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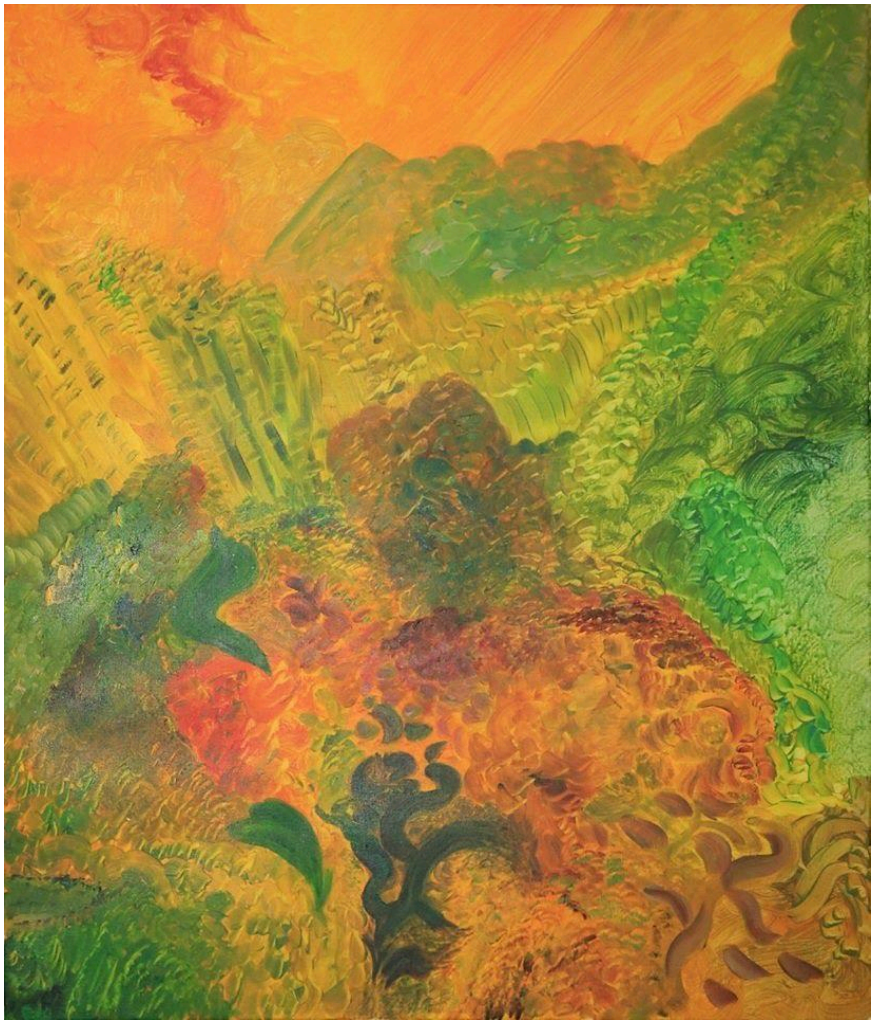

Heat, Paloma Gonzalez de Linares, 2016

The role of agroforestry in the urban environment

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Doctoral dissertation

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Contents

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I. INTRODUCTION

Cities in the world face inequalities in the face of Climate Change. There are also global disparities within the cities affecting citizens' well-being, level of vulnerability to Climate Change and access to green spaces equally (EEA, 2024). As urban agriculture is in high demand in the world with more request for access to land and shows environmental and social benefits such as education around food, community bonding, social mixity, inclusion and biodiversity in the cities, urban agroforestry was assessed as a complement to this practice to see its potential to reduce impacts of urban sprawl, urban heat islands, spatial segregation and restore landscapes. Agroforestry is a traditional practice which is being reintroduced in European agricultural lands because planting trees in productive lands has several purposes and benefits. As agroforestry is slowly spreading and engaging more attention, some urban agroforestry systems are also starting to emerge and should also be explored for their possible positive impacts on the cities' environments and social well-being. Indeed, climate change scenarios cause cities to rethink their planning strategies for mitigating the impacts of climate change. Urban agroforestry is known and developed in the Pacific Islands and is a traditional practice in many countries. In Europe, forest-gardens were introduced by the English botanist Robert Hart who created a model for Temperate Climates.

According to the Nations Food and Agriculture Organization (FAO), 75 % of people will be living in cities by 2030. The FAO estimates that about 815 million people of the 7.6 billion people in the world, or 10.7%, were suffering from chronic undernourishment in 2016. Almost all the hungry people live in lower-middle-income countries. Needs also to be considered the waste of food and a drastic reduction of biodiversity due to urban sprawl caused by expansion of cities and the use of pesticides in agriculture and monoculture and also due to climate change. According to the FAO, amongst 6 000 plant species cultivated for food supply, 9 of them represent 66 % of the total agricultural production. Must also be considered the decline of pollinators, birds, bats, and auxiliary insects for cultures, and micro-organisms in the soils (Reporterre, 2019). Deforestation in the world is mainly caused by agriculture and carbon emissions mostly originate from cities. Added to the loss of biodiversity and the need in food provisioning, cities need to find solutions to mitigate urban heat islands and restore urban soils. Climate change scenarios have social impacts such as the emergence of eco-anxiety and refugees. The Covid-19 pandemic showed the need for people for more green spaces and connection to nature, as well as the need to maintain cultural activities. Agroforestry presents important known benefits such as increased biodiversity and protection of biodiversity, a better management of the water and the soil and agroforestry plots create carbon sinks. It is an old practice which has been replaced by monoculture. It can also bring new demand in organic food and prevent loss in varieties of edibles. What we buy and consume has an impact on the market. There is a need to bring food systems closer to consumers to reduce dependency on oil and enhance access to food and materials in cities. However, cities face pressure in demand for housing and numerous cities suffer from lack of

green spaces for reducing heat stress and cultivating. This thesis states that through strategic planning and adaptation of landscape designs for food systems and materials to these contexts with principles of agroecology, it is possible to have a diverse set of productive spaces in and around cities and reduce spatial segregation. There is also the European Union Soil Strategy for 2030 which states that soil must be preserved for its biodiversity and recycled (EU soil strategy for 2030, European Commission), meaning that there is a need to restore urban soils. This is why this thesis is focused on implementing agroforestry systems in cities. This thesis questions why and how agroforestry should be a land use in cities and a long-term practice. There is also the need to stop the use of pesticides in urban green spaces and to come back to local knowledge and know-hows with exchanges and to increase access to local materials and resources. According to the FAO, water management is also a challenge in sustainable food systems (FAO, 2023). And the question of soil erosion, biodiversity, pollution and desertification needs to be taken into consideration in landscape architecture. And there is the need to less depend on oil in producing food and materials and also in arts. In planning and landscape architecture, climate change impacts on cities must be assessed and answered to, as well as spatial segregation challenges and the creation of inclusive cities. Cities are spaces for transfer of knowledge and can play an important role for environmental education and the creation of resilient landscapes with social inclusion. There needs to be a co-design through community and expert engagement and adapt the urban agroforestry types to community foodways (Taylor J., Lovell S., 2021).

Flowchart of the thesis

Figure 1. Flowchart of the thesis. Paloma Gonzalez de Linares

I.1 Research question and hypothesis

This section presents the thesis question and hypotheses.

Research question

Why and how can agroforestry systems be integrated in urban green infrastructure plans as a land use with social inclusion, for a resilient and inclusive city, and at which scale?

Research hypothesis

1. Urban agroforestry can have several social and environmental purposes in the city and be part of a green infrastructure plan including the peri-urban areas. It can increase the accessibility and diversity of multipurpose green spaces in the city. A model can be created for its integration in green infrastructure planning.
2. Urban agroforestry governance and systems link biodiversity protection, local economy and social inclusion through arts. Public participation is important for transfer of knowledge and social inclusion.
3. Urban agroforestry should be planned with a participative assessment at the watershed scale, the corridor scale and the neighbourhood scale with participation of citizens and cooperation.
4. Urban agroforestry for arts reduces spatial segregation for access to shade and materials and contributes to creating circular and inclusive cities with landscape restoration. It can be adapted to different land uses for city resilience, community-building and transfer of knowledge.

I.2 Research goals

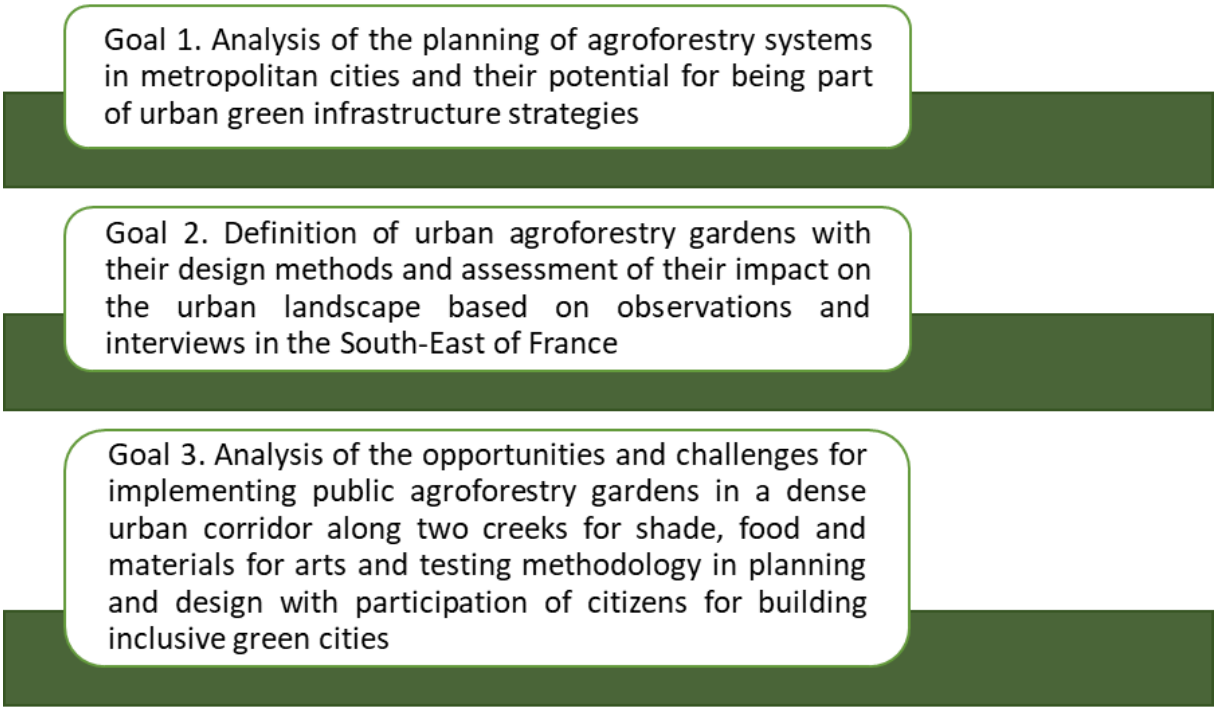


Figure 2. Thesis goals, Paloma Gonzalez de Linares

II. LITERATURE REVIEW: DEFINITION OF URBAN AGROFORESTRY AND THE PURPOSES

This section reviews the literature about the topic of urban agroforestry and the different aspects and purposes to consider when planning for this practice.

II.1 Why urban agroforestry?

Cities face global disparities, social inequality and economic imbalance in the world. There is a need for equal access to green spaces, shade, food and materials. Landscape architects face several challenges due to climate change and need to find local answers to this global problem and the need to be less dependent on non-renewable energy and resources. Urban agriculture has already shown many social and environmental benefits and is more and more in demand in the world, however there are still some limitations to the development of this practice with questions about pollution and accessibility to land. Urban agroforestry is assessed in this thesis as a possible tool to adapt to climate change and build inclusive and resilient cities by planting multipurpose trees in the city, providing shade and creating carbon sinks as well as providing several resources to the soil such as nutrients and protection from drought. Therefore it completes with the purposes of urban agriculture and the accessibility to land.

More attention is also brought to the possibilities for urban agroforestry practices to be planted for artistic purposes for valuing brownfields and the protection of the urban soils and their restoration when polluted. Cities are spaces of transformation and for meeting and exchanging goods, knowledge and culture. They can play an important role in environmental education and for raising awareness to climate change and the protection of biodiversity and local resources. As cities are expanding, it is important to share knowledge about agriculture, the need in protecting arable lands and to bring agroecological practices to urban and peri-urban landscapes for the provisioning of food and materials and social inclusion and equal access to these urban agroforestry spaces. This research focuses on the role of urban agroforestry within the field of landscape architecture and its potential for social inclusion and resilient cities with adaptation of species to climate change and the local urban climate and landscape context. The landscape is everything you can see when you look across an area of land, including hills, rivers, buildings, trees, and plants (Collins dictionary, 2022). It is also an extensive area of land regarded as being visually distinct. And a spatial expanse, natural or transformed by man, which has a certain visual or functional identity (Larousse dictionary, 2022). It is made up of all the elements observable from a specific place (Geoconfluences, 2022). Landscape architecture is a mix between science and arts. Urban agroforestry is also linked between scientific plantations and research and arts with creativity and search for freedom in gardening and transfer of knowledge. Cities are spaces of expression. They are dynamic spaces and basins of exchange of knowledge and culture which are under the pressure of climate change and with the need to adapt to the upcoming climatic scenarios with less soil sealing and more green spaces. Desertification in the countryside shows the need in planting trees and for agroforestry but also the need in bringing production closer to cities and within cities. There is also the loss of biodiversity and wildlife habitats.
According to the UN, climate change leads to flooding, melting polar ice, intense droughts, water scarcity, severe fires, rising sea levels, catastrophic storms and declining biodiversity (UN, 2022). Also, the temperatures are expected to rise to 3,2 °C by the end of the century (UN, 2022). Climate change has also an impact on cities with urban heat islands due to the change of land cover from agriculture or natural vegetation to an impervious surface (Buyantuev A. and Wu J., 2009); and an impact on the production of food due to surface ozone (IPCC, 2022). Plus, climate change scenarios alarm us to the higher risks of drought periods and heavier levels of precipitation in winter, which could lead to more flood risks. There needs to be a multilevel governance system to tend to resilience (W. Neil Adger et al., 2005). Also, according to the IPCC, climate change is affecting natural and biological processes which has an impact on food production and provisioning (IPCC, 2022), and climate change has led to warmer and drier conditions for forests (IPCC, 2022). According to the European projects MEDALUS II and III (MEditerranean Desertification And Land Use), both the mediterranean region and the Eastern European region with for instance, the Alföld region of Hungary, are facing drastic drought periods and an acceleration of desertification.

Cities are also the highest consumers of water and wood. Indeed, 90 % of deforestation is caused by agriculture. And in these agricultural systems, 60 % of the deforestation is caused by the extension of agro-industrial intensive farming and 30 % by small-scale and subsidence farmers (PurProject, 2020 and Grimm et al., 2008 in Colding J., Barthel S., 2012). Cities are

the cause of 78 % of carbon emissions in the world. Also, cities are responsible for 60 % of residential water use and 76 % of wood for industrial purposes ((Grimm et al., 2008) » in (Colding J., Barthel S., 2012)). Agroecology is a science, a movement and a practice (Wezel A. et al., 2009). It is an agricultural system which encourages the ban of pesticides in the production and a systematic plantation with companion planting to create a resilient and autonomous ecosystem. It also supports the autonomy of farmers and the end of malnutrition and poverty (FAO, 2018). However, with competition with industrial farming, it is difficult to find land and settle with an agroecological farm in Europe. With cities expanding and the expected climate change scenarios it has become urgent to rethink our green spaces and food systems within the cities and their suburbs. There is also a need for biodiversity in urban food systems. Due to this context, landscape architects are facing new challenges to answer such as access to food and water, energy, biodiversity and access to land and the need to garden in the city. However, assessing how agroecological principles could be applied in urban planning and landscape architecture has not yet been made. As K. Morgan suggests, «Planners have denied their role in planning food systems and providing food in cities, creating an imbalance in food provisioning and in the landscape. » Also needs to be addressed the potential of community food systems which lead to better quality food and to more creativity, resourcefulness and social innovation and exchange of knowledge, which leads to more resilient urban socio- ecological systems. There is a need to plan for more urban socio-ecological resilience to good quality food provisioning and climate change risks. Resilience is here defined as the capacity of a system and community to absorb a climatic phenomenon and maintain the same organisation and structure and its identity (Walker et al. 2004:4 in Folke C. et al, 2010). Practices and philosophies such as agroecology and permaculture are emerging across the globe to respond to these challenges and the need for resilience. But as urban agriculture is still poorly supported by governments and planners, these practices aren't implemented in planning orientations and strategies. This leads to the creation of micro allotment gardens in the cities and on farms with short-term contracts for production. And in some cases, like in Budapest, to the impossibility in planting trees. Indeed, there is no land security for agroecologists who wish to settle. This is due to land speculation and the real estate pressures on land. In this sense, according to Wezel et al., land accessibility is the main obstacle to the development of agroecology in Europe (Wezel et al, 2018).

It is also important to mention the impact of the world food economy and market system on landscapes and production conditions and its disparities. For example, in Spain, the greenhouses of Almeria for tomatoes and other crops occupy 26 000 ha and are the largest concentration of greenhouses in the world (Amusing Planet, 2013). There is a need to include research in species which could be adapted to climate change and find spaces to grow food and free gardening in the city. Viticulture presents new opportunities according to the climate change predictions with new areas of growth for wine production and other goods. It is also a practice which can be developed in different parts of the world and build common research to ban the use of pesticides and reduce soil erosion. There is also the need in research for new plants for water retention and less dependency on water, such as ground covers, shrubs and trees. This practice could also present new possibilities for work.

With the climate change scenarios and impacts on our cities, it will be important to reduce heat stress equally and provide open green spaces with shade to city dwellers with access to food and materials. Landscape architects need to find solutions for reducing social disparities in the cities and spatial segregation and create inclusive cities.

Urban agroforestry is more than a plantation, it is to be integrated in a whole philosophy, policy and practice, with principles and a clear planning vision and strategy. The plot needs to fit in the urban landscape and has its own identity through the encouragement of creativity with public participation. Wangari Maathai is a good example of tree nursery production and plantation in Kenya with inclusion and empowerment of women.

Figure 3. The 17 UN Sustainable development goals

In the face of climate change, landscape architects need to answer the 17 UN sustainable development goals (Figure 3) as well as find solutions to end hunger and to end poverty and social, ecological and economic challenges. These are: no poverty, zero hunger, good health and well-being, quality education, gender equality, clean water and sanitation, affordable and clean energy, decent work and economic growth, industry innovation and infrastructure, reduced inequalities, sustainable cities and communities, responsible consumption and production, climate action, life below water, life on land, peace, justice and strong institutions, partnerships for the goals. Answering these goals is a challenge because it means finding funding, good tools in planning and creating new partnerships. Urban agroforestry is a practice that meets with these sustainable development goals. The goals of urban agroforestry are ecology and social inclusion with food and arts and to provide spaces with proximity to nature.

II.2 Food planning in cities and agroecology in landscape architecture

In the case of planning food in cities, some food strategy plans exist such as the Food Smart cities with the Milan Food Policy Pact, Turin, Bruges, Brussels, Utrecht, Gent, Barcelona and Dakar. In the city it is possible to make honey, have trees, fruit and vegetables, mushrooms. But some cities have regulations in the design. For example, in Montreal it is prohibited to plant 2m high edibles such as corn for example to ensure visibility in the plot (Interview with community gardeners in Montreal, 2013). There is also an interest for creating organic based school canteens like for example in the town of Mouans-Sartoux in France where food is grown locally and served in the school canteens. There are also Territorial Food Provisionning Projects in France (Ministère de l'Agriculture et de la Souveraineté Alimentaire, 2023). Planning of urban agriculture and urban forestry have both been planned separately, here I argue that they should be integrated in an agroforestry system for the afforestation of the city and the supply of shade, sustainable food and materials in the city in the frames of urban agroforestry. This research is to find planning tools and assess the opportunities and challenges of including agroforestry in these food planning policies and agendas. Other benefits will be assessed through this literature review and this thesis. Before planning food in the city, there needs to be a reduction of cars in the city. Or to do it all at the same time. Indeed, in western European cities, 39% of artificialised lands are dedicated to mobility and parking, the car using 8 to 13 times more space per capita compared to the bicycle (Bourcier A, 2012). There is also a need to protect prairies because they are important for biodiversity and are a second carbon sink. The challenges to integrate agroforestry systems in the city will also be assessed in this thesis. In the context of European cities, there is an emergence of urban agriculture and concepts to integrate agriculture in urban planning such as *agrourbanism* (Gottero Enrico, 2019) or *agropolitain* in Clermont-Ferrand, France (PUCA, 2021). This research also focuses on the choice in plant species for their purposes and characteristics, based on the landscape context. Little research has been made for assessing the potential of urban agriculture for arts and its necessity, this is also a topic of this thesis on urban agroforestry.

II.3 Agroforestry for arts

One of the purposes of the plantations for agroecology in cities can be arts. Agroforestry systems can be explored for providing art supplies such as tinctorial plants on polluted soils and in urban community gardens for social inclusion and community-building. It can also be assessed for its potential for art-therapy practices and linking scientific knowledge in agriculture and arts in the design. It is assessed as a potential adaptation of green spaces to climate change and preventing risks such as flooding and erosion of polluted soil to the water streams. The importance of an artistic approach in participative design is to encourage creativity and social inclusion in neighbourhoods and open them to a green network with biodiversity.

II.4 Terminologies and definition of urban agroforestry in a global context with specifications for landscape architecture

This section reviews several terminologies (Figure 4) which need to be considered when planning urban and peri-urban agroforestry. The main terminologies assessed are: socio-ecology, agroecology, urban agroecology, permaculture, agroforestry, urban agroforestry, urban food forestry, permaculture guild and social design. The distinction between these terminologies helps understand the definition of urban agroforestry and how it is complementary to these existing terms.
There is a growing interest in ecologically sound agriculture so several research has been made about the production opportunities in agroforestry. However, little research has been made about the social aspects of agroforestry, especially urban and peri-urban agroforestry. In the following I give a short review of terms which are important to understand the policy around urban and peri-urban agroforestry and the principles, so it is possible to conclude with one unique vision for developing urban and peri-urban agroforestry.

General terms

Socio-ecology is the main topic grouping several theories, policies, tools and practices related to agroecology (Figure 4). There is a link between these terminologies.

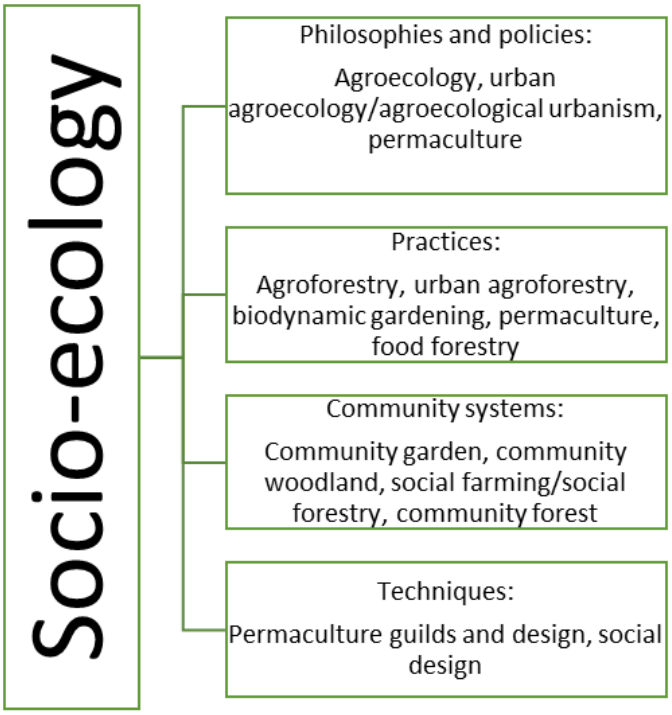


Figure 4. Summary of terminologies assessed, Paloma Gonzalez de Linares

Socio-ecology

The term socio-ecology is important because urban agroforestry isn't only about technical plantations of species, it is also the relation people have with nature and about available resources on the plot. As mentioned above, it can have therapeutic purposes and have an impact on well-being and the urban environment through the mitigation of urban heat islands and the rehabilitation of urban soils. Social and ecological factors are interdependent as the natural environment has an impact on society and society has an impact on nature. Social-ecological systems are complex systems that include interactions between societies and the environment (Cumming G S, 2017). This is a general concept which can cover all agroecological practices. According to Cuming G. S., the social-ecological questions mainly revolve around the maintenance of the resources and the management (Cumming G S, 2017). There also needs to be adaptation to climate change with plantations and solutions for new invasive species through management strategies and policies. There needs to be a socio-ecological transition in the means of producing and consuming, and creating socially equitable and viable economies (TIESS in RRAPPS Bourgogne Franche-Comté, 2023).

In landscape architecture, socio-ecology can be linked to the creation of agroecological gardens for biodiversity conservation, nature protection and restoration and well-being. On a wide scale social-ecological networks can be created, for instance along river streams (Janssen M., et al., 2006). Artistic practices and exchanges of materials and waste can also be part of a socio-ecological corridor.

Philosophies and policies

This section reviews the terms of different policies related to socio-ecology which could lead to a transition of cities through urban planning and landscape architecture.

Agroecology

According to Gliessman, agroecology is *the application of ecological concepts and principles to the design and management of sustainable agroecosystems, or the science of sustainable agriculture* (Altieri 1995; Gliessman 1990, 1997, 2013, in Gliessman 2018). It is transdisciplinary, participatory and action-oriented (Gliessman, 2018). It is also defined as a movement, a science, a political vision and a practice (RUAF, 2017).

Agroecology is both scientific and holistic, and it takes into consideration ecosystems and social aspects such as social inclusion, women inclusion and the youth (FAO, 2020). There are ten elements of agroecology according to the FAO: diversity, co-creation and sharing of knowledge, synergies, efficiency, recycling, resilience, human and social values, culture and food traditions, responsible governance, circular and solidarity economy. Agroecology is also a practice which can take the form of agroforestry and permaculture. These will be defined later in the section.

Landscape architects could play a role in agroecology by including these principles in planning and design. Agroecological principles can and need to be applied to a whole urban landscape strategy plan with social inclusion and equality in access to green spaces, shade, urban food systems and materials in cities.

Urban agroecology/ Agroecological urbanism

Agroecology can be applied to the urban context. This not only creates an agroecological practice for ecosystems but also includes social aspects. Urban agroecology aims at social inclusion, bottom-up planning and food sovereignty and security (FAO, 2020). In urban agroecology must also be evaluated the *governance of the commons* (Ostrom, 1990).

Literature shows an important wish for people, including farmers, to be heard by local governments for their empowerment and for food sovereignty. Landscape architects can work with gardeners, farmers and citizens to plan new edible spaces in the city. These spaces can have an educational purpose too such as « *social learning* » (Bandura A., 1977). A smooth transition could be started and new bondings between institutions and communities, experts and citizens could be launched. Also, « sovereignty means that agroecology is understood as part of sovereign food systems, wherein social actors are free to define, construct and defend their food culture, and they are protected from outside predatory actors (such as banks, mining companies, and agribusiness circuits) that would undermine these food cultures» (Omar Felipe Giraldo & Nils McCune, 2019). Urban agroecology is «building alternative food systems includes dealing with challenges as vast as urbanisation processes, land management, life rhythms, financial drivers and collective arrangements for food provision, education or austerity politics» (RUAF, 2017). According to the FAO agroecology is a bottom-up system (FAO, 2020) Social design also promotes social equity (Gutiérrez and Jurow, 2016).

As a landscape architect, urban agroecology means avoiding food deserts. Cities offer possibilities for food diversity and production. For example, through exchanges between neighbours and communities, exchanges of seeds and plants and plant multiplication techniques like rosemary can be replanted easily from a stem.
Planners and landscape architects could support local green initiatives, grass root initiatives in their policies and planning and find spaces for more social-ecological systems and plan their connections within the landscape. Gardens are active landscapes, places of exchange of resources and knowledge (experience from the School of Urban agriculture in UQAM, Montreal, 2013). For a successful food plan, there need to be more flexible regulations to allow more freedom for gardening and farming in the city. This was well established in the country of Cuba where urban agriculture started expanding in Cuba in 1989 with the Autoconsumo program and the creation of organopicos. For reforestation, the government also introduced the *Mi Programma Verde* to allow the plantation of trees and fruit trees in the city. It is in order to protect, maintain and create new forested areas (Mario Gonzalez et al., 2000). The Department of Urban Agriculture was created and helps in developing programmes to support the gardeners to gain experience in agriculture and not use pesticides. It supports organic farming. Now the Island counts 400 000 urban agricultural exploitations and produces 1,5 million tons of vegetables without pesticides or chemicals (Bastamag, 2015).
Landscape architects should help citizens who are aware to settle and instruct the new generation with new ways of living, less materialistic and more resilient. Socio-ecological spaces could be connected with smooth mobility, tools and exchange of knowledge to avoid creating closed communities, closed hubs. There also needs to be a concrete plan for food systems and social-ecological systems as you can’t grow everywhere, there is a need for a management plan for the city and a balance between consumed spaces and protected green spaces.

To integrate urban agroforestry, it is necessary to rethink the whole urban system and not only the plot and species. There needs to be a whole agroecological policy framework to support the landscape architect's projects and designs and for urban agroforestry plots to be public goods. Planners and decision-makers also need to rethink the functions, the usage, the activities and spaces and adapt the land use to the climate change scenarios. Urban agroforestry is more than a plantation, it is to be integrated in a whole philosophy, policy and practice, with principles and a clear planning vision and strategy. It is also necessary to understand relations between people and their environment and include the local culture.

Permaculture

Permaculture is both a philosophy and a practice. It is a system of agricultural and social design principles centred on simulating or directly utilising the patterns and features observed in natural ecosystems (Emma Chapman, Permaculture Magazine, 2015). Permaculture was developed by Bill Mollison and David Holmgren in 1978. It is a way of planting and organising a plot. The plantation and design is organic and self-sufficient. Permaculture is based on the observation of the ecosystem and focuses on doing with rather than against. It is based on practical gardening techniques and also a whole design philosophy (Emma Chapman, Permaculture Magazine, 2015). Permaculture tackles how to grow food, build houses and create communities, and minimise environmental impact at the same time.

In landscape architecture, the philosophy of permaculture is complementary to agroecology as it uses agroecological planting and management techniques and principles. In the city, urban agroecology could be linked to permaculture for social inclusion through social design strategies. In this sense, landscape architects work with communities. The planning and design strategy is based on partnerships and cooperations and exchange of goods and services. One of the main challenges is the management of pests and diseases.

Practices

There are several practices: agroforestry, urban agroforestry, biodynamic gardening, permaculture, food forestry. These can all be part of a socio-ecological system, urban planning and landscape architecture.

Agroforestry

Agroforestry is the «deliberate plantation of a woody perennial with non woody perennials in which there is a significant ecological and economical interaction» (Nair, 1993). It is also the combination of two land uses: forest and agriculture (R., Nair, 1993). On a same unit of land, it is possible to plant trees for energy and food such as sour cherry trees, and crops for food or medicinal or fodder, such as cereals. This includes more productivity in a smaller unit of land. There are several agroforestry systems: alley cropping, wood-pastures, agrisilvicultural systems, silvopastoral systems, agropastoral systems, windbreaks, shelterbelts, and forest gardens (FAO, 2020).

Agroforestry is an ancestral agricultural system which ended in the Middle Ages in Europe. It is still a practice in the Southern countries. In Tropical America, Asia and Africa, the ecosystem of the forest was recreated to produce food for families. These forests have different names and religious backgrounds. For example, in Asia, the Hanunoo of the

Philippines were practices of clearing the forest for agricultural use. This protected the soil from the sun in order to produce rice. « Trees were an indispensable part of the Hanunoo farming system and were either planted or preserved from the original forest to provide food, medicines, construction wood, and cosmetics (Conklin, 1957). Similar farming systems have also been common in many other parts of the humid lowland tropics of Asia. »

Urban agroforestry

Urban agroforestry is popular in the Southern countries in homegardens and on idle lands. According to Thaman urban agroforestry is «the planting, protection or preservation of trees for their economic, social and ecological value as part of agricultural and horticultural systems in urban areas, not only adjacent to houses and other buildings but also on undeveloped land within urban areas» (Thaman R.R, 2023). There are several urban agroforestry spaces : dooryard agroforestry, backyard agroforestry, urban agroforestry on undeveloped land, along road frontages. There are several crops and species grown : staple crops, supplementary food crops, food trees, non-food plants, animal husbandry and urban agrosilvopastoral.
Along the road frontages, there are some fruit trees but ornamental trees and shade trees are dominant. On these dry rocky soils, mainly root crops are grown. Disease-resistant and drought resistant species are also planted.

In landscape architecture, urban agroforestry systems can protect and restore urban soils, help in the management of water runoffs, and be carbon sinks and spaces for shade. Therefore it is also for well-being.

Urban agriculture

Urban agriculture defined in simple terms is the growing, processing, and distribution of food and other products through intensive plant cultivation and animal husbandry in and around cities (Bailkey, M. and J. Nasr, 2000). There is also urban horticulture. Urban and peri-urban horticulture (UPH) includes all horticultural crops grown for human consumption and ornamental use within and in the immediate surroundings of cities (Cirad, 2006).

The Food and Agriculture Organisation of the UN (FAO) introduced the acronym UPA (Urban and Peri-urban Agriculture; Nugent 2000), with ‘urban agriculture’ referring to agriculture that takes place within the built-up city and ‘peri-urban agriculture’ to agriculture in the areas surrounding the cities”, (in de Zeeuw H., Van Veenhuizen R., Dubbeling M., 2011)

Urban horticulture

Urban horticulture is defined as plant production activities which are completely or partially edible, and which are economically viable (Ohyama K et al., 2008). It also includes ornamental production (RUAF, 2019).

Biodynamic gardening

Biodynamic gardening is an organic gardening practice which takes into account the cosmos (Ilona Sombo, a biodynamic gardener in Szada, Hungary). This type of gardening is complex to take into account in an urban plan and is more centred on the plot and the production cycle. Spaces for biodynamic gardening should also be open in cities for biodynamic gardeners.

Biodynamic gardening reminds the landscape architect to consider the cosmos in his designs of new public green spaces with agroforestry.

Food forestry

Urban Food Forestry is defined as the plantation of woody perennials for production in urban edible landscapes and leads to the resilience of urban communities. The emphasis on perennial woody fruit- and nut-producing species (food trees) distinguishes UFF from conventional forms of both urban agriculture and urban forestry (Kyle H. Clark, Kimberly A. Nicholas, 2013). Therefore, it is a type of urban agroforestry practice. The concept of a food forest takes its roots in permaculture.

In landscape architecture, urban food forests are mainly edible landscapes which have a function inside the plot directly. When considering urban and peri-urban agroforestry, the production is more diverse and there is a planning strategy at a wider scale.

Community systems

There are several community- based systems which should be included in urban agroforestry planning and design.

Community garden

A single piece of land gardened collectively by a group of people. Community gardens utilize either individual or shared plots on private or public land while producing fruit, vegetables, and/or plants.

Community woodland

‘Community woodland’ (CW) refers to any woodland where the local community has some degree of control over how the woodland is run or managed. Such woodlands are usually supported by a community woodland group (CWG). The woodland may be owned or leased by the community group, or it may be managed in partnership with another organization (usually the landowner) through a management agreement.

Social farming, social forestry

Social Farming is the action of creating inclusive spaces for increasing self-esteem and improving well-being through farming activities (social farming, 2023).
Social farms can also be farms open to people with disabilities and for therapy (Réseau ASTRA, 2023).

Community forestry

Community forestry is defined by R. Nair as people's participation in tree planting activities with social objectives (Nair, 1993).

In landscape architecture, urban community forestry needs logistics and finding long term plots for planting multipurpose trees. This also requires the planning of organic tree nurseries and spaces for forestry with the right to pick and use the materials provided by the tree. It also means building a social organisation and institutional organisation for more resilient cities. Community forestry is a governance system which could be used in urban agroforestry with tree planting for social purposes and participative designs.

Community orchard

A collection of fruit trees shared by communities and growing in publicly accessible areas such as public greenspaces, parks, schools, churchyards, allotments or, in the US, abandoned lots. Such orchards are a shared resource and not managed for personal or business profit. Income may be generated to sustain the orchard as a charity, community interest company, or other non-profit structure. What they have in common is that they are cared for by a community of people.

A community orchard is the plantation of fruit trees and nut trees within a community (Ames, 2013; Ben Nobleman Park Community Orchard, 2014, OrchardPeople).

Technical aspects

There are several technical aspects in permaculture which are used to manage waste, water and companion planting. Planning urban agroforestry and combining it with planning at human scale theory lead to questions in design. These systems are compared from studies in literature review. These techniques can be part of urban planning strategies and landscape architecture.

Permaculture guilds

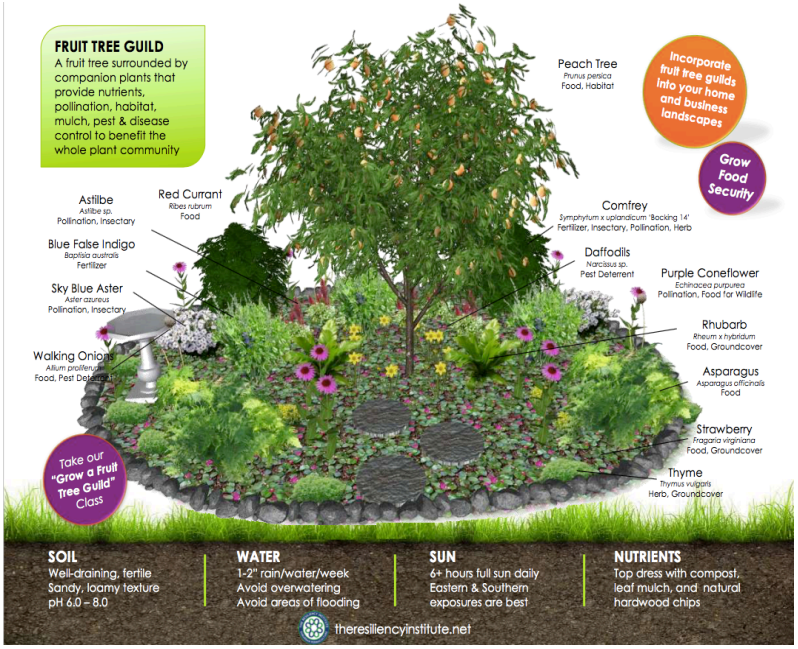


Figure 5. Permaculture guild, source: The resiliency institute

Permaculture guilds (Figure 5) are plantation systems and strategies including fruit trees, to ensure sustainable interactions between the planted species.

Social permaculture design

Social permaculture designs are participative designs of permaculture gardens.
Aesthetic value of some trees in urban and suburban areas could be assessed such as: colour and texture of trees and ground covers. There is also research to be made on design strategies in agroforestry as people don't behave the same way according to the tree plantation.

The plantation system of trees has an influence on the user's behavior and mobility on the plot (Figure 6, 7).

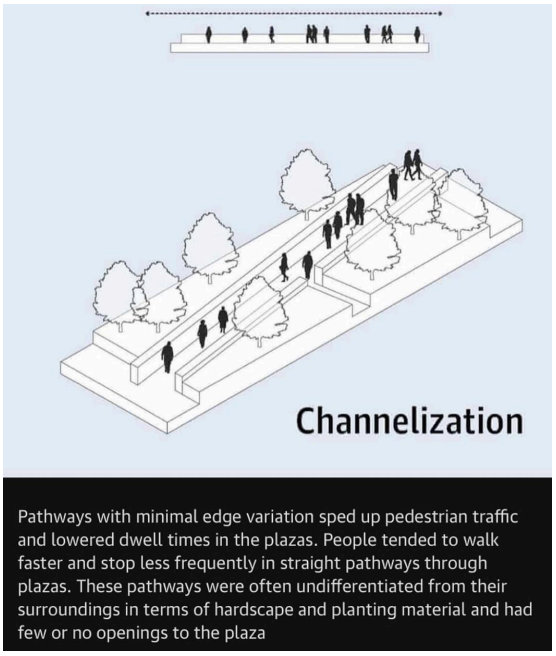


Figure 6. Channelization, source: SWAGROUP

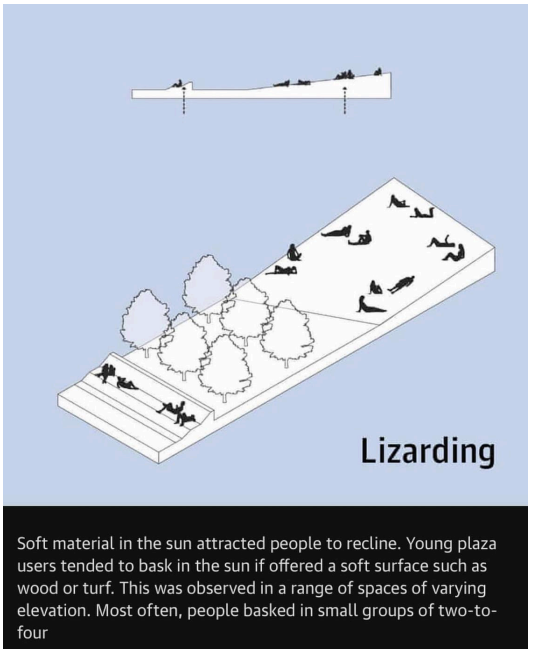


Figure 7. Lizarding, source: SWAGROUP

Conclusion of the terminologies

All terms should be brought together into the same vision: building resilient and inclusive cities through socio-ecological systems and urban agroforestry. These would be created with agroecological and permacultural philosophy and background with a community agroforestry governance through social permaculture design. This could be a good strategy for community planning and planning food systems and material production in landscape architecture with social functions. Exchanges could be made between the urban and peri-urban areas through corridors. Transport and exchange of seeds could be made through smooth mobility..
It is about connections and relations between people and nature and their economy and policy. There could be urban community agroecosystems with participative methods for planning and designing urban agroforestry systems. The challenge is to get over political barriers and administrative barriers. The landscape architect has several roles to play in urban and peri-urban agroforestry, to create socio-ecological systems with community-based organisations and agroecological principles. He/she needs to consider technical aspects in the planting system and the choice in species and work not only at the wide scale but also at the plot scale and neighbourhood scale (with analysis of the soil, drainage and bioindicators for example for soil fertility and conditions).

II.5 Urban forestry, urban agroforestry and urban agriculture

This section is about the differences between urban forestry, urban agroforestry and urban agriculture and their complementarity.

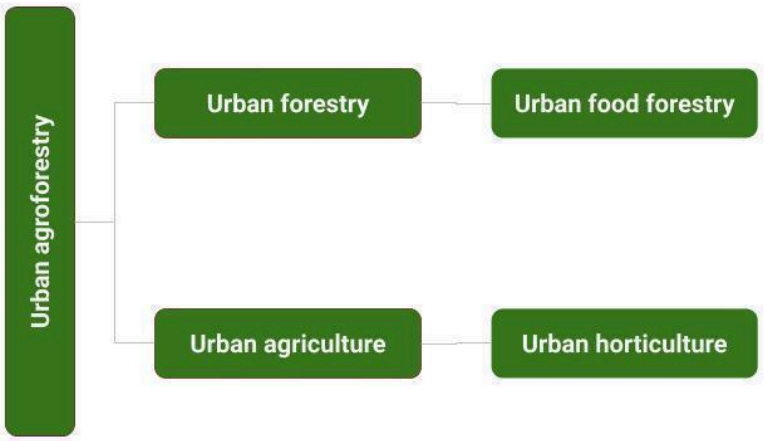


Figure 8. The different urban green systems definitions and their relations, Paloma Gonzalez de Linares

Urban agroforestry includes urban forestry and urban agriculture practices (Figure 8). It is a mix of both. Urban forestry is the art, science and technology of managing trees and forest resources in and around urban community ecosystems for the physiological, sociological, economic, and aesthetic benefits trees provide to society (van den Bosch C.K, Randrup T. B., 2004). Urban forestry and urban horticulture can also be subdivided into urban food forestry and urban horticulture. The difference between urban forestry, urban agroforestry and urban agriculture is that urban forests are usually green spaces in which people walk and cross without staying. Edible landscapes such as urban agricultural landscapes are places to stop and meet, to stroll between, to stay in. Urban agroforestry is a complement to urban agriculture (Lovell, 2020). It is a practice for providing goods and needs a space for cultivating with trees. It is possible to include urban agroforestry in urban forestry plans with areas to restore natural habitats and areas to grow food with respect for wildlife and the intent to protect and increase biodiversity in the city. Urban agroforestry presents a special objective of cultivating with a high diversity of trees and families of species with different purposes such as the nitrogen fixing with *Fabaceae* plants, attraction of pollinators with *Tagetes patula* and protection of plantations and the soil with aromatics and other green covers.

II.6 Agroforestry and urban agroforestry

Agroforestry presents a wide range of systems and landscapes which can be adapted to the city.

There are different types of agroforestry landscapes:

- Agroforestry systems of high nature and cultural value,
- Agroforestry systems integrating livestock and crops into high value tree systems,
- Agroforestry for arable systems
- Agroforestry for livestock systems

Agroforestry has a mosaic of land uses: with more than 35% of land devoted to Agriculture and more than 35% of cover by Forest, and there are at least 4 plots of Agriculture and Forestry. There is also a mosaic of herbaceous crops with tree-based crops. There can be bocages, arable lands intermixed with hedges of trees and/or shrubs, woodlots. Accordingly, agroforestry would occur at a point along a forest to open pasture/agriculture gradient (Agforward, 2020). There are an intermixture of land uses and patches.

Agroforestry in the world

Several agroforestry systems which can be found in the world and present different interactions between the trees and the agricultural land, the production objectives and the plan and management of the plot. First, there are agrisilvicultural systems which are crops including shrub/vine/tree crops- and trees: improved fallow, Taungya, alley cropping, multilayer tree gardens, multipurpose trees on croplands, plantation crop combinations, homegardens, trees in soil conservation and reclamation, shelterbelts and windbreaks, live hedges and fuelwood production. Second, there are silvopastoral systems which are systems with trees and pasture and/or animals: trees on rangeland or pastures, protein banks and plantation crops with pastures and animals. Third, there are agrosilvopastoral systems which include trees, crops and pasture/animals: homegardens involving animals, multipurpose woody hedgerows, apiculture with trees, aquaforestry, multipurpose woodlots.

There are several types of agroforestry systems. These are:
Agrisilvicultural systems:
- Improved fallow
- Taungya
- Alley cropping
- Multilayer tree gardens
- Multipurpose trees on croplands
- Plantation crop combinations
- Homegardens
- Trees in soil conservation and reclamation
- Shelterbelts and windbreaks
- Live hedges and fuelwood production
- Forest-gardens

Silvopastoral systems:
- Trees on rangeland or pastures
- Protein banks and plantation crops with pastures and animals

Agrosilvopastoral systems:
- Homegardens involving animals
- Multipurpose woody hedgerows
- Apiculture with trees
- Aquaforestry
- Multipurpose woodlots

Agroforestry with vines:
- Vitiforestry

Syntropic agroforestry

Agroforestry in Europe

In Europe, agroforestry has several characteristics, benefits and challenges.

Characteristics

According to Mosquera-Losada et al.,2012 oaks are the predominant tree species in European agroforestry systems with 17 species (Mosquera-Losada et al., 2012). Agroforestry systems based on Pinus sylvestris occur in most European agroclimatic regions and the most common agroforestry system in Europe is silvoarable practices (Mosquera-Losada et al., 2009a, b in Mosquera-Losada et al., 2012).

Another type of agroforestry system is forest- gardens. Forest garden farms originated in prehistoric times along jungle-clad river banks and in the wet foothills of the monsoon lands. The forest garden system was introduced in Temperate Climates by the English botanist Robert Hart in 1960 who created the first plantation system with 7 layers. Today, one of the main references is Martin Crawford who has a forest garden plantation of 500 species in 1 ha of land. Martin Crawford only plants perennials as they require less energy to produce.

There is also vitiforestry which is the association of vineyards with trees and/or groundcovers. This was a method used in Antiquity (Vignevin, 2023). The trees protect the vines from excessive heat, wind and hail and frost.

Finally, syntropic agroforestry was developed by Ernst Gotsch in the last 50 years. It is the growing of fruit, nuts, vegetables and timber in an area and copies the succession of nature in stratification and time things grow. The goal is to accelerate the regeneration of the soil (AFAF,2020, thriving with nature, 2019). It also has an economic purpose and output.

Benefits

Agroforestry has several benefits such as carbon storage (Schroeder P., 1994), a multipurpose production (food, fodder, biomass, energy, medicine), soil rehabilitation (Haselwandter K., Bowen Glynn D., 1996), wildfire management (Damianidis C. et al., 2020), a diversified income for farmers (Franzel S., Cooper P. & Denning G. L 2001), enhancement of soil fertility (Anitta Fanish S. & Sathya Priya R., 2013), rainwater management (Anderson S. H et al., 2009), microclimate regulation (Monteith J.L. et al., 1991) biodiversity conservation (Shibu J., 2009), improved air and water quality (Shibu J., 2009), recreation, landscape enhancement and high quality food production (Rigueiro- Rodríguez A et al., 2009).

There are several agroforestry techniques such as mulching, woodland coppicing, ramial chipped wood (Bois raméal fragmenté (BRF)) and pollarding trees. There are also systems which can have an influence on the landscape such as buffer strips, terracing, live fencing and woodlots (FAO, 2022). Woodland coppicing and pollard trees can be good ways of animating a community agroforestry plot in a public space. Mulching helps in protecting the soil from

drought and erosion, as well as limits the loss of water for the tree and plants. This can have economic benefits in the city and reduce heat stress. In the city, multipurpose trees can have three functions: productive, biodiversity and therapy.
In the city, agroforest plots could mainly serve the purpose of community bonding, social inclusion, social innovation, arts, therapy and education. Whereas in the peri-urban area it could be for food and energy production and recreotourism.

Increasing biodiversity can have several economic benefits: to have a seasonal and diverse production, to stock carbone, to reduce needs in water and heat stress, to increase nutrients in the soil, attract auxiliaries to reduce pests.

There is a diversity of stratas, ages of plants and species. Fauna and flora are invited all year round and diverse, there is a permanent ground cover.
Agroforestry plots can have different purposes such as producing food and wood, energy and materials, arts and crafts (EURAF, 2020) or even therapy (EURAF, 2020).

Agroforestry presents several benefits that could be explored to answer urban challenges such as access to healthy food, well-being, reduction of heat islands, increase in biodiversity, community development, reducing wildfire (ex: Sierra de Gata). Agroforestry can increase tree cover in the city and reduce heat stress.

Challenges

Agroforestry has several challenges such as competition management between species, need in nitrogen production, the lack of recognition in the CAP. There is also the challenge of pests and disease control, the use of chemicals and the risks of drought increasing with climate change. These challenges have impacts on landscape management and agroecology.

Agroforestry systems could be implemented in the urban and peri-urban landscapes for more sustainable food systems and environments. Indeed, agroforestry enhances biodiversity. Indeed, “The vision of agroforestry presented here is as an integrated land use that, through the capture of intraspecific diversity and the diversification of species on farm, combines and increases in productivity and income generation with environmental rehabilitation and the creation of biodiverse agroecosystems. In most places this is just a vision, but there are increasing numbers of examples where the vision is already a reality.” (Roger R. B. Leakey, 1998). “Biodiversity is conserved and generally enhanced in agroforestry systems, compared to conventional agricultural systems (Tuupanen et al., 1997; Rigueiro-Rodriguez et al., 2010b) and in some cases, biodiversity levels are greater than in both agricultural and woodland systems (McAdam et al., 1999b)” in Mosquera-Losada et al., 2012).

Example of European cases for agroforestry and opportunities for cities

1. In Germany

An interview was made with the agroforestry association of Germany.

There is no general system for subsidies for agroforestry. Orchards are well supported. They are traditional and the most common systems with funding. But they are not called "agroforestry". Farmers are not allowed to grow crops in between these trees in orchards. The short rotation coppice systems are not recognised by the governments as a full system. This makes it difficult for subsidies. They are considered separate strips. When there are over 100 trees per ha it is an afforestation and therefore a forest.

As Germany is a federal state, each state has its own rules. The problem is understanding what agroforestry is among politicians and farmers. Since January 2021, the State government supports funding for agroforestry. Farmers don't own the land, the land is rented. They need authorisation from the owner. This is the situation for 30 to 40% of the land. The problem is also with the heritage of the agroforestry land to children.

The EU can help in different ways. They can give the framework and help in finding funding. The problem is with the willingness and definition of agroforestry systems. It is difficult to find funding according to these different varieties of systems. Landscape architects can help later in a further stage. But now, they are trying to make agroforestry possible and authorised and to select species with results.

2. In Belgium

An interview was made with experts in agroforestry from the Belgium Association for Agroforestry in Wallonia and Brussels (AWAF). According to the interviewed expert, a global interest is spreading for agroforestry between public institutions and farmers. The most popular agroforestry systems which are expanding are alley cropping, hedges and orchards with pear and apple. There is some development also for dried fruit (nuts and chestnuts). Another production which is expanding with agroforestry in the region is fodder with woody perennials. The farmers can receive public funding for agroforestry. However, challenges exist between the regulations and the possible implementation of agroforestry systems. This leads to some barriers for the development of this practice despite the acknowledged interest in it and the will to increase biodiversity in agricultural systems.

Similar to the case in France, 60% of the lands are under a "farm contract" (bail à ferme) in which land owners rent their lands to farmers. Therefore, the exploitants don't own the land. The relations can sometimes be difficult between the owners and exploitants and sometimes there is low contact or communication between them, besides the annual payment of fees. The tree plantation can only be done with the authorisation of the landlord. However, some exceptions exist but remain unclear: the plantation of trees is authorised if it is useful for the conservation of goods. But the legislation doesn't clearly define what are the goods and what are the conditions. Also, in Wallonia there is a strong protection of trees. In order to be able to cut trees and maintain trees and hedges, there needs to be a permit to authorise it. This also leads to difficult boundaries for exploiting agroforestry lands and products and developing the practice. The law mentions that there is no need for a permit to cut an agroforestry tree, but there still is unclear definition of what is an agroforestry tree.

Another aspect is that in the Wallonia region, there is a very strong definition of purposes and land use for each m2 on the land. In forests, there can only be wood production and there cannot be agricultural production or commercial agriculture. This for example leads to the difficulty in creating forest-gardens which is often a practice wished by new gardeners or citizens in professional reconversion. Agroforestry can only be developed on agricultural lands but these are much more expensive than forest lands and rarer.

The situation in Wallonia shows the difficulty in adapting the regulations for development of agroforestry despite the interest and benefits of the practice. It also shows a need to define new productive spaces and find a balance between natural conservation and production.

Finally, according to the interviewed expert, there are low relations between agroforestry and landscape architecture. The farmers and experts mainly work with engineers in agriculture, forestry and biology. In his opinion, the landscape is a very low motive to motivate farmers in converting to agroforestry.

3. In France

In France, there is the Development Plan for Agroforestry 2015-2020, and the Pact in favor of Hedges 2023. These national plans could be part of city strategies too. Agroforestry could also be part of Territorial Food Planning Programs and regional planning with consultation with agronomists, experts in agroforestry, naturalists and planners.

National context

In France, agroforestry is supported by the government with the introduction of a National Plan for Agroforestry (Ministère de l'Agriculture et de l'Alimentation, 2021). This plan started in 2015 and ended in 2020. The goals were to promote agroforestry, create better regulations and funding opportunities for farmers. According to the French Association of Agroforestry (AFAF), there is a rural code which specifies that the property of the tree is related to the property of the land. So, there is a possibility to create long term agroforestry plots on farmlands. One of the major challenges is that most of the agricultural lands are rented to farmers by the owners. This represents 60% of the agricultural lands. Therefore, there is a need for an authorisation from the owner to grow agroforestry systems. This is called the "Fermage". According to the President of the AFAF, the National Plan for Agroforestry didn't lead to any major development on the field but it contributes to communicating and thinking about the topic. It was also mentioned that the CAP doesn't bring any major constraints to the development of agroforestry in France. However, the regulations are too complicated for farmers who often have to turn to experts for help and therefore, they don't have much autonomy and need to add fees to the implementation of their agroforestry system. The difficult environmental context and problems are the main motivations for farmers to turn to agroforestry in France. They need to find more resilient solutions and more independence. There is a need to rebuild the soils, the landscapes and diversified economy on the same unit of land. The Key Lines design (Figure 9) is a good and useful tool for this purpose (Interview with the President of AFAF, 22nd May 2021). This

methodology is to plan according to the contour lines of the topography for better management of the water and the soil (Paysages fertiles, 2021).

Figure 9. Keyline Design (Source: Paysages Fertiles, 2021)

Agroforestry is mostly an agricultural system planted with ecological and economic interactions and benefits. In this thesis, the focus of urban agroforestry is on the social aspect, for social inclusion and arts and expression in cities with ecological purposes. The economic aspect needs to be deepened and more developed in further research.

II.7 Benefits of urban agroforestry

This section covers the social, economic and environmental benefits of urban agroforestry to consider in planning and landscape architecture.

Social aspects

Access to green spaces increases well-being. It has positive effects such as reduction in stress and anxiety and recovery from surgery (Ulrich, 1984). It also leads to a reduction in crime (Kuo and Sullivan 2001) and improvement of self-discipline (Faber Taylor et al., 2002). Urban and peri-urban agroforestry could be orientated to have these positive effects on people and be restorative spaces. Restorative experiences are experiences that help people recover from mental fatigue (Kaplan, 1992) but involuntary attention instead of voluntary attention (Kaplan, 1992). There can be elements of soft fascination: trees, clouds, vegetation, grass, a mass of flowers, sunsets, snow patterns (Kaplan, 1992). There can also be restorative activities which are nature-related (Kaplan, 1992). In medical institutions such as the Nacadia therapeutic forest garden it has been proven that the sense of wildness helps in healing stress and burn out. Plus, urban agroforestry needs to be planned with the theory of *Small is beautiful* (Schumacher E F., 1973). There are already existing concepts for small-scale urban agroforestry such as agrihoods in the United States and agro-neighborhoods in Rungis, France.

Not only the green space is important but also the choice in species and the biological diversity and quality (Carrus G. et al, 2014). It is also possible to use phytogeography for design and companion planting strategies. Well-being depends on the design of the garden (P. Walch interview). For example, it depends on the wilderness of the plot (Corazon S. et al., 2010). Abundance of a taxonomic group may be more noticeable by people than the number of species (Dallimer et al. 2012). Therefore, there is a need to explore the influence of specific species on well- being. Thus, due to the war in Ukraine anxiety and depression cases are

rising for example in Central Europe (Riad A., et al., 2022). And there is also the phenomena of eco-anxiety which needs to be addressed in newly planted green spaces.
The urban tree has benefits on human health (Wolf K. L., et al., 2020). Agroforestry can also have a therapeutic purpose through horticulture therapy principles and art-therapy practices. Horticulture therapy is the use of horticulture for therapy and rehabilitation (Rutgers, 2022). Landscape architecture is both an artistic and a scientific practice. Therefore, urban agroforestry can be assessed in these two fields. Art and creativity can be a way to social cohesion and resilience. Creativity and social innovation can influence the urban peasant of tomorrow.
Art therapy is a therapeutic support of people put into a situation of creation in a way that their evolution between their artwork is a process of self-transformation (JP Klein, 1997). Urban trees can have multipurpose and include therapeutic purposes such as Tilia cordata which is relaxing (Rustica, 2020). In forest bathing we also find trees which emit phytoncides, which reinforce the immune system, such as walnut trees (Karimi A. R., et al., 2015). Walnut trees are also good multipurpose trees for reclaiming deteriorated land (Vahdati K., et al., 2018). Walking in the forest reduces stress and anxiety (science et vie, 2018). It is called sylvotherapy. Therefore, design practices can be turned to therapy. This can lead to multifunctional agroforestry (Jo Smith et al., 2012).
What needs to be assessed is the creativity agroforestry offers in a public space. Some public spaces should be open and left to creativity, gardening and therapy and managed by citizens to increase responsibility, well-being and awareness of climate change and the close environment. There could be permanent animators employed by the city to create and design agroforestry plots in the city for the betterment of neighborhoods and food provisioning and other resources. This leads to the development of third spaces which are emerging in North America (Janis Timm-Bottos, 2017). Third spaces are spaces where “institutions provide places for people to connect, strengthen their voices, renew their love of each other and develop their own community solutions with the support of university research”. Urban agroforestry could be part of these third spaces. Design could probably be a therapeutic practice too. This will also be assessed in the thesis.
In this case the landscape architect needs to work with medical professionals and could also include artists. There should also be participants (Conference of Philippe Walch, 15th July 2020)
Landscape architecture is already a discipline mixing art and science. Therefore, creating agroforestry therapeutic gardens can be part of the discipline. Agroforestry practices can have therapeutic goals such as watering and mulching. It is also beneficial to play with the 5 senses: smell, sight, touch, hearing and taste. For example herbaceous species can be planted next to benches for they can be stroked by the patients (conference of Philippe Walch, 15th July 2020). These gardens should include therapists and landscape architects (Grahn et al., 2007). A good example of a garden for therapy is the Alnarp rehabilitation garden in Sweden. There is also the therapeutic garden Nacadia in Denmark (Figure 10) which has a therapeutic forest-garden and is aimed at healing patients suffering from burn-out and stress (Corazon S. et al., 2010). These principles can be transposed to public gardens for social well-being. Urban agroforestry should include environmental psychology and leave space for creativity

(Taylor J., Lovell S., 2021). There is also the need to plan for food sovereignty and to build a food provisioning system less dependent on fossil fuels.

Figure 10. The Nacadia therapeutic forest garden in Denmark (Sidenius U. et al., 2017)

Finally, the urban tree is important for human health (Wolf K., et al., 2020). Also, according to Wolf K. et al., urban foresters and professionals in health should work together. This can also be the case for urban agroforestry. Urban agroforestry aims to grow healthy food with integration of ecology principles and planning for increasing access to food. Urban agroforestry can also have artistic purposes. One of the social purposes which it could have and hasn't yet been explored is art therapy.

Citizen-based organisations and participative methods

Today, edible green infrastructure planning needs to consider social aspects through public participation. There are several participative methods which can be used for planning and designing urban agroforestry systems. The public participatory GIS can be a good tool for assessing the needs of people in urban agroforestry. For example, PPGIS has been used to assess ecosystem services of agroforestry land use, for cultural services and well-being (Fagerholm N et al., 2016). This can be a good tool to create *urban community agroforestry systems*. And there are public consultations such as in the case of the city of Sceaux (Sceaux, 2020) in France.

The city of Montreal created eco-neighborhoods initiative in 1995. These are citizen-based institutions in several districts of Montreal in which citizens are employed to embellish the neighbourhoods and green them. One of the main outcomes of these eco-neighborhoods are green laneways and the expansion of urban agriculture after a major petition for urban agriculture in 2011. Planning for urban agroforestry leads to a reflection on the governance system between decision-makers, gardeners and farmers and on-site socio-ecological management systems.

Economic aspects

Urban agroforestry is about thinking in a circle, with a circular vision. It is linked to a circular urbanism with use and reuse of vacant lands and share and exchange of resources. Planning for urban agroforestry could include a full new economic vision through circular economy, recycling of spaces and reuse of lands. This could also be part of a circular urbanism strategy (S. Grisot, 2020). This includes the management of food, energy, resources in the city and compost, waste and the urban soil.
Planning for urban agroforestry could include a full new economic vision through circular economy, recycling of spaces, restoration and reuse of lands. There is a need in equal access to green spaces in cities. According to research, linear parks with long distance walking/cycling tracks along blue spaces (rivers) are a good way to ensure equal access to green spaces (Ngom R. et al, 2015). Urban fruit trees can also be used for biomass from the waste collection from their pruning (Velasquez Marti B., et al., 2013). Therefore, there could be linear parks as resources for well-being, therapeutic purposes and energy resources as well as food. There is an imbalance between the destruction of old forests for food supply in the world and the plantation of new forests in cities. For example, Soya could be grown on rooftops and be integrated in a rainstorm management system for watering. It is also important to mention the impact of the world food economy and market system on landscapes and production conditions. There is also the need to work on the access to healthy food and help low- income families and homeless and increase social inclusion. Above the access to food, there is a need to access sustainable energy, materials for arts and crafts and cosmetics. Also, there is a need to bring back the production to local and not relocate to other countries to avoid exploitation of peasant lands. This leads to thinking about how to plan food in a new global vision without land overexploitation and socio-economic segregation.
Planning food with agroforestry leads to rethinking the categories of Von Thünen in the landscape where agroforestry, crops, forests and farming are combined. The agricultural system is not monocultural and divided into sectors. There is more mixity within the plots. It is not so sectorial and there are also extensive farming systems. In landscape architecture, the balance between the productions and distributions with agroforestry systems needs to be made.

Agroforestry contributes to a diversification in production and economy on the land and aims to adapt to seasonal changes and rhythm. With urban and peri- urban agroforestry there is a need to rethink the market places. For example, there could be direct short circuit farms and markets in the city. There should be a network of beneficiaries of organic food with agroforestry practice such as school canteens, hospitals and food banks. There can also be the inclusion of forest bathing and land art in the economic cycle. There can be various sources of income for agroforestry: research funds for farmers which wish to experiment agroforestry on their land or test new productions, environmental conservation funds. There is also the possibility to plan High Nature and Cultural Value (HNCV) agroforestry defined here as systems that integrate woody vegetation with livestock and/or crops and which are valued for their biodiversity and their cultural heritage (Pantera A et al., 2018).

Economy depends on the value of the tree, the understorey system and the rotation of the production. This needs to be considered when planning urban agroforestry and searching for adding value to land in the city. Also, there are less costs for inputs as the resources on the land are valued and reused in a cycle. There needs to be a calculation of possible yields in the city through several experimental plots. There is also the level of labour needed to be considered. The agroforestry system depends on resource availability: land, labour, capital and productive objectives, the markets and the risk management (J.E.M. Arnold, 1987)
At the European level, the economic aspects of agroforestry can be evaluated through the Common Agricultural Policy (CAP). According to Mosquera-Losada et al, 2018, agroforestry is not fully recognised by the CAP. Indeed, "the EU currently indicates that arable land, and therefore agroforestry on such land, is not be eligible for direct payments if it contains more than 100 trees per hectare, as established by Regulation 640/2014 (Mosquera-Losada et al. 2016b), although it allows Member States to select tree densities below this maximum if local practices are implemented on permanent grassland" (Mosquera-Losada et al., 2018). Also, "the eligibility of arable lands is limited by the Delegate Act 640/2014 (EU 2014a) to those lands with a tree density below 100 trees per hectare. This specific constraint makes it difficult for farmers to introduce trees on their arable land, in particular when they own small plots. The conditions for those trees, defined as isolated trees, are provided in the Delegated Act 639/2014 (EU 2014b) as those with a minimum crown diameter of 4 m, which means a tree cover of 1256 m2 per hectare (12.56%) when considering the 100 trees per hectare rule. If trees are grouped, the maximum area allowed for woody vegetation is even lower, as the CAP allows the 10% of the hectare (1000 m2 per hectare) to be paid. Regarding hedges or hedgerows, the regulation protects those already existing with a width of up to 10 m (Regulation Act 639/2014 (EU 204b)), but only those with a 2-m width can be claimed as eligible land for payment even if the Member State protects wider hedges (DEFRA 1997)."
Urban agroforestry leads to a reflection in the economy on the reuse of materials and lands and the inclusion of citizens in local creative activities and productions with less dependence on oil. There also needs to be more connection to local food and materials and the protection of natural resources.

Environmental aspects

The European Union has created a new Biodiversity Strategy for 2030 to enlarge Natura 2000 areas and a Nature Restoration Law (European Commission, 2022). The Biodiversity Strategy 2030 aims that 15% of deteriorated ecosystems should be restored with green infrastructure planning (European Commission, 2020). There is also an EU framework for forest monitoring. At city scale, the green infrastructure *is a strategically planned network of natural and semi natural areas designed and managed to provide a wide range of ecosystem services in urban and rural areas* (European Union 2013 in Interreg, 2020). Green Infrastructure allows to plan green spaces at a macro-scale and protect wild natural corridors and habitats. Agroforestry systems can be included in green infrastructure planning but also be part of an Edible Green Infrastructure which is a sustainable planned network of edible food systems within the urban ecosystem (McLain et al., 2014 in Russo et al. 2017). The brown network is an ecological network for biodiversity in the soil (Cluzeau D, 2018). This

network is important to consider in decision-making and planning of agroforestry spaces. There is also the EU soil strategy for 2030 and new policies for reducing soil sealing in cities and the peri-urban areas. One of the main challenges is the management of soil resources in the city. Indeed, there is a need to protect fertile soils and biodiversity in soils for erosion or soil sealing and pollution. The soil stores pollutants to avoid them from going to the underground water. But these absorption sites can be saturated if we put too much and therefore the metals are no longer fixed and the waters are polluted. Pollutants in the soil do not enter immediately, they are not always in plants. Metals and fertilizers which can be degraded by the soil can also be found in the soil, but also medicines (antibiotics given to animals). The soil stores carbon in the first 30 cm of the soil. An initiative was launched in France by the Ministry of Agriculture in 2015: the 4 per 1000 which aims at increasing the stock of carbon in the soil at 0,4 % per year, in the first 30 to 40 cm of the soil in order to reduce the level of CO2 in the atmosphere (4p1000, 2020). It takes 5 years to create humus again. The soil is important in agroforestry because it defines the possibility and the type of agroforestry system which is possible to implement. The dead wood is also important as it is a long- lasting carbon pool, retains and stores water which increases the resilience of forests to droughts. Therefore, the soil is an important resource to maintain and needs to be taken into consideration in planning and design in the field of landscape architecture. Landscape architects need to plan with the soil which means planning at the ground level, from the existing ecosystems. Cities were grown on fertile soils (%) but the main focus in green infrastructure development is the green cover and the surface. The soil also needs to be considered and thought of as a resource to protect and rehabilitate. There is an effect of drought on soil, it can cause famine and with global warming there will be periods of droughts and rewetting which has an impact on microbial activity (Schimel J.P, 2018). It is also important to include the research and knowledge on surface albedo in cities, not only on impermeable surfaces but also on urban agricultural lands. Indeed, the albedo has an impact on nitrogen in the atmosphere and other environmental aspects (Zhang X., et al., 2022). Also, surface cover and site-specific conditions are necessary to predict soil temperature. (M. Chalhoub et al., 2017)

E. Howard started thinking about the gardens in the city and P. Geddes, the vision of a green belt. Today we are rethinking the implementation of foodscapes in these green infrastructure visions. There is also the concept of Continuous Productive Landscapes developed by A. Viljoen and Bohn.

For these global goals and strategies, there is a possibility to use urban agroecology principles in planning with urban and peri urban agroforestry. As noticed during the covid-19 pandemic, when nature is left alone, it revives on its own and takes over. This thesis suggests leaving a percentage of natural areas in design to let the wildlife take over naturally. Of course, there can also be areas of wilderness and wild gardens like the English gardens, but some areas should be left untouched.

The choice of the plant species depends on the conditions of the site and the location, such as the proximity to traffic and the silhouette of the canopy of the tree and shrub and the root system. For example, there are characteristics for choosing good alley-cropping trees (figure 14). The choice of the urban tree is also according to the canopy and the air circulation under

the trees. Indeed, urban tree height, canopy density and leaf area index have an impact on the dispersion of PM2.5 (Jin S., et al., 2014). Therefore, the linear plantation of trees along streets with high traffic should be for restoration purposes even with agroforestry practices and the distance from roads should be measured for the plantations. The same questions about the roots, distance from roads, foliage system goes to understory stratas with edibles such as berries, crops and cereals. The urban tree can also be a resource to bring back water in the cities as trees bring back water (Forest News, 2012). An example of a good multipurpose tree is the Sorbus species. It can be used for stabilising slopes (Bouton S., 2008), and be intercropped in the frames of vitiforestry, with vineyards. Urban agroforestry can increase shade with the planting of trees and this can be beneficial in urban heat islands and to grow food in high temperature areas. It can also be for the management of water in the city.

There can be three root systems to consider when planting an agroforestry tree: taproot, heart root and flat root (Iastate, 1997). Root systems are important to know for companion planting strategies and also to adapt to the pavements of the cities.

The tree plantation needs to take into consideration the density: for intimacy, safety with visibility (site visit with NGO Incredible Edibles in Bristol, 2018) and air circulation- design scenarios and concepts. Based on experience, the distance of the plantation between fruit trees is 3 meters for production. There is also the need to choose the right tree and other plant layers for the city which are resistant to pollution and heat and don't expose city dwellers to biogenic gases.
On a smaller scale, research is made about spontaneous flora and reducing the weeding (Plante et Cité, 2022). Finally, there is a need to protect ancient trees and rethink their purpose in the city for biodiversity. These could be included in urban agroforestry plans.

The first preoccupation to consider when planning and designing for agroforestry is the soil. For many specialists, the soil is the « heritage for humanity ». It has a role in capturing and storing carbon (france culture, Christian Feller and Ghislain de Marsily) and in storing and transferring water to the underground. Agroforestry could be a good alternative for carbon sequestration. It could be a good tool in the urban and peri-urban spaces. Finally, the ecological integrity of urban and peri-urban landscapes must be considered. It is necessary to have a multiscale approach when planning for urban agroforestry, from country scale to city scale and plot scale with inclusion of citizens. For example, for sustainable urban planning for urban food production, the country of Mozambique has created a “Green Zoning”. This is a measure to protect lands for growing food in the city for households and markets.
Making a landscape analysis is important to build connections between green spaces and safeguard existing ecosystems. Agroforestry systems should be part of a corridor and reduce landscape fragmentation for more protection of biodiversity and more equal accessibility to resources such as shade, water and fertile soils.

II.8 The question of the scale in urban and peri-urban agroforestry

The question of the scale in urban and peri-urban agroforestry is important to be able to plan from and with existing and available resources such as soil and plants. It is needed to plan with living ecosystems. It is important to have an interdisciplinary approach when planning for urban and peri-urban agroforestry and to plan at several scales for better implementation in the landscape.

A bioregional scale approach

The definition of a bioregion is: *a land and water territory whose limits are defined not by political boundaries, but by the geographical limits of human communities and ecological systems. It may be no bigger than a small watershed or as large as a small state or province. In special cases, a bioregion might span the borders of two or more countries* (The Bioregioning Learning Center, 2021).

The Bioregion of Florence is along the left side of the Arno riverbed. The project is to create an agricultural park including agroforestry. It involves three municipalities on the Florence Plain through the support of Regione Toscana based on participatory processes (Poli D., 2017). The objective was to create a "river contract" for the functioning of an agricultural park which would be managed through social contracts involving local communities. For example, schools, teachers, prisons and farmers. There is also the project of using agroforestry plots for biomass to supply the power plants along the river.

There is also a project for creating an urban jungle in the city of Prato. This project isn't only about greening the city but it is also about social inclusion and the renewal of difficult neighbourhoods (Pratourbanjungle, 2021).

The bioregional scale is useful in planning agroforestry systems in urban and peri-urban areas because it has an impact on the location of the plots and the choice in tree species and plantations.

A watershed scale approach

According to the Landscape Architect Iris Chervet, landscape architects need to be part of decision-making processes and administrative boundaries need to be overcome to plan and adapt to climate change at the watershed scale or the bioregional scale (Libération, 2024). This approach will be assessed in the third goal of the thesis with its opportunities and challenges.

A city scale approach

At the city scale, the focus is on the land use type and the ownership of the plots. There are

existing green infrastructure plans in European cities which could take into consideration urban agroforestry. For example, along the Arno River in Italy, there is an agroecological bioregion with agroforestry systems for several purposes and the creation of social contracts along the Arno with several institutions such as prisons and schools. The Bioregion of Florence is along the left side of the Arno riverbed. The project is to create an agricultural park including agroforestry. It involves three municipalities on the Florence Plain through the support of Regione Toscana based on participatory processes (Poli D., 2017). The objective was to create a "river contract" for the functioning of an agricultural park which would be managed through social contracts involving local communities. For example, schools, teachers, prisons and farmers. There is also the project of using agroforestry plots for biomass to supply the power plants along the river.

A district scale approach

In planning urban and peri-urban agroforestry the organisation of the plot needs to be planned at a human scale with a vision from a person's level and sight. The elements which need to be considered are the share of resources, recycling and reuse of materials and resources, relationships, community planning and development. Plus, "public participation in the planning process is essential to successful planning. Research has shown that people are more likely to accept an issue resolved when they have had a voice in the decision-making process" (Decker and Chase, 1997, in Botequilha LeitaÄo A and Ahern J, 2002).

The planning of urban agroforestry can be crossed with urban sustainability indicators with social, environmental and economic aspects. For example, there is a project for creating an urban jungle in the city of Prato in Italy. This project isn't only about greening the city but it is also about social inclusion and the renewal of neighborhoods (Pratourbanjungle, 2021). Urban agroforestry should also be planned at the neighborhood scale (Taylor J. and Lovell S., 2021).

Scale of the plot and the tree

The scale of the plot and the tree is important to consider for the inclusion of the soil and on-site species in the design of agroforestry plots in cities and the development of the root system. It is also to be used for using the green resources on the plot such as wood for carbon and leaves for nutrients in the soil and creating a circular system. At this level, the species are chosen and the design is made with care for the people's circulation in the plot and the possible amount of production.

II.9 New definition of urban agroforestry

Urban agroforestry in this thesis is defined as: a practice where citizens grow local products in the city with agroecological principles for social and ecological purposes and harmony. Woody perennials are planted with non woody perennials in the city, with economic, environmental and social outcomes, like employment, social inclusion, solidarity economy, education, art therapy and biodiversity. All aspects are related and interdependent. Peri-urban

agroforestry is the implementation of agroforestry systems in the urban fringe and peri-urban crowns for food, energy and medicinal production with an economic, landscape and ecological interaction with the cities.

Urban agroforestry is a practice linking urban agriculture with urban forestry to create multipurpose green spaces in the city not only for production but also for well-being and therapy. It is the inclusion of the urban tree in an agricultural plot or the use of urban trees for different purposes, from existing trees to newly planted trees and regarding the existing green patterns and species on the ground. It is also interdisciplinary and includes human ecology. Urban and peri-urban agroforestry systems can be planned together and not separately.

In this thesis, the focus is about planning urban agroforestry systems for food and arts such as art-therapy practices and the plantation of tinctorial plants with ecological purposes with community-building.

III. METHODOLOGY

This section presents the methodologies of the three different goals of this thesis.

III.1 Goal 1. Analysis of the planning of agroforestry systems in metropolitan cities and their potential for being part of urban green infrastructure strategies

This first goal is to assess why and how agroforestry systems were planned in five European metropoles. The methodology for this goal was to do five questionnaires in three French cities, one German city and one Belgium city: Nantes, Rennes, Montpellier, Donzdorf and Liège. The questionnaires were online with the metropole of Nantes, the Chamber of Agriculture of Rennes, an NGO in Montpellier managing a vitiforestry plot, a municipality representative of Donzdorf and a member of the Edible belt of Liège. These cases were chosen because of the will of the municipality for planning agroforestry systems in the urban and peri-urban area and because of the initiatives taken by NGOs and citizens and because they are all crossed by rivers. The information was found through conferences and documentaries. In addition to the interviews, a map analysis of the location of the agroforestry plots was made in the whole urban policy framework for green infrastructure planning at the watershed scale, with assessment of the protection of agricultural lands and urban forestry projects. The watershed scale was chosen because of the need in integrating the water cycle in agroforestry systems and rivers and creeks present interesting corridors to protect and value.

III.1.1 Study areas

The 5 European cities assessed are: Donzdorf in Germany, Liège in Belgium, Nantes, Rennes and Montpellier in France (Figure 11). They are all crossed by rivers. There is also a

landscape analysis of the locations of these agroforestry systems through map analysis and descriptions in the questionnaires.

Figure 11. Map of location of the case studies: Rennes (France), Nantes (France), Montpellier (France), Donzdorf (Germany) and Liège (Belgium). Source: Mapchart, Paloma Gonzalez de Linares

Donzdorf

Donzdorf is located in southern Germany at 48°41′N 9°49′E. It has a population of 10 878 inhabitants and a density of 136 inh/km2. It has a continental climate and is surrounded by hills and crossed by several river streams. There are some agricultural lands in the Western part of the town. The town has an organic urban fabric. The average amount of annual precipitation is 730 mm (Weather and Climate, 2023). Two rivers flow in the town, the Lauter and the Seizenbach.

There are municipality owned orchards which were converted to agroforestry.

Liège

Liège is located in the east of Belgium at 50°38′N 05°34′E. It has a population of 195 278 inhabitants and a density of 2 844,39 inh./km2. It has an oceanic climate and is crossed by the river La Meuse. The city is structured with a city center and suburbs. The average amount of annual precipitation is 975 mm (Weather and Climate, 2023).

Liège launched in 2012 a Food Land Belt program in the city with strong cooperations between farmers and citizens. This was started by citizens, with a bottom- up approach and is managed by citizens. This green belt includes agroforestry. There is not a map of the belt because it is based on cooperations with existing producers.

Nantes

Nantes is located in the west of France, 50 km from the Atlantic coast at 47°13′05″ N 1°33′10″ W. It has an oceanic climate and is crossed by the river La Loire. It is crossed by the river Loire and other rivers: l'Erdre, la Sèvre Nantaise, la Chézine, le Cens and le Gesvre. There are also several creeks. It has a population of 303 382 inhabitants and a density of 4 920 inh/km2. It is a metropolis and its fabric has different parts: the medieval part and a rebuilt modern part. There is an important urban sprawl effect. The average amount of annual precipitation is 747 mm (Weather and Climate, 2023). The metropole of Nantes counts 24 communes and covers 53 000 ha.

The city of Nantes has created an urban forest plan including agroforestry on wastelands. This urban forestry project was mainly to protect the water quality and stop the use of pesticides in green spaces.

Rennes

Rennes is located in northwestern France at 48°06′53″N 1°40′46″W. It has a population of 216 366 inh/km2 and a density of 4 415 inh/km2. It has an oceanic climate. Its city has a polycentric form and there is a green belt to protect the surrounding agricultural lands. The average amount of annual precipitation is 734 mm (Weather and Climate, 2023). The city is crossed by the river la Vilaine.

The city of Rennes is protecting traditional hedges as agroforestry systems called *Bocages* which are hedgerows.

Montpellier

Montpellier is located in the south of France at 43° 36′ 43" N, 3° 52′ 38″E. It has a population of 299 096 inhabitants and a density of 5 258 inh/km2. It is in the Mediterranean climate. Montpellier has a historical center and an organic form. The average amount of annual precipitation is 693 mm (Weather and Climate, 2023). Montpellier is crossed by 5 rivers: the Mosson, the Rieu Coulon, the Verdanson, the Lez and the Lironde.

III.1.2. Questionnaire

This questionnaire (Table 1) was fulfilled by the municipality of Donzdorf, the association Ceinture Aliment Terre Liégeoise in Liège, the metropole of Nantes, the chamber of agriculture of Rennes and the association Oasis Citadine in Montpellier. It was filled online. The objectives of the questionnaire are to assess how agroforestry was implemented in the urban and peri-urban areas, why it was implemented and what are the challenges. There are several categories: the context, the location and accessibility, the citizen's involvement, the management and the challenges.

Context, purpose	Location and accessibility
• What type of agroforestry plots are there? (Parcel, garden, park, alley) • What were the motivations? • Was it implemented under a program? If yes, which was it? • What purpose does this plot have? • What was the plot like before the project? • Is the plot open for recreational activities?	• In what type of neighborhood are the different plots? (Central, enclaved, difficult to access, upmarket) • How is the accessibility to the plot from the city or from other surrounding neighborhoods? • Is it in an enclaved space? In neighborhoods with low access to food and energy? • Why was this space a suitable space? • To which other green spaces is this plot connected to?
Citizen's involvement	**Management and challenges**
• Are people involved in the plot? If yes, how long did it take people to be involved? How are they involved?	• How did you find your resources? (Funding, soil, plants, water) • What is the management system? What is the production quantity? (If any) Are there any regulations? • Would you consider creating a forest garden? • What were the most challenging issues in creating such a project?

Table 1. Questionnaire for the case studies, Paloma Gonzalez de Linares

The expected results are the possible integrations of agroforestry systems in green infrastructure plans at the watershed scale with the common and different goals, opportunities and challenges.

III.2 Goal 2. Definition of urban agroforestry gardens with their design methods and assessment of their impact on the urban landscape based on observations and interviews in the South-East of France

This goal focuses on the types and designs of urban agroforestry systems through on-site analysis and semi-structured interviews. The plots assessed are located in the South-East of France. Two of the agroforestry plots are located on drystone terrasses, two are in horticultural highschools and one is in an abandoned land from the motorway. These gardens are implemented by local NGOs and in the case of one, by teachers. These gardens were chosen because of the involvement of citizens and institutions in urban agroforestry and also because of the European MEDALUS program which was about Mediterranean desertification

and land use. As Hungary is also facing struggles with desertification, these gardens were assessed to see the possibilities for urban and peri-urban agroforestry for this matter and how they are managed. As Hungary and Mediterranean cities are facing common challenges in the face of climate change, common research can be made with agroforestry, for example for soil erosion, drought and also fire risks.

III.2.1 Description of drystone terrasses

Drystone terrasses were built in the XVIIIth century to reduce erosion of slopes and were used for agriculture but have been abandoned due to change in agricultural practices and secondary housing, leading to the spread of weeds and undergrowth plants. They are terrasses built with drystones found on-site and are a landscape heritage. Drystone terrasses create ecological corridors for vegetation and fauna and require more protection and management from secondary housings and urban sprawl and also from bushfire risks. To preserve and maintain these drystrone terrasses the Council for Architecture, urbanism, environment and landscape of the french department of the Alpes Maritimes (CAUE 06) instilled internships and educational programs around their restoration and management. Flowers used to be grown on these terrasses and sold. The main species found on these terrasses now are *Arbutus unedo* (Strawberry tree), Olive trees, different bushes and aromatics (Martigues tourisme, 2024). Another issue affecting the vegetation of these terrasses is the *Xyllela fastidiosa* bacteria which makes the olive tree and fruit tree growth vulnerable. In this context, the type of species grown will be assessed and the water and soil management with the governance system.

III.2.2 Presentation of the semi-structured interviews and on-site analysis in the South-East of France

Semi-structured interviews were carried out in person in six gardens in the South of France presenting an agroforestry system (Figure 12): Le Petit Pessicart in Nice, Les Jardins du Loup in Pont du Loup, La Ferme des Calanques in Marseille, Le Talus in Marseille, Terre et Humanisme in Lablachère and the Horticultural Highschool CFPPA in Antibes. The NGO Terre et Humanisme has a cooperation with the town of Sidi Boubker in Morocco, so an interview call was also made with the gardeners of this town. The gardens were visited and the semi-structured interviews were made with the managers of the plots. The gardeners of Terre et Humanisme in Lablachère (France) were not available for an interview but there were panels in the garden to explain the different areas and techniques.

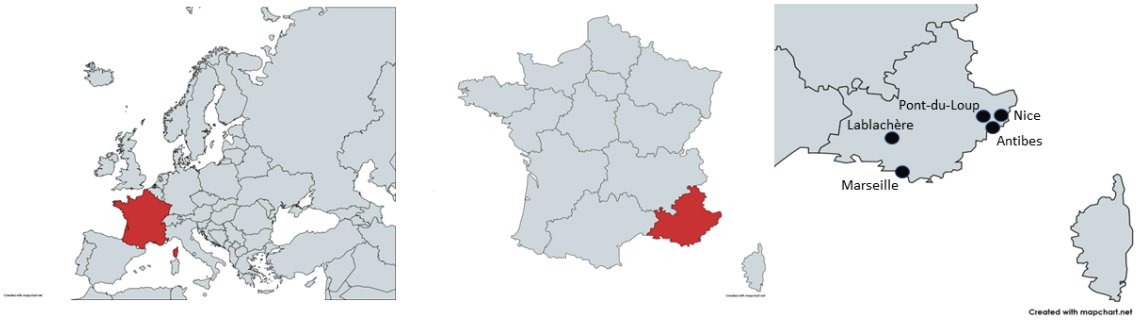


Figure 12. Map of the location of the studied gardens in France. Source: Mapchart

The questions (Table 2) asked were to assess the plantations and chosen agroforestry systems in the gardens and the link between scientific and technical knowledge, artistic practices and involvement of citizens. There are several sections: governance, management, techniques and observations.
First was assessed the type and size of the organisation. Then, the governance system and the involvement of citizens was assessed and the ownership. The management system was assessed for the water, the soil, the compost, the production and the plantation. For the techniques, the agroforestry system, the watering system, the structure of the plantation and the artistic practices were assessed. Further observations were made about the location of the plots and the connections with the surroundings. The goal was to understand the plantation systems and management of agroforestry plots and define urban agroforestry gardens as a land use for cities.

Questionnaire and comparison points

Type of organisation:

Size of the organisation:

Governance	**Technics**
• Governance system • Water management and governance • Waste management and governance • Soil management and governance • Participation of citizens in the design • Inclusion of artistic approaches	• Conception of the plot • Plantation system • Stratas, types of plants planted
Artistic practices	**Surroundings and accessibility**
• Artistic activities and practices	• Accessibility • Connections to other green spaces

Table 2. Assessed and compared aspects in agroforestry plots, Paloma Gonzalez de Linares

Gardens

Les jardins du Loup

The land is private and it used to belong to the perfume factory of Grasse for growing bitter oranges and therefore it used to be an agricultural land. The garden is 13.000 m². The management is done by two main managers and several volunteers. The managers had experience and training in gardening and agroecological farming from the beginning because one did a training in the Horticultural Highschool of Antibes for the BPREA and a PDC in permaculture. Other training was taken such as agroforestry with the organisation GAIA.

Horticultural highschool of Antibes, CFPPA

The Horticultural highschool of Antibes has opened a training platform of 5 000 m² for agroforestry on the site in 2016. It was created in the frames of a professional diploma program called the BPREA.

Le Jardin du Petit Pessicart

The garden is 1 ha wide and is located on drystone terrasses in the city of Nice. The land belongs to a property, but the NGO is in prospect of buying the land. The funding is through the Maison de l'Environnement (House of the Environment) which is a structure in the city council encouraging eco-citizenship.

La ferme des Calanques

The Ferme des Calanques is a 1 000 m2 syntrophic agroforestry plot located in the horticultural highschool of Marseille. There are 3 managers, from an NGO and a Design Office. One has a diploma in Landscape Architecture whereas others did a training in Syntropic Agroforestry.

Terre et Humanisme, Lablachère

The garden of the Mas du Beaulieu is located in the city of Lablachère in France. The plot belongs to the NGO Terre et Humanisme. The NGO was inspired by Pierre Rabhi, a pioneer in agroecology in France.

Le Talus de Marseille

Le Talus de Marseille is a 3 500 m2 urban farm located in Marseille. It is managed by and NGO. The interviewed manager has a background in economics.

III.3 Goal 3. Analysis of the opportunities and challenges for implementing public agroforestry gardens in a dense urban corridor along two creeks for shade, food and materials for arts and testing methodology in planning and design with participation of citizens for building inclusive green cities

This goal is about finding potential spaces for agroforestry along the Rakos and Szilas creeks through a participative research, from Szada to Budapest and assessing the opportunities and challenges for implementing agroforestry systems in a corridor with the involvement of citizens and create a participative methodology in planning agroforestry in cities. The process of the landscape architect and the methodology for planning and designing urban agroforestry are assessed through field work experiences with the implementation of a public forest-garden in the 14th district of Budapest. The figure 13 presents the steps of the methodology.

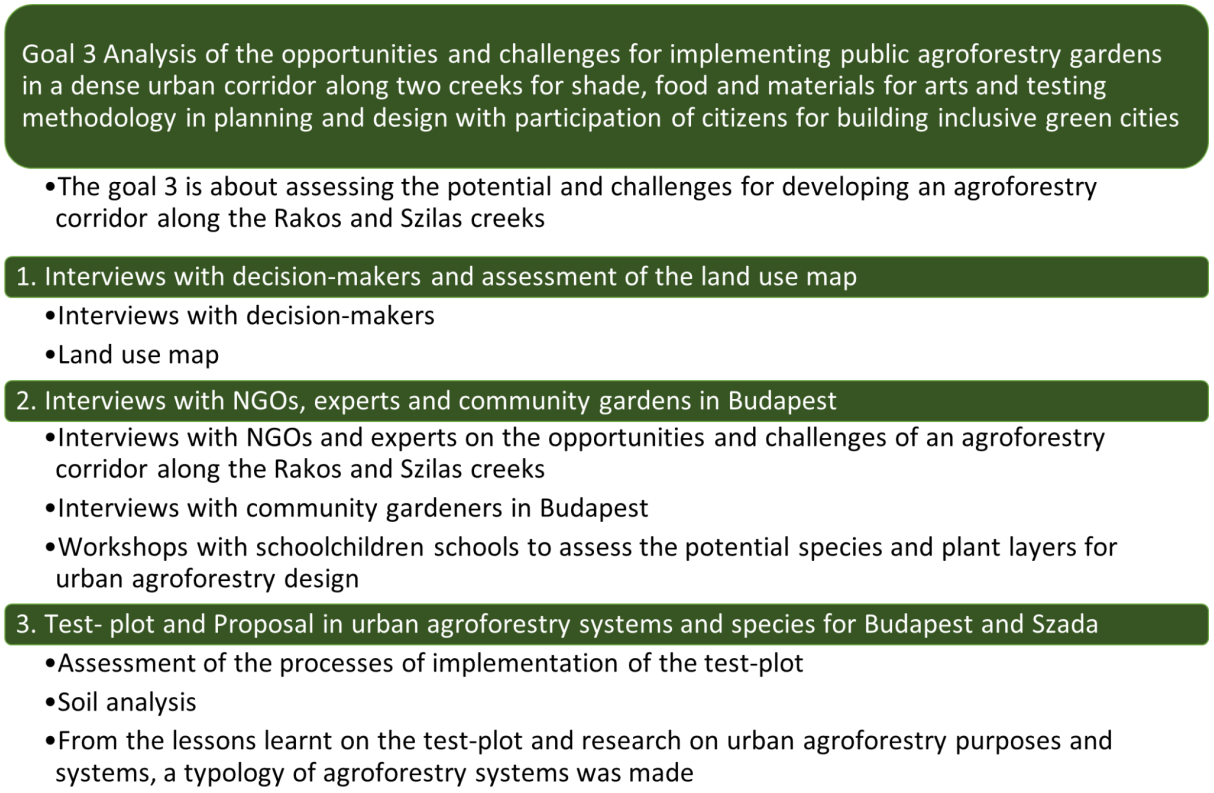


Figure 13. Flowchart of the methodology for Goal 3. Paloma Gonzalez de Linares

III.3.1 Map of potential agroforestry plots in Budapest and Szada

The main aspects considered to define good spaces for urban agroforestry were:

1. The ownership

The ownership is important because it defines the rights to the land for implementing an agroforestry garden. It also defines the possibility to use the land and the rules and obligations

to the land. The owner could be open to the practice and to its purposes, whether it is private or public. This research focuses on public lands for urban agroforestry gardens.

2. The land use

The land use defines the agroforestry purposes (artistic, phytoepuration, green waste management, food production). Agroforestry systems also depend on the soil conditions and characteristics.

3. The proximity to city dwellers

The proximity to city dwellers is important for the role and maintenance system of the plot and its use and purpose.

4. The accessibility of the plot

The accessibility of the plot depends if it is private or public and easy to get to with public transport and smooth mobility in order to reduce the dependency on oil.

5. The size of the plot

The size of the plot defines the design of the agroforestry system and the possible number of users.

6. The presence of pipelines and infrastructures on the plot

The presence of pipelines and infrastructures such as gas lines has an impact on the possibility of growing trees.

7. The connection to wildlife habitats

The connection to wildlife habitats needs to be taken into account when planning agroforestry systems as new plantations can have an impact on existing ecosystems. It affects the purpose of the agroforestry system and the nature of the plantation with the choice in species.

8. The equity in the distribution of green spaces in the city

Urban agroforestry gardens should be prioritised in highly mineralised neighbourhoods which don’t have an open green space and according to the heat map.

III.3.2 Interviews with experts and NGOs and workshops

Interviews were made with experts to define the possibilities and challenges for the implementation of a community-based agroforestry corridor along the Rakos and Szilas creeks.

First, interviews were made with NGOs and experts in Budapest to assess the opportunities and challenges of creating an urban agroforestry corridor along the Rakos and Szilas creeks with social inclusion (Table 3). The questions for the NGOs and experts in Budapest were:

Purposes and challenges of urban agroforestry	Opinion about the possible locations for urban agroforestry plots
● To what issues and challenges can urban and peri-urban agroforestry answer? ● What purposes could urban and peri-urban agroforestry have in Budapest? ● What does urban and peri-urban agroforestry bring more than urban forestry? ● What products could we make from agroforestry plots in the city of Budapest? ● Open question: Would you like to have an agroforestry plot in your institution?	● Is the Rakos creek a suitable space for urban agroforestry? ● Are there any districts or neighborhoods where urban agroforestry should be prioritised? ● Could we build urban community agroforestry plots in Budapest? How and where?

Table 3. Questions for the interviews with the experts and NGOs in Budapest, Paloma Gonzalez de Linares

Second, interviews were made in the community gardens along the Rakos and Szilas creeks in Budapest to assess the importance of community based agroforestry systems with their goals and obstacles (Table 4). These interviews explain the challenges future agroforestry community gardens could face and the gardeners can be part of a potential network for exchanges of resources and knowledge for agroecological practices and connectivity between community gardens through a green network.

The questions were:

Land accessibility	Opportunities for community agroforestry gardens in Budapest
• How did they get the land? • How long is the contract for? • To what issues/challenges do the gardens answer?	• What are the types of plants? • What are the technical challenges? • Who designed the garden?
Challenges for community agroforestry gardens in Budapest	**Garden connectivity**
• What is the purpose of the garden? • Is there a link with arts? • To what main challenge in Budapest should the gardens answer?	• Is there contact with the other community gardeners of Budapest?

Table 4. Questions for the interviews with the community gardens in Budapest, Paloma Gonzalez de Linares

Third, workshops were held in 2 schools in Budapest to assess the perception of schoolchildren on urban gardens and involve them in the planning process. The schoolchildren could paint and draw their ideal urban garden. The first workshop was in the Waldorf school in Kaposzta megye, Budapest, where 30 students between 15 and 16 years old took part during their Art class.

The second workshop took place in the Török Ignác Gymnasium in Gödöllő, where 13 students between 15 and 16 years old participated during their History and Geography class.

Before the sketching exercise a short introduction to urban agroforestry was given.

From all these actors interviewed a governance system can be drawn for urban agroforestry and community-based planning tools can be suggested. The present community gardeners, NGOs, decision-makers and experts interviewed are a potential network for the development of urban agroforestry along the Rakos and Szilas creeks.

III. 3.3 Planning and design methodology and proposal in plantations of agroforestry systems for Budapest and Szada for food, arts and social inclusion

In order to plan and design urban agroforestry gardens, it is necessary to consider the local climatic context and the challenges in the face of climate change. Hungary is in the bioregion of the Carpathian Mountain and Plains Mixed Forests. The climatic scenarios are increased heat stress, decrease in precipitation periods and risks in flooding. This climatic context shows a need in readapting cities to climate change. The map of the surface temperature in Budapest shows a high diversity along the Rakos and Szilas creeks. The heat map shows areas where

there is a need to prioritise the plantation of trees and other layers to reduce heat stress. There is also a high rate of sealed soil in Budapest, affecting the temperature and increasing heat islands in the city.

I. Context of agroforestry in Hungary

An interest in agroforestry is growing in Hungary. Experimental plots were funded by the European program AGFORWARD in the south of Hungary, in Fajsz, and managed by a cooperative. There is also a research department on agroforestry in the University of West Hungary in Sopron. Within the 2007-2013 CAP, Hungary was the only country in Central Europe to implement the EU Measure 222 (First Establishment of Agroforestry on Agricultural Land). The measure contributed to the establishment of agroforestry systems for grazing purposes with a view to maintaining a sustainable land management and facilitating protection of soils against erosion. These systems were to be maintained for a minimum period of 5 years (support only for the establishment of tree elements), maximum density 250 trees/ha (Szedlák, 2006.)

In the new CAP 2014-2020 agroforestry is promoted through Article 23 of the new Rural Development Regulation 1305/2013. Hungary implemented sub-measure 8.2. “Support for establishment and maintenance of agroforestry systems”. Current national Rural Development Program supports the implementation and maintenance of the following types of agroforestry systems:

- Grassland management (mowing or extensive livestock production) combined with agroforestry system
- Field-protective afforestation (eg. shelterbelts or woody spots)
- Innovative Agroforestry Systems (Forestry Innovation Operative Groups - cooperation projects)

Thanks to the agri-environment subsidies, nature conservation management practices, and the rising demand for organic food the number of newly established agroforestry systems are increasing, as well as some formerly abandoned areas are now farmed again as wood pastures. Forest grazing which was prohibited before, is now legally allowed under certain conditions (EURAF, 2020 https://euraf.isa.utl.pt/countries/hungary).

In Hungary, agroforestry is supported by the Ministry of Agriculture but the regulations remain difficult for the implementation of this practice due to the conflict between agriculture regulations and forestry regulations. Indeed, on an agricultural plot, farmers can plant trees until a certain extent to remain under the agricultural policy. After a wider plantation, the land use is converted to forest and the regulations change to forestry. There is a need for cooperation between farmers and foresters to share knowledge about trees and mix agricultural knowledge with forestry knowledge. The motivation for Hungarian farmers to turn to agroforestry is growing with the encouragement from the Ministry of Agriculture and the growing experiences in this practice for biodiversity and adaptation to Climate Change. The farmers see new opportunities in agroforestry (interview with the Forest Research Institute).

Hungary has an important rate of agricultural lands. There is a need for research in the development of agroforestry to mitigate the land desertification and soil erosion and also value the important diversity and conservation of endemic species. Hungary could be an important seed bank for Europe and has preserved many valuable edibles.

II. Context of agroforestry in Budapest

A few families and NGOs are growing forest-gardens in towns and settlements outside of Budapest. For instance, a forest- garden is managed by an NGO and students on the campus of the University of Gödöllő. An NGO 'Zöld XVII' is improving the landscape of the Rakos creek in the 17th district by planting trees with the community and raising environmental awareness campaigns.

In order to find a plot for my urban agroforestry project in Budapest, in October 2017, for the benefit of this thesis research, a conference and workshop were organised in partnership with the Center of Contemporary Architecture of Budapest (KEK) and with the involvement of Cargonomia to present the concept of urban agroforestry and find potential plots. The KEK runs half of the community gardens in Budapest. The event gathered 50 people and a high level of motivation could be observed. The public consisted of locals, agronomists, architects, biologists, planners and representatives of district municipalities.

Multipurpose trees and woody perennials could also be tested in allotment gardens. Community gardens could be used to try agroforestry practice for environmental, social and economic outputs. By assessing these gardens with high resolution aerial images in Google Earth we could see whether trees were planted on the plot or not and if there were any other edibles than annual crop. For example, Leonardo Kert was a 1400 m 2 community garden held by the KEK. Despite the width of the area, no trees were planted. Due to an ending contract this was closed in 2017. Árnyas kert is a 1213 m2 community garden with 29 gardeners. Trees were already planted on site but these are not valued and used. These gardens could be expanded and connected to wider green connections in the city. For example, public open green spaces between high residential buildings offer small-scale green connections, which could be explored for planting continuous edible landscapes.

In Budapest, the main trees planted are: A*cer platanoides, Acer negundo, Aesculus hippocastanum, Acer saccharinum, Acer campestre* (native), F*raxinus excelsior, Ailanthus glandulosa, Celtis Ulmus effuse Populus* and genus of native Sorbus and Tilia (Szaller V. et al., 2015). City trees are planted and managed by Fökert, a non- profit organisation. The public green spaces are managed by the districts. Since 2017, a program has been funded by the government to plant 10 000 trees in Budapest. These are mainly planted in rows on central reservations of the roads and do not serve any social or environmental purposes. The problem is that most young trees do not survive more than 10 years and often need to be replaced (Szaller V. et al., 2015). This is due to the poor conditions of the soils, to the inaccessibility to water and nutrients and a bad preparation of the soil for the roots to develop.

The garden city movement of Budapest encourages community gardens and urban agriculture. The Ministry of Agriculture and the FAO support family farming. There is an afforestation regulation and plan for Budapest implemented by the Ministry of Agriculture. The city of Budapest owns 300 ha of forest. The Fökert association is planning on assessing these forests throughout the summer 2021 to evaluate the nature of these forests and what should / could be done to improve their condition.

About the situation of forests in Budapest, "most of the forestry area has been declared a forest since 1954 and has been under nature protection since the late 1970s. In the last decade, the management of the forests of the capital has had to deal with difficulties such as the growing scale of illegal public dumping or the emergence of homeless settlements. These social problems can only be solved with the responsible involvement of the local population, so forestry places great emphasis on establishing effective cooperation with local governments and the civil sphere." (Pilisi Parkerdö, 2021). The Budapest forestry of Pilisi Parkerdő Zrt. manage 2,500 ha of forest within the administrative boundaries of Budapest (these are state-owned forests). "Most of it is located in Buda, the smaller part in Pest, i.e. all segments of the city are affected by them" (Fökert, June 2021 interview).

In addition to these characteristics, it is interesting to highlight that Budapest is twinned with the city of Florence which has developed a bioregion including public agroforestry plots with social contracts. Both cities could cooperate to compare their experiences in developing a bioregion. There could be a bioregion in Pest. There could be a bioregion with agroforestry with social contracts in Budapest.

III. Diagnosis of the Rakos and Szilas creeks

The Rakos creek connects several districts in Budapest: the 13th, the 14th, the 10th and the 17th. It also connects several cities in its 40 km long stream: Budapest, Gödöllő, Pécel, Isaszeg and Szada. The source of the creek is in Szada and the end is in the 13th district of Budapest where it goes into the Danube. Focusing on the Rakos creek is strategic because there are already community projects in agroecology along the creek. There is a public community forest-garden in the 14th district which was created through this thesis as a test plot. There are also community gardens along the creek, there is a forest-garden on the MATE University campus of Gödöllö and also an agroecological educative garden, there are agroecological gardens in the city of Gödöllö and there is the project for a biodynamic farm in Szada.
The Szilas creek also connects several districts: the 4th, the 15th and the 16th and connects the municipalities of Kerepes, Kistarcsa and Nagytarcsa. The 13th district of Budapest, the City Council of Budapest and the Mayor of Szada have expressed an interest for urban agroforestry.

When planning for urban agroforestry it is also important to know the existing green cover and tree species. According to a poster a Master student's research in Landscape Architecture in the MATE University, the overall tree canopy along the Rakos creek is 40% in the case of

Budapest and the main species along the Rakos creek are: A*cer platanoides, Acer pseudoplatanus, Fraxinus excelsior, Fraxinus ornus, Tilia cordata, Tilia tomentosa, Platanus x hispanica, Celtis occidentalis, Crataegus x media, Kerria japonica, Koelreuteria paniculata, Populus alba, Populus nigra "Italica", Prunus serrulata "Kanzan, Robinia pseudoacacia, Salix alba, Salix purpurea.* The main shrubs are *Berberis x media, Cornus alba "Sibirica", Forsythia x intermedia, Syringa vulgaris, Viburnum opulus, Rosa spinosissima, Cotinus coggygria, Lavandula angustifolia.*

There is also the need to know the soil properties. The main soils along the Rakos and Szilas creeks are Arenosols, Cambisols, Luvisols and Chernozems. The soil is mainly sandy.
It is important to know the potential resources and managers of green spaces and green waste for its reuse in urban agroforestry gardens. The Rákos Patak and Szilas patak, belong to Budapest Sewage works Pte Ltd. (Budapest Sewage works Pte Ltd., 2025). Fökert is only responsible for mowing the lawn on the sides. The organisation makes compost, but they don't use it in the urban forests. They process about 50-60 thousand m3 organic waste in a year, and make 5-6 thousand m3 compost of it. They sell it and also use it for their areas (Fökert, June 2021, interview).

Finally, it is necessary to know the accessibility in smooth mobility and public transport. The district of Rakosliget is well desserted in public transport, with bicycle lanes, a train station to Budapest and bus stops. The Szilas creek bed is well connected with cycling paths.

IV. Process in planning and design of a public urban agroforestry garden in the XIVth district of Budapest

From my initiative and for the benefit of this thesis, a test plot was created with the 14th district council of Budapest to meet with several objectives:

- involve local communities and assess the participative design possibilities for agroforestry gardens,
- assess the potential for urban forest-gardens and the impact of tree species on the soil,
- create a public agroforestry garden for educational purposes, food and arts,
- assess how urban agroforestry can be implemented according to the regulations and the limits and challenges.
- the process for the landscape architect was also assessed through experience in the implementation of the agroforestry system.

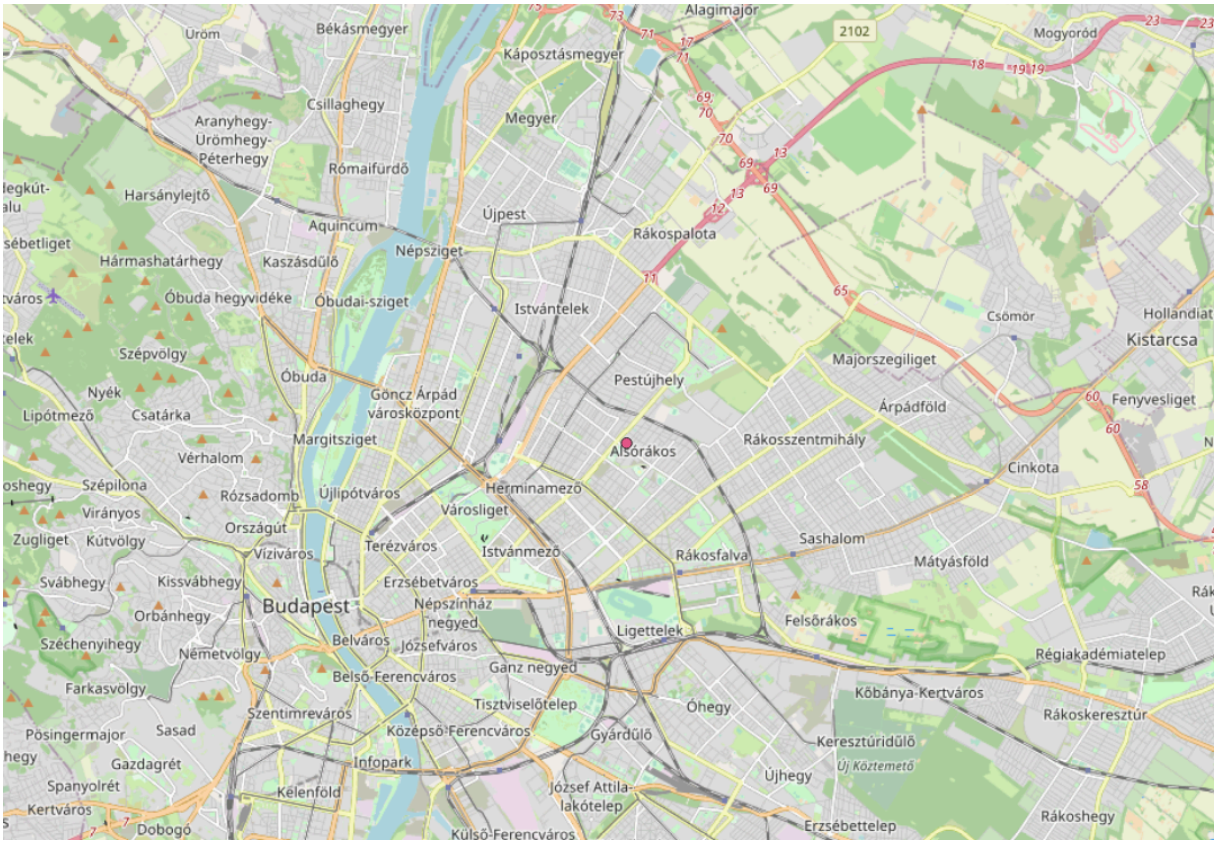


Figure 14. Location of the test plot on Németprona utca, in the 14 district of Budapest, Paloma Gonzalez de Linares, source: Openstreetmap

The project was to open a public forest-garden in the city of Budapest. The first step of this project was to meet with local NGOs and community gardeners to involve local communities and find a plot for a participative urban agroforestry plantation with the size of an average traditional Hungarian homegarden of 200 m2 (Vandenbroucke P. and Feher I., 2013). After giving a conference on urban agroforestry and the project at the KEK and with local NGO Cargonomia, the Vice-Mayor of the 14th district of Budapest expressed an interest in the project. The public forest-garden project was planted in 2018 and 2019 on a residential plot of land in the 14th district of Budapest, in Németpróna utca (Figure 14). The plot was chosen because it was public and next to a school for visually impaired children and in a residential area. It belongs to the district council. It was implemented with an assessment of the land for the soil characteristics and contamination, the water drainage and the presence of vegetation and bioindicator plants. The plot is used for the purpose of the thesis to assess the potential of species on the urban soil and to build a method in planning and designing urban agroforestry public gardens with participation of citizens.

During the process of the planning of the public forest-garden, before and during the planning, several interviews were made with experts in permaculture, agroforestry, garden design and nature conservation to assess the best trees to plant but also to involve them in the project and create a network around the garden and share the project and opportunity. This

helped in knowing the local species and networking with local actors in the field of agroecology and nature protection. Only endemic species were planted. These were local Quince, Apple and Pear trees, Mulberry, Mountain Ash, Hazelnut and Lime trees. According to an engineer in agroforestry in the university of Sopron, Quince is a very valuable tree. Later, aromatics and berries were planted in Spring 2019. To avoid isolation of the plot, a study was made to assess its possible inclusion in an agroforestry corridor through participative methods. The Rakos creek presents an opportunity for this corridor. A map of underground pipelines was also used to plan the plantation of the trees. It was recommended not to plant invasive species, toxic species or species with thorns. Sketches were made to present the possible species to plant and their functions.

The methodology used in the design of the system was to use the permaculture guild concept from the Permaculture Design, a consulting and design office in France, with different tree species, shrubs and aromatics from different families. All the energy in the garden would be used such as the leaves for composting and for mulching. A first plan would be made and the community would be involved in the plantation and later in the design so they can appropriate the space and adapt it to their needs and perception. There was the need to plan a watering system and a compost box and evaluate the potential people which could be connected and involved in the garden. They would be the direct recipients of the open public garden. The soil was assessed for its acidity, texture and contamination. Bioindicators were also searched with the identification of plant species, for example for the soil fertility, and the topography was analysed for the water flows.Through the participative plantation of the plants with citizens in the garden, some of the plants were donated. Indeed, the project was open to donations with the principles of non-invasive species, toxic species and thorns. This was to involve citizens, share knowledge about species and encourage an appropriation of the space.

The effect of the planted trees on the soil was assessed in comparison with other green spaces and species in Buda campus and the campus of the MATE university in Gödöllö. These samples were made in Summer 2022 and took into account the agroecological methods and groundcovers in raised beds made by citizens and compost coming from community gardens. The goal is to analyse the organic matter under different tree species, in different soils conditions and with different ages. The Arboretum of the Budai campus of the University MATE in Budapest is 100 years old and has trees between 100 and 20 years old, the agroecological garden of the Budai campus has a parcel which used to be used as a nursery for ornamental trees and has been converted to agroecology for 15 years, the forest-garden of the campus of Gödöllö which was started by students 5 years ago and the public community forest-garden of Zuglo which is 2 years old. In the case of Zuglo and the agroecological garden of Buda, the soil is sandy and compost and sheep manure in Zuglo or hen manure and cow manure in Buda. In the case of Buda hay and cut grass are regularly added to the plot for mulching. In the case of Zuglo, the mulch is made with leaves, mainly from Populus. Under each tree species, 5 holes 10 cm deep were dug. The distance from the tree trunk was measured as well as from possible pavements and staircases.

The tool used to analyse the samples was the scanning device from Agrocares in the campus of MATE university in Gödöllö. The assessment was made while the citizens can use the plot for gardening and arts and appropriate it. The plot is also a teaching space in agroecology and agroforestry. The communication on the plantation event was made through social media and leaflets in the neighbourhood to involve citizens.

V. Planning process for an agroforestry corridor along the Rakos and Szilas creeks

Szada

In Szada, a meeting was organised with the Mayor and the organisation of the Biodynamic garden. The Mayor provided the maps of the available municipality owned lands which could be used for the project.

Budapest

From the interviews with decision-makers, map analysis and on-site analysis, a map of possible plots for urban agroforestry development was made for Budapest. A base-map (Map 8) for the possible location of public agroforestry plots for food and arts and social inclusion along the Rakos and Szilas creeks in Budapest was made according to the land use map and interviews with the city council and exchanges with the bfvt and the 13th district council which has a local green infrastructure strategy plan to which urban agroforestry plantations could be part of.

IV. RESULTS

IV.1 Goal 1. Analysis of the planning of agroforestry systems in metropolitan cities and their potential for being part of urban green infrastructure strategies

This chapter presents the results from the questionnaires and interviews and a map analysis of the location of the plots and their managers. This section focuses on social organisations, master plans and urban green infrastructure plans to assess how agroforestry can be implemented in cities at a metropolitan scale to adapt to climate change.

Study area Donzdorf, Germany

Pilot area

1. Context, purpose

Donzdorf is a small town of 11 000 inhabitants. The agroforestry system of Donzdorf are meadow orchards. They are owned by the municipality. The municipality wanted to establish

a system of land use with almost the same ecological value like the traditional meadow orchards which are easier to cultivate at the same time. The idea was born in their local Agenda 21.The municipality wants to establish agroforestry as a supplement to traditional meadow orchards, not as a replacement.

2. Location and accessibility

The plots are located between 500 to 2000 meters away from the main city.

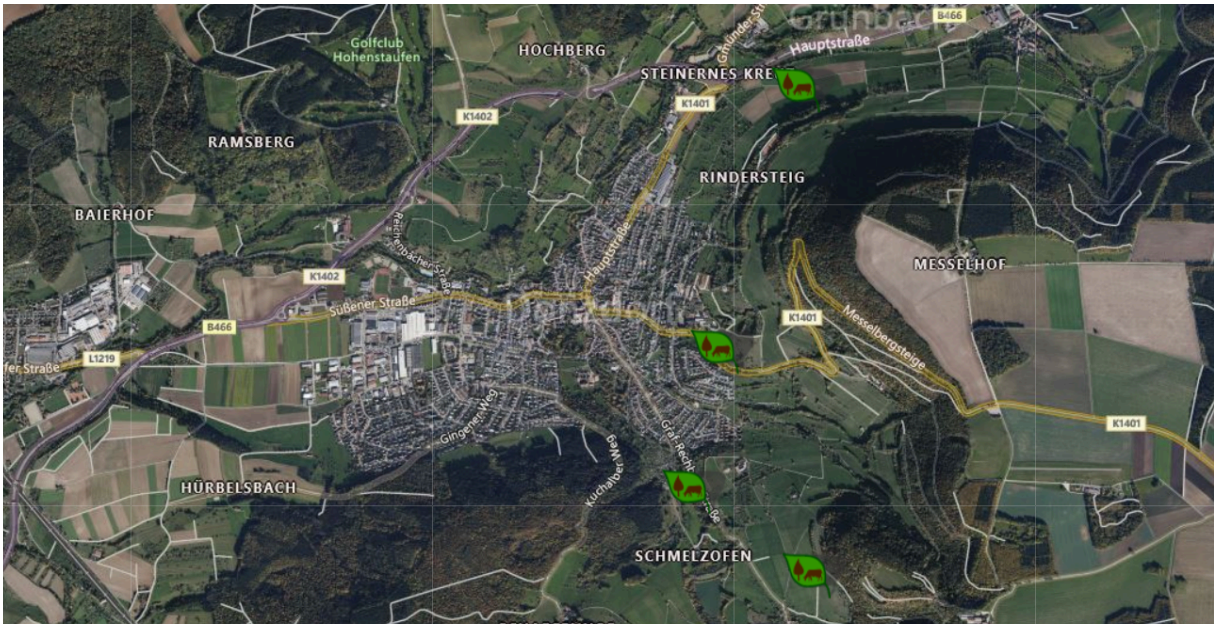


Figure 15. Location of the agroforestry plots (sylvopastoral systems) in Donzdorf

Link to the interactive map of locations: https://agroforstkarte.agroforst-info.de/

3. Citizens' involvement

Citizens were not included in the planning process.

4. Management and challenges

The orchards are maintained by the city council and farmers which are mainly shepherds. The main challenge is the slopes of the hills which make it difficult to mow the lawn with machines. There are no design regulations.

Figure 16. Images of the agroforestry meadow orchards in Donzdorf, source: Euraf: http://euraf.isa.utl.pt/fi/node/1364

According to the map of locations of the agroforestry plots in Donzdorf (Figure 15), these plots (Figure 16) are in areas with low canopy and low density of vegetation and trees, mostly in farmlands in the Eastern outskirts of the town. Most of them are close to the dwellers and main roads. The systems are all silvopastoral systems. The productions are: fodder, husbandry, pear, cherry, production for materials, wood production, orchards, alder, walnut/black walnut, wild apple.

The motivations are to have a more diverse product range, a livestock protective effect and the landscape appearance / aesthetics. There are four plots with different sizes and proportions of trees:

- Plot 1: 30% of the plot is trees. Size: 0.25 ha
- Plot 2: 30% of the plot is trees. Size: 0.1 ha
- Plot 3: 50% of the plot is trees. Size: 0.25 ha
- Plot 4: 20 % of the plot is trees. Size: 0.4 ha

These plots show that there can be a diverse production between different plots with the same agroforestry systems. According to the survey of this map, one of the motivations for the farmers to turn to agroforestry was aesthetic. However, there doesn't seem to be a connection between these agroforestry plots in the landscape, meaning they remain isolated patches among other agricultural lands.

Study area Liège, Belgium

Pilot area

1. Context, purpose

Liège has a Food Land Belt including forest-gardens. The goal is to provide local food to the city. There are projects such as supplying school canteens (https://www.catl.be/projets-impulses/). The purpose of the plots is for vegetable growing.

2. Location and accessibility

Some plots are located in rural areas and some in urban areas. The plots are easily accessible. Some plots are located in difficult areas, enclaved spaces and with low access to food and energy. It is not a permanent land use. The spaces were good spaces because they weren't polluted and they were available via CREAaFARM of the City of Liège which is an organisation which provides communal lands for projects in urban agriculture (https://www.liege.be/fr/vivre-a-liege/commerce/alimentation-locale/creafarm#c6=faceted-cards).

3. Citizens' involvement

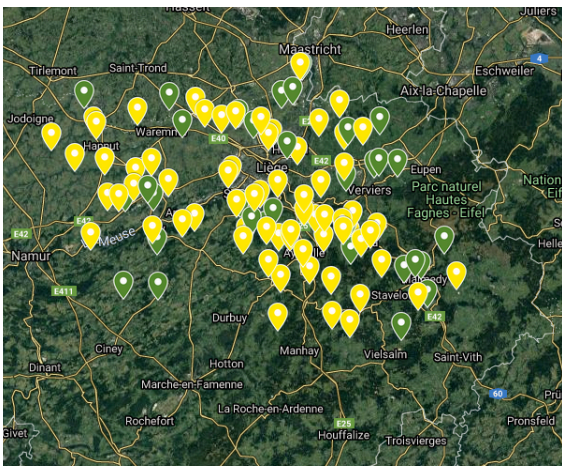
Citizens are involved in the plots of the Pousses Poussent program which is an employment of market gardening farmers through the City of Liège (Les Petits Producteurs, 2024).

4. Management and challenges

Funding was found via the region for the Pousses Poussent and via crowdfunding for the other cooperative. The management is done by volunteers. There are no design regulations. Below is a map of the market gardeners in Liège. The main agroforestry system is alley cropping (CCI Mag, 2015). Some plots are located on brownfields of old steel factories.

The lands belong to private owners and the city but they are managed by a network of partners with cooperatives and non-profit organisations to encourage agroforestry techniques.

The main challenge is the lack of water.



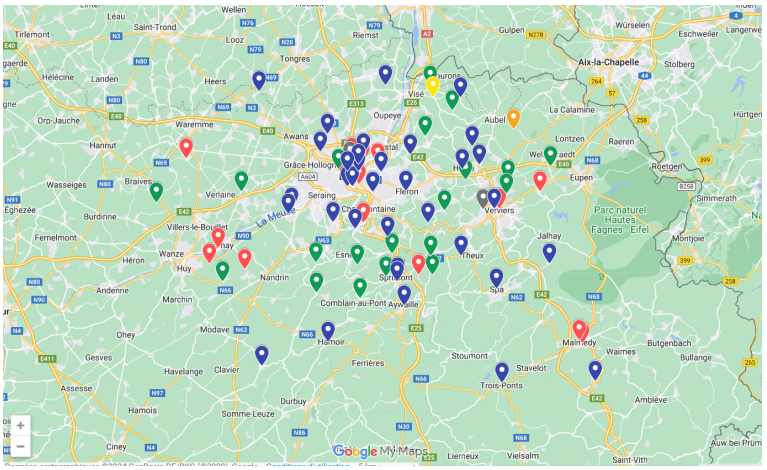


Figure 17. Map of the market farmers and gardeners in Liège, source: https://www.catl.be/producteurs-2/; Figure 18. Market spaces in the Edible Belt of Liège. (https://www.google.com/maps/d/u/3/viewer?mid=1MPh5GcWmwraEcqMIyob-hFu11uDWk0FU&ll=50.58151007256771%2C5.63015253401681&z=10)

There is no map about this belt because it is based on the cooperation between existing farms and citizens. This cooperation (Figure 17, 18) shows that agroforestry systems can be part of an urban economy.

In the center of the city is the project Pousses Poussent which is a project of market gardening. The plot is of 17.946 m² and was provided for free by the City of Liège in the frames of the project CREaFARM. The belt La Ceinture Aliment-Terre Liégeoise (CATL) provides technical expertise and helps instaure innovating commercial systems. The cooperative Les Petits Producteurs (LPP) pre-financed the installation of the farmers.

The Pousse Poussent garden in Liège ⅔ of the area will be cultivated for the system of ASC (Agriculture Soutenue par la Communauté) as a “pick your own” farm and ⅓ will be cultivated to supply part of the needs to the shop Les Petits Producteurs in Sainte-Walburge (Alimentation Locale Liège).

About 50 varieties of vegetables are produced in a year as well as several herbs and edible flowers.

They also planted an edible hedge with redcurrants, raspberries, blackcurrant and elderflower with apples, pears, plums, cherries and apricots.

There are several market spaces for the productions (figure 18). These are independent stores (in blue), on farm stores (in green), cooperatives (in red), peddlers (in grey), NGOs (in orange) and honey producers (in yellow).

The closer to the city is the horticulture school of Liège with a farm and productions sold on site.

Study areas of Nantes, Rennes and Montpellier, France

Pilot area-Nantes

1. Context, purpose

The motivations behind urban and peri-urban agroforestry were the greening of public spaces and increasing the amount of woodland in the territory with the dual objective of improving biodiversity and increasing the islands of freshness in the territory. The initiatives were made in the frame of the guide plan “L’arbre et les forêts de demain” (“Tree and forests of tomorrow”) which suggests the development of the tree in all its forms, from the woodland to the hedges and with agroforestry. And the initiatives were also made through the communal policies of greening the green spaces. There is a planned development project for creating a public policy of trees in the new mandate which is starting.

2. Location and accessibility

The plots relating to urban forests are mainly located in natural or agricultural areas and some concern urban "neglected" areas that the community wanted to plant, sometimes under

management when it comes to "gourmet resorts" on green spaces (especially on Nantes), sometimes in connection with citizen initiatives to recreate wooded islets on areas of little value in different municipalities of the Metropolis (eg MiniBigForest association). The areas concerned are generally completely accessible to the public, except (if applicable) during the planting period. The agroforestry development is located in several types of spaces: natural spaces, enclosed spaces not used and relevant to initiate an innovative project to plant a "green island" and green spaces transformed into spaces for local food production. If the planted spaces have no real use (leisure, games, relaxation), they can thus find a new vocation.

3. Citizens' involvement

Depending on the configuration, management is provided by associations and citizens. Some spaces are planted with associations such as MiniBigForest.

4. Management and challenges

The funding is varied. It can be public or plants can come from communal nurseries. There can also be participatory funding for projects carried by associations. The metropole and the communes manage several agroforestry plots with different configurations. There are no design regulations.

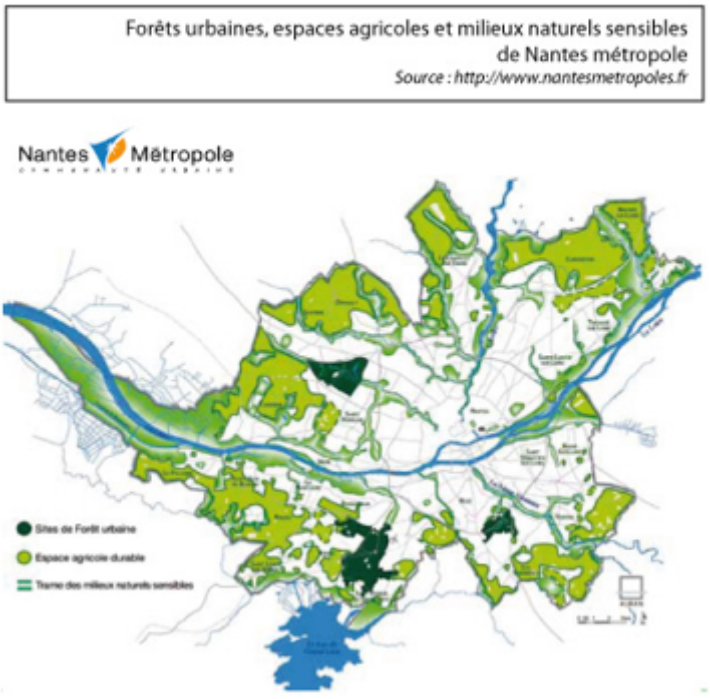


Figure 19. Map of the urban forests (in dark green), agricultural spaces (in light green) and sensitive natural areas of Nantes (in blue), source: Ville de Nantes

The goals of the urban forestry project are:

Preservation of natural spaces, reduce or stop the use of pesticides in green spaces and protect the quality of the water, value agricultural wastelands through the forest, generate wood production by employing workers with social difficulties through solidarity companies, to be a carbon sink (Nantes Métropole, 2021). The figure 19 shows the map of the locations of the urban forests.

The NGO Nantes Ville Comestible cooperates with the metropole of Nantes. It is a 5-year-old association with a group of different people from different backgrounds. They want to federate a network of actors. They have a lot of volunteers which make it difficult to manage. They manage the 48h of urban agriculture festival for 6 years. They are part of a city project called "potagers nourriciers" for creating edible gardens in the city. These are managed by NGOs, there are 11 in all, this association runs 2. They are created for people in need. Nantes has already an important historical tradition in urban agriculture since the monarchy. So, the metropole of Nantes has strong links with these NGOs.

Either the city makes calls for projects or integrates these plots in the landscape projects. But most of their plots are only available for a short period of time with short term contracts, which sometimes can be renewed.

The metropole of Nantes funds projects for developing agroforestry in the peri-urban areas of Nantes. The edible gardens in the city don't include agroforestry systems or trees for different purposes. These NGOs try to find resources locally from donations or partnerships, such as organic seeds or young seedlings.

The city of Nantes shows a good example of development of a solidarity economy with agroforestry with an agricultural wasteland turned into a wood production site. It also shows that agroforestry can be part of urban forestry plans to protect urban water quality.

Pilot area-Rennes

1. Context, purpose

The agroforestry plots are traditional *bocages* which are traditional landscapes of hedges around the agricultural plots. These sometimes include fruit trees such as apple trees. These were degraded due to industrialisation of agriculture and the cutting of these hedges.

2. Location and accessibility

The agroforestry plots are located in the green belt of Rennes which is in the peri-urban area of Rennes.

3. Citizens' involvement

There is no participation of citizens in the agroforestry projects.

4. Management and challenges

There is funding to help the preservation of these *bocages* by the French Department of Ille-et-Vilaine. Landlords and farmers manage these *bocages*. There is no urban agroforestry. The main challenge is the urban sprawl due to a high demand for lodging by newcomers. This threatens the preservation of the green belt.

Figure 20. Bocages of Rennes, source: Agforward ; Figure 21. Example of a hedge of a bocage, Thomas Schmutz, source: bcd.bzh

The bocage hedges (Figure 20, 21) can be used for different purposes such as fruit or wood production. The plantation types a different in the number of layers and species. They consist within an elevation of the property borders with soil (Bcd, 2022). They can also be used for carbon sequestration (Drexler S. et al., 2021).

Pilot area-Montpellier

1. Context, purpose

The NGO Oasis Citadine has opened an 8000 m² agroforestry plot including 4000m² of Syrah grape vines in which they have planted 100 fruit trees and planted diversified plant cover. There is also a 2000 m² market garden in living soil in which they have planted 50 fruit trees. A forest garden of 1000 m² brings together around fifty diversified fruit trees with the companion plants that accompany them. And finally, there is a 650 m² park for their hens in which they have planted about fifty trees. The goal of this project was to teach permaculture and agroecology in theory and in practice. There are also recreational activities.

2. Location and accessibility

The plot belongs to a domain in a vineyard and is located in a peri-urban area. The plot is accessible by bicycle and public transport. It is also in a business neighborhood. The plot is also connected to a botanical garden.

3. Citizens' involvement

The citizens are involved as volunteers and for workshops and training.

4. Management and challenges

Plantations of 250 pomegranate trees in the vineyards of the estate are also maintained by the association. They produce about 2000 baskets per year. The most difficult challenges are the lack of resources and the non-use of machines in the management of the plot.

City	Location of the plots	Agroforestry system	Management	Ownership	Challenges	Goals
Donzdorf	500 to 2000 metres from the city	Agroforestry in meadow orchards	Managed by the municipality	Municipality owned land	Maintenance	For agricultural landscape conservation
Liège	In and around the city, in rural areas and urban areas	Peri-urban and urban Food Land Belt	Managed by cooperations, farmers and citizens	Land provided by the organisation CREAaFARM	Water	For food provisionning
Nantes	Metropole of 24 communes, covers 53 000 ha, the plots are both on natural and “neglected” areas in urban and peri-urban areas	Urban Forest plan including agroforestry in the urban and peri-urban areas	Managed by the metropole, the communes, NGOS and citizens	Metropolitan and communal lands		Greening of public spaces and finding new vocation to “neglected” areas
Rennes	The plots are in the green belt around Rennes	Green belt Bocages in the peri-urban area	Managed by farmers	Belong to farmers	Urban sprawl	For landscape conservation
Montpellier	In the peri-urban area	Peri-urban vitiforestry	Managed by an NGO	Private ancient viticulture land which is provided	Management without machines	For education

Table 5. Conclusion of the case studies, Paloma Gonzalez de Linares

Through the case studies (Table 5), the main systems found are alley cropping, bocages, grazing meadows, vitiforestry and forest-gardens. The agroforestry plots have several purposes: production, education, management and renewal of traditional landscapes. The agroforestry systems are implemented through different programs: the Agenda21 in Donzdorf, the urban forestry project in Nantes, the citizen-based edible green belt in Liège and the green belt in Rennes. Local NGOs also implement agroforestry systems on brownfields and vacant lands in the city or in the peri-urban area. Agroforestry systems are mainly adapted to the existing land use and purpose of the plot. In the case of Nantes, there are also plantations of trees on vacant and neglected lands, which don't have any purpose or identity. Peri-urban agroforestry can be developed on agricultural brownfields and lead to a solidarity economy.

Agroforestry systems are mainly located in the peri-urban areas but in the case of Nantes, they are also urban. The spaces used for agroforestry systems are farmlands, abandoned agricultural lands and urban vacant lands. They are located in easily accessible spaces.

Citizens' involvement isn't common in these case studies. They are mainly involved through NGOs with forest-garden projects or vitiforestry. However, the case of Liège shows a good practice for citizen-based edible green belts with agroforestry systems and a network for resources and market spaces.

In the case of Liège, the funding comes from the city. Therefore, the city can be a source of funding for these agroforestry systems. The economy is also founded on a strong network between farmers and the city thanks to a bottom-up approach. The funding sources are diverse in the other case studies. The main challenges are the lack of resources, the management and the need for water.

These case studies show that urban and peri-urban agroforestry should be planned at the watershed scale and with a bottom-up approach to create socio-ecological networks in the urban landscape and to renew traditional agricultural landscapes with trees and old cultivars. Vitiforestry should be in peri-urban areas. The main challenges found were the water resources, the management of the plots for maintenance and urban sprawl.

Conclusion

From the case studies can be concluded a graphic model for urban and peri-urban planning development as a permanent land use as a strategy to adapt to climate change and create carbon sinks in the city and the peri-urban areas. There are opportunity spaces for urban agroforestry and there is a need to renew landscapes with agroforestry systems in strategy plans. The plots are located in rural areas, peri-urban areas and city centres. They are also located in enclaved spaces like in the case of Liège. Urban and peri-urban agroforestry systems are located according to open vacant lands mainly for growing food and planting trees. They need to be part of a strategic plan for inclusive cities, education and biodiversity. Urban and peri-urban agroforestry should be part of green networks with different agroforestry systems such as forest-gardens, alley cropping and orchards with involvement of

citizens for management and education and planned at the watershed scale with the goal to protect the water quality. Agroforestry systems renew traditional agricultural landscapes with trees such as orchards and bocages. They also give a new identity to vacant lands. More functions could be carried out in the city such as agroforestry for arts and for dynamising neighbourhoods. Citizen-based initiatives and NGOs play an important role in developing edible landscapes in the city and the peri-urban area with strong socio-ecological networks. They create networks with farmers and market spaces. They should be more included in participative green infrastructure planning and design strategies at the city scale. An economic strategy plan should also be created for cities to enhance agroecological edible green spaces with involvement of the EU, cities and communities, based on funding resources and exchanges of resources. A whole new economic system needs to be thought of in the planning of future cities for ecological and agroecological transition. In the frames of a green network strategy plan, agroforestry should be included with a spatial diagnosis at the watershed scale. This diagnosis should also include keyline designs. A management system needs to be planned for flood risks at the watershed scale and should include agroforestry systems. A landscape analysis with landscape metrics should be made to define core areas which define agroforestry plantations and functions and define the corridors and green network to connect them to. There is also the need to assess isolated patches to open and connect to.

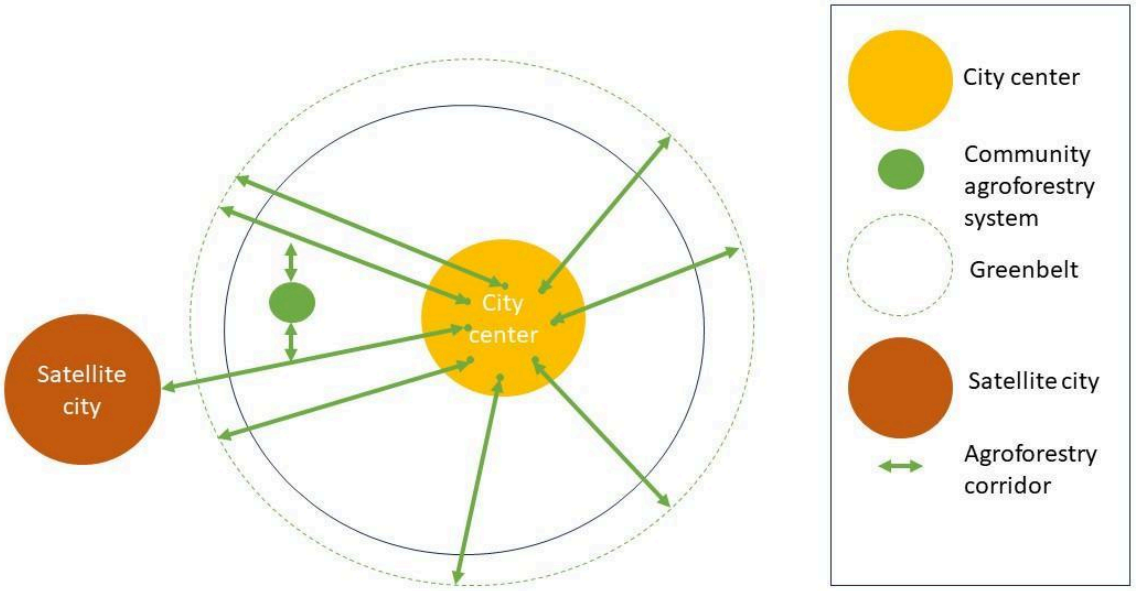


Figure 22. Model for urban and peri- urban agroforestry planning, Paloma Gonzalez de Linares, MATE, 2022

This graphic model (Figure 22) shows several agroforestry based green infrastructures which could be planned in the city. First there would be a natural green belt outside of the cities, around the satellite cities, which would not include agroforestry. This is to preserve the existing forests, woodlands, prairies and other natural areas outside of the city. Then there would be plantations of urban forests. Third, there would be agroforestry corridors with alley cropping, orchards and forest-gardens linking the satellite cities to the city centre with bicycle lanes and smooth transport. These agroforestry infrastructures could be part of a green and

blue infrastructure plan of the European cities with inclusion of farmers and citizens. And as mentioned in the introduction, linear parks increase the equal accessibility to green spaces. This should be adapted to the needs and context of the city. These measures would lead to the renewal of third spaces and abandoned land in cities. The corridors connect the peri-urban areas to the city center. The width of the belts depends on the city's context. Some abandoned lands should be left and kept wild. The landscape architect needs to ensure a continuity in the landscape for urban and peri-urban agroforestry patterns. And some plots or sections in the plots should be left for creativity. The borders of the agroforestry plots need also to be connected to a wider green network to avoid creating closed communities with agroforestry parcels and also landscape fragmentation. Therefore, there need to be cross border cooperations and cross border landscape patterns. Must also be considered that the patterns also change in time. Indeed, the patterns change with the seasons when for example the trees lose their leaves.

There can be a typology of agroforestry systems within green belts and corridors. There can also be a typology of purposes of urban agroforestry and peri-urban agroforestry systems:

- for renewing brownfields,
- for cultural landscape preservation,
- for education

There is also the need in creating public institutions for community planning around agroecology. For example, the city of Liège in Belgium has just opened a House of the Sustainable and Inclusive Food (MAdiL).

The bocage systems can be a good tool for rehabilitating peri-urban soils and reusing green waste and compost in greenway planning. There can be different openings with different points of view in the landscape. The system of the bocages can be used to adapt to different urban soil conditions and reuse urban soils because they are raised planting systems. They can be part of urban green infrastructure plans as local shelterbelts and cover long distances. They can be planned around existing green spaces, parks and gardens or residential open spaces and create continuous raised beds with urban compost and green waste to create new topsoil and plant edibles.

The applicability of the model depends on land uses and the availability of open spaces and ownership and economic returns of agroforestry systems and regulations.

There should be regulations for hedgerows in cities for regenerative agroforestry systems with a possible inclusion of pollard trees and rehabilitation and reuse of soils.

Vitiforestry should be planned far from heat islands as grapes are sensitive to heat. Using the heat map is a good method to plan agroforestry systems and find strategic spaces and choose species and agroforestry systems.

Due to the diversity of financial resources such as the city or crowdfunding and the dependency on funding to pursue projects in urban and peri-urban agroforestry, a permanent fund should be created for the development of agroecology in and around the cities. This could be city-based or/and farm-based and community-based.

In these case studies, the artistic purpose of agroforestry systems hasn't been explored. The main focus is on the production of food and for increasing the canopy from trees in cities. When designing an agroforestry garden or park for arts, it is necessary to have a plan at the bioregional scale and watershed scale to integrate it in the whole landscape for preservation of biodiversity. The purpose is for education and agroforestry systems need to be designed with participation of citizens and through cooperation with market spaces and farms. Urban agroforestry plots can also be planned in vacant lands for artistic purposes.

IV.2 Goal 2. Definition of urban agroforestry gardens with their design methods and assessment of their impact on the urban landscape based on observations and interviews in the South-East of France

As Climate Change is an important factor to take into account and urban heat islands are an important factor in cities, it is important to assess the water, soil and species management of agroforestry systems in dry climates to find solutions to adapt our landscapes and local resources and economy. This section focuses on the type of agroforestry systems and their design with the choice in species and how urban agroforestry can rehabilitate landscapes under arid and semi-arid climates at a garden scale, so a definition of urban agroforestry gardens could be built. It also focuses on the governance system and their impact on the organisation of the city. These terrasses were chosen because they are an existing corridor and can potentially be agroforestry corridors in a cultural agricultural landscape in a semi-arid climate. The inclusion of artistic practices for designing the gardens was also assessed to see how it can be linked to new agroforestry spaces.

1. Governance system

Les jardins du Loup

The plot is managed by an NGO and is on private land on a drystone terrasse in Pont- du-Loup. Most of the resources come from the garden but the hay used for mulch comes from a neighbour. The production is mainly for private consumption and the volunteers but they also produce safran and sell it to restaurants. This means that there is a division in the production in the garden for different markets and with different values. There are workshops in art and training in permaculture design. A collective landscape design was made at the beginning of the creation of the garden. Land art sessions are organised.

Horticultural highschool of Antibes, CFPPA

The plot is managed by 5 professors and the students. The products are sold to the highschool canteen, so there is direct production and consumption on the site. Also, with this garden

being part of a horticultural highschool, there is easy access to tools. According to the interviewed expert teacher, for this parcel of 5 000 m2, there is the potential in an urban area to include 12 people, each having 400 m2 in a community garden.

Le Jardin du Petit Pessicart

The plot is managed by an NGO and is on private land on a drystone terrasse in Nice. The managers preserved some natural wide parts in the garden and only produced within one terrasse. The design was participative. There are also social design activities to create permaculture gardens.

La ferme des Calanques

The plot is managed by an NGO in a horticultural school in Marseille. The water comes from the city of Marseille canal and is considered as agricultural water. Thanks to the location, the gardeners have access to the machines of the highschool.
The compost is made of mushrooms from the mushroom production of Marseille and is called "champost". The gardeners also compost the waste from the canteen of the highschool. Hay and manure are also added to the garden and come from a park. Therefore, there are several sources for the compost, in the garden and outside the garden. The goal is to have a high density of plants and a high diversity and production. The management of the farm is done by 3 experts and 3 interns and 3 permanent volunteers.

Terre et Humanisme, Lablachère

The association Terre et Humanisme is located in Lablachère. It is a pedagogic garden focusing on training and education around agroecology. Another goal is to see how to manage an agroecological garden in difficult conditions, especially the management of water in dry areas. The association has other gardens in Morocco and Tunisia. An interview was also made with the association in Morocco. In Morocco, the watering is done with oyas, a system of underground basins called "Metfiya" and the drip watering system.
The garden is 30 km away from Marrakech in a very arid area. It was chosen by Pierre Rabhi to show agroecology in the most difficult soils. These are rocky soils and there is a lack of water.
There are several platforms in the garden: a compost area, a small breeding of goats, sheep, hens and a bee hive and there is a seed bank to preserve the seeds of the region but they aren't allowed to sell the seeds so they exchange seeds.
There is the creation of an agroecology centre with training and accommodation as the usually last one week. These trainings include theory and practice in agroecology and new ways of cultivating, crop rotation, companion planting and vermicomposting. In all, there are three animators trained who do not also have farms.
There is a network of agroecological farms in different climates: in the Mountains of the Rif up in the North which has also developed eco- tourism; a farm near Casablanca. For example, the garden which is 30 km from Marrakech sells compost to farms and sells vegetables to restaurants in Marrakech. Therefore, there is a connection between the gardens and the cities.

There is also the presence of urban agriculture destined to feed the city and create short circuits but it is mainly annual crops and there is land pressure from real estate companies.
The State finances forestation programs and the creation of agroforestry gardens, especially for the Argan tree as the Argan tree gives products with high value for cosmetics and exportation. It is a "treasure" of Morocco according to the interviewed expert from the NGO in Morocco.
Moreover, there is a convention with a university to plant an agroforestry garden with students and there is a lot of funding by an Egyptian NGO and Moroccan NGO and the State to fund organic production. For example, they finance the soil analysis and water analysis for organic farms and the organic production is funded by the State for exportation.

Le Talus de Marseille

In the Talus de Marseille soil was provided by Veolia company. The farm focuses on training and volunteers can rent a vegetable garden and come to give their compost. It is managed by an NGO gathering two managers, 10 permanent volunteers and 1 600 volunteers and was created on a site belonging to the motorway society. The State lends the land for 26 years with reconduction. However, the land is being taken back by the company for a new development. The goals of the farm are experimenting and ecology.

Conclusion on the governance system

The owners of the lands are NGOs and horticultural highschools. The citizens governing these gardens are trained and build solutions for resistance to drought through the choice in species and maintenance system. Participative designs and gardening activities are good communication tools around agroecology and can be used for urban planning agendas. The maintenance of these agroforestry gardens depends on a network to find resources. Urban agroforestry is an activity which is based on the protection and enhancement of biodiversity with participative designs through education programs and training and/or internships. The case studies show that agroforestry gardens are mostly educational landscapes. Teaching is done through participative garden design workshops and contributes to a swarming effect of knowledge and development of future agroforestry gardens. The community gardens show a governance concept and system which could be adapted to the whole city scale with participative designs and training programs for the maintenance of these gardens and a network for waste management and resources. According to the managers of les Jardins du Loup, participation of citizens leads to a swarming effect for the development of other agroforestry and permaculture gardens in the city not only for the techniques but also for the philosophy for resilience. According to the Jardin du Petit Pessicart, participative designs create eclectic groups with for example artists, biologists, economists, sociologists. Therefore, it is a work group and it helps in creating social ties.

2. Technics

Les jardins du Loup

In the Jardins du Loup (Figure 23, 24), the watering is done with microporous pipes and by hand, there is also a phytoepuration space for the waste water. There are five drystone terrasses with a diversity of crops, herbs, berries and fruit trees such as Grenades, Oranges, Avocados and Sour Oranges. The soil is very fertile, it is clayish and with limestone and it is not too rocky. There are several compost platforms in the garden and there are also shreds from branches.

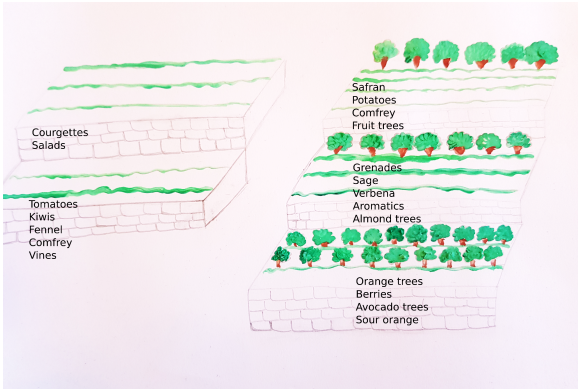


Figure 23. Sketch of the drystone terrasses of the garden "Les Jardins du Loup". Source: Paloma Gonzalez de Linares

Figure 24. Les Jardins du Loup, source: lesjardinsduloup.fr

Horticultural highschool of Antibes, CFPPA

In the horticultural school of Antibes (Figure 25, 26), an automatic watering system with electrovannes is used in between each alley.
Several fruit trees have been planted such as Avocado, Grenade, Almond, Olive trees and Citrus. Some crops are grown such as fennel. There is also a mychorization experiment under roses in partnership with the research institute INRA. The culture is made on small mounds because the soil is clayish and horse manure is added to the soil. The interviewed initiator of this agroforestry plot does not believe in citrus trees for the future of agroforestry because these trees like to keep their feet bare.

Figure 25. Photo of the agroforestry plot in the horticultural school of Antibes. Source: Paloma Gonzalez de Linares

Figure 26. Photo of the agroforestry plot in the horticultural school of Antibes. Source: Paloma Gonzalez de Linares

These photos represent a section of the agroforestry plot in the horticultural highschool of Antibes. Due to the Covid pandemic, there were no crops growing in the beds, but it is planned to grow a mix of fruit, vegetables and aromatics. These beds are surrounded by an alley of citrus trees, an alley of roses with fungus and fennel.

Le Jardin du Petit Pessicart

In the Jardin du Petit Pessicart (Figure 27, 28), there are three sectors of automatic watering with drips, which takes place 3 hours every 3 days. There are several fruit trees, with an area for forest gardening and syntropic agroforestry. These fruit trees include: Feijoa, Acacias, Cherries, Lemon, Orange, Avocado, Almond, Peach and Figs, Olive trees and Banana trees.

Figure 27. View on the forest-garden in the Jardin du Petit Pessicart, Nice. Source: Paloma Gonzalez de Linares

Figure 28. View on the forest-garden in the Jardin du Petit Pessicart, Nice. Source: Paloma Gonzalez de Linares

The raised beds include diverse fruit trees with crops and herbs. These beds were designed on one of the drystone terrasses of the garden. They are plantations of different species through the frames of companion planting and to enhance biodiversity. In this environment, the gardeners chose to grow a forest-garden and a banana plantation. The soil is composed of Poudingues and pebbles, which make it hard to work on, therefore, they add soil and compost from their garden.

La ferme des Calanques

In the Ferme des Calanques (Figure 29, 30), the watering is automatic. The soil is poor, very sandy and there is mainly limestone, therefore there is need to add compost.
Champost is composed of hay, coffee, mycelium of mushrooms and shreds.
There are 17 main rows of 30 meters long and large from 80 cm to 1 m which are axed North to South with a small slope of 10%. The total production is about 100 kg of vegetables per week.
The plants planted are: Peach, Redcurrant, Blackcurrant, Almond, Apricot, Fig, Grenade, Potato, Beans and there is also Poplar because it adds a lot of biomass. There are also Courgettes, varied Tomatoes, Aubergines, Peppers, Chili peppers, Butternut squash, Cabbage and Melon.
The garden also benefits from a view on the Basilique Notre-Dame de la Garde and therefore there is a project to plant an alley of trees with Almonds, Cherries and Pecan Nuts.

Figure 29. Photo of La Ferme des Calanques in Marseille, source: Journal La Marseillaise

Figure 30. La ferme des Calanques, source: Agri-City.info

Terre et Humanisme, Lablachère

There are several areas in the garden (Figure 31, 32): one area for alley cropping, one forest-garden and one area with hens. The compost comes from the garden and the dry toilets.

Figure 31. Map of the agroecological garden of the Mas de Beaulieu in Lablachère, France, source: https://terre-humanisme.org/jardins/

Figure 32. View on a parcel in the garden of the Mas de Beaulieu in Lablachère, source: Paloma Gonzalez de Linares

Le Talus de Marseille

In the Talus de Marseille, the watering is done with an automatic watering system.The farm is structured by several platforms: intensive cropping, a windbreak hedge of edible bushes and shrubs and a space for hens. The plot produces about 2t of vegetables per year which are sold with eggs. There is rainwater harvesting.

Conclusion on the technics

According to the garden assessment different systems are used for watering but the common aspect is the rainwater harvesting and water dripping or soaking (Table 6). There can also be phytoepuration on drystone terrasses for waste water. The hay is a solution to keep soil moisture and the compost in the gardens and farms or champost to make the soils more fertile. The system used in the Mas de Beaulieu cannot be implemented on drystone terrasses as it is too wide. The production is sold to school canteens, restaurants and/or people. Cooperating with school canteens can be a good solution for the production management on drystone terrasses and plots within cities. The plantations have mainly different layers and include trees, crops and bushes. Grenades and berries are good to plant in these gardens. There aren't any flowers apart from Safran in the Jardins du Loup. According to the CFPPA of Antibes, orange trees aren't possible for agroforestry and companion planting. The compost is mainly provided on-site but there needs to be a network to provide hay and horse manure. Highschools can be good spaces for experimenting species and management of the soil like in

the CFPPA of Antibes. The plantations are mainly linear and can be implemented in homegardens.

Garden	Watering system	Soil management
Les Jardins du Loup	Microporous pipes and by hand, there is also a phytoepuration space for the waste water.	Compost, shreds from branches, hay.
CFPPA Antibes	An automatic watering system with electrovannes is used in between each alley. There is a rainwater harvesting project planned.	A mychorization experiment under roses in partnership with the research institute INRA. The culture is made on small mounds because the soil is clayish and horse manure is added to the soil.
Le Petit Pessicart	There are three sectors of automatic watering with drips, which takes place 3 hours every 3 days. There is also rainwater harvesting.	The soil is composed of Poudingues and pebbles, which make it hard to work on, therefore, they add soil and compost from their garden.
La Ferme des Calanques	The watering is automatic. The water comes from the city of Marseille canal.	Champost (compost made from mushrooms) and compost from the farm.
Terre et Humanisme	The watering system is with 2 tanks of 600m3 with rainwater harvesting and a drainage system and they use a soaker hose which is incorporated in the mounds under the hay. They also use underground water.	Compost and hay.
Le Talus	Automatic watering system.	600t of soil was provided by Veolia.

Table 6. Table of comparison of the watering systems in the agroforestry gardens

3. Inclusion of artistic practices

Artistic practices aren't common in these plots, the plantations are mainly to enhance biodiversity and for production. The plantations are mainly linear. Thanks to one of the managers who is a mosaist, there is an artistic background in the garden with workshops in

land art in les Jardins du Loup. There is also land art in le Petit Pessicart. This adds an artistic purpose in urban agroforestry plots design with participation of citizens and education about agroecology.

4. Surroundings and accessibility of the plots

Les jardins du Loup

The garden is located in a residential area, close to the river of the Loup in the city of Tourrettes sur Loup, in a Natura 2000 site and at the entrance of the Natural Regional Park of the Préalpes d'Azur. The is easy to access from the Loup River and is connected to other green spaces but there is a high tourist traffic on the river beds.

Horticultural highschool of Antibes, CFPPA

The plot is surrounded by a residential neighbourhood and it is connected to other gardens in the horticulture school of Antibes. The highschool is well connected to roads and close to the train station of Antibes and a direct bus to the train station.

Le Jardin du Petit Pessicart

The garden is connected to other residential gardens on the hills of Nice. It is easily accessible by bus.

La ferme des Calanques

The garden is far from the city center but it is well connected with a tramway.

Terre et Humanisme, Lablachère

The plot is surrounded by fields and is located in a small town. It is difficult to access by public transport.

Le Talus de Marseille

The plot is easily accessible by a road and a bus to the city center. It is not connected to other green spaces.

Conclusion

Several lessons can be learnt from these community agroforestry systems and a definition of urban agroforestry gardens can be concluded. Urban agroforestry gardens are gardens with a productive and educative purpose, based on the protection and enhancement of biodiversity with participative designs and plantations through training, volunteering and/or internships.

They are spaces with common plantations, based on companion planting. There can be rainwater harvesting and reuse of green waste. They depend on a network for provisioning of local resources. All elements in the garden are part of a cycle for nourishing the soil and water management. They are also spaces for arts. Indeed, artistic approaches can be used in the design such as land art. They can be integrated in the urban landscape through tree lines with perspectives and viewpoints. Also, they are spaces of creation, expression and transfer of knowledge. Drystone terrasses used to have flower beds, this could be reintroduced for marketing and painting, arts, creating tools and materials for designing the gardens and making decisions, drawing the plans with less dependence on oil. Urban agroforestry gardens therefore have several purposes.

These case studies show technical possibilities, limitations and adaptation strategies to climate change and to renew landscapes with agroforestry. The type of agroforestry systems which can be implemented are syntropic agroforestry, forest-gardens and alley cropping. They are mainly linear plantations and systems and can be sources of food for citizens, canteens and market spaces such as restaurants. The common aspect is that it is important to have a network with gardens and parks to have access to resources for the garden such as compost and manure. Horticultural highschools are good spaces for agroforestry as there is space for the management of resources such as compost and there is access to tools and the canteen. The case studies also show that urban agroforestry is appropriate in homegardens which can be open to communities and volunteers for learning. There can be a high diversity of species and functions and productive spaces on a small unit of land. However, the choice in species needs to be monitored, such as the potential of citrus trees in agroforestry systems. There are several watering systems but the main one used is automatic: dripping water systems, automatic spraying and a soaker hose. Another possibility is rainwater harvesting if there is enough rain and *Matfya* in dry areas. The case studies also show that it is possible to have a local economy with urban agroforestry through the exchange of resources and the selling of local production. For example, the Ferme des Calanques in the horticultural highschool of Marseille produces its own compost but also has mushrooms and manure provided from partners in Marseille. They are also spaces for recycling materials and a circular economy. Considering biodiversity, the case studies also show that a wide diversity of trees and crops can be grown in a small space and that there can be several agroforestry systems in the same garden and several functions. It is possible to link science and arts in agroforestry with perspectives, view-points, irrigation systems, art performances and land art.

Urban and peri-urban agroforestry also need to be planned at the neighbourhood scale to find local resources and create a circular economy with participation of citizens through participative design and workshops. It is a strategic method to open spaces, even with small parcels to a circular economy. Agroforestry gardens are important resources of knowledge and self-management. The organisation of these community agroforestry gardens is to open gardens to gardening and design workshops, artistic practices such as land art and food provisioning. They also integrate a circular economy in the city and renew landscapes. However, these gardens and farms need to be part of the whole urban dynamic. Their system can be used in public spaces. More networks need to be made between the gardeners and the

municipalities. This could be through participative planning and mapping of resource spaces, market spaces and the plots. These gardens show that agroforestry systems can be integrated in existing green environments and be part of ecological corridors in cultural agricultural landscape heritages and be organised as community agroforestry gardens. Decision-makers and landscape architects can open new agroforestry gardens in the cities with participative designs. Landscape architects have a role to play in the transfer and spreading of knowledge. Landscape architects need to cooperate with naturalists and agronomists to monitor the species grown in the gardens and report the information to decision-makers for the planning of cities with participation of citizens. Urban and peri-urban agroforestry could be a solution for increasing green community spaces in the city and managing the urban soil and rainwater, adapting to drought and managing drystone terrasses. The circular systems and agroforestry designs from these case studies can be spread to the whole city plan and design with a strong network for finding and exchanging resources. They can also spread or be transposed to rural farms and peri-urban areas and create connections between rural farmers and urban farmers and gardeners.

These citizen-based agroforestry systems play an important role in creating a local and circular economy through networks and exchange of resources. They also show that agroforestry can be a solution for the economy of water, with rainwater harvesting, a choice in perennial species which don't require much water and a work on the soil through mulching.

The landscape architect can play a role in connecting these communities and systems in the whole landscape with participation of citizens and providing new land for more agroforestry development.

The citizens governing these gardens are trained and build solutions for resistance to drought through the choice in species and maintenance system. Participative designs and gardening activities are good communication tools around agroecology and can be used for urban planning agendas. The challenge is the ownership of the plot. Schools and public institutions are good spaces for urban agroforestry. They are important for training and spreading knowledge. Agroforestry systems can be a solution for private housings on drystone terrasses for the maintenance of this cultural agricultural landscape heritage. More research needs to be made on the type of species which could be implemented, especially green covers. The Strawberry trees can be better valued in agroforestry systems as it is resistant to fire. The maintenance of these agroforestry gardens depends on a network to find resources. It is an activity which is also for education and training, not only the design and to communicate about biodiversity and gardening with agroecological principles. Therefore, a socio-ecological network could be created on these drystone terrasses and create socio-ecological corridors with agroforestry systems and a high diversity of species and layers.

IV.3 Goal 3. Analysis of the opportunities and challenges for implementing public agroforestry gardens in a dense urban corridor along two creeks for shade, food and materials for arts and testing methodology in planning and design with participation of citizens for renewing landscapes and building inclusive green cities

This goal is about assessing possible public lands along creeks for urban agroforestry gardens and the purposes and methodology for planning and designing agroforestry systems in a participative way. The process for the landscape architect is also assessed.

IV.3.1 Results from the land use map analysis, the on-field assessments and the interviews with decision-makers

The land use map of Budapest shows potential spaces as some agricultural lands are marked as woodlands and brownfields. After assessment on the field for the potential for agroforestry systems to expand along the Rakos creek, it is possible to deduce that urban agroforestry can be a tool to restore and value ancient woodlands which have turned into agricultural lands or vacant plain lands. They can have several purposes and be diverse in their species and design system. An on-site analysis of residential areas in the 13th district of Budapest along the Rakos creek was made to show potential for development of urban agroforestry plots. There are also brownfields along the Rakos creek which could be used for urban agroforestry practices. On top of these on-field assessments, several interviews were made to find possible public lands along the Rakos and Szilas creeks and assess the opinion from decision-makers for this practice. A map was drawn from these assessments. A landscape assessment was made to plan for equal access to urban agroforestry gardens along the creeks.

1. Opportunity spaces for public urban agroforestry gardens and parks along the Rakos and Szilas creeks

Several interviews were organized to find possible public lands for the development of urban agroforestry along the Rakos and Szilas creeks.

<u>Szada</u>

After discussion with the Mayor and the local NGOs and gardeners, it was suggested to start with a focus on the plot at the source of the Rakos creek. There used to be orchards there. The soil is sandy and there is a small slope. It was decided to include the waste management and compost management. Following the meeting, the Mayor would like to include agroforestry systems in the planning of community neighbourhoods. These could be connected to the existing biodynamic garden of Szada. An agroforestry system, such as a community woodland could be grown at the source of the creek in Szada. Connections can be made with the schools. There are municipality owned plots which could be used for urban agroforestry systems. The management of compost and Robinia pseudoacacia needs to be taken into

consideration in the system of the corridor. There is a need to assess the soil. The municipality owned plot at the source of the Rákos creek can be used for an agroforestry plantation (annexe).

Budapest

After a presentation of urban agroforestry to the City Council of Budapest, support and interest were found for community building in urban agroforestry gardens. From finding the plots, it is possible to build a planning system for urban agroforestry species choice and functions and to implement urban agroforestry as a land use according to the landscape context.

Location of the possible vacant lands assessed for urban agroforestry in Budapest

Figure 33. Map of the potential agroforestry spaces in public lands along the Rakos and Szilas creeks according to the land use map and interviews with decision-makers in Budapest, Paloma Gonzalez de Linares, Openstreetmap.

The map shows potential agroforestry garden spaces on public lands along the Rakos and Szilas creeks (Figure 33). Public open spaces are potential areas for agroforestry gardens within dense residential areas with blocks of flats. The creeks create a corridor to connect the agroforestry gardens to.

There are three municipality owned plots which can be used for agroforestry. One in the 13th district, between Reitter Ferenc utca and Szent Laszlo utca, owned by Budapest, (Figure 34,

35) and one between Váci út and Madarász Viktor utca, owned by the 13th district (Figure 36, 37). The last plot which can be used is in the 4th district, owned by Budapest (Figure 38, 39).

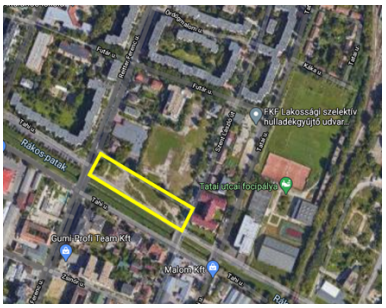


Figure 34. Aerial image of the location of the plot between Reitter Ferenc ut and Szent László ut, source bfvt.

Figure 35. Photo of the plot in the municipality owned plot in the 13th district, Paloma Gonzalez de Linares

The plot between Reitter Ferenc ut and Szent László ut in the 13th district is on soil type River-Aeolian sand. The plot is uneven and there is the presence of electric lines.

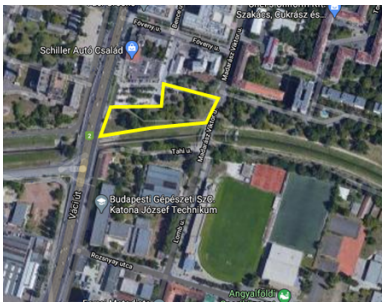


Figure 36. Aerial image of the location of the plot between Váci ut and Madarász Viktor ut, source bfvt.

Figure 37. Photo of the plot between Váci ut and Madarász Viktor ut, Paloma Gonzalez de Linares

The other site is between Váci ut and Madarász Viktor ut. This plot is on a soil type River-Aeolian sand. However, due to high traffic and air pollution, it is not recommended to grow edibles in this area. It should be for restoration with species adapted to floods and for artistic purposes. The plot is flat.

Figure 38. Aerial photo of the municipality owned plot in the 4th district of Budapest, source: bfvt

Figure 39. Photo of the municipality owned plot in the 4th district of Budapest, Paloma Gonzalez de Linares

Dense residential areas in the 13th district show potential public spaces for urban agroforestry (Figure 40, 41).

Figure 40. Open green space at the Rakos Falva park, source: Paloma Gonzalez de Linares

Figure 41. Rakos creek along the Rakos Falva park, source: Paloma Gonzalez de Linares

The Rakosrenddezö brownfield was assessed for its potential for urban agroforestry. It could be for arts with tinctorial plants and plants for phytoepuration.

IV.3.2 Results from interviews and workshops with experts, NGOs, community gardeners and schoolchildren about their perception on urban agroforestry for food and arts in public lands along the Rakos and Szilas creeks

This section presents the results from the interviews with institutions, NGOs and community gardens in Budapest. The objective is to assess the importance and requirements for social inclusion in agroforestry gardens and the challenges they would face.

1. *Results from the interviews with NGOs and institutions in Budapest*

According to the interviews, several aspects need to be considered when planning for urban agroforestry. The wildlife management and tree management need to be defined for reducing impacts and risks of Red Deer and Wild Boar. According to a volunteer of the Permaculture Association of Hungary (MAPER), gardening is a hobby and it is easier to buy in markets due to the time it requires. One aspect which was mentioned is the need for developing more market spaces for organic food. The ownership is also an important matter because the gardens are different whether it is a private or public ownership. According to the FAO, there is a need for a clear definition of urban agroforestry and to reduce trees with pollen and allergies. According to an expert of the Forest Institute of Hungary, there is a need for a long-term vision for planting the trees with a 100-150 years vision. An expert in fruit trees and ecotoxicology suggested planting diverse fruit trees along the creeks such as apples, stone fruit species, cherries, plums, walnuts (persian walnut), hazelnut, elderflower, quince, old cultivars. Old cultivars are more resistant to climate change, diseases and pests. Apricots and peaches should be avoided. According to the interviewed expert, food could be grown, there could be animal breeding and the compost could be a marketable brand. The soil needs to be assessed before plantation.

According to the interviews, planning urban agroforestry covers several aspects: wildlife management, health, social inclusion, management of invasive species and landscape restoration. One of the opportunities found was to include agroforestry systems and permaculture in the Rakos creek restoration plan with the National Institute of Biodiversity of Hungary. Therefore, urban agroforestry can be part of restoring landscape planning strategies. For social inclusion of the homeless, health and medical professionals are needed for participative designs (Seeds4Hope-BBM).

2. Results from interviews with community gardens

1. Land accessibility

The community gardens are provided by the district councils. This means that urban agroforestry also depends on authorisations from district councils. But this is for a small scale community garden. More attention should be paid to its development at the regional scale and corridor scale in order to embed urban agriculture and urban agroforestry into planning strategies for biodiversity in the city and greening the city.

2. Opportunities for community agroforestry gardens in Budapest

The main aspect to consider for urban agroforestry is that agroforestry requires wide spaces. There is a will for community spaces in Budapest and dense residential areas appear to be good locations for their development. The community gardens were mainly located in dense residential areas. This means that urban agroforestry gardens can be implemented in dense residential areas but they need a wide plot of land. The community gardens mainly have raised beds which are for defined users.

The significance of the tree is different between the gardens. Some gardens already have trees on the plot, which can be a problem for growing crops such as tomatoes between each parcel. In urban agroforestry the shade and the leaves and wood of the tree would be valued in compost for the soil moisture and nutrients. Some gardeners planted fruit trees on the border of the plot. An edible hedge could be planted on the edges of community gardens to enhance shared fruit and nutrients for the soil. The descriptions of the gardens can be found in the annexes. Urban community gardens are good spaces for avoiding isolation. So they also have an important social impact which can be a goal for urban agroforestry. The main goal of these gardens is community development. Also, according to a community gardener, community gardens are important for keeping knowledge and cultural heritage in gardening. Therefore, urban agroforestry would also be a space for transfer of knowledge in gardening.

3. Challenges for community agroforestry gardens in Budapest

The gardeners don’t have time to exchange their experiences and share which means that new tools need to be created. A platform could be created for this purpose, including urban agroforestry plots. Another challenge is the need for a wider space for agroforestry systems, more on farmland.

From a landscape architecture point of view, these gardens are isolated and would need more connections to open green spaces through a green network and corridors. They should be part of a long term vision and planning policy, in the economy of the city with social inclusion. This is why they need to be part of a wider scale planning agenda for the region and the city with participation of citizens. This could be a citizens-based mapping system with landscape architects and monitoring of the plants according to the climate change and urban climatic context. A community garden has trouble in waste management (pests in compost boxes). Therefore, there needs to be help and support from the community or urban gardeners or from the district councils to find solutions.

Results of the school workshops with assessment of the perception of urban agroforestry gardens

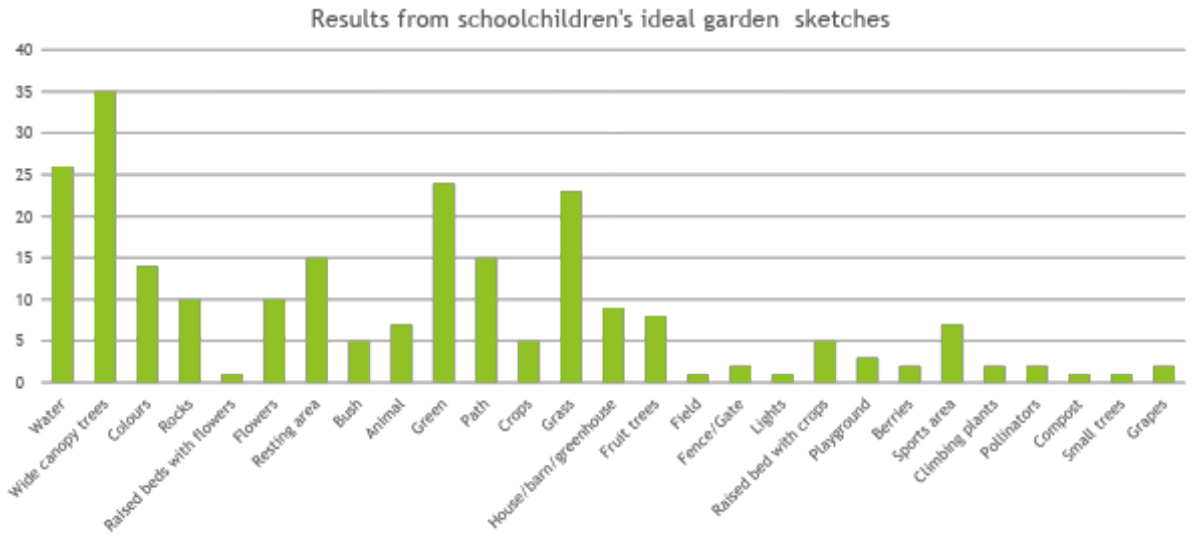


Figure 42. Componants of the schoolchildren's drawings

According to the schoolchildren, the main elements which came out of the garden sketches are water and wide canopy trees, green elements and grass. Then, there were resting areas and colours, fruit trees and flowers (Figure 42).
The painting workshop was a way to involve schoolchildren in agroforestry garden and park designs and to teach about agroecology and agroforestry. The drawings reveal that there need to be mainly water elements, wide canopy trees and green extensive covers in agroforestry garden and park designs. Then, there can be small fruit trees and flowers. So there is a need for shade and maintenance and protection of water resources in urban agroforestry. The advantages of using drawing and painting tools is that each participant can express his idea and vision.

Conclusion of the interviews and the workshops

Urban agroforestry can be a practice for public spaces with educational purposes and for growing food and art materials with participation of citizens. It is a tool for greening cities with respect for biodiversity and restoring landscapes such as woodlands as well as engaging social inclusion with support from social workers and psychologists. The agroforestry plots can be planned in partnership with research institutions in forestry and biodiversity, homeless shelters, community gardens and food banks. There is a need to define the watering systems and specific species to plant and monitor under climate change and to find specific areas where agroforestry could be developed according to the existing green cover and land use regulations. There is a need to define the watering systems and specific species to plant and monitor under climate change and to find specific areas where agroforestry could be developed according to the existing green cover and land use regulations. Also, when involving homeless or health institutes, it is necessary to involve social workers and experts in

health and psychology. According to the interviews, there is also the need for wildlife management as there is the presence of deers and wild boars which can become problematic for agricultural plots. Finally, there is a need in the management of pests especially where there is a compost site. Therefore, experts, citizens and NGOs should gather and cooperate to build a strategic plan and network at the city scale and corridor scale, around natural resource management and protection and food growth in the city. Due to a lack of time, a communication space and platform system need to be created to exchange knowledge, experiences and resources as these are important pieces of information to share and maintain the gardens.

The dense residential areas appear to be good spaces for developing agroforestry gardens. They can involve local dwellers in the garden. In the case of Budapest, they also show proximity to water streams creating potential corridors and existing green spaces and recreational spaces with playgrounds. These are also areas well connected by public transport. And compared to the cases in France, these are on public lands and not on private lands or institutional lands. However, their perennity depends on the authorisations of the local governments at the district level.

Agroforestry systems can answer different social issues and protect and manage public natural resources such as water and compost. They need to be co-designed with landscape architects and open to the public in order to share knowledge and restore nature in a participative way and enhance the appropriation of public agroforestry gardens and their diversity in shapes and species. Workshops make it possible to include agroforestry systems in a whole urban dynamic through participation. They are important to communicate opportunities, needs and challenges in urban agroforestry planning and design and create a possible network for an agroforestry corridor. The PPGIS can be difficult to implement because it requires a longer process than drawing, painting, writing and sketching. Workshops can be held during the participative design sessions to present and discuss about species and functions of the urban agroforestry gardens.

Through cooperation between different stakeholders, it is possible to plan agroforestry systems at a watershed scale and to build a network between different neighbourhood-scale projects for agroforestry gardens. The possible actors to involve in the corridor: community gardeners, research institutions (Forestry Institute of Budapest, Biodiversity Institute of Hungary), NGOs (SZIA agroecological garden of Gödöllö, Diverzitas, Miradoor), NAIK, the Biodynamic garden of Szada, Budapest Bike Mafia-Seeds4Hope, the National Institution for Biodiversity, the Food Bank Association, MAPER and citizens in the planning and design process of urban and peri-urban agroforestry corridor along the creeks. A PPGIS project was started with decision-makers and local NGOs to create an inclusive and participatory community-based corridor. This is a good tool for community bonding and decision making for planning agroforestry systems and gathering actors, managing the connections between agroforestry plots and public spaces and green spaces, green waste management and invasive species such as Robinia pseudoacacia. However, it is long to implement and active drawing can be a better tool for planning and designing urban agroforestry gardens with participation of citizens. There could be citizen-based institutions linked to researchers and experts in the

neighbourhoods, like in the case of Montreal's eco-neighbourhoods. The agroforestry community landscapes need to be co-built with experts and citizens, the landscape architect being a mediator.
According to the workshop with schoolchildren, the agroforestry garden is both for contemplation and for citizens to be active. There is a wish for wide canopy trees and water elements. These could be rainwater agroforestry gardens with wide trees for shade. The 4th district plot design can be made according to the wishes of the schoolchildren in the 4th district.
In Gödöllő, it is possible to make connections between existing gardens and new potential gardens from institutions like churches and schools. There was no land use map or municipality owned plot available for this city. There are several municipality-owned plots in Szada which are possible to use for agroforestry and connected to the local institutions such as schools and other green spaces. These spaces can also be new local market places with connections to the bicycle lanes.

IV.3.3 Planning and design process for a publicly open agroforestry garden for food and arts along the Rakos creek

Plot in Zuglo- the XIVth district of Budapest

The planning tool used by the district council to implement this urban agroforestry project was the Climate Forest because it avoided change in land use of a public vacant land into a public urban agroforestry garden and was fast to implement. It is a special initiative in the XIVth district of Budapest to create forests in order to adapt and reduce impacts of climate change and enhance biodiversity in the district. Later in 2019, this Climate Forest became part of the Energy and Climate strategy program of the XIVth district. Therefore, urban agroforestry systems can be part of climate and energy strategy plans.

Due to administrative deadlines, a first plantation was made in a short space of time, with a first plantation of 4 fruit trees in Autumn 2018. Another plantation was made in Spring 2019.
The tree species planted were *Sorbus aucuparia*, *Sorbus domestica*, *Tilia cordata greenspire*, *Morus alba*, *Corylus colurna, Malus sp, Pyrus sp, Cydonia oblonga.*
Sorbus species was planted for its resistance to pollution and drought and its capacity in spreading and attracting birds. *Tilia cordata greenspire* was planted for its fast decomposition and high potential for carbon in the soil.

The participative plantation and donations of trees, shrubs, berries and herbs were the key to involve the citizens in the process and for starting a community and appropriation of the plot. The garden was left to the community and was reappropriated by citizens and will become a permaculture park managed by citizens and for education around permaculture.

The method used for planning and designing this plot can be carried out on other plots with a better network between citizen-based organisations. However, more research and attention

should have been made on the watering system. In the process, the master plan (Figure 43, 44) is made with the choice in species by landscape architects and the definition of purposes and practices should be with the citizens and engage participative plantations. The involvement of citizens shows the need in animating the garden and more design techniques could be implemented such as land art. To start a transition to agroecology in cities' governance and strategy plans, the harvesting time and management system should be made both with a scientific and an artistic approach, the district being responsible for the maintenance with the employment of an animator and gardeners. The citizens should participate in the decision-making and in the design, the choice in ground covers and species and the purpose of the garden and their vision. This could be through public consultations about the projects. This needs to be with agroecological principles for biodiversity and social inclusion and also for creativity. In a long term process, with a circular economic system, these gardens could be self-managed and organised by citizens.

Challenges

The main challenge of this project was the watering management. Indeed, the watering depends on the school and should have been better planned. A system could have been created for this purpose with the use of grey waters. There needs to be more research about the regulations on watering systems and management in agroforestry gardens for rainwater retention, collection and distribution. This can be done with participative designs.
A first proposal was made but due to lack of resources and the rising concern from the municipality for plant stealing the project plan was changed. Indeed, a cooperation with the NGO Fökert was planned for providing trees, but this ended at the beginning of the project. A well was also supposed to be provided but due to political disagreements it was not possible. More research needs to be made on the plantation of agroforestry gardens which are low in water needs and a participative watering system design could engage citizens to reuse grey waters. A monitoring plan of the plants also needs to be organised with landscape architects and research institutes.

Figure 43. Proposal for the urban agroforestry project in the Némeprona utca, 2018

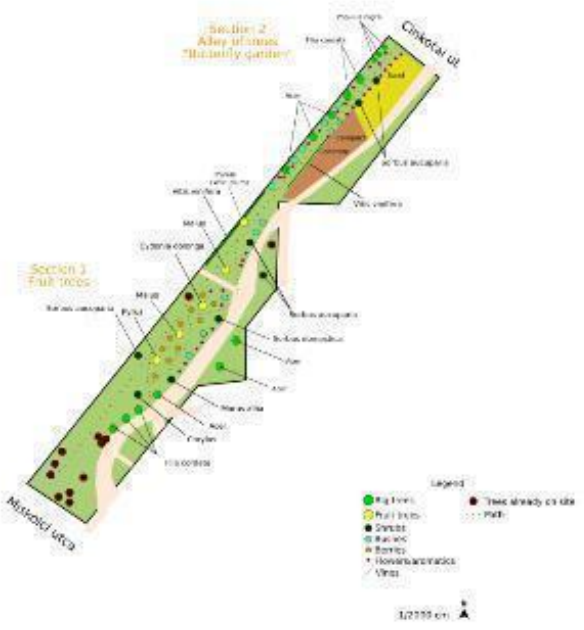


Figure 44. Implemented urban agroforestry project on Németprona utca, Paloma Gonzalez de

A resident from the neighbourhood uses and maintains the garden and organises workshops and the network around the garden. As it is participative, the plantations evolve in time and so does the density of tree canopy. These urban agroforestry gardens can be used for research as well as be public open spaces for citizens.

Soil sample results and possible tree species to plant in urban agroforestry systems

All the samples present a PH level between 7 and 8 so there is no acidity. The highest organic matter was in the Buda campus in the arboretum, second was in Zuglo, under the *Tilia cordata* tree. It is the same for the level of nitrogen. The highest level of phosphore was in the Buda biogarden. The vacant area in the Climate Forest test plot in the 14th district of Budapest has a total of organic matter of 3.4%. The grassland covered with clovers on the Buda campus has a total of organic matter of 2.3% and the lower part of the arboretum has a proportion of 4.4% of organic matter. *Tilia cordata greenspire* shows potential for increasing organic matter in the soil on urban vacant lands compared to the other species. Sorbus aucuparia and Morus alba also show potential.

The proportion of organic matter which could be produced by these tree species was calculated for the average size of a 200 m2 plot with a plantation of 20 trees. The ground cover type and density should also be taken into consideration in the calculation. The management system is also important as mulching adds organic matter to the soil.

Species	**Organic matter quantity per tree with mulching on a residential vacant land**
Sorbus aucuparia	5.6%
Tilia cordata greenspire	7.1%
Morus alba	5.6%
Species	**Organic matter quantity per tree without mulching in an ornamental green space**
Ficus	2.5%
Species	**Organic matter quantity per tree without mulching in a woodland**
Prunus	3.3%
Malus	2.9%

Table 7. Table of the proportion of organic matter generated per tree species with and without mulching on a residential vacant land, in an ornamental green space, in a woodland, in an urban area.

These results (Table 7) show that *Sorbus aucuparia*, *Tilia cordata greenspire* and *Morus alba* have a valuable importance on soil in cities and should be part of agroforestry gardens.

Conclusion on the opportunities and challenges of public urban agroforestry gardens

Some trees could have multipurpose in the city and be more suitable for the urban environment. For instance, *Sorbus* spp. has a high tolerance to urban pollution and has resilient seeds, which can grow in poor soils even after 5 years (Bouton S., Baraton A., 2008). The fruit from *Sorbus aucuparia* attracts birds. Seeds spread out widely and these trees do not require much maintenance. They are also popular in homegardens for their easy level of maintenance and aesthetic value. There is a possibility to connect spaces through exchange of species and seeds, rewilding and multiplication for example with Rosemary. This plant attracts pollinators and can be a good ground cover, it has low cost to plant and grow and can be valuable to use. The management can be made with artistic practices, harvesting and teaching.

The main challenge is the cost for the assessment of the soil. Another challenge is the cooperation between political parties and the definition of the role of different stakeholders for the maintenance of the garden. Finally, the watering system needs to be planned and integrated in urban practices.

Through a bottom-up process in urban agroforestry, there can be a network of local actors for finding resources such as compost and plants. From these local networks, a socio-ecological corridor can be created with agro-districts along rivers and creeks. Therefore, the test-plot can be connected to the whole watershed through agroforestry corridors and a network of gardeners, experts, citizens and farmers. For this matter, an interactive platform or a PPGIS can be a useful tool for connecting the network and for participative planning. Agro-district or agro-neighborhood plans could be made with active drawing, sketching and writing by citizens to create the plot and organise a circular economy.

Vacant residential lands are opportunity spaces for the development of urban agroforestry. Participative plantations in vacant residential areas are a good tool to involve citizens in decision-making, sharing of knowledge and reappropriation of green spaces for their management.

The landscape architects can both ask what the community wishes to plant and make suggestions. The landscape architect helps the communities in the design at the district scale or neighbourhood scale. The landscape architect can also create communities through garden designs with participation in the plantations. The landscape architect plans agroforestry systems first with participation of NGOs and experts at the regional, city and corridor scale and then with participation of citizens at the neighbourhood and district scale.

IV.3.4 Proposal in choosing agroforestry systems and management in the potential public plots in Budapest and Szada

IV.3.4.1. Proposal

The administrative and political boundaries can be an obstacle to creating agroforestry corridors as not all municipalities or districts have the will to participate. The management of local resources and protection of wildlife habitats are necessary. Urban agroforestry planning needs to take these elements under consideration. This is why it is necessary to study possibilities for urban and peri-urban agroforestry at the watershed scale and assess the potential for arts and creativity by communities. A specific and detailed map of the soils needs to be created with soil type, temperature, moisture, organic matter and drainage in order to choose the spaces and species to plant. A landscape analysis with landscape metrics and the use of heat maps and the map of sealed soils can be used to plan. Along the Rakos creek, several different land uses and open spaces were found. The agroforestry system needs to be adapted to the location context and potential risks such as drought, pollution and flood. Urban agroforestry mainly has a restorative purpose and the production should be with ecological purposes such as natural paints and food provisioning.

In order to reduce landscape fragmentation and to equally distribute food and materials to the city, hedgerows are the best urban agroforestry system. They build connectivity in the landscape. They need to be with shrubs and small trees, some herbs, ground covers and wild flowers can be planted underneath. Landscape connectivity of agroforestry systems generates socio-ecological networks between communities, institutions and ecosystems. Cooperation and participative research in planning and monitoring is necessary for analysing watersheds and planning agroforestry systems along the creeks.

Through the map analysis and on-site visits, and from the lessons learnt through the test plot in the XIVt^{h} district of Budapest, it is possible to suggest agroforestry systems on the possible vacant plots in Budapest and Szada , where municipality owned and district owned plots were found, as well as residential vacant lands and brownfields. It is also possible to create an agroforestry corridor with hedgerows to provide equal distribution of food and materials to city dwellers and reduce landscape fragmentation.

The choice in plants can be according to the albedo of the plants, their shade providing and their capacity in fertilising the soil and their purpose for arts. The agroforestry systems should be adapted to the local ecosystems in place and the bioindicators such as nettles which indicate fertile soils.

<u>Dense residential areas with blocks of flats along the Rakos creek in Budapest</u>

The dense residential areas assessed with community gardens along the Szilas creek and along the Rakos creek can be good spaces for urban agroforestry systems such as hedgerows and open forest-gardens for arts. These can be called residential agroforestry hedgerows and

include perennials with wild flowers and/or tinctorial plants. The hedgerows need to be connected to residential areas and institutions for their management. A balance needs to be created between annual crops for food and arts and their management for avoiding rotting. Perennial plants can be planted for artistic purposes and wildlife in the city.
There can be Sorbus species and Tilia species in these hedgerows.

Brownfields

In the case of the brownfields, first there could be a phytoepuration park to clean the soil and then there can be a conversion to an agroforestry park for biomass and arts. Some brownfields need to be left to rewild and can be left for plants to grow naturally. The brownfields used in the city are those from the industrial past, to clean the soil, store water, provide shade and reuse old buildings for local communities. There should also be shelterbelts to protect from winds and soil erosion. Agroforestry can be used for biomass production with the reuse of tree branches from pruning. There can also be plantations for artistic practices.

Brownfields and plots which have a high pollution in the soil and the air due to the proximity to roads with high traffic can't be used to grow edibles. In this case, a possibility is to design agroforestry systems for biomass production for electricity. Biomass is a renewable resource and can provide electricity with low pollution risk. The perception of the participants is an important factor for this because biomass production involves pollarding trees every 2-3 years and can have an impact on the beauty of the landscape. A strategy could be developed to reduce this visual impact and combine other community green activities such as community green walls to reduce noise from the traffic and ornamental species. Some plants can be both unpolluting, valuable and aesthetic. It is the case for example with the Alyssum murale (Reporterre, 2021) or Salix viminalis (Mleczek M. et al.,2010).

The Rakosrendezö train station is located in the 14th district of Budapest, along the Rakos creek. It is a good example of a brownfield which could be used for agroforestry with some limitations. It is a highly polluted and noisy area. It is on a soil type River-Aeolian sand. This brownfield could be greened and valued with agroforestry for biomass production, phytoepuration with Alyssum murale for example and arts with communities. There could be community green walls for mitigating the noise from the traffic. There can also be small ornamental plantations in raised beds and art works in the plot, but there can't be a dense tree plantation due to the polluted air circulation. An interview was made with WWF about the potential development of agroforestry on brownfields for biomass production. There is a need to define the production and collection system. More research should be made for this potential on test-plots. There can be the plantation of trees for biomass production such as Salix in the city. Salix viminalis is good on degraded soil (Mleczek M, et al., 2010). It can be used for phytoremediation and biomass and also woodcrafts. The waste can be used for biomass production.

The case of the Friche la Belle de Mai in the city of Marseille (Figure 45) is an example of an agroforestry system for rewilding and restoring biodiversity on a brownfield. It is a

brownfield next to a railway. The Rakosrendezö brownfield can also leave areas for rewilding and simple restoration purposes with a natural plant succession.

Figure 45. Photo of the brownfield La Friche la Belle de Mai, Paloma Gonzalez de Linares

It can be mixed with art practices.

Public vacant lands

13th district plots in Budapest

These plots can be connected to the local green infrastructure plan of the 13th district. On the plots in the 13th district we can grow products for art purposes such as tinctorial plants as well as fruit trees and berries and herbs. There needs to be an assessment of the soil for adaptation and decision-making. There needs to be a good management of compost and runoff to avoid pollution of the water, there could be a buffer strip. In case of contamination and pollution there are alternatives and restrictions: no salads, no cabbage. An agroforestry garden can be created on these two sites:

- *Plot between Reitter Ferenc utca and Szent Laszlo utca, 13th district*

This could be a space for agroforestry for art purposes and therapy. The trees and other plants need to be adapted to floods. It could take the form of a flooded hedgerow. There can't be any wide canopy trees due to the electric lines. Therefore, it is not possible to plant a forest-garden.

- *Plot between Váci road and Madarász Viktor street*

It is for leisure and can be an agroforestry garden for arts, education and therapy.

Figure 46. Photo of the alleys of trees, Paloma Gonzalez de Linares

The hedgerows need to be at a 3m distance from the paths to avoid falling berries and fruit on the paved paths. They can include shrubs and berries and be watered by grey waters from the residents.

There can be a continuous alley of edible agroforestry hedgerows with wild flowers and/or tinctorial plants, adapted to floods along the Rakos creek in the 13th district. A soil evaluation needs to be made. The figure 46 shows the potential space for hedgerows.

The scenario designs for the 13th district can be integrated in the local green infrastructure plan of Budapest.

Along the Szilas creek

The Szilas creek corridor presents potential areas for agroforestry in the 4th district, which is a public space belonging to the City of Budapest, and along the recreational cycling trail which goes along the creek. It is also a place for dog walking, jogging, rollerblading and more. On this recreational path there are vacant lands marked as woodlands which could be areas for picking and spaces for resting with shade.

Plot at the source of the Rakos creek in Szada

The municipality owned plot at the source of the Rakos creek can be used for planting an agroforestry garden including a forest-garden and vitiforestry for the production of grapes.

There can also be biogas production from the waste from urban agroforestry systems, homegardens and organic waste from the cities. This can be for transport like in the case of Sweden. An agroforestry park can be created on this site due to the width of the plot and the possibility to mix tree species, vines and crops. There can be at least 3 tree family species and mainly perennials with the proximity to wildlife habitats and woodlands. In this environment, the chipped wood and branches from the woodlands and the leaves can be used in the agroforestry park.

Conclusion for co-creating an agroforestry corridor along the Rakos and Szilas creeks, opportunities and challenges

The agroforestry corridor brings together several agroforestry plots managed by citizens and cities. These can be for food and/or for arts. A first landscape assessment needs to be made with landscape metrics and the use of heat maps and sealed soil maps to define priority spaces to plant. Then, an assessment of the soil and green cover need to be made and after, a PPGIS and participative designs through drawing can be made. Developing urban agroforestry has several challenges. First, there is a diversity of land uses and functions in the city which make it complex to plan agroforestry. Second, there is a need to consider wildlife protection and management. For example, along the Rakos creek is a high population of wild boar and red-deer and beavers. So, the choice of tree species and other layers of vegetation needs to be measured carefully to avoid too much attraction, as well as not disrupt the natural ecological balance of the area. By choosing specific trees it is possible to influence biodiversity and attract or repel species of fauna and flora. In urban and peri-urban agroforestry there also needs to be support from the local governments, policies and administrative boundaries and soft measures to mix forestry and agriculture on the same unit of land.

Participation is important for the design and creativity with biodiversity in the agroforestry plot and to create an engaged community to look after the management of the plot and spread agroecological principles, both on public open spaces and private open spaces. When planning and designing agroforestry on an urban farmland, it is needed to consider the economic aspects of the production and the management. The more biodiversity and species on the land, the more knowledge, monitoring and expertise is needed.

For public participation, mapping through a PPGIS increases community bonding and exchange of experiences and knowledge and links science and arts with a bottom-up approach for social inclusion in planning and design. The PPGIS is a good tool to respond to local issues such as the management of invasive species, the connection to institutions and the creation of networks between plots and schools. However, it requires technological knowledge and can be a long process. Some alternative interactive maps should be created to involve citizens, community gardeners and farmers in the process. Once the planning is made and the keyline design is created by the Landscape Architect, there can be participative designs at the human scale with creativity for the plantation for example with the involvement of psychologists and social workers to include the homeless or a garden animator. There is a need to include and co-build local green infrastructure programs with citizens and NGOs to increase and exchange knowledge about biodiversity. For the agroforestry corridor there is a need to overcome administrative boundaries and political limits, to plan at the watershed scale and bioregional scale and have a participative planning and design process to create local communities and agro-districts or agroforestry neighbourhoods in the frames of the eco-neighbourhoods of Montreal. Through participation and cooperation it is possible to learn more about biodiversity and assess it on the field and monitor landscapes. Participative

planning and design is important for education and exchange of knowledge to build resilient communities in the face of climate change; for community-building and maintenance of the landscape. Participating in designs of gardens and plantations can also be therapeutic, to take action in the face of climate change, and a tool to build resilient communities.

Agroforestry plots can be in public spaces and also in urban private gardens, on brownfields, in former woodlands and on farms. Some brownfields need to be left to rewild. The brownfields used in the city are those from the industrial past, to clean the soil, store water, provide shade and reuse old buildings for local communities. Residential areas are good opportunity spaces for public forest-gardens and shelterbelts. Public institutions can be spaces for therapeutic and educational agroforestry systems.

The purposes of urban agroforestry are rewilding, protecting, restoring landscapes and biodiversity, providing shade, transfer and share of knowledge, contemplation, therapy and social inclusion through food production and arts.

This practice is also important for the protection and rehabilitation of urban soils. Indeed, most cities are built on fertile land and the compaction and soil sealing lead to the loss of soil resources, therefore loss in organic matter and biodiversity and also threat in flooding and reduction in water infiltration on productive lands, which lead to the loss of harvest. Soils are important resources in the city for carbon storage (INRAe, 2019). It is important to add mulch and carbon to the soil with compost and organic animal manure. From field experience, with a strategic network, it is possible to use local resources within the city and its periphery, thanks to a network and thanks to exchange of services between farmers and foresters and community gardeners. Urban agroforestry isn't just about a land plantation and culture, it is about a socio-ecological network.

When planning agroforestry there must be an ecological and economic interaction in the ecosystem and social needs. Urban agroforestry creates spaces of production and consumption. There is an economic diversity with trees, flowers and crops for food production and arts. The type of tree and its purpose and consumption will have an impact on the landscape. There also needs to be agroforestry spaces for restoration, contemplation and shade. The main challenge in urban agroforestry is how to fund it and maintain it economically. It requires new reflections on the local economy and circular economy. Research in forestry and agriculture are required to choose the tree species and monitor the productivity and companion planting efficiency. Combining community plots with research creates good opportunities for funding, exchange of knowledge and long-term assessment of the resilience of the plot. There is a need to consult farmers and involve them in the decision-making and economic research. Agroforestry systems can be a good tool for transition in agricultural economy and ecological landscapes especially with the rehabilitation of soils and better management of water. Urban and peri-urban agroforestry are linked with human ecology. A circular economy can be created with local resources and reuse of green waste based on interactions and exchanges within the city. Linked to a corridor with bicycle lanes and pedestrian areas, urban agroforestry development and production can be less

dependent on import of materials and petrol. The city green waste, compost and soil can be reused in these urban agroforestry gardens and parks.

Urban agroforestry gardens can lead to the creation of an agro-district with a socio-ecological network between other gardeners, residents, the district council and market-spaces. An agro-district is a district with an agroforestry plot connected to different market spaces in the district and institutions and community organisations.
The challenges for expanding from an agroforestry garden to an agroforestry district or neighbourhood are the watering system and the costs for assessing the soil and providing public trees. There is also the cooperation between different political parties which can be a limit to creating agroforestry gardens and include them in a corridor. This is why encouraging community-based organisations is necessary. The landscape architect can be a mediator between decision-makers and citizens and assess the landscapes for implementing agroforestry systems. Through a bottom-up approach it is possible to have a diversity of agroforestry gardens and connect them through a network at the corridor scale. The schoolchildren and school could have been included in the design of this agroforestry garden in the 14th district and a better definition of the role of the different stakeholders needed to be made for the maintenance and the monitoring of the garden.

The agroforestry plantation and purpose depends on the conditions of the soil and the land use and ownership. This is why transfer of knowledge and education on biodiversity through participative planning and design and gardening workshops are important. The planning strategy of the agroforestry systems should be based on the soil conditions and characteristics through soil sampling, GIS analysis and mapping. Then the green cover should be defined for specific spaces and areas with an ecological continuity between green spaces and agroforestry gardens.

An assessment of the plots needs to be made:

1) soil characteristics (assessment of the pollution of the soil, organic matter, texture)
2) existing ecosystem (assessment of living species on the plot and neighbouring the plot, above ground and in the soil)
3) presence of plants (assessment of plant species and their indication on the soil)
4) demography (assessment of residential and public institutions and infrastructures neighbouring the plot)
5) presence of parks, gardens and markets to connect with the plot for a socio-ecological and economic network

There are technical aspects to consider when choosing the plants and the management system of the soil and the water resources:

1) the soil texture and contamination for water management and to assess the need in depolluting the soil
2) the soil drainage for water management

3) the fertility of the soil
4) the soil organic matter and moisture
5) albedo of the plants for their capacity in reflecting sunlight and heat
6) resilience to heat and demand in water
7) shared economic outcome from protecting, producing and transforming the public goods and resources

There can be bioindicators when planning urban and peri-urban agroforestry: soil quality, species on the site, species adapted to climate change with scenarios for 30-40 years. Testing the soil quality of the land is costly, there needs to be a funding solution for it or participative sampling.

There are also artistic and aesthetic aspects in choosing the plants and designing the agroforestry system:

1) Land art can be a community bonding and landscape design activity related to urban agroforestry
2) Perspectives in the landscape can be considered for tree plantations
3) Colours can be considered for the aesthetic aspects, seasonal changes in the landscape
4) Architecture of the plants can be considered to design plant beds, hedgerows and accessibility to productive trees and shrubs

According to the test-plot in the 14th district of Budapest, an agroforestry garden can start at least with 200 m2 plots with trees, bushes and crops that a community can use to cultivate, teach and organise artistic activities in.

The best urban agroforestry system is hedgerows to equally distribute local resources in the landscape, adapt to the different land uses and risks and create corridors. They can also reduce wind and soil erosion, distribute shade and goods in the landscape, protect biodiversity, fertilise the soils and create corridors. The agroforestry plots and hedgerows can be part of an agroforestry corridor concept that would also be for arts and culture as well as biomass, mulch and picking. Urban agroforestry parks, gardens and farms would be spaces of creativity and could include workshops with local production in the city for different purposes. A socio-ecological network can be made between urban agroforestry community gardens and traditional community gardens by planting similar species and also exchanging and multiplying plantations. For example, one Rosemary plant can be multiplied on the same plot or between other plots. Citizens can participate in the design through artistic practices, participatory mapping like a PPGIS and sketches. A call to plan and design at the neighbourhood scale needs to be made. The assessment at the watershed scale needs to be made by researchers and experts and transferred to the people. The management of agroforestry plots with arts and teaching helps in maintaining the plot and monitoring.

From the interviews, test-plot process and workshops, a new governance system needs to be thought of with planners, decision-makers, public institutions and citizens. The landscape architect needs to collect scientific information about the existing biodiversity on the sites and for the development of agroforestry corridors with alley cropping, forest-gardening and hedgerows. Forest-gardens are useful to enhance biodiversity in the city and create spaces of shade and fertile lands. Information such as the presence of species, birds and wildlife habitats can be collected from a cooperation between cities, NGOs and research institutions. An on-site analysis needs to be made as well to make a diagnosis of the plot and its surrounding neighbourhood. The choice in species and agroforestry systems is based on the scientific information and maps such as heat maps, land use maps and the present and future plans for public transport and smooth mobility. We don't just need to plan more green spaces, but we need more diverse green spaces which would be interconnected in a network to safeguard land for future settlement. It can be appropriated by citizens for different uses: social inclusion, education, therapy, forest bathing and land art. Agroforestry shouldn't just be integrated in green corridors but should be planned as a strategy with a clear definition of the shared resources and protection of resources and adapted species to the cities and a network in order to feed and green the cities of tomorrow and encourage the transition toward agroecological food systems and therapeutical or slow systems for better management in time and well-being.

Some species are not recommended in the planning and design of urban and peri-urban agroforestry. This is the case for bioaccumulating species and invasive species. Bioaccumulating plants are plants which accumulate contaminants. Indeed, some edibles need to be avoided such as cabbages as they accumulate soil pollution.
There needs to be a diversity of species and agroforestry production in the city and the peri-urban lands. This is possible with a rotation of the cultures and the plantation of diverse perennials.

Other species can be planted in cities for their purposes: tinctorial plants (trees, bushes, flowers), wide canopy trees (*Tilia cordata 'Greenspire', Castanea sp.*), fruit trees (S*orbus domestica, Sorbus aucuparia*), shrubs (*Corylus colurna, Arbutus unedo*), berries (Ribes sp.), ground covers *(Portulaca oleracea*, herbs and aromatics), wild flowers.

Criterias for selecting species for urban agroforestry:

- Condition of the soil (pollution rates and properties)
- Temperature of the soil
- Urban heat islands
- Management (number of users, water conditions, local green waste resources)
- Ownership (public design or private design)
- Accessibility of the plot by smooth transport (leave difficult accessible lands to rewild naturally, privilege easily accessible plots)
- Topography of the plot
- Land use (brownfield, old woodland, old agricultural land, residential land)

- Non toxic
- Non invasive
- Low risks in allergies
- Low risk in accumulation of pollution if edible purpose

Selection of the species which can be planted with their social and ecological purposes:

Tree species
Morus kagayamae (shade)
Morus alba (edible)

Shrub species
Corylus colurna (edible, tinctorial)

Flower species
Annual flower: *Tagete patula* (tinctorial)
Biennial flower: *Isatis tinctoria* (tinctorial)
Perennial flower: *Calendula officinalis* (tinctorial)

V. CONCLUSIONS AND NEW SCIENTIFIC ACHIEVEMENTS

V.I Conclusions

From this research I conclude that the main role of urban agroforestry is education with transfer of knowledge. The process to plan and design agroforestry gardens should be participative to assess the social and ecological purposes of the agroforestry systems according to the demographic, climatic and soil context. Art practices should be included for social inclusion and the plantation. The artistic approach can be with the design strategy such as land art and with the plantation of tinctorial plants. These tinctorial plants can be used on brownfields, in vacant lands and in hedgerows. Urban agroforestry can also be a solution to value and reuse green waste such as branches and leaves, dried flowers for artistic practices.

From this research several conclusions can be made and lead to guidelines for planning and designing agroforestry systems and reflect on the role of the landscape architect. The importance of the soil for planning and designing urban agroforestry systems was stressed through this thesis research. It is the most important element for landscape architecture. Then the transfer in knowledge about plants and biodiversity is important through landscape planning and design at a community scale.

The steps in planning urban and peri-urban agroforestry are:

1. **Plan at the watershed scale** in the green infrastructure plan: plan along rivers, creeks and water areas. Use heat maps to choose the agroforestry system for example to plan vitiforestry and species, the watering system and prioritise areas, use the keyline design, plan rainwater harvesting sites and phytoepuration with agroforestry gardens, parks and linear residential agroforestry hedgerows. Plan the green belt and community agroforestry gardens. Assess the landscape with landscape metrics.
2. Involve citizens at the **neighbourhood** scale and create agro-neighborhoods or agro-districts : create socio-ecological networks for resources such as green waste and management for agricultural landscapes such as hay, manure, plants and seeds.
3. Create socio-ecological agroforestry corridors with public participation through **participative mapping, sketching and drawing**: create the management plan for green waste and paths between the plots, meet with decision-makers, involve schools.
4. Design from the scale of the soil and existing ecosystems and vegetation.
5. Prioritise enclaved spaces and neighbourhoods with high heat stress rates.
6. Administrative boundaries need to be overcome to plan at the watershed scale. There needs to be cooperation between cities, researchers and citizens.
7. Planning at the watershed scale is also to manage wildlife habitats and corridors.
8. Socio-ecological corridors can be carried out with networks through education, training and participative designs.
9. Communication between plots and exchange of knowledge.
10. Exchange of knowledge and research in plant species and monitoring between researchers, engineers and citizen-based organisations with on-site practice and experiences. The landscape architect collects the information and transfers the information through his/her designs and with participative workshops.

Guidelines can be drawn for the plantation of species:

1. Landscape architects need to plan and design from the existing ecosystems, especially the soil conditions and characteristics.
2. The choice in species is according to the site location, the soil, the context and the purpose.
3. New species shouldn’t be introduced in protected areas. It should remain protective and with endemic species.
4. Several trees, bushes, ground covers and flowers could be explored and planted for artistic purposes with environmental benefits in urban agroforestry systems.
5. The choice of species can be according to the albedo of the soil and the species already present on the site.
6. The Sorbus domestica and Sorbus aucuparia can be good multipurpose trees for cities because they are useful for stabilising slopes, they are resistant to drought and air pollution and are also useful for attracting birds in the case of Sorbus aucuparia or as a fruit tree in the case of the Sorbus domestica. The wood is also useful for woodworking. They can be planted in hedgerows.
7. Tilia species are good to plant in urban hedgerows.

8. Alyssum murale could be used for depollution on brownfields, to take away heavy metals especially nickel. It can be a green cover on spaces where production is impossible and in vacant lands close to high traffic roads.
9. The Robinia pseudoacacia woodlands shouldn't be used for paths because it can contribute to spreading the seeds.
10. The drawings from the workshops with the schoolchildren reveal that there need to be mainly water elements, wide canopy trees and green extensive covers in agroforestry garden and park designs.
11. Tinctorial plants can be planted.

The limits and challenges are:

1. No high pollinator attractors near jogging paths and sports areas. There needs to be a balance between the gardening activities and the other recreational activities.
2. Areas near high traffic agroforestry could be used for landscape restoration and biodiversity conservation and be an ornamental plantation.
3. Fruit trees should be avoided along paved paths or be planted so the fruit doesn't fall on the paved path.
4. According to the interviews, the main challenges are social inclusion for homeless and refugees and wildlife management. In the face of climate change, geopolitical instabilities and economic disparities, these issues need to be solved.
5. Vitiforestry needs to be planted at a far distance from high traffic and urban heat islands. It is best located in peri-urban areas.
6. Avoid the introduction of cows, they should stay outside of the city, in peri-urban areas because of methane and trampling.
7. Go from the existing species identified to plan, such as indicators of soil fertility.
8. Include agroforestry engineers in the process to plan the system.
9. Decision-makers need to find new participative planning tools to renew landscapes with agroforestry and build socio-ecological corridors and networks. The PPGIS is a solution for this matter.
10. New regulations need to be made by planners for the design of the water management systems of these agroforestry plots.
11. Landscape architects need to work with agronomy engineers in order to calculate the quantity of production which can be grown on a unit of land and plan the plantations.

The landscape architect has several roles to play in urban and peri-urban agroforestry.

He/she:

1. Finds land for agroforestry systems by using maps and with on-site analysis.
2. Assesses the urban soil and works at the plot scale to choose the agroforestry systems and species.
3. Makes concepts, sketches and designs with research in species and companion planting and according to the land use, the watershed scale, the location of the plot and local context of the climate, pollution and soil.

4. The landscape architect needs to plan, design and monitor the plantations with participation of researchers and institutions for social purposes and wildlife management.
5. Can play a role in connecting community-based agroforestry systems through creating socio-ecological corridors with agroforestry systems.
6. Can be a mediator between organisations and decision makers and citizens. Landscape architects are mediators between the regulations and on-site ecological, social and economic needs.
7. Provides and co-designs new spaces for arts with agroforestry systems with involvement of citizens.
8. Is also an artist and uses different mediums to communicate on designs and share knowledge. He/she can develop land art with urban and peri-urban agroforestry.
9. Renews landscapes with agroforestry for artistic purposes with involvement of citizens for the transfer of knowledge.
10. Needs to cooperate with agricultural engineers, decision-makers, farmers and citizens to organize the functions of the agroforestry systems and the management. With a participative method, the landscape architect plans resources around the plot and the network. He/she listens to the citizens and creates the master plans from exchange of knowledge and participative projects.
11. Has a role in education about trees and species to plant in cities and to renew landscapes with agroecological gardens and arts. The landscape architect can transfer knowledge and teach about trees and companion planting through the designs.
12. Makes keyline designs.
13. Leaves spaces for expression and participative planting and design by citizens. These spaces can be included in hedgerows.
14. Makes connections between technical and scientific research and arts in the designs.

<u>The landscape architect faces several limitations:</u>

He/she is limited by the fact that agroforestry and urban agroforestry are not a land use. This means that it is difficult to find long term plots for these practices. The watering management regulations need to be made and authorised by decision-makers. The emergency and challenge for the landscape architect is to find adaptive watering systems and species adapted to heat and drought and also mitigate desertification when it is present. More participative planning tools need to be created for involving citizens, NGOs decision-makers and experts with inspiration from the PPGIS method. Another tool such as a platform could be created for this purpose. The landscape architect can make suggestions to manage invasive species with experts. The plot needs to provide space for free plantations with some restrictions such as no poisonous and non-invasive species.

<u>Governance system:</u>

The landscape architect is a mediator between decision-makers and citizens. Decision-makers and city planners cooperate with researchers, agronomists and naturalists and with citizens, community gardeners and schools. The PPGIS and participative designs are used to involve citizens in the planning and design of agroforestry systems with waste management, water management, creation of paths and networks for resources. The Landscape Architect works

with local garden animators for defining the management strategies and the self-organisation of the garden. Citizens also take part in participative planting and the maintenance of the plots. The city provides public land for cultivating with agroforestry systems.

Methodology for co-designing urban agroforestry gardens

From the interviews and the test-plot a methodology for co-designing landscape agroforestry landscapes can be created.

The people involved are experts, NGOs, community gardeners and voluntary citizens and institutions such as schools. There needs to be an assessment of the needs and wills and some workshops to express interests in agroforestry systems and imagine them. They can be designed in many different ways and enhance creativity in the city with exchange of knowledge.

Limits of the research

This research has some limits due to the lack of time. First, more farmers could have been included in the research to develop the peri-urban agroforestry systems and discuss the species which could be planted in goal 3. The perception of agroforestry from the farmers could be assessed and they could be connected to the urban gardens and the agroforestry corridor project. Second, the economic aspect needs further development but the potential for a circular economy and new economy based on local urban and peri-urban production was revealed. Third, more assessment of the soil needs to be made for defining more possible plants for the agroforestry systems. Finally, the watering management needs to be discussed in a participative way between decision-makers, researchers and local NGOs and citizens.

Further research

The limits to the research lead to further needs and possibilities for research for the evolution of the agroforestry corridor concept. Mainly, the research in the economic and watering systems and selection of species resistant to drought for agroforestry gardens need to be made for planning and design of urban agroforestry gardens.

Finally, landscape architects could explore deeper knowledge about urban soils to define the plantation systems and species which would be adapted to the land.

V.2 New scientific achievements

Thesis_1: Definition of urban agroforestry

From the summary of the different benefits of urban agroforestry and its purpose in the literature review with the terminologies, I defined urban and peri-urban agroforestry.

Urban agroforestry links urban agriculture with urban forestry to create multipurpose green spaces in the city not only for production but also for well-being and therapy. Urban and peri-urban agroforestry are a practice where citizens grow local products in the city with

agroecological principles for social and ecological purposes. Woody perennials are planted with non woody perennials in the city, with economic, environmental and social outcomes, like employment, productivity, social inclusion, solidarity economy, education, nature restoration and biodiversity. Peri-urban agroforestry is the implementation of agroforestry systems in the urban fringe and peri-urban areas for food, energy and medicinal production with an economic, landscape and socio-ecological interaction with the cities.

Urban and peri-urban agroforestry are interdisciplinary and include human ecology with a reflection on the management of resources. It is not only about producing, it is also about well-being and creativity with biodiversity in the city. Peri-urban agroforestry systems need to be linked to the urban agroforestry systems through landscape architecture research, for instance with a bioregional scale approach.

Thesis_2: Elaboration of a model for strategy planning of urban and peri-urban agroforestry in green infrastructure

From the questionnaires and location analysis of the four European cities in goal 1, I defined a model for strategy planning of urban and peri-urban agroforestry.

Based on my research different types of agroforestry systems can be created, in underused spaces and old farms, in a network in the urban and the peri-urban regions.
Agroforestry corridors could be created and included in the green infrastructure plans with connections between different cities, cores and patterns in the landscape such as prairies and other existing wildlife habitats. The model created (Figure 47) needs to be applied at the watershed scale for the protection and management of water resources and finding the best locations for agroforestry systems. At the city scale, urban agroforestry is useful for reducing pesticides and pollution in water, valuing old fruit tree cultivars and traditional agricultural landscapes, providing local food and for education purposes. Urban vacant lands are opportunity spaces for greening with agroforestry systems and educating. Edible belts can be created, including different agroforestry systems. Urban and peri-urban agroforestry should be part of green networks with different agroforestry systems such as forest-gardens, alley cropping and orchards in core areas. Agroforestry systems can be implemented in corridors and provide food and resources to cities and within the surroundings of the cities. There can also be urban forests, but these need to be continuous and can create mixed patterns with urban agroforestry plots within cities. Agroforestry systems can be used to renew traditional landscapes and species and be part of urban forestry plans to protect urban water from pesticides. The outskirts of the cities should be protected with natural wildlife habitats.
Urban agroforestry also needs to be planned in enclaved neighbourhoods to create networks and open spaces to a green and blue network.
Urban and peri-urban agroforestry should be embedded in planning agendas and regulations as a land use and part of green infrastructure planning with a bottom-up approach through educational programs with participation of citizens and at the watershed scale for water management and a landscape analysis. The farmers should be included in the peri-urban areas in the agroforestry green infrastructure plan.

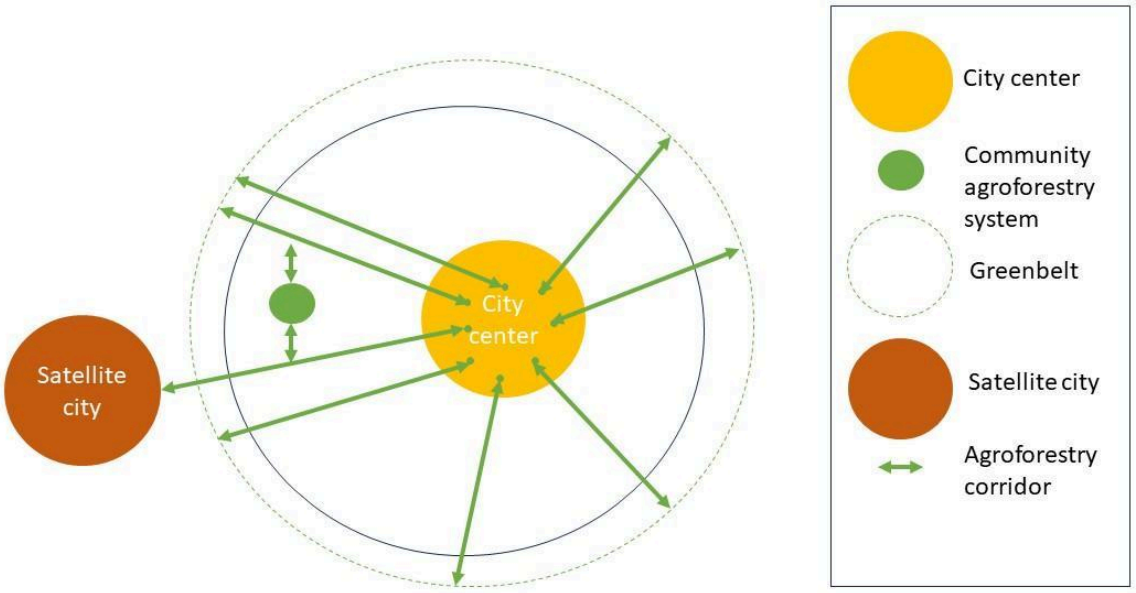


Figure 47. Model for urban and peri- urban agroforestry planning, Paloma Gonzalez de Linares, MATE, 2022

Thesis_3: **Definition of design principles and practices in urban agroforestry gardens**
Based on common findings through observations and semi-structured interviews in urban agroforestry gardens, I defined practices and principles for the design of urban agroforestry gardens and their impact on the urban landscape

Urban agroforestry gardens are plots with a high diversity of trees, bushes and crops from different families and varieties, that a community can use to cultivate, restore and recycle green waste, teach and organise therapeutic and artistic activities in, with participative designs. They don't have defined plots for single families but common growing food and materials with a common management system , based on companion planting. The watering system which is mainly privileged is rainwater harvesting and automatic watering systems. The plots are connected to other gardens and surrounding fields, on residential or institutional ground. They are spaces managed with a circular system and need socio-ecological networks to collect, reuse and exchange resources.
Even if urban agroforestry gardens are based on common principles, they can differ in their spatial arrangement and design, which makes each garden unique and creates a high diversity of gardens in the landscape.
Participative designs use smooth communication tools such as drawing and sketching. By providing spaces and tools for cooperating in designs for urban agroforestry, more resilience of communities is possible and common strategies can be created to adapt to climate change and monitor the landscapes and plants. Urban agroforestry plays a role in education and transfer of knowledge for adapting to climate change, observation and understanding of natural ecosystems and participating in the creation of gardens with different artistic and expressive approaches. Participating in designs of gardens and plantations can also be therapeutic, to take action in the face of climate change.

The potential for agroforestry to be a tool to mitigate fires through permanent management needs to be more assessed. However, it is a solution for maintaining ecological corridors.
What needs to be planned and monitored is water management and the adaptation of trees to climate change. These gardens show that agroforestry systems can be integrated in existing green environments and be part of ecological corridors in cultural agricultural landscape heritages. More research should be made to plant ground covers and reduce heat stress. Agroforestry can be a solution for the economy of water, with rainwater harvesting, automatic dripping pipes, a choice in perennial species which don't require much water and a work on the soil through mulching.
Urban agroforestry is a strategic method to open spaces, even with small parcels to a circular economy and transfer of knowledge. The circular economy and agroforestry designs from these case studies can be spread to the whole city plan and design with a strong network for finding and exchanging resources, maintaining and renewing traditional agricultural landscapes.

Thesis_4: **Creating socio-ecological corridors with urban agroforestry through participation and cooperation**
From the experience of the test-plot and the participative planning of an agroforestry corridor in goal 3, I can state that urban agroforestry creates multipurpose green spaces in the city with participation of citizens to create socio-ecological corridors and agro-districts

Socio-ecological corridors are to link social needs with the proximity to nature and protection of biodiversity. Socio-ecological corridors can be created through the renewal of vacant lands, public open spaces and brownfields. According to the third goal, creeks, rivers and streams are good spaces for connectivity between rural, peri-urban farms and urban agroforestry gardens and creating corridors through planted hedgerows with equal access to the urban agroforestry gardens which provide shade, food and materials to citizens. There should be equal access to the hedgerows and gardens with their proximity to inhabitants and their ergonomic design. This is why it is important to cooperate and co-design agroforestry systems, to answer as many social and ecological needs. The common hedgerows should not be difficult to manage by planting species which don't require a lot of water and maintenance (privilege trees, aromatics, wild flowers), avoid annual crops (keep these for the gardens). Urban agroforestry gardens also need to provide spaces of shade and depend on a fine assessment of the climatic context and the soil. Therefore there need to be wide canopy trees for shade included in the garden. For the planning and design strategy plants for urban agroforestry, tinctorial plants are suggested to be planted for artistic purposes with social inclusion and ecology.
Urban agroforestry plantations and spaces need to be integrated into existing land use plans which makes the planning process complex. The plantation will be different according to the land use type and the quality of the soil. There is also the need to take into account the proximity to water to avoid contamination. There is also the need in caring for the connectivity of the agroforestry plots with other green spaces in the city and to farms in the peri-urban areas. A reflection on the mobility between these areas is necessary with smooth

mobility and public transport. Peri-urban agroforestry is for food provisioning to cities and for farming with proximity to cities. The economic balance and viability of urban and peri-urban agroforestry needs to be assessed.
There can be a diversity of social purposes for urban agroforestry gardens and they have to be participative designs for social inclusion. A base map for public urban agroforestry plots in Budapest could be made from interviews with decision-makers and the assessment of the land use map. With participative mapping tools such as a PPGIS, it is possible to involve citizens, decision-makers and NGOs in the planning and design of agroforestry plots with the definition of paths and resource management strategy plans. Drawing and painting tools are useful for exchanging ideas and decision-making and sharing and exchange of ideas. The youth need to be included in the decision-making through sketching and drawing. Also, local tinctorial plants can be used to create the designs.
When co-creating urban agroforestry gardens it is important to define clearly the roles of each stakeholder and to build a long-term cooperation with NGOs and institutions which work in social inclusion, health, ecology and biodiversity protection. There are several challenges in building community-based agroforestry corridors such as the wildlife management and the accessibility to softwares and the available time of each participant. There needs to be a social map of districts or neighbourhoods to use for planning urban agroforestry plots and defining priority spaces and social purposes.
These urban agroforestry gardens integrated in their districts or neighborhoods for socio-ecological purposes can be spaces for finding information, materials and connecting neighbours and lead to the creation of agro-district, connected through the corridor for learning and exchanging ideas and knowledge. They can also include the connection to local market spaces.

Thesis_5: **From the three goals I can define the different stakeholders in urban agroforestry and their roles**
The main role of urban agroforestry is education with sharing, exchanging and transfer of knowledge for social inclusion, reducing spatial segregation and disparities in the face of climate change.

The main stakeholders in urban agroforestry are decision-makers, planners, landscape architects, research institutes, agroforestry engineers, institutes (schools, hospitals, care homes, homeless shelters) and citizens through NGOs or public consultations and participative designs and plantations.

1. <u>Finding the place and planning of urban agroforestry gardens</u>
   The decision-makers provide the land according to the planning from planners and landscape architects based on the pedoclimatic conditions, accessibility, heat map, land use map, brownfield assessments and infrastructures. Through cooperation with institutes, the landscape architects define the purpose of the suggested agroforestry plantations and their management system. They can also define a management plan for collecting and reusing green waste for example for artistic purposes.

2. Creation of urban agroforestry gardens
   On public lands, landscape architects cooperate with agroforestry engineers, research institutes in nature protection and social sciences to ensure protection of biodiversity and social inclusion. Citizens can participate in the design process through drawing and painting methods and the plantations. The Landscape Architect transfers knowledge through his/her designs by reusing and recycling spaces with urban agroforestry. The species need to be adapted to the local climatic context and soil and reduce heat stress.
3. Management of urban agroforestry gardens
   The managers of the urban agroforestry gardens depend on the ownership (institution or public) but can be organised by a garden animator, public gardeners or civic organisations. On public lands, the city council or district council should communicate the events of the garden in partnership with the gardeners.
4. Monitoring of urban agroforestry gardens
   The monitoring of the plants is required. It should be by agroforestry and forestry research institutes in cooperation with the landscape architects and citizens.

Thesis_6: **Elaboration of the guidelines for planning and designing urban agroforestry**

Based on the results of the three goals which include interviews, landscape analyses, urban agroforestry garden observations and experience with a test-plot and a participative planning for an agroforestry corridor, I defined guidelines for planning urban agroforestry and the scale.

I have defined several guidelines as well as limits and challenges to urban and peri-urban agroforestry.

1. **Integrate urban agroforestry systems in the watershed scale and bioregional scale** through cooperation, a landscape and urban diagnosis and mapping tools to collect information about the biodiversity in the landscape. Some brownfields need to be left to rewild. The brownfields used in the city are those from the industrial past, to clean the soil, store water and provide shade. There should be shelterbelts to protect from winds and soil erosion.
2. **Assess the landscape** and prepare for planning and design and monitoring. Assess the contexts of the spaces with land use, infrastructure, heat maps, sealed soil maps and green cover maps as well as on-site analysis and collection of existing plant species.
3. Build networks through socio-ecological agroforestry corridors with urban agroforestry gardens with public participation through a **participative mapping and design strategy such as the PPGIS at the city scale to connect different institutions and neighborhoods to the gardens, define the purposes of the agroforestry systems, cooperate and involve citizens in the design, share knowledge and organise the maintenance system**: create the management plan for invasive species, green waste and paths between the plots, meet with decision-makers, involve schools. For the agroforestry corridor there is a need to overcome

administrative boundaries and political limits, to plan at the watershed scale and bioregional scale and have a participative planning and design process to create local communities and agro-districts or agroforestry neighbourhoods in the frames of the eco-neighbourhoods of Montreal.

4. Involve citizens at the **neighbourhood** scale and create agro-neighborhoods or agro-districts with accessible tools and materials such as sketching and painting materials with tinctorial plants. This will encourage the creation of socio-ecological networks for resources and management for agricultural cultural landscapes such as hay, manure, plants and seeds. Based on experience, there needs to be a definition of the leader of the community urban agroforestry garden and to define his/her role.
5. Design from the **scale of the soil** and existing ecosystems and vegetation.
6. Exchange of knowledge and research in plant species and monitoring between researchers, engineers and volunteers with on-site practice and experiences. The landscape architect collects the information and transfers the information through his/her designs.

Landscape architects need to plan and design from the existing ecosystems and prioritise enclaved spaces and neighbourhoods with high heat stress rates.

Some species are recommended for cities. The *Sorbus domestica* and *Sorbus aucuparia* can be good multipurpose trees for cities because they are useful for stabilising slopes, they are resistant to drought and air pollution and are also useful for attracting birds in the case of *Sorbus aucuparia* or as a fruit tree in the case of the *Sorbus domestica*. The wood is also useful for woodworking. They can be planted in hedgerows. Tilia species are good to plant in urban hedgerows. Vitiforestry needs to be planted at a far distance from high traffic and urban heat islands. It is best located in peri-urban areas. Tinctorial plants should also be included in urban agroforestry gardens and peri-urban agroforestry farms. The Landscape Architect needs to prioritise species which are not toxic or with high allergy risks.

The landscape architect has several roles to play in urban and peri-urban agroforestry.

He/she:

- Makes a diagnosis of the landscape in the city to choose the species and the systems.
- Assesses the soil and the landscape of opportunity spaces for agroforestry gardens with participation of citizens and transfer of knowledge in design.
- Makes concepts, sketches and designs with research in species and companion planting and according to the land use, the watershed scale, the location of the plot and local context of the climate and soil.
- Works with local garden animators.
- Teaches and transfers knowledge through participative designs and plantations.
- Builds inclusive cities with agroecological principles through transfer of knowledge in the designs and participation of citizens and connects urban agroforestry gardens through green networks and hedgerows.
- Makes connections between technical and scientific research and arts in the designs.

He/she is limited by the fact that agroforestry and urban agroforestry are not a land use. There is the need to reflect on this to design permanent agroecological spaces in the cities. The watering management regulations need to be made and authorised by decision-makers. The emergency and challenge for the landscape architect is to find adaptive watering systems and species adapted to heat and drought and also mitigate desertification when it is present. The PPGIS is a good tool for cooperating between cities and creating an agroforestry corridor. It needs to include decision makers and experts. Another tool such as a platform could be created for this purpose. The landscape architect can make suggestions to manage invasive species with experts. The plot needs to provide space for free plantations with some restrictions such as no poisonous and non-invasive species.

The landscape architect is a mediator between decision-makers and citizens. Decision-makers and city planners cooperate with researchers, agronomists and naturalists and with citizens, community gardeners and schools. The PPGIS and participative designs are used to involve citizens in the planning and design of agroforestry systems with waste management, water management, creation of paths and networks for resources. Citizens also take part in participative planting and the maintenance of the plots. There needs to be an animator of the plots and a landscape architect for teaching and transfer of knowledge. The city provides public land for cultivating with agroforestry systems.

The production from agroforestry gardens can be marketed to restaurants and school canteens and also to different infrastructures: medical, educational, cultural. Peri-urban agroforestry can generate a new diversity of production for cities with an economy of water and the management of nutrients in the soil. There can also be a new artistic development with natural products and mediums from agroforestry plantations.

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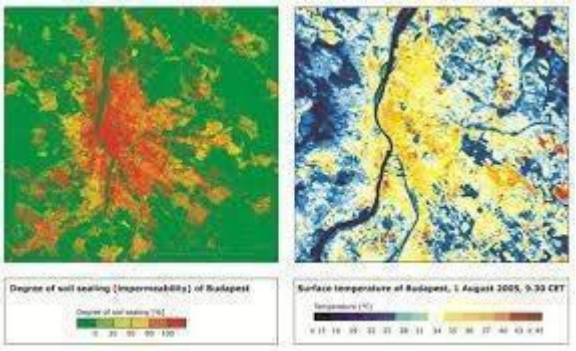
Annexes

Annex 1- Methodology

Maps of the context of Budapest.

Green intensity map of Budapest.
Source: Sándor Jombach, in Green Infrastructure Concept of Budapest, BFVT Ltd., 2017.



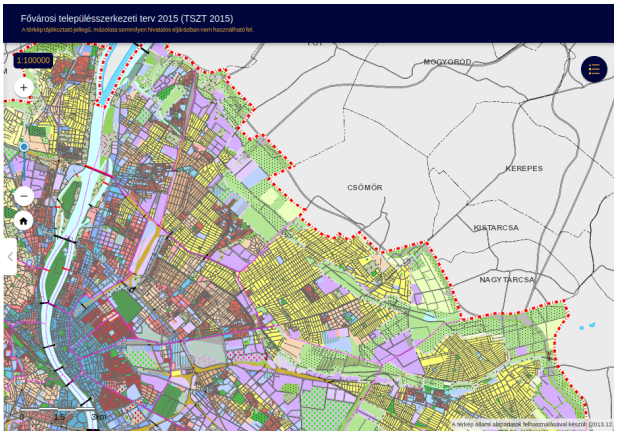
Map on surface temperature, Budapest.
Source: EEA, Richard Ongjerth, Péter Gábor

Annex 2-Methodology

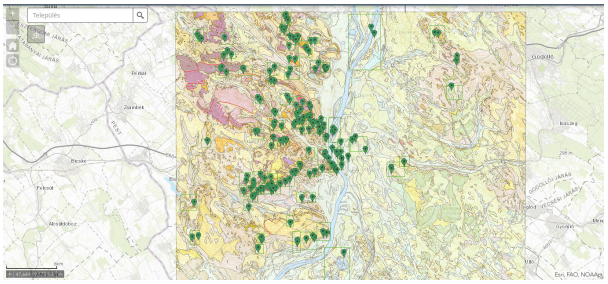
Maps of the aspects evaluated for the location of the potential agroforestry plots in Budapest, along the Rákos and Szilás creeks.

1. Budapest

The land use map of Budapest
https://geoportal.budapest.hu/varosrendezes/tszt2015/

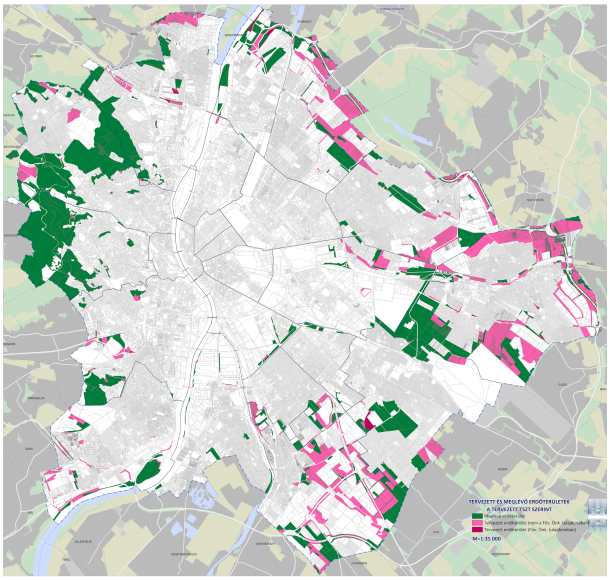


The soil map of Budapest
https://map.mbfsz.gov.hu/bp50/



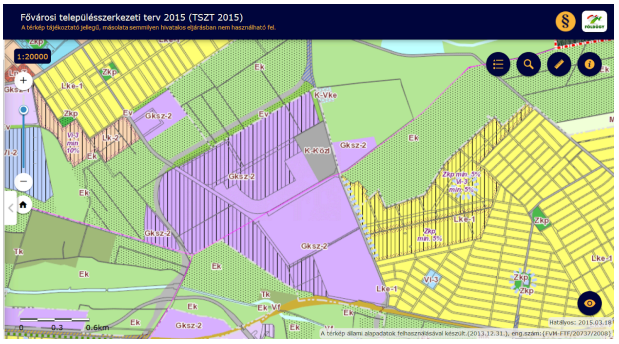
The soil of the studied area of the Rakos creek and Szilas creek is River-Aeolian sand, Great Plain Formation with clay, Running sand and Lower Middle Pleistocene river gravel, sand. Along the Szilas creek it is river gravel and sand.

The map of potential areas for community tree planting in Budapest
Source: BFVT ltd from the Municipality Structural Plan



The map of existing community gardens in Budapest
The map of community gardens in Budapest.
Source: Cs. Bende and G. Nagy, Effects of community gardens on local society: the case of two community gardens in Szeged, January 2016, Belvedere Meridionale 28(3):89-105, DOI: 10.14232/belv.2016.3.7

Location of the Hungarian Food Bank Association Lokator u. 3
https://geoportal.budapest.hu/varosrendezes/tszt2015/

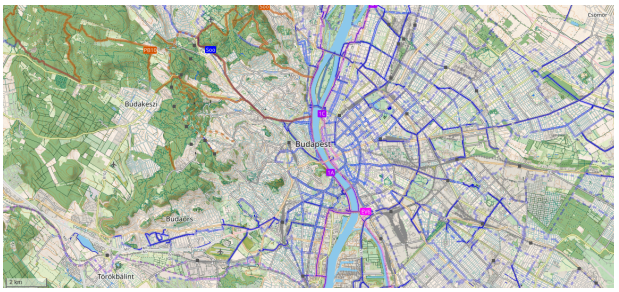


The map of abandoned fruit trees in Budapest

This is the map from FallingFruit, an interactive map which shows fruit trees to harvest in the world, and here in Budapest. In the site of Gazdagrét is an abandoned orchard. This could be turned into an agroforestry garden.

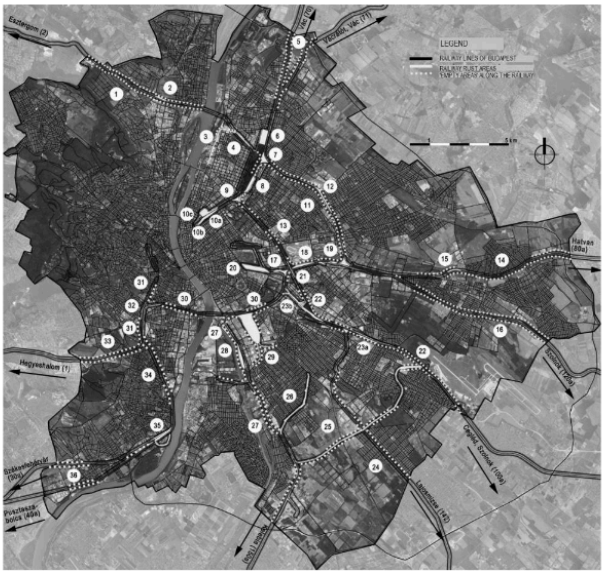
The map of the topography, trails and cycling paths in Budapest

Source: openstreetmap

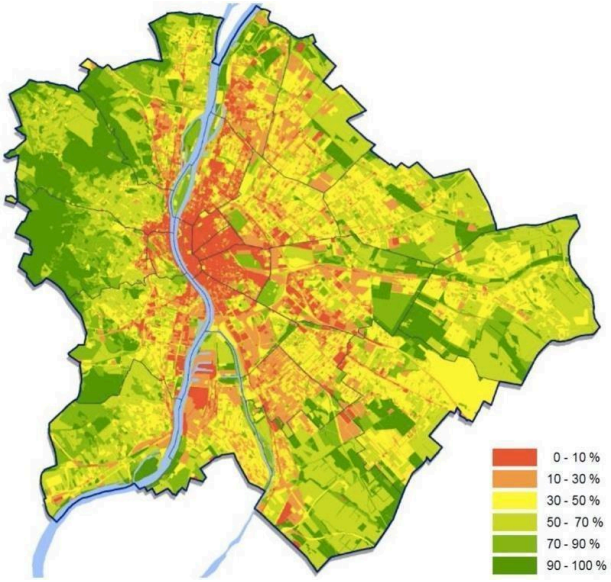


Map of the brownfields of Budapest

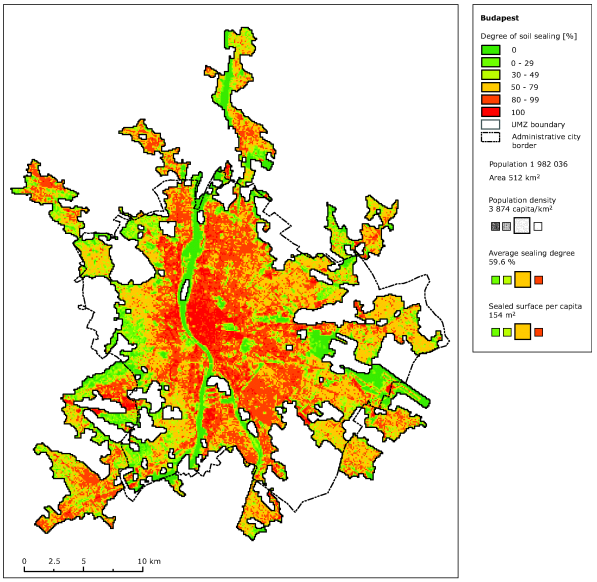
Map of brownfields in Budapest, Hutter Dora
https://scholarworks.umass.edu/cgi/viewcontent.cgi?article=1087&context=fabos



Heat map of Budapest, Buzási A., and Szimonetta Jäger B., 2020



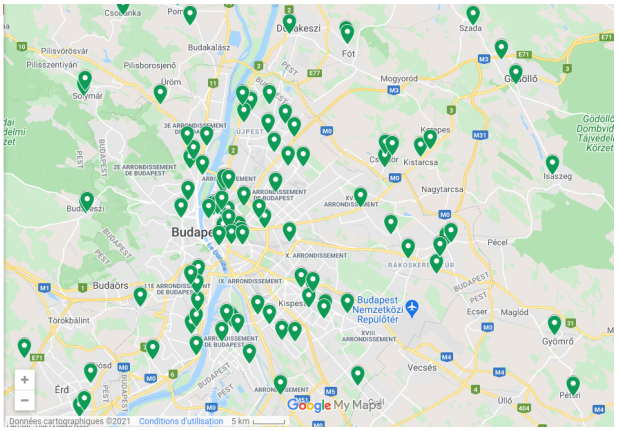
Map of sealed soils in Budapest, Soil sealing in Budapest, EEA Europa, https://www.eea.europa.eu/data-and-maps/figures/soil-sealing-in-the-capitals/budapest-eps-file



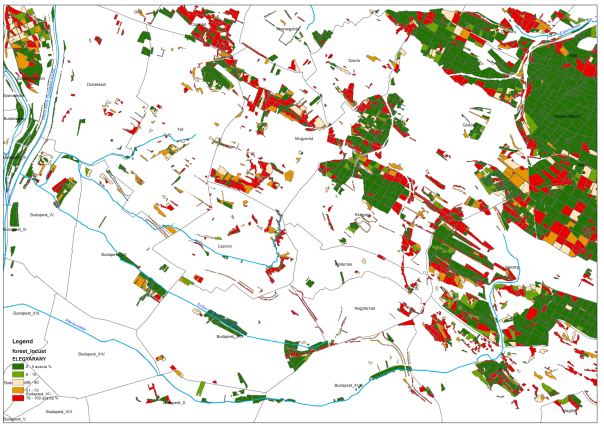
Food banks and partners to the Hungarian Food Bank Association

https://www.elelmiszerbank.hu/hu/tevekenysegunk/hova_kerulnek_a_megmentett_elelmiszerek.html

This is the map of the partners and food banks of the Hungarian Food Bank Association in Budapest.



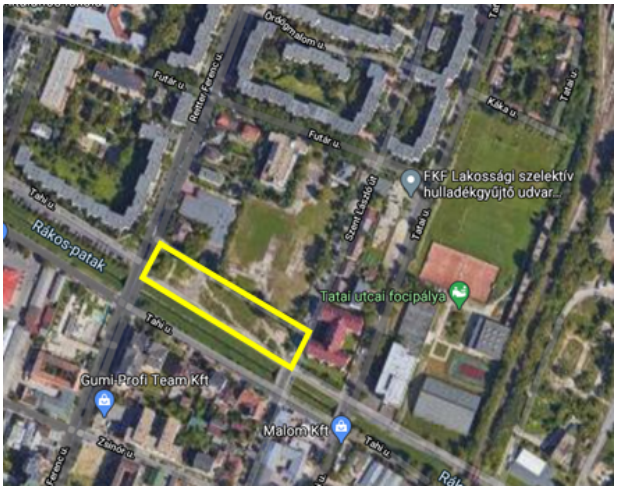
Robinia pseudoacacia distribution along the Rakos and Szilas creeks



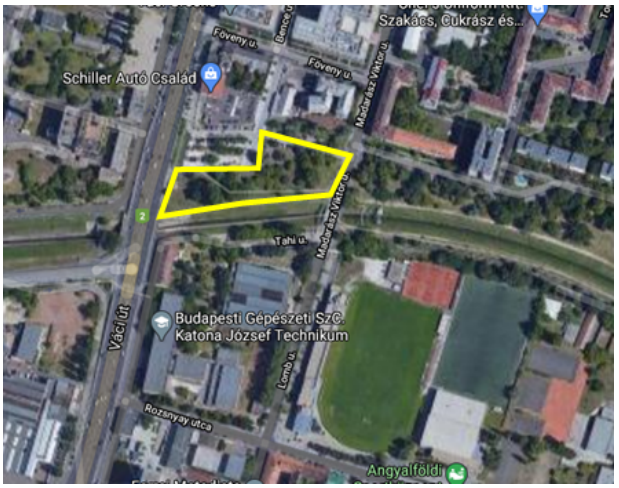
XIIIth district available plots

1. The plot between Reitter Ferenc street and Szent László street in the 13th district is on soil type River-Aeolian sand.

2. The other site is between Váci road and Madarász Viktor street. The plot between Váci road and Madarász Viktor street is on a soil type River-Aeolian sand.



1. Source: bfvt



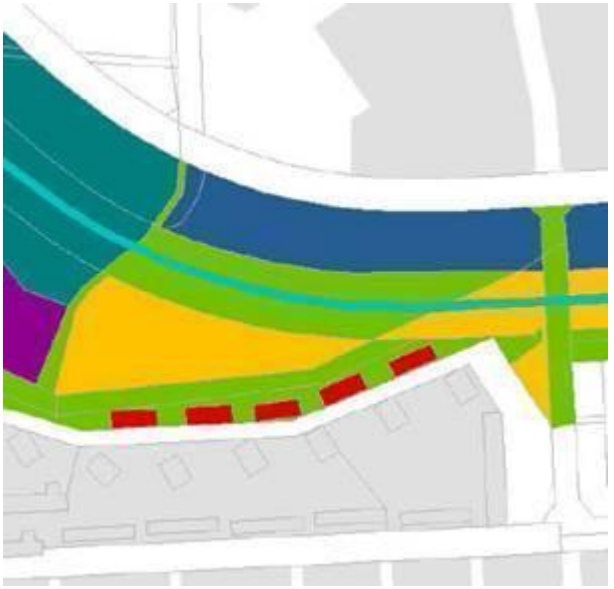
2. Source: bfvt

Ownership map, source: bfvt

XVIIth district available plots
Source: ZöldXVII

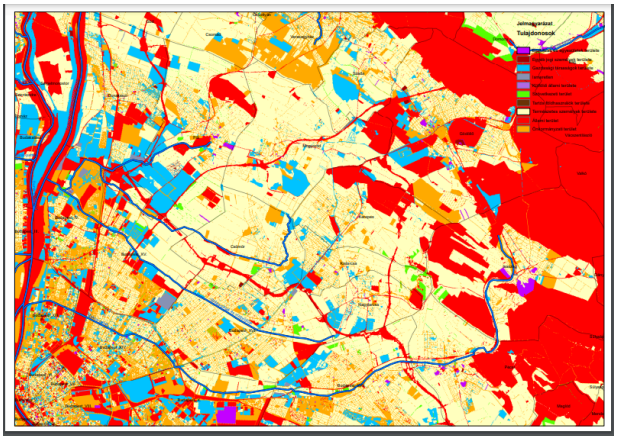
IVth district municipality owned plot location with owenrship map

Source: bfvt



Source: bfvt

Rakos creek ownership and land use maps
Source: University of MATE



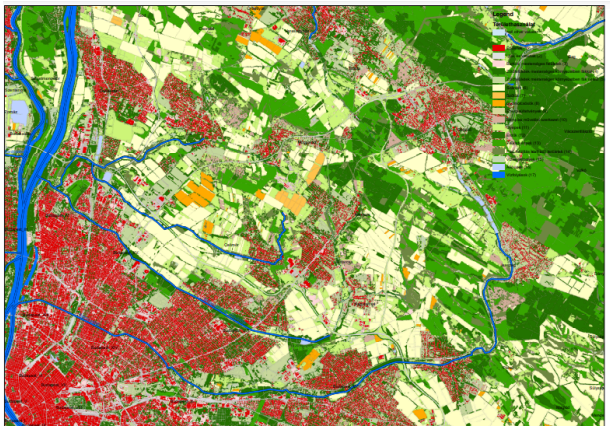


Table of the maps used for scenario plans in Budapest and along the Rakos and Szilas creeks

Annex 3- Methodology

Gazdagrét abandoned orchard

The Gazdagrét abandoned orchard is an example of potential plot for agroforestry in Budapest

Photo 1 of the Gazdagrét abandoned orchard, Paloma Gonzalez de Linares

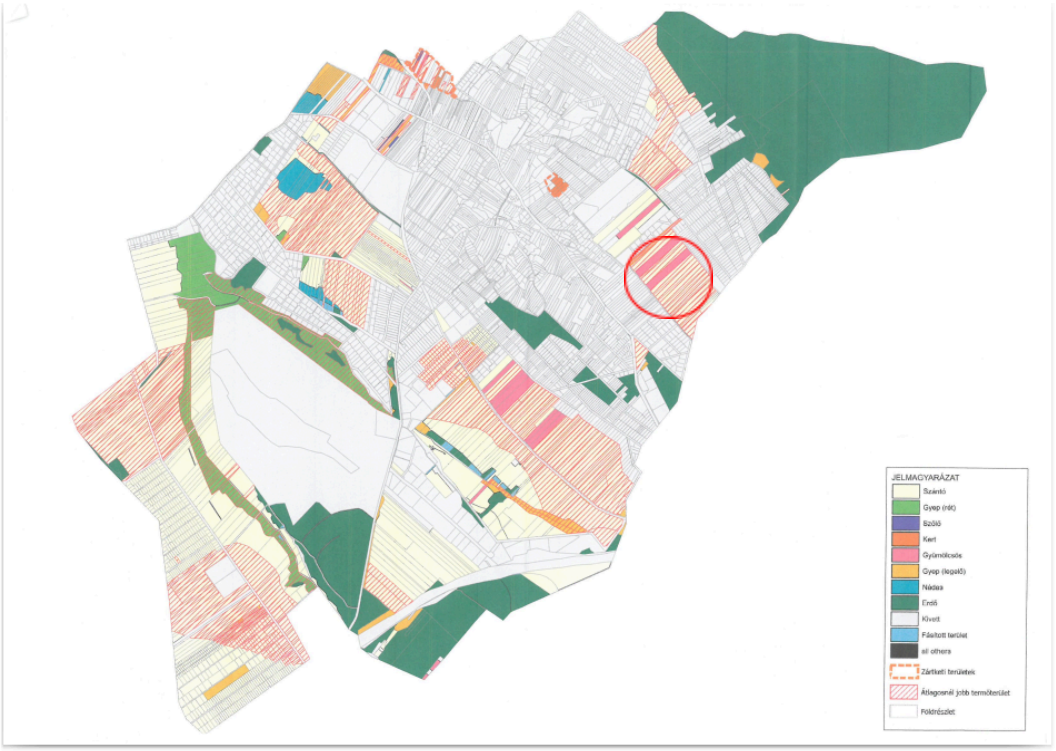
Photo 2 of the Gazdagrét abandoned orchard, Paloma Gonzalez de Linares

Photos of a potential space for community urban agroforestry in an abandoned orchard in Gazdagrét, on Angyalka utca, in the 11th district of Budapest.

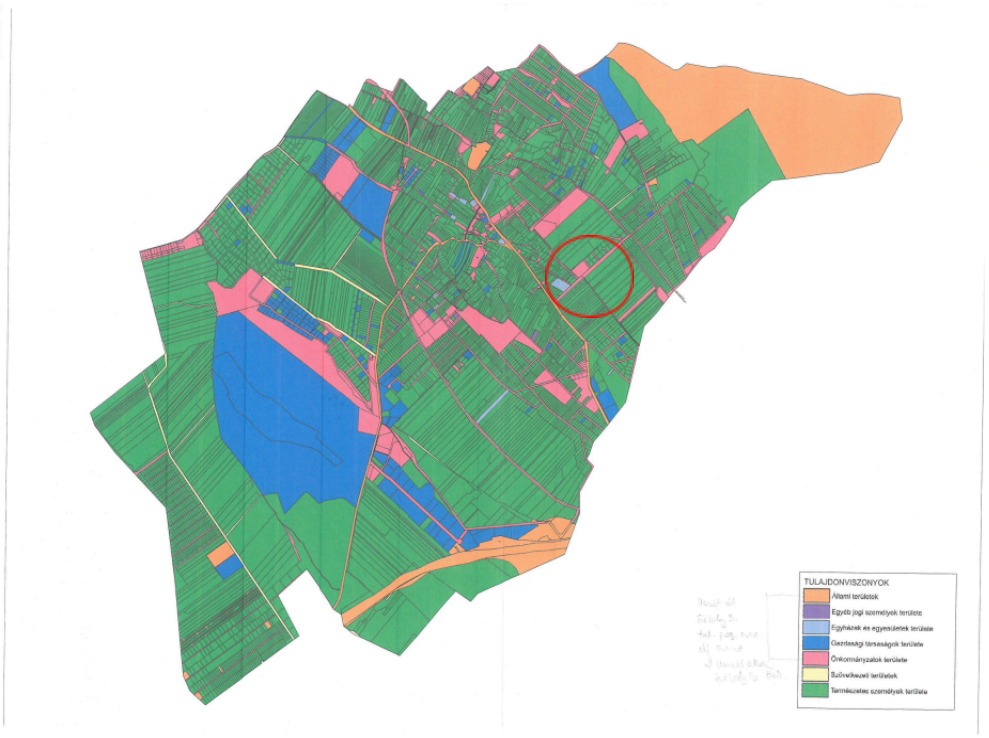
This plot is an abandoned orchard in a dense residential area with a high variety of fruit trees such as almonds and plums. It is a potential space for a community agroforestry plantation. This space should remain open and not be fenced. The soil is Slag sediments. It shows potential for vitiforestry, forest-gardening and alley cropping.

Annex 4- Results of Goal 3

Maps of the available municipality owned lands in Szada for urban agroforestry implementation.



Map of the land use in Szada, source: municipality of Szada



Map of the ownership of the lands in Szada, source: municipality of Szada

The municipality provided two land use maps with the location of municipality owned plots which could be used for agroforestry. The first map shows the existing green cover and land use, the second map shows the municipality owned plots in pink. One of these plots is located at the source of the Rakos creek.

Annex 5- Goal 3. Soil sample results

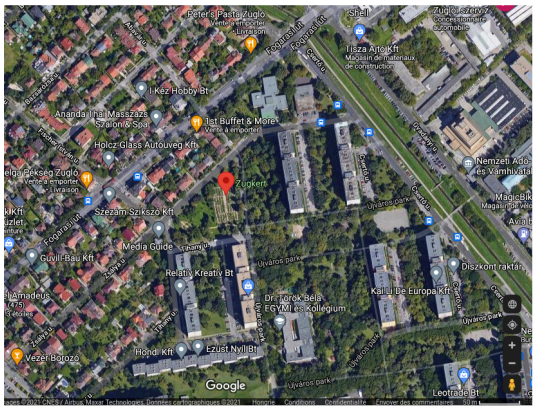
Field Name	Creation Date	pH (H2O)	Soil organic matt	Total nitroge	Total phospor (M3 metho	Potassium (exchangeab	Calcium (exchangeabl	Magnesium (exchangeabl	A_N_PMN	A_N_PMN_Mir	Cation Exchange Capa	Total aluminium	Total Iron	Clay
zuglo populus	26/07/2021 16:20:1	7.8 Ph-értéki	5.1 %	2.8 g/kg	42.5 mg/kg	5.1 mmol / kg	269.9 mmol / kg	33 mmol / kg	113	22.00	298 mmol / kg	40.1 g/kg	21.6 g/kg	20%
zuglo tilia cordata greenspire	26/07/2021 16:13:2	7.7 Ph-értéki	7.1 %	3.7 g/kg	23.6 mg/kg	5.3 mmol / kg	260.9 mmol / kg	25.4 mmol / kg	153	22.00	242 mmol / kg	32.1 g/kg	15.9 g/kg	17 %
zuglo vacant area	26/07/2021 16:07:4	7.5 Ph-értéki	3.4 %	3.1 g/kg	36.3 mg/kg	4.3 mmol / kg	192.1 mmol / kg	28.5 mmol / kg	121	22.00	206 mmol / kg	37.4 g/kg	22.2 g/kg	26 %
zuglo mulberry	26/07/2021 15:58:5	7.9 Ph-értéki	5.6 %	3.4 g/kg	51.8 mg/kg	4.9 mmol / kg	257.2 mmol / kg	29.9 mmol / kg	137	22.00	240 mmol / kg	30.7 g/kg	16.1 g/kg	19 %
zuglo corylus colurna	26/07/2021 15:46:2	7.7 Ph-értéki	5.7 %	3.4 g/kg	43 mg/kg	4.6 mmol / kg	312.4 mmol / kg	32 mmol / kg	138	22.00	298 mmol / kg	29.5 g/kg	14.2 g/kg	20 %
zuglo sorbus aucuparia	26/07/2021 15:19:0	7.7 Ph-értéki	5.6 %	3.2 g/kg	57.1 mg/kg	5.9 mmol / kg	282.2 mmol / kg	27.7 mmol / kg	129	22.00	280 mmol / kg	32.8 g/kg	17.3 g/kg	21 %
godolloerdokert apple tree	26/07/2021 15:09:2	7.2 Ph-értéki	2.9 %	2.2 g/kg	48.4 mg/kg	4.3 mmol / kg	148.3 mmol / kg	19.1 mmol / kg	87.1	22.00	176 mmol / kg	38.9 g/kg	20.3 g/kg	14 %
godolloerdokert plum tree	26/07/2021 14:52:4	7.0 Ph-értéki	3.3 %	2.4 g/kg	55 mg/kg	4.9 mmol / kg	193.9 mmol / kg	24.7 mmol / kg	94.8	22.00	216 mmol / kg	41.6 g/kg	22.6 g/kg	16 %
lowergarden buda grassland	26/07/2021 14:38:1	7.8 Ph-értéki	4.4 %	3.2 g/kg	52.6 mg/kg	6.9 mmol / kg	256 mmol / kg	26 mmol / kg	129	22.00	239 mmol / kg	42.6 g/kg	24 g/kg	20 %
lowergarden buda Tilia tomer	26/07/2021 14:29:2	7.9 Ph-értéki	4.9 %	3.1 g/kg	59.5 mg/kg	5.2 mmol / kg	281.3 mmol / kg	29.7 mmol / kg	122	22.00	243 mmol / kg	37 g/kg	19.4 g/kg	22 %
lowergarden buda acer pseu	26/07/2021 14:21:5	7.6 Ph-értéki	3.2 %	1.9 g/kg	56.5 mg/kg	5.1 mmol / kg	259.9 mmol / kg	25.3 mmol / kg	73.3	22.00	251 mmol / kg	41.3 g/kg	23.9 g/kg	18 %
upper garden buda fig tree	26/07/2021 14:14:0	7.8 Ph-értéki	2.5 %	1.5 g/kg	40.3 mg/kg	4.6 mmol / kg	215.9 mmol / kg	13.8 mmol / kg	56.5	22.00	185 mmol / kg	44.1 g/kg	25 g/kg	18 %
upper garden clovers	26/07/2021 13:58:5	7.3 Ph-értéki	2.3 %	1.7 g/kg	51.5 mg/kg	5.1 mmol / kg	135.6 mmol / kg	14.5 mmol / kg	66.5	22.00	146 mmol / kg	41.1 g/kg	22.2 g/kg	17 %
upper part Buda	26/07/2021 13:47:3	7.8 Ph-értéki	3.9 %	2.2 g/kg	49.3 mg/kg	5.4 mmol / kg	203 mmol / kg	21.8 mmol / kg	84.2	22.00	181 mmol / kg	39.7 g/kg	22.4 g/kg	20 %
lower garden Buda	26/07/2021 13:36:0	7.3 Ph-értéki	3.5 %	2.2 g/kg	55.8 mg/kg	6.1 mmol / kg	230.1 mmol / kg	20 mmol / kg	85.1	22.00	228 mmol / kg	41.3 g/kg	23.2 g/kg	18 %
buda proba upper garden	26/07/2021 13:25:5	7.8 Ph-értéki	8 %	4.8 g/kg	61.3 mg/kg	4.8 mmol / kg	349 mmol / kg	28.8 mmol / kg	205	22.00	339 mmol / kg	29.8 g/kg	15 g/kg	16 %
biokert buda	26/07/2021 13:13:1	7.8 Ph-értéki	5.4 %	3.8 g/kg	65.5 mg/kg	4.3 mmol / kg	236.3 mmol / kg	23.8 mmol / kg	157	22.00	238 mmol / kg	27.3 g/kg	14.5 g/kg	16 %

Table of the soil sample results, Paloma Gonzalez de Linares

Annex 6- Goal 3. Interviews with community gardens in Budapest

Zugkert

The Zugkert community garden is located in the 14th district of Budapest. It is in a densely populated and residential area with a block of flats called the "*Lakotelep*". The garden started in 2013 with the authorisation from the local district government who provided the land. The garden is managed by the NGO ZUG Közösségi Kertekért Egyesület. The Whole surface is 1000 m2 but the cultivated surface is 640 m2. There are 64 parcels of 10 m2. The contract for the land is 5 years long and can be renewed. The garden is also located near the Rakos creek. The main users are elderly and retired residents and families. The users are allowed to plant trees in the garden, therefore, they privilege the edges to avoid the raised beds with crops from shade. The garden is fenced but there is both a compost box in the garden and outside the garden for the local residents. Very little soil was added to the garden, the main soil comes from the plot itself. The water comes from a central tap near the garden. According to the interviewed manager of the garden, community gardens are good meeting points for all generations and for social mixity. The manager doesn't see any relation between gardening and arts. He also added that there was no contact with other community gardeners in Budapest which is a shame because he thinks it is important for exchange of experiences.



Location of the Zukert, Budapest, source: Google maps

Photo of the Zugkert, Budapest, source: Paloma Gonzalez de Linares

Zöld Palotakert or Újpalotai kert

The Zöld Palotakert is located in the 15th district of Budapest. It started in 2015 with the initiative from the 15th district council, 5 community gardens opened in the district for free.

I was created by Palota-15 Nonprofit Kft (https://palota15nkft.hu/). The garden is also located near the Szilas creek, in a dense residential area of block of flats "*Lakotelep*". There are 24 parcels of 7 m2.

http://kozossegikertek.hu/garden/zoldpalota-kert/

Location of the Zöldpalota kert, source: Google maps

Photo of the Zöldpalota kert, source: Paloma Gonzalez de Linares

There is no deadline for the contract. The gardener is not familiar with agroecology or agroforestry.
The regulations allow the plantation of annual crops and herbs and flowers. It is forbidden to plant fruit trees and berries. The water comes from a well which was provided by the district. There used to be a compost system but it stopped because of management problems and technical difficulties and not enough resources. The soil was provided by the district council. One of the technical challenges is to grow salads because of snails. There are trees on the site, but one provides shade on a raised bed so one family can't grow tomatoes. The trees on the site are not useful to the garden. The district council designed the garden. The intentions of the Mayor who initiated these gardens was to start up a community idea and to give a chance to the city dwellers to do some gardening. A diversity of generations come to the garden: elderly, young and families. For the gardener, there is no link with arts but the gardener hopes a volunteer would come and initiate an artwork. According to the gardener, the main issues community gardens in Budapest need to answer are the cultural heritage through the maintenance of practical knowledge from the past and avoid losing the connection to gardening despite the comfort cities can offer. The gardener does not have any contact with other community gardeners in Budapest due to a lack of time except with 2 other gardeners from the same district.
The gardener is an IT engineer who grew up in a city in the countryside. He thinks it is important to do gardening and get closer to nature. He attended a course in gardening set up by the local cultural house in which one teacher was an agricultural engineer. However, his main source of information is youtube and his instincts.

Green space next to the Zöldpalota kert, source: Paloma Gonzalez de Linares

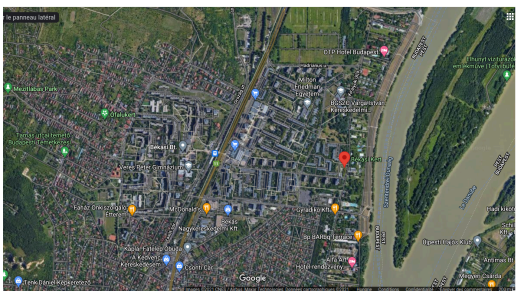
Photo of the Szilas patak near Zöldpalota kert, source : Paloma Gonzalez de Linares

A small forest along the Szilas patak, can be used for land art or other artistic performances. According to the land use map, the agricultural plots along the Szilas patak area are marked as woodlands, therefore it is possible to grow agroforestry systems. These could be connected to the existing community gardens in the district. It can also revive the historical use of the Szilas patak where there used to be a mill.

Békasi kert

The garden Békasi kert is located in the 3rd district of Budapest. It is in a dense residential area with blocks of flats and close to both the Danube River and the Barat creek. There is an important green surrounding and a diversity of activities close by with a beach and a lake, a market space, Békasmegyeri piac and a farmer's market, Termeloi piac. The owner of the land is the Óbuda-Békásmegyer district council. It opened in 2013 under the initiative from the City Garden Association, *Városi Kertek Egyesület.* The whole surface is 1005 m2 but the cultivated surface is 258 m2. There are 27 parcels of 7 m2.

http://www.varosikertek.hu/kertek-budapesten/bekasi-kert/



Location of the Békasi kert, source: Google maps

Photo of Békasi kert, source: Paloma Gonzalez de Linares

The design was made by landscape architecture students from the former SZIE University of Budapest, now the MATE University. The *Városi Kertek Egyesület* has opened 7 community gardens in Budapest with the local governments. According to the leader of this NGO, the best size for a community garden is to provide a maximum of 30 beds. The creator of these gardens helps in the maintenance in the 2 first years and later leaves it under self-management and autonomy. In this garden, a well was provided for the water and there is a solar panel with a pump for irrigation. There is a need to rebuild the raised beds which were made out of wood and are now falling apart. The ground is covered with pebbles which are good for maintenance. The main users of these gardens are elderly people and families with very young children. According to the manager, one of the main issues that community gardens in Budapest need to address is loneliness. Other aspects are the need for beauty, fun and community building. They can also contribute in making the neighborhood safer. There are fruit trees outside of the garden and only 2 inside to avoid shade. At the beginning of the project, there was a competition for the land for parking. The space was provided by the district because of the bad quality of the soil which makes it impossible to use. This is also why raised beds were created. There is no time limit to the use of this land. According to the manager, community gardens are not spaces for arts or entertainment, they are spaces to meet. He also mentioned that landscape architects need to create landscapes for communities. It costs about 10 million forints to create a community garden.
The manager used to work in a multinational company and wanted to do something useful.

Photo of the residential area near Békasi kert, source: Paloma Gonzalez de Linares

Photo of an open green space near Békasi kert, source: Paloma Gonzalez de Linares

Grunkert

The garden of Grunkert is a special example because it has existed since 2015 but has been forced to move 4 times due to ending contracts with construction companies and the reconstruction of the 8th district. The gardens were opened thanks to authorisations with building companies who had spare land. The company participated in lending machines and provided some soil. The former garden had 25 parcels of 10 m2 and a high diversity of crops and flowers were grown including fruit trees. There were several community events in the

garden. There were also resources directly in the garden with a compost space. According to the interviewed coordinator, there is more will and support from the 8th, 9th and 7th districts to open community gardens. Therefore, the new Grunkert garden will be provided by the 8th district council. The conditions for opening the garden are stricter, the gardeners need to provide plans and designs. So, the process is slower. The new design includes a plantation of fruit trees at the entrance of the garden to provide some intimacy. There is also a project for rainwater harvesting as the water is better for the crops than tap water. They never had any automatic watering system; it has always been done by hand. The main purpose for community gardens in Budapest, according to the coordinator, is to show people that in a very small space there can be a large amount of production. It is also to provide a space for community bonding and for asking questions. And it is a place for a mixity of generations. The gardeners have contact with other community gardens in the district and have started some exchange of compost. It is useful for them to also exchange knowledge and resources for free. He also believes that agroforestry systems could be beneficial to provide more trees in the city. Landscape architects need to find solutions for conciliating nature and buildings. They started a raised bed for refugees in 2017.

The Forest-garden of Gödöllő (Zöld klub)

There is a forest-garden on campus of the MATE university in Gödöllő. They have several fruit trees, raised beds with crops and herbs.

A community garden in Sas Hegy

This garden is at the limit with the protected area of Sas Hegy. An engineer manages the invasive species and animates a community garden with schoolchildren.

Annex 7- Goal 3. Interviews with NGOs and institutions in Budapest

Department of Wildlife Management, University of MATE, Gödöllő

According to an expert in Wildlife management, urban and peri-urban agroforestry is a good tool for increasing biodiversity in the city but a strategy in tree plantation should be made to avoid the introduction of red deers and wild boars and beavers in the city through the corridor. Also, research could be made to choose trees to bring back specific species in the city and its outskirts.

We have to be aware that more biodiversity and production along the creeks can lead to a potential corridor for wild animals in the city center and residential areas. Adapted species need to be assessed.

MAPER

MAPER is the Hungarian Association for Permaculture. It is led by a group of volunteers which make Permaculture Design Course (PDC) training in permaculture. These attract

several profiles of people and also help farmers to convert to permaculture. According to the interviewed volunteer, one of the main challenges for urban and peri-urban agroforestry is to find the land. The implementation of agroforestry also depends on the ownership of the plot, if it is private or public. According to the volunteer who does research on food self-sufficiency, the main benefit is not necessarily the food production because it takes a lot of time, energy and money to grow a low production in the city. This means that gardening in cities is mainly a hobby and timewise, it is easier to go to the market to buy food.

On the planning and landscape aspect, she said that Sas Hegy is a good space for gardening because there is already a natural landscape. But agroforestry could be a solution for greening the city, which in her opinion is a must.

FAO Forestry Research Institute

According to the FAO, the main challenge is where to find the space and there needs to be a clear definition of urban and peri-urban agroforestry for planning. This means that city planners need to gather and discuss the topic. In their opinion, there is also the need to control the birds because in the city the population of birds is high and there is also the need for trees with less pollen and less allergies.

Forest Research Institute

According to Veronika Honfy, the introduction of new species depends on the context of the area. It is preferable to focus and privilege endemic and local species, however, it is a possibility to plant new species if these native species don't work and in anticipation of Climate Change scenarios. The tree planting strategy needs to be made with a long-term vision, to plant species which will survive in 100-150 years' time. The Robinia pseudoacacia is a difficult subject because it is an invasive species and it is very valuable in agroforestry and a resistant tree to drought and it is fast growing. Robinia can be used for many things, bee pasture when it flowers, the flowers are even edible, wood is perfect for energy. So, it can be either coppice (method) as an energy plantation, or pollarding - also for fuelwood. Otherwise, it can be used for industrial purposes but then you need proper management - for furniture, construction, poles, etc. The leaves are very nutritious for animals (some cattle like it, and I imagine goats would munch on it also, for example).

Budapest Bike Maffia (BBM)

Budapest Bike Maffia is an association based in the 13th district of Budapest. They work with homeless shelters and make gardens in the shelters with the Seeds for Hope project. They plant trees and vegetables and teach the homeless in the shelter. According to their experience, the gardens are different whether it is a private or a public homeless shelter. Focusing on the Rakos creek, the biggest homeless shelter is in the 13th district but there are also a lot of homeless shelters in the 10th district.

Menedékház Alapítvány

The interview with the Foundation was made to assess the situation of homeless in Hungary and Budapest and understand the possible benefits and challenges in involving homeless in urban agroforestry. According to the Foundation, the situation of the homeless today is due to the change of regime, in the winter of 1989. "In Hungary, the number of homeless people did not increase linearly or exponentially, but jumped exponentially to a thousandfold, when the

factories left behind by the Soviets were closed during the change of regime, and with them their workers' hostels. As a result, the inclusion of the homeless has not been as organic as in other countries, especially in the West. Social and economic exclusion from the very beginning was very high for the homeless, which was what hindered their catching up and reintegration. There have been several attempts at social inclusion in recent decades, but no breakthrough has been reported. Housing first projects, other rehabilitation programs, sensitization among the population, involvement of homeless people in local affairs - in my experience, all failed."

"They also tried to integrate and catch up with the homeless in many ways in an economic way: public benefit work programs (https://kozfoglalkoztatas.kormany.hu/tajekoztato-a-kozfoglalkoztatas-rendszererol), homelessness work center (https://www.korhuanyhivatalivatal.hu) budapest / jarasok / ix-keruleti-Hivatal-ii-szamu-munkaugyi-branch office), other catch-up and rehab programs, which were certainly enough to keep the homeless people alive, but there was little to catch up."

"It is also an old idea to involve the homeless in rehabilitation in some way on the agricultural and horticultural line, thus providing them with the possibility of a 'self-sustaining' lifestyle. My experience is that, in most cases, there is already such a gap between society and the homeless, detached from society that it was not possible to bridge this type of project. The experience is that in many cases, the disadvantages of homeless people, both mentally and healthily, and in terms of skills and abilities, are such that there is only a much more complex help to catch up. Their financial situation is often so hopeless that a project based on forestry - presumably only promising long-term returns - is not a solution to current problems, and for their current situation, I cannot compete with offers - often only in fantasies and memories - like construction."

"The Menedékház Alapítvány has a rehabilitation program, which includes gardening and agricultural activities on a 3x1000 sqm plot (this is also included in the professional program), but experience does not show that long-term success can be achieved in reintegrating homeless people."

BBM-Seeds for Hope

An interview with BBM- Seeds for Hope was made and two gardens were visited in two homeless shelters in the 9th district of Budapest. The initiating gardener and conceptor of the project has a background in permaculture and participated in a permaculture design course. Her idea was to link permaculture with homeless. According to her, the simply well maintained and access to the gardens for homeless is enough to reduce stress and create well-being. Gardening with homeless requires work with social workers and psychologists to be able to manage and adapt to the different physical and psychological challenges of the community. The permaculture gardens help in sharing the idea of community and gardening. It is a a challenge to design gardens for homeless because of the waste management and the possible disabilities which require some knowledge in the design of raised beds for example.

Hungarian Food Bank Association

The Hungarian Food Bank Association collects the food from multinational companies to avoid waste. They deal with food surplus but not with the production. For example, they do

food collection at Christmas time with private households. They had a project to collect seeds and make gardens with the municipalities for people in need and then these people did the gardening. Mostly, they educate on how to manage food safety at home and reduce food surplus. They also send food to the countryside, especially in the East.

NAIK research institute

An expert in fruit trees and ecotoxicology suggested planting diverse fruit trees along the creeks such as apples, stone fruit species, cherries, plums, walnuts (persian walnut), hazelnut, elderflower, quince, old cultivars. Old cultivars are more resistant to climate change, diseases and pests. Apricots and peaches should be avoided. According to the interviewed expert, food could be grown, there could be animal breeding and the compost could be a marketable brand. The soil needs to be assessed before plantation.

Magyar biodiverzitas-kutato tarsasag

According to the national institute of biodiversity, agroforestry systems and permaculture can be included in the Rakos creek restoration plan.

Interview with the 13th district council of Budapest and the City council of Budapest

There are available municipality owned plots which could be used for community development with agroforestry. Wildlife management must be taken care of. There is an interest for urban agroforestry in these councils.

Interview with Tracey Wheatley

There is a need for reflection on the management of Robinia pseudoacacia.