Landscape and Greenway Planning Land use and urban policy analysis for implementing urban agroforestry, a cross-border analysis in European cities

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1. Abstract

As agroecology movements are emerging in the world to mitigate economic, social and environmental vulnerability it has become urgent to search for long term tools and regulations to create sustainable agroecosystems well adapted and integrated in the landscape. This paper assesses the different problematics and challenges in implementing agroforestry systems in the urban landscape. Agroforestry is defined as the deliberate plantation of woody perennials with non-woody perennials on a same unit of land for ecological and economic purposes (Nair R., 1993). If the tree plantations and movements to plant food in the cities contribute to creating attractive cities and providing a good image of the city, they often depend on political parties and decision-makers' will to adapt cities to climate change and increase green spaces and biodiversity in the cities. There is a need to assess how agroforestry systems can be part of urban planning policies and agendas and complex projects for greening cities with multifunctional green spaces. Greenways appear to be good agendas to include agroforestry projects in. Indeed greenways are systems and/or networks of protected lands that are managed for multiple uses including: nature protection, biodiversity management, water resources, recreation, and cultural/historic resource protection (Ahern J., 1995). This paper suggests a cross-border analysis of regulations, policies, environmental constraints and land use changes for implementing agroforestry in cities through -the case of Rennes, Nantes, Donzdorf and Liege. Field trips in urban and peri-urban agroforestry community gardens helped understand the functions of this practice in cities and its benefits such as waste management, regeneration of urban soils and revitalising under-managed landscapes, crop and production diversification and protection of seed, assessment of new plantations and tree species according to the climate change scenarios and the need in growing local food and materials with less dependency on importations. Urban agroforestry can have several benefits through participative designs such as community bonding, reflection on policies, consumption, governance systems and lifestyles and exchange of knowledge. Besides these benefits, urban agroforestry can contribute to creating therapeutic green spaces and social inclusion. This article also assesses how agroforestry projects could contribute to a greenway system? The methodologies used are questionnaires, interviews, maps and policy analysis. The results are that agroforestry systems in greenways can help in providing equal access to productive green spaces in the cities and link them to the peri-urban areas. This paper concludes with a call for more cooperation in agroecological landscape planning and management for creating agroecological landscape networks with social inclusion through public participation and the inclusion of civic organisations and citizens in the planning process and governance system.

2. Introduction

As agroecology movements are emerging in the world to mitigate economic, social and environmental vulnerability it has become urgent to search for long term tools and regulations to create sustainable agroecosystems well adapted and integrated in the landscape. Agroecology is a

theory, a policy and a practice. After being to the school of urban agriculture in Montreal in 2013 and making a study about this practice, observations showed that the social and environmental benefits were important and that this practice should be part of urban planning policies. There is a need to find permanent space for this practice. Also agroforestry shows that implementing trees in agricultural fields was beneficial for soils, water management, biodiversity and also that they could have an impact on yields. Urban agroforestry could be a good practice to create multipurpose edible spaces. Therefore the use of tree species and different plant species with agroecological principles can bring out new functions in open spaces. And people can use the city differently and be organised differently. This paper assesses the different problematics and challenges in implementing agroforestry systems in the urban landscape. The planning systems and policies are assessed through case studies of existing urban and peri-urban agroforestry systems and plots in Donzdorf (Germany), Liege (Belgium), Nantes and Rennes (France) Are they used in green plans and in what types of green plans? What are the functions? Which spaces are used and what are the challenges?

3. Background and Literature Review

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). 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. There are several agroforestry systems : alley cropping, wood-pastures, agrisilvicultural systems, silvopastoral systems, agropastoral systems, windbreaks, shelterbelts, and forest gardens (FAO, 2020). Agroforestry systems have proven several benefits such as soil rehabilitation, enhancement of biodiversity, carbon storage (P. Schroeder, 1994), productivity, nutrient cycling, soil biodiversity, water retention, pollination, reduce soil erosion, reduce fire risks and provide recreational and cultural benefits (Maya Sollen-Norrlin et al, 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 and carry on community development. 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, 1995). Urban agroforestry hasn't yet been explored in European cities or is only starting to emerge in 5 years. Urban agroforestry goes beyond a simple plantation. It is also about rethinking the economic system, agricultural policies and educational programs. Urban agroforestry in this article is defined as a practice where citizens grow local products in the city with agroecological principles for social and ecological purposes and balance. Woody perennials are used with non woody perennials in the city, with economic, environmental and social outcomes. One of the problems urban agroforestry could solve is the rehabilitation of urban soils and agroforestry systems need to be adapted to the soil conditions of the cities. Indeed cities were built on fertile soils but with past industrialization urban soils have been contaminated. Therefore the urban soils also need to be taken into account in planning agroforestry systems and new green spaces or maintaining green spaces. According to the EURAF, "An increasing population, which requires more land for food production, urbanisation and industries, is putting the soil under additional pressure. It can take up to 1,000 years to produce 1 cm of fertile soil but only a couple of years to lose it." (EURAF, 2019). The hypothesis of this article is that green infrastructure planning and greenways can be a good tool for planning urban and peri-urban food systems. Indeed, 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). The Biodiversity Strategy 2030 aims that 15% of deteriorated ecosystems should be restored with green infrastructure planning (European Commission, 2020). The brown network is an ecological network for biodiversity in the soil (Cluzeau, 2018). Greenways are systems and/or networks of protected lands that are managed for multiple uses including: nature protection, biodiversity management, water resources, recreation, and cultural/historic resource protection (Ahern, 1995). Also, greenways are systems and/or networks of protected lands that are managed for multiple uses including: nature protection, biodiversity management, water resources, recreation, and cultural/historic resource protection (Ahern, 1995). 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).

4. Method and Data

This paper suggests a cross-border analysis of regulations, policies, environmental constraints and land use changes for implementing agroforestry in cities through -the case of Rennes, Nantes, Donzdorf and Liège through a questionnaire to the chamber of agriculture of Rennes, the metropole of Nantes, the municipality of Donzdorf and the coordinator of the edible green belt of Liège. One questionnaire was filled per municipality. These cases were chosen because of the implication of the municipality in the planning of agroforestry systems in the urban and peri-urban area. Interviews were also made with an expert in agroforestry in Germany, in France and in Belgium to understand the context of agroforestry in these countries. The interviews were made with the association of agroforestry of Germany, the association of agroforestry in France and the Belgium Association for Agroforestry in Wallonia and Brussels (AWAF). These questionnaires and interviews were answered online. Donzdorf is located in southern Germany at 48°41′N 9°49′E. There are municipality owned orchards which were converted to agroforestry. Liège is located in the east of Belgium at 50°38′N 05°34′E. Liège launched in 2012 a Food Land Belt 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 is located in the west of France, 50 km from the Atlantic coast at 47°13′05″N 1°33′10″W. The city of Nantes has created an urban forest plan including agroforestry on wastelands. Rennes is located in northwestern France at 48°06′53″N 1°40′46″W. The city of Rennes is protecting traditional hedges as agroforestry systems called *Bocages*.

Questionnaire

This questionnaire was fulfilled by the municipality of Donzdorf, the metropole of Nantes, the association Ceinture Aliment Terre Liégeoise in Liège and the chamber of agriculture of Rennes. 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 localisation, the citizen's involvement, the management and the challenges.

Context
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?
Localisation
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 a difficult area ? An enclaved space ? In neighbourhoods 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
Are people involved in the plot? If yes, how long did it take people to be involved? How many people are involved?
Management
How did you find your resources? (funding, soil, plants, water) What is the harvesting system? In addition, how is the product processed? What is the management system? What is the production quantity? (if any) Are there any regulations? Would you consider creating a forest garden?
Challenges
What were the most challenging issues in creating such a project?

Table 1. Questionnaire used for assessing the agroforestry systems in Germany, Belgium and France, Paloma Gonzalez de Linares, MATE 2020

5. Results

1. Urban agroforestry in Donzdorf

According to the interview based on the agroforestry association of Germany, the main system supported is orchards because they are traditional and the most common systems. But they are not called "agroforestry". Farmers are not allowed to grow crops in between these trees in orchards. As Germany is a federal state each state has its own rules. The problem is understanding what agroforestry is among politicians and farmers. The funding from the EU is difficult as agroforestry and agroforestry systems aren't well defined. Donzdorf is a small town of 11 000 inhabitants. The agroforestry systems of Donzdorf are meadow orchards. They are owned by the municipality. The idea was born in their local Agenda 21. The plots are located between 500 to 2000 meters away from the main city. 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.

2.   Urban agroforestry in the city of Liège

The city of Liège has a Food Land Belt including forest-gardens. The goal is to provide local food to the city. There is no map about this belt because it is based on the cooperation between existing farms and citizens. The purpose of the plots is for vegetable growing. Some plots are located in rural areas and some in urban areas. Most of the plots are easily accessible but 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 (Vivre à Liège, 2022). 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. 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. 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. The different cooperations and networks include independent shops, cooperatives, on farm markets, associations, honey producers and bakers. The closer to the city is the horticulture school of Liège with a farm and productions sold on site.

3.   Urban agroforestry in the cities of Nantes and Rennes

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 metropole of Nantes counts 24 communes and covers 53 000 ha. 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. 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. Depending on the configuration, management is provided by associations and citizens. 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. There are no design regulations. The goals of the urban forestry project are: preservation of natural spaces, value agricultural wastelands through the forest, generate wood production by employing workers with social difficulties through solidarity compagnies, and to be a carbon sink (Nantes Métropole, 2021). Sometimes there is an inclusion of citizens. It depends on the plantation projects. Some spaces are planted with associations such as MiniBigForest. The metropole and the communes manage several agroforestry plots with different configurations.

In the case of Rennes, the agroforestry plots are located in the green belt which is in the peri-urban area of Rennes. These 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. There is funding to help the preservation of these *bocages* by the french Department of Ille-et-Vilaine. There is no participation of citizens. 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. So this threatens the preservation of the green belt.

6. Discussion and Conclusion

These case studies show that there is a difficulty in finding land and implementing agroforestry systems in the countryside and also in cities. This is due to the ownership of the land and tree and the definition of agroforestry systems. However, cities provide good spaces for agroforestry systems. These cases show that agroforestry can be used on vacant land, in urban forestry plans and for landscape heritage. The case of Liège and Nantes show the importance of cooperations and networks for economic and social viability. The main agroforestry system which seems to be expanding is orchards. However, these agroforestry plots are not connected to each other in the landscape. This is why green infrastructure plans and greenways are useful. Also, there needs to be a planning term to define regular spaces for productive gardening and agroforestry systems. In this paper, it is suggested to plan permanent urban green productive spaces and support the development or rehabilitation of landscapes with agroforestry.
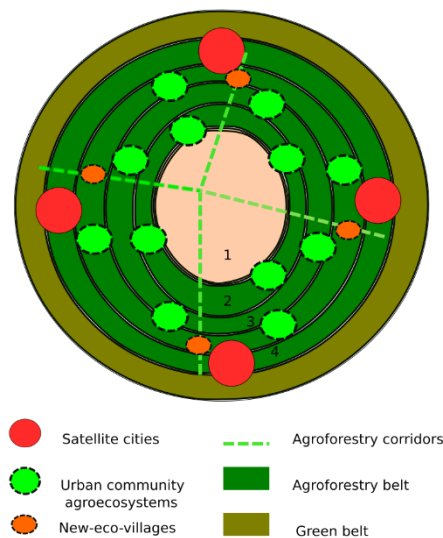
Figure 1. Model for urban and peri- urban agroforestry planning, Paloma Gonzalez de Linares, MATE, 2020

This graphic model shows a theory for implementing agroforestry systems in green infrastructure plans. These could be integrated in green belts or corridors with a network between agroforestry systems and other open green spaces such as existing forests, woodlands, prairies and other natural areas outside of the city. This agroforestry belt would include agroforestry for food and wood production and shelterbelts like the *bocages* with plantations of fruit trees. These could be planted around existing gardens or parks. Other plantations could be implemented such as alley cropping and forest-gardens in abandonned woodlands and finally, there would be community agroforestry patterns in the city. The most traditional form of community agroforestry is forest-gardening. This system is also the most suitable for small productive spaces as there is more biodiversity than in the other agroforestry systems. And as mentioned in the introduction, linear parks increase the equal accessibility to green spaces. Also, there should be an agroforestry belt to increase biodiversity. Agroforestry corridors are green corridors which include agroforestry practices on existing agricultural land or abandoned land. The corridors connect the peri-urban areas to the city center. Some abandoned lands should be left and kept wild. 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 and when the products are harvested. Finally, in urban and peri-urban agroforestry the production and plantation and management depends on the social-ecological organisation of the plots and the network. There could be several zones in urban and peri- urban agroforestry with types of productions. Close to the city center, in zone 1, high value production should be planted for selling on touristic markets and crops which are rich in calories and with fast growth should be grown and climbing crops. There can be community forest- gardens in the city. Further from the city center in zone 2, 3 and 4 should be a production which requires more space and for supplying basic needs with alley cropping such as cereals. For example there could also be local horse

breeding for high natural and cultural agroforestry systems. And there could be wild edibles in peri-urban forest- gardens because they require less management. There should be several agroforestry systems according to land size, land use, existing land cover and proximity to the urban center. For instance, have small but nourishing edibles in the city and climbing edibles in the city and have wider plains of crops further out of the city and wild edibles in peri- urban forest- gardens.

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