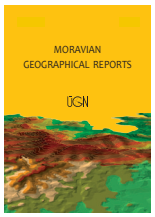

MORAVIAN GEOGRAPHICAL REPORTS

Institute of Geonics, The Czech Academy of Sciences

journal homepage: http://www.geonika.cz/mgr.html

doi: 10.1515/mgr-2017-0017

DE GRUYTER OPEN

Challenges for the revitalisation of peri-urban agriculture in Spain: Territorial analysis of the Madrid and Oviedo metropolitan areas

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Abstract

Contemporary urban sprawl and urban functional centrality at the regional scale have made the classical urban-rural dichotomy no longer valid. Instead, urban development generates a range of peri-urban transitional areas in which urban and rural uses are mixed in a fragmented land mosaic. The main objective of this paper is to detect opportunitites for the revitalisation of peri-urban agriculture based on an analysis and comparison of its evolution in two different regional contexts in Spain. The peri-urban space is delimited according to density, topography and perceptual criteria. Aerial images and cartographic bases are used to identify land quality and land use changes in the areas, concluding that peri-urban agriculture has suffered both urban occupation and internal changes in crops and agricultural uses, experiencing a process of decline. Innovative initiatives performed in these spaces are also explored as opportunities for revitalisation from a multifunctional approach, linking urban population to peri-urban agriculture, organic farming or landscape management. This analysis serves as a prerequisite to develop new policies for the planning of peri-urban agriculture at local and regional scales, based on a deep understanding of the territory and its evolution.

Key words: *land use changes, urban sprawl, multifunctional agriculture, Madrid, Oviedo, Spain*

Article history: *Received 30 September 2016; Accepted 3 August 2017; Published 30 September 2017*

1. Introduction

For the last few decades, urban sprawl has resulted in a new peri-urban landscape determined by the presence of a complex mix of land uses, shaping a heterogeneous mosaic of urban, rural and natural systems, in a dispersed settlement pattern (Adell, 1999; Carusso, 2001; Allen, 2003). Peri-urbanisation has been a general dynamic in Europe (Piorr et al., 2011; Nilsson et al., 2013), as previously rural spaces around cities change in many ways: into low density residential areas; commercial, leisure and sports facilities; industrial or technological hubs and logistic areas; as well as indirect urban uses such as waste disposal or extraction sites. Accessibility by high-capacity infrastructures allows these urban uses to be located in areas with lower land prices, or with higher environmental and landscape quality.

Agriculture located in peri-urban areas faces a double vulnerability (Simón et al., 2014) related to general problems in the agricultural sector and with those due to its peri-urban location (spatial fragmentation, urban pressure, land prices ...). Proximity to the city, however, also provides opportunities for a differentiated orientation of agriculture, through the development of urban-rural linkages, and the adaptation to new uses and functions. In this respect, multifunctionality refers to the shift from a productivist focus in food provision to the integration of new environmental and social goods and services that can help to improve sustainable development alternatives and the spatial embeddedness of the agrifood sector (Jouvé and Padilla, 2007; Marsden and Sonnino, 2008; Renting et al., 2009; Andersson et al., 2009).

As Zasada (2011) points out, multifunctionality in peri-urban agriculture is related to urbanites' preferences and demands for environmental quality, enjoyment of cultural landscapes, leisure and recreation, regional food, and other kinds of new urban-rural linkages. These linkages can be developed through a better spatial and functional

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integration of peri-urban areas into the urban socio-ecological metabolism (Vejre et al., 2015): for example, through diversification measures such as the provision of environmental services, recreation and social-oriented activities, or short food supply chains in order to take advantage of the urban location, responding to new lifestyles and social demands. The different scales and typologies of agricultural spaces, from those located on the urban fringe to those in rural areas, can play an important role in regional sustainability and resilience (Poli, 2014).

Planning and agricultural policies have a central role to play in the preservation, adaptation and success of peri-urban agriculture. As an intermediate urban-rural space and because of its distinct morphological and functional characteristics, peri-urban areas are complex spaces to operate, both from urban and regional planning perspectives, and from the environmental and agricultural disciplines (Fanfani, 2013). Integrating peri-urban agriculture in urban policies and planning could help to enhance urban resilience related to food security, climate change adaptation and the local economy (Dubbeling, 2014).

The main objective of this paper is to detect opportunitites for revitalisation of peri-urban agriculture based on an analysis and comparison of its evolution in two peri-urban locations in different regional contexts: northern and central Spain, represented by the metropolitan areas of Oviedo and Madrid. A land use analysis has been conducted in order to: (i) delimit and compare peri-urban agriculture in the case studies, identifying land quality, as well as agricultural and urban uses located in these spaces; (ii) describe the evolution of the case study areas in the last 40 years, quantifying land use changes; and (iii) identify emergent initiatives that could support the reorientation of peri-urban agriculture based on multifunctionality.

This analysis will enable us to respond to the following research questions: (i) What are main trends of peri-urban agricultural land transformation in Madrid and Oviedo?; (ii) What are main challenges and constraints for revitalisation?; and (iii) What are the main opportunities? Unlike previous studies in the Spanish context, this analysis is focused on two regions that are not expansive horticultural territories of high quality land, as can be seen in the Mediterranean orchards located in historic meadows in southern and eastern Spain. In this regard, the interest in the case studies is in analysing the evolution of peri-urban agriculture in cities with an industrial and tertiary economic orientation, and understanding the role such activities might play in the future, with the aim of developing better planning and policies.

2. State of the art: theoretical framing

2.1 Peri-urban studies

A unique and agreed-to method for the spatial delimitation of peri-urban areas does not exist. Different methodological approaches have been proposed, based on physical features, such as distance and population size (OCDE, 1979; Larcher, 1998; Audirac, 1999), population density and size (Bibby and Shepherd, 2004; Piorr et al., 2011), or settlement density (Vizzari, 2011). To achieve a more complete definition of peri-urban areas it is necessary to consider the presence of urban functions in rural landscapes. In this regard, recent studies based on multicriteria analysis and spatial statistical analysis (Murgante and Danese, 2011; Russo et al., 2014; Diti et al., 2015), conducted using GIS methods, combine morphological and functional information - such as land use, planning classification, landscape fragmentation, production capacity, accessibility, agricultural employment and commuting – in order to define land classification categories and sets of indicators. These approches are useful for the creation of thematic maps, the assessment of different land use models, and to inform public policies.

Peri-urban agriculture provides a wide range of services to urban areas, beyond food provision, services that are related to cultural identity, recreation, education or the regulation of natural cycles, and that have been quantified and assessed in recent studies (Willemen et al., 2010; Brinkley, 2012; Simón et al., 2014). The public policy approach to multifunctionality in these areas is usually focused on environmental issues that are more likely to be included in planning tools, and perceived as important by local authorities, although social actors also recognise and value other economic and social issues (Vandermeulen et al., 2006; Ives and Kendal, 2013; Marraccini et al., 2013; Olsson et al., 2016).

2.2 Peri-urban agriculture in Spain

Studies focused in the Mediterranean context show that there are social and economic pecularities in their peri-urban agriculture systems, due to the distinct cultural landscapes, built heritage, diet, land planning traditions or property structure (Jouve and Padilla, 2007; Morán et al., 2015).

The dynamic of peri-urban areas in Spain since 1970 is linked to major landscape transformations and urban sprawl. Among Spanish scholars these processes have been analysed by considering land use changes and spatial planning as the main arguments, although other authors as Gómez Mendoza (1987) overcome this framework in focusing on the potentialities of development of a dynamic and innovative peri-urban agriculture. Land use changes have been analysed in recent years through new techniques and sources of information, which have led researchers to quantify these processes more accurately. Peri-urban agriculture land use transformations and planning regulations have been studied for Andalucia by Perez-Campana (2015), for the metropolitan region of Barcelona by Paül and Tonts (2005) where an urban sprawl process tended to isolate pockets of peri-urban agriculture, and for medium-sized towns by Simón et al. (2014).

Regarding the diversification of peri-urban agriculture, the case of the Baix Llobregat (Barcelona) as an alternative food network was studied by Paül and Mackenzie (2013), while in the peri-urban area of Valencia, Marques-Perez et al. (2014) highlighted social preferences for the functions, goods and services that agriculture provides. An ecosystem services assessment in Spain found that as cultural services related to traditional knowledge decrease in the agricultural areas, those associated with recreational, educational and aesthetic services have increased (Ministry of Agriculture, Food and Environment, 2013). Local and organic food is progressively more valued and short food supply chains have increased its market presence (López, 2016).

Social concern for the future of cultural landscapes and agricultural heritage has resulted in the mobilisation of civil society and the development of processes against urban development (Matarán, 2013). The social demand for short food supply chains, organic food and food sovereignty has encouraged the Public Administrations to provide protection over some peri-urban areas, as Segrelles Serrano (2015) has

pointed out. Governance and management instruments such as the agrarian parks have also been developed (Zazo, 2015), as spaces in which environmental and landscape improvement are linked to services such as direct sales or agritourism (Gaviglio et al., 2014).

3. Materials and methods

In order to address the research questions regarding land transformation, challenges and opportunities of peri-urban agriculture, a land use analysis and identification of emergent initiatives in the case study areas has been conducted. Land use categories have been defined based on public cartographic and photographic sources, and their evolution is presented in a matrix in which changes from one category to another can be identified. Additionally public policies and social initiatives reflecting new urban-rural linkages have been detected through a literature review.

3.1 Land use classification

Historical aerial photography is an important resource when analysing landscape dynamics, useful for understanding how the process of change unfolds, and the amount of land that is occupied. Moreover, if it is carefully observed, this source provides the possibility to identify traditional agricultural landscapes, which are normally good examples of sustainable practices (Antrop, 2005). Aerial images and other public cartographic sources (see Tab. 1) have been used to analyse land use evolution in the case study areas.

Urban land uses have been mapped through photointerpretation databases, and buildings and infrastructures maps. For non-urbanised land, two main sources have been used: the Map of Agrological Classes – that considers the productive capacity of the soil; and the Map of Crops and Agrarian Uses – that reflects the actual use in each year. The relationship between the defined categories, the cartographic bases, and the CORINE Land Cover classes can be seen in Table 2.

Regarding the suitability of soils to support agriculture, the Map of Agrological Classes identifies eight categories, representing the capacity of soils to maintain their productive capacity regarding intensity of use. The eight categories have been grouped into the following four types:

1. I, II and III, systematic soils tilling;
2. IV, occasional soils tilling;
3. V, VI, VII, no arable soils; and
4. VIII, unproductive soils.

Using photointerpretation techniques, the map has been updated to reflect the current land distribution, adding the new impervious soil to class VII.

3.2 Land use changes

Land use change is addressed analysing the loss of agricultural land due to urban development. From the intersection of geographical land use information in the considered years, a matrix is generated, adapted from Naredo and García (2008), in which land use changes from one category to another can be identified. The total surface of each category in the two years analysed can be seen in the row and column totals (see Tab. 3).

3.3 Peri-urban revitalisation opportunity elements

Public policies and social initiatives in the study areas that may indicate a reorientation towards a multifunctional peri-urban agriculture, have been identified through a literature review of planning documents, newspapers, and the internet sites of public and social actors. The initiatives considered are those that fulfill functions referring to the links between the urban population and peri-urban agriculture, such as leisure and recreation activities, social agriculture, short food supply chains, organic farming or landscape management.

4. Case studies

A wide diversity of topographic and climatic conditions can be found in Spain, giving rise to different settlement patterns, agricultural systems and cultural landscapes. Nevertheless, agriculture has lost its importance in an increasingly tertiarised national economy, accounting only for 4.4% of the total employment in the country (National Statistics Institute, 2016). Construction has been the main driving force for the Spanish economy in the last decades, so peri-urban agriculture has been especially pressured, suffering processes of degradation and abandonment in waiting for urban development.

Although urban sprawl and peri-urbanisation processes can be found in almost every Spanish city, rural space still covers the majority of the territory in the country, accounting for 90% of its surface and being home for only 20% of the population (Ministry of Agriculture, Rural and Marine Affairs, 2009). There is high territorial polarisation in terms of population and urbanisation (Serrano, 2015), with urban pressures especially intense on the Mediterranean coastline and the large metropolitan areas, thus significantly affecting peri-urban agrarian spaces (Paul and Tonts, 2005).

Document	Source
Orthophotographs, inter-ministerial flight corresponding to 1973–1986 (approximated scale of flight 1 : 20,000) and 2015 flight (Scale of flight: 1 : 15,000)	National Plan of Aerial Orthophotography (2015)
BTN25 (2015). Buildings and transport infrastructures	National Geographical Institute of Spain (2015)
Urban and Industrial Land Uses Database, applied to the Madrid region	Naredo and García (2008)
Map of Crops and Agrarian Uses. Data obtained in the periods 1975–80 and 1999–2008 (Scale 1 : 25,000).	Spanish Ministry of Agriculture (2008)
Map of Agrological Classes. Elaborated between 1986 and 1994* (Scale 1 : 50,000).	Spanish Ministry of Agriculture (2008)

Tab. 1: Cartographic and photographic sources
*Note: *The Map of Agrological Classes has been elaborated at different dates for the different Spanish regions*

Land use categories*	Corine Land Cover 06**	Map of crops *** (use and overuse data)
Built-up area		
Urban continuous	Continuous urban fabric	
	Green urban areas	
Urban discontinuous	Discontinuous urban fabric	
	Green urban areas	
Industrial, commercial and leisure	Industrial or commercial units	
	Sport and leisure facilities	
Infrastructures	Road and rail networks	
	Port areas	
	Airports	
Extraction, dump and construction sites	Mineral extraction sites	
	Dump sites	
	Construction sites	
Agriculture		
Dry land farming	Non-irrigated arable land	Dry land farming
Irrigated arable land	Permanently irrigated land	Irrigated arable land
Fruit trees	Fruit trees and berry plantations	Non irrigated fruit trees
		Irrigated fruit trees
Olive groves and vineyards	Vineyards	Non irrigated groves
	Olive groves	Non irrigated vineyards
		Irrigated groves
		Irrigated vineyards
Scrubland	Shrub and/or herbaceous vegetation associations	Scrubland
		Dry grassland
Forest	Forests	Coniferous
		Broad-leaved forest

Tab. 2: Land use categories relationship with CLC06 and Spanish Map of Crops
*Sources: *defined by the authors; **European Environmental Agency; ***Spanish Ministry of Agriculture*

Fig. 1: Location of case studies. Source: authors' compilation

	Built-up area	Urban continuous	Urban discontinuous	Industrial or commercial	Inf. & indirect urban uses	***Agriculture***	Dry land farming	Permanently irrigated	Fruit trees	Olive groves and vineyards	***Scrubland-Pasture***	***Forestry***	**TOTAL 2015**
Built-up area													
Urban continuous													
Urban discontinuous													
Industrial or commercial													
Inf. & indirect urban uses													
Agriculture													
Dryland farming													
Permanently irrigated													
Fruit trees													
Olive groves and vineyards													
Scrubland-Pasture													
Forestry													
TOTAL 1980													

Tab. 3: Land use change matrix
Source: Adapted from Naredo and Garcia (2008)

The cities analysed, Madrid and Oviedo (Fig. 1), are located in two regions in which agricultural activities have experienced a long process of de-intensification and abandonment, beginning with industrialisation and urban development in the last decades of the twentieth century. The relevance of these cities lies in their functional centrality at a regional scale, and the marginal share of agriculture in their economies. Analysing land use changes, the remaining surface of agricultural land and the new uses that these areas are supporting, is necessary for developing innovative planning approaches.

The two cases exhibit different climatic and geographical conditions, thus the traditional farming systems are quite different. The peri-urban space in the Madrid area is predominantly occupied by dry land farming aimed at commercial grain production (irrigated arable land, olive groves and vineyards can also be found). In the Asturian area, irrigated arable land forms the greatest portion of the agricultural space, including herbaceous crops, horticultural part-time farming and fruit crops; olive groves or vineyards are not present in this region. In addition, the two regions have distinctive traditional settlement patterns: a polycentric structure of compact cities in Madrid, typical of the central plateau, and a dispersed urbanisation pattern in Oviedo, specific to the Atlantic Arc in northern Spain.

4.1 Delimitation of the peri-urban space in the case study areas

The following criteria have been applied in order to delimit the peri-urban space:

- Population density: more than 100 inhabitants per km^2 (according to census section data);
- Urbanisation density: more than 0.4 km^2 urbanised over 1 km^2 surface (GIS neighbourhood analysis: 10 metres raster resolution and 5 km radius);
- Topography: changes of slope; and
- Boundaries perception: natural and artificial barriers.

The southern metropolitan area of Madrid covers a wide territory of flat topography with a high population and urbanisation density. In order to narrow the case study delimitation, functional and perceptual criteria have been used, and a representative section of 115 km^2 has been selected that does not correspond to administrative limits, but comprises the wedge delimited by two main radial highways. It is a functional area articulated by the road connecting the cities of Leganés and Fuenlabrada, and includes land belonging to four municipalities and its corresponding urban centres (Leganés, Fuenlabrada, Humanes and Moraleja de Enmedio).

For the case study area of Oviedo, the peri-urban area of 104 km^2 was defined according to physical and perceptual borders, but also taking into account their functionality. It covers part of the municipalities of Oviedo, Siero, Llanera and Noreña. As a basin, it is easy to delimit the area in which slopes increase, as the mountain chains act both as a physical and perceptual barrier. There is a prevalence of elements of the traditional landscape such as meadows, farmhouses, rural roads, place names or auxiliary buildings like Hórreos (a granary built in wood, raised from the ground by pillars, a typical element of the rural landscape in northwest regions of Spain).

4.2 Southern Madrid metropolitan area

Madrid, the capital city of Spain, is located in the centre of the country. The administrative region has a diversified topography, from the western and northern mountains to the south-eastern river basins. The city is located in the central plain. Urban development has sprawled over the more topographically appropriate areas, forming two axes of lineal development along the floodplains of the rivers Henares (eastwards) and Guadarrama (north-westwards), and a dense polycentric southern development, in a grid pattern along the plain, which is the area on which the present analysis is focused.

The study area is located in a Tertiary basin with a flat topography (less than 3% of land slope), constituted by gypsum, sand and clay soils. Regarding climatic conditions, the average annual temperature is 15 °C, and precipitation ranges from 400 to 500 mm, with 2,800 sunshine hours and 60% relative humidity.

Although land quality is not very high, the availability of water from the tributaries of the river Manzanares, and especially from groundwater, has made this area an historical space of food supply for Madrid. There has never been a continuous irrigated agrosystem of horticultural cultivation, however, but an atomised land ownership structure characterised by small plots (0.5 to 5 ha), and a mosaic pattern of vegetable and grain production. These small farms have a low profit margin, and have gradually specialised in monocultures of chards or cabbages (Mata Olmo and Yacamán, 2015).

Due to migration processes during the 1970s and 1980s, the former agricultural villages became industrial cities, causing a 22-fold increase in population between 1960 and 1981 (Community of Madrid Statistics Institute, 2015). A major shift has occurred in the 21st century due to the tertiarisation of the economy linked to city region development. Although industry still accounts for 20% of the total employment in the area (compared to only 7% in the entire Madrid region), services are the main economic sector (70% of employment), and agriculture represents less than 1% (Community of Madrid Statistics Institute, 2015b).

The rupture of rural-urban linkages that occurred in the 1980s was due to a deep cultural shift, affecting not only consumer behaviours (diet and purchase options) but also employment and farm orientation (de-intensification, lack of labour, low agricultural income, industry and construction development). As a consequence, there was a massive sale of agricultural land, intended for urban development or ownership concentration, and also a loss of diversity in crops and in processes of commercialisation (Morán, 2015).

4.3 Oviedo metropolitan area

Oviedo, the capital city of the autonomous region of Asturias, is located in the north of Spain (approximately 43.4 °N, 5.8 °W). The study area is located in a Mesozoic and Tertiary basin with a moderate topography. The lithology is dominated by clay and limestone. The climate is represented as an annual average temperature around 12.5 °C, total precipitation is 960 mm, 1,756 sunshine hours and 78% relative humidity. The industrialisation of the region in the 1970s led to an increment in population due to migration processes, so since the 1950s the population has doubled. At present, about 300,000 inhabitants live in the Oviedo basin. In Asturias, the tertiary sector accounts for 75% of total employment, whereas employment in the agricultural sector is about 4% (Asturian Society of Economic and Industrial Studies, 2015).

The Oviedo peri-urban area is characterised by its flat topography and mixed land uses which shape a diffused landscape. In this area, the largest extent of flat surfaces within the Asturias region can be found, i.e. the slopes under 3% total over 100 km^2. As a result, the area studied has a fragmented landscape, such that agriculture is limited to isolated areas (Fernández, 1998). Two rivers flow through the study area, both of which are natural corridors where peri-urban agriculture was traditionally carried out.

Agriculture is currently reduced to isolated areas on the margins of middle-sized-towns and parallel to linear features such as rivers, roads, railways and highways. Part-time farming and fruit crops are the main types of agriculture, associated mainly with private initiative and small orchards for self-consumption. Fruit cultivation has a long tradition in Asturias, especially apple trees, *pumaradas*. The spatial impact of market-oriented farming is low.

A key element of the cultural landscape is the so-called Ería, a closed set of plots dedicated to cereal and vegetables crops, in long and narrow parcels. They are located in flat areas – alluvial plains, meanders and riverbanks – and managed as traditional commons, with private exploitation of the plots but collective decision making about harvest dates, crop rotations or entry of cattle. This type of farming is strongly related to the land ownership structure, only 4% of the plots in the area studied are over 1 ha according to the General Direction of Cadastre of Spain (Ministry of Economy and Finance, 2016).

5. Results

5.1 Peri-urban agriculture in the Southern Madrid metropolitan area

5.1.1 Land use changes in the Southern Madrid metropolitan area

According to the Agrological Classes Map, all the non-urbanised soils in the area are suitable for cultivation, corresponding to a medium quality land (III class). Taking into consideration that there are no class I soils in the Madrid region, and that the class II soils can only be found in the wide river basins in the southeast, conditions in the study area can be seen as 'normal' for the metropolitan space of Madrid. While in the 1980s artificial land covered only a sixth part of the area, it has tripled its surface in the period, such that in 2015 fully one half of the area was urbanised (Fig. 2 and Tab. 4).

Class	1986	2015
	km^2	km^2
VIII	18.55	59.93
VII	0.00	0.00
VI	0.00	0.00
V	0.00	0.00
IV	0.00	0.00
III	96.87	55.49
II	0.00	0.00
Total	**115.42**	**115.42**

Tab. 4: Surface evolution of agrological classes in Southern Madrid. Source: authors' calculations

Regarding urban and agricultural land use changes, several dynamics can be identified in the peri-urban space, either related to urban pressures or to internal changes in agricultural uses. The 1980 land cover map (Fig. 3) shows a tendency to urban sprawl, mainly due to industrial developments located along the main roads, as well as to dump and extraction sites concentrated near Madrid and the intersecting irrigated areas in the north of the area. Nevertheless, the cities still presented a compact pattern, and irrigated agriculture occupied considerable extensions around the cities and a continuous space of dry-land farming could be found all over the area.

Between 1980 and 2015 there has been intense urban development. While the urban fabric, including residential, industrial and commercial areas, has tripled its total surface, the transport infrastructures surface has had an 8-fold increase, due to the construction of consecutive bypasses and radial roads around Madrid (M-40, M-50 and R5 highways go through this area). The urbanisation dynamic has been paralysed by the current economic crisis, leaving a surface of 9 km^2 of sites in which urbanisation remains incomplete.

As can be seen in Table 5, in the period analysed agricultural land has lost almost half its surface (42%), due mostly to urban land occupation. In quantitative terms, the greater loss has occurred in dry land farming (33 km^2 have been urbanised), which was the majority of the agricultural land, but it must be emphasised that almost one third of irrigated land has been lost, which is a worrying percentage considering the relatively small surface of this kind of land in the area.

Permanent irrigated land has been affected by urban pressure in two ways. Firstly, four square km have been lost because of industrial and residential developments, both continuous urban fabric and discontinuous residential areas. Secondly, almost the same surface (3 km^2) has suffered a loss in crop productive intensity, changing from fruit and vegetables production to arable crops.

There has also been a noteworthy trend in agricultural land abandonment and degradation. These processes have been identified as affecting previously cultivated land that is currently occupied by less demanding crops and non-urban uses. In this way, 2 km^2 of no longer cultivated dry land farming spaces have been detected, surrounding the urban continuum. But this dynamic is especially significant in irrigated areas, where 3.3 km^2 are now occupied by dryland farming, scrublands or pastures – this is almost the same surface that is cultivated.

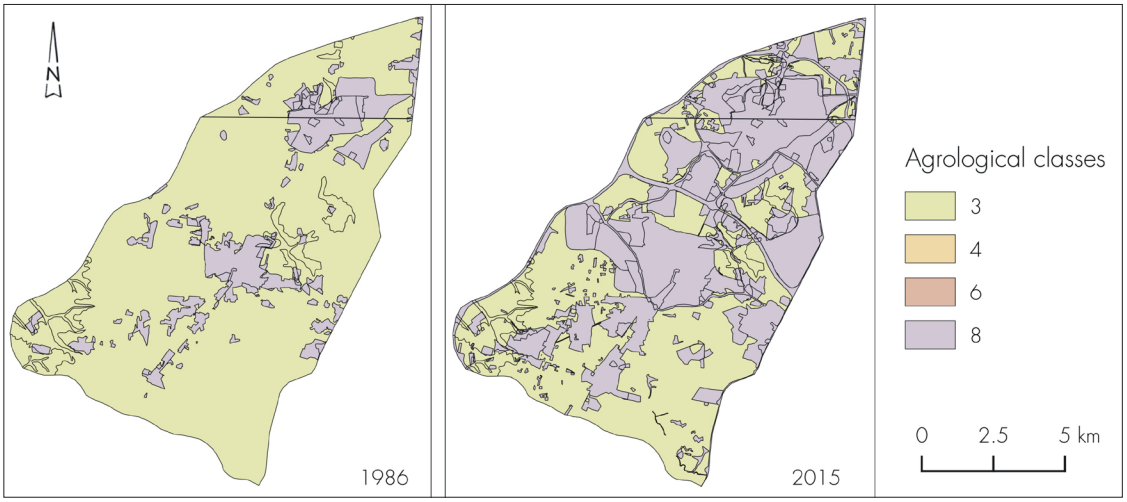

Fig. 2: Agrological classes dynamic from 1986 to 2015 in the Southern Madrid metropolitan area
Source: Agrological Classes Map (1992)

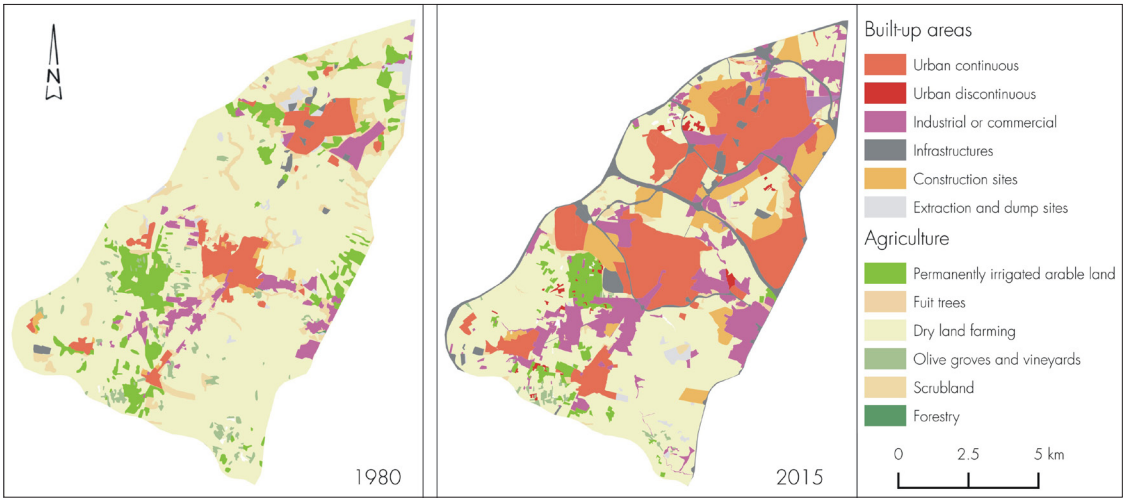

Fig. 3: Land uses in 1980 and 2015 in the Southern Madrid metropolitan area. Sources: elaborated by the authors from Naredo and García (2008), PNOA and BTN25, IGN (2015)

	Built-up area	Urban continuous	Industrial or commercial	Inf. & indirect urban uses	***Agriculture***	Dry land farming	Permanently irrigated	Fruit trees	Olive groves and vineyards	***Scrubland-Pasture***	***Forestry***	**TOTAL 2015**
Built-up area	16.11	7.71	5.15	3.25	38.13	33.36	3.98	0.05	0.73	5.62	0.03	59.88
Urban continuous	9.11	7.67	0.01	1.43	14.37	12.34	1.74	0.02	0.27	2.86	0.01	26.36
Urban discontinuous	0.02	0.00	0.00	0.02	0.69	0.46	0.20	0.01	0.02	0.06	0.00	0.77
Industrial or commercial	5.83	0.00	5.09	0.74	8.27	7.17	0.89	0.01	0.20	1.33	0.02	15.45
Inf. & indirect urban uses	1.15	0.04	0.05	1.06	14.79	13.39	1.15	0.02	0.24	1.37	0.00	17.31
Agriculture	0.27	0.00	0.10	0.18	51.21	44.44	5.38	0.01	1.38	1.68	0.00	53.16
Dryland farming	0.27	0.00	0.10	0.18	46.98	42.79	3.07	0.01	1.11	1.65	0.00	48.90
Permanently irrigated	0.00	0.00	0.00	0.00	3.63	1.28	2.25	0.00	0.10	0.03	0.00	3.66
Fruit trees	0.00	0.00	0.00	0.00	0.04	0.04	0.00	0.00	0.00	0.00	0.00	0.04
Olive groves and vineyards	0.00	0.00	0.00	0.00	0.56	0.33	0.06	0.00	0.17	0.00	0.00	0.56
Scrubland-Pasture	0.08	0.03	0.02	0.03	1.81	1.60	0.17	0.00	0.03	0.41	0.00	2.30
Forestry	0.00	0.00	0.00	0.00	0.03	0.02	0.00	0.00	0.01	0.02	0.00	0.05
TOTAL 1980	16.46	7.74	5.27	3.45	91.17	79.42	9.54	0.07	2.15	7.73	0.03	115.39

Tab. 5: Land use changes 1980–2015 in the Southern Madrid metropolitan area (km²)
Source: authors' calculations

5.1.2 Peri-urban agriculture revitalisation opportunities in the Southern Madrid metropolitan area

Almost one half of the area surface is still agricultural land; in addition, an important amount of land intended for urban development but not yet urbanised has been identified, land which could be recovered for agriculture. In order to define a successful policy for the preservation of these areas, a change in their cultural signification should be achieved.

Some public policies are already addressing the revitalisation of peri-urban agriculture by linking it with the city. In 2012, an 8 km² Agrarian Park was defined by the municipality of Fuenlabrada: its Management and Development Plan was approved in 2013, setting out actions related to infrastructure improvement, farmer training, and short food supply chains (Yacamán and Zazo, 2015). A range of tools is being applied, such as a quality label for fresh and local products cultivated and processed in the park, or short food supply chains through monthly farmer's markets, direct sale points within the city, and a map of local shops and restaurants that sell local food[1]. Social economy food enterprises are also settled in the park, processing organic preserves[2]. Alliances with other cities are being developed. Particularly relevant is the case of Madrid: the city capital signed the Milan Urban Food Policy Pact in 2015 and from 2016 is holding farmer's markets for the first time, in which farmers from the Fuenlabrada park and other agrarian spaces in the region sell their products. Fuenlabrada also joined the Milan Urban Food Policy Pact in 2016, which can be considered an opportunity for developing innovative policies related to food access, social inclusion, and relocalisation of the food chain, although clear results have yet to be identified.

Regarding leisure, education and social activities, different types of vegetable gardens can be found in the area. There are municipal allotment gardens in the larger cities (Fuenlabrada and Leganés), some of them organised for the unemployed and retired population and others open to anyone interested in growing food; all of them are located in green and open spaces within the urban fabric. Private organic garden sites can be found in the peri-urban space, where plots are rented (Fig. 4). These emerging initiatives are too recent to be proven changes, so their impact on land preservation, changes in crops and agrarian uses and on the economic diversification of peri-urban agriculture is not known, but they can be highlighted as promising elements for the revitalisation of the area.

5.2 Peri-urban agriculture in the Oviedo metropolitan area

5.2.1 Land use changes in the Oviedo metropolitan area

Most of the soils in the peri-urban area of Oviedo are arable. The first class is not present in the analysed area, but classes II and III are considered highly suitable for agriculture, as possible crops in this area: cereals, legumes,

[1] Website of the Fuenlabrada Agrarian Park: https://parqueagrariofuenlabrada.es/

[2] Driadas is a women social enterprise that makes organic preserves from local crops. http://proyectodriadas.blogspot.com.es/

root vegetables, forage crops, vegetables and fruits. In 1992 these classes covered 57% of area, by contrast in 2015 they occupied about 46%. The decrease is strongly related to the development of built-up areas, as the difference in coverage in class VIII in the period analysed shows a 15% increase (Fig. 5 and Tab. 6).

Focusing on land uses, Table 7 summarises the transformation processes that occurred from 1970 to 2015. In 1970 the area was characterised by a clear distinction between urban and rural landscapes with strong presence of agricultural activities (Fig. 6). The industry was located near commodities and commercial functions were exclusively urban. By then the area was awaiting a collapse of the historic landscape construction model, since the new regional highway and the first industrial parks were built.

Class	1986	2015
	km^2	km^2
VIII	23.47	39.54
VII	4.89	4.84
VI	6.22	5.41
V	1.15	1.07
IV	9.57	5.64
III	35.25	30.9
II	23.45	16.6
Total	**104.00**	**104.00**

Tab. 6: Surface evolution of agrological classes in Oviedo. Source: authors' calculations (Note: percentages rounded)

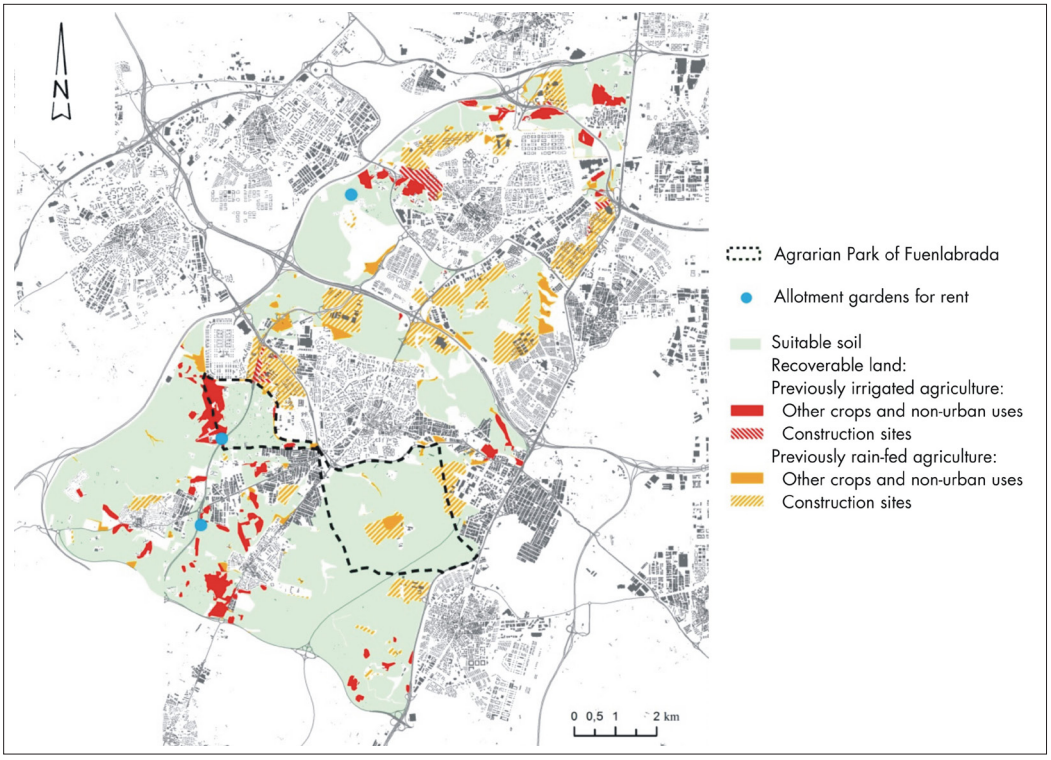

Fig. 4: Suitable soil for agriculture and new agricultural peri-urban uses in the Southern Madrid metropolitan area, 2015. Sources: elaborated by the authors from Naredo and García (2008), PNOA and BTN25, IGN (2015), Fuenlabrada Agrarian Park (2016)

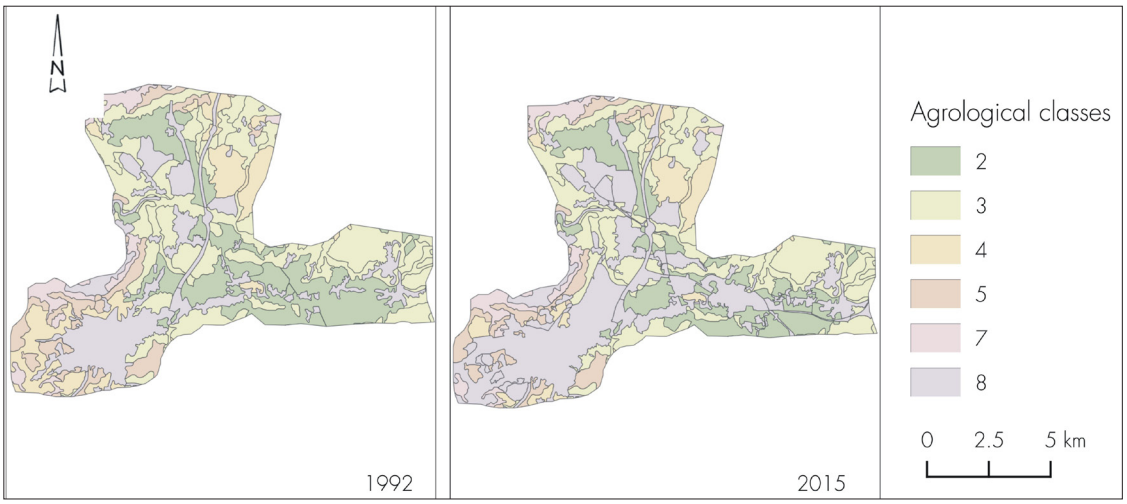

Fig. 5: Agrological classes dynamic from 1992 to 2015 in Oviedo
Source: Agrological Classes Map (1992)

Between 1970 and 2015 there has been an intense urban development, built-up areas have increased from 9.7km^2 to 25.5 km^2. Industrial and commercial land uses have experienced more than a 6-fold increase, located mostly in former arable lands in the dynamic of urban sprawl. In this period, agricultural land has lost 10 km^2 and fruit trees diminished by 75%, so 2.1 km^2 of *pumaradas* have been replaced by other agrarian uses. The consumption of soils of the permanently irrigated areas is due mainly to the urbanisation process: the increment of the continuous urban fabric represents the replacement of 1.63 km^2, whereas the discontinuous sums up 2.8 km^2, evidencing residential dispersion processes.

The main reasons for soil consumption are urban sprawl process, ineffective planning instruments and the development of new infrastructure. In 1976, the highway which links the cities of the Asturian central area was inaugurated. Since that point in time, it is commonly accepted that the process of urban sprawl began (Fernández, 2003; 2007). The residential function is traditionally dispersed in the north of Spain. In recent decades, however, the low-density housing model has gained importance (Herrán Alonso, 2002). This process was carried out, on the one hand, by the densification of rural villages with new types of buildings and new inhabitants and, on the other hand, by the spread of small residential developments to the suburbs.

	Built-up area	Urban continuous	Urban discontinuous	Industrial or commercial	***Agriculture***	Permanently irrigated	Fruit trees	***Scrubland-Pasture***	***Forestry***	**TOTAL 2015**
Built-up area	4.54	3.61	0.41	0.53	20.66	20.37	0.30	0.00	0.29	25.49
Urban continuous	4.12	3.61	0.28	0.23	8.84	8.76	0.08	0.00	0.17	13.13
Urban discontinuous	0.09	0.00	0.09	0.00	4.39	4.26	0.13	0.00	0.06	4.54
Industrial or commercial	0.31	0.00	0.01	0.30	6.21	6.12	0.09	0.00	0.05	6.57
Infrastructures	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Agriculture	5.07	1.63	2.81	0.64	56.33	53.86	2.47	0.09	9.91	71.40
Permanently irrigated	5.07	1.63	2.80	0.64	55.65	53.40	2.25	0.09	9.90	70.72
Fruit trees	0.00	0.00	0.00	0.00	0.68	0.47	0.22	0.00	0.00	0.69
Scrubland-Pasture	0.00	0.00	0.00	0.00	1.39	1.39	0.00	0.00	0.28	1.67
Forestry	0.05	0.00	0.00	0.05	2.88	2.86	0.02	0.00	2.48	5.42
TOTAL 1970	9.67	5.24	3.22	1.22	81.27	78.48	2.79	0.09	12.95	103.99

Tab. 7: Land uses changes 1970–2015 in Oviedo (km^2)
Source: authors' calculations

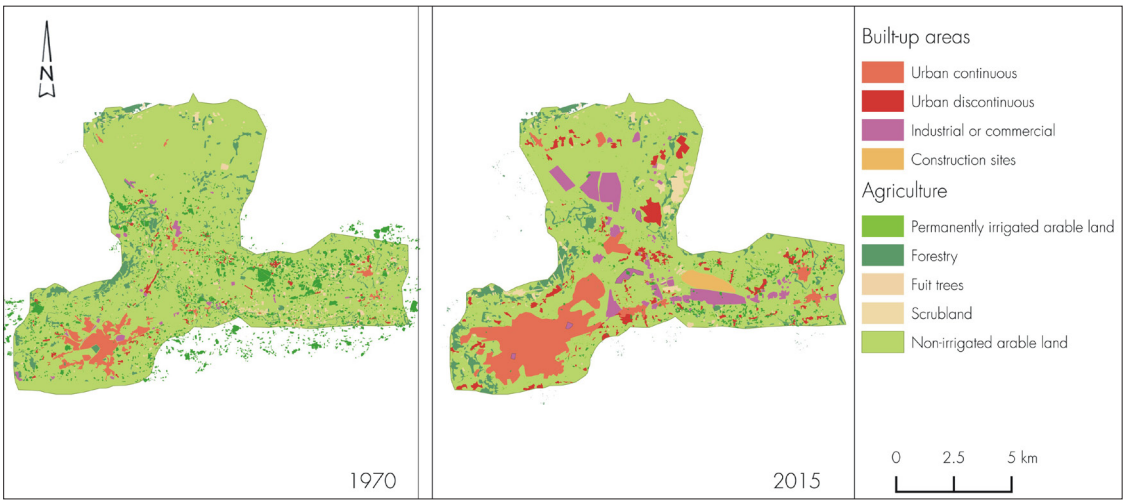

Fig. 6: Land uses in 1970 and 2015 in Oviedo
Sources: elaborated by the authors from PNOA and BTN25, IGN (2015)

Since 1980, various initiatives have promoted the construction of peri-urban industrial areas (Fernández, 1997). Nevertheless, the dispersion of industries, above all along the road which leads to the East, constitutes further evidence of the ineffectiveness of planning policies. A concrete example of these practices is located in Bobes, where an Ería was totally removed to build an industrial park. As a consequence of the lack of financial funds, the project is currently stopped. Other functions such as commerce had a great impact at the regional scale. Two malls are located outside the city of Oviedo; one of them was built in 1977, the Pryca/Carrefour was linked to the highway. In 2001 a new mall was inaugurated near a highway junction; Parque Principado / Intu Asturias, a strategic place for which isochrones show that the maximum area of Asturias is covered from this location.

5.2.2 Peri-urban agriculture revitalisation opportunities in the Oviedo metropolitan area

The area identified as suitable for peri-urban agriculture covers 47 km^2, most of it located in agrological classes II and III, mainly along riverbanks, meanders and pockets of soils which surround both rural and urban settlements (Fig. 7).

At the regional level some actions were implemented with the financial support of European funds, such as the Leader programme, which stimulated the creation of Local Action Groups. These groups fund diversification projects such as those of red fruits, modern apple orchards or greenhouses. The Strategy for Competitiveness of Primary Sector and Economic Development of Rural Environments in Asturias contemplates actions for peri-urban agriculture. At the municipal level there has been an increasing social demand for urban agriculture facilities and this encouraged public administrations to provide solutions such as community gardens. The Oviedo municipality has approved a new regulation on urban agriculture and 155 urban gardens in three different peri-urban locations have been built. More might be expected in the future since there are waiting lists.

Private stakeholders and non-governmental organisations have built their own peri-urban farms: some of them are initiatives to rent allotment gardens, others concern actions to promote social cohesion such as the integration of unemployed migrants through farming. Some grassroots movements have developed community-supported agriculture schemes based on short food supply chains linking local producers and urban demands, an example of which can be found in the self-managed social centres and the rural network Red Campesina de Asturias, among others.

5.3 A comparison of peri-urban agriculture in the Southern Madrid and Oviedo metropolitan areas

The preceding descriptive accounts of peri-urban agriculture in the two case study areas can now be compared statistically: the principal concern is with the aggregated categories of built-up area (BUA), agriculture (A), scrub-pasture (S-P) and forests (F); indicated as BUA_M for Madrid, BUA_O for Oviedo, … etc.; and changes in their land use composition over the two time periods (Time M_O: 1980–2015 for Madrid; 1970–2015 for Oviedo).

A contingency analysis is used for this purpose. Table 8 shows the results of this (three-way) cross-tabulation, with the significant differences in specific categories indicated by numbers in bold.

The association reported in this table is statistically significant (CHI-square = 49.32, df = 7, $p < 0.0001$). Clearly, as highlighted in the table, the expected proportions of built-up areas for both Madrid and Oviedo (BUA_M [7.7 to 27.1%] vs. BUA_O [4.5 to 11.8%]) are much greater than expected from their marginal proportions over their respective time periods, indicated as significantly different column proportions using the Z-statistic in SPSS).

Importantly, however, the proportions of agricultural areas do not differ significantly: for A_M: 41.2 to 24.0% is seen as significant, but for Oviedo the difference from 36.7 to 32.1% is not significant. A plausible inference in this case is that the rates of conversion of peri-urban land from agricultural purposes to urban land uses is much greater in Madrid than in Oviedo – the processes are likely quite similar, but the rate of change is remarkably different. The remaining proportions of scrub-pasture and forest are largely insignificant in this larger scenario. The changes in proportionate terms are presented in Figure 8.

6. Discussion

Although biophysical conditions in both areas have caused distinct cultural landscapes and urban settlement patterns in the past, urbanisation processes in the last decades have followed the same path, based on the layout of

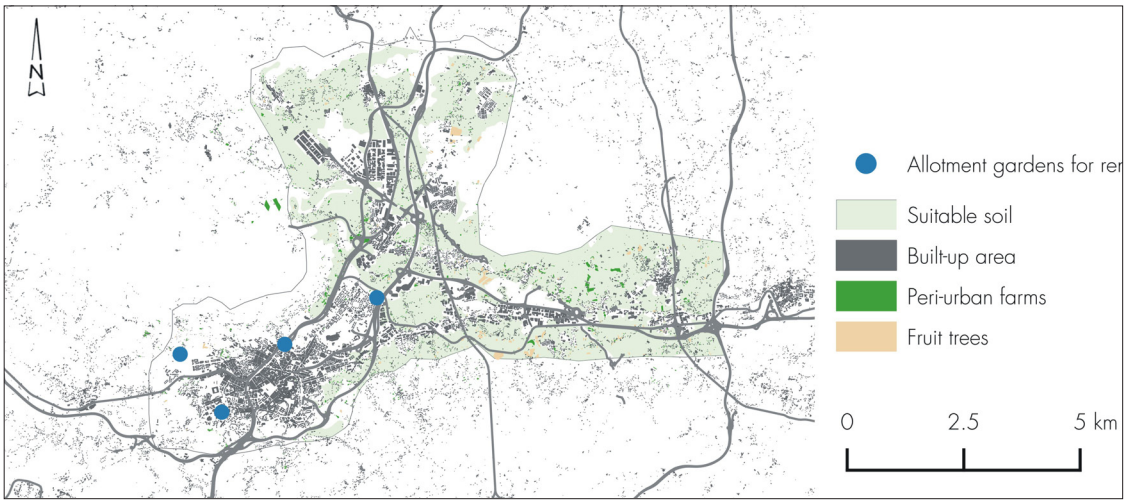

Fig. 7: Suitable soils for agricultural functions in the peri-urban area of Oviedo, 2015
Source: elaborated by the authors from PNOA and BTN25, IGN (2015)

			Time M_O		
			1980/1970	2015	Total
Land use group M_O	BUA_M	Count	17a	60b	77
		Expected Count	38.5	38.5	77.0
		% within Time_M_O	7.7	27.1	17.4
	A_M	Count	91a	53b	144
		Expected Count	72.0	72.0	144.0
		% within Time_M_O	41.2	24.0	32.6
	S-P_M	Count	8a	2a	10
		Expected Count	5.0	5.0	10.0
		% within Time_M_O	3.6%	0.9%	2.3%
	F_M	Count	0a	1a	1
		Expected Count	.5	.5	1.0
		% within time_M_O	0.0%	0.5%	0.2%
	BUA_O	Count	10a	26b	36
		Expected Count	18.0	18.0	36.0
		% within Time_M_O	4.5	11.8	8.1
	A_O	Count	81a	71a	152
		Expected Count	76.0	76.0	152.0
		% within Time_M_O	36.7	32.1	34.4
	S-P_O	Count	1a	2a	3
		Expected Count	1.5	1.5	3.0
		% within Time_M_O	0.5	0.9	0.7
	F_O	Count	13a	6a	19
		Expected Count	9.5	9.5	19.0
		% within Time_M_O	5.9	2.7	4.3
Total		Count	221	221	442
		Expected Count	221.0	221.0	442.0
		% within Time_M_O	100	100	100

Tab. 8: Contingency matrix for (land use_area × time) for Southern Madrid vs. Oviedo. Source: calculated by authors
Note: Each subscript letter denotes a subset of Time M_O categories whose column proportions do not differ significantly from each other at the 0.05 level

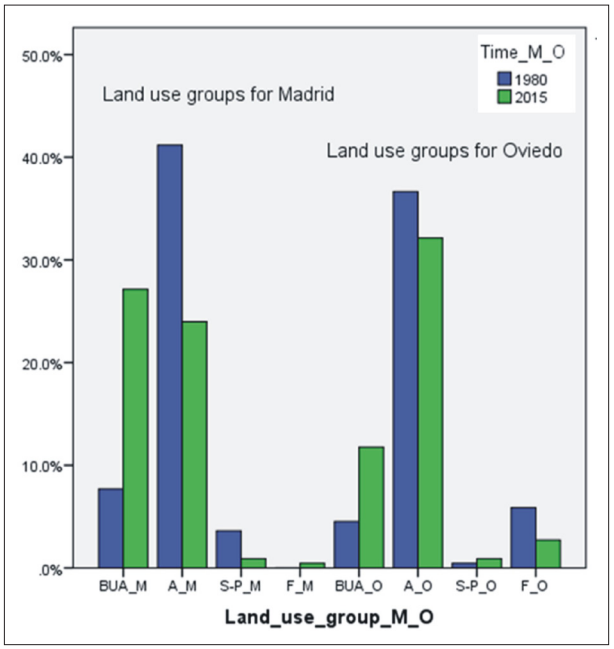

Fig. 8: Changes of land use in Oviedo and Madrid in proportionate terms. Source: calculated by authors

infrastructures over valleys and plains, and the expansion of urban sprawl, resulting in a similar mosaic of land uses, and standardising the territorial model, affecting both the agricultural systems and the urban development pattern.

In the period analysed the built-up area has increased practically fourfold in both cases. In terms of land quality, none of the peri-urban spaces have land of the highest quality, but there is a similar percentage of land suitable for agriculture, occupying nearly half of their total surface. The agricultural area at the beginning of the periods analysed was almost the same (around 90 km^2), although the distribution of crops was very different.

As can be noticed in Table 8 peri-urban agricultural land transformation has been due to urban occupation – including residential, industrial and commercial uses, as well as transport infrastructures. There's also a remarkable trend of loss in productive intensity, changing from human food crops, as vegetables and especially fruit trees, to less demanding agricultural uses, as arable crops and, in the most extreme cases, resulting in processes of land abandonment and degradation. These trends are similar to those occurring in peri-urban agricultural spaces within Europe and specifically in other Spanish regions (Nilsson et al, 2013; Simón et al, 2014); although regarding

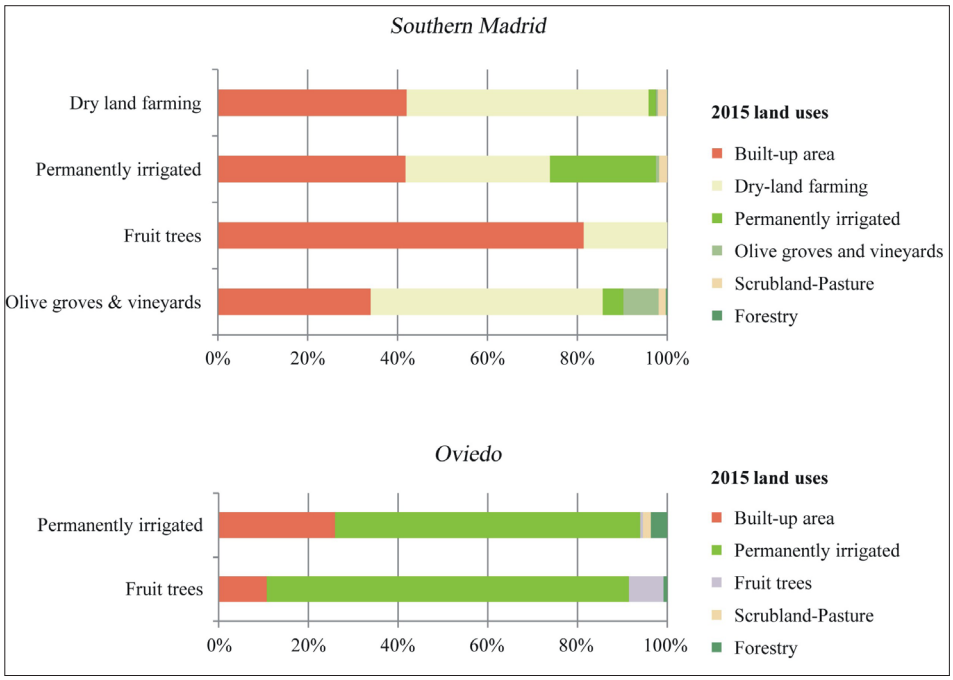

Fig. 9: Percentage of land uses occupying by previously agricultural land
Source: elaborated by the authors

deintensification, it is interesting to note that some high quality agricultural spaces, as those in Andalucia studied by Pérez Campana (2015), are experiencing an intensive agriculture development, even occupying previously non-irrigated areas, which might indicate a large scale territorial specialisation process. Considering the national scale in terms of employment, surface and quality of agricultural land, the peri-urban spaces studied might not seem to have a significant value. Nevertheless, the interest in its preservation and regeneration arises from a systemic approach to the functions these areas can fulfil, and the strategic role they can play in the context of environmental and social crisis, avoiding defensive localisms, and planning from a deep understanding of the ecological capacity of the areas, their historical uses and the current situation.

Important challenges and constraints for revitalisation have been found: firstly, land planning does not integrate the social and ecological potentialities of peri-urban agriculture, although new tools as Agrarian Parks are being explored there is not a solid regulative framework that allows for the preservation and revitalisation of peri-urban agriculture; and secondly, wider participation from economic and social actors is needed, as has been noted by other authors (Fanfani, 2013; Zazo, 2015). As urbanisation processes have spread over administrative borders, peri-urban areas should also be addressed from a supra-municipal scale: its hybrid nature between rural and urban also makes necessary an inter-sectoral coordination, in which spatial, agricultural, economic and environmental planning meet. Although municipal policies are useful and cannot be neglected, cross-scale coordination is required in order to establish common strategies and actions.

On the other hand, an economic planning orientation in metropolitan areas lacks recognition of the primary sector as a suitable way of encouraging development. Despite being traditionally an agricultural country, neither agricultural activity nor spaces have been socially valued in Spain, especially within urban contexts, in which better paid jobs can be found and more profitable uses can be located.

In terms of spatial planning, an opportunity arises in redesigning the urban fringe, and defining a more accurate transition between urban and rural spaces. Understanding these territories as biophysical systems opens up the possibility of developing green infrastructures including agricultural land, which can act as urban growth limits and ecological networks, through green rings and corridors.

Several emerging processes have been detected that may indicate a resignification of (peri-urban) agriculture, as urban population demands for goods and services provided by these areas, and farming diversification, especially regarding food supply and leisure, which is consistent with the findings from Zasada (2011), although the environmental dimension defined by the author is weak in the case studies. Another potentiality can be noted in innovative urban and rural policies, such as those developed in the framework of the Milan Urban Food Policy Pact, and in the Regional Agricultural Policies that are beginning to attend to urban-rural linkages, short food supply chains and peri-urban areas. Consequently peri-urban agriculture, despite the declining processes described above, shows a potential for regeneration.

7. Conclusions

As has been demonstrated in these case studies, peri-urbanisation is a dynamic that acts in a similar way over different regions and cultural landscapes, standardising urban settlement patterns through urban sprawl and the proliferation of infrastructures, which causes fragmentation of agricultural spaces. This contributes to the degradation of cultural landscapes, and to the loss of traditional crops and cultivation systems.

The preservation and regeneration of peri-urban agriculture has not been a priority in spatial planning or other urban and sectoral policies. Nevertheless, these areas are strategic resources, even in countries with a large agricultural surface in rural areas, as in Spain, because they might serve a wide range of ecological and social functions.

Knowing the history and evolution of these areas is one of the key factors in order to design effective policies based on local resources and identity, instead of implementing deterritorialised models of development. The methodology proposed in this paper is a useful tool for supporting planning and public policies adapted to the local contexts and taking advantage of the distinctive characteristics of the territories. Through it, a better understanding of land use changes at a local scale is achieved, the more suitable land for agriculture is identified, as well as the traditional uses carried out in it.

The analysis conducted in the selected cases has identified areas to recover, preserve and regenerate, as a first approach to the charactierisation of peri-urban areas. Further development of the methodology could include other information (for example, land tenure, legal status, water resources) in order to propose detailed uses and activities for particular areas.

In order to define a successful policy for the preservation of peri-urban agriculture, a shift in its cultural signification should also be addressed: the public policies and social initiatives identified in the case studies can serve as inspiring examples that show ways of strengthening the links between urban and peri-urban spaces, enhancing their social valuation.

Learning from the landscapes of the past, leads us to assess the soil potential in order to create new peri-urban agriculture facilities at a regional scale, like riverbanks corridors, green belts or land pockets. Therefore, urban agriculture constitutes an opportunity to develop regional sustainable planning based on traditional landscapes, an extraordinary source of knowledge and collective learning about sustainable land use management.

Acknowledgment

Financial support from the FPU grant (FPU14/04710) from the Spanish Ministry of Education is gratefully acknowledged. The authors would like to sincerely thank both anonymous reviewers and the Editor-in-Chief Prof. Bryn Greer-Wootten for their very constructive comments, which led to a significant improvement in the manuscript.

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Please cite this article as:

MORÁN ALONSO, N., OBESO MUÑIZ, Í., HERNÁNDEZ AJA, A., FERNÁNDEZ GARCÍA, F. (2017): Challenges for the revitalisation of peri-urban agriculture in Spain: Territorial analysis of the Madrid and Oviedo metropolitan areas. Moravian Geographical Reports, 25(3): 192–207. Doi: 10.1515/mgr-2017-0017.