the planting. She also noticed that the trees planted in the schoolyard by the municipality's employees were not cared for as much by the students and were often damaged, unlike the pocket forest trees that the students planted.

The visit to the MF at the Barvaux Municipal School in Belgium led to a discussion about the restriction of forest access by children when unsupervised by adults. It is important for children to be given autonomy and independent mobility to explore green spaces (Wales, Mårtensson & Jansson, 2020), but it was understandable that it was a necessary measure at that point to let the forest recover from damage. The forest designer, the school director, and the author, along with some children engaged in the planting, pointed out that as the students involved in the forest project got older and moved on to new schools, they were replaced by younger students who didn’t have the same emotional connection to the green space and, as a result, didn’t care for it as much. The interviewed children brought the same conclusion up as a complaint: that the younger kids did not care for the forest, were messy, broke branches, and stepped on seedlings. The biologist mentioned that this behavior was compromising the quality of the forest nowadays and the director said that after only one month of restriction the birds were already

being seen again in the forest. The children said that they remembered the exact trees that each one of them planted and that their trees have names given by them. The adults discussed that, since this is the last remaining class that participated in the forest development, some strategies could be adopted to engage the younger classes and try to foster place ownership on them. When leaving the school, the older children could donate their own trees to young students and inform them of the name given to each tree. This repeated process over the next years could rescue the sense of ownership and responsibility to this MF.

The same approach was suggested when following the planting at Ejby school in Denmark. The school had chosen only one class to engage in the design and planting of the MF, and those children will leave the school in less than two years. When receiving instructions about the seedlings, the author asked students to give names to the trees they were planting and observed their progress during the process. They gave first names, names of pop stars and soccer players and cute nicknames to their seedlings. This could be useful in the future to engage younger children and develop place attachment. On the last day of the planting process, there was a ceremony in the presence of the whole school community, local authorities, and the landscape architect's company to inaugurate the MF. The children gave a speech collectively written by themselves. This was a valuable approach to engage the other children and school staff in nature conservation of that green space.

4.2 Biodiversity and environmental awareness

Even a young forest like the Danish Nordic forest, with only one and a half year of development, was capable of attracting children's attention towards its biodiversity. Visiting pollinators during spring is one of the outcomes of a diverse natural environment, and the MFs are expected to express 18 times more biodiversity than a forest of the same age (Manuel, 2020). While the forest is not officially being used as a classroom, the children are engaging with it in a way that teaches them about nature. They are still able to absorb lessons from the forest on their own, outside of a structured classroom setting.

The areas designated to become MFs were formerly green areas with mown lawns in most of the visited school yards. Lawns are considered biodiversity deserts by ecologists (Ignatieva & Ahrné, 2013). They are usually

composed of grass monocultures, do not afford complex food webs, and do little for biodiversity conservation in urban environments (Borden et al., 2022). MFs, even young and before reaching their climaxes, are much more biodiverse (Ottburg et al., 2018) than yards and parks with manicured mowed lawns.

The Atlantic Forest Classrooms in São Paulo municipal suburban school grounds, as seen at CEU Tiquatira, are useful for the enrichment of the teaching process in resource-limited neighborhoods. The beneficial contact of the school children to nature goes further than the day of planting. Teachers can supplement lessons of various subjects related to natural sciences with hands-on experiences. The NGO staff engage with the academic community, teachers, and students in their cultural activities during the annual maintenance, with one example being the singing of traditional songs related to nature conservation. Children's families are also encouraged to be in the school yards and be in contact with the developing MF, as we observe in the example of the student's mother using her informal knowledge to identify species of edible plants that she can take home and feed her family with. School children in lower socio-economic environments may face many obstacles preventing them from having contact with greenery (Gabriel, 2021), and implementing MFs in their schools can mitigate at least this aspect of their unequal social realities. Children are recognized as social actors and agents of change at their communities (Wales, Mårtensson & Jansson, 2020) and the act of inviting their families to be in nature in the middle of a concrete megalopolis like São Paulo introduces nature preservation as a familiar topic of daily life.

4.3 Design aspects

It was observed that when the entire traditional MM was not followed, the MF struggled more to develop in the early years.

Soil preparation, even in fertile soils, is a crucial step for ensuring the successful establishment of newly planted seedlings, due to the higher demands of rapid forest succession (Hellwer, 2023). Soil improvement ensures adequate aeration (Miyawaki, 2023), keeps adequate moisture (Lewis, 2021), and makes nutrients easily available as it increases soil biomass, accelerating tree development (Ottburg et al. 2018). The addition of wood chips and straw to the soil before planting supports beneficial fungi

development and enhances carbon sequestration by the soil (Ottburg et al. 2018). Because natural succession occurs in a shorter time span in the MM, the seedlings demand extremely good soil conditions.

The species choice is also crucial to the forest establishment. Careful research into the native species in the planting area is valuable and necessary. According to the MM, only native plants should be chosen to make it possible for the MF to reach its climax in the intended period (Miyawaki, 1999). Conifers are not usually included in MFs, and preference must be given to native broadleaved species (Miyawaki, 2023). It was observed that *Picea abies* seedlings were almost all struggling to establish in the Danish Nordic MF. Conifers also tend to limit understory development due to the acidic litter from their needles, (Mestre, Toro-Manríquez & Soler, 2017) and can compromise succession. In the Zaanstad study (Ottburg et al., 2018), two different tiny forests, both using a similar MF implementation method developed by a Dr. Miyawaki's disciple, were compared with each other and with controls. In one of the tiny forests, the method was completely followed, while the other was adapted to allow the planting of fruit-bearing shrubs. After two years, both plots showed significantly higher biodiversity compared to the control plots, and a distinct pattern of resident and visiting animals was observed in both forests. The full-method forest fostered more heat-adapted species, and the adapted method had more pollinators (Ottburg et al. 2018). These MFs were young when assessed, as our forest subjects also are, leaving open questions about how succession will develop in the next decades, and if there will be any impact of the use of non-native species and conifers in the future.

Special attention must also be given to the choice of invasive species. We observed the use of *Syringa vulgaris* on the Danish forests. This is an ornamental exotic species from the Balkans, widely introduced in the rest of Europe and North America with a high potential for spreading, competing with native species. In Denmark it is not listed as threatening, but in the neighboring Sweden it is (GRIIS, 2020). If it is expected to be a future quasi-natural climax forest, an exotic and potentially threatening ornamental species could pose a risk to the succession process.

Some observed forests with adapted MM did not receive mulching cover on planting day over the full area, which delays the forest implementation and poses serious risks to the seedling's development. Mulching keeps soils moist, especially during dry European summers, and avoids weed establishment, which could compete with the intended species for resources (Lewis, 2021). The use of wood chips for soil covering also allows

a better establishment of fungi and enhances carbon uptake (Ottburg et al., 2018).

Another issue was the experimental planting of *Ulmus glabra* seedlings in the effort to support the species despite of the threatening Dutch elm disease caused by fungi *Ophiostoma ulmi* and *Ophiostoma novo-ulmi* (Potter et al. 2011). It was observed that it did not pose risks to the neighboring trees, nor to the children playing in the MF, but it increased the forest mortality rate and could therefore delay the succession and the development of a climax forest.

4.4 Miyawaki Forests in Southern Sweden

The simple answer to our question about the feasibility of MFs in Sweden is “yes.”

There have been no reported cases of the MM being used in boreal zones, but the method was developed in Japan, where the climate varies by terrain and latitude, ranging from temperate to subtropical (Chapman, 2024). The results have been shown to be positive in both settings. There is a wide range of well-developed MFs planted around the world and on all continents (Sugi Project, n.d.c), suggesting that the method is applicable to temperate regions within Sweden.

Further indication of the potential is the successful establishment of MFs in Denmark, which has climate conditions similar to the southern third of Sweden. The potential native species in both places would be nearly the same. For example, beech (*Fagus sylvatica*) would play a crucial role in reforestation, as it was once widespread across southern Sweden, along with genera such as *Quercus, Tilia, Alnus,* and *Corylus*, before the onset of widespread deforestation (Björkman, 1997).

Public engagement in environmental-friendly initiatives and climate change-tackling approaches is common in Sweden (Gabrielsson, 2016), there would likely be low barriers for the development of projects by NGOs and companies that implement Miyawaki’s principles. Lund municipality has been a leader in the implementation of green infrastructure, nature-based solutions, and in offering ecosystem services to citizens (Lunds Kommun,

2024). Future initiatives could seize the opportunity to align with municipal green policies, not only in Lund but also in other less “green” Swedish cities.

The Swedish school settings are similar to the Danish, with children encouraged to learn by experience and with frequent contact with urban open spaces and greenery since preschool (Jansson & Lerstrup, 2020). It is not unusual to see groups of children followed by teachers lead around parks or even nearby woods. Most Swedish schools offer some sort of green areas within its limits, but many are still mostly covered by concrete, creating a demand for greening approaches (Mårtensson et al., 2014). Lack of space is not a limitation for implementing a MF (Sugi Project, 2024). On the contrary, it represents a niche for the development of MFs. The opportunity to regreen school grounds should be attractive to urban planners and landscape architects.

Absence of funding may not be an impediment for the planting of forests in schoolyards because Swedish municipalities usually have a budget designated for green initiatives (Lunds Kommun, 2024). As seen with the example of most of the visited forests, public and private institutions usually engage themselves in funding environmental initiatives (UN Decade on Restoration, n.d.b). If this type of funding is not available, we may refer back to the Japanese traditional planting festivals (Miyawaki, 2023), in which volunteers engage themselves in funding, preparing, and planting the *shinju no mori* sacred forests. If there is community mobilization, many citizens are engaged, and costs are distributed. The benefits to the community are immense, for the next generations and for the environment.

5. Conclusion

Children have always been included in Japanese tree planting festivals, which inspired Dr. Akira Miyawaki to develop the Miyawaki method. The process of planting Miyawaki forests on schoolyards is a powerful tool, not only enriching the school environments, but also giving opportunity for school children to effectively participate in the planning, design, and implementation of their wills over their schoolyards. Children are not only consulted or informed about decisions but are given power and influence.

When engaged both intellectually and physically in the implementation of MFs, the students develop place attachment and sense of ownership for these spaces, which thus result in forming environmentally aware individuals that will care for nature and can spread this awareness to their families and their own children in the future.

MFs are usually used in schools as open-air classrooms for natural sciences classes and as playing environments, but many other uses can be found. Cultural activities and family integration are just two of many such examples. For schools with mainly gray surfaces, the development of quasi-natural forests in a short period of time can provide ecosystem services and enrich the playing environments.

Most of the MFs excluded from the study still had potential for use by teachers and children, even at a young stage of development, for studying biodiversity, pollination, or decomposition, for example. We encourage the staff of these schools to take the opportunity to enrich the teaching process and take advantage of MFs in a close distance.

The MM has been developed and used for decades in a successful way, and most of its statements have been extensively tested and have clear purposes and roles in the fast forest succession process. We advise that all of these crucial steps may be followed for the best development of the newly planted forest.

Based on the positive results obtained on the field visits, we conclude that it is certainly possible to implement MFs in school grounds in Southern Sweden, where the climate is temperate. We highly suggest that urban planners, landscape architects and managers engage in this effort to enrich

schoolyards, empower children, and contribute to biodiversity and nature conservation.

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