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*Special Issue 2.2023*

# Burn or sink
# Planning and managing the land

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TeMA Journal of Land Use, Mobility and Environment

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# BURN OR SINK
# PLANNING AND MANAGING THE LAND

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# The Eco-Pedagogical Microforest a shared oasis of proximity. A cutting-edge project at the intersection of ecology, urbanism and pedagogy

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**Abstract**
Cities and urban areas are one of the critical global systems that can accelerate and upscale climate action and more than ever need to achieve the 11 goals of Agenda 2030 becoming inclusive, safe, resilient and sustainable. In 2019, Science published a paper suggesting that planting trees, on a massive scale and sustained period of time, represented one of the most effective solutions at our disposal to mitigate climate change. Cities across the world have started implementing urban forests to address multiple environmental issues. Urban forests are capable to provide more complete solutions than other urban NBS. In this context, the challenge for cities is to disseminate UF-NBS throughout the city in order to release environmental and social benefits even in the most dense areas, spreading wellbeing for all citizens. The paper illustrates a cutting-edge experimentation of a tiny forestation action at the neighborhood scale, aimed at integrating both regulative and social-cultural ecosystem services. In line with the principles of the UN Agenda 2030, the Eco-Pedagogical Microforest project, that took place in Rome, demonstrates that even a small patch of nature can increase young people's biospheric values, influencing pro-environmental behaviors and actions, enhancing wellbeing.

**Keywords**
Climate change; Green infrastructure; Urban forestation; Environmental learning; Citizen science.

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# 1. Climate change, green urge

## 1.2 Cities as key actors

New environmental, ecological and social emergencies call into question the Global Economic Model and the anthropocentric approach to development. Today, the planet's inhabitants exceed 8 billion (Worldometer, 2023) and will reach the threshold of 9.8 billion in 2050, according to UN estimates (United Nations, 2022). By the same date, the world economy could have more than doubled, according to the World Economy Report (PWC, 2017). But already by 2020, the weight of man-made materials exceeded the weight of biomass: not an easy achievement, marking a watershed moment for our species (Elhacham et al., 2020).

How can the course of events be redirected? In 1972, Aurelio Peccei, in the foreword to the Italian publication of the Meadows Report, expressed his fear of a dead-end crisis and the need to start a process that must go to the very roots of our economic model. As the founder of the Club of Rome noted at the time, "the political class in every country will continue to lag behind the times, prisoner of the short term, of sectorial and local interests" (Peccei, 1972). And 50 years later the framework is still the same. During the Sharm El Sheikh COP, in 2022, the nation-state engagements of the Paris summit (COP 21) have failed and a goal that seemed essential to keep global warming below the +1.5 °C threshold has vanished.

**Fig.1 Global warming. Low cost NBS to temporary mitigate heat island in cities. Paris, Parc Rives de Seine**

Producing less energy, reducing fossil resources consumption, a sector that for Our World in Data Lab accounts for 84% of global primary energy, seems unachievable (Our World in Data, 2023). But it has been possible for a handful of weeks. In 2020 the planet came to a standstill to fight the Covid-19 pandemic, which caused over six million deaths (WHO Covid 19, 2023). Instead for the seven million people who lose their lives every year due to air pollution, the world's great economies are unwilling to slow down the GDP locomotive (WHO, 2021).

Pending structural macro-economic revisions and the consideration of models that move in the direction of prosperity without growth (Jackson, 2009), the UN urges cities to become agents of change with Agenda 2030, Objective 11: Make cities and human settlements inclusive, safe, resilient and sustainable (United Nations, 2016).

This perspective turns out to be not only achievable, because mayors are more collaborative than national rulers, but also strategic: 70% of greenhouse gas emissions and more than 50% of the world's population are concentrated in cities (World Bank, 2023). Cities and urban areas are one of the critical global systems that

can accelerate and upscale climate action (Papa et al., 2015; AA.VV., 2018). As well as gaining prominence in its own right, this focus on cities is also to be found in the increasingly converging international agendas for urgent action on climate change and biodiversity.

The New Urban Agenda SDGs have pointed to both the interconnected nature of sustainable development and the importance of cities and communities. If states stand back, cities are at the forefront of mitigation and adaptation actions. As the Covenant of Mayors initiative demonstrates, cities have become key actors of a worldwide green, soft transformation towards resilience. Since 2008 over 10,000 cities and mayors are increasingly the protagonists of change adopting the Sustainable Energy and Climate Action Plan (SECAP) and taking action to implement it (European Commission, 2023).

## 1.2 The green colour of urban resilience: from NBS to UF-NBS

In order to create more resilient and sustainable cities and societies, Europe set its agenda to implement research and innovation projects. Since 2014, the European Commission has been funding multiple green projects for cities through the Horizon 2020 programme (H2020) by identifying Green Infrastructures (European Commission, 2013) and Nature-Based Solutions (European Commission, 2015) as key elements to mitigate the impacts related to Climate Change in urban contexts (Galderisi & Ferrara, 2012).

Among NBS that produce services, which in turn provide social and ecological benefits for communities, the role played by Urban Forests is growing in importance. Therefore cities across the world have started implementing Urban Forests to address multiple environmental issues (Uforest, 2022).

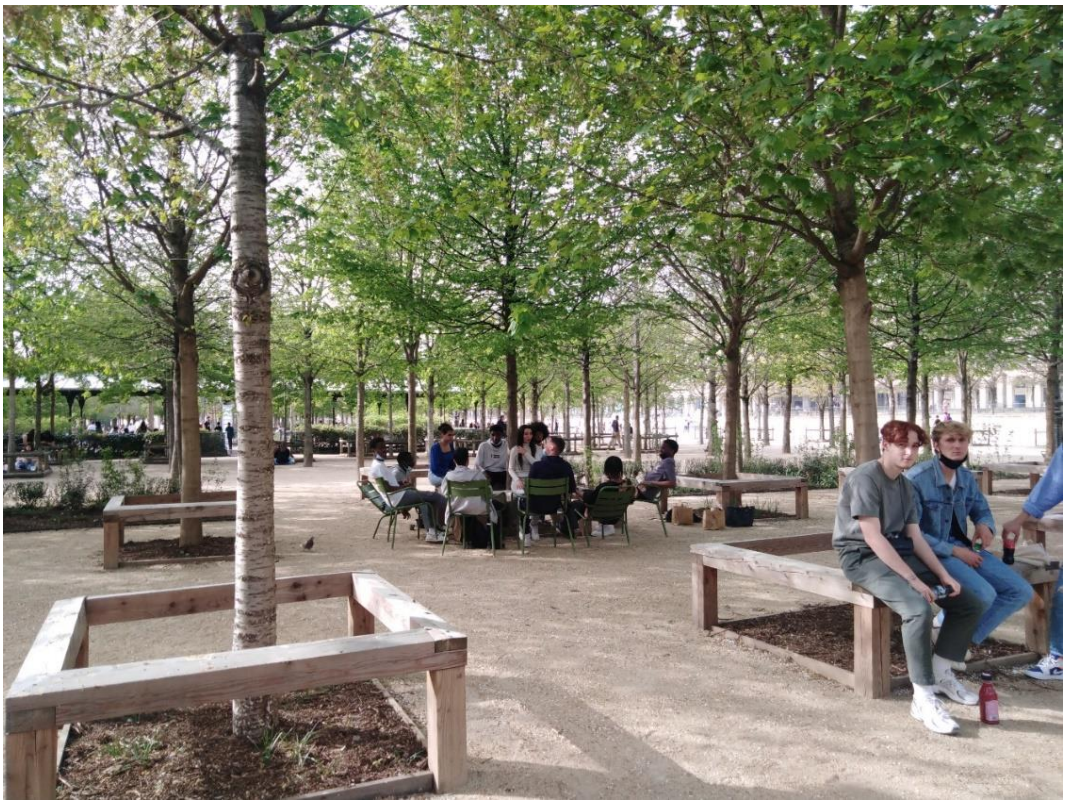


**Fig.2 Urban Forest an effective solution to increase people's resilience**

In 2007, the New York 'Milliontreesnyc Programme' opened the race for urban forestation. Since then, other capital cities follow the path of trees to counteract the effects of climate change and increase biodiversity (Dickinson, 2022). These bring nature and the city closer together, develop cost-effective actions and long-term measures able at enhancing urban resilience (FAO, 2021). In this regard, Science published a paper suggesting

that planting trees, on a massive scale and sustained period of time, represents one of the most effective solutions at our disposal to mitigate climate change and improve the quality of life (Bastin et al., 2019).
The same year, the United Nations Economic Commission for Europe launched the 'Trees in Cities Challenge'. Worldwide mayors and local governments are invited to make a tree-planting call and set objectives for making cities greener, resilient and more sustainable (UNECE, 2019a). By 2022, over 11.2 million trees have been planted thanks to the commitment of 70 world cities. Europe in 2018 launched the Green Deal (European Commission, 2018) and in 2020 started to invest in forestation mainly in urban and peri-urban areas through the 'New EU forest strategy for 2030' that envisages the planting of 3 billion trees by 2030 (European Commission, 2021).
And if urban forests can contribute significantly to generating ecosystem services (Roeland et al. 2019) providing recreation and amenity values (Konijnendijk, 2005), what new studies tend to argue is the importance of the cultural and social services produced by UF-NBSs, such as social cohesion and the engagement of local communities in favor of the environment, highlighting their ability to provide more comprehensive solutions than other NBSs (van den Bosch et al., 2017).
Thus UF-NBS need to be experimented in order to demonstrate if this can constitute a better solution to build stronger link between communities and nature that can develop long term care practices able to increase resilience, environment quality and wellbeing as well (Clearing House, 2021).
From this acknowledgement, the illustrated project investigates and experiments 'for real' a new form of UF-NBS that can enhance at one time regulating, social, cultural and pedagogical ecosystem services in order to strengthen the link between people and nature and therefore guarantee a long term stewardship that helps UF-NBS blossom and thrive. This new form is the Microforest or Tiny Forest, a cutting-edge kind of forestation that can be spread in the dense city, conquering underused and empty urban spaces.
'Forests can cover vast areas as in the Amazon and Borneo. A Tiny Forest can cover vacant islands of land, a highway roundabout, a small portion of a playground in a nursery school' (Hawken, 2022). From field experiences, the press and the web, more than from scientific literature, this new pocket-sized forestation is emerging and conquering cities and neighbourhoods of the world: 'Tiny Forests are popping up in big cities' (Hewitt, 2021).

## 2. Forests for the dense city: the Tiny Forest revolution

### 2.1 Tiny Forests' short profile

Tiny Forests are germinating, blossoming and colonizing worldwide city spaces. Thanks to Japanese botanist Akira Miyawaki (Miyawaki, 1996) and Shubendu Sharma (Afforestt, 2011), the mini forestation has become a Method that encourages public involvement, can be implemented by everyone and everywhere. 'By communities, classrooms, cities, clubs, families. We do not have to wait for nations, banks and corporation to act' (Hawken, 2022). Generally, Tiny Forests are no larger than a tennis courts, 250 m2 is the average size, but they can even be smaller and easily fit in any kind of public space. These features make the Miyawaki Method revolutionary (Lewis, 2022).
This urban patch of nature, inspired by the Miyawaki's Method, has been developed from 2011 first in India, by former Toyota engineer Shubendu Sharma who registered the Tiny Forest trademark (Sharma, 2014). In 2015 the format was imported into Europe by the Netherlands' IVN Natuureducatie association (IVN Natuureducatie 2023a) and since it has spread in Belgium, from England to Germany, arrived in France and more recently landed in Italy. A Tiny Forest can be planted in one day, grows fast and becomes more biodiverse than a 'classical' one. It took only 5 years to the trees of the first European Tiny Forest of Zaandam (Netherlands) to rise and gain 12 meters height (IVN Natuureducatie, 2023b).

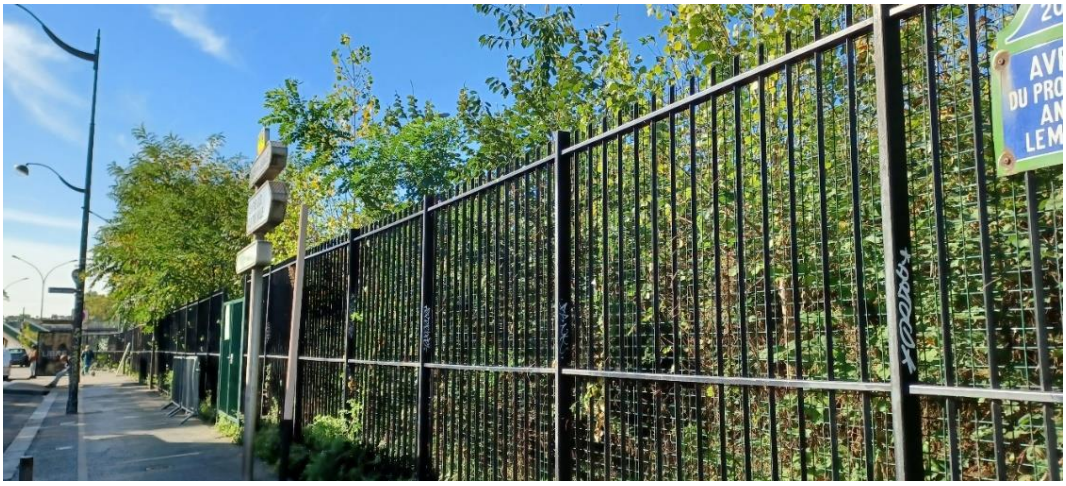


**Fig.3 The first Tiny Forest in Paris, 400 m2 along the périférique. Paris, XX° Arrondissement**

Since the Tiny Forest movement began, 3,000 tiny forests have been planted, 96.7% of which developed into resilient ecosystems within 10 years (Earthwatch Europe, 2023).

Tiny Forests foster a new approach of urban forestation as place-making and reinforce the links between citizens and nature, supporting citizen's environmental engagement. EarthWatch Europe based in UK, the most European active association on the field along with the Dutch IVN, states that each Tiny Forest is expected to engage up to 100 volunteers on planting and monitoring days; 4-6 volunteers as a Keeper Team to take care of the forest; wider community, visitors and school children as an inspiring place to enjoy nature (EarthWatch Europe, 2023).

## 2.2 What a Tiny Forest can do

The Tiny Forest's recent history has not made it possible to develop a conspicuous scientific literature on the matter, but the beneficial invasion underway in the landscape of the planet's urban contexts unquestionably demonstrates its value.

There are only two sources that publish reports on the subject and in both the findings are the results of volunteering citizen scientists who undertake scientific research projects: IVN Natuureducatie and Earthwatch Europe that has partnered with IVN.

IVN cooperated along with Wageningen University in order to develop scientific surveys focused on the topic of biodiversity, with the support of 12 volunteers involved in a Citizen Science performance. The first place investigated is Zaandam where the first Dutch Tiny Forest has been implemented in 2015.

The report released in 2017 by the University demonstrates that the Tiny Forest is a biodiversity attractor to a greater extent than neighbouring forests giving home to 595 plants and animals (Ottburg et al., 2018; Müller, 2021).

The following report, published on the IVN website, includes a wider range of case studies (11 Tiny Forests) and encompasses multiple issues: biodiversity, microclimatic comfort, $CO_2$ sequestration, water retention. The surveys show an average number of 270 species per Tiny Forest, including both plants and fauna; a cooling capacity of 7 °C; 127.5 kg/year of $CO_2$ sequestration for the first 5 years, then 250 kg/year as the mini-forest grows older (IVN Natuureducatie, 2022). Finally, the average value of water / year absorbed by each Tiny Forest is around 10,000 litres.

The second source is the Earthwatch Europe association, which published on its website two reports on its monitoring activities in 2021 and 2022 (149 Tiny Forests). Here too, the data are collected by citizen scientists who have increased in number significantly from 776 volunteers in 2021 to 3,465 in 2022 (Earthwatch Europe, 2023).

As the most recent data demonstrate biodiversity thrives in Tiny Forests (36 species) and this is the main documented research field investigated. The sequestered $CO_2$ has been calculated considering the green weight of the different species planted and the result is that each Tiny Forest absorbs on average 160 kg/year.

Tiny Forests' infiltration rates are determined by measuring the length of time taken for 450 ml of water to fully infiltrate in the soil. And the experiments demonstrate that water infiltration is 32% faster inside the Tiny Forest than outside. Concerning the thermal comfort, no consistent trends could be discerned from data. Thus, as the thermal comfort is related to individual feelings, physical and psychological factors, a survey through questionnaires has been realized with the results that 93% of people attending the Tiny Forest feel cooler.
Finally, even though the data released by the two sources cannot be compared, at the end the reports achieve similar outcomes. The capacities to demonstrate are biodiversity attraction and water absorption. But Tiny Forests can do much more. They can release environmental quality, wellbeing, social cohesion and connectedness to nature.
To assess this, social surveys are being gathered across the Tiny Forest network from volunteers and partners of Earthwatch Europe association (73 participants surveyed at 11 Tiny Forests in 2021 and 2022). "90% of participants surveyed said the Tiny Forest made them feel calm and relaxed (88% in national Monitor of Engagement with the Natural Environment survey); 93% of participants said the Tiny Forest made them feel refreshed and revitalised (90% in national MENE survey); 97% of participants said they felt close to nature; 98% of participants using the Nature relatedness scores (80) had a score greater than 3 showing they already had a strong connection to nature which is related to how much people care for and act to protect the environment" (Earthwatch Europe, 2023).
So in short, this unusual form of nature easily finds space in urban contexts, grows and generates ecological benefits in a short time. When the development of Tiny Forests is accompanied by an active multigenerational community and the project is enhanced by paths of scientific knowledge, including Citizen Science actions, the social and cultural benefits complement the ecological ones, increasing not only the community's wellbeing, but also environmental awareness. In the end, a Tiny Forest helps reconnect people with nature.

## 2.3 The urge of neighbourhood Microforest

The Tiny Forest is definitely a neighbourhood forest, a Micro ecosystem and a cutting-edge urban green component where regulating ecosystem services, biodiversity, wellbeing, participation, place-making topics converge.
From this point of view, it presents analogies with the concept of the Oasis, which recalls the need to develop multisensory and participatory approaches to propose new figures of urban composition capable of integrating environment, sociality and physical space (Fratini, 2020a; Leroy-Thomas et al., 2021). Like the Oasis, a Microforest increases, at the size of a neighbourhood, the multisensitivity of local landscape (Peyrouzère, 2018; Pelorosso et al., 2013; Miles et al., 2001).
The social activities that can take place around a Microforest, the multiplicity of observations that can be carried out from nature's life, the sensitive phenomena released by the vegetation and fauna induce a sense of curiosity, contentment, calm and well-being (Balaÿ et al., 2018). In this regard a Microforest, as an UF-NBS, reveals all its potential as a complex ecosystem, providing more comprehensive solutions than other NBS (van Den Bosch, 2017).
Furthermore the Microforest is not an island, it is an urban ecosystem surrounded by roads, buildings, activities, people. A dimension that requires multidisciplinary expertise, the interaction between place and users, a metric of uses attuned with the specificities and rhythms of nature (De Biase et al., 2018).
An approach is thus configured that outlines a new urban vision, at the intersection of ecology and urbanism (Clergeau, 2020), which reinforces the importance of a planning approach focused on the environment potentialities of empty spaces, capable of reactivating links between city spaces, nature and citizen's community (Marry, 2018).
From this point of view, the Microforest can support the reconstitution of a system of possible meanings, values and roles to be defined through the contribution of local society, giving 'sense to place' (Di Giovanni, 2018).

**Fig.4 The Microforest aims at increasing curiosity and exploration, fostering interaction between very young people and nature. Rome, Parco dei Caduti**

The multifaceted dimension of the ecosystem services delivered also intersects the drive for an innovative interpretation of the theme of urban welfare, proposing Microforest as a 'neighbourhood equipment' in tune with the principles of the 2030 Agenda.

In this regard the NBS Institute suggests the 3-30-300 rule for greener, healthier, and more resilient cities which means at least 3 trees in sight from every home, school or workplace; no less than 30% tree canopy in every neighborhood; and never more than 300 meters to the nearest public green space (NBSI, 2023). As Konijnendijk states, the rule focuses on the crucial contribution of urban forests to our health and wellbeing, as well as climate change adaptation, and it also addresses the need for urban forests to percolate into our living, working, and living environments. We need to bring trees and nature into neighborhoods, streets, and on people's doorsteps in order to capitalize on their many benefits (Bell, 2005; Dwyer, 1992; Livesley, 2016). By creating more leafy neighborhoods we also encourage people to spend more time outdoors and to interact with their neighborhood, which in turns promotes conviviality and wellbeing (Konijnendijk, 2021).

Finally planting neighbourhood forests means pursuing an integrated approach to mitigate climate change impacts, enhance people's nature connectedness and encourage multipurpose experiences for healthier and happier cities for all, within 15 minutes walking distance (World Urban Forest Forum, 2018; Semeraro et al., 2022).

# 3. From Tiny Forests to the Eco-Pedagogical Microforest

## 3.1 Seven objectives for an Eco-Pedagogical Microforest project in Rome

All that being said, the paper illustrates an empirical project that intends to explore an easy to handle and fast growing Microforest to be planted within the size of a neighborhood. Given that the Eco-Pedagogical first goal is to attract and educate very young people, schoolchildren, to the cause of the environment and increase connectedness with nature. the project envisages the involvement of very young people, the schoolchildren community, from the early steps of the process through an Eco-Pedagogical Pathway. Therefore, from the beginning, the Microforest has become Eco-pedagogical.

The theme is indeed a subject of significance considering that cities need more than ever to be sustainable, time for changes is short and Urban Forestation is the easiest and fastest way for cities to try and mitigate climate change impacts and increase resilience, especially in the dense city.

The underlying challenges of the project can be summarized as following:

- Diffuse Urban Forestation in the dense city, considering the principles delivered by Agenda 2030;
- Promote Urban Forestation at the neighborhood scale;
- Implement multistakeholder partnerships to support the neighborhood forestation project;
- Design and realize a cutting-edge Urban Forestation project local-based, low cost and fast growing;
- Build a successful involvement process to empower children and teenagers in the design, realize and monitoring stages;
- Design an Eco-Pedagogical Pathway to awake in young generations empathy towards nature, turning education into an experience to learn about the environment;
- Disseminate the project and build synapses with existing planning programmes.

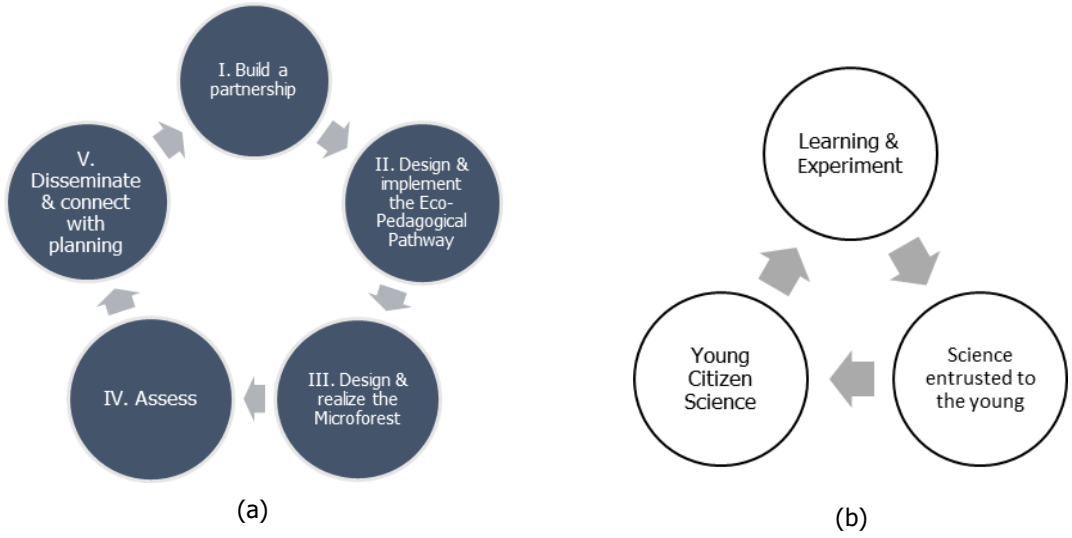



**Fig.5 The 5 stages of the methodology (a) and the 3 stages of the Eco-Pedagogical Pathway (b)**

The Eco-Pedagogical Microforest project, funded by a Third Mission Sapienza research, intends to decline urban forestation on a local scale, framing the experimentation within a multilevel strategy, empowering young citizens through the proactive involvement of the schoolchildren community. The multistakeholder and multilevel partnership which made it possible is composed by Regione Lazio – Progetto Ossigeno, Comune di Roma, Municipio II, Municipio VIII, ICS Tiburtina Antica 25, local associations and University Sapienza Engineering, Biology and Psychology Faculties with 7 professors of different disciplines, 3 PhD students and 100 students.
The methodology is articulated in five main stages. The first is dedicated to building a multistakeholder and multilevel partnership. While the second consists in the design and realization of Microforests, the third is focused on the Eco-Pedagogical Pathway. The assessment stage is related to the third stage because the surveys are mainly released through young citizen science actions. The last stage concerns dissemination and the research of possible connections with the urban regeneration programmes of Rome.
While the Eco-Pedagogical stage has been developed following a timetable, the timing of the realization, related to the decision-making trajectories, has been impossible to foresee. But at last, after only one year the project has been concluded in all its parts.

## 3.2 Stage I - Kind of partnerships, different results

Within this framework, two Microforests have been created within 12 months from the start of the Third Mission Sapienza research. The first was planted the 17th of December 2022 in the Parco Malaspina (Municipio

VIII), the second the 24th of February 2023 in the Parco dei Caduti, in the San Lorenzo neighbourhood (Municipio II).

The mosaic of the partnership, and the mix of stakeholders involved, the sources of funding determine the difference between the two case studies.

With a Public – Private – People Partnership (UNECE, 2019b; Boniotti, 2023), the Municipio VIII, along with Sapienza, the Azzero$CO_2$ private firm, Fasteweb and Ostiense – Garbatella neighborhood committee has planted, the 17th December 2022, 1,000 small trees and bushes in an area of 800 $m^2$ located close to the Ostiense railway station. In this case the process, that was put in place in short time due to Fastweb's priorities, was led by Municipio VIII, the local association participated as the entity responsible for the area, and Sapienza was consulted for the Microforest project. The second stage of the process, the one focused on the involvement of the local school, was not considered a priority and so it is still in progress. The result: the Microforest is now suffering from a lack of stewardship and waiting to be "discovered". The multiple benefits that it can produce remain, for now, in incubation.

**Fig.6 Parco Malaspina, the Microforest planting day. 1,000 plants distributed in 800m2 by the Fastweb team**

In the case of the Parco dei Caduti, a Public – People Partnership led by the University was put in place with the Municipio II and the Lazio Region – Progetto Ossigeno and the Microforest was planted the 24th February 2023. From the early stage of the process the school community has been actively involved and the Microforest has blossomed thanks to the primary and secondary schools of ICS Tiburtina Antica 25.

Teachers and schoolchildren have been guided through the 'eco-pedagogy of the Microforest' process by the University team (Nogué, 2010). The one-year learning and experiment pathway that took place in San Lorenzo nurtures the growth of a relation between very young people and nature. During this time children and teenagers increase their awareness on environmental topics and thus improve their behaviors in a way that will allow them to safeguard nature (Chistolini, 2016). At the end of the process, the Microforest has become a scientific laboratory, a symbol of rebirth, a perceptive reference for the neighborhood's community.

Thus the paper illustrates the Microforest of Parco dei Caduti's successful process that starts with the school community of San Lorenzo gathered in the Parco dei Caduti to design the border of the Microforest to be built and is still continuing with the young citizen science activities that have been implemented to monitor and assess the 'healing power of the forest', quoting Miyawaki (Miyawaki, 2007).

'We need to tell the stories of success from communities across the globe, these achievements are grassroots, wholesome, and empowering, and ensure that trees will not be neglected, as a passing by fashion' (Clearing House, 2021).

# 4. Stage II - Design and realize the Microforest: the pilot case of Parco dei Caduti

## 4.1 Why San Lorenzo

San Lorenzo is the place where the first Eco-Pedagogical Microforest of Rome has been planted. The neighborhood is, since 2016, the field of green-oriented empirically based experiments carried out through Sapienza funding in collaboration with the Municipio II, associations, and the local school. 'Oasi San Lorenzo Green Network' is the research that frames the temporary and nature based micro-realizations inspired by an approach of urban acupuncture (Lerner, 2014; Fratini, 2020b).

The first cutting-edge experimentation is the 'San Lorenzo Temporary Forest' built in 2018 with 100 potted trees, 18 donated by the Presidential Reserve of Castel Porziano, and located in the Ex-Dogana area (Fratini, 2020). From the success of this case comes the Eco-Pedagogical Microforest in the Parco dei Caduti.

The choice of location is inspired by a place-based approach (Castellar, 2021), and is aimed at regenerating a central and disputed public space, with the purpose of developing multifunctionality and favor tolerance, new uses and behaviors, environment awareness and the respect of nature, stewardship to help the Microforest to grow and thrive.

**Fig.7 The Bosco Temporaneo San Lorenzo, 100 potted trees under the tangenziale to bring nature in a former railways deposit area, today under construction**

The Parco dei Caduti is a space included in the urban fabric surrounded by buildings, what Gordon Cullen would call an enclosure (Cullen, 1964). The area is lived in and crossed daily by the inhabitants and the children of the school, which is located just 20 meters from the entrance. Proximity with the school, multifunctionality, mixed users are the successful ingredients of a UF-NBS project that intends to increase conviviality, include nature in the urban landscape, develop links between citizens (young but not only) and forms of vegetation closer to a "nature reserve" than to a garden.

Within a Green Infrastructure approach, the Eco-Pedagogical Microforest of the Parco dei Caduti is a component of a neighborhood green layout, to be put in practice, designed to connect public space, existing green areas and those to be regenerated through green streets and slow mobility, with reference to the Barcelona Superblock Programme (Ajuntament de Barcelona, 2022). These interlinkages can have multiple benefits, providing ecosystem services (Hansen & Pauleit, 2014; Carrus et al., 2015; Zardo, 2017) integrating the social and environmental concerns of landscape with urban planning (Arcidiacono & Ronchi, 2021; Tulisi, 2017).
Finally the Microforest is not an isolated dot but a node of the neighborhood's green network (Local Green Infrastructure), a green-multifunctional recreational opportunity located at walking distance from the center of the neighborhood and close to the school. Thanks to its features the Eco-Pedagogical Microforest has the capacity to decline ecology, proximity, participation and solidarity within the neighborhood unit and thus become a green equipment for the 15 minute-city model (Moreno, 2021).

## 4.2 What? The shape of the Microforest

What does the Microforest look like? The more diffused kinds of Microforest, as the city experimentations on the field demonstrate, are edible Tiny Forest (Zandaam, 2015); adaptive Microforest (Reggio Emilia, 2023); natural Microforest (Paris, 2018). The type selected for the Eco-Pedagogical Microforest is the latter with the purposes of creating a tiny natural reserve of Mediterranean scrub enclose in the Parco dei Caduti area providing a landscape of a shared natural and cultural heritage (UNESCO, 1994; Lowenthal, 2005).

**Fig.8 Microforesta Parco dei Caduti, 24 February 2023. The inauguration day with over 300 schoolchildren**

As the European Landscape Convention (2000) and the Faro Convention (2005) outlined, landscape and cultural landscape link people and places, tangible and intangible elements and provide fundamental resource for human well-being and sustainable development (Bianconi et al., 2018; Sodano, 2018).
On the other hand the purpose is to fulfill the Method designed by Akira Miyawaki in order to increase the survival chances of the trees and bushes. The Method is based on vegetation ecology, is able to encourage public involvement and nurture a small ecosystem that restores life (Miyawaki, 1996).

The 4 principal rules of the Miyawaki Method concern the selection of native species, high density, a multi-layered architecture, soil preparation (Miyawaki, 1999). Miyawaki calls for planting young native species close together, with a standard density of 3 plants/$m^2$, to mimic a mature natural forest and to make plants to quickly thrive. Therefore the 123 plants chosen for the Parco dei Caduti Microforest are all native and adapted to the Mediterranean climatic zone, able to resist to climate stress, especially heat and dryness phenomenon, facilitate higher biodiversity and cope better with disease. The plants are supplied by the forest nursery of the Monti Aurunci Regional Natural Park. The Miyawaki Method also suggests a planting density between 2 and 7 trees per $m^2$ and a distribution of plants according to functional layers, based on the ecophysiological characteristics of the vegetation (Miyawaki, 1996). Dense planting stimulates mutualistic and competitive interactions and facilitates connections with soil microorganisms (Lewis, 2022).

With regard to density, account was taken of the first experimentation of the Miyawaki Method in Mediterranean contexts carried out in Sardinia in 1996, which envisaged a density between 2.1 and 0.86 plants/$m^2$ (Schirone et al., 2010) while, in Northern European countries, the density averages 3 – 5 plants/$m^2$. Thus the planting density adopted in the Parco dei Caduti Microforest is 2 plants/$m^2$ closer to the Sardinia experiment than to Northern European experiences rooted in a colder and more rainy climate zone, in order to enhance the survival rates of the plants.

The Japanese botanist identifies the most appropriate species mix that would naturally occur in a specific area in order to create a biodiverse, multi-layered forest identifying the potential natural vegetation (PNV) (Miyawaki, 1999). Accordingly, a mix of 13 species of Mediterranean plants are distributed in an area of 120 $m^2$ on the basis of 3 layers. The first consists of trees, Quercus ilex and Quercus pubescens. All around are scattered tall shrubs, such as Phillyrea latifolia and Arbutus unedo (85 specimens), punctuated by low shrubs (123 specimens) with flowering plants (such as Coronilla emerus, Spartium junceum) and berries (such as Viburnum tinus, Myrtus communis), so as to attract birdlife and pollinating insects, favoring biodiversity.

Finally the Method requests a preparation of soil aimed at decompacting and amending the site with organic materials and covering the ground with a layer of mulch made of natural ingredient (straw, fallen leaves, wooden barks). In this regard a 60 cm deep hole has been excavated, the ground amended and 20 cm of fertilized soil added on top.

To discourage invasive species from taking root, the planting ground is covered with a biodegradable fabric and a thick layer of pine bark.

This, from the very first day of planting, gives off a forest scent that radically changes the perception of this part of the Park considered, before the arrival of the Microforest, a marginal area.

For a period of at least 3 years the Method suggests to water the plant, but afterwards the forest plants will be able to grow and shade the soil, mitigating the water evaporation. Consequentially, the watering system has been developed in two phases. For the first few months after planting, a citizen's pact was set up under the direction of the Environment Department of Municipio II, between associations (neighborhood committee, Oltre cooperative, senior citizens' association) and the school to guarantee the water necessary for the plants. The second phase involves the construction of an underground tank fed with surplus water from the park fountain, a water pump, and a drip irrigation system.

Based on these parameters, a Miyawaki forest grows ten times faster than a classical forest, is 30 times denser and 20 times more biodiverse (Urban Forests, 2022).

Observing the evolution of the landscape of the Parco dei Caduti, what emerges today is the importance of enhancing the multifunctional nature of the forest (Hale et al., 2015), pursuing a project at once "of place and of community", the purpose of an open coexistence towards exploration, knowledge and respect between worlds and species (Endreny, 2018).

A little over three months after its planting, the Microforest does not record any acts of vandalism or theft of plants, despite being located in a complex neighborhood and a contested space (Mattijssen et al., 2017).

# 5. Who? University, students & schoolchildren

## 5.1 Stage III. The Eco-Pedagogical Pathway

The Eco-Pedagogical Pathway (EPP) takes shape from the concept of nature as an educating factor and involves from the beginning the community of the Borsi secondary school of San Lorenzo neighborhood (ICS Tiburtina Antica 25), 68 pupils and 4 teachers.

The outdoor activities are scheduled to promote an experiential environmental - oriented learning and aimed at increasing young people's awareness, support their commitment to nature as a solution to climate change challenges (Jucker & von Au, 2022). The 7 objectives that inspire the EEP process are:

- focus on experiences that promote environmental and climate change awareness through scientific applications;
- provide time for direct engagement with nature and immersion in green areas;
- share examples of people's enthusiasm and care for nature;
- make young people partners of scientific communication concerning their learning and outdoor experiences;
- transform the care activity in the young citizen science;
- support cultural and scientific vertical and horizontal exchanges between different kinds of students / pupils (schoolchildren and university students) through shared experiences;
- take seriously the young people's efforts and realize pupils' and students' ideas.

In order to set-up a wide range and cutting-edge environmental training activities, topics and contents are shaped on the basis of IVN Naatureducatie, Earthwatch Europe experiences, Outdoor environmental learning websites, H2020 Clearing House project and shared with school community. All the activities designed are meant to increasing curiosity, interest, exploration; develop empathy and caring for natural habitats (Clearing House, 2021).

Therefore the Microforest is designed to become both a place and an educational pathway, starting from the youngest, aimed at changing attitude and behavior in favor of the environment; it constitutes a step toward empowerment, nature connectedness, environmental stewardship and nurturing (Kudryavtsev et al., 2012; Tidball, 2011). Starting from these premises the methodology is developed in 3 steps 'Learning & Experiment'; 'Science entrusted to the young'; 'Young Citizen Science'.

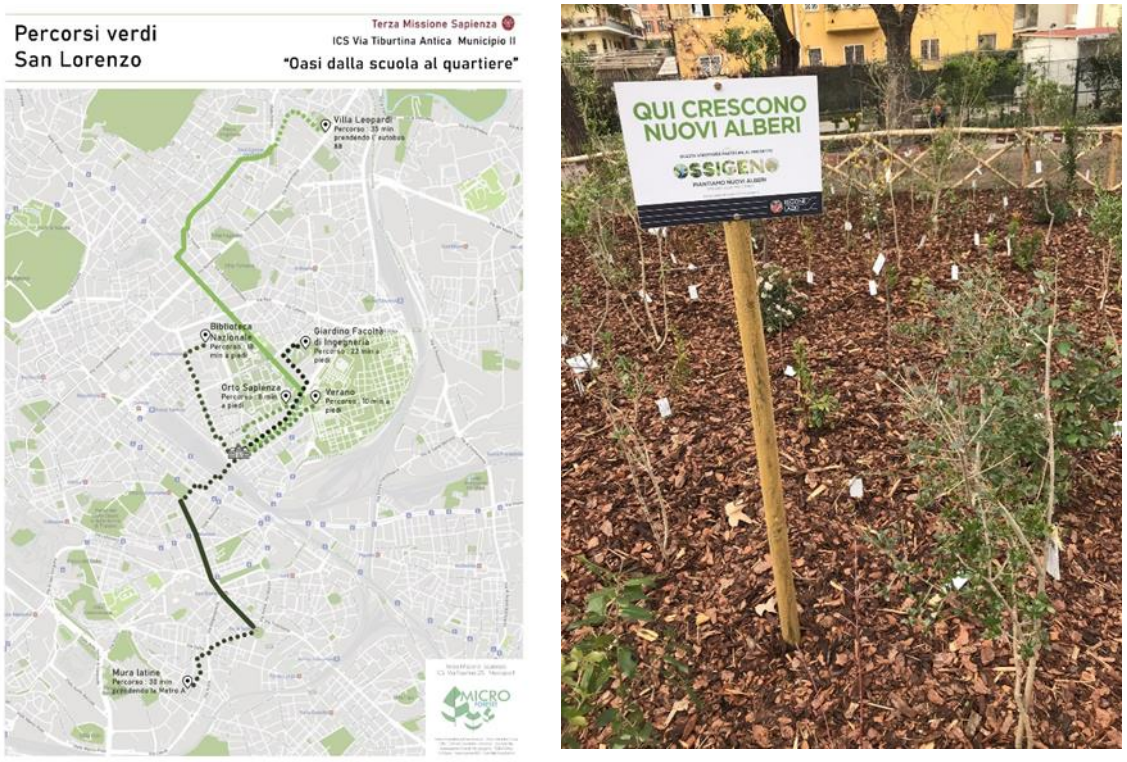
## 5.2 Learning & Experiment

The first stage of the EEP is implemented taking into account four components: topics, places, key actors and tools.

The multidisciplinary palette of the topics selected for this first stage concerns climate, air quality, water, vegetation, pollinators, wellbeing, waste cycle. The lectures – experimentations are designed and held by the Sapienza Third Mission transdisciplinary team.

The places chosen for the outdoor green spaces are accurately selected taking into account their accessibility through slow mobility, therefore maximum 20 minutes' walk from the school or reachable with public transport, and the opportunity to meet people, experts and associations, from outside the school community.

Key actors. Places and key actors are the dot of the outdoor activities' map. Among them Sapienza Scientific Garden and Professor Laura Varone, who develops experimentations on vegetation biomonitoring and plant phenology; Roda Onlus engaged in the care of the spice garden at National Library of Rome with disabled young people; Villa Leopardi and its association involved in the regeneration of the area and supporting biological fight against tree pest.




(a) (b)

**Fig.9 (a) The Eco-Pedagogical paths: green places, slow mobility, experts and association to talk about climate change, NBS and wellbeing and (b) Trees and bushes of the Microforest, Progetto Ossigeno Regione Lazio**


**Fig.10 Mobile sensors to measure temperature, humidity, CO2, PM10, PM 2,5. A scientific tool able to catch at best children attention**

The tools used for experiments and measurements are both do-it-yourself and digital. Sensors are used as a medium to increase the children's and students' awareness of climate phenomena, he benefits of nature's solutions and catch at best their attention.

The experimentation of mobile sensors guides the understanding of concepts such as the heat island and NBS that can mitigate its effects. The fundamental role of trees is revealed by measuring the temperature values collected by a portable sensor, and the intensity of harmful rays, monitored by means of a UVA & UVB light meter, in the district's most mineral square, Piazza dei Sanniti, and in the Verano cemetery under the protective canopy of cypresses and holm oaks.
The fluorescent light that illuminates an alga and urges it to produce oxygen turns the spotlight on the fundamental role played by the sun and vegetation, even in the city: trees allow us to breathe.
And more: every plant is a value in itself. Not only because our lives depend on them, but also because much of our possibility of happiness depends on them (Mancuso, 2019).

## 5.3 Science entrusted to the young

How to make young people partners of scientific communication concerning their learning and outdoor experiences? How to help them become young citizen scientists?
The second stage explores how to help children and teenagers to become young citizen scientists by transferring the knowledge acquired during the workshops.
In this stage from listeners and novice experimenters, schoolchildren of different ages are called to become science communicators during the 'Science entrusted to the young' cycle of activities, which is implemented through 4 events. The European researchers' night at the children's Explora Museum of Rome (30$^{th}$ September 2022); the Science Festival of Rome (21$^{st}$ November 2022); the Saffi school Open Day (20$^{th}$ December 2022); and the Inauguration of the Microforest (24$^{th}$ February 2023) are the events that seal the change of the role of the schoolchildren, challenging them in scientific communication, and allow them to act in favor of nature, actively support the realization of their future Microforest.

## 5.4 Become a young citizen scientist

The third stage is dedicated to put into practice a monitoring programme based on Citizen Science activities, taking into account the IVN and Earthwatch Europe's experiences. And though it is a step forward to the stage IV: the assessment part of the project.
The designed activities are developed on the basis of the knowledge and tools tested during the Learning & Experiment phase through a timetable focused on five issues: air quality; soil quality; water cycle; plant health; biodiversity; wellbeing and nature connectedness.
The first workshop of this third stage was held at the Microforest with 100 university students, over 100 schoolchildren from the primary and secondary schools and a trained équipe of Sapienza thesis students (4$^{th}$ May 2023). Children and students were arranged in small mixed groups and worked together.
The workshop was dedicated to the knowledge of the Mediterranean plants and the programming of questionnaires focused on the topic of nature connectedness to be answered by the children assessing their own experience.
In order to fulfill the first assignment, children were invited to delicately pick the leaves of trees and bushes of the Microforest, name the species, draw and write down their features, including the capacity to stock $CO_2$ and filtrate PM2,5 and PM10. A register of the trees and bushes will be put in place and updated with the height, and the healthy state of the vegetation observation along the year.
For this purpose during the workshop a first check of the chlorophyll activity of the different species was implemented with a mobile sensor by Sapienza thesis students supported by the schoolchildren. These data will be checked again every 3 months.
The second assignment consists in the programming of a questionnaire. Two groups of children of the secondary school and university students were assigned to this activity. In this regard the task begins with an explanation of the five pathways to nature connectedness listed in the 'City of Tree inspirational package'

delivered by Clearing House (Clearing House, 2021). From this starts the elaboration of the questions aimed at measuring the growth of their own sensitiveness towards nature thanks to the Microforest project. The questionnaire will be posted online.

**Fig.11 The first Young Citizen Science workshop. Children and students work in small groups to check the Microforest species, their features and their capacity to produce chlorophyll**

Ultimately, young citizen science aims to weave bonds between the youngest and nature, represented by the Microforest, which will accompany their growth into adulthood and beyond. Eco-pedagogy plays a fundamental role in this respect and in the whole process.

School is the ideal place to initiate a process of growth and empowerment through long-term learning, and the creativity of the Citizen Science process encourages stewardship. Thus, it is important to integrate ecological pedagogy into community development programs because a heightened awareness of environmental issues and their implications can initiate new patterns of behavior towards the environment (Mochizuki & Bryan, 2015).

# 6. The final stages, assess and disseminate

## 6.1 Has young people's awareness increased?

Looking back, what becomes clear is that the time spent experimenting with and measuring natural phenomena, involving schoolchildren, teachers, lecturers and young university students, transforms the Microforest into a call for nature that pupils address to local decision makers.

The mission that the young and very young people have accomplished is to convince the institutions of the inescapability of the realization of the Microforest.

During the one year of the project implementation the Parco dei Caduti and the micro - local community have been changed. The change observed in the school community is a perception shared by the pupils themselves, teachers and lecturers of the Sapienza. This is how Maja explains, at the end of the project, her personal

connection to the Microforest. New awareness and sensitiveness have grown: 'when I take my children to see the San Lorenzo micro-forest, I will tell them that I planted these trees with my classmates, thinking of their future' (Maja Sechi, III b, Borsi school). Helping children learn to be responsible, becoming leader of virtuous change in favor of their environment can increase the likelihood that they will be more environmentally aware throughout their lives (Thor & Karlsudd, 2020; Gough & Scott, 2003; Littledyke, 1996).

However, in order to measure and categorize the effects of this training course on the pupils of the Borsi school, the Terza Missione Sapienza project developed, with colleagues from the Faculty of Psychology, a survey to assess its impacts by means of a questionnaire consisting of a battery of measurement scales adapted from the literature.

At the current stage of the project, it is important to emphasize that the increase found in the experimental group suggests that the children involved in the project have started to increase their awareness of issues related to climate change, the consequences on urban environmental quality and psychophysical wellbeing, as well as their own capacity to act in favor of the environment, beginning to strengthen their motivation to take care of the neighborhood's green spaces in order to contribute to a common long-term goal' (Bonaiuto & Chiozza, 2023).

Ultimately the Microforest experience is both a project about environment and an invitation to learn about nature. A Microforest will not change the quality of the air of a neighborhood but it creates a microcosmos of wellbeing, knowledge and collaborative behavior, enhancing the capacity of all to increase their resilience and therefore to behave in a proactive way facing climate changes. Around this small patch of nature the biodiversity thrives, people will feel protected by the shadow of the trees and gather to check how the trees grow.

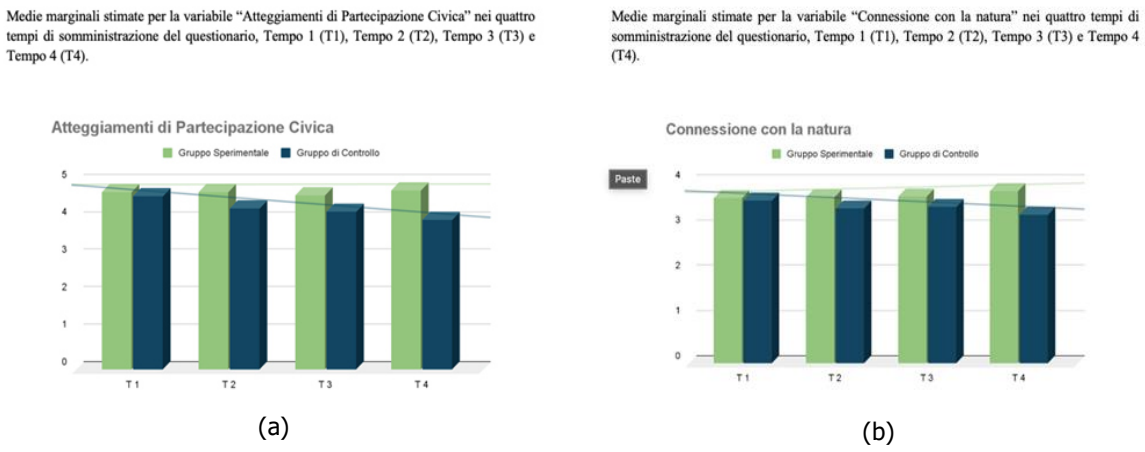



**Fig.12 Effects of the Eco-Pedagogical Pathway on the pupils of the Borsi school. (a) Civic Participation and (b) Nature connectedness**

The Microforest constitutes a lever to spread knowledge and fundamental values to the benefit of children and adolescents to enable them to cope with the changes that will occur in the coming decades in the best possible way, improving their relationship with nature, their living environment, with others and with themselves.

As the case studies of Parco Malaspina and San Lorenzo demonstrate, the fact of planting trees and bushes does not make in itself an Eco-Pedagogical Microforest. The success of the project has been achieved only through a shared pathway dotted with places, people, experimentations and lectures all bounded together with the invisible thread of empathy.

Between difficulties and success, the Microforest becomes a training ground for implementing new forms of partnership that bring 'value for people' and become a more effective and valuable tool to meet the challenge of the UN 2030 Agenda.

## 6.2 What's next: Microforests for the 15 minute-city model a planning opportunity

With the successful realization of the Eco-Pedagogical Microforest in San Lorenzo, a new cycle opens for which the collaboration between Sapienza and the Councillorship of Urban Planning of the City of Rome is in progress. In 2022, the City of Rome, partner of C40, presents the Programme "15 Municipi – 15 Projects for the 15 minutes city" a model of a "city of proximity" developed in collaboration between the Councillorships of Urban Planning and of Decentralisation for the 15 minutes city. The strength of the Programme is that it starts from the bottom, actively involving the 15 Municipi of Rome to regenerate 15 neighborhoods, one for each Municipio, with a funding of EUR 22.5 million.

The novelty of a model that crosses the history of urbanism with continuity, from Ebenezer Howard's Garden City (1898) to the Clarence Perry's Neighboorhood Unit (1929) and more recentely the Peter Calthor's Transit Oriented Development (1993) and Richard Rogers' Urban Renaissance Neighbourhood Model (1999), is related to a new interpretation that emphasizes its sustainable potentialities.

In fact, the polycentric urban development underpinned to the concept of 15 minutes city suggests that cities are made by a number of local units that can be regenerated and transformed in sustainable neighbourhoods that cut emissions and improve urban quality, social cohesion and a healthy way of life while boosting city and nature integration. In this context, neighbourhoods provide a new focus to respond to the urgency of the global climate agenda.

So the innovative side of the strategy proposed by the city of Rome is to implement within a short timeframe, a regeneration programme centered on public space, green areas, soft mobility and inspired by the goals of Agenda 2030. The Programme intends to address the theme of eco-sustainability through the strengthening of green and blue infrastructures.

Within this framework a collaboration Comune di Roma – Sapienza University took place to create Eco-Pedagogical Microforests within the 15 Municipi Programme. In order to guarantee the final success of the Microforest project 4 conditions have been set up by the Sapienza team in order to outline that forestation, place-making and eco-pedagogy are inseparable aspects of the same process.

The success of the Microforest, as demonstrated by the case of San Lorenzo, is related to material goals and immaterial links and activities as well. The young people's pro-active involvement and the teachers' willingness have had the power to enlighten the pathway towards an urban, social, cultural and ecological regeneration. And this 'lesson learnt' on the field should be respected for the success and the future of Microforests and young people.

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## Image sources

Fig.1 to 11: Author's elaboration;

Fig.12: Bonaiuto & Chiozza (2023).

## Author's profile

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