



CHARACTERIZING POPULATION DYNAMICS AND EARLY PROCESSES OF URBANIZATION IN RURAL TUSCIA, CENTRAL ITALY

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Abstract

Urbanization adapts itself strongly in rural areas, in terms of shape and structure, depending on the local-cultural customs that are usually linked to agricultural activities. With its landscapes, Italy offers a variety of settlements used by the primary sector, that however have changed over time. In the last century, urban dispersion has mixed the typical rural settlements with the new residential low-density ones. Sprawl in Italy has been successful thanks to the irregularities and the lack of compliance with the plan rules, sometimes not present or inefficient. Tuscany, which coincides with the province of Viterbo, is still a treasure trove of great natural and agricultural value, located in the heart of Italy. Also there the dispersive dynamics took place, but following the only rules dictated by the agricultural mentality, escaping from the control of urban planning. The paper focuses that, even today this territory is certainly more liveable compared to the neighbourhoods around the capital city of Rome, the urbanization of Tuscany rural areas accords with a population that is still strongly sensitive to the primary sector's activities, which therefore allows to preserve a strong naturalness of the local context. Tuscany is probably one of the rare Italian reality in which the spatial dynamics have had to adapt to the lifestyle of its inhabitants, who persist to defend the local rural identity, still reaping the fruits of their territory.

Keywords: urban sprawl, rural areas, landscape, urbanisation, sustainable development, Italy, Tuscany.

JEL classifications: J11, R10

1. Introduction

Rural landscapes have evolved over centuries in Europe, leading local communities to act and shape land on the base of natural and social changes (Salvati et al., 2016). This adapting process has guaranteed food, energy, new lifestyles and building materials, joining a cultural landscape that conserves a knowledge wealth in agronomic practices and construction techniques since the Middle Age (Kostrowicki, 1984). In past decades, especially the European Mediterranean areas, widespread land-use transformations and urbanization (also accompanied by e.g. industrialization, agricultural mechanization, land abandonment of rural areas) caused relevant environmental diseases and local soil erosion and degradation processes (Conacher and Sala, 1998; Basso et al., 2000; Abu Hammad and Tumeizi, 2012; Salvati, 2014a). Agricultural landscape appeared affected to such transformations. Since the 1970s, Europe has undergone a rapid change of its rural landscape until then never seen, mainly due to socioeconomic factors (Meeus, 1993) and sprawl phenomenon (Salvati, 2014b). The latter invades rural areas away from the inner city (Bruegmann, 2005), giving

rise to further changes, such as landscape fragmentation, homologation or spatial polarization, alteration of the traditional proximity pattern among uses of land, ecosystem deterioration and loss in biodiversity, in both quantitative and qualitative terms (Luck and Wu, 2002; Berling-Wolf and Wu, 2004; Song and Knaap, 2004; Seto and Fragkias, 2005; Couch et al., 2007; DiBari, 2007; Català et al., 2008; Aguilera et al., 2011; Salvati et al., 2014b; Serra et al., 2014). The loss of landscape and environmental quality produced strong consequences in the agricultural sector where an intensive conversion of cropland to compact urban fabric happened, determining soil sealing and socioeconomic consequences due to marginalization of rural communities and damages of traditional agricultural practices (Munafò et al., 2010; Salvati, 2014b).

During the millenary human-landscape interactions (Alphan, 2003), urbanization adapts itself in rural areas, in terms of shape and structure, depending on the local-cultural customs that are usually linked to agricultural activities. Also in Italy, sprawl has occurred as witnessed various studies (EEA, 2006; Couch et al., 2007; Salvati and Carlucci, 2016): its unique landscape has changed over time, conciliating its urban and rural contexts. The conversion of natural and agricultural land to urban uses and the expansion of compact settlements have caused high levels of soil sealing, habitat fragmentation and degraded landscapes (e.g. pastures, abandoned fields and low-intensity agricultural areas) that are located outside the towns (Salvati and Sabbi, 2011). Several inequalities are present in the Italian country, including population density, rural-urban forms, income and natural resource distribution, that lead also to thoughtful environmental problems (Salvati and Carlucci, 2011; Salvati et al., 2014a).

As in other Mediterranean contexts, sprawl was supported by the inclinations of systems towards illegal housing and land speculation (Economidou, 1993; Weber et al., 2005; Polyzos et al., 2008; Ioannidis et al., 2009; Salvati et al., 2013; Salvati 2014b). Abusiveness and the lack of respect of the planning tools (determining by their limited and often weak efficiency) allow the rise of informal settlements, resulting into a land appropriation and uncontrolled process of building settlements since 1980s (Leontidou, 1990; Barata Salgueiro, 2001; Gargiulo Morelli and Salvati, 2010). Now dispersion process is slightly reducing, however, its effects are still visible in the territory (e.g. Català et al., 2008; Chorianopoulos et al., 2010; Munafò et al., 2010). Fortunately, there are few areas where the communities' mentality and their strong local agricultural identity have appeased the strong pressure of urban sprawl. In these contexts, sprawl took place in a milder way, avoiding serious environmental, natural and landscaping damages.

The paper aims to analyse the urbanization processes, especially related with the phenomenon of sprawl in Tuscany, located in the heart of Italy. Central Italy can be considered a

region where urban and rural areas coexist in traditional landscapes circumscribed by hills and mountains. Economic structure is structured by low- and medium-income agriculture and tertiary activities (such as commerce and the public sector) (Salvati, 2014a). Tuscany is still a treasure trove of great natural and agricultural value, regardless of whether the dispersive dynamics have also occurred there. It is expected that the main limit to the dispersive phenomenon is derived from the social and economic components, which have allowed to preserve its rural and environmental identity, protecting a portion of the Mediterranean landscape. Tuscany can be considered as one of the rare Italian reality in which the spatial dynamics and urbanisation processes have had to adapt to the lifestyle of its inhabitants.

Although the literature has studied agriculture in its various aspects in the province of Viterbo (see e.g. Colantoni et al., 2016), there are few studies that deepen the relationship between urban and rural areas through economic, social and territorial prospective. The need to reflect on the sustainability and to face new environmental and natural challenges is necessary also in realities like Tuscany. The awareness and the sustainable behaviour from citizens and economic activities, the implementation of appropriate policies and actions, the conservation and management of the typical landscape are just some topics that allow to think about the future of this reality with high landscape-natural value in order to ensure the most relevant opportunities.

2.Methods

2.1.Study area

Central Italy, separated from northern Italy by the Apennines, is a polarized region in urban and rural areas with traditional landscapes located in the internal mountainous zone (Salvati et al., 2014a). Tuscany coincides with the province of Viterbo (NUTS3 region), located in the north of Lazio region, in the heart of Italy (Di Felice et al., 2014). It includes 60 municipalities that surround the capital city of Viterbo that is located enough centrally. This area has a total surface of 3615.24 km², with a population density equivalent to 87 ab./km². It confines with Tuscany on the north-west, with Umbria on north-east, with the province of Rieti on the east, with the metropolitan city of Rome on the south and with the Tyrrhenian Sea on the west.

Tuscany has a rich history of civilization, traditions and events, which date back to the Etruscan period and the Stone Age (Gobattoni et al., 2015): in fact given the numerous historical vicissitudes, the name “Tuscany” was attributed to that area previously occupied by the Etruscans, including the northern part of the Latium region (including the provinces of Viterbo and Rome) and the southern part of Tuscany. Currently the territory of Tuscany refers largely with the province of

Viterbo (Di Felice et al., 2014): it is a historical context, full of art, archaeology, uncontaminated landscapes, picturesque medieval villages and nature.

The structure of GVA (understood as gross domestic product at market prices per inhabitant, from Istat database in 2011) in the Latium region occupies the 7th position (29726.7), preceded by other key regions such as Lombardy, Trentino Alto Adige and Emilia Romagna (respectively 33597.6, 32032.1 and 33765.3), while the lower one concerns the nearby Campania (16458.6). At the provincial level, employment rate of Viterbo (equal to 54.4, reported by the Istat census in 2011) is close to the other Latium provinces (e.g., Rieti with 54.6 and Rome with 61.1), observing an average value compared to the national context (the lowest score was recorded in Naples (36.2) and the highest in the province of Bolzano (69.5), followed by other provinces like Bologna and Milan (respectively 69.5 and 66.3) which are the Italian economic driving forces.

The agro-forestry system is the element that contradistinguishes its landscape, always strongly linked with ancient traditions, such as the pasture, grain-crops, vineyards, olive groves and forest management. Tuscany is characterized by the presence of typical traditional activities related to the production of food crafts (including cheeses, olive oil, hazelnuts and wine) and handmade decorative objects (such as wood carving, hand-work clay). The agricultural sector is still well ingrained in the Tuscany. Following the Istat data (2011), the ratio of people employed in agricultural sector in total people employment, evidences that the Latium region records only a value of 2%, while other Italian ones assume higher values (e.g. Emilia-Romagna: 3%; Campania: 4%). However, large cities have low rural occupation rates, such as the province of Milan (0.2%), of Rome (0.7%), of Naples (1.3%) and of Bologna (1.7%). While in the case of Latium region, Viterbo's province reaches 6.4%. Much of the surface area of Viterbo's province consists of cultivated lands, forests and pastures (approximately 94%, with soil sealing values equal to 0, therefore a significantly rural and natural vocation), distributed along the urban-to-rural gradient. In fact, the conjugation of rural and natural contexts increase the quality of the environmental system. Forests cover a total surface of about 360000 hectares, covering the 19% of the entire province. The water heritage has numerous rivers, torrents and lakes (such as Lake Bolsena), of volcanic origin. For orographic characteristics, climatic conditions and for its land use, Tuscany represents a typical area of central Italy (Colantoni et al., 2016).

2.2. History of early processes of urbanization

Dispersive processes took place also in Tuscany, escaping from the control of urban planning but following the only rules dictated by the agricultural mentality. The province of Viterbo is certainly

more liveable compared to the neighbourhoods around the capital city of Rome. According Salvati (2014b), Rome's metropolitan area can be considered a semi-compact and dense Mediterranean city experiencing sprawl and then structural and composition changes of its peri-urban landscape. Its main landscape transformations comprise: (i) mixed developments of settlement densification and dispersion through an increasingly degraded and fragmented agricultural landscape, (ii) reduction of the semi-natural land into scattered woodlands, especially in marginal areas and (iii) increasing mixing of the traditional rural landscape and anthropic settlements (Salvati, 2014b). In the Viterbo's province, the low-density settlements are situated in a less chaotic and scattered way if it is compared to the Roman experience. The majority of buildings constructed possess a regular planning permission for rural building. Until recently, this title could be obtained simply: the possession of minimum rural lots and being agricultural entrepreneurs were essential regardless of income derived from the relative activities. In this way, a legalization of soil consumption was permitted in such rural contexts. However, the rural countryside and the forest system have managed over the years to remain as they represent a current income for many families. In fact, today, the highest densities (with degree of soil sealing > 60) assume a very low percentage compared to the whole territory (only 0.47%), located in Viterbo and few urban centres. The entire area is characterized by the absence of sealing (approximately 94% of the provincial surface is natural and rural), with settlements with medium-low density. Despite having experienced informal practices, the administrations of the Viterbo region have always kept an approach detached from the industrial sector, defending the agricultural activities and the local workforce. These policies made possible to better protect the local countryside, avoiding a possible further urbanization and pollution.

2.3. Statistical analysis

The investigation was performed by statistical analysis and GIS processing. The unit of analysis is based on the municipal areas. The latter constitute the province of Viterbo, which represents the NUTS 3 region in the European classification. Municipalities seem to be the most relevant spatial unit for analysing land-use transformation, useful also for environmental reporting of land vulnerability to desertification and informing sustainable management of rural and peri-urban land (Salvati and Zitti, 2009).

A total of 49 indicators have been developed from a collection of variables regarding each municipality present in Tuscany (Table 1). Most of them were obtained from the Italian National Census of Population and Buildings available on the web site of the National Statistical Office

(Istat), mainly referring to the last census carried out in 2011. Indicators allow to investigate on the area though an exhaustive socio-economic and demographic description, providing an extensive classification of territorial structure at the local scale. In addition to these variables, a work carried out by ISPRA (Institute for Environmental Protection and Research) was considered (Munafò et al., 2015a), in which a set of indicators have been developed to analyse how and where soil consumption affects the Italian context, from the regional scale to the local one. ISPRA also provides a National map of soil consumption at high resolution (2012), attaching a table of relative indicators elaborated.

Table 1. List of the context variables elaborated in the present study.

Abbreviation	Extension Name	Unit	Source
DEM51-11	Demographic Variation 51-11	%	Istat - Census
DEM51-81	Demographic Variation 51-81	%	
DEM81-11	Demographic Variation 81-11	%	
DEM01-11	Demographic Variation 01-11	%	
DEM11-15	Demographic Variation 11-15	%	
DEN	Density	inhabitants / km ²	
BUID50	Buildings Constructed until 1950 / Total Buildings	%	
BUID80	Buildings Constructed until 1980 / Total Buildings	%	
BUIREC	Buildings recently constructed from 1981 / Total Buildings	%	
MSH	Medium Size Household	population/families	
UNIFAM	Family from a Component / Population	%	
EAGR	Employed in Agriculture / Total Employed	%	
ECRED	Employed in Credit and Insurance and Business Services / Total Employed	%	
EMPL	Employment Rate	%	
AGE	Aging Index	*	
MAGE	Medium Age Index	*	
COMM	Commuters / Population	%	
LMOB*	Long Mobility	*	
AINC	Average Income Per Capita	€ / population	
DIST-VT	Distance from Viterbo	km	Istat - Census GIS processing
DIST-ROME	Distance from Rome	km	
SC	Soil Consumption	hectares	Elaboration on Ispra - sinanet.isprambiente web site
NAT	Mainly Natural Areas with A Very Low Density / Surface Area	%	
LDA	Urbanized Areas with Low Density / Surface Area	%	
HDA	Mainly Artificial Areas with High Density of Urbanization / Surface Area	%	
ART	Artificial Surface / Surface Area	hectares	Ispra - Elaboration on CLC
RAA	Anthropized Area / Surface Area	%	2012
CROP**	Crops / Surface Area	%	
WOOD***	Forests / Surface Area	%	
WATE	Water System / Surface Area	%	
ICROP	Intensive Crops / Surface Area	%	
CRS	Residential Areas in Continuous Fabric / Surface Area	%	
DRS	Residential Areas Discontinuous tissue / Surface Area	%	
CHA1-1	Conversion from 1 a 1 from 2000 / surface area	%	Ispra - Elaboration on change

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CHA2-1	Conversion from 2 a 1 from 2000 / surface area	%	CLC
CHA2-2	Conversion from 2 a 2 from 2000 / surface area	%	
CHA2-3	Conversion from 2 a 3 from 2000 / surface area	%	
CHA2-5	Conversion from 2 a 5 from 2000 / surface area	%	
CHA3-1	Conversion from 3 a 1 from 2000 / surface area	%	
CHA3-2	Conversion from 3 a 2 from 2000 / surface area	%	
CHA3-3	Conversion from 3 a 3 from 2000 / surface area	%	
RSS0	Soil Sealing0 / Surface Area	hectares	EEA - Elaboration on soil sealing map
RSS1-20	Soil Sealing1-2 0/ Surface Area	hectares	
RSS21-40	Soil Sealing21-40 / Surface Area	hectares	
RSS41-60	Soil Sealing41-60 / Surface Area	hectares	
RSS61-100	Soil Sealing61-100 / Surface Area	hectares	
TEXP	Total Expenses / Surface Area	€ / kmq	Elaboration on Interior
MEXP	Mobility Expenses / Surface Area	€ / kmq	Ministry's database
LEXP	Land and Environment Management Expenses / Surface Area	€ / kmq	
YPRG	Year of the most recent municipal planning instrument	year	Latum Region's report

*Elaboration of Istat

** It includes different types of crops (areas with sparse vegetation, predominantly occupied by crops with the presence of important natural areas, extensive crops, temporary crops and olive groves), excluding the intensive crop.

*** It includes different types of forest (wooded areas and shrub evolving, woods with a prevalence of chestnut, forests of beech prevalence or prevalence of Mediterranean pine trees).

The Italian Corine Land Cover (CLC), always provided by ISPRA to 2012, is useful to analyse the land use and to understand how the Viterbo's province is structured. CLC was classified into the following classes: residential areas in continuous fabric; residential areas in discontinuous fabric; anthropized area (excluding residential areas); crops land; intensive crops area; forests; water system (with sea, lakes and rivers). Following the data elaborated by Ispra, the present study has considered also the land use change cartography (considering the recent available years: 2000, 2006 and 2012). The indicators elaborated estimate how many hectares of each type of land-use have been converted to another use since 2000, with the aim to assess land-use transformation in Tuscany and which tissue has mostly suffered from this changing. Territorial transformation identifies the conversion from the original state of land-use to the final use, classifying from 1 to 5, respectively: the urban areas; agriculture territories; forest areas; wetlands; and water system.

Another mapping, that has been chosen to validate the reliability of the CLC, is one available from the EEA web site, in relation to the degree of soil sealing. It is a raster data set of built-up and non-built-up areas, including continuous degree of soil sealing, in percentage terms from 0 to 100, in aggregated spatial resolution (100 x 100 m). The relationship between sprawl and soil sealing is very strong: in recent years, the debate around the evaluation of soil sealing through effective monitoring schemes is very actual (European Environment Agency 2006). And Italy represents an emblematic area where there is an increasing rate of conversion of land to urban uses

(Munafò et al., 2010). It was chosen to identify five classes of soil sealing: the one corresponding to '0', for the natural contexts natural; classes '1-20' and '21-40' for contexts with low density; class '41-60' identifying settlements with medium density; and then the class that indicates the most dense and compact situations (represented by the class '61-100'). Ispra also provides a National map of soil consumption at high resolution (2012), attaching the relative table of indicators elaborated.

The data regarding the Certificates Advisory were also collected from Interior Ministry at the level local. The database is an open data accessible by everyone from the website of the Interior Ministry, in order to ensure transparency from the institutional activities, such as those of municipalities. In this way, annual final balance sheet (2012) can be analysed in terms of total charges, focusing on expenses of mobility, territorial and environmental management.

Territorial objectives and strategies, defined by each Italian region, constitute a programmatic reference to the provincial and municipal policies and their respective programs and sector plans. The Master Plan (PRG) is the predominant spatial instrument at the municipal level. The Latium region regularly checks the general situation regarding the local urban planning. Through such report, another analysis variable refers to the year in which the last approval (or update) of the PRG was done, observing if a condition of inertia of spatial planning tools exists.

All these data have been developed into useful indicators with the purpose to evaluate the study area. Very often the indicators express the standardization of the selected variables compared to its municipal area surface, identifying where the most interesting contexts are located. A simple correlation verified whether there is a relationship between two indicators, demonstrating their inclination to change together. Among the statistical calculations, a non-hierarchical cluster analysis (using standard k-means computation strategy) was carried out to classify municipalities into homogeneous spatial clusters using a Euclidean distance, with a hierarchical cluster with similarity index (Euclidean) with algorithm "paired with group". The processing of maps regarding the indicators and their spatial analysis using GIS program allowed the detection of the most interested contexts and the validation of the results obtained (Salvati et al., 2011).

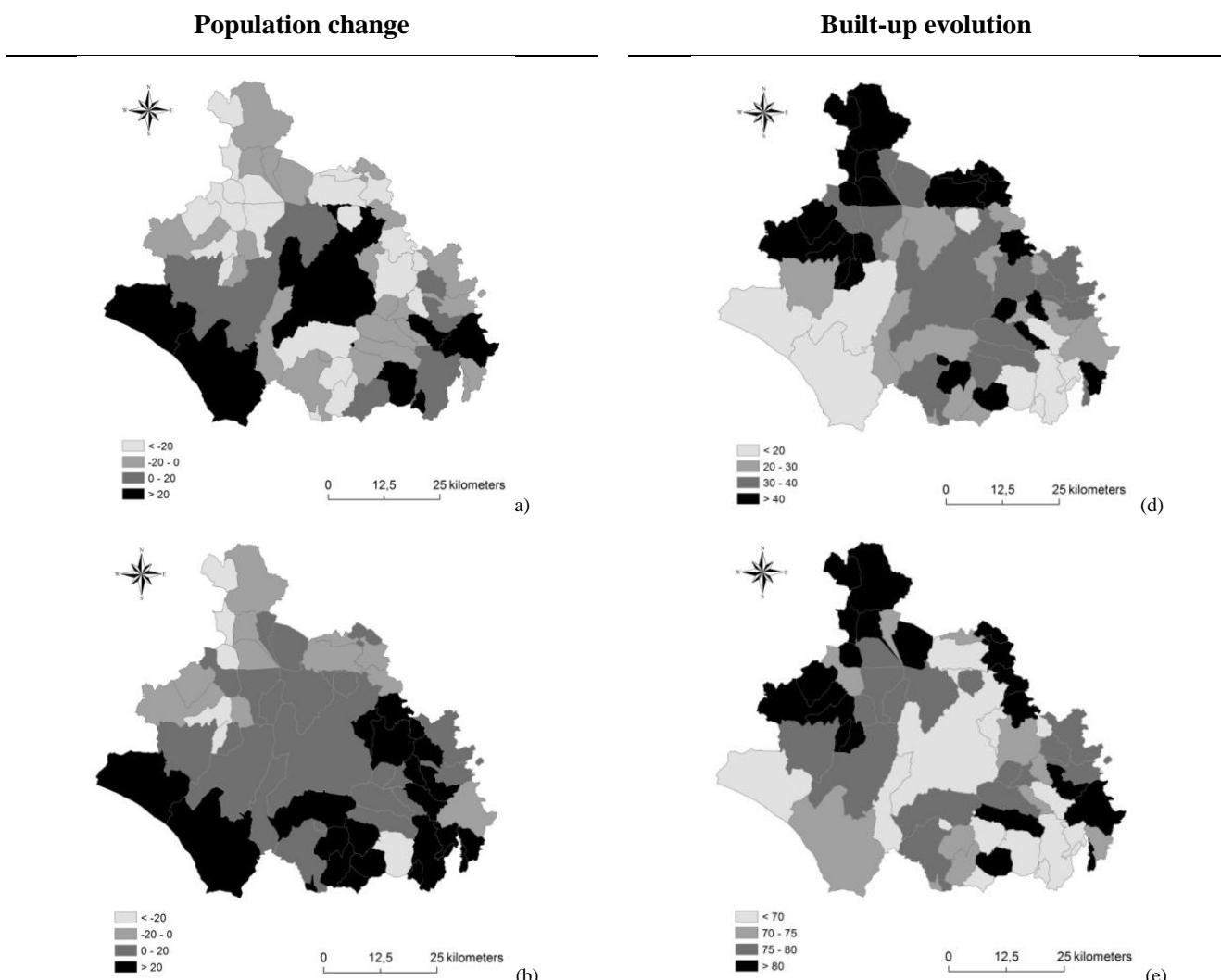
3. Results

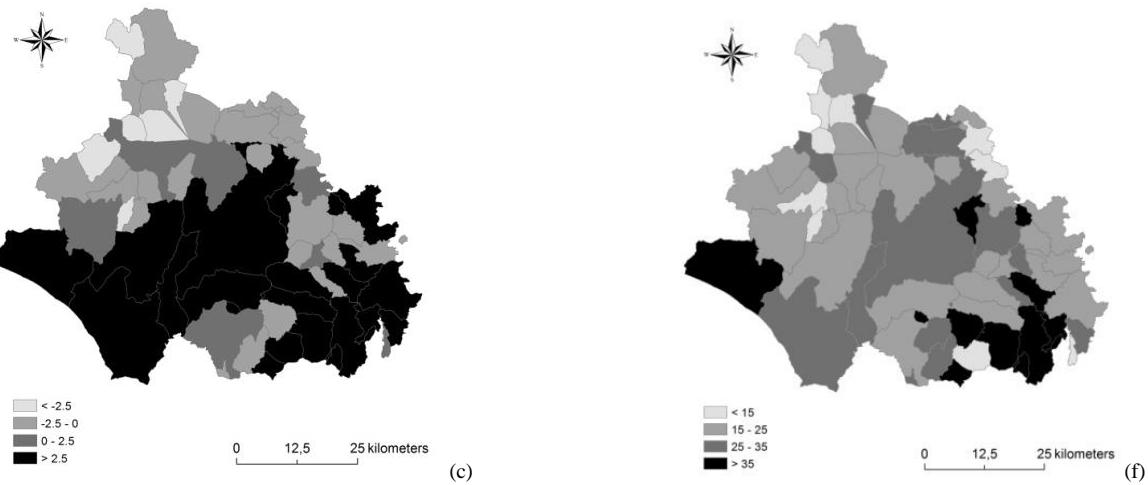
Demographic changes help to track the settlement processes in Tuscany. Figure 1a shows how, from the 50-80s, the largest population change was located around the main town of Viterbo; as time went on, the city of Viterbo has recorded a lower demographic change, which in turn has assumed maximum levels into the surrounding contexts and especially along the coast of Tarquinia and

Montalto di Castro (Figure 1b). It is exactly in this period that even the phenomenon of second homes manifested, where the evolution construction occurred also along the Tyrrhenian coast. This trend is a typical character of sprawl present throughout the Mediterranean area. In recent years (Figure 1c), demographic change was heavily concentrated around Viterbo, its surrounding municipalities and coastal municipalities.

Figure 1 (d,e,f) shows the built-up evolution. Until the 50s, the largest number of buildings were around the Viterbese hinterland. From 1950 until 1980, a building boom occurred in the area surrounding the city, highlighting that also sprawl manifested itself in the Tuscany countryside. The latest map instead concerns the percentage of buildings built in the last thirty years, where the dynamic dispersive has always taken place mainly in the coastal area and around the chief town.

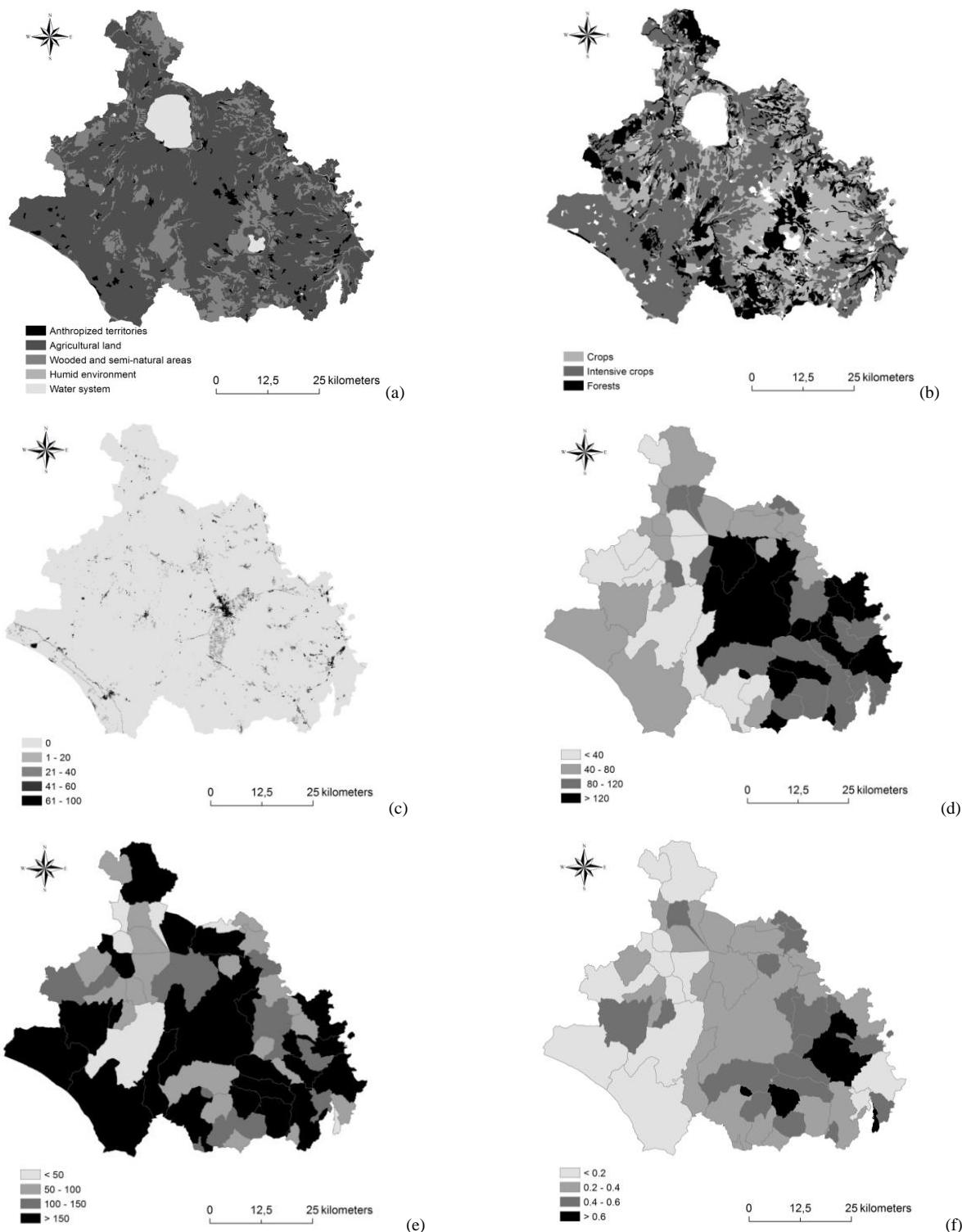
Figure 1. Population change from 1951 to 2015 and built-up evolution. Maps correspond to: DEM51-11 (a); DEM51-81 (b); DEM11-15 (c); BUID50 (d); BUID80 (e); BUIREC (f).





Despite demographic and settlement change, Tuscia strongly maintained its rural connotation. Figure 2 reflects on its territorial structure. In 2012, maps reveal a predominantly rural land use. This is demonstrated by CLC's map (Figure 2a), classified following the level 1, that highlights where the anthropized and agricultural territory, forestry, humid environments and water system are placed. Figure 2b shows only the agricultural fabric, which extends across the province of Viterbo, leaving a few empty spaces (that indicate other land-uses). Rural activities are primarily concerned with crops, while more intensive crops are located near the sea, where the largest greenhouse cultivation is settled. Soil sealing (Figure 2c) confirms the CLC's data, pointing out that the largest concentration of populated areas (with soil sealing degree $>$ of 60) and density (Figure 2d) are close to the crop lands (Figure 2f), while the most intensive farming spatially corresponds to the very sparse built settlements. Soil consumption summarizes the most affected contexts by illegal building and urban sprawl (Figure 2e). The affected municipalities are located around Viterbo and along the coast. The latter assume a mostly artificial configuration with medium-high density of urbanization and soil sealing compared to the total municipal area. Through a comparison, maps relating to demographic change are similar to those for population density and soil consumption.

Figure 2. Elaboration of the territorial configuration of Tuscany: CLC's classification (2012) according to the level 1 (a); classification of the rural context of CLC (2012) according to the type of cultivation (b); soil sealing map (c); density (d); soil consumption (e); percentage of agricultural land (excluding intensive crops) on the surface area (f).



Results demonstrated that the social - economic determinants have driven the dispersion process in Tuscany (much more than planning tools), affecting also the environmental component. Correlation permitted to understand the relationship between the various indicators developed.

Table 2 contains only an extract of the correlation regarding the indicators of density (DEN), aging index (AGE), percentage of residential areas discontinuous tissue on the total municipal surface area (DRS) and the conversion from rural areas to urban fabric since 2000 on the total municipal surface area (CHA2-1). Density (DEN) is positively correlated with the: percentage of newly buildings (since 1981) on the total built-up elements; family medium size; degree of commuting; percentage of total expenses, expenses relating to the viability and management of the territory and the environment in respect of the municipal area, in 2011; percentage of urbanized areas with low density compared to the municipal area; anthropic contexts, in particular regarding residential areas discontinuous tissue with degree of soil sealing with values ranging from 1 to 60, where there is a strong presence of rural activities. In recent years, a re-compaction processes have been assisted where the cultivation area has a considerable presence at the local scale. Instead density is negatively correlated with: percentage of buildings constructed until 1980 on the total of buildings; single-family households compared to the resident population; employed in the agricultural sector on the total employed; old age and middle age index; predominantly natural areas or with very low density ('0' degree of soil sealing) compared to the municipal surface. Correlation demonstrated that sprawl has taken place in the Viterbo's context, but avoiding those high natural settings, where the strong presence of the primary sector has prevented an excessive land consumption. These contexts are identified by a greater value of aging index, where construction activity dates to the 80s. Aging index is also associated with very low values of demographic change, average income per capita, employment rate, while there was a strong presence of single-family households (consisting of elderly widowers) and employees in the agricultural sector.

Table 2. Extract of the correlation with the three most interesting indicators (population density ‘DEN’, aging index ‘AGE’, discontinuous residential areas on total municipal area ‘DRS’, land-use conversion from rural areas to urban areas from 2000 on total municipal area ‘CHA2-1’) in columns and processed variables in rows with value $> |0.5|$.

<i>Variables</i>	<i>DEN</i>	<i>AGE</i>	<i>DRS</i>	<i>CHA2-1</i>	<i>Variables</i>	<i>DEN</i>	<i>AGE</i>	<i>DRS</i>	<i>CHA2-1</i>
<i>DEM51-11</i>	0.6	-0.7	0.6	0.6	<i>NAT</i>		-0.7	0.5	-0.7
<i>DEM51-81</i>					<i>LDA</i>		0.7	-0.5	0.7
<i>DEM81-11</i>	0.6				<i>HDA</i>				
<i>DEM01-11</i>	0.6	-0.7	0.7	0.5	<i>ART</i>		0.8	-0.5	0.8
<i>DEM11-15</i>	0.6	-0.7	0.6	0.5	<i>SSO</i>		-0.8		-0.7
<i>DIST-VT</i>					<i>RSSI-20</i>		0.7		0.5
<i>DIST-ROME</i>	-0.6	0.7			<i>RSS2I-40</i>		0.8		0.7
<i>DEN</i>	1.0	-0.6	0.8		<i>RSS4I-60</i>		0.7	-0.5	0.7
<i>BUID50</i>		0.7			<i>RSS6I-100</i>				
<i>BUID80</i>	-0.6	0.6	-0.7		<i>RAA</i>		0.5		0.9
<i>BUIREC</i>	0.6	-0.6	0.7		<i>CROP</i>		0.5		
<i>MSH</i>	0.6	-0.7	0.6		<i>WOOD</i>				
<i>UNIFAM</i>	-0.6	0.6			<i>WATE</i>				
<i>EAGR</i>	-0.5	0.7			<i>ICROP</i>				
<i>ECRED</i>		-0.5			<i>CRS</i>				
<i>EMPL</i>		-0.5			<i>DRS</i>		0.8	-0.5	1.0
<i>AGE</i>	-0.6	1.0	-0.5		<i>CHA1-1</i>		0.5		1.0
<i>MAGE</i>	-0.6	1.0	-0.6		<i>CHA2-1</i>				1.0
<i>COMM</i>	0.5	-0.9	0.5		<i>CHA2-2</i>				
<i>LMOB</i>					<i>CHA2-3</i>				
<i>AINC</i>		-0.6			<i>CHA2-5</i>				
<i>TEXP</i>	0.9	-0.5	0.8		<i>CHA3-1</i>				
<i>MEXP</i>	0.6		0.5		<i>CHA3-2</i>				
<i>LEXP</i>	0.9	-0.5	0.8		<i>CHA3-3</i>				
<i>SC</i>					<i>YPRG</i>				

Typical contexts of sprawl with medium-low density are concentrated in the southern part of Tuscany and along the coast. Indicator ‘DRS’, that refers to “Residential Areas Discontinuous Tissue / Surface Area”, is positively correlated with demographic change (especially the recent ones), density, percentage of recent buildings since 1981 and commuters, medium size household, all the voices of the municipal expenses (stating that a greater dispersion also implies a greater collective

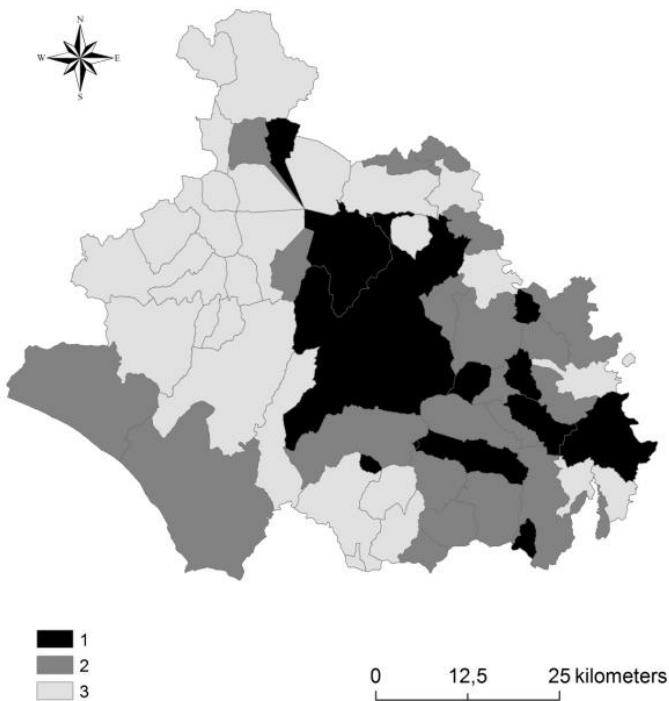
cost), intermediate levels of soil sealing (between 1 and 60). DRS appears opposite to natural contexts, with soil sealing with values equal to 0, where a discordant trend of percentage of buildings constructed until 1980 and old age indicators is reported.

As expected, correlation has revealed a modest change of agricultural land intended for urban use since 2000, compared to the other changes in land use. The conversion from agricultural land to urban fabric involved most of the municipalities, highlighting however that the case study was not exempt to land consumption processes. Capranica, Montalto di Castro, Monterosi, Orte, Proceno and Viterbo are the municipalities that have seen a re-functionalization of the built-up environment. The transformation of agricultural land for new buildings occurred mainly where there was a strong demographic change and medium-high population density, with soil sealing values greater than 0, as a result to prevent natural territories. This outcome demonstrated that the Viterbese area avoids to convert highly natural contexts into a scattered and fragmented spatial organization.

Results affirmed that the greatest demographic change occurred in dispersed contexts, with degrees of soil sealing between 1-60. However, it is strongly linked to the “density” factor, which not allow to lose too much building fabric in the surrounding countryside. Now large group of young population live in these contexts, moving around the territory. They have a medium - high income levels, preferring the convenience of living close to more dense and compact contexts. As correlation highlighted, Tuscany represents one of the few Italian cases in which the majority of soil consumption is recorded in urban contexts, with medium - high density, minimizing extensive land consumption (Munafò et al., 2015b).

A non-hierarchical cluster analysis (using standard k-means computation strategy) was carried out to classify municipalities into homogeneous spatial clusters using a Euclidean distance. The k-means cluster analysis identified three clusters characterizing the main territorial typologies present (Figure 3). With dark colours (value 1 in the legend), Viterbo, Ronciglione, and San Lorenzo Nuovo emerged as some of the most compact and dense settlements. Dispersive areas, with medium density, surrounded by the countryside (value 2 in the legend), such as Vetralla and Caprarola, appeared occupying the southern part of Tuscany. Highly natural areas are represented with the lightest colours (value 3 in the legend), indicating contexts with high landscape value, characterized by occasional low-density settlements: Acquapendente, Bagnoregio and Barbarano Romano are some municipalities that are included in this last cluster.

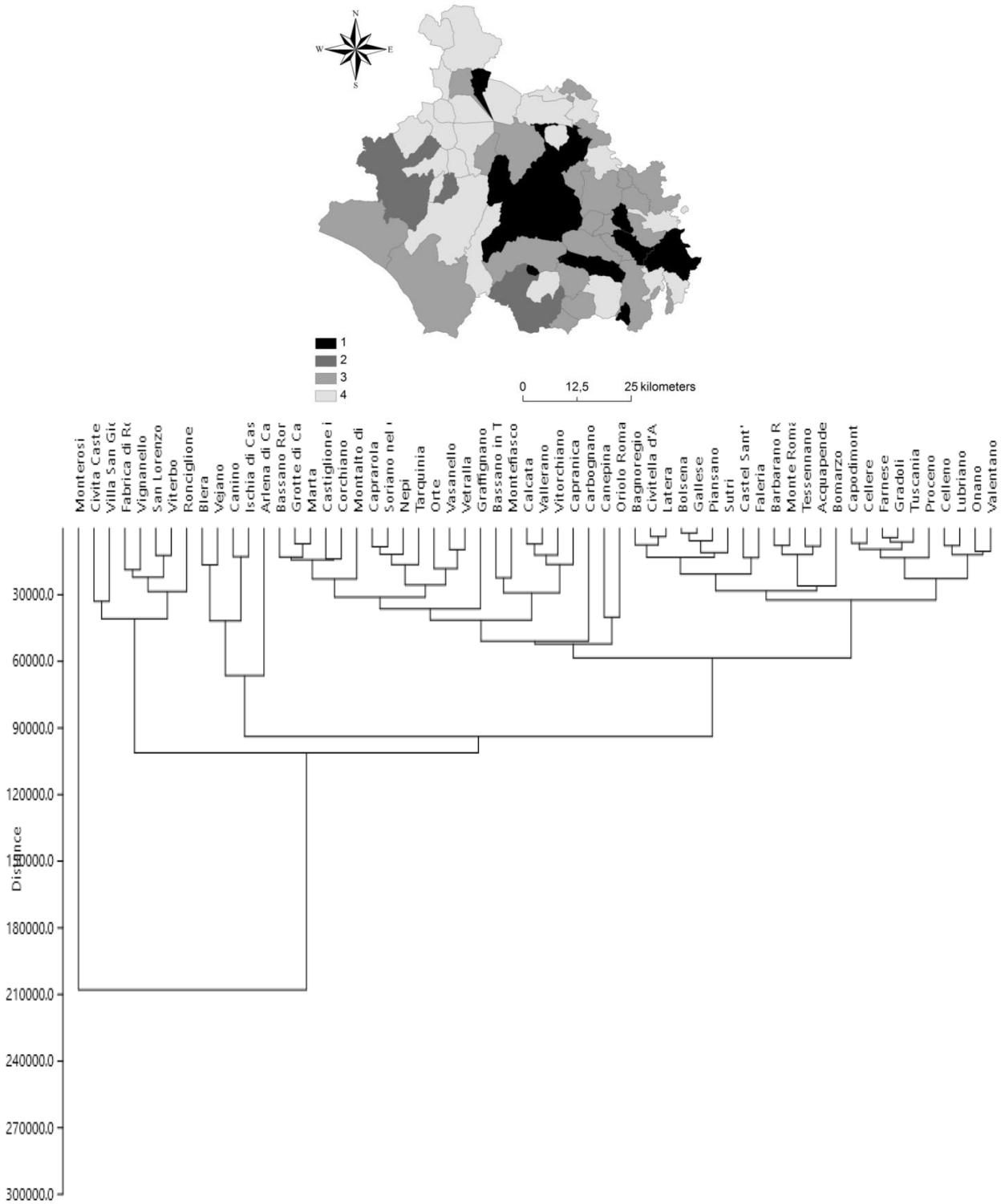
Figure 3. The k-means cluster analysis.



Validating the preliminary results, a hierarchical cluster with similarity index (Euclidean) was carried out with algorithm “paired with group” (Figure 4). In this case four specific clusters are identified, however confirming the results obtained from the k-means cluster analysis. The group with the city of Viterbo is the one that stands out compared to other clusters, given its features. It identifies the most compact contexts, where high values are related to the positive demographic change especially in recent years, employment rate and income per capita. Its society is mainly composed by young people, enough large families and commuters. Urban settlements have experienced a decline until the 80s, then have a significant increase in recent years. In fact, this cluster recorded the highest provincial values of soil sealing, rural land converted into urban surface and soil consumption. Surrounded by the typical Viterbo’s rural landscape characterized by extensive crops (as olive and hazelnut), these municipalities do not assume a strong rural quality, like other contexts of Tuscany. This condition results into an increase in expenses, which weighs in municipal budgets especially for the items concerning the territorial and environmental management (see also Burchell et al., 2005). A specific group (cluster 2) stands out in the hierarchical clusters with similarity index. Blera, Vejano, Canino, Ischia di Castro and Arlena di Castro appear different from other municipalities. Despite it is similar to the cluster 4 (according to the k-means cluster analysis, the two clusters are included in the same group), these municipalities are differentiated by the high naturalness and extremely low population density, where sprawl has

not been successful there. With a constantly negative demographic change, its residents are mostly older and low-income people, static in the territory, resulting into a low employment rate despite a mighty agricultural presence. Such socio-economic structure has preserved a rural area, where the land consumption rates are the lowest around the case study. In fact, the built-up evolution has stopped in the 80s, in favour of agriculture (mainly in the intensive form, generally concentrated in the western area). The certain socio-economic and landscaped profile affects also the municipal budgets, in which the costs are the lowest. The third cluster concerns particularly the southern part of Tuscany. Medium-high values of land consumption identify an area where urban sprawl has occurred, without excess, and the real estate expansion has grown over time, especially along the coast where tourism has developed in the last decades. The advent of urban dispersion may be the consequence of a collective application, resulting in an effective economic and social welfare as, in this cluster, are recorded: a consistently positive demographic change, which has improved especially in recent years; strong territorial mobility; medium - high employment rates, young people and large families, confirming the presence of an active population. Results describe a cluster characterized by medium-density settlements, surrounded by a rural landscape, ranging from intensive farming in the west to less intensive crops in the east. Finally, the fourth cluster identifies the most natural environments, with medium-low density. The area did not report high land consumption rates and a consequent urbanisation processes. In fact, soil consumption and rural areas converted for urban purposes have been very limited. Its territorial connotation, especially in the western municipalities, is delineated by a landscape where intensive agriculture is its protagonist. This assumption derives a reflection concerning the environmental issues. The cluster can be recognized as those economically disadvantaged and marginal contexts (with negative demographic rates, lower incomes and employment rates), in which attend situations of social - economic inequalities and environmental and eco-systemic problems (Salvati et al., 2014a).

Figure 4. Hierarchical clustering



The existence of four clusters also confirmed a different political implication regarding the land management instruments. The present work has detected a general status of inertia of the Master Plan (PRG) in the whole province of Viterbo. The municipalities with the highest density rate and land consumption (specifically the cluster that includes the city of Viterbo) possess a more

dated PRG. Only the municipalities of Soriano nel Cimino, Proceno and Acquapendente (which belong to other clusters) have performed an adjustment (known as “*variante*”) of such instruments recently (from 2010 to present). This passive attitude leads to a territorial design that can be defined defective, because Master Plan is not updated regularly, due also to a not-effective spatial policy. During the analysis, a negative correlation (-0.5) demonstrates a noticeable relation between the year of the most recent land use planning tool (or PRG) and the indicators HAD and SC. In fact, the municipalities with a more dated local planning instrument have recorded a greater soil consumption and a higher high-density urbanization rate.

4.Discussion

The Mediterranean basin represents an example of the durable interaction between natural ecosystems and human activities (Alphan, 2003; Ferrara et al., 2014). Since the 70s, urbanization, land abandonment, crop intensification, soil degradation, new economic dynamics and other many factors have determined land-use changes in southern Europe (Paul and Tonts, 2005; Català, et al., 2008; Nolè et al., 2009; Chorianopoulos et al., 2010; Munafò et al., 2010; Ferrara et al., 2014). Drivers, such as and changes towards urban sprawl (Cakir et al., 2008) and intensive agriculture (Alphan, 2003), have altered the traditional landscape, fragmenting it and endangering the most vulnerable rural and peri-urban areas (Salvati et al., 2016). The collective costs that result from the dispersive phenomenon has already been studied (Burchell et al., 2005). Municipal budgets have investigated on this problem, highlighting that the higher expenses are localized in the medium-high density contexts with a greater presence of dispersive residential areas. Results produced a series of reflections that range to social - economic issues (e.g. situation of segregation and polarization, economic marginality,) and environmental and natural (e.g. phenomena of land degradation) that affected disadvantaged rural regions of southern Europe (Rubio and Bochet, 1998; Iosifides and Politidis, 2005; Wilson and Juntti, 2005; Salvati and Carlucci, 2011; Salvati et al., 2014a). Likewise, Tuscany appears affected by these factors but in a very circumscribed way. In terms of land use change, dispersive dispersion has been severely restricted and limited in the already dense contexts. Urbanisation processes seem to be also influenced by the strong local identity. In this way, natural and agricultural landscape has remained mostly unchanged in time. In fact, Viterbo is one of the few Italian cities that have recorded a low percentage of land consumption referred to the whole municipal area (Munafò et al., 2015b). The presence of a very consolidated rural setting allowed to limit an excessive soil consumption over time, maintaining its traditional socio-economic profile.

The present study explored a poorly researched reality, in terms of urban-rural gradient. Crop intensity and soil compaction characterize the Viterbo area, despite also being sensitive to the of urban sprawl, soil sealing and environmental phenomena (e.g. salinization and fire risk) (Salvati et al., 2011). The preservation of rural-cultural landscapes in peri-urban contexts can result complex due to the interactions of various elements (i.e. biophysical, social, economic, cultural and institutional). Peri-urban areas should be treated as rural landscapes, which can be effectively protected in ecologically long-term feasible approach, thanks to a reasonable human pressure and tools that integrate “social” functions (derived from the primary sector) with eco-conscious local communities (Salvati et al., 2016). This has happened in the Tuscia: land consumption has limited the denser areas, leaving the agriculture to be the unique protagonist of the landscape, without scattered settlements.

Agriculture has managed to limit the spread and informal dispersion processes in the Viterbese area. Results revealed that municipalities with more recent Master Plan have suffered less land consumption. A constant control of urban planning instruments would allow, for example: to avoid potential damaging impacts to the environment and to the built-up system; to ensure continuous territorial maintenance and conservation; and to verify compliance with the guidelines dictated by higher institutional levels. Now we must look ahead, implementing policies and actions to achieve an increase of sustainability. Outcomes have then encouraged reflections on the regulatory framework. With its Regional Development Plan General (PTRG), the Latium region imposes a set of specific objectives that must be followed at lower territorial levels, such as: to enhance the vocations and restrict land consumption; to limit urban sprawl; and to safeguard agro-forest landscapes. General and specific objectives imposed by the region must be included and adapted to each local context (through the municipal Master Plan). However, given the regional variability, different realities exist such as Rome with its complex metropolitan area and the province of Viterbo with a strong rural vocation. Agriculture correspond to a real added value for the Viterbese territory. The final purpose of rebalancing urban, peri-urban and rural areas into a new urban-to-rural ‘sustainable continuum’ is essential (Salvati et al., 2016). Agricultural activities, which should improve their organization particularly in the peri-urban contexts, could help to achieve a better ecological equilibrium in the neighbouring urban systems, enhancing their sustainability degree (Silvestri and Bonari, 2010). For example, the development of circular economy in agriculture can limit and control farming wastes, utilizing them as a sustainable strategy (Jun and Xiang, 2011). Agricultural waste can be used as biomass (such as biochar), giving energy to productive processes (and maybe even residential) (Pan et al., 2015; Zabaniotou et al., 2015). A

sustainable cycle of economy is the way to reach a real development between environment and economy (Frayssignes, 2011; Jun and Xiang, 2011). The awareness that the local resources can result an effective opportunity for the future is decisive. The establishment of agro-energy districts can be a standpoint of sustainable development, as possible solution for: create a network of actors and stakeholders; reuse waste and natural resources and other clean energy; increase rural identity, quality and protection of landscapes; ensure the sustenance of local businesses (e.g. Frayssignes, 2011; Shamsuzzoha et al., 2012; Tziolas et al., 2016). Associated with an assessment which identifies other environmental issues and land vulnerability degree to the various factors of instability on a spatial scale compatible with the development of planning (Salvati et al., 2016), even Tuscany, as other national contexts, should implement sustainable land management strategies, continuing to protect its agricultural landscapes.

5. Conclusion

The present work has explored Tuscany, permitting to investigate on its local identity, traditional economic activities and spatial processes. Urbanization processes in its rural areas has found a population that is still strongly sensitive to the primary sector's activities, which therefore allows to preserve a strong naturalness of the local context. The province of Viterbo represents a unique context where the social and economic components, reinforced by cultural belief, characterize and preserve its landscape until today. The strong rural connotation stimulates to reflect on future management of peri-urban and agricultural land. The area appears as a perfect candidate to become a territorial model that combines traditional activities and progress through a series of strategies that include a variety of sustainable policies and the establishment of agro-energy districts.

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