Land urbanization in Central Italy: 50 years of evolution
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Land urbanization in Central Italy: 50 years of evolution

Bernardino Romano* and Francesco Zullo

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The increasingly fast pace in urban conversion of land over the past 50 years in Italy is a phenomenon that is still difficult to quantify reliably owing to the chronic lack of knowledge at every territorial level, from national to municipal. This article describes the results of a study on the features of urbanization in the 1950s in the peninsular regions of Central Italy, based on uniform historical maps of the entire country. The historical data were compared from a qualitative and quantitative viewpoint with the present-day geography of settlements. Interesting information has emerged on possible significant thresholds in the relationship between demography and urban use of land, 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: urbanization impact; land-use change; land-use planning; land uptake

1. Introduction

The purpose of this study is to elaborate data on the quantitative and qualitative evolution of land urbanization in Central Italy from the post-war period (1949–1956) to the first decade of the twenty-first century.

According to consolidated scientific opinions, land use caused by urbanization is one of the main causes of political and social conflicts (Plotkin, 1987) and altered environmental quality of land (Ellis & Ramankutty, 2008; Sala et al., 2000).

The aspects involved, either directly or indirectly, in urban conversion of land include the following:

Economic and energetic field:

- diseconomies in transport
- waste of energy
- reduced agricultural produce

Hydro-geo-pedologic field:

- geological destabilization
- irreversible use of land
- alteration of underground and surface watercourses.

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Physico-climatic field:

- increased thermal reflection and climate change
- reduced emission absorption capacity
- effects on carbon sequestration
- spatial propagation of physicochemical disturbances

Ecobiological field:

- physical erosion and destruction of habitats
- ecosystem fragmentation
- dystrophy of ecological and biological processes
- penalization of the ecosystem services of the environment
- reduction in overall ecological ‘resilience’

Some European countries that are more sensitive to the foregoing consequences have already adopted regulations to curb the phenomenon and one of the most significant experiences is the German one (Bundesregierung, 1985; Illy, Hornych, Schwartz, & Rosenfeld, 2009).

There are not many studies in the international literature on the Italian case (Bonifazi & Capello, 2001; Heins, 2001) and very few regions (only 3 out of 20) have vector information on land use over the past 50 years. There are also very few cases in which data covering a shorter time span are available (1970s–2000) regarding both overall magnitude of urbanization and statistically significant historical series and there are no coordinated survey activities among local governments (regions, provinces, and municipalities).

The negative aspects of this phenomenon are still considered only marginally by scientific, communication, and land governance agencies (Emiliani, 2007; Mercalli, 2009; Pileri, 2007).

Some contributions on ecological networks and the threats on the biodiversity due to urbanization are in Battisti (2011). Some Universities (Turin, Florence, Pavia, and L’Aquila) have studied the relationship between land-use change and decreasing of ecosystem quality (Gambino & Romano, 2004, Malcevschi, 2010; www.planeco.org).

In other countries, information and publications are far more numerous (Bockstael, 2007; García-Call, 2011; Hall, Gracey, Drewett, & Thomas, 1973; Hauri, Steiner, & Vinzens, 2006; Irwin & Zaninetti, 2006; Mellor, 1983; Yanitsky, 1986). 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 (Batty, 2008; Lowry, 1990; Sharma, Pandey, & Nathawat, 2012).

One of the most recent initiatives in this regard is the one taken by the National Land Use Observatory, set up by the Milan Polytechnic and INU (Urban Planning National Institute) (http://www.inu.it/attivita_inu/ONCS_2.html) which however makes use of relatively recent information bases (end of the 1970s) and has very little data available. Toward the end of the 1980s, other authors highlighted landscape change modalities using large-scale national databases (1:250,000) (Astengo & Nucci, 1990; CNR-IPRA, 1988) or European standards such as Corine Land Cover (CLC) (APAT, 2005; Bossard, Feranec, & Otahel, 2000; Comber, 2008) derived from satellite remote sensing on a nominal scale of 1:100,000 (Berdini, 2009; Falcucci & Maiorano, 2008). Some international organizations, such as the European Environmental Agency (EEA, 2006), have estimated, in the case
of Italy, that approximately 8000 ha/year were artificialized between 1990 and 2000, again based on CLC satellite remote sensing. Other data have been processed by ISTAT (National Institute of Statistics) and the information derives from the census which this Institute conducts nationwide (ISTAT, 2009) and, in particular, referred to businesses operating in the agricultural sector.

Table 1 shows a differential test on urbanized areas conducted in some Italian regions based on CLC satellite remote sensing and data taken from regional land use maps (Carte regionali di Uso del Suolo – CUS) drawn up over the past 10 years by all Italian regions by means of photo interpretation with levels of detail ranging between 1:10,000 and 1:5000 (far more reliable than CLC as they plot scattered and minute built-up areas too). As may be noted, there is considerable variability and huge differences, sometimes in excess of 80% too, which force technical and scientific operators to be extremely cautious in making diagnoses and outlining problematic scenarios. Out of the sample of 14 regions shown in Table 1, actual urbanized areas (surveyed by CUS) are 60% greater on average than the same areas surveyed by CLC remote sensing.

In our article, urbanized areas in the 1950s have been extrapolated from uniform historical maps of the entire country, using an appropriate Geographical Information System (GIS) technique, in order to obtain comparable values for all Italian regions. Two years of studies were needed to produce these data and we expect to obtain data for the entire country in three years’ time.

2. Methodology

As mentioned previously, in order to develop a reliable national evolutionary picture of urban conversion of land from the second post-war period to the present day, it is necessary to use cartographic bases that are homogenous for the period across the entire country and with a sufficient scale of detail to highlight even the most scattered and fragmented urbanized parts.
This is why, in the study presented in this article we used Italian maps published on a scale of 1:25,000 by the Italian Military Geographical Institute (IGMI) between 1949 and 1962, as our reference time source for the 1950s. These maps are part of the 25V Series, plotted on a scale of 1:20,000, organized in 3545 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).

From these maps, available in raster version, it is possible to extrapolate urbanized areas in the 1950s, formed by areas covered by buildings plus all ancillary areas (parking areas, streets within neighborhoods, goods storage and handling areas, and various other structures) (Figure 1).

Within the framework of this study, we developed a GIS technical procedure capable of semi-automating vector extraction of urbanized areas from historical raster maps (Romano & Zullo, 2010). Then, the overall parts corresponding to urban functions (built
and ancillary areas) were isolated and tested using additional topological devices. The results obtained from this study on 1:25,000 maps were then compared with those of urbanized areas available in vector format from regional maps generally derived from photo interpretation on a nominal scale of 1:10,000 or 1:5000.

The regions presented in this article are those of Central Italy, namely Umbria, Marche, Abruzzo, Molise, and Lazio. The territories in these regions include the highest mountainous areas in the Apennine, with the highest peak in peninsular Italy (the Corno Grande 2914 m above sea level), as well as considerable hilly expanses and over 350 km of coastal strip. This is why the relationship between morphology and settlements is so close and has given rise to historically highly diversified phenomena, which however have become more homogenous since the post-war period to the present day, as described later.

3. Results

3.1. Urbanization in the 1950s

The regions analyzed have a very diverse territorial history. Prior to the unification of Italy in 1861, Marche, Umbria, and northern Lazio were part of the State of the Church, while the Abruzzo and Molise and some areas of southern and eastern Lazio belonged to the Kingdom of Naples.

Geoclimatic features and political administration have had a varied impact on land transformation from both a town planning and a agricultural perspective. For centuries, the prevailing hilly morphology of Umbria and Marche, the abundant watercourses, and a particularly favorable temperate climate have fostered profitable farming based above all on the specialized production of wine and oil. Farming in these regions was marked by the sharecropping model (Reid & Joseph, 1975; Shaban, 1987; Singh, 1989) which was widely used in other Italian regions too, such as Tuscany, Emilia Romagna, and Veneto and strongly developed in the fourteenth and fifteenth centuries. It persisted until the 1960s, when law no. 756/64 put an end to new sharecropping contracts.

This form of agricultural production, through which the landowner and the farmer team up to farm an estate in order to share produce and profits, has led to very evident results in the landscapes of the regions in question. The utmost care of the land, made evident by the accurate layout of fields and canals, is the consequence of the sharecropper’s need to produce everything his family needs by tapping the potentialities of the estate as much as possible. The average expanse of farming estates ranging between 6 and 9 ha (250–300 m square block), where the house of the sharecropper’s family and outbuildings were situated, has led to the significant spread of settlements with highly scattered buildings that clearly distinguish the regions of Umbria and Marche from all the others considered in the study sample.

In the Abruzzo, Molise, and Lazio farming was historically based on an entirely different model, that of the latifundium (Cardoza, 1994), that is to say large landed estates, sometimes even in excess of 1000 ha (the famous record of 14,000 ha being held by the Torlonia family in Abruzzo) owned by nobles or the ecclesiastic aristocracy used to farm traditional crops, but more frequently as grazing land, by the farmhands hired by the landowners.

In Western Europe, this system, typical of the Ancien Régime, was overcome only between the eighteenth and nineteenth centuries, due to the spread of capitalism in the running of farms.

In these large landed estates, not much attention was paid to innovation and the owner was only interested in obtaining a good rent and neglected farming details. This is why
the type of farming practiced in large landed estates was often extremely backward. This latifundistic model did not require a dense system of settlements on the territory and, as a result, urbanized centers are historically far more clustered.

This phenomenon is very clear when examining Figure 2 and represented analytically by the urban dispersion index (UDI), which is calculated as follows:

\[
\text{UDI} = \frac{Nuc}{A}
\]

where \(Nuc\) is the number of urbanized nucleus and \(A\) is the regional area (km\(^2\)).

Table 2 shows a very high UDI in the 1950s for Umbria and Marche (values ranging between 4 and 7), while it is far lower in the regions of Lazio, Abruzzo, and Molise (between 1.6 and 1.3). In the 2000s, the regions of Umbria and Marche are still marked by dispersion, with values significantly on the rise too, while the other regions showed a clustering trend of urbanized areas, mainly linear along the valley lines, with reductions even in excess of one-half of the original urban nucleus.

### 3.2. Comparison between the 1950s and the year 2000

The regions studied are marked by great differences in urbanization between the 1950s and after the year 2000 for reasons tied undoubtedly to the aforementioned prevailing territorial policies over the years and their climatic, geographical, morphological, and productive features. The variations in question are, however, quantitatively significant (Figure 2 and Table 3), with minimum increase rates of about 100% in the case of Umbria, over 200% in Marche, and over 400% in Lazio, Molise, and Abruzzo.

In Molise, one of the smallest Italian regions, land has been urbanized at an average pace of over half a hectare per day, while in Umbria the rate of conversion was slightly lower than 1 ha/day. Abruzzo and Marche showed decisively higher rates with over 1.7 ha/day, while Lazio (the region containing Rome) ranked first with over 5 ha/day.

Overall in the regions studied, urban areas have increased threefold on average with an increment of almost 200,000 ha in approximately 50 years, that is to say an artificialized surface equal to that of a large European national park. Daily land uptake refers to varying survey periods, but the average value amounts to about a total of over 10 ha/day. Considering that the territories in the regions analyzed account for 17% of the entire country, if these values were extended to 100% of the Italian territory, we would have an average daily conversion surface of about 60 ha/day. If this land transformation trend should persist in the future too, we would have a scenario of almost 500,000 ha of built surfaces in the next 20 years, which may be roughly represented as a square of over 70 km per side (almost half of the average width of the Italian peninsula between the Tyrrhenian sea and the Adriatic sea).

Table 4 gives us a very effective dynamic image of the actual scope of the process analyzed. In the last post-war period, the regions studied had very low urbanization density values: Molise, Abruzzo, and Marche were below 7‰, while the other regions ranged between 1% and 2%. All these values varied their order of magnitude significantly in the 50 years observed: Umbria, Abruzzo, and Molise reached 3%, Marche rose and exceeded 5%, while Lazio came close to 8%. As far as the per capita value is concerned, in Molise and Abruzzo it has increased almost fivefold, while the lowest values are found in Umbria with an increment factor of less than 3 (even though in the 1950s these two regions had the highest per capita values).
In the overall territory investigated which, as mentioned earlier, is a sample accounting for over 17% of the entire national surface, urbanization density has increased fivefold on average between the mid-twentieth century and the early twenty-first century, while the per capita values of the areas converted to urban functions have increased threefold.
Table 2. Territorial dispersion index of urban nucleus.

<table>
<thead>
<tr>
<th>Regions</th>
<th>Area (km²)</th>
<th>Number urbanized centers (1950s)</th>
<th>Number urbanized centers (noughties)</th>
<th>UDI (1950s)</th>
<th>UDI (noughties)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Umbria</td>
<td>8461.07</td>
<td>35,109</td>
<td>58,892</td>
<td>4.15</td>
<td>6.96</td>
</tr>
<tr>
<td>Marche</td>
<td>9749.54</td>
<td>74,487</td>
<td>87,675</td>
<td>7.64</td>
<td>8.99</td>
</tr>
<tr>
<td>Lazio</td>
<td>17,226.28</td>
<td>28,302</td>
<td>16,886</td>
<td>1.64</td>
<td>0.98</td>
</tr>
<tr>
<td>Abruzzo</td>
<td>10,830.15</td>
<td>15,366</td>
<td>6057</td>
<td>1.42</td>
<td>0.56</td>
</tr>
<tr>
<td>Molise</td>
<td>4461.03</td>
<td>5720</td>
<td>7553</td>
<td>1.28</td>
<td>1.69</td>
</tr>
<tr>
<td>Total and average</td>
<td>50,728.07</td>
<td>158,984</td>
<td>177,063</td>
<td>3.13</td>
<td>1.11</td>
</tr>
</tbody>
</table>

Table 3. The analytical result of the study for the sample of Italian regions investigated.

<table>
<thead>
<tr>
<th>Regions</th>
<th>Urbanized area 1950s (ha)</th>
<th>Urbanized area noughties (ha)</th>
<th>Difference 1950s-noughties (ha)</th>
<th>Increasing rate</th>
<th>Land uptake speed (m²/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Umbria (1956–2002)</td>
<td>15,750.51</td>
<td>30,124.74</td>
<td>14,374.23</td>
<td>0.91</td>
<td>8561</td>
</tr>
<tr>
<td>Molise (1956–2002)</td>
<td>2316.00</td>
<td>12,028.05</td>
<td>9712.05</td>
<td>4.19</td>
<td>5784</td>
</tr>
<tr>
<td>Abruzzo (1956–2002)</td>
<td>7242.98</td>
<td>36,740.00</td>
<td>29,497.02</td>
<td>4.07</td>
<td>17,568</td>
</tr>
<tr>
<td>Marche (1954–2007)</td>
<td>16,454.41</td>
<td>50,580.37</td>
<td>34,125.96</td>
<td>2.07</td>
<td>17,641</td>
</tr>
<tr>
<td>Lazio (1956–2004)</td>
<td>26,356.00</td>
<td>132,078.31</td>
<td>105,722.31</td>
<td>4.01</td>
<td>53,639</td>
</tr>
<tr>
<td>Sum and average</td>
<td>68,119.90</td>
<td>261,551.47</td>
<td>193,431.57</td>
<td>3.05</td>
<td>103,193</td>
</tr>
</tbody>
</table>

Table 4. Regional and per capita urbanization density values in the time span considered.

<table>
<thead>
<tr>
<th>Regions</th>
<th>Regional area (km²)</th>
<th>Resident inhabitants</th>
<th>Urbanization density (%)</th>
<th>Urbanization per capita (m²/inhabitant)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Umbria (1956–2002)</td>
<td>8461.07</td>
<td>803,918</td>
<td>0.019</td>
<td>195.92</td>
</tr>
<tr>
<td>Molise (1956–2002)</td>
<td>4461.03</td>
<td>406,823</td>
<td>0.005</td>
<td>56.93</td>
</tr>
<tr>
<td>Abruzzo (1956–2002)</td>
<td>10,826.99</td>
<td>1,277,207</td>
<td>0.007</td>
<td>56.71</td>
</tr>
<tr>
<td>Marche (1954–2007)</td>
<td>9727.70</td>
<td>1,362,863</td>
<td>0.017</td>
<td>120.73</td>
</tr>
<tr>
<td>Lazio (1956–2004)</td>
<td>17,206.40</td>
<td>3,340,798</td>
<td>0.015</td>
<td>78.89</td>
</tr>
<tr>
<td>Sum and average</td>
<td>50,683.19</td>
<td>7,191,609</td>
<td>0.013</td>
<td>101.84</td>
</tr>
</tbody>
</table>
It is interesting to observe that, although per capita values of urbanization were very
different in the 1950s, there was a realignment of all the regions at about 300 m²/inhabitant
in the 2000s, thus marking an urbanized area requirement constant at regional level in
contemporary society. In confirmation of this, the per capita quantity in the year 2000 has a
standard deviation of 13% of the average for the five regions, while this deviation exceeded
57% of the average in the 1950s and moreover seems to be independent from demographic
changes and the varying number of industries and services present in the regions. As a
matter of fact, in the 50 years considered, there has been substantial demographic stability
(Table 4) in Umbria, Marche, Abruzzo, and Molise (the average yearly rate is about 1‰,
while Molise touched −3%). The only region with a significant rise in population has been
Lazio (with an average yearly rate of 8%), but in this regard, it is important to clarify that for
decades the region containing Rome has received a larger number of migrants from Central
and southern Italy, attracted by the many job opportunities offered by the metropolitan area
of the capital. Despite these differences, the present-day per capita urbanization value has
reached similar levels.

The correlation analysis carried out on a municipal basis between urbanization and
population variation rates in the 50 years considered (Figure 3) still shows significant dif-
fferences between the two groups of regions Marche–Umbria and Abruzzo–Lazio–Molise.
In the first group, common aspects include the scarce dependence between the two vari-
ables ($R^2$ not greater than 0.27) and limited increase in urbanization (between 1% and
1.5%) in the case of demographic stability during that time span.

In the other three regions, the regression curve is very different: the dependence
between the variables ($R^2$ between 0.31 and 0.37) is significantly higher, while the increase
in urbanization corresponding to a zero-rate demographic rise is of about 5%. In these
cases, the angular coefficient of the regression curves is much higher, suggesting that even
modest demographic variations have been followed by significant increases in urbanized
areas. This confirms what we stated earlier regarding the ‘run-up’ phenomenon of per
capita levels of urbanization that has occurred in the group of three regions Abruzzo–
Lazio–Molise and that in half a century has led them to conform with the ‘standard’ average
level of 300 m²/inhabitant of urbanization which Marche and Umbria were far closer to
already back in the 1950s.

The regions considered are formed by 1155 municipalities of which the majority, as
evidenced by Figure 3, have witnessed a demographic decline in the 1956–2000 period.
In the entire territory examined, only two of these municipalities in the 1950s were urban-
ized beyond 20%, while approximately 700 did not even reach 1%. After the year 2000,
municipalities urbanized beyond the 20% threshold were 32, while over 350 were around
5%, and only 175 remained below the level of 1% (Figures 4 and 5).

Figure 6 shows that the phenomenon is more intense in some inland areas of Lazio and
Abruzzo, but above all along the coasts of the Tyrrhenian and Adriatic seas. Considering
a coastal strip 500 m in width, over the past 50 years, the overall urbanization growth
values along it amount to almost 350% for the Tyrrhenian side and approximately 300%
for the Adriatic side, thus evidencing the important transformations that have occurred
along the coasts. In the last post-war period, urbanization along the coastline of the Lazio
region barely exceeded 1500 ha, but the situation changed drastically after the year 2000,
when urbanized areas along the coast reached almost 5500 ha. Analyzing the 390 km
coastline of Molise, Abruzzo and Marche from a historical perspective has shown that
urbanization along the coastal strip has risen from just over 10% in the 1950s to over 30%
today, with Marche reaching a peak of 41% (Table 5). It is also interesting to note that the
daily urbanization rate of this strip over the past 50 years, assessed as surface and linear

\[
\text{Journal of Land Use Science} 151
\]
Figure 3. Correlation analysis between urban increasing rate and demographic variation rate (1950s–2000s) on a municipal basis.
distance, is very similar (about 2100 m²/day and around 2 km/year) on both the Adriatic and Tyrrhenian coasts.

In addition to the coastal strips in the regions of Central Italy, urban growth has also had a significant impact on inland low-hilly areas and basins where the main towns of the provinces are situated that have always sought economic conditions comparable to those of coastal areas (Figure 6). The policies pursued to this end for decades have always led to an excessive number of public and private services and regular incentives for residential and productive building activities, regardless of the population load and what the places in question were actually suitable for.

Regarding demographic trends, Figure 7 shows the distribution, on a municipal basis, of the values of the demo-urban increment index (DUI). This parameter has been obtained as follows:

\[
DUI = \frac{\Delta urb_{(01-51)}}{\Delta pop_{(01-51)}} \text{ (m}^2/\text{inhabitant)}
\]
Figure 4. Map of percentage of urbanization in municipalities in the 1950s.

Figure 5. Map of percentage of urbanization in municipalities in the 2000s.
where \( \Delta \text{urb}_{(01-51)} \) is the difference between urbanized areas in municipalities between the 1950s and the early 2000s and \( \Delta \text{pop}_{(01-51)} \) is the variation in the population residing in municipalities between the 1950s and the early 2000s.

Figure 7 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 consumed per inhabitant acquired by the municipality in the period considered). The map shows that average-sized and big cities are mostly in this condition (main cities of provinces or regions) and their surrounding hinterland, as well as coastal strips owing to the driving effects of agricultural, industrial, and tourist economies. Almost all the areas resulting from the aforementioned selection had DUI values at the highest levels of the assessment scale (over 500 m\(^2\)/inhabitant in urbanized surface increase).

Another index examined, complementary to the DUI, is the demo-urban contradiction index (DUC), which is calculated as follows:

\[
\text{DUC} = \frac{\Delta \text{urb}_{(01-51)}}{-\Delta \text{pop}_{(01-51)}} \quad (\text{m}^2/\text{inhabitant lost})
\]

where \( \Delta \text{urb}_{(01-51)} \) is the difference between urbanized areas in municipalities between the 1950s and the 2000s and \( -\Delta \text{pop}_{(01-51)} \) is the demographic drop in municipalities between the 1950s and the 2000s.

In this case, we selected only municipalities with a negative demographic balance between 1951 and 2001 and calculated the increase in urbanized land between the 1950s and the year 2000, later checking the quantity of the urbanized land corresponding to every
### Table 5. Differences per region in urbanized areas along coastal strips having a width of 500 m.

<table>
<thead>
<tr>
<th>Regions</th>
<th>Coastal belt area (ha)</th>
<th>Urbanized area 1950s (ha)</th>
<th>Urbanized area noughties (ha)</th>
<th>Urbanized area increasing (ha)</th>
<th>Urban % 1950s</th>
<th>Urban % noughties</th>
<th>Urban area increasing 1950s-noughties (%)</th>
<th>Land uptake speed (m²/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marche</td>
<td>8721.09</td>
<td>1414.23</td>
<td>3647.57</td>
<td>2233.34</td>
<td>16.22</td>
<td>41.82</td>
<td>257.92</td>
<td>1154.48</td>
</tr>
<tr>
<td>Abruzzo</td>
<td>6209.94</td>
<td>292.15</td>
<td>1472.18</td>
<td>1180.03</td>
<td>4.07</td>
<td>23.71</td>
<td>503.91</td>
<td>702.82</td>
</tr>
<tr>
<td>Molise</td>
<td>1782.81</td>
<td>59.87</td>
<td>272.03</td>
<td>212.16</td>
<td>3.36</td>
<td>15.26</td>
<td>454.37</td>
<td>126.36</td>
</tr>
<tr>
<td>Lazio</td>
<td>33,365.71</td>
<td>1583.26</td>
<td>5412.99</td>
<td>3829.73</td>
<td>4.75</td>
<td>16.22</td>
<td>341.89</td>
<td>2185.92</td>
</tr>
<tr>
<td>Adriatic coast</td>
<td>16,713.84</td>
<td>1766.25</td>
<td>5391.78</td>
<td>3625.53</td>
<td>10.57</td>
<td>32.26</td>
<td>305.27</td>
<td>2069.37</td>
</tr>
<tr>
<td>Tirrenian coast</td>
<td>33,365.71</td>
<td>1583.26</td>
<td>5412.99</td>
<td>3829.73</td>
<td>4.75</td>
<td>16.22</td>
<td>341.89</td>
<td>2185.92</td>
</tr>
</tbody>
</table>
inhabitant lost. The geographical outcome is extremely varied (Figure 8), but shows a significant trend toward urban growth even in places subject to major population drops, with concentrations of the highest values (over 800 m² more urbanized surfaces for every inhabitant lost) in the mid-hilly strips, but also in inland mountainous and submountainous areas. The tourist models applied to mid-mountainous areas, based on holiday homes, are certainly the main cause of this, but undoubtedly the policies pursued for decades to provide economic support to so-called ‘marginal areas’ have contributed to this too. The propensity of municipalities to collect taxes and dues to support public services is hardly negligible, but a significant thrust comes from the tendency, over the past 30 years, of privates to invest in real property to offset either reduced the economic convenience or high risks of other forms of investment.

4. Effects on landscape
An effective interpretation of landscape effects of urban sprawl over the past 50 years is the one based on the 37 types of physiographic landscape units censused by the National Institute for Environmental Protection and Research (ISPRA, 2004). In the post-war period, the ‘intramountainous plateaus’ had the highest urbanization rates, with almost 6% of artificialized land, while coastal, open, and valley-line plains were well below 2%. The urbanization analyzed at the year 2000 shows a clear reversal in the value of this index: coastal plains have soared from the previous 2% to over 16%, just like the category of coastal elevations which have seen their urbanization rate reach values in excess of 18%, while the other types of plains have increased well beyond 4% and even 5%. However, it is particularly interesting to note that the ranking of hilly areas, scarcely or not at all...
encroached upon by constructions in the 1950s, has risen. Hilly areas of all types have shown a significant increase in their urbanization rate which, from their original level ranging between 0% and 5%, now exceeds 2% by far and in some cases even 8%, that is to say closer to the values of plains.

In a country like Italy which lacks plains that may be easily saturated (approximately 23% of the national territory), these are clear signs that denote a trend of massive ‘attacks’ of hilly areas by settlements, with considerable risks of altering agricultural landscapes, among the finest in Europe, and significantly deteriorating ecosystems, since over 40% of Nature 2000 Sites of the European ecological network (SCIs) are found in hilly areas.

While in the 50 years considered, plains were replaced by settlements at an average pace of over 18 ha/day, for hilly areas the rate has been of almost 6 ha/day, but this could merely be the sign of the trigger for subsequent and more vigorous development (Figures 9–11).

Figure 12 shows a simulation made throughout the national territory by applying the urbanization rate recorded in the past 50 years in the regions studied to the landscape units (Figure 9). The results highlight national sensibility concentrated essentially in some sensitive areas which, in addition to having suffered urban events over the past 50 years, still have a significant predisposition toward additional increases even today.

5. Conclusions

The research conducted in the regions of Central Italy has highlighted some fundamental aspects: first, the average regional per capita urbanization value is about 300 m²/inhabitant for any type of territory, which suggests that this may be a standard need of present-day society. This value, reached spontaneously in half a century in various regions starting from
very diverse bases, may be considered a reference threshold for future planning beyond which other land should not be used for urban functions.

Second, we have observed that the increase in urbanized areas is scarcely correlated to demographic trends, either positive or negative. In other words, the development of urban areas over the past 50 years has been marked by a huge dispersion in diffused forms scarcely governed by interpretable rules, leading to the systematic reproduction of a city model ‘lacking town planning’.

The third point concerns the relationship with the landscape, that is to say the signs of urban sprawl from the plains to the hills with adverse effects on the agro- and ecosystems, the most valued agricultural productions and rural landscape.
In this regard, it is important to note that in Italy, the contact between city and countryside has never been clear-cut, but rather nuanced between consolidated fabric, non-consolidated fabric, dispersed and degraded fabric, urbanized countryside, and agricultural areas. The periurban areas are always marked by forms suggesting their precarious state of pre-urbanization.

These reasons have led to anarchy in the layout of Italian territories, where residential settlements are always scattered and have a chaotic and metastatic organization from a developmental point of view (Figure 13), as evidenced by the values of the UDI in the case of Marche and Umbria. The ensuing urban structure is lacking in public spaces and related services, profoundly devastating for the agricultural landscape, the integrity, and ecological efficiency of natural habitats and gradually exacerbates all the adverse effects of uncontrolled urbanization described in the Introduction to this article.

Low-density rural settlement, especially when tied to an urban lifestyle, is a source of major organizational difficulties for services and transport.

As a matter of fact, especially in Central and southern Italy, ‘hub-and-spoke’ (Babcock, 2002) public mobility models are almost inapplicable, owing to the failure to meet the necessary user and distance thresholds. A territorial organization of this kind inevitably forces the residing population to depend on private transport means, with all the ensuing consequences for environmental sustainability and quality of life.

The information emerging from this study may serve as a reference for town planning coordination tools so that they may help stabilize the amount of artificialized areas and reorganize forms and functions of urban spaces. In this respect, some positive signals come from Lombardia and Umbria regions that issued laws about regional ecological networks, where the land uptake is controlled, but with tools that should be improved (Malcevschi, 2010; Romano, 2009).
Desirable territorial governance policies should be geared mainly toward the systematic implementation of actions for the functional recovery and reconversion of abandoned urbanized areas. In order to do this, local governments need to have technical and administrative monitoring tools based on actual data on the evolution of land transformation at appropriate details scale.

Figure 12. Simulation, extended to landscape units across the national territory, of the percentage variation of urbanization calculated on the sample regions in the course of the past 50 years.
In Italy, at present these tools do not exist and every municipality works independently as far as the size and distribution of urban areas of any kind are concerned. Moreover, structured communication links between regions and municipalities about land-use changes are not formalized in current legislation.

A so disconnected land planning system makes impossible any quantitative control of transformations on a regional scale. Therefore, one of the first essential steps to be taken toward regulation involves the setting up of Regional Observatories and Land Registers which can be used to monitor the development of the phenomenon at different levels (municipal and regional) and on different scales, using advanced GIS technology.

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