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Peri-urban Agroecosystems in the Mediterranean: diversity, dynamics and drivers.

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Abstract:

To address sustainability challenges of agro-ecosystems located in Mediterranean urban regions, this paper focuses on the multidisciplinary subject of urban agricultural systems. To better understand the diversity and dynamics of peri-urban agro-ecosystems and the main drivers of their sustainability, we compare six case-studies located in Southern Europe (Montpellier, France; Pisa, Italy; Lisbon, Portugal; Athens, Greece) and the Maghreb (Constantine, Algeria; Meknes, Morocco). The research is based on fieldwork in each urban region (qualitative analysis) and literature analysis aimed to position each case study in its national and Mediterranean contexts. The comparison between local contexts indicates large discrepancies in the integration of environmental focus among the respective urban planning objectives. Generally, urbanization tends to accentuate agricultural diversity. The different forms of peri-urban agriculture evolve despite their persistent decline, and they also show a capacity to resist, and even new growth in response to urban demand.

Keywords:

Agriculture – Urbanization – Comparative analysis – Qualitative analysis – Public policy

Introduction

The Mediterranean region is one of the areas in the world most exposed to the combined effects of urban growth and climate change. The Mediterranean region covers roughly 854 million ha, but only 118 million (14 per cent) are suitable for agricultural production (Zdruli 2012). The population is expected to continue increasing (from 446 million in 2000 to 570 million in 2025) and remain concentrated in cities and on coastlines. The peri-urban agro-ecosystems face major global issues. In order to address these threats over the long term, three challenges must be met: the conservation of ecosystem diversity, the scarcity of water resources, and food security.

Challenges for the peri-urban agro-ecosystems

The first challenge is the richness and vulnerability of Mediterranean ecosystems. According to Underwood *et al.* (2009), the Mediterranean biome is richer in terms of biodiversity than Africa and tropical Asia combined.

However, this biodiversity is at risk. Urbanization threatens biodiversity, first through the ‘artificialization’ of land, and also through patches of urban development mixed with wildlands that fragment habitats and increase the risk of fire (Spyratos et al. 2006). A second challenge is the scarcity of water resources. According to Garcia-Ruiz *et al.* (2011), the overexploitation of water in plains and valleys comes as a result of (1) urbanization (including tourism and industry) and (2) intense agriculture through irrigation. These factors act in concert with the reduced water storage capacity of rural areas, plateaus and highlands, resulting from agricultural abandonment (erosion, landslides) and climatic change (reduced rainfall and snowmelt consecutive to warming). The third challenge is food security. Agricultural areas of the Mediterranean have always needed to engage in trade for food. According to Turmo (2012), the Mediterranean diet derives from trade among agricultural areas of the basin. However, population growth has increased food dependency. According to AgriMonde (2009), the Mediterranean is and will be the region that is most dependent on imports for food. Therefore, the issue of food security arises at the level of trade between Europe and the Southern Mediterranean shore, but also between the Mediterranean and other exporting countries (Hervieu *et al.* 2006). Local and regional exchanges will play a key role as interfaces of social and environmental sustainability.

Agriculture represents divergent interests in the analysis of environmental and food issues: providing ecosystem services and food, yet generating threats to resources. The apparent contradictions in these issues suggest the need to adopt a systemic approach. Conserving natural resources during production, ensuring food security, allowing the supply and marketing of agricultural products, and elaborating strategies for developing rural and urban territories, are all objectives that should be part of the search for sustainable solutions (MediTerra 2008). In this Mediterranean context, urban and peri-urban agriculture can be viewed as one means for agricultural development to make more efficient use of land. The scarcity of arable land, water, and the fragility of cultivated ecosystems hinder the development of agriculture in the Mediterranean (Ben Ali *et al.* 1996; Nasr et Padilla 2004). This explains the focus of the literature on one hand on agricultural lands facing urbanization (Jarrige *et al.* 2003; Elloumi *et al.* 2011; Perrin 2013), and on the other hand on the internal contradictions of Mediterranean agricultures, where both productivist and non-productivist intertwined trends (Ortiz-Miranda et al. 2013). In contrast, research works on the diversity of peri-urban agro-ecosystems and their development in the Mediterranean remain sporadic.

The Mediterranean agro-ecosystems in the urban and peri-urban areas

Urban agriculture still exists. Nasr and Padilla (2004) have shown that its presence in Mediterranean cities is historical. It has appeared in various forms that remain an integral part of society: gardens, huertas, oases. However, it has declined sharply with agricultural modernization and urban development. At the cities’ periphery, urban expansion absorbs agricultural and natural terrains. The peri-urban agricultural that was once rural and primarily oriented towards national markets and exportation is now found within the jurisdiction of urban policies.

Some local experiments on the conservation of threatened urban agriculture have been studied: the Huerta of Valencia and the agrarian park Baix Llobregat in Barcelona (Paül & McKenzie 2013), the peri-urban agricultural parks in Italy and Spain (Giacché 2014), the plain of Mitidja and the Setif region in Algeria (Imache *et al.* 2010; Boudjenouia et al. 2008), the Soukra plain in Tunisia (Bouraoui 2013), the urban agriculture in Casablanca (Kasper & Rau 2012). These works investigate local initiatives that seek to enhance the economic, social, and environmental value of urban and peri-urban agro-ecosystems. The studies tend to be focused on symbolic locations, and have little relationship with each other.

Some recent publications have compiled summaries of the agricultural dynamics in urban regions, showing the key role of urban agriculture in the food security of southern Mediterranean cities (De Bon et al. 2010; Hamilton et al. 2013), or analysing agriculture’s positive and negative contributions to the self-sufficiency of cities in developed countries (Mok et al. 2013). However, recent comparative work on the Mediterranean region is almost non-existent, even though the region offers a particularly interesting perspective with its amalgamation of Northern and Southern countries with contrasting socio-economic profiles but quite similar problems of urban expansion, agriculture and the environment.

The object of our paper is to compare the relationships between urban systems and agricultural systems in some cities of the Mediterranean: Are there contrasts between Northern and Southern cities? Do we confirm the differences reported in the literature between developed and developing countries? Are the differences between local contexts stronger? Are there some specific issues due to the Mediterranean context? In order to give some responses to these questions, we will compare six peri-urban agro-ecosystems in the Mediterranean region, and analyse their diversity and evolutionary dynamics, through an agricultural-urban systemic approach.

Method

The methodological challenge of our work is to better understand the relationships between urban systems and agricultural systems by looking beyond the 'rural-urban divide' separating urban perspectives from agricultural perspectives, and examining the interactions between these systems. We used this systemic approach in the comparison of six urban regions on the northern and southern banks of the Mediterranean (Valette et al. 2012). In each case study, we described agricultural-urban dynamics at three levels: farms, local community projects, urban region. Sustainability was assessed at each level through global and local challenges, drivers, and actors that foster (or not) the links between cities and agriculture. To do this, we analysed urban sprawl, peri-urban farmland use, adaptation of farming systems, natural resources management, public policies, actors' strategies and territorial governance. This comparative approach (Perrin 2015) shows how local issues of urban and peri-urban agroecosystems reflect the ways in which global trends (on land, climate or political issues) impact specific agroecosystems throughout the Mediterranean region. It also highlights how local initiatives and policies actually deal with these global trends.

We compare six case studies. In each, we use two elements to characterize the urban agricultural system: the diversity in agro-ecosystems and the dynamics of evolution in the city-agriculture relationship. The case studies were conducted in six countries from the northern and southern Mediterranean regions, located in the west and centre of the basin (Table 1). The cities involved have all been subject to sustained population growth and the dynamics of urban spread, both compact as in the Maghreb and more diffused as in Southern Europe.

Table 1 Six case studies

Case study	Constantine (Algeria)	Meknès (Marocco)	Athens (Greece)	Lisbon (Portugal)	Montpellier (France)	Pisa (Italy)
Study area						
Area (local name)	City region (wilaya)	Urban development plan (SDAU) boundaries	Metropolitan Athens area	Lisbon Metropolitan region (RML)	Montpellier metropolitan (MMM)	Urban region (Unione dei Comuni Area Pisana)
Population	938 400 (wilaya)	599 555	3 737 750 (2011)	3 436 948 (INE, 2011)	434 100	200 000
Surface, km2 (density, inhab/km2)	2297 (408)	633 (947)	42 (8700)	9 497 (362)	423 (356)	500 (400)
Growth (10 last years)	2,2%	21,3%	1,3%	5,35%	13,8%	3,5%
Ecosystems						
Geography	Plateaus, hills and plains	Plateau	Coastal plain	Alluvial plain, coastal plain, hills	Coastal plain	Alluvial plain, Hills
Water resource	Low	Irrigation and rain	Limited irrigation	River, aquifers, irrigation	River, irrigation	River, reclaimed area, coastal lake
Biodiversity interest	Shrubland, Aleppo pine	Olive trees!	coastal wetlands- Natura 2000 coniferous forests shrublands natural pastures	Forest (and corktrees), Wetlands	Matorral, Wetlands	Coastal Forest, Wetlands, 3 Natura 2000 areas, a Regional Natural Park
Natural hazards	Flooding, erosion, high temperature	Drought, flooding, fire	Fire	Flooding, Fire, erosion, streams and aquifers pollution	Flooding, Fire	Flooding, Landslide
Agricultures						
Main periurban productions	Cereals	Vegetables Cereals Orchards	Vine Olive trees Shrublands	Rice, Vine, Fruits and Vegetables, Cork, Olive trees	Vine Cereals Shrublands,	Cereals Industrial crops Livestock (cattle, sheep)
Types of farms (average farm size)	Specialized farms (dry farming)	Small and large scale farms	Small scale farms (vine), Part-time farmers	Specialized farms, small scale farms	Specialized farms (vine)	Small and large scale farming, Pluriactivity (14 ha)
Public policies						
Agrifood sector policy	Agricultural national plan	Agricultural national plan, Plan Maroc Vert (2008)	CAP (general) Social policy which includes urban municipal gardens	CAP (Rural Development Program 2014- 2020)	CAP	CAP, regional agricultural and livestock plan
Urban planning	Zoning	Zoning (weakly enforced)	Zoning weakly enforced Mega-projects	Zoning (urban growth; natural agricultural z.)	Zoning (urban growth, agricultural and natural zones)	Zoning (urban growth, agricultural and natural zones)

Agri-urban actions	No Agri-urban public actions	Emerging agri-urban public actions	Urban gardens Wine Altican road CSA baskets	Wine road Short food chains Urban gardens	Wine road, Agri-parks Short food chains, Urban gardens	County food plan, urban gardens, olive oil road, short food-chains
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Although the case studies cannot pretend to represent the totality of Mediterranean contexts, they do present different types of relationships between cities and agriculture: (1) separation and competition dominate these relationships in Maghreb, in Constantine (Algeria) and Meknes (Morocco); (2) the relationships in the two biggest cities, Athens (Greece) and Lisbon (Portugal), are equally scarce but demonstrate a resurgence following the economic crisis experienced by the countries of southern Europe; (3) Montpellier, (France) and Pisa (Italy), which are middle size cities, are characterized by a city-agriculture relationship at the heart of public policies promoting sustainable development.

Constantine, Algeria

Constantine is marked with a long history of specialization in cereal production, political upheavals creating insecurity in access to land for farmers, and national urban policies dominated by housing and construction objectives. The economic viability of local agricultural systems depends on markets found outside of the city, in Algeria or internationally.

Periurban agriculture is dominated by cereal production

There is limited diversity among the agro-ecosystems surrounding Constantine (Fig. 1, a). The land, flat and fed by winter rains, is well adapted to cereal cultivation. To the north of the city, a *huerta* was developed on an upwelling of water at Hamma Bouziane, the historic garden of Constantine. There are also extensive forest zones of Aleppo pine, eucalyptus, oak, and cork oak. Traditional agriculture was historically characterized by social inequality and a system of tenant farming on the land. But after the country's independence in the 1970s, the government's socialist policies led to large collective farms on nationalized lands of European colonists and Algerian land-holders, or on public lands. By the end of the 1980s and during the 1990s, the failure of socialist policies led to the restitution of land to the original Algerian owners or the reorganization of socialist farms into a different style of collective (*Exploitations Agricoles en Commun*) or individual activity (*Exploitations Agricoles Individuelles*). The irrigated land of small traditional peri-urban agriculture of Constantine (market farms and fruit trees) has been largely overtaken by development, and today, the cultivation of cereal alternated with fallowing is the predominant system of agriculture. Any diversification towards fruit trees and market farming is limited to irrigated areas around the ancient Hamma Bouziane gardens. The province of Constantine holds 5,941 farms of which only 492 (8%) are irrigated. Beyond the uncertainty of available land generated by urban growth, the agricultural sector is weakened by the naturally poor soil, adverse weather conditions, and a lack of water resources.

The agricultural terrains remain a reserve for planned urban expansion

As seen throughout Algeria, the focus is on clearing constructible land to absorb the considerable urban growth that has occurred for the last 40 years. Urban planning is conceived as identifying land to reserve for habitation, commercial development and infrastructure. Agriculture is not part of the formula for peri-urban space. As a result, farmers in the area are constantly concerned about the vulnerable access to land. Beyond the typical coexisting property markets with different price structures (agricultural versus urban) that favour urban development on agricultural land, the national housing policy prescribes low prices for the transfer of State lands (usually agricultural) with the specific intent of supporting construction efforts. This policy has increased development pressure on public land and resulted in the integration of large tracts of agricultural land into the urban perimeter. In the most recent urban plan, 1,676 ha of land previously designated as agricultural (part of a grouping of 2,099 ha of public and private land in the area of Constantine) were designated for urban development.

Few projects integrate rural and urban systems

There are, however, some farms geared towards diversification: arboriculture and market gardening in the irrigated zones (ancient Hamma Bouziane gardens), dry arboriculture, legumes (in crop rotation rather than fallowing), and a few instances of poultry and dairy farming. This diversification is not significantly linked to the city itself and suffers from the uncertain access to land and a lack of capital investment. Our research (Bendjaballah et al. 2013) shows that diversification appears to be more prevalent among the larger farms in the areas of Hamma Bouziane and Aïn Smara. Small producers are interested in diversifying but generally don't have the capital to make the

investments necessary. Any attempts at diversification are even more difficult when the farmer does not own the land.

Meknes, Morocco

The province of Meknes is located in the centre of the Saïs plain, one of the most fertile areas in Morocco, and Meknes owes its reputation to the prosperous, surrounding agriculture. In 2011, there were approximately 36,285 ha of agricultural land in the urban and peri-urban area of Meknes and its adjacent municipalities (Valette *et al.* 2013), including around 1,800 ha within the urban perimeter. In 2004, the total surface was estimated at 31,900 ha, of which 10% was irrigated.

There is a gap between urban and peri-urban agriculture

Intra-urban agriculture occupies three valleys (non-constructible) holding very small farms (between 75 a and 3 ha) with limited production in market gardening and arboriculture, and a few head of cattle or sheep (Fig. 1, a). The farms are irrigated with water from the wadi and with city waste water (which affects the sanitary quality of the products). By contrast, the peri-urban zone encompasses vast, mechanised and well irrigated farms. These farms are primarily producers of winter cereals (77% of all cultivation), market farming (13.2%), and arboriculture (27.7%), intensified with irrigation and inputs, including a growing presence of olive production. These peri-urban examples of highly productive agriculture are the target of the Moroccan national plan supporting agriculture (*Plan Maroc Vert*) which aims to transform Moroccan agriculture into mechanised production for export.

Public action threatens agriculture

In spite of national programs, the major threat to the sustainability of urban and peri-urban agriculture is urbanization. In Meknes, there is a sharp contrast between (1) national agricultural policies addressing food security and water management issues at a national level, and (2) urban policies focusing on social housing and economic development. A remote sensing analysis of land changes in the Meknes region showed that 2.4% of the agricultural areas existing in 2001 became urbanized by 2011 and 6.1% was transformed into bare soil, which can be considered as a first step towards urbanization. Despite a history of compact urban growth, land speculation is extending the perimeter of the city of Meknes faster than required by the increase in population. This urbanization and its impact on farmland is directly influenced by local and national public policies. In the early 1990s a trend emerged in Morocco advocating the privatization of state, collective, and *guich* (religious orders) landholdings, as one of the best incentives to encourage farmers to initiate improvements. This perspective leads to the *main levée*, a law endorsed in 2005 that allows a cooperative's beneficiaries to become private owners of their agricultural land. However, most farmers refused to invest and either sold their land at very attractive prices or modified their farming practices (annual crops, fallowing) in a strategy of land speculation. Prior to privatization, there were 32 cooperatives in the Meknes region covering a total surface of approximately 15,000 ha with a UAA (used agricultural area) of 14,000 ha. Since being distributed among 1,119 assignees, at least 3 of the cooperatives located closest to the city fringe have almost completely disappeared (as of 2014), and approximately 60% of the remaining cooperative land has been sold (Valette *et al.* 2013).

The few agricultural urban projects are likely not to be implemented

The hard truth remains that very few projects have been well designed to develop the synergy between agriculture and the city. Two emblematic examples stress the divergent issues of agriculture and urbanization that we have observed in this case study. First, the landscape plan for the Oued Boufekrane valley, designed by the local urban agency in 2008 attempts to integrate agriculture into the urban system as one of the structural elements enhancing multifunctionality (conserving urban green space, and food production). This plan sets aside 25% of the project's surface for market gardening, but it doesn't specify the source of farmers or the mechanism for supporting them. In the real world application, there appears to be very little political will to see this project succeed, even now, seven years after it was conceived. A more informal project introduced as intra-urban CSA (Community supported agriculture) currently led by a local association claims to promote and support synergies between intra-urban agriculture and the urban population. A closer examination suggests that rather than developing a genuine agricultural-urban initiative, the project's main objective is to establish roads, a water supply and electrical service in the valley in order to make it attractive to investors and more suited to welcome urban activities such as restaurants and playgrounds.

Fig. 1 Periurban agroecosystems in Meknès/Constantine (a), Lisbonne (b), Pisa (c)



a) Maghreb: Social housing programs in the periphery of Meknes. Periurban market gardening in Meknes. Olive trees groves surrounding Constantine. Photos: Dugué 2014, Bendjaballah, 2014.



b) Lisbon: Subsistence agriculture in the periurban town of Almeirim. Unplanned subsistence agriculture in occupied areas in Almada. Hortas urbanas de Almada. Photos : P. Abrantes.



c) Pisa: Mosaic of land uses in the urban region. Pluriactivity: cattle and horse breeding, direct sales of meat, rural tourism. Urban sprawl: the airport enlargement on an old area of family gardens. Photos: E. Marraccini.

Athens, Greece

Peri-urban rural and open space of the Athens metropolitan area (35% of the national population, Attiki Region) is marked by pronounced urban sprawl at the expense of open space. This has been the result of a massive rural exodus after the World War II and rapid urbanisation in the absence of a coherent and efficient institutional framework regarding land use planning and control. The absence of a national cadastre and forest register has allowed illegal construction and encroachment on public land resulting in fragmentation of agricultural land, forest fires, and spatial discontinuities with alternating residential patches, degraded scrublands and fallows.

A diversity of family farming strategies face urban sprawl

Family farming practices use a diverse range of strategies to respond to a constraining context; they must manage geo-climatic factors and local specificities such as soil fertility, farming specialization, and vulnerability to urban expansion: (1) the use of intensive agricultural methods (greenhouse horticulture, poultry), innovative methods

(organic, Attican wine tours, on-farm sales) and remunerative strategies (market proximity); (2) speculative land management strategies such as leaving land fallow, flexible cultivation methods (short cycle crops), and income support from pluriactivity; (3) abandonment of extensive agriculture (e.g. cereals, olive groves) through progressive fragmentation and liquidation of farms lacking succession (proximity of urban labour market) or deduction in agronomic value (urban ecological burden) (Moissidis & Duquenne 1997).

In the Messoghia plain, urban sprawl continues

In the late 1990s, these phenomena were more exacerbated in East Attiki, and especially the Messoghia plain (38.900 ha belonging to 11 Municipalities). The construction of mega-projects in relation to the 2004 Olympic Games in Athens (including the new airport and peripheral highways) triggered counter-urbanisation phenomena causing a population shift from the inner city to peri-urban spaces, and encouraged the transformation of littoral residences from seasonal to permanent, further shrinking farmland and degrading the natural environment (Nikolaidou 2011). Between 1996 and 2006 the population on the plain of Messoghia increased by 42% and the surface of agricultural land was reduced by 36%. In particular the emblematic vineyard (the famous “Retsina wine of Attiki”- traditional appellation) decreased by 52%, especially in the expanded new airport area (land expropriation to establish major infrastructures).

The economic crisis showed that another paradigm based on localised agri-food systems is possible

The outbreak of the public debt crisis (2009) and collapse of the real estate market has dampened the frenzied urban development in the peri-urban region of Athens. The economic crises also led to a broader questioning of the urban consumerist pattern and living conditions. However, the public debt crisis contributed to the relaxation of the national urban development plan (including legislation on specific building conditions on coastal, protected natural areas, agricultural land) in an effort to attract international investors through privatization or concession of public land. The self-managed urban farm of “Agros in Ellinikon” is an emblematic grassroots movement conceived in metropolitan Athens (2011) to combat the large scale fast track privatisation of public land (620 ha, former international airport). The farm (2,600 m², organic, traditional seeds, vegetables and olive grove) which focuses on food production for educational and social purposes (Anthopoulou 2013), was originally planned to become a high green Metropolitan Park. Municipal allotment gardens are the most widespread and popular form of urban agriculture in Greece. They first emerged in 2011 as a spontaneous initiative of municipalities developing social policy schemes to tackle the poverty and depression of urban dwellers affected by the economic crisis and severe austerity measures. There are approximately 25 small-scale gardens in the metropolitan Athens area. They are primarily oriented towards vulnerable social groups with the intention of easing family food expenses and enhancing social solidarity in neighbourhoods (Anthopoulou 2013). All of these civic and institutional initiatives confirm the social need for food re-localisation and reconnecting with agricultural land. The economic crisis highlighted problems in the post-war urban development model in Greece and the absence of an agricultural-urban perspective in spatial planning. It showed that another paradigm based on localised agri-food systems in peri-urban areas is possible.

Lisbon, Portugal

In the Lisbon Metropolitan Region (LMR), one of the most fertile regions of the country, a highly professionalised agriculture co-exists with small-scale subsistence agriculture, giving the landscape a somewhat rural quality through the juxtaposition of agricultural and urban spaces, be it within city limits, in its outskirts or in peri-urban spaces. Urban expansion and sprawl have not been pervasive enough for this type of traditional agriculture to disappear (Abrantes et al. 2013). In fact the rural exodus during the 1960s and later in the 1980s, the return of Portuguese nationals from the former African colonies, as well as the economic crisis since 2009 were key elements keeping and boosting agricultural practices and the tradition of farming within the city and its surroundings (Luiz & Jorge 2012).

The crisis has given rise to new types of small-scale subsistence agriculture

During interviews made throughout the LMR, we identified three types of subsistence agriculture related to the type of farmer and the land tenure: (1) Traditional subsistence agriculture that is practiced on farms or on private plots waiting for construction. This is practiced by farmers and by landowners as a complement to employment or income (Fig. 1, b). According to INE data (2009), this type of agriculture within the LMR accounts for 7% of the national utilised agricultural area dedicated to family farming. (2) Subsistence agriculture called “unplanned” (Luiz, Jorge 2012), is carried out on utility and restricted areas (e.g. near roads, transportation routes) and on vacant parcels, many of those areas without the knowledge of the property owner. This type of agriculture is usually associated with an elderly or unemployed population and can be found throughout the region but mostly in suburban municipalities. The municipality of Almada (a suburban area on the southern bank of the Tagus river)

has 537 ha of agricultural terrain, 60 ha of which are dedicated to “unplanned” agriculture. (3) An agriculture that we have called “planned” (*hortas urbanas*), is practiced in community gardens, most of them were originally unplanned gardens that have been developed by the municipalities and replicated both in urban and peri-urban contexts. These municipal agricultural-urban projects keep expanding both in offer and demand. The population has diverse social-economical backgrounds, ranging from retirees and former agricultural or industrial workers to younger employees in the services sector. In the case of all three types, the production accounts for 80% to 100% of the food source of each family (3 to 5 family members on average); and in some cases surplus products are either exchanged or sold out.

Small-scale subsistence agriculture is progressively integrated into municipal master plans

The expansion of the *hortas urbanas* and its progressive integration into urban planning through instruments like the Municipal Ecological Structure (e.g. Lisbon and Almada masters plans) or the Metropolitan Ecological Network become a factor of permanence of these areas. These types of agricultural practices benefit from the sustainability dimensions that they can provide, their contribution to environmental issues such as the capability to create, regenerate and/or maintain green corridors, and their impact on socioeconomic issues such as income generation for the families. The uncertainty and fragility of traditional subsistence agriculture and the unplanned agriculture is related to their dependence on the variations of the real estate market on one side, and social-economic conditions on the other. However, the current trend of acquisition by the municipalities increases the chance that these unplanned agriculture spaces will be transformed into community gardens (e.g. 51 ha of the 60 ha of unplanned gardens will be integrated into the Almada community garden municipal network, thus representing almost 10% of the total farming area in the municipality). The current orientation of National public policies towards self-sufficiency and local food supply indicates a promising future for the sustainability of subsistence agriculture and for the strengthening of the relationship between city and agriculture at the scale of these urban regions.

Montpellier, France

The viticulture crisis leaves space for other agricultural dynamics

The Montpellier region has a long history of a wine grape monocrop, but there has been a recent trend in diversification of peri-urban agro-ecosystems. Vineyards still occupy the majority of peri-urban agricultural terrains, however, the surface in grape production has decreased significantly since 1960, challenged by a succession of crises in wine production. More than half of the vineyards in the Hérault department were torn out between 1974 and 2010. This crisis is linked to a drop in the demand for table wines, but it has also been affected by the rapid expansion of the residential and service sectors of Montpellier. The population of the metropolitan region tripled in fifty years, from 145,000 inhabitants in 1960 to 432,000 in 2012. This demographic growth created a striking urban spread around the city of Montpellier and the surrounding villages. During the same period, declines in the wine industry left land available for other farming systems: horse farms and forage cultivation, market gardening and cereal crops. The spread of these agro-ecosystems in the context of intense pressure from urban expansion is based largely on spatial mobility: they use the land temporarily until urban expansion overtakes them.

Agricultural spaces and natural spaces enter the realm of urban planning

The relationship between the city and agriculture were also evolving during this period (Perrin et al. 2013). Until 1960, the growth of Montpellier was linked to the expansion of the vineyard and wine economy. Then between 1960 and 2000, relations between the city and farming grew apart. But since then, the relationship between the two has been on the rise, and the city of Montpellier has come to tie high quality wines to its image. A list of community support for the industry bears witness to this relationship: a trail of wine and heritage, an annual festival of vineyards and wine, the promotion of wine and direct sales, the addition of a ‘Grès de Montpellier’ wine at official events. In 2006, the city adopted a metropolitan Master Plan which includes specific planning tools for farmland conservation and urban containment. In a complete about face, agricultural and natural spaces have become recognized as a framework of urbanization at the scale of the metropolitan region. These strict regulations have been incorporated into local urban planning of the peri-urban municipalities and have slowed the rate of urban expansion on agricultural terrains. Nevertheless, not even the strictest regulations favour the sustainability of an agricultural presence in the absence of existing agricultural projects.

Agriculture, nature and food favored the emergence of multiple urban agriculture initiatives

In recent years, many agricultural-urban initiatives have emerged. From a top down perspective, the city fosters new multifunctional farming systems in order to address two major issues: (1) environmental issues, such as natural hazards related to floods and fires, and (2) local food supply through short chains. Such issues are key drivers of the reconnection between cities and agricultural sustainability. These intentions are manifested by several agri-park projects on agricultural terrains acquired by the city or the metropolitan region, with the objective of combining agricultural production, forest and environmental services (protection against natural risks) and recreation spaces for residents. The quality of life and the environment as well as food sources (farmers' market) is making peri-urban agriculture an issue in the small peri-urban municipalities. Livestock has been introduced to defend forest land from fire risks, and maintain grasses along river banks or in fields designated to hold flood waters. From a bottom up perspective, the demands of city residents for access to nature and gardening has resulted in a program initiated by the city in 2004 to create collective and shared gardens in the heart of urban space. The sustainability of this amateur urban agriculture rests on its occupation of the interstitial spaces between habitations and its social functions. The governance of these interactions between the city and agriculture is still under construction. An agricultural and food production policy was developed in 2014 which represents the first effort to link the different metropolitan services and the peri-urban municipalities to encourage a return to cultivation on fallow agricultural terrains, and promote agricultural production to supply the local restaurant industry and school catering.

Pisa, Italy

Urbanization has had a profound effect on peri-urban agriculture and on the competitiveness of Italian small-scale farming.

The number of periurban farms are diminishing, the remaining survive by diversifying

The urban region of Pisa (Tuscany, Italy) is composed of a coastal plain with cereal and industrial crops, livestock and vegetables, and hills exclusively planted in olive trees. The plain and the hills are connected by a complex hydrological system composed of two sub-systems: a reclaimed area and a bench terraced-based drainage area. Marraccini et al. (2013) analyse a combination of stakeholder interviews and policy documents to identify issues for peri-urban agriculture in the region of Pisa. The most frequently encountered issues were the quantity and quality of water resources, food production and the protection of farmland against urbanization. Farmland protection is integrated into several institutional and planning documents, e.g. urban planning at the municipality and county levels (Marraccini et al. 2013), and has also been the object of regional legislation on the establishment of a land bank for the management of abandoned or unexploited agricultural areas. Despite the importance that policies accord to peri-urban agricultural land, the last agricultural census highlighted a steady decrease in the Usable Agricultural Area (UAA) (16% less) and the number of farms (71% less) in the urban region since the 1980s. This decrease affects more small and non-diversified farms, whereas larger and diversified farms are more adapted to the urban context (Fig. 1, c).

The hydrological network links plain, mountains and the city of Pisa

Water issues are quite complex and heterogeneous in the area. They are both localized (e.g. nutrient leaching within a lake basin, underground water salinization) and diffuse (e.g. flooding). Although these water issues are the most recognized issues related to peri-urban agriculture in the area, they are poorly integrated into territorial projects and when they are included, they relate exclusively to sectoral water policies (reclaimed area and protection against natural hazards) or European Union water regulation implementation (water plans and vulnerable area action plans) (Marraccini et al. 2013). However, farmers and other land managers need to use different practices, at the individual and collective level. For example, to mitigate flooding risks farmers in the plain have specific tillage practices and manage drainage channels to let water flow, whereas olive growers in the hills need to conserve bench terraces and their drainage system. A land reclamation consortium is charged with ensuring proper water drainage within the whole system and requires farmers to maintain these practices locally.

Food issue links agriculture and the city

Food production for the city has been the subject of several territorial projects joining institutional and local stakeholders (e.g. road of the oil, local farmers markets, and local meat labels). These initiatives were unified under the umbrella of a provincial food plan (Di Iacovo et al. 2013) to provide local food and sustain local farms. In this context, we investigated the ability of peri-urban farms to feed the local population. Filippini et al. (2014) highlighted that the potential food capacity depends not only on the effective size and number of farms but also on the collective actions targeting a product. The analysis of the beef and lamb production from peri-urban farms and sold in the local food supply chain showed that most local beef production was sold locally under a local label, whereas most of the locally produced lamb, which is not labelled, was marketed through conventional food chains.

The relationships between agriculture and the city (agricultural-urban system) are defined by different issues (water, food production, and farmland protection in the case of the urban region of Pisa) which in turn are managed at different levels (farming systems and local policies) and target different elements of the agro-ecosystems.

Conclusion

Agro-ecosystems differ depending on the urban region. Around Athens, Montpellier and Constantine, the farming systems remaining are the ones which are the more adapted to the constraints in water and soil (grapes, olives, winter cereals). The urban regions endowed with better agronomic resources allow more diversification as found in Meknes (the Saïss plain), Lisbon (the Tejo valley) and Pisa (the Arno valley). But pressures from urban growth are evident in all these regions: the city encroaches on agricultural land, engendering changes in land use well beyond the limits of urban development. But the retreat of agriculture in face of this expansion is not the only phenomenon that characterises the dynamics of peri-urban agro-ecosystems.

Urbanization accentuates the diversity of agro-ecosystems.

Our observations indicate that urbanization heightens agricultural diversity. The disruptions and opportunities created by the pressures of urban growth encourage the development of hybrid agro-ecosystems that adapt to the specific urban conditions or conserve more classical forms. These conditions also support the evolution of multiple agricultural systems, some of which may be declining and others which show a capacity to resist or even expand in response to urban demands. These dynamics are perceptible in all six city regions, though in different proportions. In some cases we can identify the effects of agro-tourism or the promotion of regional products due to the urban proximity. These positive effects co-exist with the challenges to agro-ecosystems that struggle with varying success, or evolve towards more viable production strategies. Other 'alternative' agricultural systems have appeared along with production efforts taken up by urban and periurban farmers to serve the urban market. The transformations in Mediterranean agro-ecosystems are complex and merit further analyses, not only from the perspective of productivity and land use, but also in view of the advantages of developing the relationship of exchange between urban and agricultural systems.

Our comparison calls attention to the importance of the national contexts for three large types of regional agricultural-urban system. Firstly the urban regions of Constantine and Meknes exhibit a divide between the city and agriculture, leading to segregated sectoral policies and urban policies which ignore the problems of remaining urban agriculture and treat peri-urban farmlands as a reserve of land for urban expansion. Without local support, the peri-urban agro-ecosystems are weakened by urbanization. Secondly by contrast, the urban regions of Southern Europe have witnessed a renewal of the links between urban development and agriculture. The urban regions surrounding Athens and Lisbon have experienced this renewal in response to the economic crisis. The fall in property values slowed construction and the growing poverty encouraged the development of subsistence forms of agriculture and food initiatives. Thirdly, the mobilization of urban actors has influenced the regions around Montpellier and Pisa, regions less affected by the urban economic crisis, but benefitting from local projects established to address agricultural, food, and environmental issues. These urban demands stimulate the development of diverse agro-ecosystems: urban or rural, professional or amateur, oriented towards food or social issues. The 'rural-urban divide', the resurgence of urban agriculture in times of crisis, and new projects linking agriculture, food and environment, all provide research avenues that should be further explored to reinforce the typology of these contexts and identify Mediterranean specificities.

Global and local drivers: What are the peri-urban agro-ecosystems of tomorrow?

The future of peri-urban agro-ecosystems depends on evolving factors, both globally and locally.

On a global scale, the divergent or convergent trajectories of agricultural policies and urban policies are powerful levers controlling the evolution (or disruption) of peri-urban agro-ecosystems. Neither the support structure of the organisation for national industry and export in the Maghreb, nor the Common Agricultural Policy (CAP) in Europe, offer particular support for peri-urban agro-ecosystems: the agricultural dynamics vary as much whether a function of production networks or that of urbanisation dynamics. But the development priorities of urban policies in the Maghreb are very different than those in Europe, where they promote (recently) the value of agricultural and natural spaces in urban regions. Finally, the question of climate change is one that is just beginning to be addressed in the support directives of local policies (e.g. the recent local climate and energy plans in France).

The future research on the ability of Mediterranean farming systems to adapt to climate change (Inglesias et al. 2013) should be applied to peri-urban agro-ecosystems.

On the local scale, the comparison allows us to identify other factors controlling the evolution of urban agro-ecosystems. First, environmental issues are major factors in the fate of urban and peri-urban agro-ecosystems. Water stands out as an important object at the interface between the city and agriculture, whether it is a question of managing the quality of the water resource or the quantity of that resource. This question includes the likelihood of increasing periods of drought as well as those of flooding and the related human and material losses (landslides). Fire risk is also an issue at this interface, justifying the preservation of open space around habitations, or the reintroduction of pasturing livestock. The issue of biodiversity can also be a source of local mobilisation, much as seen in the Metropolitan Ecological Network of Lisbon where the project came about as a response to the explosion in demand for gardens, and will serve as support for an urban agriculture strategy. Second, the social movements act as another factor promoting evolution. In Southern Europe, they emerge as new forms of community driven agriculture, and involve a diverse public: the urban poor, the affluent, investors in rural land, etc. Even in the Maghreb, the possibilities for such an evolution are plausible, given recent urban agriculture initiatives developed in Casablanca, Rabat and elsewhere. Finally, local policies represent a third factor influencing the evolution. When policies are developed on a city-region scale as in Pisa or Montpellier, the recognition of agro-ecosystem specificities allows these policies to simultaneously address urban issues (food security), agriculture issues (opportunities for local farmers) and environmental issues (risk management). Placing these issues at the heart of integrated policies emerges as a challenge.

In conclusion, ten years after a beginning overview of peri-urban agriculture in the Mediterranean (Nasr & Padilla 2004), the resurgence of these peri-urban agro-ecosystems is driven by a transition towards urban policies which include agriculture and food issues. This transition must take place on large scales of space and time. As underlined by Braudel (1978), Mediterranean cities were built on constant exchanges with their rural hinterlands, and trade with the countries of Europe and Africa. Being able to renew and reinvent these exchanges in the current context of competing resources and threats of climate change is a challenge for the future.

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