



Acció
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**Criteria for planting tiny,
fast-growing urban forests in the
metropolitan area of Barcelona**

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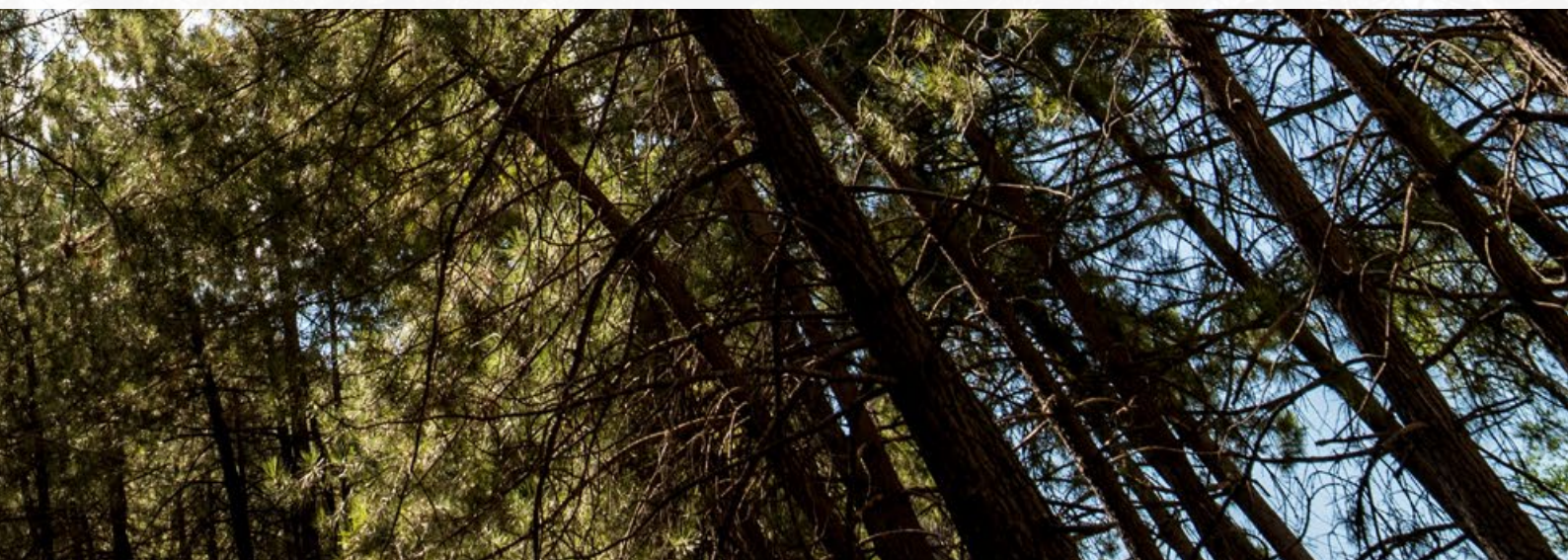
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Acció climàtica

In the context of the climate crisis in which we live, implementing solutions that are effective and long-lasting is essential, given the uncertainties awaiting us. It is difficult to know what we might face in the future, and maybe the only certainty is that there will be change and we will have to learn to live within the limits of our planet.

We know that creating more resilient cities, adapted to the challenges of climate change, is a priority of the highest order for local governments and people who live and work in cities. In addition, we know that urban environments, where many climate and related social challenges are concentrated, will inevitably play a key role in tackling climate change. It is therefore a matter of extreme urgency that we start taking daring, transformational action against climate change.

When we talk about *climate action* we are referring to policies, measures and programmes aimed at cutting greenhouse gas emissions, strengthening resilience to climate change, implementing adaptation measures and generating a collective transformation through environmental education. It also includes support for initiatives that aim to achieve these goals.

Local climate action aims to seek out possibilities for innovative solutions and the challenge lies in applying them, spreading them and strengthening their impact throughout the country. This is particularly important in such a densely populated and urbanised territory as the metropolitan area of Barcelona, with its numerous climate challenges.

It is also becoming increasingly necessary to integrate alliances between urban areas and the parts of the country they depend on into this action, otherwise climate action will be partial and limited. Two clear examples of this are the future shortage of water resources and the need to recover agricultural and forest land.

This collection of publications features different aspects of climate action and includes practical tools and work frameworks to guide specific actions at local level. The collection includes the methodological guide for defining the potential for installing green roofs in the metropolitan area, bioclimatic criteria to improve the quality of urban green spaces, an informative summary of the climate change vulnerability index and a methodological guide to defining local adaptation plans.

Introduction

We are pleased to present the guidelines for the implementation of tiny, fast-growing urban forests. This document provides an initial outline of all the aspects that should be considered when planting a tiny, fast-growing urban forest using the Miyawaki Method, applied to the environmental conditions in the metropolitan area of Barcelona.

The method is gaining ground in many cities and regions around the world. It is a nature-based solution that meets the need for a fast and efficient increase in urban green spaces providing environmental benefits within cities. The Miyawaki Method requires rigorous attention to steps such as soil diagnosis, proper species selection, site preparation, planting density and initial maintenance management.

Establishing a set of guidelines allows standardised approaches and ensures technical consistency to avoid overlooking essential factors that determine the success of a tiny urban forest in all phases of implementation while preventing misinterpretation of the Method and ensure that each forest meets solid and comparable quality standards.

A guideline document also facilitates planning, as it sets out the required tasks and allows for more accurate estimates of time, resources and budgets. In doing so, it makes it easier to replicate the initiative in different areas of the territory, based on the same guidelines. It also helps reinforce a solid and accessible framework to explain and justify the technical decisions adopted, as well as informing the citizens about the importance and rigour of such projects.

It should be stressed that this is a living, evolving document. Its guidelines should be continuously reviewed and updated based on information and experience gained from planting and maintaining tiny urban forests. In doing so, we will be able to adapt and improve our practices based on the new knowledge we acquire.

Description of the Miyawaki Method

The Miyawaki Method is an ecological restoration technique that dates back to the 1970s, when Japanese botanist Akira Miyawaki applied the concept of *natural vegetation potential* (vegetation that would develop naturally, without human intervention) to create dense forests in degraded or highly industrialised urban and peri-urban environments, enabling forests to grow 10 times faster and 30 times denser than in a natural forest.

While a lush forest develops over 150 to 300 years on fertile land with no human intervention, applying the Miyawaki Method means a relatively mature forest can be obtained within only 20 to 30 years.

A forest developed using the Miyawaki Method consists of a number of plant communities chosen to recreate a forest ecosystem similar to one existing naturally without human intervention.



First experience in applying the Miyawaki Method: the Oita production plant forest (Japan, 1971)

Key points in the Miyawaki Method

- 1. Select native and other species adapted to the regional climatic conditions** to ensure the plants are better adapted to the terrain and climate of the area, favouring the resilience of the vegetation. When selecting species for planting, it is important to examine the vegetation of representative Mediterranean ecosystems and forests in the region (for example, holm-oak woods, pinewoods, maquis and riverbank forests).
- 2. Improve the soil structure** to promote permeability. This involves decompacting the soil and then adding organic material to improve its physical, chemical and biological properties before planting the seedlings. Adding biomass helps to enriching the soil with organic matter, which enhances future interaction between trees and soil and promotes their growth.
- 3. Arrange seedlings randomly** to reproduce the complexity of a natural environment, involving

competition and complementarity between species, thus accelerating vegetation cycles. This contributes to the diversity and development of a dense and resilient forest community.

4. **Shape the terrain** to maximise rainwater capture and adapt it to local climatic conditions. The topography of the terrain is important in small forest design, as slopes and areas of higher land influence infiltration and surface runoff, making the adaptation and suitability of the terrain a key factor.
5. **Autonomy of the forests.** After three years, the trees should be over two metres tall and no longer need human intervention to survive. However, this depends on climatic conditions in each location.

In the case of the metropolitan territory, most sites have been affected by humans, leaving the soil degraded and infertile. However, they may still be candidates for this type of solution, as the Miyawaki Method has a high potential for ecological regeneration, especially in abandoned or degraded urban areas, because it promotes the restoration and generation of ecosystems.

Benefits of urban forests for the environment and human health in a context of climate change



Cork oak trees in Los Alcornocales Natural Park. Author: Fernando Domínguez Cerejido, 2016. Available at: https://en.wikipedia.org/wiki/Southwest_Iberian_Mediterranean_sclerophyllous_and_mixed_forests. CC BY-SA 4.0

Forest restoration and the creation of new forests in “abandoned” urban areas is a good way to enhance urban green spaces and mitigate the effects of climate change. In addition, these tiny urban forests can provide numerous benefits, such as:

- Lowering air and soil temperatures in and around the forest.
- Reducing the heat island effect.
- Cutting air pollution, as trees absorb CO₂ and store carbon.
- Reducing noise pollution, as vegetation absorbs ambient noise and reduces its intensity.
- Greater biodiversity.
- Greater control of surface runoff in heavy rains.
- Improving people’s health and emotional well-being.
- Providing spaces for socio-educational and pedagogical activities.

General guidelines to plant tiny urban forests

Site selection

A key factor in the success of an urban forest is the ecological regeneration potential (ERP) of the area to be restored. ERP is the capacity of the ecosystem to recover after some form of disturbance (e.g. forest fires, logging or land clearing, land development and agricultural activities).

Analysing the ERP of a terrain to determine the viability of planting a tiny, fast-growing urban forest requires a number of actions on the site:

- Assessing the condition of the site and how it is used. This process includes:
 - Obtaining complete knowledge of the climatic conditions of the area of study.
 - Conducting a study on soil structure, quality and composition.
 - Making an inventory of biodiversity in the area, including both animal and plant life.
 - Identifying the uses of the site.
- Identifying past and present disturbances produced by human activity, through land use history.
- Identifying the risk of natural disturbances, such as fires, floods or pests.
- Studying the natural regeneration capacity of native species.
- Analysing propagation mechanisms to increase the regeneration capacity of the plant species.
- Identifying possible hurdles to establishing the forest, such as invasive species, chemical pollutants and other forms of pollution.

All these factors will determine the feasibility of ecological regeneration in a given area. The more favourable the conditions there are, the more suitable the site will be for planting an urban forest using the Miyawaki Method.

Assessment of the climatic conditions

Another factor that determines the successful development of the forest community and its long-term survival is the local climatic conditions, as well as future climate projections, in a context of global change.

The municipalities in the metropolitan area of Barcelona have a Mediterranean climate, characterised by mild winters, recurrent periods of drought during the summer months, and rainfall concentrated in the spring and autumn months.

These climatic characteristics have a major influence on soil make-up and the type of vegetation that grows in it.

It should be noted that climate models predict a change in temperature and rainfall patterns during the 21st century, which could affect the long-term survival of the forest. The main climatic trends in the Mediterranean region are:

- Rise in annual warming rates, especially in summer.
- More extreme temperatures and heatwaves.
- Slight decrease in average annual precipitation.
- Greater frequency and intensity of heavy rainfall events.
- More frequent episodes of drought.
- Rising sea levels, causing coastline retreat.

These trends projected for the Mediterranean region will have knock-on effects, such as more forest fires and river flooding, which will in turn affect native vegetation.

Soil composition

It is important to establish the characteristics of the soil under study by assessing the following characteristics:

- Texture and degree of compaction. The relative proportion of mineral particles of different sizes (sand, silt and clay) in the soil. Ideally, it should be loam soil, with a proportion of 20-45 % sand, 20-50 % silt, 30-40 % clay and 5-10 % organic matter. This determines properties such as water retention capacity, permeability and ability to break down organic matter.
- Proportion of organic matter (OM). Amount of decomposing plant material and organisms. Soils with a moderate OM percentage (between 5 % and 10 %) are ideal for natural vegetation growth, as they are fertile and well-structured.
- pH. The degree of acidity or alkalinity of a solution. In the case of soil, most plants are considered to grow well at a pH between 6.0 and 7.5, since soils with this pH provide most essential nutrients (such as nitrogen, phosphorus and potassium) at optimal amounts for plants.
- Sodium (Na⁺) adsorption in soil. This parameter is representative of the sodium concentration in relation to magnesium and calcium, indicating the soil infiltration capacity. High values (above 26 milliequivalents per litre, mEq/L) suggest that irrigation water may cause sodicity problems, as it promotes soil compaction and hinders water infiltration.

All these characteristics indicate the composition of the soil, but measures can also be taken to improve its quality, such as adding substrates and organic fertilisers.



Coffee seedlings growing among banana trees in an agroforestry area near Nazaré Paulista, state of São Paulo. Author: Lucas Ninno. Available at: <https://dialogue.earth/es/alimentos/378612-brasil-impulsa-la-recuperacion-de-tierras-degradadas/>

Adding substrates helps improve soil aeration and reduce compaction, which allows the roots to grow further.

Some substrates – such as wood chips – function as water retainers and help retain moisture in the soil.

Organic fertilisers provide essential nutrients for plant growth and improve soil quality. Such fertilisers are vermicompost (100 % organic fertiliser obtained through the decomposition of organic matter by red worms) and bokashi (compost fermented using micro-organisms in anaerobic conditions).

Preparing the site

Once the site for the urban forest has been identified, a number of steps are required to prepare it for planting.

- 1. Marking out the site.** It should be at least 4 metres wide, and between 100 and 1,000 m² in size. It should also receive at least eight hours of sunlight a day. The site can be marked out using natural elements, such as shrubs or hedges, or artificial elements, such as wooden fences. Given the low rainfall in the metropolitan area, priority should be given to plots where the topography of the land allows for the creation or use of small depressions to facilitate natural water retention and infiltration.
- 2. Drawing up an irrigation plan.** This involves designing an irrigation system (manual or automated) based on the water requirements of the plants, supported by wells and elevated tanks, if appropriate.
- 3. Planning the project execution.** Areas should be allocated for storing material, saplings kept until planted, and rest areas provided for workers and volunteers. Sufficiently wide entrances should also be created to allow heavy machinery, such as excavators, to enter if required.

4. Marking out and defining the planting areas.

Seedlings should be staked for planting. They are normally distributed in small areas, one square metre each, in which four to eight seedlings are planted.

Finally, the forest can be customised and complemented with other elements, such as water features (streams, ponds, etc.) or leisure and rest areas.

Designing the list of species

The choice of plant species is one of the key steps of the Miyawaki Method and should follow these criteria:

- They should be native or other species adapted to the Mediterranean climatic conditions, to ensure their compatibility with the rest of the local ecosystem.
- They should be adaptable to future climatic conditions. Among other features, the chosen species should be resistant to high temperatures, have low water requirements and be able to withstand prolonged periods of drought.
- They should be suitable for the soil conditions and composition of the site.
- They should occupy different forest layers, i.e. a combination of trees, shrubs and plants. This creates a natural forest community and enhances ecosystem diversity.
- The presence of insects should be encouraged, to facilitate pollination. In addition, plant species that bear fruit during the migration or wintering season should be chosen, to boost strategic support for wildlife.

Consequently, the specific characteristics of each site (substrate, water availability, sunlight) should be considered when drawing up each list, to obtain a structural base that recreates a natural Mediterranean ecosystem.

Planting

The planting process in the Miyawaki Method is as follows:

1. **Set out the planting quadrants.** In the Miyawaki Method, each small plant community is created on a 1-m² plot. Ensure a mixed topsoil layer (80-100 cm) in the plot in order to favour decompaction and increase water infiltration into the subsoil. Spread the soil again to provide a uniform surface. Add biomass and mix it evenly with the rest of the soil.
2. **Prepare the seedlings.** Ensure the roots of the seedlings are moist and in good condition before planting.
3. **Place the seedlings.** After digging a small hole with a shovel, place the seedling inside and level the soil around the stem, without pressing or compacting it. It is important to ensure good contact between the roots of the seedling and the soil. These distribution guidelines should also be followed:
 - 3.1. Planting density should be high, with the seedlings placed very close to each other (4 to 8 seedlings/m²), to simulate natural competition.
 - 3.2. The aim is to recreate an ecosystem as diverse as possible, ensuring that each quadrant contains a mix of species from both the shrub and tree layers.
 - 3.3. Seedlings should be randomly distributed, not planted according to a pattern.
 - 3.4. There should be a minimum straight-line distance of 60 centimetres between specimens of the same species. This promotes the overall structural diversity of the forest and impedes the spread of pests and diseases.
4. **Apply mulch.** Mulch is a layer of organic material applied to the soil surface with the aim of conserving moisture, improving soil fertility and reducing the growth of invasive species, among other benefits.
5. **Initial irrigation.** Once the forest has been planted, it should be watered to ensure soil compaction and to provide the seedlings with the initial water reserves they need.

Maintenance during the first three years

Thorough maintenance should be provided during the first three years. Although the aim of the Miyawaki Method is to create a self-sustaining ecosystem that does not require maintenance or human intervention, a number of actions are required during the first three years to lay the foundations for the forest and ensure plant survival.

Specifically, three key changes in forest growth occur in the first three years:

- The deep root systems of the plant species develop.
- An internal microclimate is created to reduce water and heat stress.
- Biodiversity increases, which helps to create a more complete and healthier ecosystem.

Maintenance tasks

- The forest should be kept free of invasive species for the first two to three years. Once the forest starts to grow, the proliferation of invasive species will decrease significantly.
- The forest should be watered periodically (either manually or automatically) according to the water requirements of the vegetation, but a minimum of once every two months. During the summer months (June, July, August) the forest should preferably be watered weekly.
- On the day of planting, initial watering should be generous.
- A low-pressure spray hose should be used to avoid damage to the seedlings.
- The characteristics of the water should be considered, as some species cannot tolerate certain characteristics, such as a high calcium carbonate content.
- Adequate drainage must be maintained to prevent the water accumulating anywhere in the forest. Building water retention dams is not recommended, as the accumulation of water can drown the roots.

- The plant mortality rate is usually between 2 % and 5 %. Mortality should be checked approximately three to four months after planting.
- Regarding pests, use of chemicals (such as pesticides or inorganic fertilisers) should be minimised, to allow the forest to slowly build up its own mechanisms to stay healthy.
- The mulch layer should be maintained for at least one year. It is best not to remove fallen leaves from trees, as they provide food for the soil-dwelling micro-organisms responsible for decomposing organic matter.
- The perimeter of the site should be defined by barriers, using synthetic or plant materials, to prevent large numbers of people from passing through, thereby maximising survival of the seedlings in the early stages.
- As the seedlings grow, they may need support structures to ensure they remain upright and do not bend or weaken.
- The forest should be kept clean of litter.
- It is recommendable not to prune or cut back the species in the forest. However, if it is necessary, for whatever reason, the remainder should be returned to the same forest.



Replacing the mulch layer in a Miyawaki forest in Toulouse, France

Follow-up and monitoring

Growing a Miyawaki forest requires regular follow-up and monitoring, more intensively in the early stages. This type of project also plays a significant social and educational role, by raising awareness of the importance of preserving the environment, through actions such as environmental activities and workshops.

Soil moisture

In a Mediterranean urban forest designed using the Miyawaki Method, it is essential to implement an irrigation programme during the initial period to compensate for the water constraints inherent to the Mediterranean climate, characterised by hot, dry summers and irregular rainfall.

The Miyawaki Method requires a soil with sufficient moisture to sustain the initial intense competition among individuals and species for resources such as water or nutrients. Without a proper irrigation programme, soil dehydration can lead to significant plant mortality.

Irrigation also promotes biological activity, such as the decomposition of organic matter and proliferation of micro-organisms that improve soil structure and fertility. Healthy soil retains moisture better and enhances the resilience of the forest.

The irrigation programme is designed to be temporary and adaptive: intensity is gradually reduced until the plantation is completely self-sufficient. This approach ensures that the forest develops sustainably, with minimal long-term impact on water resources. However, given the variability of rainfall in the region, it is advisable to leave irrigation systems in place to support the vegetation at times of insufficient rainfall.

Plant survival

Regular monitoring of plant survival helps detect possible problems in the plant community in the early stages, so that corrective measures can be implemented to reduce mortality rates.

In addition, other functions are served by monitoring plant survival, such as:

Monitoring progress towards forest self-sufficiency. If many plants survive the first few months, measures can be taken to progressively reduce human intervention, such as decreasing irrigation and the provision of external nutrients.

Providing information for other experiences. A high survival rate of the plant community is largely due to implementing the practices and procedures of the Miyawaki Method in a particular environment, which can be replicated in projects with similar characteristics.

Growth of the planted species

The following actions are required to control the growth of species:

- Eliminate invasive species to avoid unwanted competition.
- Protect trunks, stems and leaves from herbivorous animals.
- Add organic matter and biofertilisers to the soil to boost plant growth.
- Replant the seedlings in cases with high mortality rates.

Applying these techniques ensures optimum forest development, boosting the biodiversity and long-term health of the ecosystem. In addition, it allows the overall density of the vegetation to increase.

Pest and disease control

In the Miyawaki Method, disease control is crucial for ensuring healthy urban forest development and avoiding imbalances that could compromise biodiversity and the ecological function of the ecosystem. In Mediterranean environments, climatic conditions can favour certain pests and pathogens, both of local and tropical origin, so monitoring and preventative action is essential.

The high planting density characteristic of the method means that plants are in proximity, which can favour the rapid spread of pests and diseases. Examples include:

- Borer beetle (*Xylotrechus arvicola*), which affects holm oaks and oaks, significantly weakening them.
- Powdery mildew (*Oidium*), which can affect species such as the Aleppo pine or the strawberry tree.
- Pine processionary (*Thaumetopoea pityocampa*), a common pest that can severely affect pines and reduce their vitality.

Continuous monitoring and the implementation of ecological control measures, such as natural predators or manual removal of processionary nests, are essential for maintaining a healthy and resilient urban forest.

Monitoring biodiversity

Monitoring biodiversity helps in assessing the ecological success of the urban forest and ensuring the ecosystem functions in a balanced way. In terms of biodiversity, the Miyawaki Method aims to recreate a diverse and indigenous forest, where each species plays a specific role in the ecological cycle.

The diversity of plant species boosts the presence of insects, birds and other organisms, creating a complete and self-sufficient ecosystem. Biodiversity monitoring helps detect possible imbalances, such as monodominance of a single tree species or the emergence of invasive species. For example, in a Mediterranean forest, the presence of birds, such as the great tit, or pollinating insects, such as bees, are indicators of positive ecological health.

In addition, monitoring means adjustments can be made to enhance the resilience of the forest regarding external factors, such as climate change and human pressure.



The European honey bee (*Apis mellifera*) contributes to pollination of shrubby plant species such as rosemary (*Salvia rosmarinus*) and thyme (*Thymus vulgaris*)

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