Planning, Planting, and Maintaining New Urban Forests in the Metropolitan Area of Milano

Case Study of Forestami

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Abstract

Urbanization presents profound challenges to environmental sustainability, characterized by the depletion of green spaces and the degradation of urban ecosystems. Acknowledging the pivotal role of urban forests in mitigating environmental degradation and enhancing urban life quality, cities are increasingly adopting participatory approaches to afforestation. This paper explores the relationship between research and the practical implementation of urban forests, emphasizing the significance of constructing a robust network of stakeholders.

The case study selected is the research project called Forestami, which aims to plant three million new trees and shrubs within the metropolitan area of Milan by 2030. This initiative promotes green infrastructure, ecological connections, and related ecosystem services; improves the public health of citizens; increases urban and peri-urban permeable surfaces; and protects and expands territorial biodiversity. By examining the interplay between research insights and on-the-ground implementation, this paper underscores the critical importance of forging a diverse network of stakeholders to navigate the complexities of urban forestry initiatives. Through this collaborative framework, cities can cultivate resilient and vibrant urban ecosystems that enrich the lives of residents while safeguarding the environment for future generations.

Keywords

Engagement, land use, trees, urban forestry, urban planning.

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Introduction

Urbanization presents profound challenges to environmental sustainability (Eckert et al., 2014), characterized by the depletion of green spaces and the degradation of urban ecosystems. Acknowledging the pivotal role of urban forests in mitigating environmental degradation and enhancing urban life quality (Van den Berg et al., 2007; Bratman et al., 2012; Keniger, 2013), cities are increasingly adopting participatory approaches to afforestation (Cernea, 1989). This paper explores the relationship between research and the practical implementation of urban forests, emphasising the significance of constructing a robust network of stakeholders involved.

The case study is the research project called Forestami, which aims to plant three million trees and shrubs within the metropolitan area of Milan by 2030. Promoting green infrastructure, ecological connections, and related ecosystem services, the Forestami initiative also aims to improve public health, increase urban and peri-urban permeable surfaces, and protect and expand territorial biodiversity. The project started in 2018 with the aim of mitigating the effects and risks caused by climate change and improving overall air quality.

Urban forestry, encompassing strategic planning, tree planting, and management, aims to bolster ecological resilience, enhance air quality, mitigate urban heat island effects, and foster biodiversity (Lafortezza et al., 2009; Ekkel & de Vries, 2017; O'Brien et al., 2017). Traditional top-down approaches to urban forestry often overlook community engagement and fail to address the diverse needs of local residents. In contrast, a participatory model for urban afforestation advocates for the active involvement of community members, stakeholders, and local organizations across all stages of the reforestation process. This model prioritizes community empowerment, social inclusion, and collaborative decision-making, thereby ensuring the enduring success and sustainability of urban green spaces. By examining the interplay between research insights and on-the-ground implementation, this paper discusses the critical importance of forging a diverse network of stakeholders to navigate the complexities of urban forestry initiatives. Through this collaborative framework, cities can cultivate resilient and vibrant urban ecosystems that enrich the lives of residents while safeguarding the environment for future generations.

Territorial Analysis: Città Metropolitana di Milano, Italy

The Città Metropolitana di Milano (CMM) is a densely populated area in Northern Italy, with a population of 3.25 million inhabitants (ISTAT, 2023). The Municipality of Milan, the capital of the Lombardy Region, accounts for 42% of the population of this territory. CMM encompasses 133 municipalities with a total surface area of 1,575.65 square kilometres, approximately 6.6% of the Lombardy Region (Milan Metropolitan Area, Metropolitan Observatory, accessed December 2023). From the analysis of different land uses, data related to CMM shows that approximately 41% of the territory is urbanized, equal to approximately 645 square kilometres, while 52% remains agricultural land. Only 7% is designated as forests (data processed by DUSAF 6.0) [fig. 1].

CMM is characterized by dense urbanization in the northern part, interspersed only with small enclosed agricultural plots, and numerous urban parks and gardens scattered throughout the residential fabric, including the prominent presence of Parco Nord Milano. These spaces are dedicated to leisure, free time, and recreational activities, defining the quality of this environment. The southern part of CMM is distinguished by the presence of Parco Agricolo Sud Milano, established in 1990 to protect agricultural fields from erosion due to urban development. Today, it primarily hosts agricultural production, covering an area of 47,000 hectares.

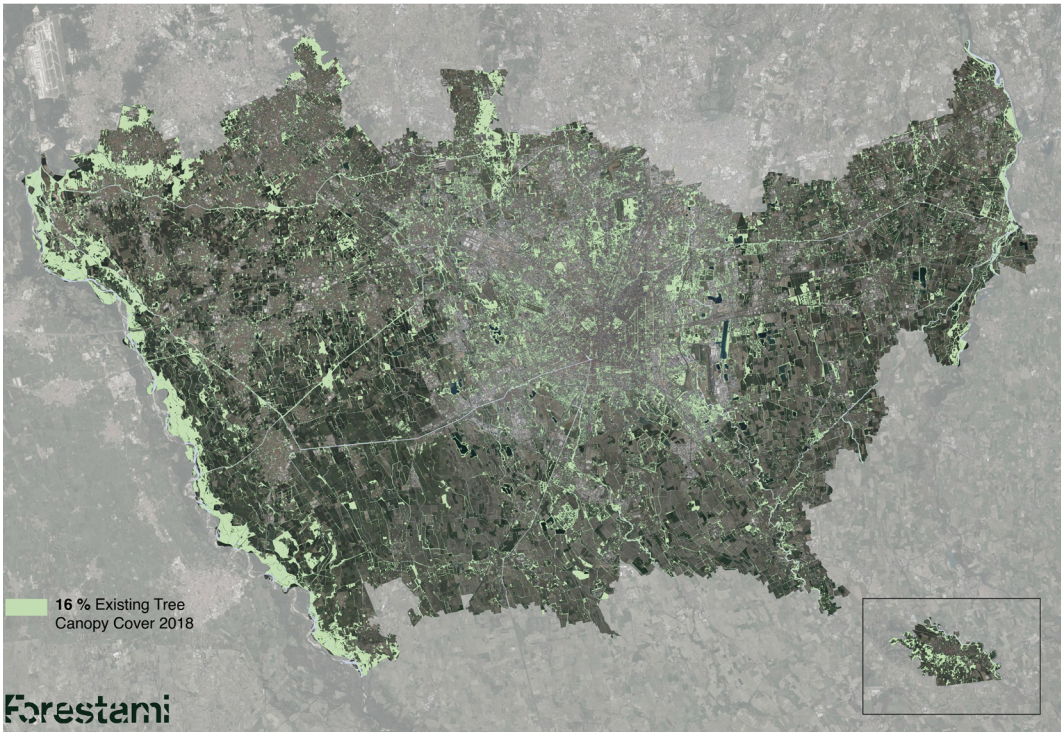

FIGURE 1 *Existing Tree Canopy Cover, Città Metropolitana di Milano, 2018.* Elaboration by Politecnico di Milano Lab SimUrb Laboratorio di Simulazione Urbana Fausto Curti

Steps towards Afforestation

Priorities

When initiating a project aimed at planting three million new trees and shrubs within a densely urbanized environment such as the CMM, defining the initial set of priorities within the afforestation strategy becomes crucial. This process connects the importance of increasing natural capital with addressing specific territorial challenges and provides a potential roadmap for the spatial planning of new plantations.

Therefore, the research initially focused on studying the characteristics of the CMM in relation to spatial information concerning permeable/impermeable surfaces, water runoff, urban heat island effect, and population density. Two specific research areas were developed for the project: (i) data regarding the existing tree canopy cover and (ii) the percentage of the population with accessibility to existing green spaces contributing to the well-being of people.

Tree canopy cover serves as an indicator of vegetation density, widely used in the literature as an alternative to simply counting the number of trees. It accounts for the actual consistency of vegetation in an area, representing the projection of tree crowns on the ground. Within the count of tree canopy cover, only trees with a tree canopy are identified, indicating that they are alive and in good health. Various calculation methods exist to obtain tree canopy data, with the precision of estimates depending on available data. For estimating the tree canopy cover of the CMM, satellite images were primarily used to provide an initial assessment of existing greenery through the calculation of the Normalized Difference Vegetation Index (NDVI), indicating the vitality of greenery. Through research conducted in collaboration with LabSimUrb of Politecnico di Milano, it was determined that the existing tree canopy cover of the CMM was 16.58%.

Equitable distribution of urban green space has long been a topic of research, given the increasing relevance of ecosystem services and their impact on people's well-being (Feng et al., 2019). Accessibility, measured in terms of time and physical distance, to open spaces is essential for well-being. Studies demonstrate that residing in green neighbourhoods and having daily exposure to trees reduces stress levels and physical fatigue (Marselle et al., 2021; Ward Thompson et al., 2016; Wolf et al., 2020). Accessibility serves as a key indicator for measuring the equity of spatial distribution of urban green spaces, directing policies and investment decisions for new projects. Accessibility to a space refers to the ability to overcome resistance, such as travel time and distance required to reach a location (Páez et al., 2012). Through spatial analysis of the different databases, the research conducted found that within the Metropolitan City of Milan, 37% of the residential urbanized surface area is accessible within 300 metres of publicly accessible green open spaces. All these studies and analyses formed the baseline for our priority strategy, providing a roadmap for the areas of intervention.

The Potential

The second step involved the analysis of the territory's potential to accommodate trees and shrubs by considering different land uses and understanding the capacity of the CMM to host trees [fig. 2].

The approach taken was to construct a programmatic scenario wherein the design is not dictated by a specific project but rather by the availability of areas suitable for tree planting. The study analysed and provided estimates of afforestation across 21 project focuses. Initially, afforestation scenarios were developed based on the categories of urban and peri-urban forestry identified by the Food and Agriculture Organization (FAO) in its Guidelines publication on Urban and Peri-urban Forestry (2016).

After contextualising these categories and their associated afforestation actions to the territory of the Metropolitan City, the main urban and peri-urban afforestation strategies were identified. These were useful for the subsequent development of project focuses and the consequent identification of areas and pilot projects.

The project focuses were identified by a working group based on several main criteria: (i) the maximum potential for afforestation achievable based on technical and territorial knowledge pertaining to the project; (ii) the social and symbolic significance of certain land use categories; and (iii) the clear identification of stakeholders with whom dialogue is necessary.

The relevance of this study is to:

- Provide a sound background to the capacity of the CMM to host three million new trees and shrubs;
- Facilitate specific initiatives across various project focuses through the development of sectoral projects and policy instruments, promoting interventions;
- Make the mapping openly available to all, allowing for the precize and localized verification of suitable areas, starting from the larger areas and proceeding on a municipality-by-municipality basis.

The analysis revealed that more than three million new trees and shrubs could be accommodated. In total, planting three million new trees and shrubs corresponds to an increase in tree canopy cover from 16% to 21%.

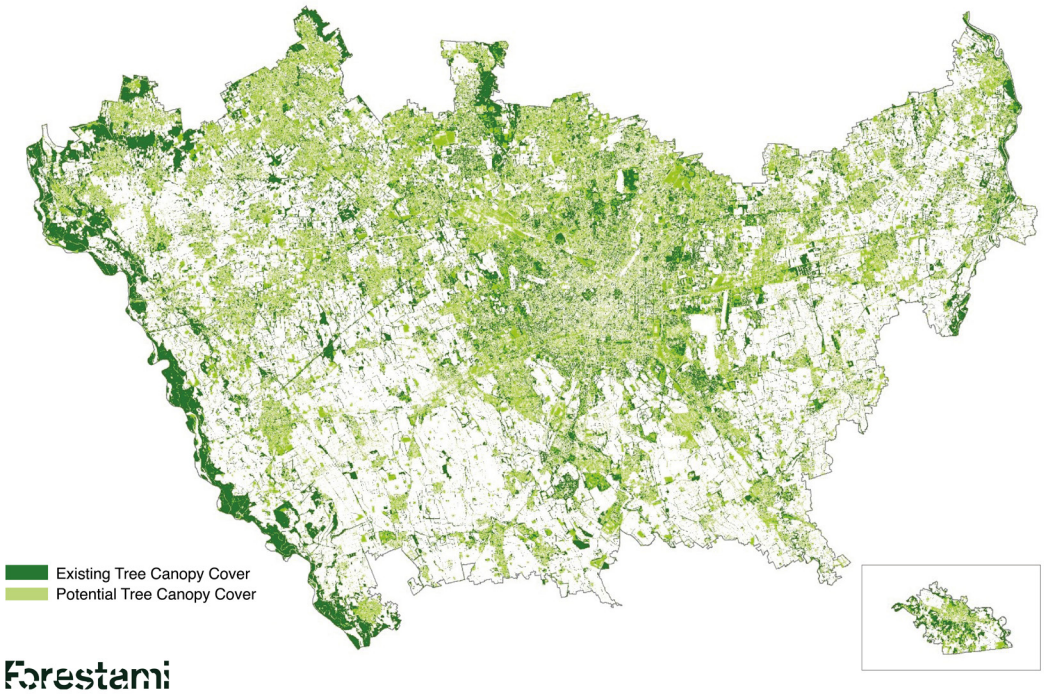

FIGURE 2 *Potential spaces for tree planting*, Città Metropolitana di Milano, 2019. (Elaboration by Politecnico di Milano Lab SimUrb Laboratorio di Simulazione Urbana Fausto Curti)

The Willingness to Plant

The third element, an ongoing process, involves the collection and design of the transition of the CMM into an urban forest. To achieve this, the research group is engaging in discussions with the different municipalities in CMM (133) to identify areas that may be involved in the urban forestry process. This activity is fundamental to the entire process as it defines the challenges, relations, and characteristics of different territories and creates a strategy for afforestation, providing a design framework for the entire metropolitan area.

To engage the municipalities, the research facilitates one-to-one discussions with the technical and political sectors for each municipality. In March 2019, the Metropolitan City of Milan managed the distribution of a questionnaire, resulting in initial feedback from administrations regarding the availability of areas for urban afforestation interventions. This allowed for the first expressions of interest from the municipalities towards the project and the opening of initial dialogues.

The engagement of local entities has also been supported over time by actors within the territory who advocate for interests and activities sensitive to urban afforestation themes. Within this framework, project presentations and roundtable discussions have been organized, constructing a potential agenda for collaborations and synergies.

The main operation representing the activity of engagement and dialogue with the territory is based on the construction of detailed reports tailored for each individual municipality. Starting from the areas identified by municipalities as potential intervention sites, strategies and shared visions are developed to help visualize the ecological transition of the territory. Engaging with existing or updated urban planning instruments is the other fundamental aspect for the realization of shared strategies, providing the real technical and political intentions of the transformation of the territory on which we can imagine the ecological transition.
The emerging themes and needs of the local areas are rearticulated within complex scenarios where municipal resources intersect with other possible interventions, involving different entities, often private, as well as existing and planned territorial projects with synergies with the themes addressed.

The Planting

At the end of 2019, the Municipality of Milan, the Metropolitan City, Parco Nord Milano, Parco Agricolo Sud Milano, and ERSAF (Regional Agency for Agriculture and Forest Services) signed a joint Memorandum of Understanding with Politecnico di Milano. These partners then worked together with Fondazione di Comunità (a third-sector organization) to establish a fund, Fondo Forestami, which provided capacity for collecting donations from private entities. In early 2020, thanks to the initial donations, the first plantations started in the Metropolitan City before the planting season finished.

Parallel to that, a technical committee comprising representatives from Parco Nord Milano, Parco Agricolo Sud Milano, ERSAF, the Municipality of Milan, and Politecnico di Milano was formed, with the objective to oversee the plantations. This committee is responsible for overseeing the design, coordination, and evaluation of all projects directly funded by Fondo Forestami. The committee, thanks to a Memorandum of Understanding signed with Fondazione di Comunità, works with territorial social cooperatives and is responsible for designing, planting, and maintaining the plantations for a period of five years [fig. 3].

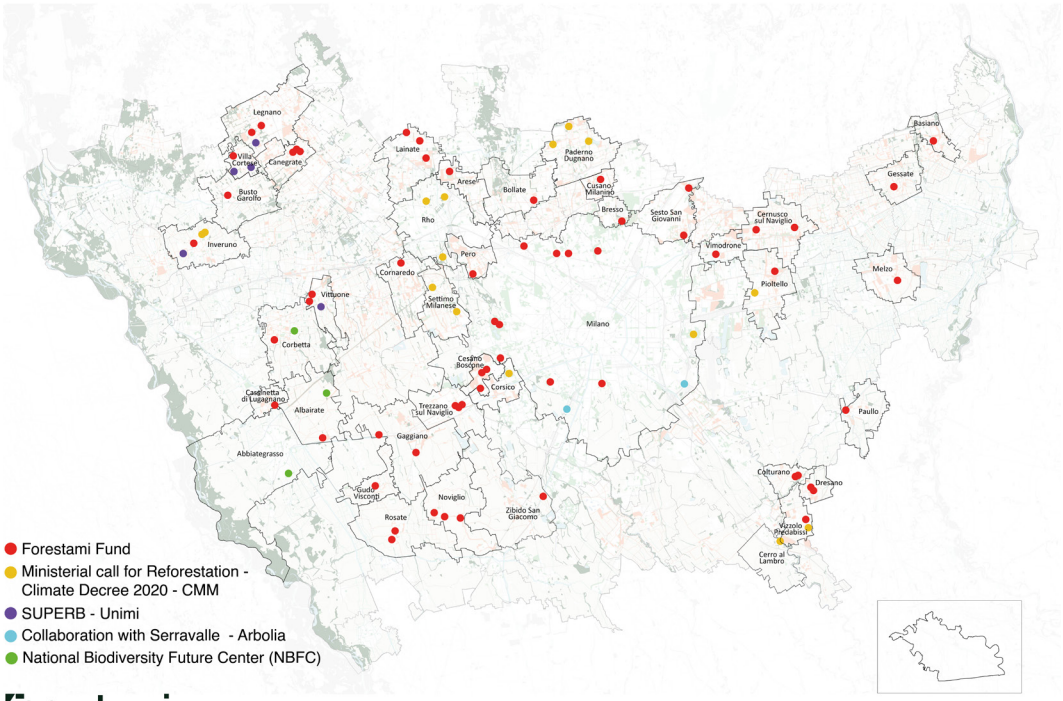

FIGURE 3 *Tree planting map within Città Metropolitana di Milano since 2018 by Forestami.* (Elaboration by Politecnico di Milano, Forestami research group)

Planting trees and shrubs includes the specific study of the area, its context and functions, and the choice of the layout and species, which follow a very specific methodology.

In most cases, areas predominantly targeted for urban afforestation projects consist of green spaces, both small and large, which have become part of the public heritage through various urban transformation processes. These areas are often found in residential or industrial contexts, having undergone construction activities and subsequently transferred to municipal ownership. Their soil is often highly compacted and mixed with debris residues. Additionally, they may include remnants around roads and roundabouts (urban and peri-urban), with poor soil and environmental quality due to high temperatures near infrastructure.

As for urban parks, the main aspects to consider include: the park's character (whether predominantly naturalistic or recreational), the size of the interior space that could accommodate new plants, and park usage elements. The specific history leading to the construction of the area in question is also relevant in guiding project design.

Among the areas better adapted to hosting plants with a high level of successful plantation are agricultural and uncultivated areas. Most interventions conducted by Forestami in these types of areas have yielded very satisfactory results due to the presence of a good organic soil component. Uncultivated areas are those no longer involved in agricultural production for various reasons. Therefore, if publicly owned and not subject to urban planning interests, municipalities designate them for renaturalization interventions, often integrating and revitalising spontaneous growth that has occurred over time due to lack of cultivation.

In the case of agricultural fields, the decision to convert all or part of the area to forest/tree-lined areas/ hedgerows is carefully evaluated in collaboration with municipalities. Factors considered include location, context relationship (peripheral or interstitial), and the potential contribution to agroforestry structure implementation and ecological and environmental connectivity at the urban and territorial scale.

Interventions carried out by Forestami so far mainly fall into the aforementioned types of areas precisely because they are considered among the most appropriate to accommodate new plants. However, there have also been experiences of plantations [fig. 4] in more challenging environments, such as disused and/or degraded areas. These areas require significant efforts and resources for actions such as depaving, cleaning the area of various objects, and careful agronomic species selection for compromized soils. These are complex areas of work that, together with the broader issue of depaving hard surfaces (roads, parking lots, squares, etc.), represent the highest ambition of afforestation projects in terms of city transformation: making room for nature by reversing the physical structure of the soil from impermeable to permeable.

Working with Nature-Based Solutions (NBS) in these environments is very challenging, as it involves not only high implementation costs but also dealing with what lies beneath the asphalt. A significant issue affecting many urban areas, particularly streets, is the presence of underground utilities, often without precise technical information. Along with overhead power lines, the utility system strongly influences the implementation of afforestation projects, affecting tree placement and species selection.

For these issues, the research group of Politecnico di Milano plays a fundamental role in proposing and experimenting with new forms of regeneration and space redevelopment, increasingly bridging the gap between study, opportunity, and application.

However, the evaluations and choices of areas to initiate urban afforestation projects and interventions are also the result of a process of engagement with the territory. This involves aligning all necessary elements to ensure that the Forestami project accompanies and promotes change, not only in the physical aspects of places but also in cultural aspects. This helps to foster greater awareness and a change in perspective among those who support it, from administrators to individual citizens.

To date, 63 interventions have been carried out by Forestami Fund, while 88 interventions have been implemented through the collaboration among the entities since the establishment of the project.

The Tools

To actively provide space for the trees, two main tools have been created to sustain the change. The first refers to the engagement with the municipalities to have an official commitment to the project. The second element regards the creation of a repository of all the information, a unique geospatialized database comprising all the information related to the project.

Memorandum of Understanding

To officially engage the municipalities, a Memorandum of Understanding has been in place since 2020, "to pursue the construction of a strategic vision on the role of nature in the Milan Metropolitan Area, encompassing, enhancing, and valorising all major green systems within the Metropolitan City perimeter by planting three million new trees and shrubs by 2030. This is aimed at making the metropolitan territory

more resilient and effectively addressing issues related to climate change, while also increasing the natural capital and biodiversity of this territory" (MoU, Protocolli di Intesa Forestami, 2020).

The protocols outlined commit the involved municipalities to several key actions:

- Provision of public spaces: This involves the concerted effort to design and develop public spaces to improve natural capital. These areas will likely be targeted for interventions aimed at enhancing natural ecosystems, biodiversity, and environmental quality.
- Sharing a general framework of reference: The municipalities agree to share and use a comprehensive framework provided by the Polytechnic of Milan. This framework serves as a guide, offering prospective scenarios, ongoing projects aligned with the objectives of the Forestami initiative, and potential areas within private property that could accommodate interventions aimed at enhancing natural capital. This framework is intended to be dynamic and regularly updated.
- Implementing Forestami objectives: Through a Memorandum of Understanding, the municipalities commit to adopting the objectives and purposes outlined in the Forestami project. This entails integrating Forestami strategies into their own planning tools and collaborating throughout all stages of project development.

Collaboration and provision of technical information: The municipalities pledge to collaborate closely in all phases of the Forestami project, providing necessary technical information to facilitate accurate planning and effective implementation of interventions aimed at increasing natural capital. This cooperation ensures that the project progresses smoothly and efficiently.

Overall, the protocols emphasize collective actions among the municipalities to advance the goals of the Forestami project, integrating environmental objectives into urban planning and fostering collaboration between public and private stakeholders for the enhancement of natural capital. The project frameworks in which pilot projects are identified should be understood as dynamic and ever-evolving fields of action, thus subject to potential changes. The materials produced represent a platform for exchange and openness to new forms of implementation, support, and management of identified interventions; an exchange that indissolubly brings together technical and political aspects toward a shared approach.

FIGURE 4 *Tree plantations.*

The Database

To sustain the information provided by the different municipalities and all the other involved actors and institutions, a territorial database has been constructed to systematize and locate all collected information, thus generating data to support territorial investigation and scientific monitoring. The project focuses underlying the Forestami research are thus designed based on the areas identified by the municipalities and parks as possible areas for increasing natural capital. Often, it is through comparison and exchanges with the research group that the project frameworks are enriched through possibilities that were not initially identified by the same partners. This might involve proposing more specific projects and processes to be promoted, not only with the resources initiated by Forestami but also involving other actors. These might include landowners, farmers, companies, other private entities, and directing authorities.

Representation of areas potentially subject to urban afforestation interventions within an overall framework at the municipal scale. These areas include:

- Interventions financed and implemented through the Forestami project.
- Afforestation areas identified by the municipality and parks. These areas, whether public or private property, are identified during interactions with relevant entities and are categorized as follows:
    - Afforestation areas: These are areas potentially suitable for afforestation interventions, where the location and specificity of plantations depend on the type of project to be developed and yet to be defined.
    - Rows and hedges: These refer to potential planting of rows and hedges with identified intervention locations. These interventions often occur along existing or planned routes or involve the revitalization or establishment of existing rows or hedges.
    - Reflection areas: These are areas of varying natures and extent that could potentially undergo future afforestation interventions. It is important to initiate processes for activating and engaging potential stakeholders.
    - Other local afforestation projects: These are areas affected by ongoing or planned afforestation projects/interventions within the municipality or parks that have a synergistic and complementary role with the project framework built with Forestami.
- Afforestation areas identified by private entities. These are privately owned areas (individuals or groups of citizens, companies from the industrial and agricultural sectors, landowners, etc.) that may be subject to afforestation interventions due to their synergy with the project framework. Such interventions can be carried out according to Forestami's quality requirements and objectives using private resources, thus falling within the activities included in the project.

Dissemination

The dissemination of information and coordination among various institutions and citizens is another crucial activity. Since the inception of the project, the establishment of a database outlining plantation opportunities and monitoring the actual sites of plantation has provided valuable data and information to multiple institutions, research teams, and stakeholders. This facilitates the creation of new approaches to urban forestry, which is inherently complex in built environments. Establishing an urban forest requires the collaboration of diverse competencies from different backgrounds, all sharing the common goal of planting trees and shrubs.

Engaging the population is another essential aspect of the process. Since the inception of the project, the working group has designed various activities to create a community of interest, with the broad objective of recognising the importance of trees and shrubs for the liveability of our cities and being able to be part of this ecological transition. This engagement is achieved through joint plantation activities, initiatives like Scuola Forestami dedicated to kids in school, and Forestami Academy, a three-year programme dedicated to a large audience to increase knowledge in urban forestry, as well as programmes like Custodiscimi, which provided trees and shrubs to 5,000 citizens to improve knowledge on the species planted in CMM and the importance of caring for living species. These initiatives aim to create knowledge and communities that are aware of and empowered to take action to create, enhance, and protect urban forests, ultimately the biggest challenge to create substantial change in the CMM.

Discussion

Considering the vital importance of green spaces and tree-lined areas for improving physical and mental health, cooling the environment, enhancing air quality, increasing biodiversity, preventing floods, and boosting job opportunities, as evidenced by scientific studies, it is essential to examine some of the reasons behind the decline of urban forests in the decades preceding this project, as well as interventions to ensure a positive contribution of trees in our cities.

Three key barriers or complexities hinder tree planting in urban and peri-urban areas. The first is that trees require ample space to grow and thrive. However, in urban areas, green spaces are often contested due to various competing functions such as housing, commercial activities, production, and agricultural needs. Additionally, trees compete for space with infrastructure like roads, pavements, cycle paths, railways, and underground utilities. Building space for trees requires envisioning urban environments where vegetation is not confined to certain areas but is integrated as a fundamental component of the urban landscape. Addressing this challenge requires coordinated efforts across different departments and entities responsible for urban planning and management. Urban forestry must be viewed as a transdisciplinary sector that intersects with various domains, necessitating collaboration and coordination among stakeholders.

A second key barrier is that trees take time to develop and provide their full range of benefits. Unlike many other urban infrastructures with immediate impacts, the benefits of trees are often indirect and realized over time. While the initial investment in trees is relatively low compared to other infrastructure projects, the return on investment is not immediate. Careful nurturing, maintenance, and occasional replacement of trees are necessary to ensure their long-term viability and benefits.

A third key barrier is that trees are living organisms with their own needs and characteristics. Despite finding adequate space and securing funding for planting and maintenance, misapprehensions about trees persist. Concerns include potential hazards such as falling branches, clogged gutters from leaves, raised pavements from root growth, and obstructed visibility of commercial establishments. Additionally, trees may attract insects and animals, and certain species may produce allergenic pollen or toxic leaves.

Rebuilding a positive relationship with trees requires careful species selection, intensive educational campaigns emphasising the benefits of trees in urban environments, and fostering a sense of solidarity with trees amongst the public. Recognising the multifaceted benefits that trees bring to society and understanding the consequences of tree absence or scarcity are crucial steps toward fostering a harmonious coexistence between urban environments and nature, ensuring the sustainability of our cities.

Conclusion

The goal of planting three million trees and shrubs in the Milan metropolitan area is a joint endeavour, reflective of the complexity and interconnectedness of urban environments. In the face of pressing environmental challenges, the Forestami project emerges as a cornerstone of Milan's environmental transition.

Beyond its numerical target, Forestami transcends quantitative objectives to embrace a qualitative vision focused on enhancing and valorising existing and future green systems. At its core, Forestami is a testament to care, attention, participation, and shared responsibility through the act of tree planting.

Forestami seeks to amplify the myriad grassroots initiatives led by citizens, schools, associations, and environmental groups, harnessing collective efforts to improve the planet's future and the well-being of urban communities. From individual gardens and balconies to institutional spaces, everyone is invited to contribute to the greening of the CMM.

Yet, Forestami's vision extends beyond mere tree planting; it seeks to fundamentally alter the relationship between nature and the city across the entire metropolitan area. This paradigm shift needs widespread but decisive collaboration with the 133 municipalities of the metropolitan city and Milan's technical authorities.

To bolster natural capital, Forestami champions concrete actions aimed at promoting active and planned care of green spaces, ensuring the optimal delivery of ecosystem services and enhancing territorial governance effectiveness and quality.

With Forestami, the Milan metropolitan area pioneers an approach to urban forestry which could be applied nationally, fostering continuous woodland systems and vital tree networks that safeguard biodiversity, provide shade, mitigate urban heat, purify the air, reduce CO2 emissions, and enhance public health and quality of life for all residents.

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