

Chapter 7

Community Gardens and Their Potential for Urban Biodiversity

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Abstract The aim of this research was to explore the potentialities of community gardens—a specific type of urban garden—in terms of urban biodiversity and ecological continuity in the city. We considered the three main scales of organisation of urban ecosystems: local individual habitat, intermediate urban landscape and the larger scale encompassing the entire urban area. The study site within the urban agglomeration of Tours currently contains 29 clusters of community gardens, mainly situated in three central municipalities of the urban area; 12% of the community gardens have disappeared over the last ten years due to residential and industrial urban development. Analysis of land tenure and morphological characteristics of the gardens highlighted that alongside a gradient of very varied gardens, two groups of community gardens can be identified, one more precarious situated on building land, the other established on non-building land in floodable areas, and on road and railway easements. Indeed, at the agglomeration scale half of the community gardens are located in high flood hazard areas and about a third are situated less than 100 m from a railway line or main road network. A measure of the potential ecological continuity of the urban green corridor provided by community gardens compared to urban green spaces shows that the loss of ecological continuity in the event of urbanisation of community gardens would be considerable. Relegated by urban pressure to areas of non-building land, some community gardens could play the role of a discontinuous ecological corridor due to their location along linear axes within the city: water courses, main roads and railway lines. However, the gardening techniques practised there can limit their capacity to contribute to plant diversity in the city.

Keywords Community gardens · Urban wasteland · Urban biodiversity
Ecological continuity · Urban green infrastructure

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7.1 The Place of Community Gardens in Research on Nature in the City

Over recent years, the theme of nature in the city has aroused growing interest in the scientific community. This can be explained by two processes. On the one hand, urban nature as an affirmed subject of study is linked to the emergence of urban ecology. Arising from social sciences, particularly geography and urban planning, urban ecology emerged as a branch of ecology in the seventies, initiated by the work of Herbert Sukopp in Germany. As the paradigm “balance of nature” was declining, ecologists recognised that anthropogenic habitats were legitimate subjects of ecological study. Analysis of urban ecosystems thus flourished. The UNESCO development programme *Man and the Biosphere* (MAB) in 1974, and later the creation of two urban *Long-Term Ecological Research* (LTER) programmes by the *US National Science Foundation*, contributed to encouraging research on the ecological and social components of urban ecosystems throughout the world (McDonnell 2011).

On the other hand, the scale of urbanisation both in its spatial dimension—manifested by the increasing spread of urbanised areas—and its demographic dimension—demonstrated by the increasing proportion of the population living in cities—has contributed to focusing attention on urban ecosystems. In 2012 in France, urban areas covered 21.8% of the national territory, having increased by around 20% over 10 years (Laugier 2012). The spatial dimension of urbanisation has resulted in a barrier effect formed by expanding urban areas which thus restrict the movement of species at a regional level: with growing urbanisation, the important role of cities in conserving biodiversity has been recognised (Kowarik 2011). Moreover, over half the world’s population, which has increased by 30% over the last 50 years, lives in cities, representing 80% of the population of most European countries and the USA, and 77.5% of the French population (Antrop 2004; Pickett et al. 2011). The demographic dimension of urbanisation results in natural spaces in the city being subjected to growing social pressures and expectations, which can be contradictory. The urban population density means that these spaces support multiple ecosystem services (Weber and Mehdi 2012), including recreational and environmental education roles, which constitute challenges in terms of environmental justice (Cohen et al. 2012).

Natural spaces in the city thus support a commonplace biodiversity whose ecological and social value is recognised in particular for recreational and educational functions. Today, these spaces are considered as a whole, and their mutual spatial relationships as an ecological network, the urban green infrastructure, with multiple functions (Mehdi et al. 2012).

Among the natural spaces in the city, private gardens concern a large part of the French population: according to a survey on the gardening industry, in 2011 almost 90% of the population had a garden space linked to their first home including a patio, balcony or window-sill and 70% gardened (Promojardin 2012). Overall, the

space take up by private gardens is significant (Smith et al. 2005; Loram et al. 2007, 2008); 15 years ago in France, of the 1.6 million hectares occupied by individual housing 30% was covered by lawns, 14% by vegetable gardens and 12% by ornamental gardens (Girardin 2002). However, private gardens are also characterised by a strong spatial fragmentation (Gaston et al. 2005; Mathieu et al. 2007). Moreover, several studies developed particularly in Great Britain have shown the value of private gardens in urban biodiversity (Thompson et al. 2003; Gaston et al. 2007; Davies et al. 2009) and this despite the presence of invasive species of horticultural interest (Smith et al. 2006; Goddard et al. 2009). Coordinated management at a larger scale than that of the individual garden is thus necessary to orient management practices and internal organisation of these private areas towards protection of biodiversity (Nassauer et al. 2009; Goddard et al. 2010).

Within this context, community gardens represent more extensive areas which can constitute real ecological units in an urban environment, and they can also be organised in collective structures more sensitive to public action. Originally linked to industrial paternalism and culturalist urban planning, and thus representing a buffer for conflicts of the industrial city (Werquin and Demangeon 1997), community gardens have successively varied since the beginning of the twentieth century and in recent years have experienced a revival in several countries. Their existence is related to popular gardening practices which have developed since the beginning of the nineteenth century, linked to sociological changes in gardeners (Frauenfelder et al. 2014) and urban mutations (Tozzi and D'Andrea 2014). These developments are visible in the form and designation of these gardens in French: *jardin ouvrier* to *jardin familial* and then to *jardin collectif* (also called *jardin associatif* or *communautaire*) or *jardin partagé* (Dubost 2007). This change in language has also been observed in English, in which the term *community garden* (*public access community garden* or *gated community garden*) has succeeded *allotment garden* (Bendt et al. 2013).

In 2003, in a bill of the French Senate, *jardins familiaux* were defined as “land divided into plots, which are allotted to individuals for gardening purposes for their own needs and those of their family, with the exception of any commercial use” (bill passed by the Senate in 2007). In the present paper, we will use the general designation “community garden”.

As indicated by a literature review of community gardens (Guitart et al. 2012), these spaces are the focus of research rooted in social sciences. Many studies have analysed the interactions between the different categories of gardeners (Bouvier-Daclon and Sénécal 2001; Guyon 2008; Agustina and Beilin 2012; Ghose and Pettygrove 2014; Chan et al. 2015; Passidomo 2016). Other work has studied the relationships between the gardeners and local authorities (Baudry 2011; Baudry et al. 2014; D'Andrea and Tozzi 2014; Tozzi and D'Andrea 2014) and have investigated competition between community gardens and other uses of urban space (Foo et al. 2014; Frauenfelder et al. 2014). From a public health perspective, several studies have measured the effect of community gardens on diet (Alaimo et al. 2008; Corrigan 2011; Lardon and Loudiyi 2013; Wang et al. 2014), household economics

(Algert et al. 2014) and gardeners' physical and psychological health (Armstrong 2000; Okvat and Zautra 2011). The ecological and landscape features of community gardens remain relatively unknown (Consalès 2003), although work has recently grown on the role of community gardens in urban biodiversity (Joimel et al. 2013; Paris et al. 2013; Consalès et al. 2016).

The present study aimed to investigate the potentialities of community gardens in urban biodiversity and ecological continuity in cities: to what extent do community gardens represent elements of an urban ecological network? We addressed this question from the three main perspectives of urban ecosystem organisation (Clergeau et al. 2006): the local scale of individual habitat (here a cluster of community gardens), the intermediate scale, characterised by a different structure of land cover between the centre and the outskirts of the urban area, and the larger scale encompassing the entire urban area (morphological agglomeration). Firstly, we investigated the diversity of urban gardens at these different scales, and then we measured their potential role in the ecological continuity of the city.

7.2 Methodology

7.2.1 *The Study Site: The Agglomeration of Tours*

In contrast to the majority of research on urban nature, focused on large agglomerations and sites with high population density, the work presented here focuses on an urban area of medium size and population density but characterized by strong urban expansion: it is in fact in medium-sized cities that urban sprawl, understood as the conjunction of demographic growth and urban spread, is the most marked (Santamaria 2000; Brun 2015). The agglomeration of Tours (until 2010 consisting of 14 municipalities) is situated in the middle valley of the Loire, south of the Parisian Basin in the Centre-Val-de-Loire region, and it is characterized by the presence of two river corridors, the Loire and the Cher.

7.2.2 *An Operational Definition of a Community Garden*

From field experience, we clarified the definition of a community garden mentioned above. We have defined community gardens as areas divided into plots allotted to individuals to practise gardening for non-commercial use and organised collectively in a management or landowner structure. This completes the definition in the French Rural Code and is necessary to rule out some groups of private gardens spatially combined and morphologically similar to community gardens, but which are not organised collectively and can thus be assimilated to any other private garden. Despite their interest, this led us to rule out informal community gardens set

up on land belonging to private individuals or public authorities, located within dyke-protected areas in otherwise floodable zones close to the Loire (Beucher and Rode 2009).

We regularly observed that several management structures of community gardens were located in the same place and the spatial boundaries of each structure were vague or unknown, which prevented each community garden being precisely located; for this reason we worked at the scale of *clusters of community gardens*, each cluster consisting of adjoining plots managed within the framework of one or several collective structures. These clusters are nevertheless called community gardens in the rest of the present work.

An exhaustive inventory of community gardens in the municipalities of the agglomeration of Tours was conducted in the summer of 2005, based on information from municipalities and analysis of aerial photographs, followed by verification in the field (Deperrois et al. 2005). This inventory and the precise localisation of the community gardens were updated in 2015 using cartographic data and verifications from the field.

7.2.3 Diversity Criteria for the Gardens Studied

The community gardens studied were described at local (the community garden itself), landscape and agglomeration scales (Table 7.1); these data were combined in a geographic information system (GIS; using ArcGis software).

Table 7.1 Data collected on the community gardens

Scale	Variable		
Agglomeration	Number of community gardens situated in flood hazard areas (five hazard levels)		
	Number of community gardens situated close to main road and rail networks (in the buffer zones within three radii: 100, 200 and 500 m)		
Landscape	Percentage of area in each of the six classes of land cover (in the buffer zones within three radii: 100, 200 and 500 m)		
	Distance from the centre of the agglomeration (m)		
Garden (local features)	Land tenure characteristics	Regulatory	Zone of municipal urban planning scheme (three zones)
			Flood hazard area (five classes)
		Legal	Landowner (four types)
	Management structure (two types)		
	Physical	Surface area (m ²) (two classes)	
		Number of plots (three classes)	
Morphological features		Fences (three classes)	
		Upkeep (four classes)	

At the scale of the community garden, we measured the diversity of the gardens in terms of land tenure and morphological features identified through analysing urban planning documents, a survey of community garden managers and field observations.

The *land tenure* characteristics collected involved three aspects: regulatory, legal and material physical. Regarding regulatory matters, we considered the future use of the garden within the framework of two planning documents (the most recent versions available): municipal planning documents (*Plan d'Occupation des Sols, POS, ou Plans Locaux d'Urbanisme, PLU*), which indicate the medium term purpose of the community gardens (urbanised, to be urbanised, non-building land) and the inter-municipal flood risk prevention plan (PPRI) which classes the area into five flood risk levels (from 0: no hazard to 4: very high hazard). Regarding legal characteristics, the type of landowner (classed into four categories: local authority, association, private individual or mixed) and the type of management (divided into two categories: local authority or association) were taken into account. Regarding physical characteristics, we considered the surface area of the garden (in terms of two classes) and the number of plots (three classes).

The morphological features observed were in terms of the internal spatial organisation of the gardens; two parameters were recorded: the presence and type of fencing between plots (no fence, variable or wire fencing) and the degree of upkeep estimated visually and qualitatively on a scale of 2–5 (from 2: poor upkeep to 5: intense upkeep) (Fig. 7.1).



Fig. 7.1 A well-kept wire-fenced community garden

At the urban landscape scale, considered here as the space surrounding the community garden, we used one of the main descriptors of landscape, i.e. land cover. Six types of land cover were considered based on a land-cover map from several public sources and available in France: urbanised space (built, road and rail networks), semi-natural space (particularly wooded), hydrography (source: *Institut Géographique National: BD Topo, BD Ortho*), agricultural space (source: *Référentiel Parcellaire Graphique, 2012*), green public space (source: *Agence d'Urbanisme de l'Agglomération of Tours*, based on spatial data of green spaces in the centre of the agglomeration, updated in 2013) and interstitial space (wasteland and private gardens not included in the other types of land cover).

The land cover of the area surrounding each community garden was characterised by considering buffer zones of three radii from the centre of the garden generally used to estimate the diversity of urban land cover: 100, 200 and 500 m (Kong et al. 2005; Kong and Nakagoshi 2006; Muratet et al. 2008; Vallet 2009; Brun 2015). The percentage of each type of land cover in the three neighbouring buffer zones was calculated for each community garden (composition of adjacent land cover; Fig. 7.2).

In order to estimate the position of the garden in the urban gradient, we also measured its distance from the geographical centre of the agglomeration (Place Jean Jaurès, Tours; Lussault 1993); this distance varied between 1400 and 6700 m (median of 3013 m).

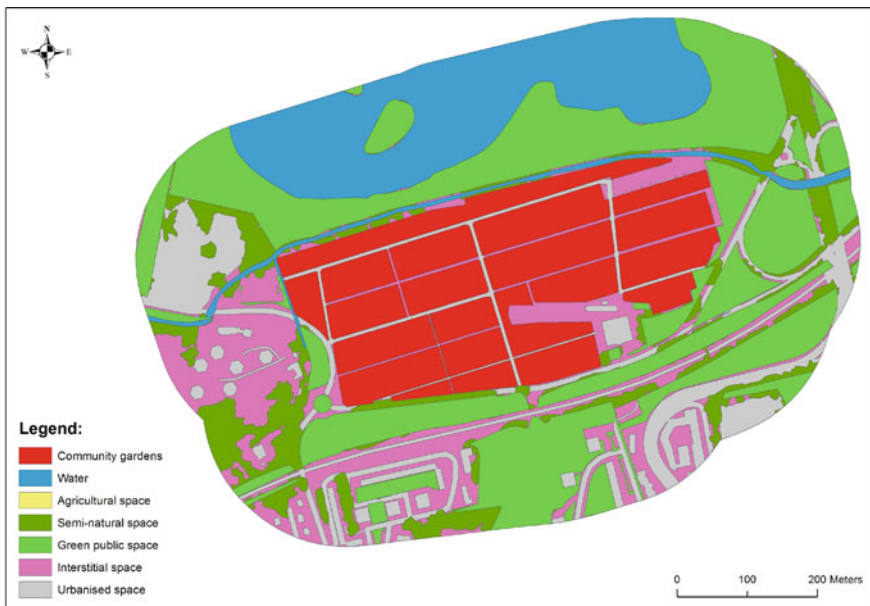


Fig. 7.2 Example of how the composition of land cover adjacent to a community garden was calculated

At the agglomeration scale, it involved estimating the type of space occupied by community gardens in terms of the constraints the space imposes on urbanisation. Two types of constraints were considered here: flood risk and the proximity of major linear transport infrastructures, such as a main road network (motorways and expressways) and railway lines. We thus calculated how many community gardens were located in the different floodable zones and how many were situated close to linear transport infrastructures (at a distance of 100, 200 or 500 m from a main road network or railway line).

With a view to investigating the local diversity of gardens and its relationship with the urban landscape, these variables underwent three multivariate statistical analyses: multiple correspondence analysis (MCA) of local data, classification of gardens through k-means clustering on their F1-F2 coordinates (MCA) and canonical correspondence analysis enabling the contribution of landscape variables to local diversity of gardens to be measured. As most variables did not follow a normal distribution, correlation between two quantitative variables or links between two qualitative variables were checked using nonparametric tests (Spearman correlation and Fisher's exact test).

7.2.4 Modelling Ecological Continuity

The potential contribution of community gardens to ecological continuity in the city was estimated in an exploratory way using the landscape graph method (Foltête and Giraudoux 2012). This method enables an eco-landscape distance to be calculated between landscape elements defined as habitat. This distance is called the *lowest cost distance* because it is estimated from the constraint that different types of land cover impose on the dispersal of a hypothetical species range; this constraint, called the *cost of dispersal*, is attributed to each land-cover class. In the light of the methods used in planning urban green structures, we considered the substructure of forest habitats, indicated by semi-natural spaces, as main habitats (Hubert-Moy et al. 2012). An expert-based dispersal cost is designated for a large range of species associated with woody species and varies between a very low level (1% for the habitat considered, here semi-natural spaces) and a maximal level (100% for the least favourable land cover for dispersal, here urbanised spaces). Combining the least-cost distances between habitats outlines an ecological network measured by a cumulative dispersal cost, which is the total distance estimating the potential movement of species in the network, determined from the dispersal costs of the different classes of land cover. In order to obtain an element of comparison, an analogous method was used for public green spaces. Table 7.2 shows the dispersal costs attributed to the six main types of land cover defined here in the optimal scenario (community gardens are as permeable to species as semi-natural spaces). The movement calculated in this scenario was compared to that calculated in the scenario of urbanisation of community gardens, consistent with changes in a part of the community gardens (Calenge 2007; Di Pietro 2007) and supported by this same

Table 7.2 Dispersal cost (DC) attributed to the main types of land cover identified in the urban landscape in several scenarios: optimal community garden (S1), minimal community garden (S2), optimal public green space (S3) and minimal public green space (S4)

Land cover	DCs. optimal CG (S1)	DCs. minimal CG (S2)	DCs. optimal PGS (S3)	DCs. minimal PGS (S4)
Urbanised space	100	100	100	100
Agricultural space	50	50	50	50
Water	40	40	40	40
Interstitial space	30	30	30	30
Public green space	20	20	1	100
Community gardens	1	100	20	20
Semi-natural space (habitat)	1	1	1	1

study (see here below). The rate of variation of the total distance between the two scenarios (graphs) was used here to estimate the potential contribution of community gardens to the ecological continuity of the city. Graphab software was used.

7.3 Community Gardens, Conditional Elements of Urban Green Infrastructure

7.3.1 *Changes in Community Gardens Over Ten Years (2005–2015)*

In 2005, 34 clusters of community gardens were inventoried, located in seven of the fourteen municipalities of the agglomeration and with half of them (17 gardens) administered by several management organisations. In 2015, 29 of the 34 community gardens still existed, six gardens having disappeared due to residential (four gardens) or industrial (two gardens) urbanisation, the latter linked in particular to railway easements; a garden in the planning stage in 2005 has since been created. Thus almost 12% of the community gardens surveyed in 2005 disappeared over ten years due to urbanisation. Consequently, in 2015, 29 community garden clusters existed, located in five of the seven municipalities which had community gardens in 2005. Most of these gardens are located in three central municipalities of the agglomeration (Fig. 7.3).

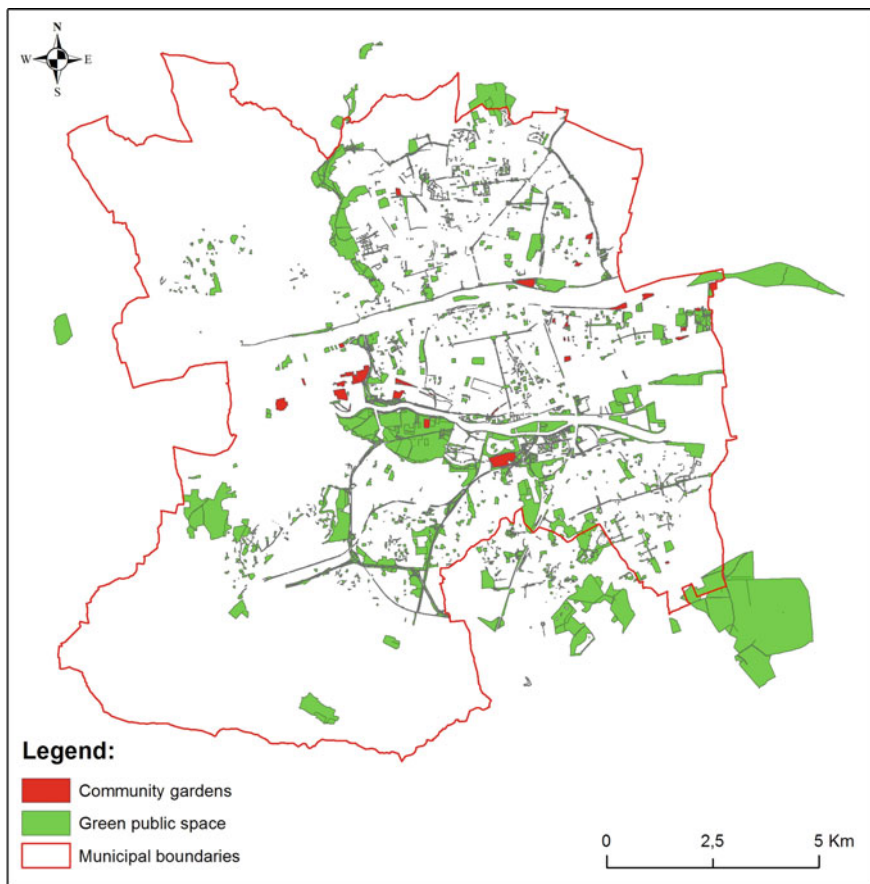


Fig. 7.3 Localisation of community gardens of the agglomeration of Tours in 2015

7.3.2 *Local Diversity of Community Gardens*

The local, land tenure and morphological characteristics of the 29 community gardens are presented in the box below.

Box 1. Land tenure and morphological characteristics of the 29 community gardens studied.

Regarding **land tenure characteristics**, community gardens are located in three areas of the municipal planning document: N (non-building land), U (urbanised) and FU (for future urbanisation). The N areas, which cover more than half of the gardens (16/29), are mainly linked to risk (14 gardens, of which four are located in a floodable area specifically intended for community gardens) and are close to transport infrastructures (two gardens). Other

gardens (eight) are located in U areas, residential areas (in the heart of a block: three gardens) or in activity and facility or combined areas. Finally, a few gardens (five) in zones to be urbanised in the short term are located in a peri-urban municipality committed to densifying its centre. Half of the community gardens (14/29) are situated in areas of high flood hazard (three gardens being in a very high flood hazard area); only five gardens are located outside flood hazard zones.

The majority of community gardens are managed by gardening associations (25/29); ownership includes local authorities—mainly municipalities—for almost half (12/29), some private individuals (five gardens), associations (four gardens), companies (two gardens) or several types of owners (six gardens).

With the exception of four extensive gardens (larger than six hectares) located in a floodable area, the size of most of the community gardens is limited (961 m²—13.8 ha, median 7900 m²); they consist of a very variable number of plots (6–511 plots, median of 32 plots; three gardens have more than 300 plots and three others have between 100 and 300 plots). The plot dimensions vary between 27 and 690 m² (median 300 m²).

Regarding the internal morphology of the gardens, most of them (19/29) have plots surrounded by wire fencing, indicating fear of theft, frequently expressed by gardeners; only three gardens of a small surface area and including a small number of plots (between 6 and 32) have no internal fences. The upkeep of the gardens varies, and most of them (21/29) show an intermediate range of levels of upkeep between intensive (5/29) and abandoned (2/29).

An exploratory analysis of the diversity of community gardens (MCA, 57% of inertia on the two main axes) shows that the variables which contribute the most to local diversity are the garden size, the regulatory zoning (flood hazard area and municipal planning zoning) and the type of ownership and management. The main gradient of community garden diversity (axis 1 of the MCA: 44% of inertia) highlights extensive and intensively maintained gardens, located in low flood hazard areas. The secondary gradient (axis 2: 13% inertia) opposes gardens managed by local authorities and situated in areas to be urbanised, against those belonging to associations, and situated in urbanised areas (Fig. 7.4).

The type of management, but not the type of ownership, is in fact correlated with the urban planning zoning, gardens managed by local authorities being linked to an allocation of gardens in an area to be urbanised in the urban planning scheme, and those managed by an association being in the majority allocated on non-building land. There is no correlation between the type of owner and manager of community gardens. The size of the gardens (surface area and number of plots, two correlated variables) and the hazard area is negatively correlated: the stronger the hazard, the smaller the garden. Flood hazard is also negatively correlated with the type of fencing: as the hazard level increases, fewer gardens are fenced.

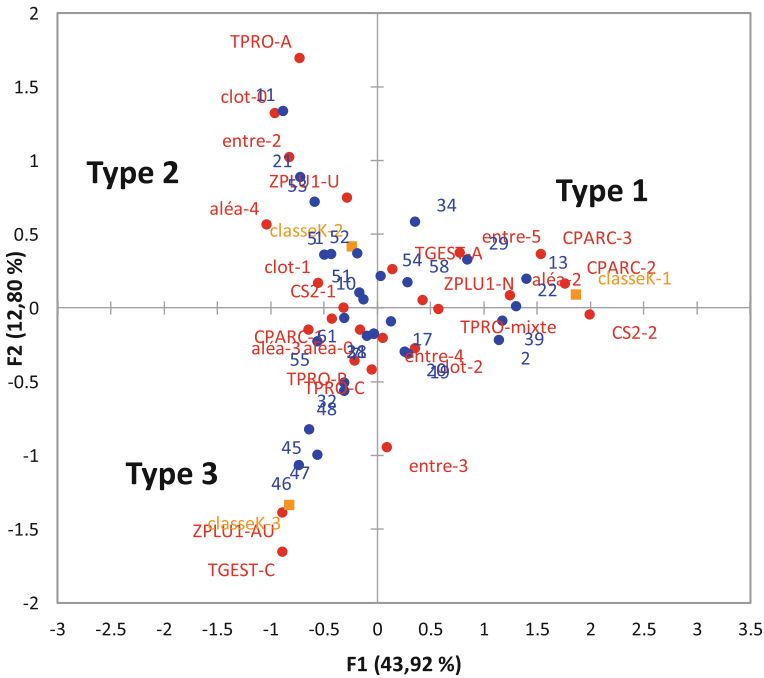


Fig. 7.4 Three types of community gardens (first factorial plan of the multiple correspondence analysis of local variables; digits indicate the community gardens, characters indicate the variables)

Three types of community gardens have been identified (classified using k-means clustering): type 1: large clusters of community gardens consisting of several hundred fenced and well-maintained plots (5 gardens); type 2: relatively small gardens with very varied morphological (upkeep and fences) and land tenure (ownership and hazard) characteristics (18 gardens); type 3: gardens managed by local authorities (while most gardens are managed by associations) and situated in areas to be urbanised, with high flood hazard (6 gardens). Thus, alongside a gradient of very varied community gardens, two opposing groups are highlighted by the analyses: well-established gardens (large and well-maintained) and gardens which are most likely to be urbanised in the medium term, located in areas to be urbanised in the urban planning scheme and managed directly by the local authorities without the intermediary of an association.

7.3.3 *Link Between the Local Biodiversity of Community Gardens and the Urban Landscape*

The characterisation of the diversity of land cover around the community gardens shows that for all the radii tested (100, 200 and 500 m around the garden) interstitial

and urbanised spaces are the most common land covers surrounding the gardens. The former are inversely proportional to agricultural and aquatic spaces; urbanised space is negatively correlated with semi-natural space; the proportion of agricultural space is positively correlated with semi-natural spaces and negatively correlated with public green spaces. The question is whether land cover next to community gardens conveys the urban gradient, and whether it is correlated with the distance to the centre of the agglomeration. For the three radii tested, this is confirmed only for the portion of agricultural and interstitial spaces, which are correlated with the distance to the centre of the city (the latter also being correlated with the degree of flood hazard).

What is the relationship between land cover and local diversity of community gardens presented above? The canonical correspondence analyses conducted on each of the three radii show that the gardens managed by local authorities and located in areas to be urbanised and of high flood hazard (type 3) are associated with a high proportion of interstitial space (wasteland, private gardens) in a small (100 and 200 m) or large (500 m) radius around the garden. Overall, land cover next to the gardens contributes to about a third of their land tenure and morphological diversity (24% for the 100 m radius and 30% for the 200 m radius) and the largest radius (500 m) explaining the greatest proportion of diversity (35% of the inertia). It is particularly the interstitial spaces (wasteland or private gardens) which contribute to the local diversity of gardens (at all the tested distances) and also the urbanised spaces (at 100 and 500 m).

7.3.4 Localisation of Community Gardens in Relation to Fluvial and Infrastructure Constraints of the Agglomeration

Observing the localisation of community gardens in terms of the constraints that space imposes on urbanisation, floodable areas and linear transport infrastructures show that half of the community gardens (14/29) are located in areas of high flood hazard (of which three are in very high risk areas); only five gardens are located in areas with no flood hazard. Furthermore, 31% of the community gardens are close to a railway line (within 100 m) and 21% to a main road network. These values rise to 62% of the community gardens close to a railway line and 69% of the community gardens close to a main road network when considering the 500 m distance (Fig. 7.5). This suggests that the localisation of community gardens in the urban area is widely but not totally linked to non-building criteria of the land.

7.3.5 Contribution of Community Gardens to Ecological Continuity

The potential ecological continuity was calculated in an optimal scenario (community gardens considered as a habitat in the same way as semi-natural spaces)

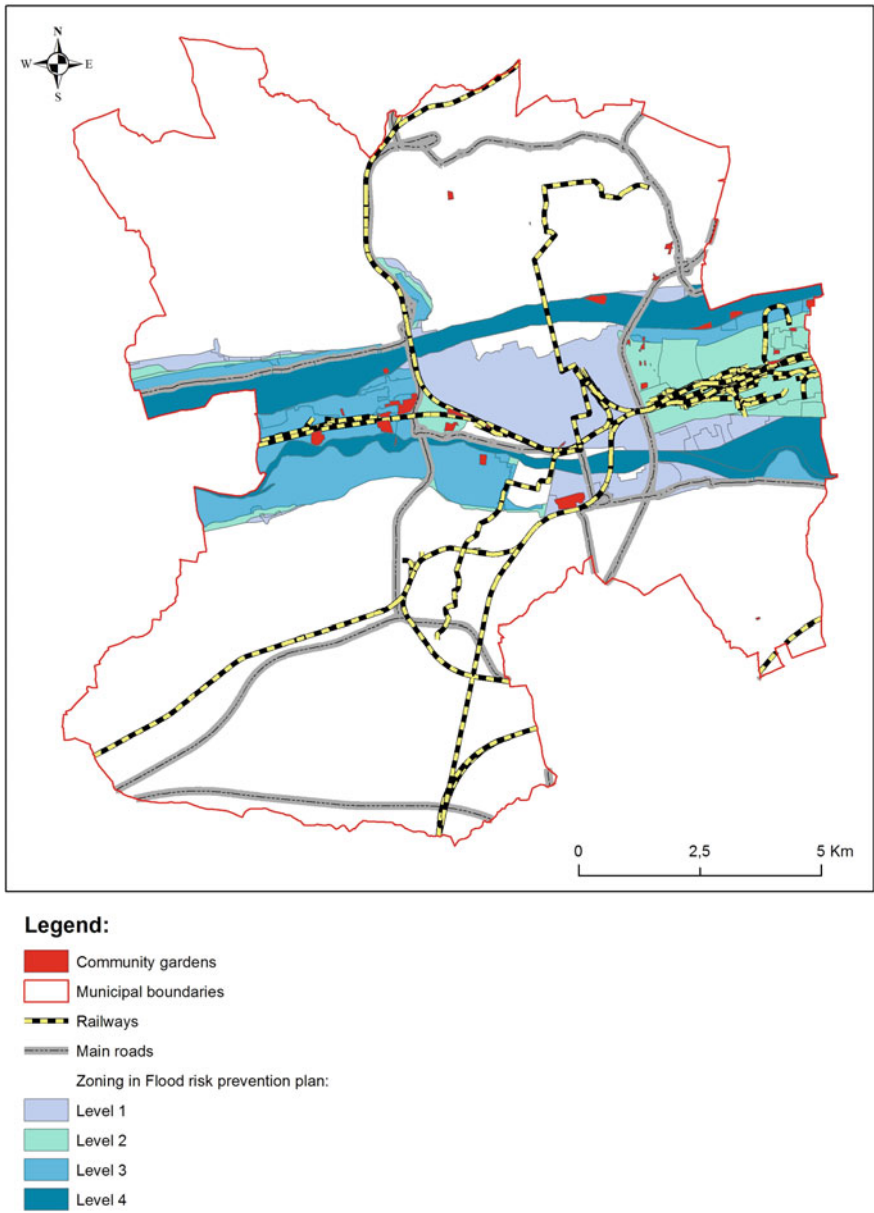


Fig. 7.5 Localisation of community gardens in relation to floodable areas, motorways and railway lines of the agglomeration of Tours

Table 7.3 Elements estimating the potential ecological continuity of community gardens compared to public green spaces

Type of urban green space	Surface area (%)	Loss of optimal ecological continuity in the case of urbanisation (%)
Public green spaces	96.38	74.11
Community gardens	3.62	6.36
Total	100	100

and in the minimal scenario (urbanisation and thus disappearance of community gardens). The loss of ecological continuity in the case of urbanisation of community gardens was 6.36% of optimal continuity; an analogous calculation applied to public green spaces (scenario of urbanisation of public green spaces) resulted in a loss of ecological continuity of 74.11%. Community gardens represent, however, small surface areas: 3.62% of green spaces (public green spaces and community gardens) on our site (Table 7.3).

7.4 Discussion and Conclusion

Compared to other types of urban public green spaces, such as parks and gardens, considering their small surface area, community gardens have considerable potentiality for the urban green infrastructure, as demonstrated by the measure of potential ecological continuity provided by community gardens at the agglomeration scale: the loss of ecological continuity if community gardens were urbanised is proportionally greater than their surface area.

Community gardens are a type of space which is more unstable than public green spaces, although less precarious than urban wastelands intended for rapid urbanisation (Kattwinkel et al. 2011). In fact, we have shown that over ten years almost 12% of community gardens have disappeared as a result of residential or industrial urbanisation (and more particularly railway development on our site), in particular in municipalities having few community gardens: over ten years, community gardens have become concentrated in the central municipalities of the agglomeration.

From the large range of situations studied, current community gardens include both stable large, well-maintained gardens and gardens located in areas to be developed, managed directly by local authorities and probably intended for urbanisation in the medium term. Indeed, the garden size and regulatory zoning (flood hazard area and municipal planning zoning) are the main variables contributing to the diversity of community gardens. This suggests that the localisation of community gardens in the urban area is widely but not totally linked to the non-building criteria of the land.

The most unstable gardens are linked to a high proportion of interstitial space (wasteland and private gardens) around the garden, at all the radii tested. Since this type of land cover is correlated with the distance to the centre of the agglomeration,

it is thus the most outlying community gardens which are threatened with disappearance due to urbanisation. These clusters of community gardens, located on building land, can play a role as a land reserve for the local authorities, for whom the community garden represents a means to enhance urban wastelands pending clarification of urbanisation projects; in this case, community gardens are temporary or even precarious spaces.

Furthermore, we have highlighted the localisation of another part of community gardens in floodable areas on non-building land and close to transport infrastructures: half of the community gardens are located in high flood hazard areas and around a third are located less than 100 m from a railway line or a main road network. These aspects support the stability of these gardens, while also being a major element to appraise their potentiality for the urban green infrastructure: marginalizing these community gardens in the urban space, although probably disadvantageous for some residents, could also constitute an advantage for ecological continuity in the city. Relegated by urban pressure to areas where building is not possible (Joimel et al. 2013; Ernwein and Cavin 2014), rejected to floodable zones or road and railway easements (Paris et al. 2013), a portion of community gardens can play a role as a discontinuous ecological corridor due to their position along linear axes in the city: water courses, expressways and railway lines (Fig. 7.6).

Although their position in the city can reinforce the ecological corridor role of certain community garden clusters, tested here for a range of hypothetical species of



Fig. 7.6 A community garden alongside an expressway

forest environments, the gardening practices used on them can limit their capacity to contribute to species dispersal in the city (Cameron et al. 2012). Indeed, in line with some recent research projects on soils of community gardens in several European countries (Hursthouse and Leitão 2015; Voigt and Leitão 2015) and in France (Grenet et al. 2016), findings have highlighted the role of past and current use on the soil characteristics of community gardens: levels of heavy metals (Schwartz et al. 2012; Bechet et al. 2016) and nutrients (Schwartz et al. 2012).

Yet we know that the whole range of horticultural practices are found in community gardens, from the most intensive and pesticide intensive, to the most organic (Guyon 2008), as in individual gardens. Gardening practices in community gardens and their links with the socio-demographic features of gardeners and the diversity of urban plant communities are the subject of an ongoing research project supported by the French Ministry of the Environment (Programme Ecophyto).

The value of community gardens in strengthening urban biodiversity depends, on the one hand, on their durability, linked to their localisation on building land and to local authority projects and, on the other hand, on the horticultural practices applied on these areas by the gardeners. To conclude, we suggest that the potentialities of community gardens for urban biodiversity should be appreciated with regard to these two conditions: habitat durability on one hand and horticultural practices implemented on the other hand.

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