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Cover image: The ZCB Zero Carbon Building, designed by Ronald Lu & Partners, conceived to promote a low carbon emission lifestyle and to be a showcase of technologies to initiate a cultural change.

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URBAN DEVELOPMENT IN TUSCANY

LAND UPTAKE AND LANDSCAPES CHANGES

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ABSTRACT

The phenomenon of urban sprawl has been already recognized as one of the major anthropic threats to natural ecosystems and landscapes while the negative aspects of the phenomenon are still only marginally taken into consideration in the scientific and local government circles. The recent decision of the European Parliament points out that the degradation, fragmentation and non-sustainable use of land in the EU is jeopardizing several important ecosystem services, threatening biodiversity and increasing Europe's vulnerability to climate change, natural disasters and desertification. The study regards the processing of data on urban land conversion over the past 50 years and the effects in the areas of high environmental vulnerability in one of the most important Italian region: Tuscany. The historical data were compared from a qualitative and quantitative viewpoint with the present-day geography of settlements, which showing changes found in today's settlement-territorial structure. The conclusion reports focuses on collated environmental criticalities and the margins for recovery of the compromised territories that still today receive little attention from central institutions and local authorities, in addition to data on landscape effects to be construed as signs of specific trends underway today and scarcely taken into account by land management tools.

KEYWORDS:
land uptake, GIS analysis, urbanization impact, land-use change, landsca

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土地与景观摄取

托斯卡纳城市发展

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A 摘要

城市扩张早已被认为是自然生态系统和景观面临的主要人类威胁，而这种现象的消极方面却仍处于科学界和当地政府部门考虑范围的边缘位置。欧洲议会最近的决定指出，欧盟境内的土地退化、零碎化和不可持续使用正危及一些重要的生态系统服务，威胁着生物多样性，并增加了欧洲面对气候变化、自然灾害和荒漠化时的脆弱性。本研究将聚焦于对托斯卡纳这个最重要的意大利地区过去 50 年城市土地转化数据的处理以及高环境脆弱性地区所产生的影响。这些历史数据将从定量和定性角度与现在的居住区地理进行比较，展示在现在的居住区域结构中发现的变化。结论报告除了关注那些将被解读成当前具体趋势信号以及很少被土地管理工具重视的景观效应数据以外，还聚焦于那些现在仍未从中央机构和地方当局那里获得太多关注的受损地区所面临的环境危险程度和恢复空白。

关键词

土壤消费, 景观, 地理信息系统

1 INTRODUCTION

The research presented here was aimed at investigating the urban development as one of the more relevant factors of landscapes changes of one of the most famous Italian regions, Tuscany, and its effects over the period of half a century. The study was carried out by analysing the settlement condition during two distinct temporal periods: that immediately following the second world war and the first decade of 2000. Tuscany is one of the most well-known Italian regions in the world, with one of the highest international tourism rates thanks in part to Florence, which was one of the most important cities in Europe during the Renaissance period, and in part to other cities such as Pisa, Siena and Lucca, which are well-known for historical, architectural and cultural reasons. However the region is famous for its landscape those has become an Italian trademark in the world's collective imagination (Paolinelli and Valentini, 2009). Suffice it to say that Tuscany hosts seven of the more than fifty UNESCO sites established in Italy, and that the European Landscape Convention was signed in Florence on 20 October 2000. This latter, to date signed by six EU member countries and ratified by 32, recognises Tuscany as a substantial economic asset, as well as an aesthetic and cultural one (http://conventions.coe.int/Treaty/ita/Treaties/Html/176.htm). It is one of the largest regions of Italy (the fourth out of 20) and hosts more than 6% of the national population thanks to a wide range of economic opportunities in the agricultural, industrial and artisan sectors, but most especially in the tourist sector with its many centres of art, its aforementioned rural landscape, the vast architectural heritage and a long and beautiful coastline along the Tyrrhenian Sea (over 400 km – about one fifth of the entire western coastline of the peninsula). The latter includes some of the most famous Italian seaside resorts such as the Versilia, the island of Elba, the Grosseto coastline and the Argentario promontory. Regional bodies have estimated that were over 11m tourist in 2006 , a third of which were concentrated in the province of Florence, and about 40% of which came from outside of Europe (HTTP://IUS.REGIONE.TOSCANA.IT/CIF/PUBBLICA/TIC2007/ZIP_PDF/TURISMO.PDF). Tuscany's tourist influx accounts for almost a quarter of the national total and the related economic dynamics are further strengthened by an affluent real-estate market that has seen, for several decades now, wealthy international clients buy and renovate buildings in rural and historic centres (Geri et alii, 2010; Paolinelli, 2012; Rosignoli et alii, 2013; IRPET, 2014a; Falqui et al., 2014). The settlement-type transformations that occurred over time were influenced in ways and with impacts that were different from the regional geo-climatic characteristics and political choices that have affected the urban aspect and agricultural landscape. Regional agriculture has long been characterized by the sharecropping model (Reid and Joseph, 1975; Shaban, 1987; Singh, 1989), an agricultural practice that has produced profound changes in the regional landscape over time. Over the centuries the introduction of sharecropping created an increasingly dense mesh of small farm holdings in land thickly planted with trees, where a large proportion of the rural population lived in isolated houses (Rombai, 2002; Vos, 1993). Sharecropping characterized regional agricultural production until the 1960s when, thanks to an act prohibiting the possibility of entering into new sharecropping contracts (Act No. 756, 15 September 1964), the sharecroppers abandoned the small farms holdings and adapted the landscape to agricultural mechanization. It is important to stress that, at the end of the 1930s, 4,125 of the 5,666 estates surveyed in central Italy were located in Tuscany (particularly in the central-southern part of the region), and they covered 40.9% of the agricultural and forestry area, and united over 70,000 farm holdings. Most obviously prevalent were the small and medium-sized farms – the former were most numerous in the provinces of Massa Carrara, Lucca and Pistoia, and were the ones most geared to the intensive cultivation of vegetables and flowers; while the latter were most numerous in the provinces of Florence and Arezzo. The large farms, instead, were a prerogative principally of southern Tuscany (the provinces of Livorno, Pisa, Siena and Grosseto). On average a farm contained 18 hectares, but it varied between the six hectares of Lucca and the 68 of Grosseto, where the many large cultivated areas included vast forests and pastures, as well as arable land. Generally, the largest farms covered the extensive arable

lands of Maremma as well as the mountainous areas (where the quantity of forest and pastureland was also significant), and the smaller ones covered the hill areas, which were the most marked by intensive farming (arable land with grapevines and olive trees). Urban conversion of the land in Tuscany is a territorial pathology resulting from economic dynamism and a population growth that, particularly over the past decade, has increased greatly. Although the international scientific world has highlighted the problems and environmental consequences of extended urban transformations for many years (Sala et al., 2000; Lambin et al., 2001; Ellis and Ramankutty, 2008), only a few studies of Italy published in international magazines have begun to provide more precise details on the character of the phenomenon of "land take" and of the artificialisation of the land (Pileri and Maggi, 2010; Romano and Zullo, 2012, 2014; Salvati et al., 2012). Very few regions (only three out of 20) have vectorial information on land consumption spanning 50 years, and there is even very limited data for smaller time frames between 1970-2000, both in terms of information on the overall expansion of urban areas and a historic series of statistically significant data, while in other countries there is much more data and there are many more articles (Hall et al., 1973; Mellor, 1983; Yanitsky, 1986; Irwin and Bockstael, 2007; Zaninetti, 2006; Garcia-Call, 2011; Hauri et al., 2006; Catalán et al., 2008; Illy et al., 2009). In addition, no local authorities (regional, provincial or municipal) have yet organised coordinated surveys, and although programs monitoring the phenomenon on a national scale have recently started to spread (Munafò and Tombolini, 2014), they are only on a small scale so we are still far from having any kind of systematic data collection that would allow us to make credible comparative evaluations (Sharma et al., 2012; Lowry, 1990). The negative aspects of the phenomenon are still only marginally taken into consideration in the scientific and local government circles (Grubler, 1994; Heilig, 1994), and for many years now the lack of a standard of reference for the protection of the land in all its uses has been highlighted (Pileri and Lanzani, 2007), while at the European level, the proposal for a framework directive on land (COM/(2006)/232) was recently withdrawn (Office Journal 22 October, 2014 C 153, dated 21 May 2014) by the European Parliament and Council, who have adopted Decision no. 1386 (20 November 2013) of the Union's 7th general programme of action regarding the environment until 2020: "Living well within the limits of our planet", which represents a binding declaration of intent from the environmental point of view. This decision points out that the degradation, fragmentation and non-sustainable use of land in the EU is jeopardizing several important ecosystem services, threatening biodiversity and increasing Europe's vulnerability to climate change, natural disasters and desertification. Only in 2013 did this issue appear on the Italian government's agenda, and it was followed by many legislative proposals (on 13 December 2013, the parliamentary bill presented by Minister Catania "Regulations relating to the utilization of agricultural areas and containment of land consumption", was approved by the Council of Ministers) aimed at curbing the negative effects of the urban land conversion phenomenon. In this sense, in order to understand its dynamics and causes and, based on these, to develop appropriate political-territorial strategies, it is essential to reconstruct the evolved dynamics of the settled areas over the entire national territory, based on standard data consistent throughout the country and with a level of accuracy that allows for an assessment of the extent of changes to the territory from the post-war period to the present day.

The objective of this paper is to provide a contribution in this direction by focusing on a significant area of the country, i.e. Tuscany. The description of the area of study outlines the socio-economic and territorial characteristics; the section on the methodology describes the origin of the data and the techniques used for their processing; and the section on the results illustrates the regional settlement conditions detected in the 1950s, and by comparing them to the conditions today, exposes the resulting changes found in today's settlement-territorial structure. The conclusion reports on and analyses the information that emerged during the study, focusing on collated environmental criticalities and the margins for recovery of the compromised territories that still today receive little attention from central institutions and local authorities.

2 AREA OF STUDY

Tuscany covers an area of approximately 23,000 km^2 (equal to about 8% of the whole national area) and is divided between 287 municipalities, each of a relatively large size and on average almost double that of national standards (8,000 ha compared to 3,600 ha), and stretching across ten provinces. without getting into detail about the vegetation, it is the region of Italy that has the highest forest coverage, with about half of its territory given over to woodland use (compared to 25% nationwide) and another 40% to agricultural use. the morphological features of the rest of Tuscany consist of hills (over 66%) and plains (about 8%). the mountain ranges of the Apuan Alps, Garfagnana and Pistoia are all located in the northern part of the region, next to the Tuscan-Romagna Apennine ridge, and occupy slightly more than 25% of the area with an altitude of almost 2,000m above sea level (Fig. 1a). The urbanized areas are largely concentrated in the plains, with a significant industrial production component. The regional council's resolution no. 69/2000 identifies 12 industrial districts, including the leather goods and footwear sectors that have for some time represented regional excellence (in the Santa Croce sull'Arno district and the leather and footwear district of Valdarno superiore).

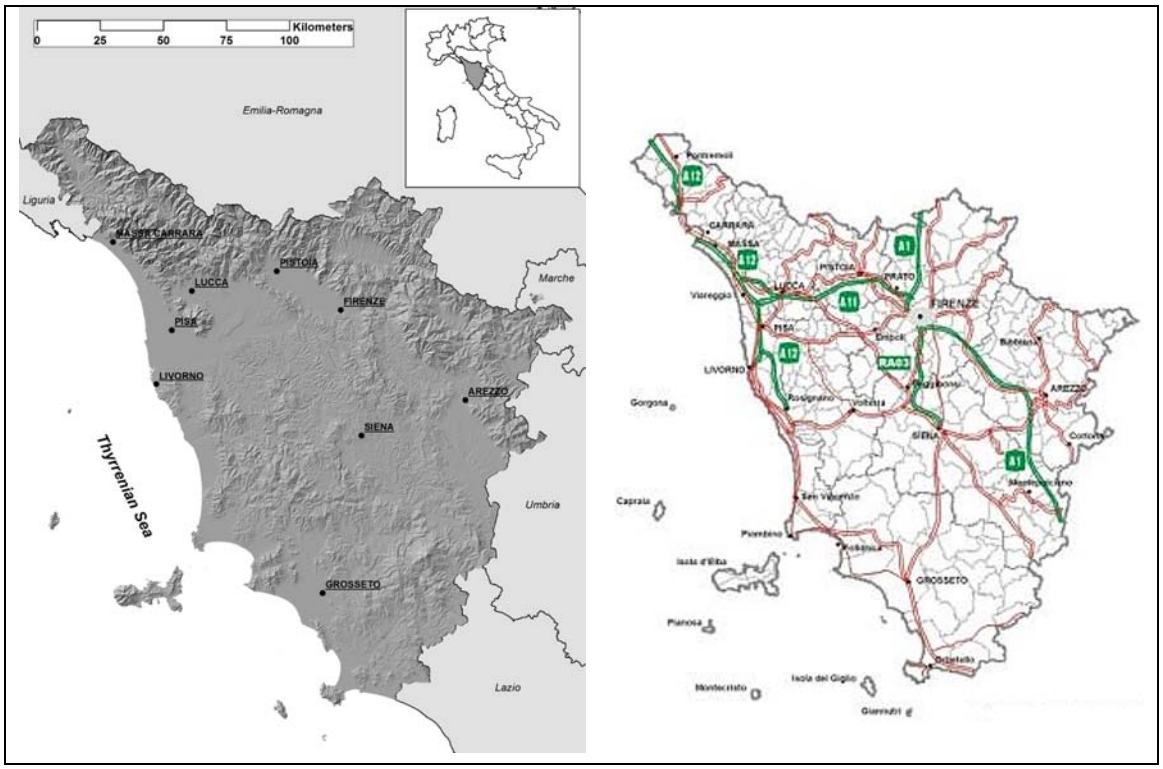

Fig. 1a/b Study area (on the left) and Tuscany Highways System (on the right)

The industrial development of Tuscany was largely founded on local systems of small and medium-sized enterprises, but today even more so on the role of big businesses, especially metalworking (in Florence, Pistoia, Pontedera). the gross domestic product (GDP) of Tuscany accounts for about 6.8% of the total italian GDP, although its per capita values are equal to other areas of the country (in particular Trentino, Lombardy, the Veneto and Friuli-Venezia Giulia). In recent years, Tuscany has arrived at between 8th and 10th place on the list based on its per capita wealth, with a figure that places it above the national average (http://www.irpet.it/index.php?page=infotoscana_economia). With over 10,000 km of roads and a density of approximately 0.5 km/km^2, the level of infrastructure in the territory (Fig.1b) is quite high compared to the Italian average of approximately 0.36 km/km^2 (data source http://www.openstreetmap.org) even if the roads have only been slightly extended (by about 500 km thanks to the A1, A11 and A12 roads).

The ISTAT (Central Institute of Statistics) census of 2011 indicates that there are over 3.6 million inhabitants in the region, equal to 6.2% of the national population, with an increase of nearly 500,000 compared to data collected at the 1951 census (about 3.15m or 6.6% of the Italian population of the time). Analyzing the demographic variation between 1951 and 2011 on a municipal basis (Fig. 2) it can be noted how all the coastal towns and the island of Elba show a marked population increase during the period indicated. The same phenomenon also happened in the inland municipalities of the provincial capitals, those along the Basso Valdarno (Livorno - Pisa - Florence) and along the A11 motorway axis (Florence, Prato, Pistoia, Lucca, Viareggio). By contrast, there was great fall in population in the Apennine area bordering Emilia-Romagna and Liguria, as well as in most of the municipalities located in the central area of the region. Among the provincial capitals, the only ones to show a demographic decline between 1951 and 2011 were Lucca (-1.2%) and Florence (-4.4%).

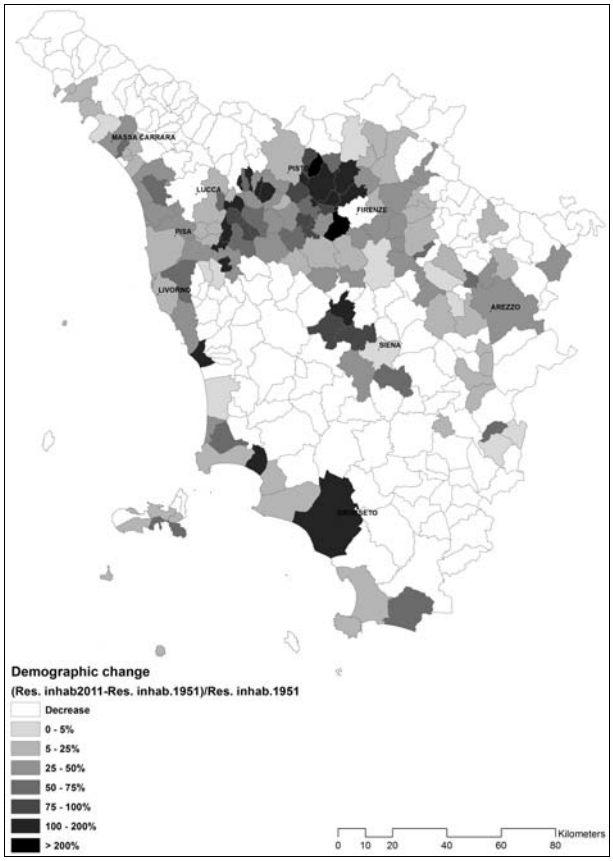

Fig. 2 Demographic change between 1951-2011

The curve of regional demographic dynamics (Fig. 3), analyzed over 60 years, shows continuous growth between 1951 and 1981 when the population increased by over 400,000, that is more than 13,000 inhabitants a year and about 60 inhabitants for every hectare of land surface. between the early 80s and until 2000, there was a significant demographic downturn leading to the loss of more than 80,000 inhabitants (4,000 per year). however a stark reversal has occurred over the past decade, with a rather rapid demographic recovery that resulted in the highest level of inhabitants in the region's recent history: more than 170,000 new residents in ten years (on average 1,700 new residents per year).

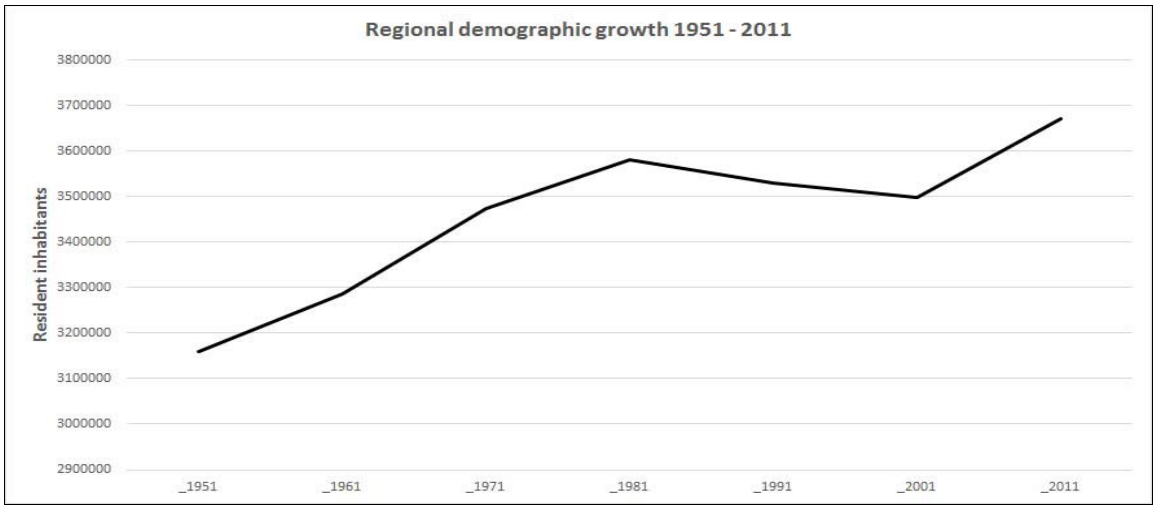

Fig. 3 Regional demographic growth between 1951-2011

Immigration data shows that this population increase is due almost exclusively to non-eu immigrants, with an increase of 226% between early 2000 and 2011, bringing immigrant levels up from 175,000 to an estimated almost 400,000 today (Cappellini, 2009). this accounts for 11% of the whole population, compared to 8.5% nationally, confirming that thanks to the economic characteristics that have been described, Tuscany is very attractive to immigrants, where even employment conditions seem to improve, despite the well-known crisis that has tormented italy for several years now (Caritas and Migrantes, 2011; Benassi and Porciani, 2010). The population density of the region of Tuscany has increased from 137 habitants per km^2 in 1951 (very close to the national one of same period, which was 157 habitants per km^2) to the current 160 habitants per km^2, which is more than 80% of the national value of 197 habitants per km^2.

3 MATERIALS AND METHODS

Analysis of the evolution of the settled areas in Tuscany was, for the historical period, carried out using maps published with a scale of 1:25,000 by the IGMI (Italian Military Geographic Institute) between 1949 and 1962. It is the 25v series, organised into 3,545 elements (panels) with dimensions of 7'30" longitude and 5' latitude, mapped to a scale of 1:20,000 according to the Gauss map representation and framed within the national geodetic system (the international ellipsoid oriented to Rome M. Mario – ED40) with a grid mileage in the projection consistent with the Universal Transverse Mercator system (European datum ED50). The areas urbanised in the 1950s, formed of those areas covered by main and ancillary buildings (such as car parks, internal roadways for the districts, storage areas, cargo-handling and various other buildings), can be extracted from these maps, which are only available as raster versions. The data from the research carried out on the 1:25,000 maps was then compared with that of the current urbanised areas (updated in 2007, http://www.regione.toscana.it/-/geoscopio), which are available in vector format from regional cartography created using photo-interpretation and the orthophoto mapping traverse methodology at the nominal scale of 1:10,000. In terms of urbanised areas, those destined for urban use with the replacement or maintenance of the natural soil were taken into consideration, including the built-up parts of the land and those destined for additional settlement uses, such as public and private gardens, sports facilities, unsurfaced roads and other waterproofed or non-waterproofed service areas (Romano and Zullo, 2013). Also included in the "urbanised" land were those areas with rural buildings and fixtures designed to support agricultural and zootechnic functions, even if their characteristics cannot strictly be called "urban". The method used for urbanized areas detection differs from that used by the Tuscany Region (2012) based on sampling points at 1: 10.000. This approach estimates the extension of the classes of land use on the basis

of sampling points distributed according to a probabilistic scheme (region divided into square of 4 hectares inside of which was randomly select a point of survey according to the scheme of systematic sampling nonaligned). In the research described in the article the historical urban areas have been digitized by skirting the built environment shown in cartography IGM (urbanized perimeters extracts from cus Tuscany Region, Fig. 4). It should be noted that the historical cartography IGM does not report the "urbanised" areas, but only those "built", for which the data obtained has a level of precision tested order of ± 5%. The comparison between the extension of the historical and current urban areas, by statistical analysis, showed that some local determinants have affected more than others on the dynamic urban region. Further investigation later revealed the dynamics of conversion of urban areas susceptible to the effects such as protected areas, the landscape units and the flood risk areas.

Fig. 4 Detail of the representation of the Tuscany region on the IGM 1:25,000 map of the 1950s (in red actual urbanized areas, in brown urbanized area 50s)

4 RESULTS AND DISCUSSION

In the 1950s there was a sensitive modification of the age-old balance between the rural and urban worlds, thanks to the intensification of two phenomena: the growth of the larger urban settlements and the abandonment of rural areas, especially those of the Apennines.

The settled areas surveyed in the 1950s were found to amount to nearly 21,000 hectares, corresponding to a rate of regional urbanization of just under 1%. Analyses of the situation in 2007 shows an urbanisation nearly seven times greater (Fig. 5), with settled areas amounting to more than 135,000 hectares, a net loss of over 115,000 hectares of land and an urbanization rate that today is almost 6%. The average speed of transformation over the period studied is just over 6 hectares per day (equivalent to about 6% of the speed of the 90 hectares per day estimated for the national territory).

If compared with the other 17 Italian regions that have available data and cover about 88% of the national territory, the rate of increase recorded in Tuscany is the highest (550%) compared to that of the

neighbouring Emilia-Romagna (510%), Puglia (475%) and Sardinia (510%) (Romano and Zullo, 2014b; Romano et al., 2015; Romano and Zullo, 2015).

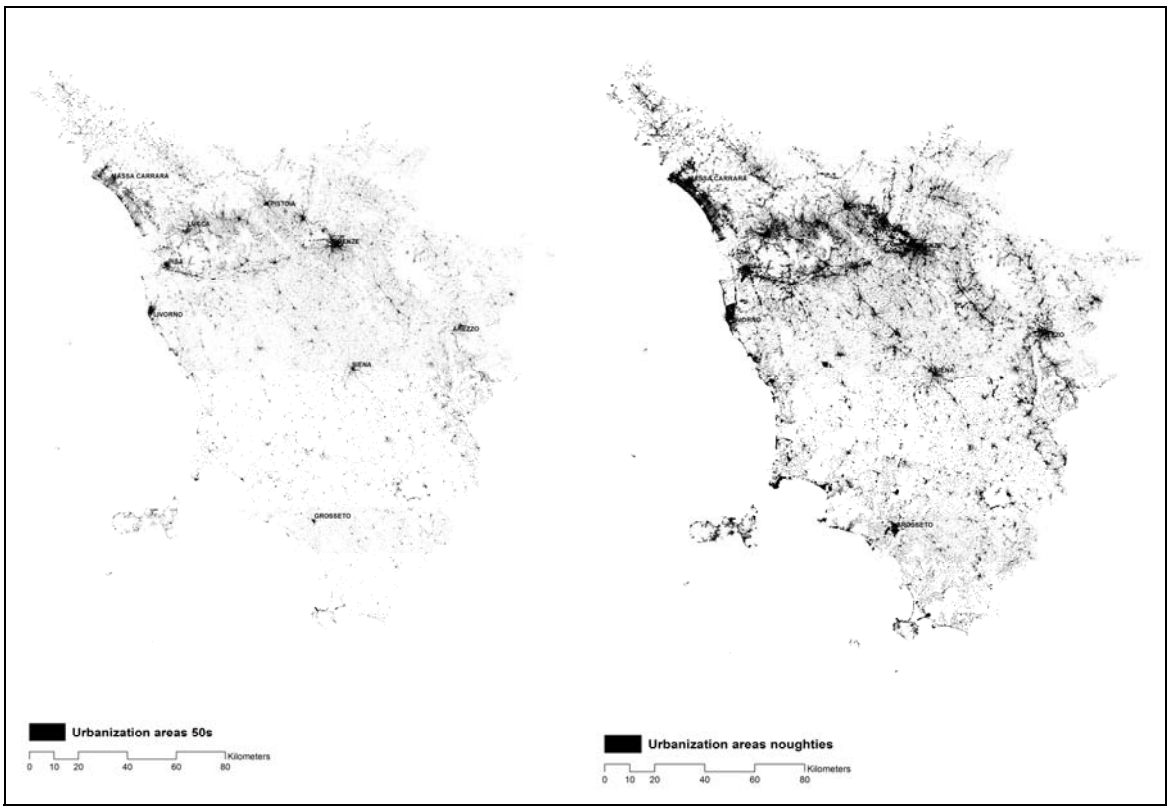

Fig. 5 Maps of the urbanization in the (a) 1950s and (b) noughties

A typical settlement behaviour index is the amount of urban area per-capita (UAPC), which was on average 66 m^2 per inhabitant in the 1950s, but which rose to 370 m^2 per inhabitant in 2007. It is important to observe the correspondence between this value and that of the nation and western European countries, in order to give evidence of a homogeneous alignment on similar models of the relationship between social communities and settlement forms.

The research carried out over most of the Italian regions showed how the UAPC indexes of up to 100 m^2 per inhabitant typified the rural economy realities, while values above 300 were typical of industrial economies and urban lifestyles.

The transition from a predominantly historic widespread rural and polycentric urban landscape to a predominantly widespread urban and post-rural agricultural landscape is also highlighted by the analysis effected by the density of urbanisation which, in the 1950s, was equal to or less than 5% for most of the municipalities. The situation changes dramatically after 2000, where only seven regional municipalities still have an index lower than 1%, 137 up to 5%, more than one-sixth a value between 10-25%, and 11 have urbanised between a quarter and half of their territory (Fig. 6).

While the municipality with the highest rate of urbanization is Forte dei Marmi, which is a Tyrrhenian coast town and whose territory is more than 70% covered by urban areas, figures 5 and 6 very clearly show the leaders in major urban density concentration along the coast and in the interior plains.

From this point of view an analysis of fig. 7 is especially effective, where some peak values of urban density emerge along the Tuscan Coast as part of a phenomenon that concerns all municipalities of this Mediterranean area with the same intensity (Romano and Zullo, 2013, 2014a).

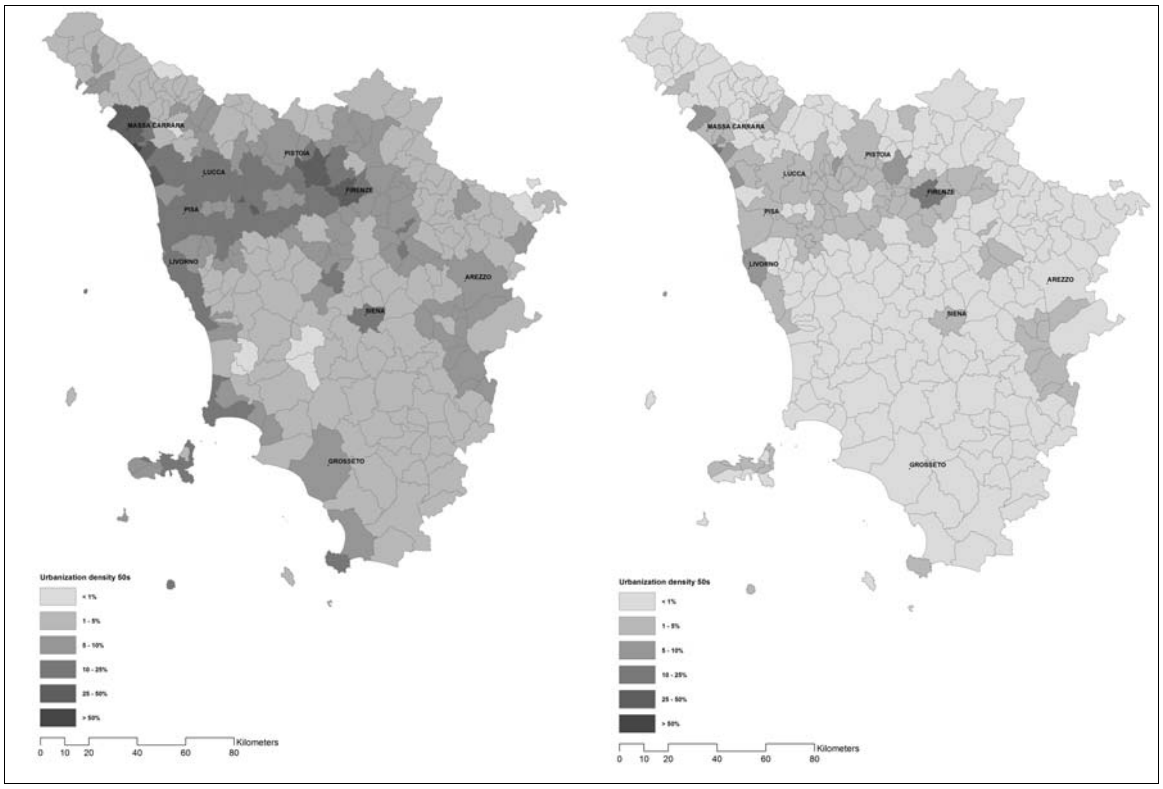

Fig. 6 Map of the percentage of urbanization in municipalities in the (a) 1950s and (b) noughties

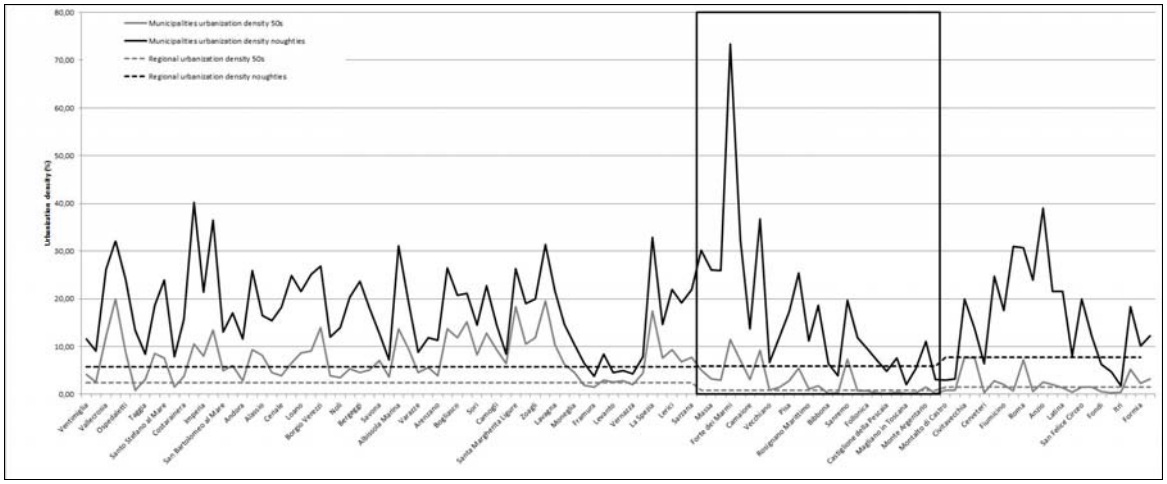

Fig. 7 Diagram of urban density in the Tyrrhenian coast municipalities during the 1950s and noughties, compared to regional averages (the Tuscany coastal municipalities are in the box)

In addition to the dynamics of the urbanised lands, from 2001 it is also possible to check those related to the growth of built-up areas, thanks to the ISTAT surveys, though the 2011 data is not yet available. The institute registers the number of buildings in inhabited areas, where the latter means a "more or less wide area of land, usually known by its own name, on which are located one or more grouped or scattered houses". The buildings are distinguished by their function and are grouped into two categories: the first consists of those for residential purposes while the second covers the buildings and complexes used for production, infrastructure, management, tourist and service purposes. Furthermore, the dates of when the buildings for residential use were built are also noted. For example, according to the data almost 367,000 buildings within the housing category were constructed in the 287 Tuscan municipalities between 1946 and 2000 (on average 18 per day). Considering the demographic increase of about 339,000 people during the same period (1951-2001 ISTAT data), to all intents and purposes just over one residential building was

constructed for each new inhabitant. It is also interesting to note that until 1946 there were little more than 300,000 buildings in this area. In other words the residential building heritage has more than doubled compared to the period after the second world war. Fig. 8 fully confirms the phenomena already highlighted by Figures 5, 6 and 7, with the highest growth groups concentrated in the coastal areas and on the plains of Lucca, Pistoia and Florence. The cited data about growth of urbanized and built up spaces identify a relevant group of factors of landscapes changes. Transformation of urban and agricultural landscapes as also lost of rural landscapes are joined with socio-economic changes and produce environmental and cultural changes. Lost of soil, as also of biological and semiological diversity are the main ones.

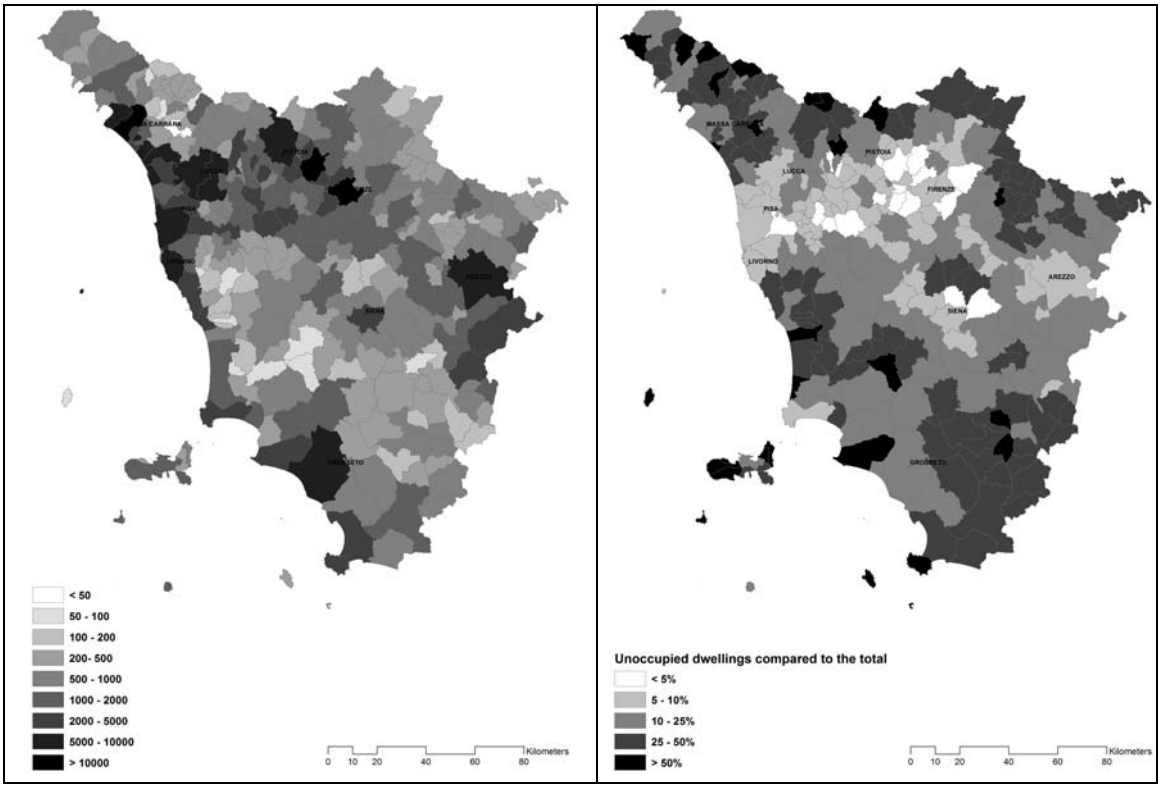

Fig. 8/9 The dynamic growth of residential buildings in the Tuscany municipalities between 1946 and 2000 (on the left); Percentage of unoccupied dwellings in 2000 (on the right)

Figures 8 and 9 show some processing of the ISTAT 2001 census data on residential buildings and housing. In particular, figure 8 confirms the urban nature of the northern sector of the region with the island of Siena and, to a lesser extent, Arezzo. It also provides interesting information about the coastal municipalities (from Massa to Capalbio) where the clearly considerable building development of these strong tourist areas has had significant repercussions on the extremely fragile coastal ecosystems. Figure 9 reinforces what has already been said by clearly showing that there is a large presence of empty homes along the Tuscan coastline that are, in all likelihood, accommodation used for tourist purposes and second homes (remembering also that ISTAT does not include accommodation facilities under the label of homes). A focus on the municipalities of the Tuscan coastline (about 25 out of a total of 287, making up 12% of the entire regional territory) shows the antinomy between population growth and increased urbanization. By analyzing the ISTAT data in detail is obvious how there was an increase of more than 160,000 people in this area between 1951 and 2001, concentrating slightly less than half of the total population increase of the whole region in a territory that covers only 12% of the whole of Tuscany. An increase that was also recorded by the 2011 census, showing over 15,000 more residents than in 2001. The number of buildings for residential use (Fig. 8) has more than tripled in the period between 1946 and 2000 (over 137,000 compared to the almost 43,000 present until 1946) with a net increase of more than 94,000 buildings, which amounts to

about 1,750 new buildings each year. By comparing this figure to the regional one seen earlier for the same period, it is clear that a quarter of the residential buildings constructed in the region were built in these areas, significantly increasing the anthropic load on the coastal ecosystems, which are subject to pressures that have often compromised their equilibrium and stability.

It should also be highlighted again that of the more than 420,000 homes present in 2001, more than 94,000 are empty (roughly one house in four), as shown in Figure 9. High percentages of empty homes also are detected in the northern part of the region along the border with Emilia-Romagna and in the central part (Maremma), but this is mainly due to the abandonment and depopulation phenomena encountered frequently in the Apennine areas of the peninsula and in the rural areas that suffer a marked socio-economic marginalization (IRPET, 2012).

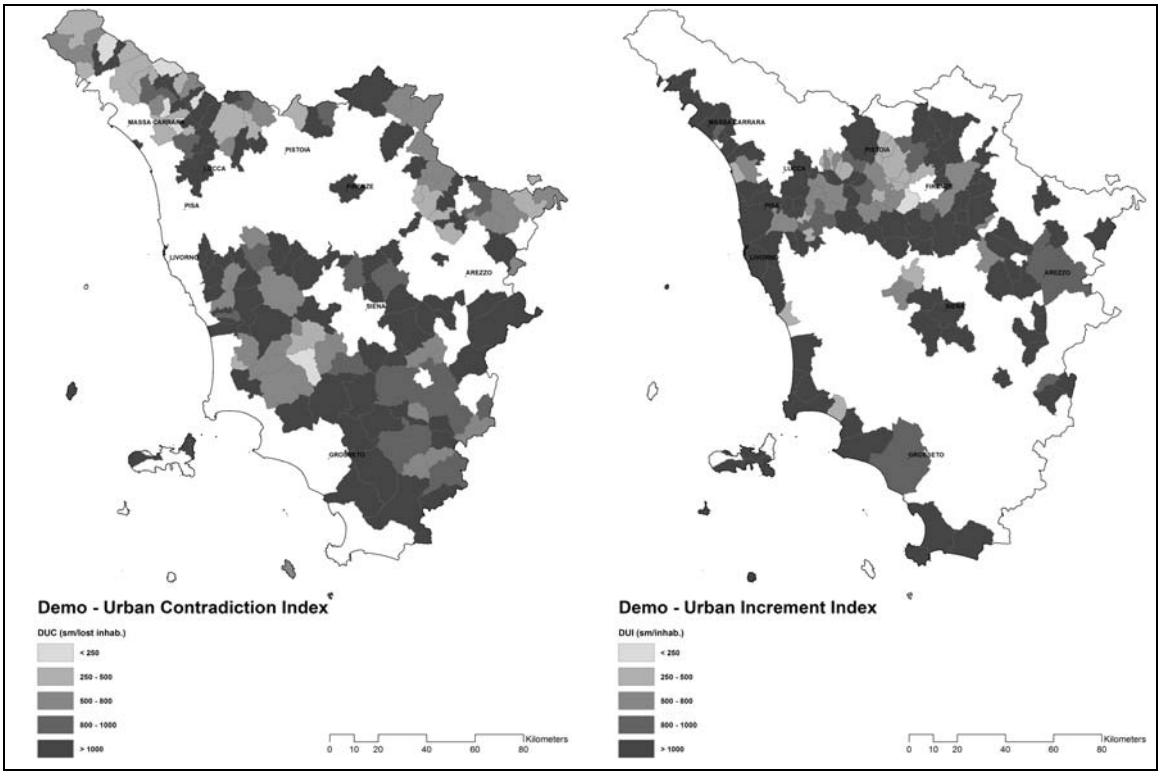

Fig. 10 Map to select the positive values of the urban-demographics increment index (on the left) and a map of the urban-demographic contradiction index (on the right)

The UDC (Urban-Demographic Contradiction Index) and its complementary UDI (Urban-Demographic Increment Index) can both connect and evaluate the population dynamics and urban growth (fig. 10). The UDC index shows the urbanised areas created for each inhabitant that has been lost by the city, while in contrast the UDI index shows the increase in urbanised area per inhabitant acquired by the municipality, irrespective of the territorial range of the municipality itself. This parameters has been obtained as follows:

$$UDI = \frac{\Delta URB(T1-T0)}{\Delta POP(T1-T0)} \qquad UDC = \frac{\Delta URB(T1-T0)}{-\Delta POP(01-51)}$$

Where:

- Δurb(t1-t0)=difference between urbanized areas in municipalities between the t1 (2007) and t0 (1954);
- Δpop(t1-t0)=variation in the population residing in municipalities between the t1 (2011) and t0 (1951);
- -Δpop(01-51)=demographic drop in municipalities between the t1 (2011) and t0 (1951);

All the municipalities in the Apennine range in the northern part of the region, together with those bordering the region of Liguria, most of those located in the Tuscan Maremma area can all be found under the conditions highlighted by the UDC index, with fairly high index values (over 800 m^2 per inhabitant lost). It must be said that high UDC index values can also be attributed to strong depopulation situations with limited variations in urbanized areas, so the information reported by this index must always be compared with the demographic dynamics. The geography of the UDI index (image on the right of figure 10) shows how the municipalities on the coastline (except Florence and Lucca), most of which are provincial capitals, and their hinterlands, as well as most of the territory of the island of Elba, can be found within this index. Over 60% of the municipal territories that emerged from this selection show a high UDI index value (over 1,000 m^2 per inhabitant).

ALTITUDE BELTS (M ASL)	AREA (KMQ)	TERRITORIAL PERCENTAGE DISTRIBUTION	URBANIZED AREAS (KMQ) 50s	URBANIZED AREAS (KMQ) NOUGHTIES	URBANIZATION DENSITY 50s	URBANIZATION DENSITY NOUGHTIES
<100	5,012.55	21.81	104.55	729.88	2.09	14.56
100-300	7,243.25	31.51	53.50	356.63	0.74	4.92
300-600	6,553.28	28.51	40.01	214.82	0.61	3.28
600-1000	3,214.24	13.98	10.83	54.74	0.34	1.70
1000-1500	871.10	3.79	0.51	5.91	0.06	0.68
1500-1800	87.18	0.38	0.01	0.55	0.01	0.63
>1800	4.96	0.02	0.00	0.01	0.00	0.17
Total	**22,986.56**	**100**	**209.41**	**1,362.53**	**0.91**	**5.93**

Tab. 1 Division of the Tuscan territory into altimetric bands (DEM 20 m). Related settlement values over the time-span of the study

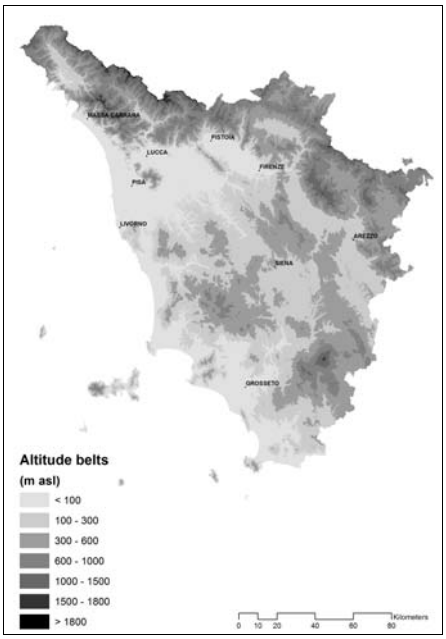

Fig. 11 Articulation of altitude belts in the Tuscany region

The data already shown indicates how morphology and altimetry have assumed a key role in influencing the dynamics of urbanisation growth. Half of the region lies between sea level and 300m above sea level, while a third lies between 300 and 600 m asl. By analysing the level of urban density within these bands in the 1950s, you can see how the portion of land lying at an altitude of less than 100 m is the one with the highest index value (2%) while all the remaining bands show settlements of less than 1%. The situation changes dramatically in 2007, where at altitudes of less than 100 m asl, the settled areas had grown seven times bigger compared to after the second world war, with a settlement conversion rate that is at almost 15% today. The same rate of increase was also recorded for the low hilly altrimetric band of 100-300 m asl, where the urbanization rate was 5%. The high-hilled bands, which hold the vast majority of the agricultural

landscapes and, most especially, the valuable vineyards and olive groves (which are of fundamental importance from a social, economic and ecosystem point of view), have instead grown to five times the size of the historic settled area.

4.1 THE PHENOMENON IN THE AREAS OF HIGH ENVIRONMENTAL VULNERABILITY

PROTECTED AREAS AND LANDSCAPE UNITS

The Protected Areas in Tuscany stretch to just under 150,000 hectares, and include the National Park of the Apuan Alps, the National Park of the Casentinesi, Monte Falterona and Campigna forests, and the National Park of the Tuscan archipelago. The habitats protected by the EU directive 92/43/EEC (SCI), on the other hand, extend over nearly 306,000 hectares. However there is much overlap between the two areas, and between them they cover 350,000 hectares. To these must also be added the Special Protection Areas (SPA) introduced by the EU Directive 79/409/EEC, which occupy a total of nearly 132,000 hectares, most of which also fall under the Protected Areas classification. So putting the Protected Areas, SCI and SPA altogether, 15% of the total Tuscan region is protected. Through a comparison with the Physio-graphical Landscape Unit surveyed by the ISPRA (Advanced Institute for Environmental Protection and Research) in 2004, it can be observed how the most protected categories are the "terrigenous mountains," with a surface area of over 118,000 ha, and the "heterogeneous hilly landscapes," which stretch to over 85,000 ha. Far less represented in this analysis are the plains that fall within the protected areas and have a surface area of just over 8,000 ha. The landscape effects of urban proliferation can be better understood by analyzing the urban dynamics that have affected these areas over the past 50 years (Fig. 12).

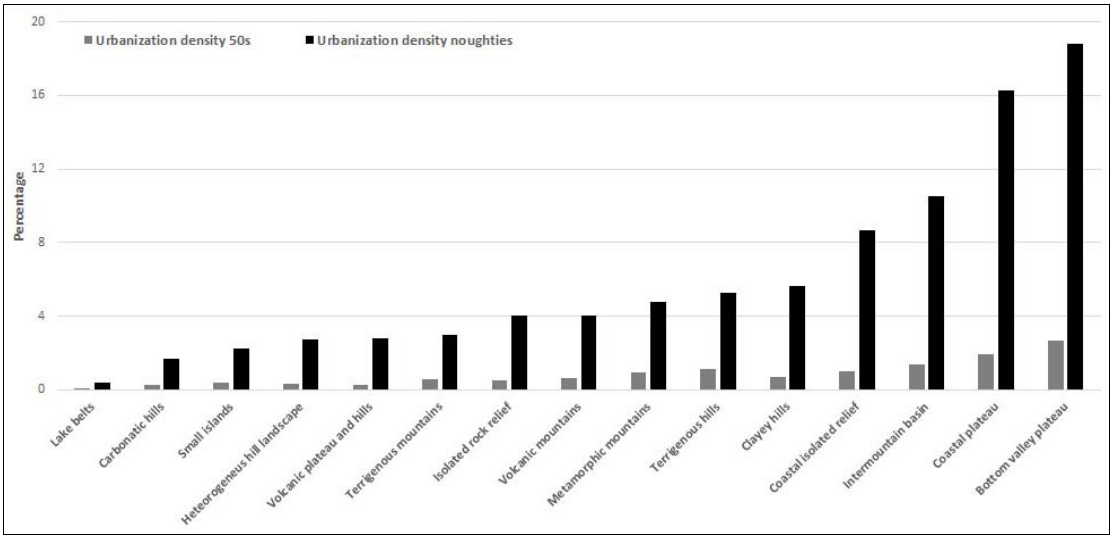

Fig. 12 Differences in the density of urbanization in the Tuscan landscape bands over the period studied

In the years after the second world war, both the coastal plains and the valley floors showed the highest rates of urbanization (about 2%), compared with the hilly categories which showed instead an increase of less than 1%. Analysing the situation in subsequent years shows that while the classification order remained unaltered, the percentages increased considerably: the urbanisation of the flat categories exceeded 15%, with nearly a fifth of the valley floors territory having been urbanised. The rates of urbanization of the hilly landscape band also increased from an average of 0.5% recorded after World War II, to an average of 3.5% – seven times more than the preceding temporal section, thereby testifying to a greater settlement pressure on the hilly morphologies with attendant effects on both local agricultural production and on Tuscan agro-ecosystems, which is important at an international level. By analysing the evolution of the settlement

conversion phenomenon of the land within the regional protected areas during the two temporal periods, it seems clear a ten-fold increase in the settled areas, where the just over 500 ha of the 1950s (0.15% of the total of the N2000 Protected Areas) becomes more than 5,000 ha today (1.4%). A study conducted in a 1km sphere (as the crow flies) from the perimeter of these areas showed an equally intense phenomena: the areas covered by the current settlement in this area increased by more than seven times compared to those detected in the 1950s, passing from almost 4,000 ha (1.13% of the buffer area) to over 27,000 ha (8% of the buffer area) today (equivalent to a 16 km^2 area). By comparing these data with those relating to the settled areas surveyed in the two temporal periods across the entire study area, it becomes clear that there was and still is about one-fifth of the settled areas within the perimetry of the N2000 Protected Areas system, with an increase of approximately 23,500 ha – the equivalent to 460 ha of land being consumed every year, or over 12,000 m^2 each day. It's true that in the 50s protected areas were almost non-existent, however, the analysis conducted shows that in these areas the impact of settlement was still limited by the morphological and environmental conditions (high altitude, terrain roughness, climate, hydrogeology).

AREA THAT ARE AT THE RISK AND HAZARDOUS

The settlement changes in the areas identified by the Floods Directive 2007/60/EC adopted into Italian law by the Legislative Decree No. 49 of February 23, 2010 are analysed here. The areas covered by the decree are those that have been assessed as being at risk of flood based the likelihood of a flood occurrence within a fixed time interval (3 levels), which means that the areas at risk of flooding are those with the combination of the probability of the occurrence of a flood event and the potential negative consequences for human health, the land, goods, the environment, the cultural heritage, as well as the economic and social activities stemming from such an event (4 levels). The areas identified by the flood risk maps are a subset of those identified from the mapping of the flood-related hazardous areas, thus the latter will be taken into consideration during the processing of the urban dynamics that have affected these areas over the past 50 years. The areas with a degree of hazardousness stretch to over 223,000 hectares (10% of the regional area), most of which are situated along the coastline, while the remaining parts are located in the surrounding areas of the main river beds and in the northern section bordering Emilia-Romagna, along the regional Apennine stretch (Fig. 13).

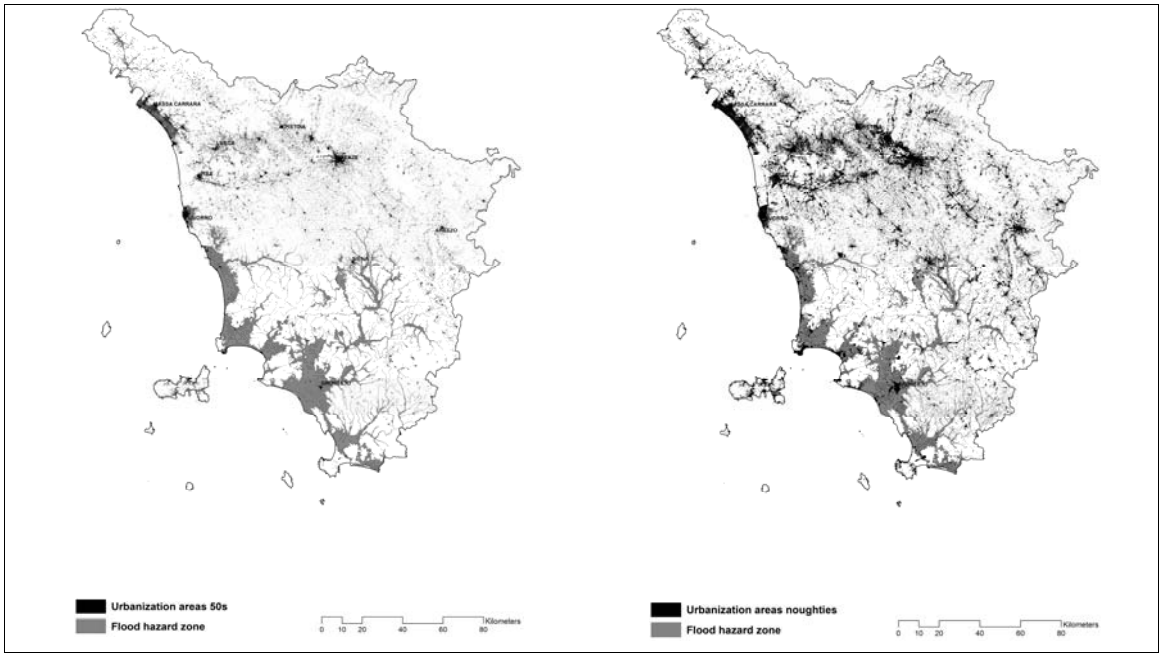

Fig. 13 The geography of the regional urbanized areas within the period studied, with a geographical indication of the flood hazard areas

An analyses of the situation of these areas in the years following the second world war, shows a settlement rate of 1.2%, however, it is interesting to note that 13% of the regional settled areas are concentrated in these territories identified as dangerous in terms of floods. After 2000 the settled areas in these zones covered approximately 24,000 ha (21,000 ha more than what was seen in 1950), which increased the settlement rate to over 10%. Of the more than 115,000 hectares of settled areas created in Tuscany between these two temporal periods, 20% were situated on those areas at risk of flood. These areas affect the territories of approximately 125 out of the total 287 municipalities, currently involving a population that now exceeds 1,200,000 people.

5 CONCLUSIONS

The data that has been presented testifies to the main socio-economic, settlement and infrastructural epochal transitions that have affected Tuscany over the past 50 years. Because of these, landscapes changed. Rural landscapes with widespread settlements often had transitions to industrialized agricultural landscapes and anyway to specialized ones. The polycentric urban settlements lost historical relationships with the rural landscapes matrix. This not only because the rural landscapes has been going to disappear, but first of all because urban settlements change socio-economic and spatial patterns from compact to fragmented and diffuse ones (IRPET, 2014b; Fregolent, 2012).From a quantitative point of view, even though the region registers a notable overall increase in population density (16.8%), it is still 8.7% below the national values of 25.5%. It should be noted that the natural structural diversity of the region - a major factor in its great scenic diversity - such as its biological, ecological, historical-archaeological, socio-economic and scenic aspects, has influenced the geographic distribution of these increments. Population concentrations have occurred in the internal territories at the foothills of the Apennine, with more marked values in the northern areas and with the sole exception of the Florence-Siena axis, and in the central-northern and central-southern coastal regions, where the positive changes almost weld them together. The reasons for these dynamics are many and their nature must be researched within the slow and progressive phenomenon of urbanization of the countryside, which has affected a vast area in the central-southern part of the region. At the same time these reasons may have influenced the different events, such as happened with the city of Florence (Magherini and Mencarini, 2001; Iommi, 2002; Regina et al., 2003), where the demographic decline was strongly influenced by the growth of real estate revenue due to the increasing outsourcing of accommodation and management control that, due to the ability to offer a competitive supply, caused the expulsion of significant numbers of residents. Population growth along almost all of the coastal municipalities is a phenomenon also seen in other Italian regions (Romano and Zullo, 2014), where the settlement pressure related to tourist and beach activities has also strongly influenced the demographic dynamics: at present about one-fifth of the entire population of Tuscany is concentrated in a territory that is only 12% of the whole regional area. It is also interesting to note how the demographic variation recorded for these coastal municipalities is distinctly higher (27%) than the regional one (16%) over the same period.
Even if Tuscany is considered to be one of Italy's regions most attuned to the conservation of its landscape and its historic centres, which supports an economically significant tourist stream, the past dynamics of land transformation do not differ much from those of other geographical areas notoriously less "careful" in this sense. In fact the regional urbanisation rate of 6%, proportional to the region's percentage impact on the national area (6% versus 7.5%) with a contribution to the average daily speed of national urban land conversion, and a rate of increase that is one of the highest in Italy (550%), together with a per capita urbanization equivalent to the national average, are all indicators of a territorial policy which looks with different sensitivities at the historical, artistic and monumental heritage and the environmental matrix.
The analysed data allow us to predict an evolutionary scenario for the regional settlement. As we have seen, over the past 60 years, the population has grown to 513,000 in the context of 1,154 km^2 of urbanised land

(2,250 m^2/inhabitant on average). The ten-year average rate of population growth in the 60 years analysed was 2.5%. Applying the rate of 2.5% for the next 10 years, there will be a further increase in population of about 92,000 inhabitants. The same standard applied to the level of urbanisation (2,250 m^2/inhabitant) would lead to a further 200 km^2 of urbanisation. This equates to a square with sides of 14 km, in addition to that with sides of over 37 km that represents current urbanisation.

The scenario would involve incremental proposed then, with high probability, those particular altitude belts that already showed a high vulnerability to land uptake. It is more than half of the region at altitudes between sea level and 300 m, in which the settlement has grown sevenfold over the past half century (actual urbanization rate is 10%). Such a perspective requires obviously a reflection in the headquarters of territorial governance, especially for a region highly vulnerable landscape in economic point of view.

Demographic data show that in the last ten years, the regional population increased by more than 170,000 units (5.3% more than in 2001, compared to 4.3% nationally calculated in the same period) and, if such a trend were to continue, it is probably that results in additional needs of urbanization and edification, maybe oriented social housing, with important consequences on the spatial changes in land use over time. To predict how these changes will affect the changes of the soil you can use different models and scenario analysis (Bibby e Sheperd, 2000; Nemmour et aliii, 2006; Villa et al., 2007; Mas, 2009; Mazzeo, 2012; Di Giacomo, 2015). Such models can be a useful tool both policies is territorial planning with important implications on future territorial and landscape asset.

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IMAGE SOURCES

Fig.1b http://www.greenreport.it/news/acqua/terza-corsia-sulla11-una-boccata-dossigeno-ma-per-uno-sviluppo-old-style/

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