Landscape change in the European Mountain Areas Settlement of the Alps: evolution and trajectories

Bernardino Romano
Università degli Studi dell'Aquila, PLANECO bernardino.romano @univaq.it
Francesco Zullo
Università degli Studi dell'Aquila, PLANECO francesco.zullo@univaq.it

Abstract

The increasingly fast pace of urban conversion of land over the past fifty years in Italy is a phenomenon that has caused serious damage to the national landscape. The problem concerns the whole of Italy but is most serious in those areas that generate important benefits thanks to the quality of their landscape. In this sense, many references are made in the European Landscape Convention tog the Alps as undoubtedly one of Italy's most iconic landscapes in the international perception, along with the cities of art. This paper describes the results of a research on the features of urbanisation in the fifties in the Italian Alps, based on uniform historical maps of the entire region. Geostatistical surveys were conducted to determine the distribution changes of urban concentration over time and analyses were developed to point out what landscape and morphological elements have emerged, and are basically confirming greater sensitivity to land artificialisation. A number of comparisons based on specific indicators were produced that show the typological and geographic variations of development taking place in the time period studied. Important information has emerged on the different territorial policies implemented by the regions over the long-term.

Keywords

Landscape change, mountain land-use change, land-use planning, land uptake.

Received: March 2016 / Accepted: April 2016
© The Author(s) 2016. This is an open access article distributed under the terms of the Creative Commons Attribution-ShareAlike 4.0 International License (CC BY-SA 4.0). If you remix, transform, or build upon the material, you must distribute your contributions under the same license as the original.
DOI: 10.13128/RV-18268 - www.fupress.net/index.php/ri-vista/

Introduction

The Alps are undoubtedly one of Italy's most iconic image in international perception, along with the cities of art. A significant part of economic performance enabled by this geographical sector are in fact due to multi-seasonal tourism influenced by the environments that the mountains, valleys, glaciers, but also the villages and cultural elements form together. Therefore, this is an example of perfectly adherent to the principles of the European Landscape Convention (ELC) according to which the conservation and proper management of landscapes allows to obtain and maintain important economic benefits for local communities and for the Country. However, just for the strong attractiveness of this area, land conversion for urban use is a territorial 'disease' resulting from strong economic dynamism and ongoing demographic growth (Bätzing et al., 1996). The study was carried out from the post-war period (1949-1962) to the noughties (2000-2008), analyzing the modalities, extent and environmental impact of the phenomenon in this area. The Alps are an extremely important area in Europe: on the one hand, a historical barrier to communication and cultures, while on the other, a great reservoir of resources and ecosystem services and therefore, always economically attractive, despite the morphological and climatic harshness.

Although the international scientific community has highlighted the problems and environmental consequences of extended urban transformation for years (Crutzen, Stoermer, 2000; Crutzen, 2002; Sala et al., 2001; Lambin et al., 2001; Ellis, Ramankutty, 2008; Ellis et al., 2010; Ellis, 2011; Ellis et al., 2013; Ruddick, 2015), regarding the Italian case, there are only five papers published in international journals (Pileri, Maggi, 2010; Salvati et al., 2012; Romano, Zullo, 2014a/b, 2015) that have started to provide more accurate details on the magnitude of the phenomenon of land take and artificialization.
Furthermore, the local Italian authorities (regions, provinces and municipalities) have not planned any coordinated survey activities. The negative aspects of this phenomenon are still considered only marginally by scientific agencies and in communication and land governance (Grubler, 1994; Heilig, 1994) and this issue appeared for the very first time on the political agenda of the government only in 2013.
In other countries, data and publications are far more numerous (Hall et al., 1973; Mellor, 1983; Yanitsky, 1986; Irwin, Bockstael, 2007; Zaninetti, 2006; Garcia-Call, 2011; Hauri et al., 2006; Catalán et al., 2008; Illy et al., 2009). Only recently, has the need emerged to set up mechanisms to monitor urban transformation dynamics, but we are still far from

having systematic and consistent data collection that would make credible comparisons and assessments possible (Sharma et al., 2012; Lowry, 1990; Murgante et al., 2008).

What is lacking, with reference to the post-war period, is a homogenous picture of the country as a whole on the basis of standard data concerning the entire territory and supported by measurements with a sufficiently high level of accuracy that makes it possible to compare land transformations among the various regions on a level playing field.

So, the critical hypothesis supported in this research refers to the process of rapid increase of urbanized and artificial surfaces without large-scale measures and controls.

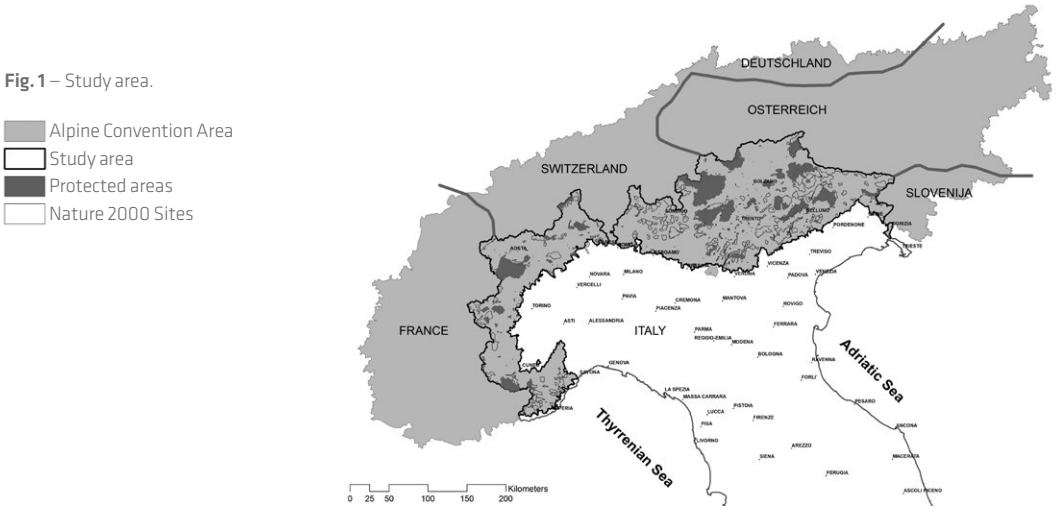
The land take phenomena have never been evaluated for half a century and only in recent years started a process, still very uncertain, of characterization of the physical effects, especially in areas of greatest environmental vulnerability. However, to get good results in this regard it is necessary to have a wide range of knowledge and consistent basis of diachronic data.

The aim of this paper is to provide a contribution to this regard, by focusing on a significant area of the country in terms of features and problems, and is broken down as follows: the specific features of the Italian Alps are highlighted in the description of the study area; the section on data compilation describes the origin of the data and the data extraction techniques used; the results section illustrates the settlement conditions in the study area in the '50's and then sets out in detail the changes that have occurred from the post-war period to the post-2000 years, describing the various aspects differentiating the territories studied; the conclusions set out the current conditions, environmental criticalities and margins for the recovery of extremely compromised territorial conditions that even today receive scarce attention from local and central institutions.

Study area

The study area is the Italian Alps stretching across the entire northern part of the country for almost 1,200 km (4° latitude, between the 43rd and 47th parallel north, and between the 6° and 14° longitude east). It is one of the most famous geographical areas in the world, divided between 8 countries (Austria, France, Italy, Germany, Lichtenstein, Monaco, Slovenia and Switzerland) separating Italy from central Europe, which for centuries has formed a natural border between the Latin, Germanic and Slavic cultures. The study area identified is the Italian section of the Alpine Convention borders (http://www.alpconv.org) and covers an area of about 52,000 km^2, 27% of the entire alpine territory and approx-

Fig. 1 – Study area.



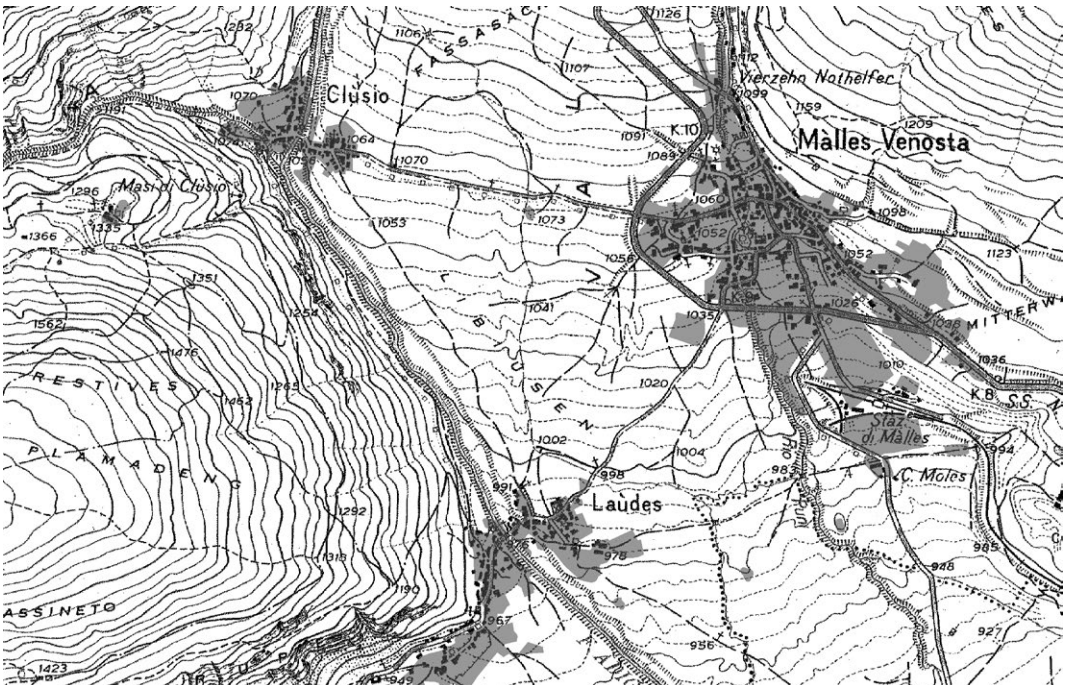
imately 18% of the country (fig. 1). In the seven regions (Liguria, Piedmont, Valle d'Aosta, Lombardy, Trentino Alto Adige, Veneto and Friuli Venezia Giulia) there are 1,749 municipalities, slightly less than one quarter of all Italian municipalities, with an average size of about 3,000 hectares, just below the national average of 3,600 hectares. Two regions, Valle d'Aosta and Trentino Alto Adige, are entirely alpine, but on average approximately one half of the entire territory of the northern Italian regions falls within this extensive mountain area (tab. 1). With 37 peaks exceeding 4,000 meters (out of 82), the alpine area is a wealth of mineral, forestry and energy resources for Italy. According to Enel data (www.enel.it), with 39.2 billion kWh, 80% of Italy's hydroelectric power is generated here, covering more than 15% of the national energy demand. It is also the largest reservoir of fresh water in the country, with about 1,370 glaciers stretching over 608 km^2, as shown by the World Glacier Inventory data (WGI 1981-84) (Serandrei-Barbero, Zanon, 1993; Zemp et al., 2008), and a main hydrographic network of almost 10,000 km.

The 2006 European CLC (CORINE land cover) (Bossard et al., 2000) satellite remote sensing survey indicates that over 43% (almost 2,500,000 hectares) of Italian alpine soil is covered by woods and 37% by pastures, rocks and glaciers, while other categories account for the remaining 20%. Under these environmental conditions, biodiversity is very high, with an estimated 30,000 animal species and 13,000 plant species (Chemini, Rizzoli, 2003; Nagy et al., 2003; Moerschel, 2004; Temple, Terry, 2007; Belardi et al., 2011).

The presence of protected areas and Nature 2000 sites (Sundseth, 2005; Rossi et al., 2009) is also very important. The former occupy over 660,000 hectares, of which 250,000 are national parks (1/6 of the Italian total) distributed over 4 of the 24 areas present in the country. The habitats protected under European Directive 92/43/EEC (Nature 2000 Sites) cover 1,125,000 hectares, but the overlap between the two systems is so significant that their union amounts to 1,250,000 hectares (tab. 2). This means that almost one quarter of the Alps is protected by conservation measures, compared to the 18% mean in Italy.

The land is very rugged, with over 40% of the total area lying at an altitude ranging between 1,500 and 3,000 meters above-sea-level, the weather conditions are harsh and mobility between the valleys is extremely difficult. However, owing to the abundance of natural resources, the Italian Alps have experienced an upward demographic trend over the past 60 years, with almost 4.3 million inhabitants to date (tab. 3). Moreover, in the alpine provinces,

Regions	Regional area (km²)	Total number of municipalities	Number of alpine municipalities	Area of alpine municipalities (km²)	Alpine municipal ratio (%)	Alpine municipal area ratio (%)
Valle d'Aosta	3260.85	74	74	3260.85	100	100
Piedmont	25386.69	1206	484	12683.54	40.13	49.96
Liguria	5416.08	235	81	1567.74	34.47	28.95
Lombardy	23862.99	1544	514	9812.44	33.29	41.12
Trentino Alto Adige	13604.71	333	333	13604.71	100	100
Veneto	18406.84	581	171	6659.88	29.43	36.18
Friuli Venezia Giulia	7862.17	218	92	4451.21	42.20	56.62
Total	97800.33	4191	1749	52040.37	41.73	53.21



the average per capita taxable income is over 16% higher than the national average.

Of the current residents in the Alps, only 750,000 (17%) reside in major conurbations, while the vast majority are distributed in the innumerable medium-sized, small and very small towns and villages scattered throughout the valleys and slopes. Among the 8 main towns of the provinces in the area, only Trento and Bolzano scarcely exceed 100,000 inhabitants. It may be argued that it is the richest area in Italy in resources and tourist facilities, both qualitatively and quantitatively (Gios et al., 2006).

The increase in equipment and facilities has exerted and continues to exert great pressure on the natural environment, exacerbated by the phenomena of global warming and climate change (Gabrieli, Barbante, 2014; Müller, 2009). At the same time, many traditional production activities have disappeared

	Protected Areas		Nature 2000	
Altitude range (m asl)	Area (ha)	%	Area (ha)	%
<1000	62550.98	0.09	167665.88	0.15
1000-1500	73785.12	0.11	160819.05	0.14
1500-2000	190338.04	0.29	325971.11	0.29
2000-3000	307121.81	0.46	428314.56	0.38
> 3000	30479.14	0.05	42897.00	0.04
	664275.09	1.00	1125667.60	1.00

Tab. 2 – Altitude distribution of protected areas and Natura 2000 Sites.

opposite page

Tab. 1 – Regions and municipalities of the Italian Alps.

Fig. 2 – Detail of the representation of an urban area on the IGM 1:25,000 map of the 1950s.

Urban areas noughties

over the years, causing the spontaneous re-naturalization of large parts of the territory with extensive forest recovery, the reappearance of animal species almost extinct half a century ago, and overall effects on the landscape (Zimmermann et al., 2010).

The function of the Alps as a vital link for national connections is also evidenced by the development of the main interurban road network that covers almost 18,000 km and accounts for one sixth of the entire national road network. Considering only the most important roads, the road density in the Alps can be estimated to amount to as much as 0.33 km/km^2 compared to the national mean of 0.36 km/km^2 (data source http://www.openstreetmap.org).

Data compilation

The details of the method followed have already been described in various papers by Romano and Zullo (2010, 2014a/b, 2015). In this case too, urbanized areas in the 1950s have been extrapolated from homogenous maps of the entire country using an appropriate GIS technique, in order to obtain comparable values for all Italian regions.

This is why in the study presented in this paper we used Italian maps published on a scale of 1:25,000 by the Italian Military Geographical Institute (IGMI) between 1949 and 1962. These maps are part of the 25V Series, plotted on a scale of 1:20,000, organized in 3,545 elements (tables) 7'30" longitude and 5' latitude in size, in Gauss's conformal representation and part of the national geodetic system (international ellipsoid oriented to Rome Monte Mario – ED40) with a kilometric grid in the Universal Transverse of Mercator conformal projection (ED50 European data) (fig. 2).

The information on Valle d'Aosta, Piedmont, Veneto, Trentino Alto Adige and Liguria was extrapolated in original from the IGM sections of the 1960's. The historically urbanized areas in Friuli Venezia Giulia and Lombardy were taken from regional geoportals and refer to 1950 for Friuli (Moland project – Monitoring Land Use, Cover Dynamics, http://irdat.regione.fvg.it/WebGIS/) (IAS, 2002; Lavalle et al., 2000; Kasanko et al., 2006), while those in Lombardy were obtained by photo-interpretation from the1954 IGMI-GAI flight (http://www.cartografia.regione.lombardia.it/rlregisdownload/).

From these sources, it has been possible to extrapolate urbanized areas in the 1950's. The following were considered "urbanized area": land used for urban functions, involving the replacement or retention of natural soil. This includes built-up land and land used for ancillary settlement functions, such as public and private gardens, sports facilities, unpaved roads and other service areas, either permeable or impermeable to water (Romano, Zullo, 2013).

Regions	Resident inhabitants		Population density (inhab/km²)		Urbanized data (km²)		Land uptake speed (ha/day)	Urbanization density (%)		Urbanized per capita (m²/inhab.)	
	50s	Noughties	50s	Noughties	50s	Noughties		50s	Noughties	50s	Noughties
Valle d'Aosta	109150	119064	33.47	36.51	23.08	47.09	0.22	0.71	1.44	211.45	395.50
Piedmont	850697	873418	67.07	68.86	298.43	642.56	2.14	2.35	5.07	350.81	735.68
Liguria	88610	71473	56.52	45.59	9.98	31.9	0.10	0.64	2.03	112.63	446.32
Lombardy	966577	1286686	98.51	131.13	119.17	497.76	1.89	1.21	5.07	123.29	386.85
Trentino Alto Adige	785967	940416	57.77	69.12	114.71	295.78	1.10	0.84	2.17	145.95	314.52
Veneto	668973	733538	100.45	110.14	119.45	333.42	1.36	1.79	5.01	178.56	454.54
Friuli Venezia Giulia	305799	218925	68.70	49.18	90.43	163.17	0.40	2.03	3.67	295.72	745.32
Total	3775773	4243520	72.55	81.54	775.25	2011.68	6.77	1.49	3.87	205.32	474.06

Land with rural houses and outbuildings used to support farming and animal husbandry is also classified as an "urbanized area", even though its features cannot be defined as strictly 'urban'.

For all the regions, data on urbanization after the year 2000 come from digital land use maps (environmental map, on a scale of 1:25,000 for Valle d'Aosta) on a scale of 1:10,000 and updated to the year 2000 for Friuli Venezia Giulia and Liguria, to 2006 for Piedmont and Veneto and to 2008 for Trentino-Alto Adige and Lombardy. Considering that the primary data on urbanization have been updated in different periods using different survey methods, the accuracy of the resulting assessments is assumed to have a statistical tolerance of 5%.

Data organization and results

Since the post World War II period, the population in the Alps has increased by 12% (almost 470,000 inhabitants) and has reached approximately 4.3 million today (ISTAT, 2011) accounting for 7% of the entire national population in an area covering 18% of the country. With an increase by over one third, population density today – 81,5 inhabitants/km² – accounts for approximately 40% of the national mean and is equal to the population density in countries such as Spain and Greece (tab. 3). This is an extremely significant increase for a mountainous area, since the same mean index for Italy over the same period is around 28% and the Apennines have, instead, lost 10% of their population (Romano, 1995). Furthermore, the demographic trend has been positive over the last decade (2001-2011) at 5%, compared to 4% for the country as a whole.

As already mentioned in the previous sections of this paper, these phenomena confirm the economic strength of the Alps, but also the risk tied to excessive settlement-induced pressure.

To this regard, table 3 shows that urbanization density over the study period has increased approximately three-fold, rising from less than 1,5% to almost 4%. The transformation of land for urban use has affected more than 1,200 km², equal to almost 20% of total urbanized land throughout the Alpine regions. The three-fold increase in urbanization is almost a standard for all the regional sectors in the Alps, with the exception of Valle d'Aosta, Piedmont, Trentino and Friuli Venezia Giulia which did not go beyond a modest two-fold increase.

Of course, urban density in the Alps is almost always lower than the mean density in respective regions that are only partially Alpine (5.07% versus 14% for Lombardy, 5% versus 11% for Veneto and 3.7% versus almost 9% for Friuli).

Although this geographical area is so inaccessible, it has contributed to the average daily urban conver-

opposite page
Tab. 3 – Analytical results of the research for the study area per Region.

sion of Italian land by 8%, with almost 7 hectares/day out of the 80 estimated for all of Italy from the post World War II period to the present day (tab. 3). Also in the Alps, as in other Italian regions, there is not a significant correlation between urban and demographic growth at the municipal level.

This is due to the very numerous functional roles of the settlements: residential, agricultural production, industrial and handicraft, summer and winter tourism...

The figure 3 shows in fact an extreme dispersion of the points corresponding to the individual municipalities with coefficients of determination that never exceed the value of 0.20 regardless of the best fit functions used.

Again, regarding demographic trends, figure 4 (left) shows the distribution, on a municipal basis, of the values of the Demo-Urban Increment Index (DUI). This parameter has been obtained as follows (Romano, Zullo, 2012):

$$DUI = \frac{\Delta urb_{(01\text{-}51)}}{\Delta pop_{(01\text{-}51)}} \qquad (m^2/inhabitant)$$

Where:

$\Delta urb_{(01\text{-}51)}$ = Difference between urbanized areas in municipalities between the 1950's and early 2000's

$\Delta pop_{(01\text{-}51)}$ = Variation in the population residing in municipalities between the 1950's and early 2000's

Figure 4 (left) shows only the positive DUI values, i.e. the values of those municipal territories where stable or increased urbanized surfaces are matched by a population rise, and a classification based on per capita increased urbanized surfaces (the amount of land take per inhabitant acquired by the municipality in the period considered).

Another index examined, complementary to the DUI, is the DUC (Demo-urban Contradiction Index) calculated as follows:

$$DUC = \frac{\Delta urb_{(01\text{-}51)}}{-\Delta pop_{(01\text{-}51)}} \qquad (m^2/inhabitant\ lost)$$

Where:

$\Delta urb_{(01\text{-}51)}$ = Difference between urbanized areas in municipalities between the 1950's and the 2000's

$-\Delta pop_{(01\text{-}51)}$ = Demographic drop in municipalities between the 1950's and the 2000's

In this case, we selected only municipalities with a negative demographic balance between 1950s and Noughties and calculated the increase in urbanized land between the same periods, later checking the quantity of the urbanized land corresponding to every inhabitant lost (fig. 4, rigth).

The DUI index distinguishes the municipalities in which there is a consistent increase in urbanized areas and contemporary population increase. Figure 4

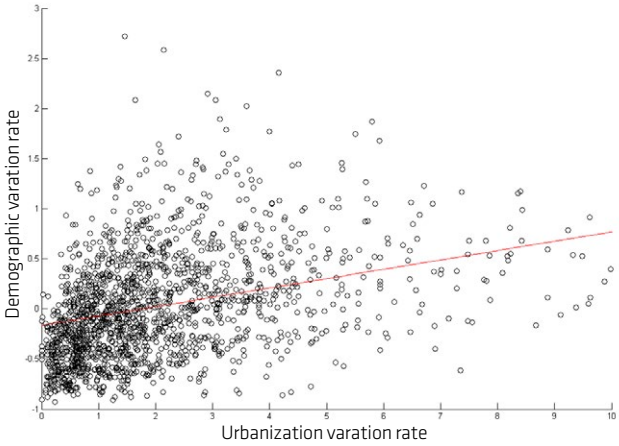


Fig. 3 – Correlation analysis between urban increasing rate and demographic variation rate (1950s-2000s) on a municipal basis.

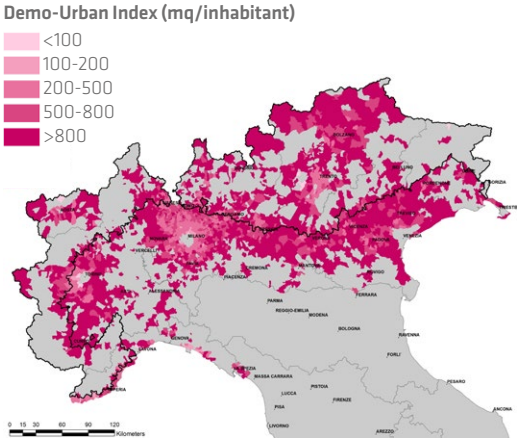
opposite page
Fig. 4 – Map to select the positive values of the demo-urban increment index (left) and demo-urban contradiction index (right).

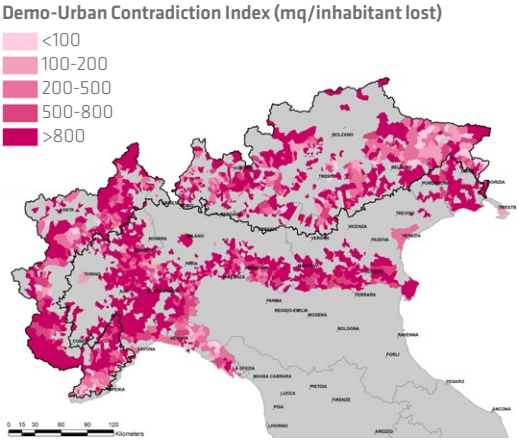
on the left shows that this situation is the case for almost all the southern foothills of the Alps, overlooking the Po Valley, including the most important urban centres and those with morphological and climatic conditions that are more favourable to more traditional economies, such as industry and agriculture. In any case, the same condition is also found in almost all the region of Trentino and in much of the Valle d'Aosta, regions in which the economy is heavily dependent on tourism, confirming the clear difference previously reported compared to other Alpine regions. In fact, the situation is radically different in Piedmont, Veneto, Friuli and, in large part, Lombardy, where there is a clear prevalence of the demo-urban contradiction index (DUC) with average values contained between 1,000 and 5,000 m^2 of urbanisation per inhabitant lost, but with peaks that go well beyond 1 hectare. In the light of these findings and those previously presented, it is clear that mountain tourism does not produce the same effect in all areas, and in many cases the tourist economy is not able to counterbalance the negative effects of isolation. Undoubtedly, this is partly related to the status of "special statute" that Trentino and Valle d'Aosta share, with objective fiscal benefits, but also the different forms of management of the tourist industry play an important role in the creation of these differentiated effects (Ludovici et al., 2006).

Per capita urbanization, a typical indicator of human settlement behavior, has doubled, reaching after the year 2000 values that are slightly higher than the national and Western European average, 474 m^2/inhabitant versus 360 (Romano, Zullo, 2013). This aligned behavior is well represented by means of standard deviations compared to mean values: in the 50's this statistical parameter for density was 44%, but dropped to 35% in 2000, thus evidencing the standardization of developments already observed in other Italian areas.

In the 1950's, there were approximately 700 municipalities with less than 1% urbanization, while 3 municipalities exceeded 25%. After the year 2000, just over one third (218) remain below 1%, while those exceeding 25% have risen to 50 and 3 exceed 50%

In a country with such radical differences in morphology, it is only too clear that the distribution of settlements is strongly influenced by altitude (fig. 5). Analysing the situation relative to the density of urbanisation in the 1950s, we note that the section of land situated at an altitude less than 500 meters a.s.l. is that with the highest index value (5.3%). This is followed by a value slightly higher than 2% of the range between 500 and 1,000 metres above sea level, while other areas have values lower than 1% with the areas above 3,000 meters showing no significant urbanisation (approximately 1 hectar of





urbanised area). After 2000, there was a significant increase in the urbanised surface area (more than 700 km^2) in the area within 500 metres a.s.l., with an urbanisation rate of the same of almost 15%. In contrast, the urbanisation rate in the range between 500 and 1,000 meters a.s.l. more than doubled (from 2.2% to 5.04% today), with an increase in absolute value of more than 300 km^2 of urbanised area. Over this same period, in the areas above this range, an area of just over 36 km^2 was urbanized, with urbanization rates that reach and slightly exceed 1.5% only in the strip between 1,000 and 1,500 meters above-sea-level. Between 2,000 and 3,000 meters above-sea-level, urbanized areas have increased six-fold, following of course the significant development of winter tourism (fig. 6). The greatest increases in urbanized areas at the higher altitudes are concentrated in the mountains of the regions of Valle d'Aosta and Trentino Alto Adige and, to a lesser extent, Piedmont and Lombardy. The landscape changes that have been constrained by morphology are also evident from the graph in figure 7, which shows how the landscape units of the Alps (ISPRA, 2004) have been affected by a net increase in urban density. In some lowlands areas and valley floor these densities far exceed even 15 %, that is twice the national average.

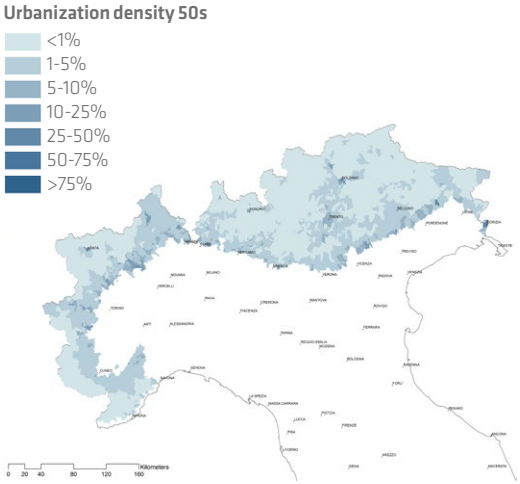
Figure 8 shows that urbanization has grown at a varying pace in four of the most famous and visited Alpine valleys: Valle d'Aosta, Valcamonica, Val d'Adige and Valtellina. In particular, there were only slight differences in Valle d'Aosta in the period considered, due to the historical role of key link that this valley line has played over the centuries in relations with France and in the growth of the steel industry in the early 1920's (Henry, 1929; Riccarand, 2004), followed by the significant and ongoing increase in commercial traffic with the opening of the Mont Blanc tunnel in the mid-60's. Moreover, almost all of the urban conversion of land in Valle d'Aosta (about 200%) has occurred in the more extensive valley floor, between 600 and 100 meters above sea level, owing to the fact that this territory lies at the sides of the Dora Baltea river. In other cases, such as Valcamonica, Val d'Adige and Valtellina, this phenomenon has increased more gradually, with the growth of tourism and production interests that have a higher economic impact than traditional agricultural activities. Approximately 7% (about 118) of Alpine municipalities have skiing facilities, reaching a peak of almost 40% in Trentino Alto Adige. Skiing is a much-debated economic sector in Italy which undoubtedly attracts a large number of visitors, but at the same time requires considerable investment, high running costs (operation, innovation and safety) of ca-

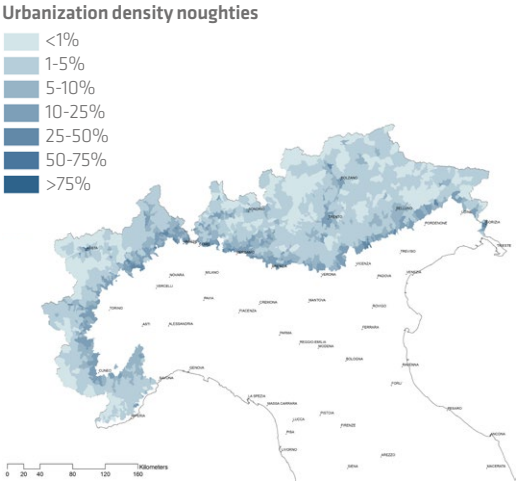
opposite page
Fig. 5 – Maps of urbanization density in municipalities in the 50's and Noughties.

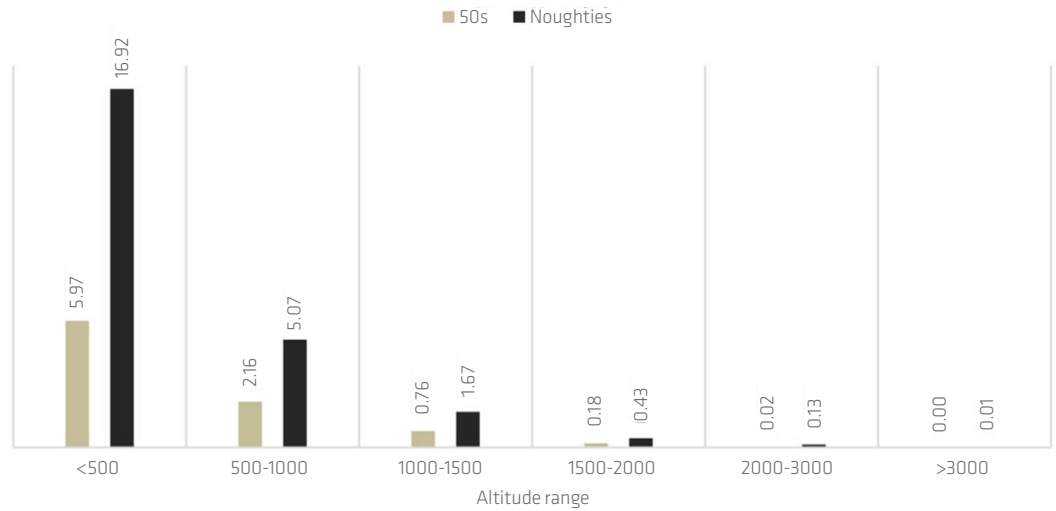
bleways and has a significant environmental impact. This is why skiing areas are often marked by economic insecurity, more or less exacerbated by weather-related events tied to climate change. The Italian "skiing industry" is concentrated mostly in the Alps, although some thirty skiing resorts are also scattered along the Apennines, especially the central part, and accounts for 5% of overall national tourism-related GDP (Barucci, Becheri, 2014). Out of about 370 million visitors in Italy, winter mountain tourism accounts for 5%, summer tourism for about 11% with a significant concentration of tourism in a few areas: 60% in the provinces of Bolzano and Trento and 10% in Veneto (www.ontit.it).

The analysis of data on the development of urban areas in these municipalities shows that it is much higher in Lombardy where, over the past fifty years, urbanization reached 600% in municipalities with skiing facilities, compared to 260% in other Alpine municipalities. Urbanized areas have increased by over ten-fold in six municipalities in particular, including the famous Livigno in Lombardy and Sestriere in Piedmont. The region where urbanization density in the skiing municipalities is slightly higher than the regional mean, after the year 2000, is Trentino Alto Adige (2.8 versus 2.17%), Piedmont (2.89 compared to 2.53%), Liguria (0.75 compared to 0.59%), Lombardy (2.47 compared to 2.09%) whilst more differences there are in Veneto (2.76 compared to 1.81%) and in Friuli Venezia Giulia (3.87 compared to 2.08%). The effects brought about by winter tourism economies on demography in Trentino, compared to other Alpine regions, are clearly evidenced in figure 9, which shows that the Alto Adige skiing municipalities are the only ones that have a steadily upward demographic trend since the 1950's in comparison with stability or slight fluctuations in other regions. This effect is partially in contrast with the 1951-2011 demographic dynamics in all the northern regions, where, for example, Lombardy, Veneto and Friuli have had far more upward trends, whereas Valle d'Aosta, Piedmont and Liguria have been rather stable. The reasons for this are to be found in the different and more efficient forms of participatory management of facilities and the better organization of tourism in Alto Adige, due, at least in part, to its "special status" of "autonomous" region with multiple tax-related benefits.

To this regard, it is important to note that article 116 of the Italian Constitution grants autonomy to three alpine regions (Trentino-Alto Adige/Südtirol, Valle d'Aosta and Friuli-Venezia Giulia), acknowledging their powers regarding legislation, administration and finance. In return, they are required to finance their own healthcare systems, school systems and most public infrastructure.







These regions have become autonomous in order to take into account cultural differences and protect linguistic minorities. Moreover, the government wanted to prevent their secession from Italy after the Second World War. Trentino-Alto Adige/Südtirol is a special case: the region is nearly powerless and the powers granted under this status are mostly exercised by its two autonomous provinces, Trentino and South Tyrol. In this case, the region plays a coordinating role (http://epp.eurostat.ec.europa.eu/). Further important indications to this regard emerge from the analysis of the population and housing census conducted by the National Institute of Statistics (ISTAT) in 2001. In particular, according to these data, in the 1,749 municipalities considered in the study area from 1946 to 2000, over 916,000 buildings were erected (about 17,000 per year, 46 buildings every day). So, taking into account the previously mentioned population growth over the same period, approximately two residential buildings per inhabitant has been constructed.

The "second-home" phenomenon (homes surveyed as 'empty') is highly concentrated in the Alpine region compared to other regions in Northern Ita-

opposite page
Fig. 6 – Examples of urbanization in high altitude.

ly. Here too, however, there is a difference between Trentino Alto Adige, Valle d'Aosta and the rest of the inner Alps.

Regarding the demographic/economic effects of these developments, the policies pursued in "special status" regions seem to be better. An example of this is Trentino – Alto Adige (Südtirol), along with the Valle d'Aosta region, 'symbol' of the Alps, where 142,000 hectares of the Dolomite region were recognized as World Heritage by UNESCO in 2009 (Orsi et al., 2013). For nearly a century now the region lies entirely within Italy and together with Tyrol and Vorarlberg (two entirely mountainous regions in Austria), it is one of the European areas with the highest concentration of skiing facilities: over 600 facilities with an hourly capacity just below one million and slopes for a total of almost 600 km. In this region, far more than in others, integrated policies to promote multi-seasonal tourism and favor technical development in the management of tourist facilities have been in place for many years. Nevertheless, the Trentino area is at the center of a major debate on the actual environmental compatibility and economic sustainability of these initiatives, if considered separately from the highly substantial public financial support that this region enjoys owing to its autonomy.

It should be stressed that the Alps are a region marked by high economic vulnerability, given that two important sectors, agriculture and tourism, are heavily dependent on factors such temperature and continental weather (Agrawala, 2007). It has been estimated that winter tourism alone accounts for over 10% of employment in the area and even minor climate changes can produce severe crises in the business sector. The concerns of skiing industry operators to this regard are witnessed by a number of recent initiatives aimed at curbing glacial retreat by resorting to reflective covers or snow preservation by means of storage and protection using layers of vegetation.

The Alpine Convention too (Price, 1999, 2000) is concerned with the future of urbanized areas. This international treaty was signed by Alpine countries (Austria, France, Germany, Italy, Liechtenstein, Monaco, Slovenia and Switzerland) and the European Union in 1991 to promote sustainable development and protect the interests of the resident population, taking into account the complex environmental, social, economic and cultural characteristics of the main central European mountainous area (http://www.alpconv.org/it/convention/default.aspx). It is one of the most important documents of unitary policy for the Alps (Caldwell, 2003; Enderlin, 2003) that, in the implementation protocol within the framework of territorial planning and sustaina-

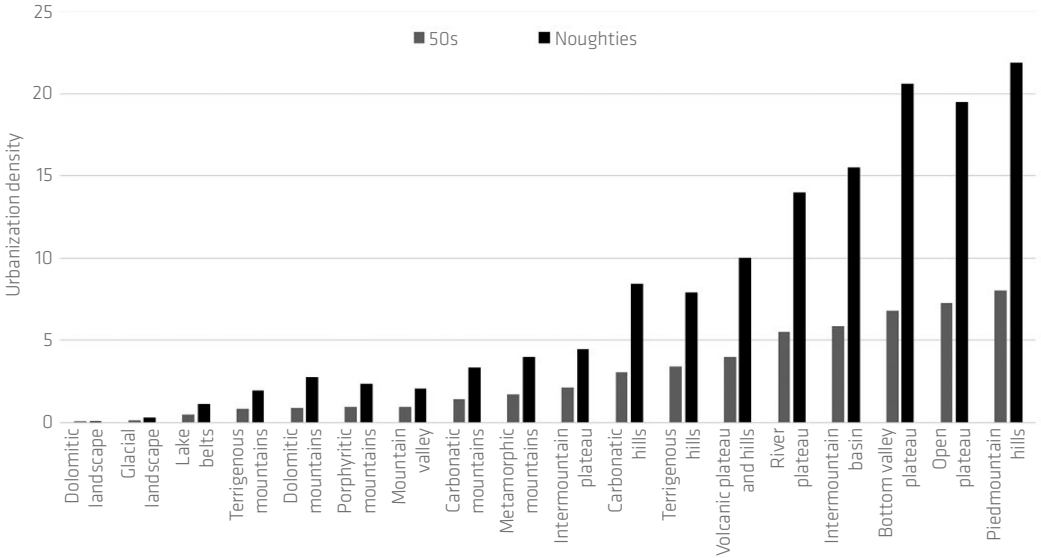


Fig. 7 – Urbanization density change on national landscape units.

opposite page

Fig. 8 – Evolution of urbanization in four of the most famous and visited Alpine valleys.

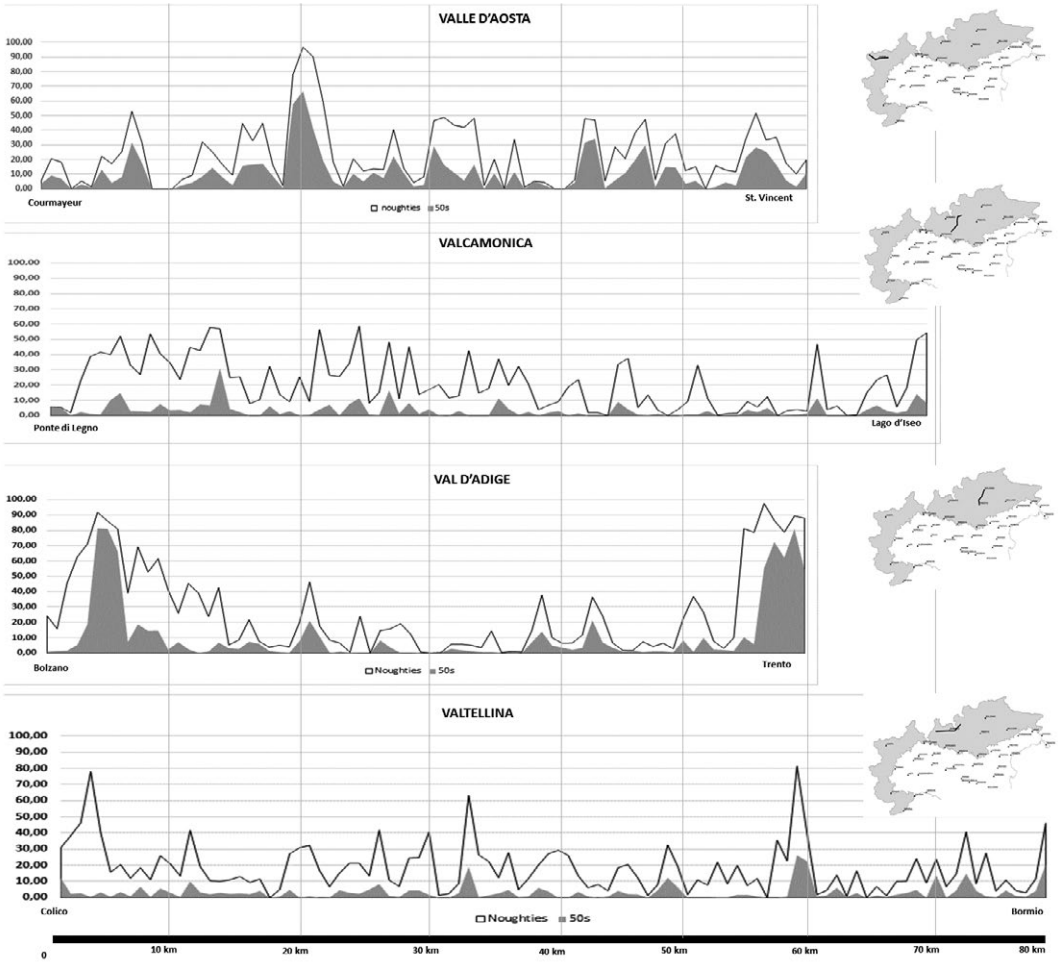
ble development (Art. 9), sets out the actions relating to urbanized areas among the contents of plans and programs:

a. Proper and contained delimiting of the areas for urbanization, and also measures to ensure that the areas so defined are actually built upon;
b. Reserving the lands necessary for economic and cultural activities, for supply services, and also for leisure activities;
c. Determining the areas subject to natural hazards, where building of structures and installations should be avoided as much as possible.
d. Conservation and creation of green areas in the town centres and suburban areas for leisure time;
e. Limiting of holiday homes;
f. Urbanization directed and concentrated along the routes served by transport infrastructures and/or continuing on from the existing constructions;
g. Conservation of characteristic urban sites;
h. Conservation and restoration of characteristic architectural heritage.

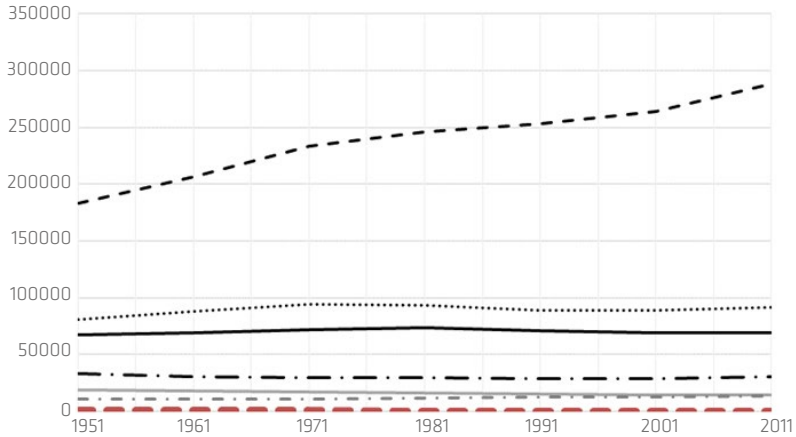
The focus on land preservation (point b), risk containment (point c) and the curbing of urban sprawl (point f) is only too clear. These are all effects that can be efficiently controlled through integrated territorial policies.

Taking into account that, in Italy, the actual decision-making authorities in territorial transformation matters are the municipalities through their urban development plans, the Alps too, like many other national areas, require strategic planning tools that are more integrated than what they are today. To this regard, it should be noted that there are cases of very small municipalities, among which the 210 below 5 km^2, and even 22 with an area of less than 2 km^2.

One last consideration concerns urbanization in areas having special arrangements owing to their natural features: protected areas and Natura 2000 sites. Over half of Alpine Protected Areas are situated at altitudes above 2,000 meters above-sea-level, while less than 9% are located at altitudes below



1,000 meters above-sea-level (tab. 2). Even in the case of Natura 2000 sites (SCIs – Sites of Community importance and SPAs – Special Protection Areas) the proportion situated at high altitudes is very significant (over 40%), but there is a greater focus on valley-floor habitats with 14% of Natura 2000 sites located in these areas. The phenomenon of urban conversion of land has also had a huge impact on the integrity of alpine ecosystems and the environment. In analyzing the evolution of the phenomenon of urbanization in these areas during the two time spans, a significant increase in urbanized areas may be observed: from the over 1,400 hectares in the 1950's (0.11% of total PA-N2000 areas) to the almost 4,300 hectares (0.35%), with an overall rise equal to over three-fold the areas in the 1950's. The same rate of increase (200%) also concerns the 1 km buffer zone (as the crow flies) around the perimeters of these areas, now comprising almost 43,000 hectares of urban areas (5.3% of the buffer surface area). This means that these zones adjacent to the areas of highest natural quality account for a quarter of all urbanized areas in the Alps, thus marking an increase by approximately 27,000 hectares (1.5 hectares per day) over a fifty-year period. This phenomenon has certainly increased the insularization



of natural areas significantly, compared to the matrix, with high habitat fragmentation and reduction of the local ecosystem functionality, thereby undermining the many potential efforts to restore the Alpine ecological network (Kohler et al., 2008; Chemini, Rizzoli, 2003).

Conclusions

This study has highlighted some even rather unexpected aspects of the development of urbanization in the Italian Alps. In particular, it has shown that to date, urbanized areas have increased three-fold compared to the post-World War II period. This has been observed both as an average throughout the study area, but even in municipalities equipped with skiing facilities and in protected areas and their immediate hinterland. The 260% rise in urbanization is surely lower than the 400-500% found in other Italian geographical areas, such as the Po Valley or central Italian regions (Romano, Zullo, 2015), but it is still significant considering the rather harsh and rugged mountain environment. However, this environment is characterized by the extraordinary availability of natural and economic-energy resources (water, forests, and pastures) which have largely offset the difficulties due to the climate and unfavorable morphology and led to a significant population growth trend, with an increase of about 470,000 inhabitants in 50 years (12% versus 25% nationwide) and an increase of almost 120,000 over the past decade, thus reaching a population density equal to the average one in leading European industrialized countries, due also in part to immigration (Bender, Kanitscheider, 2012).

It is a fact that urban conversion is largely concentrated in the pre-alpine zones south of the study area and in the valleys nestled in mountain ranges (with an urbanization density that has increased over four-fold below 500 meters above-sea-level), owing to the better economies of scale, ease of transport and the advantages of building in flatter areas. However, it is also true that there has been significant urbanization at higher altitudes, considering the almost 60 km^2 of urbanized areas (5% of the total) above 1,500 meters above-sea-level, which in this case too, have risen three-fold compared to 50 years ago, with a considerable rise in second homes, which only in Trentino Alto Adige and Valle d'Aosta seems to be more controlled.

The analyzed data have helped us develop an evolutionary scenario for settlements in the Italian Alps. As we have seen, over the past 60 years, the population has grown by 470,000 in the context of 1,236 km^2 of urbanized land (2,630 m^2/inhabitant on average). The ten-year average rate of population growth in the 60 years analyzed was 2% (5% in

opposite page
Fig. 9 – Demographic development in skiing municipalities.

the past 10 years between 2001 and 2011). By applying a 2% rate to the next 10 years, there would be a further demographic rise of about 84,000 inhabitants which, using the same standard applied to urbanized land (2,630 m^2 /inhabitant) would lead to a further 220 km^2 of urbanization. This equates to a square, 14 km per side, added to the present-day one of over 40 km per side that accounts for current urbanization.

This scenario is plausible also in view of possible compensation efforts that may be made in the production and tourism economies as a result of the difficulties for the skiing industry, forecasted by many, that will be brought about by climatic change (Cannon et al., 2008; Rixen et al., 2011).

The previous evolution and possible trajectories linked to the above-described scenarios constitute an important focus of attention for future territorial policies. Figure 6 shows a typical example of an Alpine valley settlement, which is highly linear despite the very limited size of the built-up areas. Along the sides of a road segment of just over 1 km, approximately 10 ha of isolated and mixed urbanised areas (residential buildings and factories) lie between compact settlements. This model causes many of the negative phenomena mentioned above: fragmentation of the ecosystem, propagation of environmental disturbances, high consumption of energy for transport, high costs of network services and a difficulty in the provision and use of public services. A revision of the model, which, as it is today, also allows for future linear development, is not simple when the situation is stabilised. Territorial planning must therefore focus on preventing such localised results and applying forms of aggregation (fig. 10).

It is well known that, in Italy, interventions on private land ownership, imposing limits of transformation and therefore economic limits, leads to widespread dissent and reactions. Regional planning laws however already include suitable instruments for this purpose, such as development rights (TDR programs), which have been commonly used at international level for some time (Mills, 1980; Thorsnes, Simons, 1999; Micelli, 2002; Tian, 2014). A TDR program seeks to preserve landowners asset value by moving the right to build a house from a location where development is prohibited (e.g., for environmental reasons) to a location where development is encouraged. These mechanisms are still applied in Italy with some difficulty, but if used systematically they may produce excellent results in fighting the phenomena of linearisation and dispersion that have been adopted across the country since the post-war period.

The goal of the actions should be to better manage the current landscape of the Alpine area. The

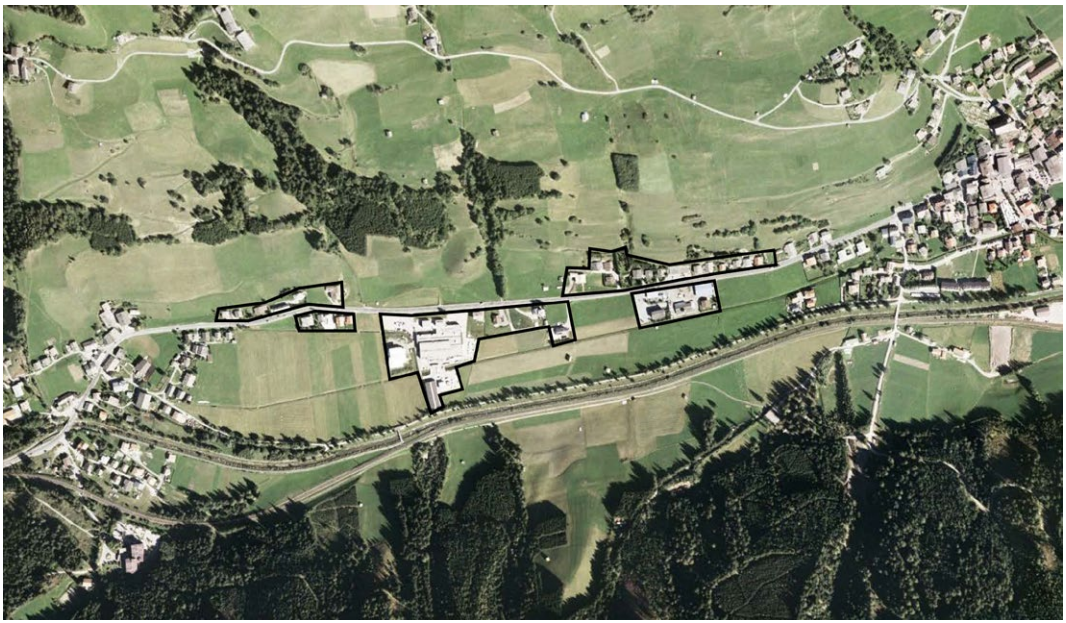


Fig. 10 – Typical example of an Alpine valley settlement (left), which is highly linear despite the very limited size of built-up areas (10 ha) – Result obtained by applying an aggregation model (right).

risk of quality loss is very high in this regard: on the one hand, climate change disrupts glacial and alter those winter landscapes, while the settlement growth has to affect valleys views and slope.
Between these two aspect the second is more controllable by the land governance and the future planning and land use planning effort should be to redevelop many of landscape degradation interventions in the past and avoid realize other wrong in the future. It can be said with some certainty that the economic outlook of the Alps are closely linked to the level of their landscape, without which the equipment and services, although excellent, are not used to a lot.

References

Agrawala S. 2007, *Climate change in the European Alps: adapting winter tourism and natural hazards management*, Cabdirect, pp. 136.

Barucci P., Becheri E. 2014, *XIX Rapporto sul turismo italiano*, Mercury Turistica, Firenze.

Bätzing W., Perlik M., Dekleva M. 1996, *Urbanization and depopulation in the Alps*, «Mountain Research and Development», n. 16(4), pp. 335-350.

Belardi M., Catullo G., Massacesi C., Nigro R., Padoan P., Walzer C. (eds.) 2011, *Alpine biodiversity needs ecological connectivity*, Ecoconnect Project, Milano, p. 67.

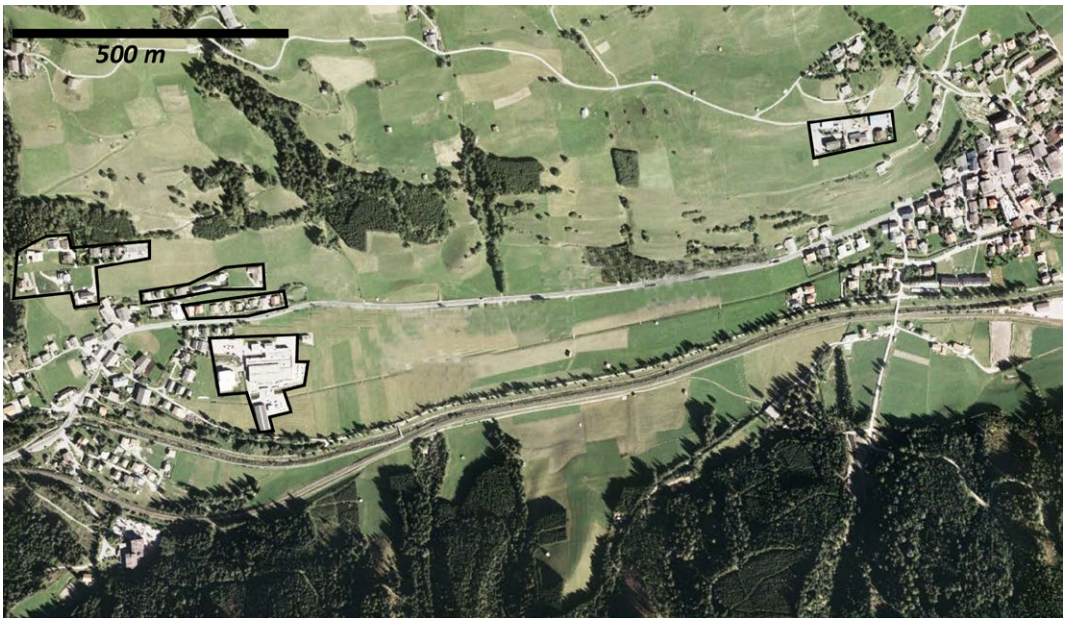
Bender O., Kanitscheider S. 2012, *New Immigration Into the European Alps: Emerging Research Issues*, «Mountain Research and Development», n. 32(2), pp. 235-241.

Bossard M., Feranec J., Otahel J. 2000, *Corine Land Cover Technical Guide*, «EEA Technical report» n. 40, p. 105.

Caldwell C.J. 2003, *Black Diamond of Harmonization: The Alpine Convention as a Model for Balancing Competing Objectives in the European Union*, 21 B.U. Int'l L.J. 137.

Cannon N., Diolaiuti G., Guglielmin M., Smiraglia C. 2008, *Accelerating climate change impacts on alpine glacier forefield ecosystems in the European Alps*, «Ecological Applications», n. 18, pp. 637-648.

Catalán B., Saurí D., Serra, P. 2008, *Urban sprawl in the Mediterranean? Patterns of growth and change in the Barcelona Metropolitan Region 1993-2000*, «Landscape and Urban Planning», n. 85(3-4), pp. 174-184.



Chemini C., Rizzoli A. 2003. *Land use change and biodiversity conservation in the Alps*, «J. Mt. Ecol», n. 7, pp. 1-7.

Crutzen P.J., Stoermer E.F. 2000, *The Anthropocene. International Geosphere Biosphere Programme*, «Global Change Newsletter».

Crutzen P.J. 2002, *Geology of Humankind*, «Nature», n. 415, p. 26.

Ellis, C.E., Ramankutty N. 2008, *Putting people in the map: anthropogenic biomes of the world*, «Frontier in Ecology and the Environment», n. 6.

Ellis E.C., Goldewijk K.K., Siebert S., Lightman D., Ramankutty N. 2010, *Anthropogenic transformation of the terrestrial Biomes, 1700 to 2000*, «Global Ecology and Biogeography», n. 19 (5), pp. 589-606.

Ellis E.C. 2011, *Anthropogenic transformation of the terrestrial biosphere*, «Philosophical transactions of the Royal Society of London A», n. 369, pp. 1010-1035.

Ellis E.C., Kaplan O.J., Fuller Q.D., Vavrus S., Goldewijk K.K., Verburg Peter H. 2013, *Used Planet: a global history*, «PNAS», n. 110, pp. 7978-7985.

Enderlin T. 2003, *Alpine Convention: A Different Compliance Mechanism*, «Environmental Policy and Law», n. 33, pp. 3-4.

Gabrieli J., Barbante C. 2014, *The Alps in the age of the Anthropocene: the impact of human activities on the cryosphere recorded in the Colle Gnifetti glacier*, «Rendiconti Lincei», Springer.

Garcia-Call A. 2011, *The process of residential sprawl in Spain: Is it really a problem?*, «Urban Research and Practice», n. 4(3), pp. 250-263.

Gios G., Goio I., Notaro S., Raffaelli R. 2006, *The value of natural resources for tourism: a case study of the Italian Alps*, «International Journal of Tourism Research», n. 8(2), pp. 77-85.

Grubler A. 1994, *Technology*, in *Changes in Land Use and Land Cover: A Global Perspective*, W.B. Meyer, B.L. Turner (Eds.), Univ. of Cambridge Press, Cambridge, pp. 287-328.

Hall P., Gracey H., Drewett R., Thomas R. 1973, *The Containment of Urban England*, London and Beverly Hills, vol. I, pp. 9-58.

Hauri E., Steiner V., Vinzens M. 2006, *Human Settlement in Switzerland, Spatial Development and Housing*, «Housing Bulletin», n. 78, pp. 1-80.

Heilig G.K. 1994, *Neglected dimensions of global land-use change: reflections and data*, «Population and Development Review» n. 20(4), pp. 831-859.

Henry J.M. 1929, *Histoire de la Vallée d'Aoste*, Imprimerie Marguerettaz, Aosta.

Hobbs R.J., Higgs E.S., Hall C. 2013, *Novel Ecosystem: Intervening in the New Ecological Order*, Wiley.

Illy A., Hornych C., Schwartz M., Rosenfeld M.T.W. 2009, *Urban Growth in Germany – The Impact of Localization and Urbanization Economies*, «IWH Discussion Papers», n. 19, pp. 1-53, Halle Institute for Economic Research.

Irwin E.G., Bockstael N.E. 2007, *The evolution of urban sprawl: Evidence of spatial heterogeneity and increasing land fragmentation*, «PNAS», n. 104(52), pp. 20672-20677.

ISPRA 2004, *Carta dei tipi e delle unità fisiografiche d'Italia scala 1:250.000*, <http://www.isprambiente.gov.it/site/it-it/Servizi_per_l'Ambiente/Sistema_Carta_della_Natura/ Carta_della_Natura_alla_scala_1_250.000>.

Istituto per l'Ambiente e la Sostenibilità (IAS), Centro Comune di Ricerca, CE 2002, *Rapporto finale del Progetto Moland-Friuli Venezia Giulia – Consumo ed uso del Territorio del Friuli-Venezia Giulia*.

Kasanko M., Barredo J.I., Lavalle C., McCormick N., Demicheli L., Sagris V., Brezger A. 2006, *Are European Cities Becom-*

ing Dispersed? A Comparative Analysis of Fifteen European Urban Areas, «Landscape and Urban Planning», n. 77, pp. 111-130.

Kohler Y., Plassmann G., Ullrich A., Götz A., Scheurer T., Hölscher S., Savoia S. 2008, *The Continuum Project: Establishing Ecological Networks Throughout the European Alps*, «Mountain Research and Development» n. 28(2), pp. 168-172.

Lambin E.F., Turner B.L., Geist H.J., Agbola S.B., Angelsen A., Bruce J.W., Coomes O.T., Dirzo R., Fischer G., Folke C., George P.S., Homewood K., Imbernon J., Leemans R., Li X., Moran E.F., Mortimore M., Ramakrishnan P.S., Richards J.F., Skanes H., Steffen W., Stone G.D., Svedin U., Veldkamp T.A., Vogel C., Xu J. 2001, *The causes of land-use and land-cover change: moving beyond the myths*, «Global Environmental Change», n. 11, pp. 261-269.

Lavalle C., Niederhuber M., McCormick N., Demicheli L. 2000, *The MURBANDY / MOLAND methodology, and its potential to support sustainable city development*, in*Proceedings of the 12th International Symposium Computer science for environmental protection: environmental information for planning, politics and the public* (Bonn, Germany October 4-6, 2000), A.B. Cremers, K. Greve (eds.), Metropolis-Verlag, Marburg.

Lowry I.S. 1990, *World Urbanization in Perspective. Population and Development Review, 16*, (Supplement: Resources, Environment, and Population: Present Knowledge, Future Options), pp. 148-176.

Mellor R. 1983, *The urbanization of Britain, a review*, «IJURR», n. 7(3), pp. 380-403.

Micelli E. 2002, *Development Rights Markets to Manage Urban Plans in Italy*, «Urban Studies», n. 39(1), pp. 141-154.

Mills D.E. 1980, *Transferable development rights markets*, «Journal of Urban Economics», n. 7(1), pp. 63-74.

Moerschel F. 2004, *Die Alpen: das einzigartige Naturerbe. Eine gemeinsame Vision fuer die Erhaltung ihrer biologischen Vielfalt*, WWF Deutschland, Frankfurt am Main, im Rahmen des WWF Europaeischen Alpenprogramms.

Müller H. 2009, *2030: Alps Tourism in the Face of Climate Change*, in *Trends and Issues in Global Tourism 2009*, R. Conrady, M. Buck (Eds), Springer, pp. 57-63.

Murgante B., Las Casas G.B., Danese M. 2008, *The periurban city: Geo-statistical methods for its definition*, Urban and regional data management, pp. 473-485.

Nagy L., Thompson D., Grabherr G., Körner C. 2003, *Alpine Biodiversity in Europe: an Introduction*, Joint Nature Conservation Committee, Report, Peterborough, pp. 1-10.

Orsi F., Geneletti D., Borsdorf A. 2013, *Mapping wildness for protected area management: A methodological approach and application to the Dolomites UNESCO World Heritage Site (Italy)*, «Landscape and Urban Planning», n. 120, pp. 1-15.

Pileri P., Maggi M. 2010, *Sustainable planning? First results in land uptakes in rural, natural and protected areas: the Lombardia case study (Italy)*, «Journal of Land Use Science», n. 5(2), pp. 105-122.

Price M.F. 1999, T*owards co-operation across mountain frontiers: The Alpine Convention*, «European Environment», n. 9(3), pp. 83-89.

Price M.F. 2000, *The Alpine Convention: A Model for Other Mountain Regions?*, «Mountain Research and Development», n. 20(2), pp. 192-194.

Riccarand E. 2004, *Storia della Valle d'Aosta contemporanea (1946-1981)*, Stylos, Aosta.

Rixen C., Teich M., Lardelli C., Gallati D., Pohl M., Pütz M., Bebi P. 2011, *Winter Tourism and Climate Change in the Alps: An Assessment of Resource Consumption, Snow Reliability, and Future Snowmaking Potential*, «Mountain Research and Development», n. 31(3), pp. 229-236.

Romano B. 1995, *National park policy and mountain depopulation. A case study in the Abruzzo region of the Central Apennines, Italy*, «Mountain Research and Development», n. 5(2), pp. 121-132.

Romano B., Zullo F. 2010, *Tecniche di rilevamento e valutazione del fenomeno di conversione urbana dei suoli*, Atti della Sesta Conferenza Nazionale INPUT 2010, Potenza, vol. I, pp. 327-337.

Romano B., Zullo F. 2013, *Models of Urban Land Use in Europe Assessment tools and criticalities*. «International Journal of Agricultural and Environmental Information Systems (IJAEIS)», IGI Global, vol. 4(3), pp. 80-97.

Romano B., Zullo F. 2014a, *Land urbanization in Central Italy:*

50 years of evolution, «Journal of Land Use Science», n. 9(2), pp. 143-164.

Romano B., Zullo F. 2014b, *The urban transformation of Italy's Adriatic Coast Strip: fifty years of unsustainability*, «Land Use Policy», n. 38, pp. 26-36.

Romano B., Zullo F. 2015, *Half a century of urbanisation in Southern European lowlands a study on the Po Valley (Northern Italy)*, «Journal of Urban Research and Practice».

Rossi G., Parolo G., Ferrarini A. 2009, *A rapid and cost-effective tool for managing habitats of the European Natura 2000 network: a case study in the Italian Alps*, «Biodiversity and Conservation», n. 18(5), pp. 1375-1388.

Ruddick S. 2015, *Situating the Anthropocene: planetary urbanization and the anthropological machine*, «Urban Geography», n. 36(8), pp. 1113-1130.

Sala E.O., Chapin F.S., Armesto J.J., Berlow E., Bloomfield J., Dirzo R., Huber-Sanwald E., Huenneke L.F., Jackson R.B., Kinzig A., Leemans R., Lodge D.M., Mooney H.A., Oesterheld M., Poff N.L., Sykes M.T., Walker B.H., Walker M., Wall D.H. 2000, *Global Biodiversity Scenarios for the Year 2100*, «Science», n. 287, pp. 1770-1774.

Salvati L., Munafò M., Gargiulio, Morelli V., Sabbi A. 2012, *Low-density settlements and land use changes in a Mediterranean urban region*, «Landscape and Urban Planning», n. 105(1-2), pp. 43-52.

Serandrei-Barbero R., Zanon G. 1993, *The Italian Alps*, in *Satellite Image Atlas of Glaciers of the World – Europe*, R.S. Williams, J.G. Ferrigno (eds.), USGS Professional Paper 1386-E, Washington D.C.

Sharma L., Pandey P.C., Nathawat M.S. 2012, *Assessment of land consumption rate with urban dynamics change using geospatial techniques*, «Journal of Land Use Science», n. 7(2), pp. 135-148.

Sundseth K. 2005, *Nature 2000 in the Alpine Region*, European Commission.

Temple H. J., Terry A. 2007, *The Status and Distribution of European Mammals*, Report, Luxembourg, Office for official publications of the European Communities, IUCN/SSC, pp. 1-60.

Thorsnes P., Simons G.P.W. 1999, *Letting the market preserve land: the case for a market-driven transfer of development rights program*, «Contemporary Economic Policy», n. 17(2), pp. 256-266.

Tian L. 2014, *Property Rights, Land Values and Urban Development: Betterment and compensation in China*, E. Elgar, Cheltenham, UK, p. 215.

Yanitsky O. 1986, *Urbanization in the USSR, theory, tendencies and policy*, «IJURR», n. 10(2), pp. 265-287.

Zaninetti J.M. 2006, *Urban Sprawl in France, a regional typology of urbanization trends and its demographics and economy background*, «Bulletin of Geography», n. 5, pp. 5-20.

Zemp M., Paul F., Hoelzle M., Haeberli W. 2008, *Glacier Fluctuations in the European Alps, 1850-2000*, in *Darkening Peaks: Glacier Retreat, Science and Society*, B. Orlove, E. Wiegandt, B.H. Luckman (eds.), University of California Press, Berkeley, CA, pp. 152-167.

Zimmermann P., Tasser E., Leitinger G., Tappeiner U. 2010, *Effects of land-use and land-cover pattern on landscape-scale biodiversity in the European Alps*, «Landscape and Urban Planning», n. 139(1-2), pp. 13-22.