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# REMOTE SENSING AND SPATIAL DATABASES FOR INVESTIGATING LATENT URBAN-RURAL DYNAMICS IN RURAL, INLAND DISTRICTS OF SOUTHERN ITALY

**VITO IMBRENDA[1,2], CASANDRA MUÑOZ GOMEZ[3]*, MARIAGRAZIA D'EMILIO[1], CATERINA SAMELA[1], LUCA SALVATI[4], NADIA MATARAZZO[5], MARIA LANFREDI[1,2], ROSA COLUZZI[1,2]**

[1]*Institute of Methodologies for Environmental Analysis, Italian National Research Council (IMAA-CNR), c.da Santa Loja snc, 85050 Tito, PZ, Italy.*

[2]*NBFC, National Biodiversity Future Center, 90133 Palermo, PA, Italy.*

[3]*National School of Earth Sciences (ENCiT) of National Autonomous University of Mexico (UNAM). Av. Antonio Delfin Madrigal 300, C.U., Coyoacán, 04510 Ciudad de México, CDMX, México.*

[4]*Department of Methods and Models for Economics, Territory and Finance (MEMOTEF), Faculty of Economics, Sapienza University of Rome, Via del Castro Laurenziano 9, 00161 Rome, RM, Italy.*

[5]*Department of Economic and Statistical Sciences, University "Federico II", Naples, Italy.*

**ABSTRACT.** It is well-known that rural-urban patterns help to capture socioeconomic interactions between different settlement forms. The sustainability challenge requires to consider the evolution of these patterns as a reliable indicator of the dynamics of land use change and potential land degradation processes occurred in a time frame. In this research, by using multisource data (Corine Land Cover, Keyhole KH-9 and Landsat satellite images), we trace the diachronic evolution (1990-2018) of the rural-urban pattern in the provinces of Avellino and Benevento (Campania region, Southern Italy) with a specific focus on the key municipality of Ariano Irpino (1975-2018). The analysis confirms the considerable urban growth occurred in the study area, mostly in the form of urban sprawl phenomena decoupled from population growth. This happens concurrently with a transformation of the agricultural sector projected toward a greater specialization favouring agritourism activities and valuable crops (e.g., vineyards). These findings can support policy makers in future planning activities by mixing conservation, mitigation, and restoration actions.

## *Sensores remotos y bases de datos espaciales para la investigación de la dinámica urbana-rural latente en distritos rurales del interior de Italia meridional*

**RESUMEN.** El uso de patrones rurales-urbanos es una herramienta bien conocida que nos ayuda para capturar interacciones socioeconómicas entre distintas formas de asentamientos. El desafío de la sostenibilidad requiere considerar la evolución de estos patrones como un indicador fiable de la dinámica del cambio de uso de suelo y los posibles procesos de degradación ocurridos en un marco de tiempo. En esta investigación, utilizando datos de múltiples fuentes (imágenes de satélite Corine Land Cover, Keyhole KH-9 y Landsat), se trazó la evolución diacrónica (1990-2018) del patrón rural-urbano en las provincias de Avellino y Benevento (región de Campania, Sur de Italia) con un enfoque específico en el municipio clave de Ariano Irpino (1975-2018). El análisis confirma el considerable crecimiento urbano ocurrido en el área de estudio, principalmente en forma de fenómenos de expansión desacoplados del crecimiento demográfico. Esto ocurre simultáneamente con la trasformación del sector agrícola proyectada hacia una mayor especialización favoreciendo actividades de agroturismo y cultivos valiosos (p. ej., viñedos). Estos hallazgos pueden ayudar a los formuladores de políticas en futuras actividades de planificación al combinar acciones de conservación, mitigación y restauración.

**Keywords**: Rural-urban pattern, urban sprawl, inner areas, remote sensing, Corine Land Cover.

**Palabras clave:** Patrones urbano-rurales, expansión urbana, áreas internas, sensores remotos, Corine Land Cover.

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***Corresponding author:** Casandra Muñoz Gomez. National School of Earth Sciences (ENCiT) of National Autonomous University of Mexico (UNAM). Av. Antonio Delfín Madrigal 300, C.U., Coyoacán, 04510 Ciudad de México, CDMX, México. E-mail address: casandragomez@encit.unam.mx

## 1. Introduction

Rural-urban is a lexical dichotomy traditionally used to indicate the complex relationships among rural and urban areas, considered as two different models of territorial organization and socio-economic context. Therefore, understanding both rural and urban areas is pivotal towards sustainable land use development (Van Vliet *et al.* 2020). Dynamics involving rural and urban areas have resulted in deep transformations of landscapes over time with significant side effects from a socio-economic and cultural point of view. Van Noorloos *et al.* (2018) point out that we need to identify in more detail the indirect and long-term effects that urban land investments have on livelihoods as well as the differentiation and complexity of these effects for different actors. The initial, striking dualism, conceiving urban and rural areas as two opposing socio-economic realities with different functional and spatial configurations, has then been replaced by an approach looking at their complementarity and subsidiarity in pursuing a sustainable development of territories. It is important that the ideas that inform rural-urban understanding today capture the abstract yet experientially recognizable spatialities that reflect human's interactions with the physical land (Dymitrow and Stenseke, 2016).

In particular, nowadays, the challenge of sustainability suggests looking at the evolution of the rural-urban pattern as an effective indicator of land cover dynamics, useful for highlighting inequalities and vulnerabilities of various geographical contexts and for indicating the most appropriate actions to preserve soil surface against sealing and contamination and its numerous environmental and socio-economic functions (Blum, 2005; EC, 2006; Carlucci *et al.,* 2018). As a matter of fact, the rural-urban migration, the expansion of urbanized areas and the simultaneous exacerbation of climate change (Wang *et al.,* 2020; Nickayin *et al.,* 2021; Zasada *et al.,* 2013; Coluzzi *et al.,* 2020; Lanfredi *et al.,* 2020; Zambon *et al.,* 2018) can cause changes on a local and global scale in several ways (Tas and Lightfoot, 2005; Sailor, 2014; Telesca *et al.,* 2009; Biasi *et al.,* 2015). Among them, they can influence the disaster risk and the vulnerability or exposure of the population to them, including escalation of environmental degradation (D'Emilio *et al.,* 2018; Barakat *et al.,* 2019; Horion *et al.,* 2019; Yu *et al.,* 2021; Samela *et al.,* 2022a; Kosmas *et al.,* 2016), change of hydrological processes with consequent rise in flood risk (Samela *et al.,* 2020; Samela *et al.,* 2022b), risk of extreme weather and geological events due to increased population vulnerability and concentration and, at times, reduced resilience (Lankao and Qin, 2011).

In this scenario, in the last decades, the international community and the European Union have repeatedly stressed the importance of protecting soil, environmental heritage and landscape by issuing specific directives (e.g., Habitats Directive, Water Framework Directive, European Landscape

Convention, etc.) and have also set strategic goals to reach within specific time frames: a state of land degradation neutrality (LDN) on a global scale by 2030 (UN, 2015) and the reduction to zero of net land take by 2050 (EC, 2016). Every nation joining the Conventions is required to meet these objectives. In this context, especially for the second target, also Italy should promote a considerable effort since it must reverse a long-standing trend of continuous and significant growth in land consumption from the 1950s to today (about 180%, see e.g., Romano and Zullo, 2014; Bimonte and Stabile, 2017; Munafò, 2019; Bianchini *et al.,* 2021) which currently places the nation in the list of European countries with the highest percentage of land consumption in relation to the surface area (Marchetti *et al.,* 2017). In addition, a tendential contraction of agricultural areas has been recorded since the 1960s (Congedo *et al.,* 2017) which testifies how the natural capital of Italy is progressively decreasing, with consequent negative impacts on the quality of environment and landscape (e.g., land degradation, see Salvati *et al.,* 2012; Recanatesi *et al.,* 2016; Imbrenda *et al.,* 2022; Lanfredi *et al.,* 2022; Rodrigo-Comino *et al.* 2022; Nickayin *et al.,* 2022) and in terms of socio-economic disparities (Salvati and Zitti, 2007; Salvati and Zitti, 2009). These impacts generally affect the urban-rural fringe in the world, which is among the most ecologically vulnerable areas due to its peculiarities of transition space (Goodarzi *et al.,* 2019; Zhou *et al.,* 2020; Coluzzi *et al.,* 2022; Zambon *et al.,* 2017).

Paying attention to the wide debate on land consumption in Italy, the analysis of the phenomenon of urban sprawl is recently conquering a primary role (Bencardino, 2015; Cecchini *et al.,* 2019). Urban sprawl, fuelled by economic growth (Di Feliciantonio *et al.,* 2018), is notoriously characterized as a highly dispersed settlement model with low or very low density, implying a considerable loss of soil (Bruegmann, 2005; Marquard *et al.,* 2020; Ciommi *et al.,* 2018; Ciommi *et al.,* 2019) with detrimental implications on water and soil management (Chelleri *et al.,* 2019; Duvernoy *et al.*, 2018; Perrin *et al.,* 2018; Salvati *et al.,* 2008). The concept of urban sprawl was born in the second half of the twentieth century in the U.S.A., where cities had predominantly assumed suburban forms as opposed to the European ones which tended to be dense and compact (Barattucci, 2004; Salvati, 2014; Salvati *et al.,* 2019; Salvati *et al.,* 2013). In recent years, the American model has influenced also Europe and Italy, first affecting large cities and gradually involving the urban forms of small towns so much that, currently, these show land consumption rates per new inhabitant higher than those of large cities (Bonora, 2013).

Small towns in Italy, especially those of Southern regions, are mostly characterized by a demographic decline and economic marginalisation, falling into the so-called "inner areas" for which Territorial Cohesion Agency has recently launched a specific Strategy (National Strategy for Inner Areas 2014-2020 and 2021-2027). This is aimed at mobilizing the huge potential of these areas by breaking isolation constraints to make them economically attractive (Carlucci and Lucatelli, 2013) and rebalance in a polycentric direction the development of marginal areas. Therefore, we conducted a research focused on two provinces (NUTS-3 - Nomenclature of territorial units for statistics - Level 3) of Southern Italy: Avellino and Benevento belonging to the Campania Region (NUTS-2) including a large number of municipalities falling in the “inner areas”. Territorial databases and satellite images were used for the multitemporal reconstruction (1990-2018) of the rural-urban pattern in both regions. A specific focus has been dedicated on some emblematic municipalities, such as the case of Ariano Irpino (province of Avellino) for which the diachronic analysis was extended to the period 1975-2018. The opportunity offered by remote sensing products and derivatives to look back in time and follow the evolution of specific environmental or anthropogenic phenomena, allowed us to highlight some issues common to the two provinces. We expect to be able to provide decision-makers with relevant information useful for preparing more effective territorial planning and to identify the best mitigation/recovery solutions against the challenge “urban sprawl”.

## 2. Methodology

### *2.1. Study area*

The study area are the provinces of Avellino and Benevento (Campania region, Southern Italy), characterized by the presence of many municipalities belonging to the inner areas, with a low infrastructural level and a rugged topography (Table 1 and Fig. 1).

*Table 1. Main demographic features of the investigated areas*

| Name of the administrative unit | Surface area (km²) | Inhabitants (01/01/2019) | Population density (in./ km²) | Number of Municipalities |
|---|---|---|---|---|
| Province of Avellino | 2 806,07 | 418 306 | 149,07 | 118 |
| Province of Benevento | 2 080,44 | 277 018 | 133,15 | 78 |
| Municipality of Ariano Irpino | 186,70 | 21 756 | 116,53 | - |

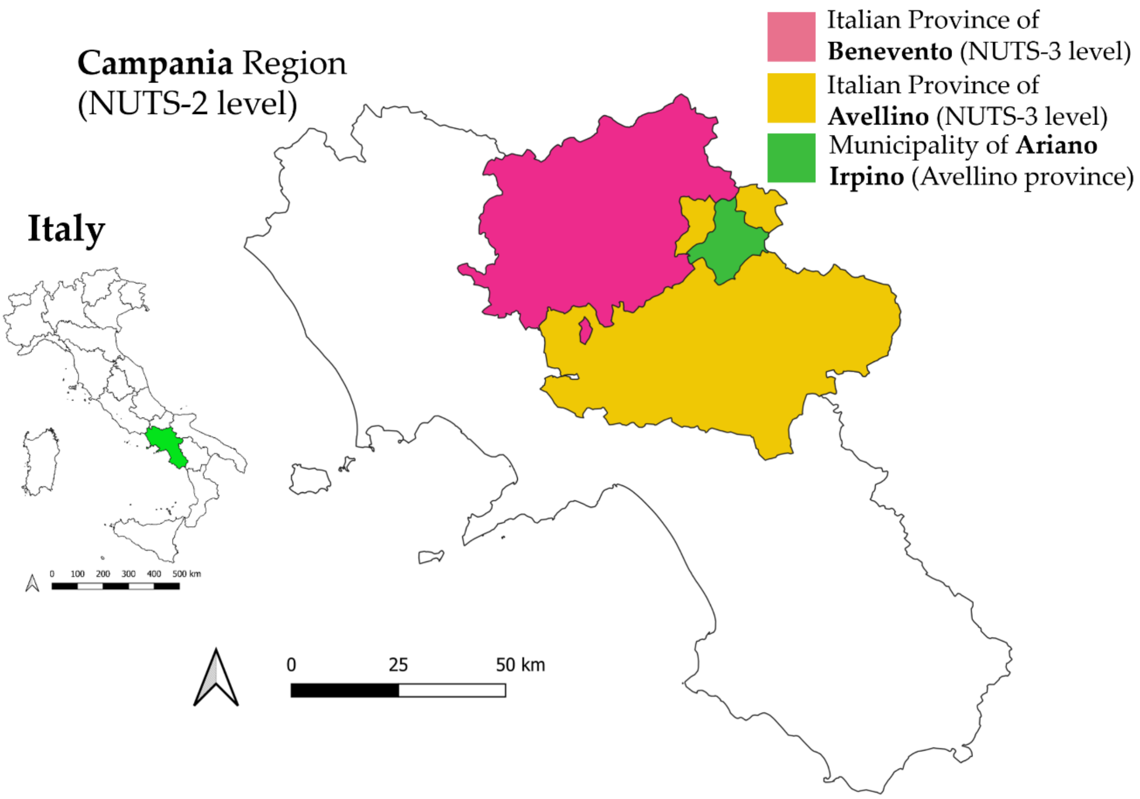


*Figure 1. Study area. Italian Provinces of Benevento and Avellino corresponding to the NUTS-3 and the municipality of Ariano Irpino (Avellino) belonging to the Campania region (NUTS-2).*

### *2.2. Data*

The availability of multitemporal satellite data derived from different sensors represents a valuable tool for the characterization of landscape changes (Bajocco *et al.,* 2015). In this study, a satellite image acquired by the Keyhole KH-9 (belonging to the CORONA program providing imagery deployed by USA for espionage purposes) and NASA (National Aeronautics and Space Administration) Landsat images were processed for the analysis of land cover changes (following the methods explained by Song *et al.,* 2015; Fekete, 2020; Simoniello *et al.,* 2015; Bajocco *et al.,* 2016). The CORONA program, designed and used between the 60s and 70s of the last century, has recently been declassified allowing access for non-military purposes and users. It provides high resolution data (with a pixel size resolution up to 1.80 meters) with a wide spatial coverage (some missions have frames covering strips up to 250 km long), which can be purchased at low cost with respect to other similar products (Stratoulias, 2020). Landsat data, on the other hand, are among the first sources of medium-resolution multispectral images with global coverage: the first satellite of the Landsat mission was launched into orbit in 1972 and carried the Multispectral Scanner-MSS sensor with 80m of spatial resolution (see e.g., Irons *et al.,* 2012; Quaranta *et al.,* 2020). Since 2013, Landsat 8 data are available with a 30-m spatial resolution, and they are distributed free of charge (Fig. 2). Finally, high-resolution satellite images available in Google Earth have been used for the analysis of the current land cover conditions in the study area.

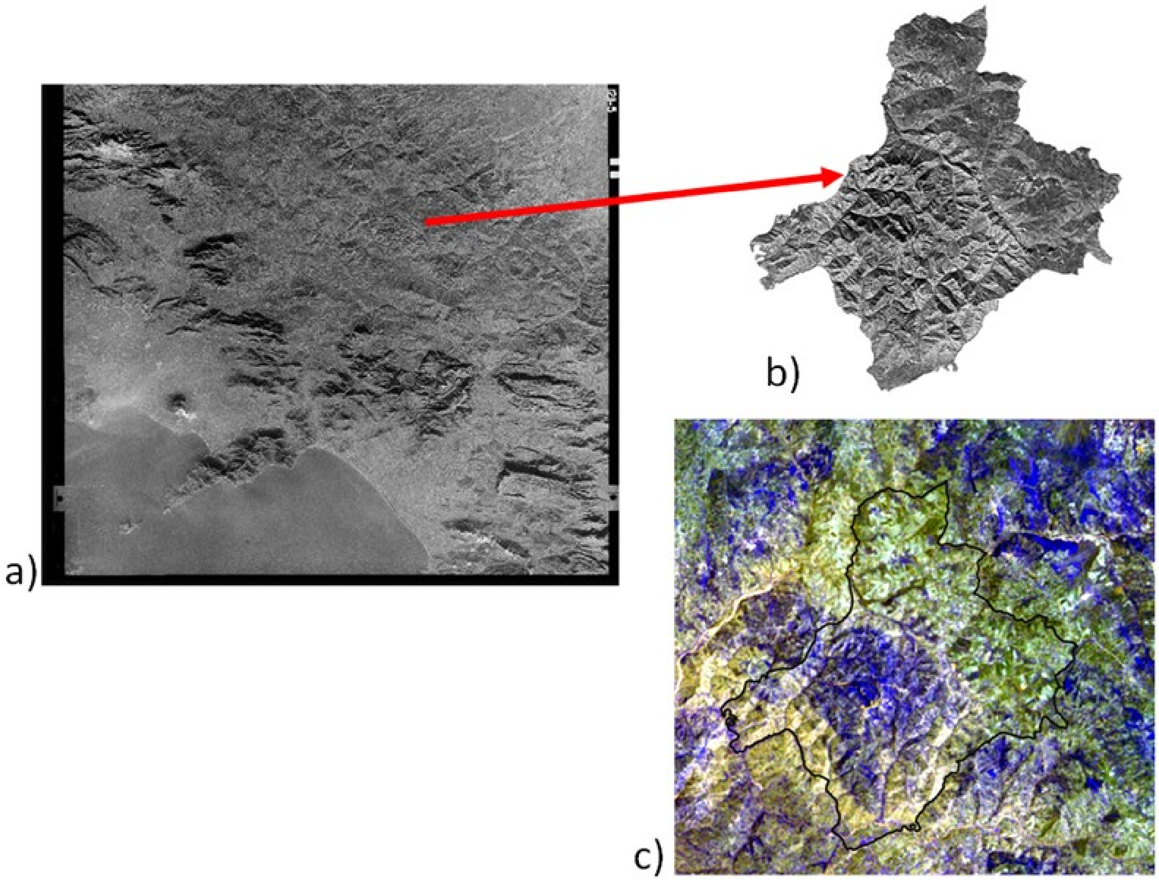


*Figure 2. (a) Satellite image acquired by Keyhole KH-9 on 29/12/1975 including areas of the provinces of Benevento and Avellino; (b) municipal area of Ariano Irpino cropped from the Keyhole KH-9 image; (c) Landsat MSS satellite image acquired on 16/07/1975 including the municipality of Ariano Irpino, false-colour composition (black lines represent the municipal boundaries).*

The database of Corine Land Cover (CLC) project has also been used in this study (Büttner *et al.,* 2002). The CLC inventory was born at a European level mainly to detect and monitor land cover/land use features and changes, with the aim of supporting the nations involved in many applications (environmental, agricultural, ecological, planning, etc.). The first structuring of the CLC project dates to 1985 when the Council of the European Community through Decision 85/338/EEC launched the so-called CORINE (COoRdination of INformation on the Environment) program to provide Member States with homogeneous territorial information on the state of the environment. The first CLC was issued in 1990, while updates have been released in 2000, 2006, 2012, and 2018. The National Reference Centers Land Cover (NRC/LC) group of the Eionet (European Environment Information and Observation Network) belonging to the European Environment Agency (EEA) took care of the elaboration. The 2012 version was the first to include CLC time series into the Copernicus program, thus ensuring sustainable funding for the future. Finally, the 2018 version was produced using Sentinel-2 satellite data (10-m spatial resolution). In this research, the 1990 and 2018 CLC maps were used at the third level, which includes a total of 44 classes (see next Figures) with a minimum cartographic unit (MCU) of 25 ha and an accuracy of approximately 85% (Diaz-Pacheco and Gutiérrez, 2014; Ahrens and Lyons, 2019; Cieślak *et al.,* 2020).

### *2.3 Methods*

For the study of the rural-urban pattern, all the different information layers (indices or maps obtained from the analysis of satellite data and territorial databases) have been organized in a GIS (Geographic Information System) environment. Specifically, CLC layers have been analysed using zonal statistics tools included in the free and open-source software QGIS. As regards remote sensing data, a Keyhole KH-9 image acquired on 29/12/1975 and a Landsat MSS2 image acquired on 16/7/1975 were used. On the first, after a pre-processing for geo-referencing the image, the urban areas have been identified through photointerpretation. Through the analysis of multispectral Landsat image, the vegetation cover areas have been identified by estimating the Normalized Difference Vegetation Index (NDVI), defined as follows:

$$NDVI = \frac{\rho_{nir} - \rho_{red}}{\rho_{nir} + \rho_{red}}$$

where $\rho_{nir}$ e $\rho_{red}$ stand for the spectral reflectance measurements acquired in the near-infrared (NIR) and RED (visible) regions respectively, corresponding to different segments of the electromagnetic spectrum. This index is a proxy of the vegetation vigor, density and overall health of the examined covers (Rouse, 1973; Bonfiglio *et al.,* 2002). To capture land cover changes that took place between 1975 and 2018 in the municipality of Ariano Irpino, the 1975 land cover map and 1990 and 2018 CLC maps have been compared. The 1975 land cover map has been produced by using the Keyhole KH-9 and Landsat satellite images, while the 1990 and 2018 CLC maps have been used in a simplified version by merging the Level-3 classes into the following macro-categories: vegetation, agricultural areas/bare soil and urban areas.

## 3. Results

### *3.1. Province of Benevento*

The multitemporal analysis of the CLC (1990-2018) for the Province of Benevento (Fig. 3) shows a considerable increase of urbanized areas of 2,428 hectares, which corresponds to a percentage growth of over 45%. This amplifies the weight of impermeable surfaces with respect to the entire provincial extent (from 2.59 % in 1990 to 3.76% in 2018, see Figs. 3 and 4).

Indeed, the most alarming fact is the increase in the contribution of the discontinuous urban fabric on the overall sealed surfaces, which goes from about 68% in 1990 to about 86% in 2018, confirming the expansion of low-density settlements (Bencardino and Valanzano, 2015). Concurrent to the phenomenon of land consumption, a demographic contraction of about 4.5% (population goes from 292,175 in 1990 to 279,127 in 2018) is recorded in the period considered accompanied by no changes in the extent of the main agricultural covers (surface variations for each crop type are below 1%).

In particular, this last phenomenon is also characterized by a tendency towards a lower specialization evidenced by the reduction of non-irrigated arable land (class 211), orchards (class 222) and olive groves (class 223) and an increase in the CLC classes defined as "heterogeneous agricultural areas", such as *complex cultivation patterns* (Class 242) *and land principally occupied by agriculture, with significant areas of natural vegetation* (Class 243). Given the endemic crisis that has hit the primary sector in recent years, these findings also reveal a transition phase of local agricultural entrepreneurship. It seems that farming entrepreneurs were more interested in differentiating the nature of investments on different types of crops in order to lower the risk threshold of the economic enterprise (Figs. 3 and 4). As an example of the dynamics observed, we report the case of San Bartolomeo in Galdo, a municipality of 4,644 inhabitants in 2018, whose land use trend at the municipal scale shows the same tendency seen at the provincial scale. The strong demographic decrease (about -27% in the period 1990-2018) is coupled with a considerable urban growth (+55 hectares corresponding to an increase of over 85%) with the contribution of the discontinuous urban fabric on the total urban coverage that rises from 65% in 1990 to 76.6% in 2018 (Fig. 5).

The agricultural component also follows the trend observed at the provincial scale. There is a substantial conservation of the overall agricultural areas, which are mainly destined to mixed crops including, in addition to traditional arable land, also perennial crops (especially olive groves) and stable meadows.

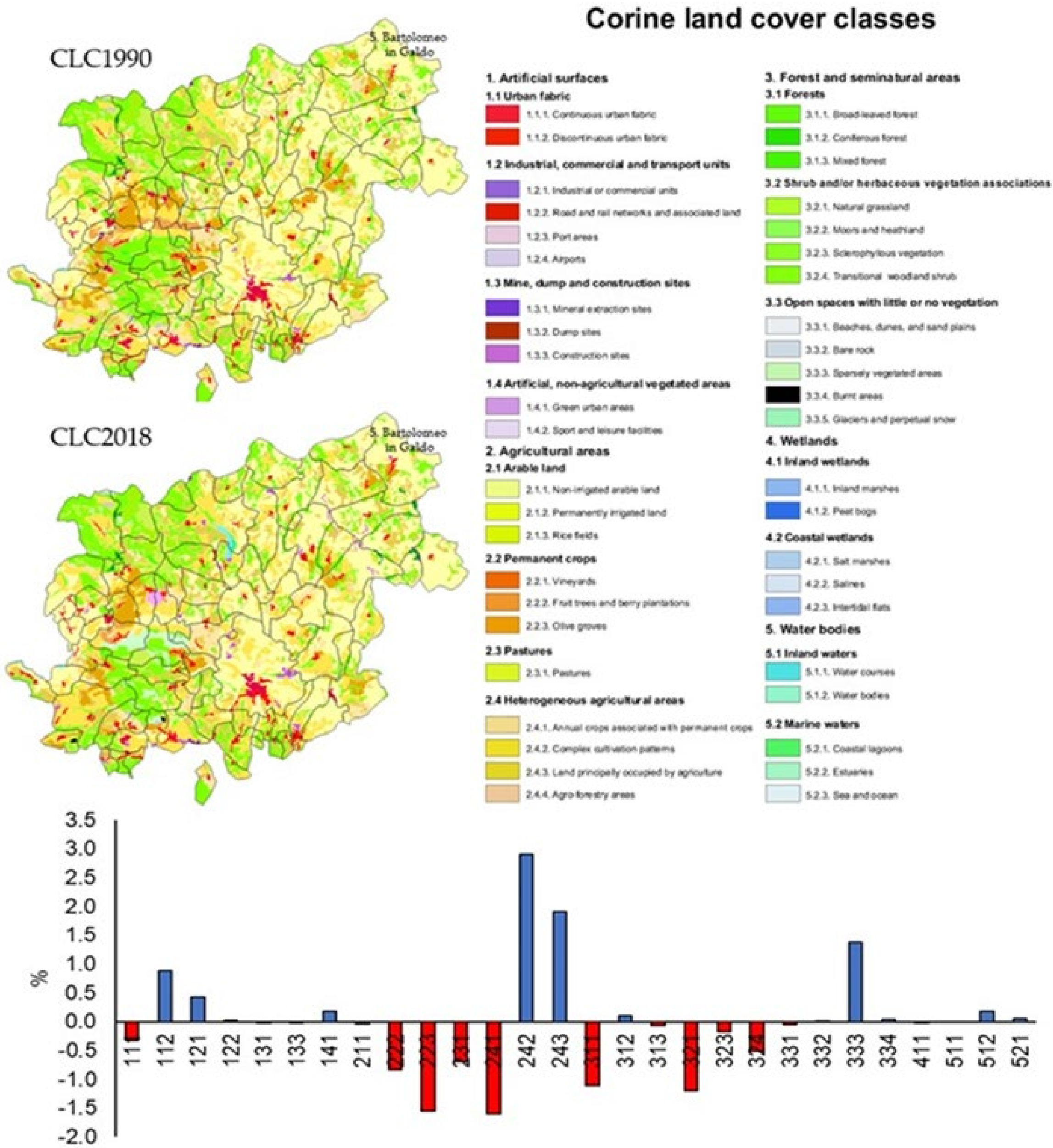


*Figure 3. 1990 and 2018 CLC maps of the Province of Benevento (the legend is extracted from Copernicus site, https://land.copernicus.eu/Corinelandcoverclasses.eps.75dpi.png/view) and percentage variations for CLC classes (level 3) observed in the period 1990-2018 for the Province of Benevento.*

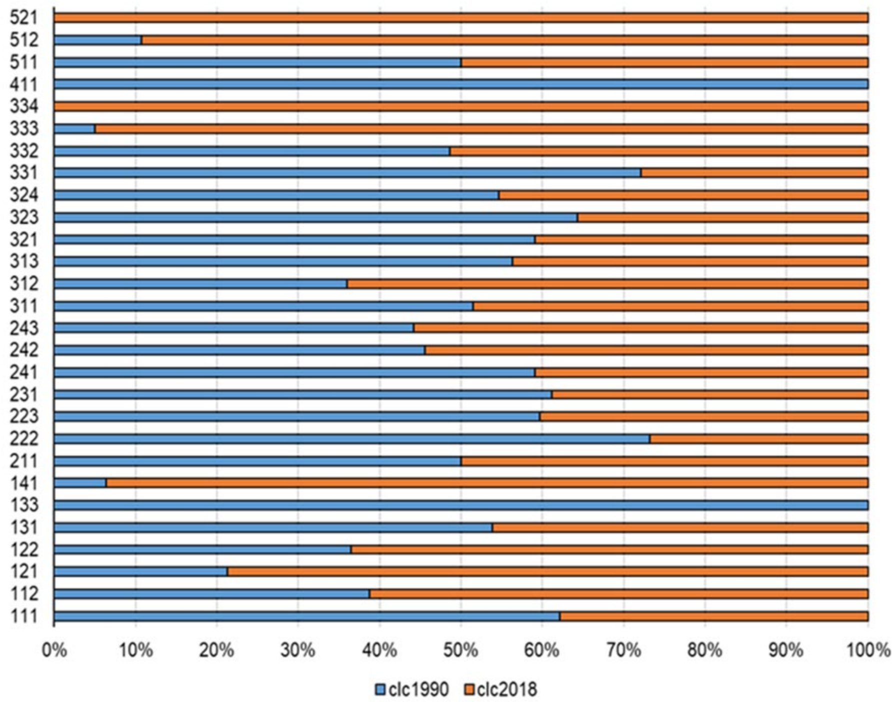


*Figure 4. Proportion of CLC classes (level 3) identified between 1990 (in blue) and 2018 (in orange) in the province of Benevento. See the legend of figure 3 to know the correct code.*

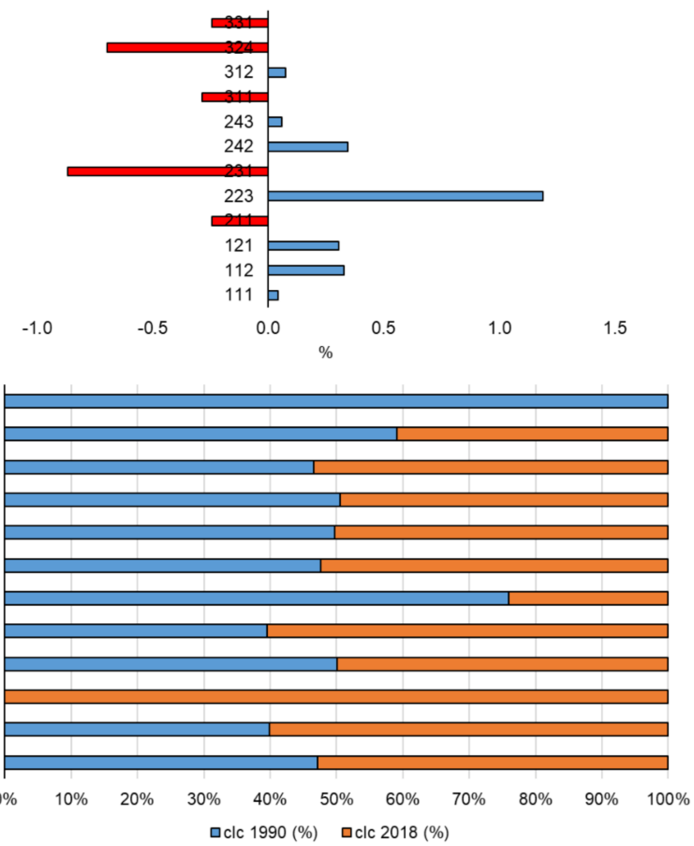


*Figure 5. Percentage differences for CLC classes (level 3) observed in the period 1990-2018 for the municipality of San Bartolomeo in Galdo and proportion of CLC classes (level 3) between 1990 (blue) and 2018 (orange) in the municipality of San Bartolomeo in Galdo. See the legend of figure 3 to know the correct code.*

## *3.2. Province of Avellino*

The multitemporal analysis of the CLC (1990-2018) for the Province of Avellino (Fig. 6) highlights an increase in urbanized areas of 3,896 ha, corresponding to a percentage growth of over 31%. The overall weight of the sealed areas with respect to the overall surface of the Avellino Province goes from 3.1% in 1990 to 4.5% in 2018. Also in this case, the already prevalent contribution of the discontinuous urban fabric on the total urban surface (75.3% in 1990) increases further (80.8%) in 2018 (Figs. 6 and 7). This accounts for a territorial structure that had a dispersive configuration since the 90s, which further consolidated in the last thirty years. In parallel with this phenomenon of land consumption, there is a demographic contraction of about 4.4% in the period considered (population goes from 437,131 in 1990 to 418,306 in 2018) and a sort of agricultural stasis with a modest increase in areas devoted to agriculture (+ 2.1% in the period considered) with a very limited variations in the surfaces of the individual

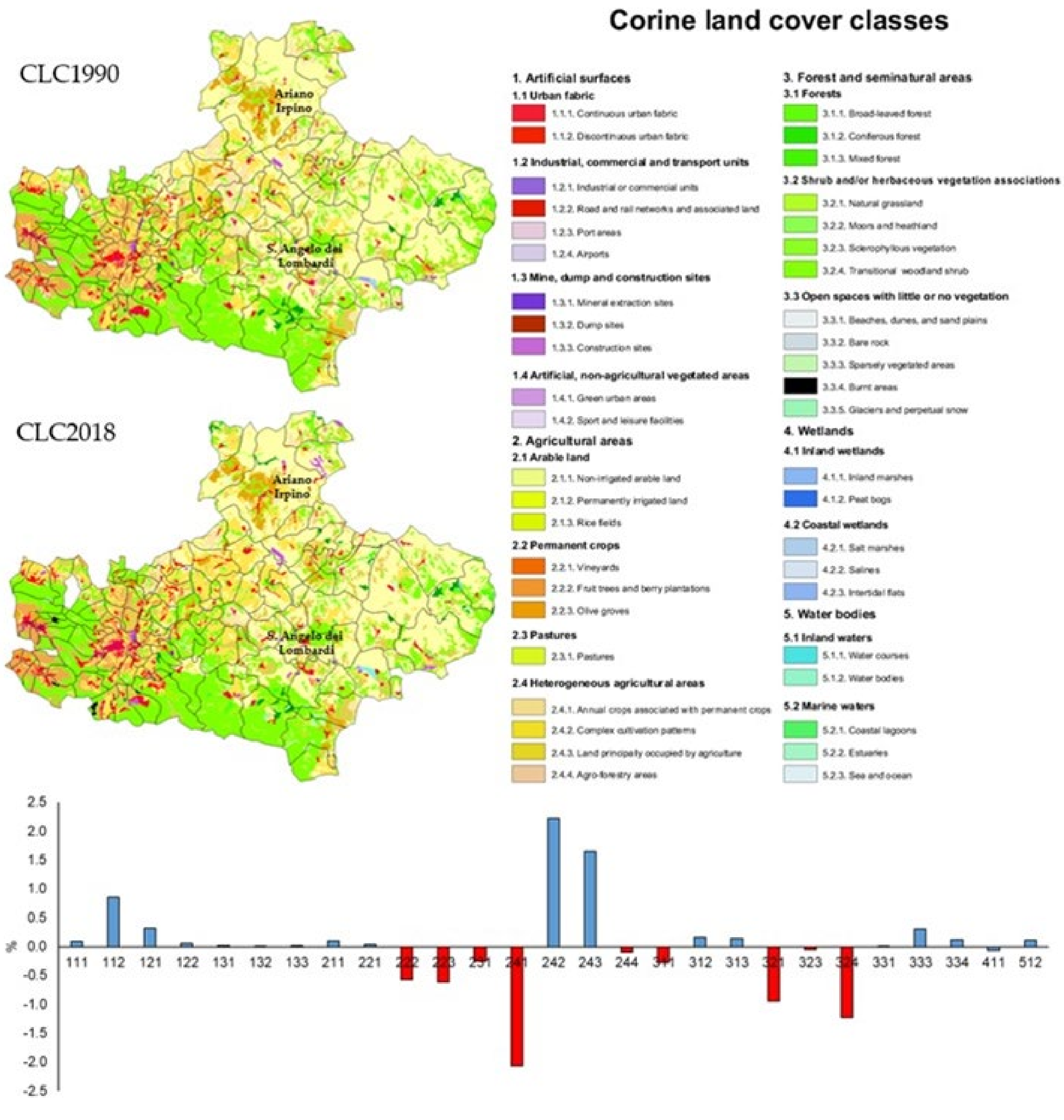


*Figure 6. 1990 and 2018 CLC maps of the Province of Avellino and percentage variations for CLC classes (level 3) observed in the period 1990-2018 for the Province of Avellino.*

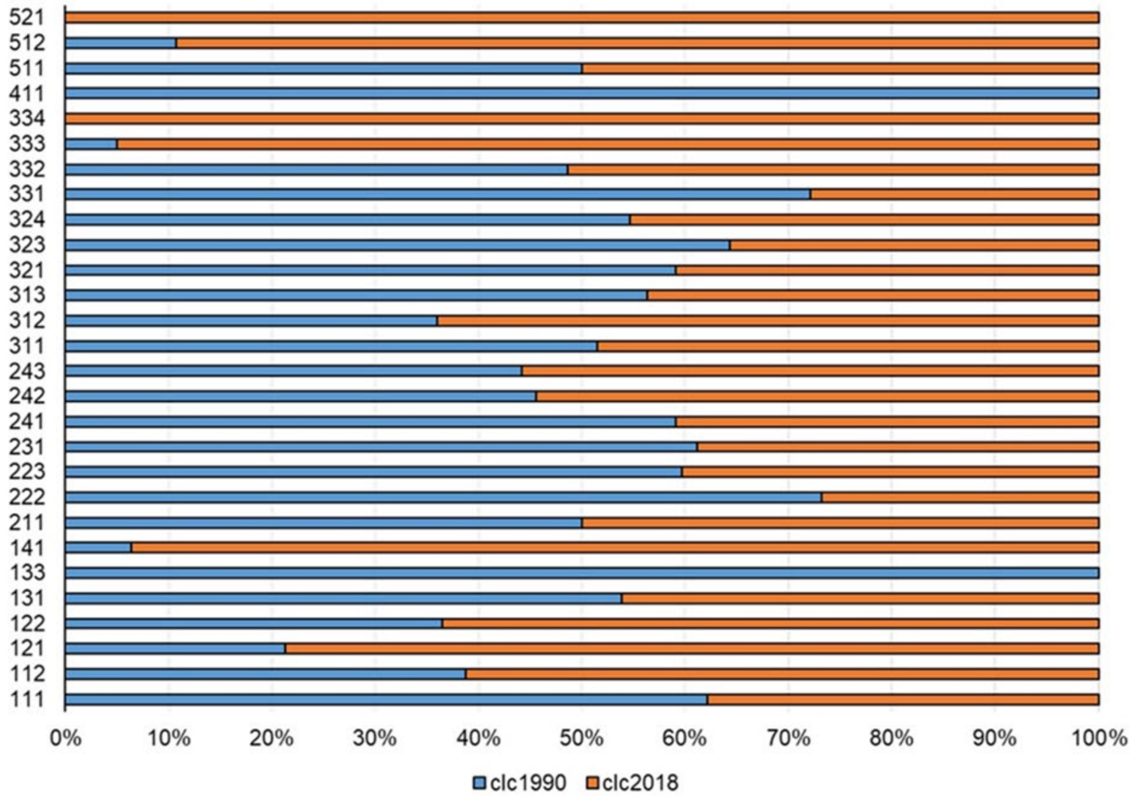


*Figure 7. Proportion of CLC classes (level 3) between 1990 (in blue) and 2018 (in orange) for the Province of Avellino. See the legend of figure 6 to know the correct code.*

crops (less than 2.3%). Specifically, non-significant transformations have interested areas within perennial crops (slight growth of orchards and olive groves to the detriment of vineyards) and heterogeneous agricultural classes (CLC 241-242-243-244).

As an example of the phenomena observed in the entire province of Avellino, we report the case of Sant'Angelo dei Lombardi, a municipality of 4,928 inhabitants in 1990 and 4,173 inhabitants in 2018. Despite the significant demographic contraction (about 15%), the sealed surfaces grow significantly (+73.7 ha corresponding to an increase of over 63%) with the contribution of the discontinuous urban fabric on the total urban coverage that goes from 69.7% in 1990 to about 100% in 2018. In other words, the whole town of Sant'Angelo dei Lombardi is characterized by a fragmented pattern of settlement which is typical of urban sprawl (Fig. 8).

As regards the agricultural component, very limited variations can be noted also in this specific case, with the reduction of class 211 (arable land), 231 (stable meadows), and 241 (annual crops associated with permanent crops) and a slight increase in 242 (crop systems and complex parcels) and 243 (areas mainly occupied by agricultural crops with the presence of important natural spaces).

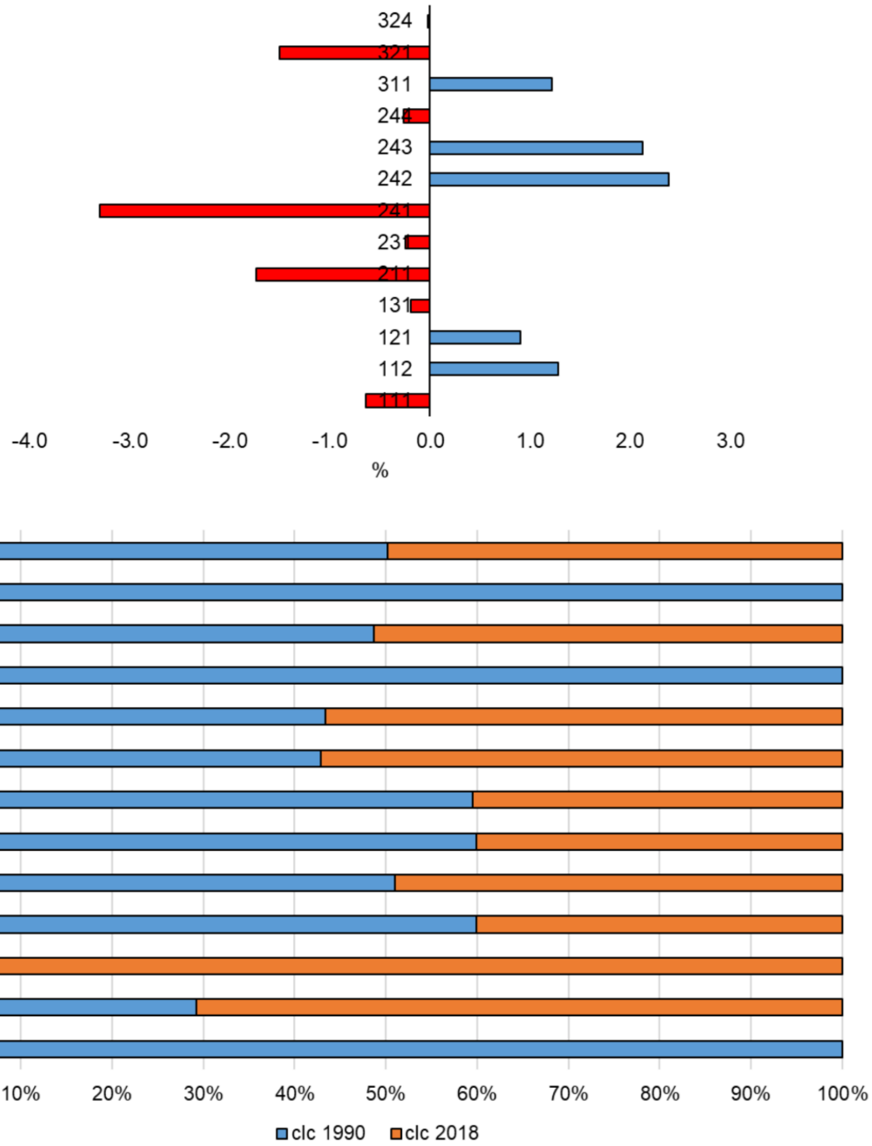


*Figure 8. Percentage differences for CLC classes (level 3) observed in the period 1990-2018 for the municipality of Sant' Angelo dei Lombardi (Province of Avellino) and proportion of CLC classes (level 3) between 1990 (in blue) and 2018 (in orange) for the municipality of Sant' Angelo dei Lombardi (Province of Avellino). See the legend of figure 6 to know the correct code.*

### 3.3. A focus on the municipality of Ariano Irpino

A detailed study has been carried out on the municipality of Ariano Irpino. Thanks to Keyhole KH-9 and Landsat historical satellite images, it has been possible to reconstruct the land cover map for 1975 (Fig. 9). The comparison between this map and the CLC 2018, after merging classes (the macro-categories are vegetation, agricultural areas/bare soil and urban areas), shows that the area was affected by an extraordinary increase in urbanized surfaces (about +175%) mainly concentrated in the period 1990-2018. Consequently, natural surfaces have undergone a considerable decrease (about -78%) over the entire period with a high rate of decrease in the time window 1975-1990 and a very low rate in the subsequent period 1990-2018 (Fig. 9). Finally, agricultural areas grow of about 29% in the period 1975-2018, but it worth noting that the entire expansion phase is limited to the first fifteen years, while the subsequent time segment (1990-2018) is characterized by an essential stability.

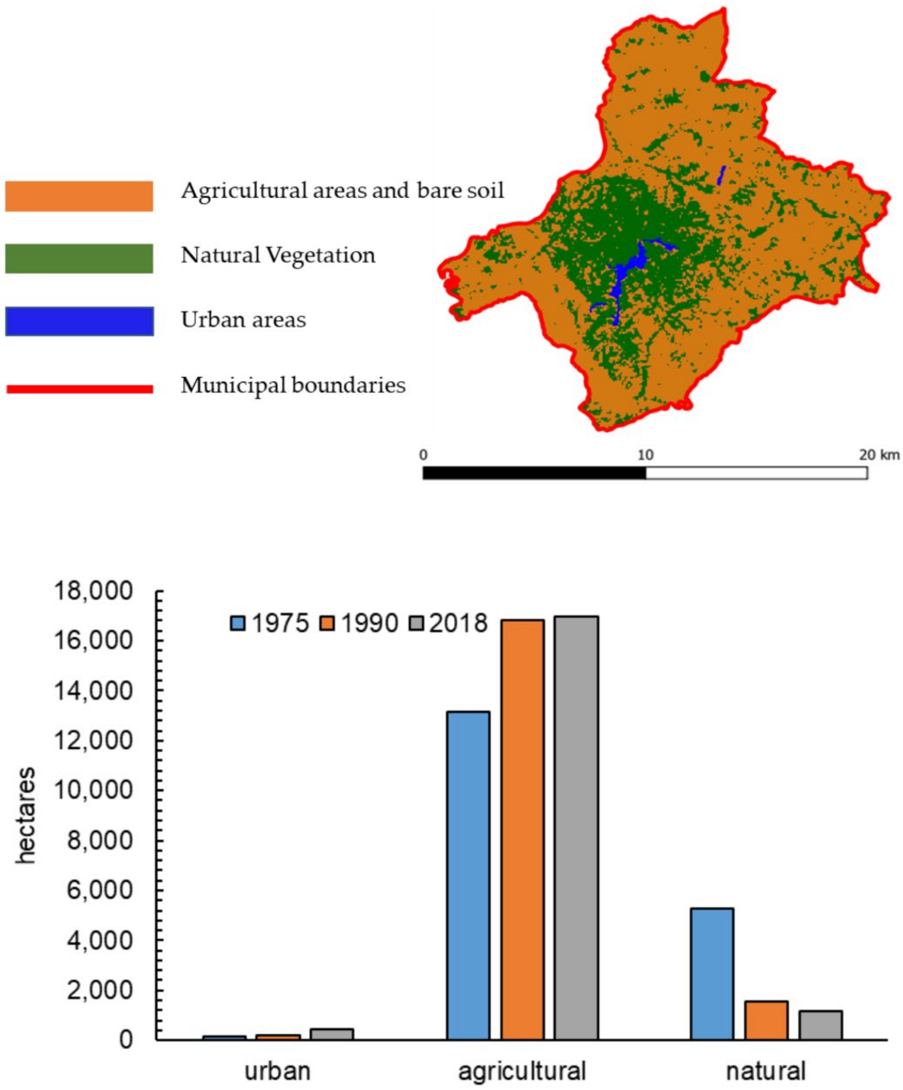


*Figure 9. Ariano Irpino land cover map relative to the year 1975 extrapolated by processing the Keyhole KH-9 and Landsat MSS satellite data and diachronic trend of the main land cover (urban areas, agricultural and natural areas) in Ariano Irpino in the period 1975-2018.*

The detailed analysis of the land cover carried out for the period 1990-2018 using the CLC maps (Fig. 10) suggests a further strengthening of the sprawl phenomenon, since the weight of the discontinuous urban fabric on the entire sealed surface increases from 79.5 % to 89.5%.

Furthermore, as observed in Figures 11 and 12 the urban surface in 2018 is largely made up (56.3%) of areas that were agricultural lands in 1990, while only 41.9% of the current urban area has conserved the same land use of 1990. Finally, 72% of the agricultural-urban transition formed new discontinuous urban fabric. Regarding agricultural areas, there are no significant variations. As usual, the trend is towards a reduction in arable land (class 211), olive groves (class 223) and annual associated with permanent crops (class 241), with an increase in the class 243 (agricultural crops with the presence of important natural spaces) with a more considerable presence of natural vegetation within heterogeneous agricultural areas.

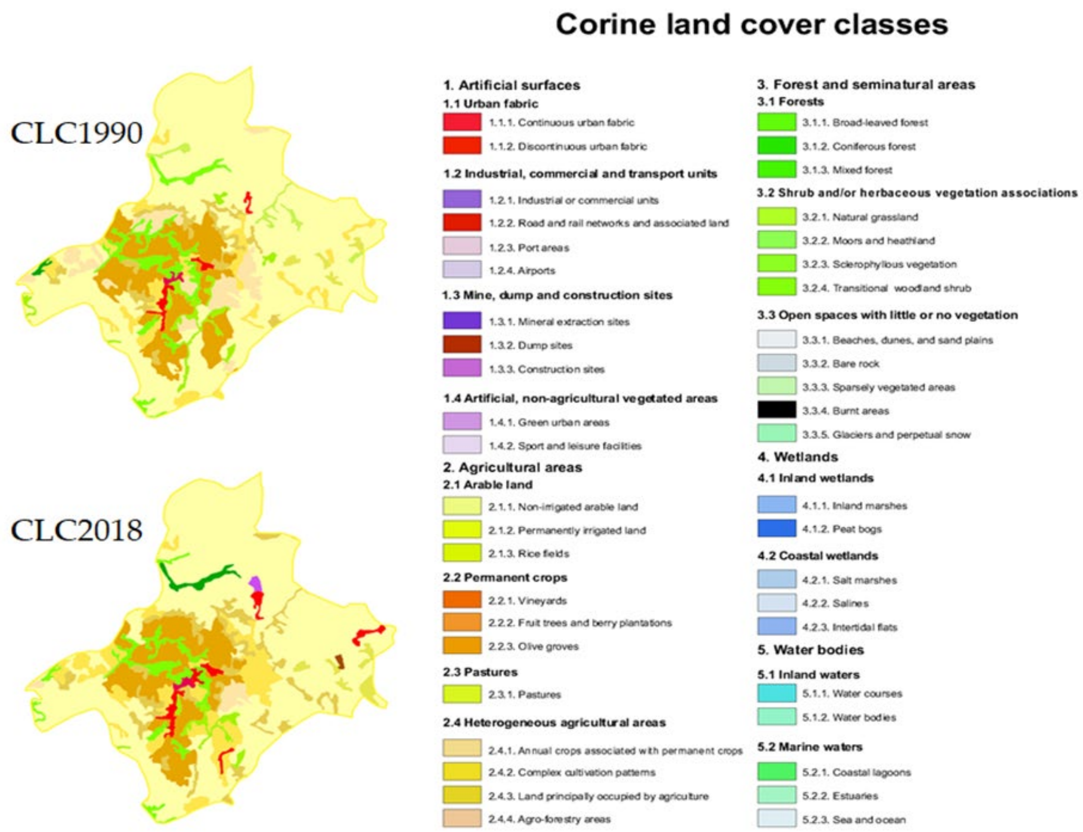


*Figure 10. 1990 and 2018 CORINE Land Cover (CLC) maps of the municipality of Ariano Irpino.*

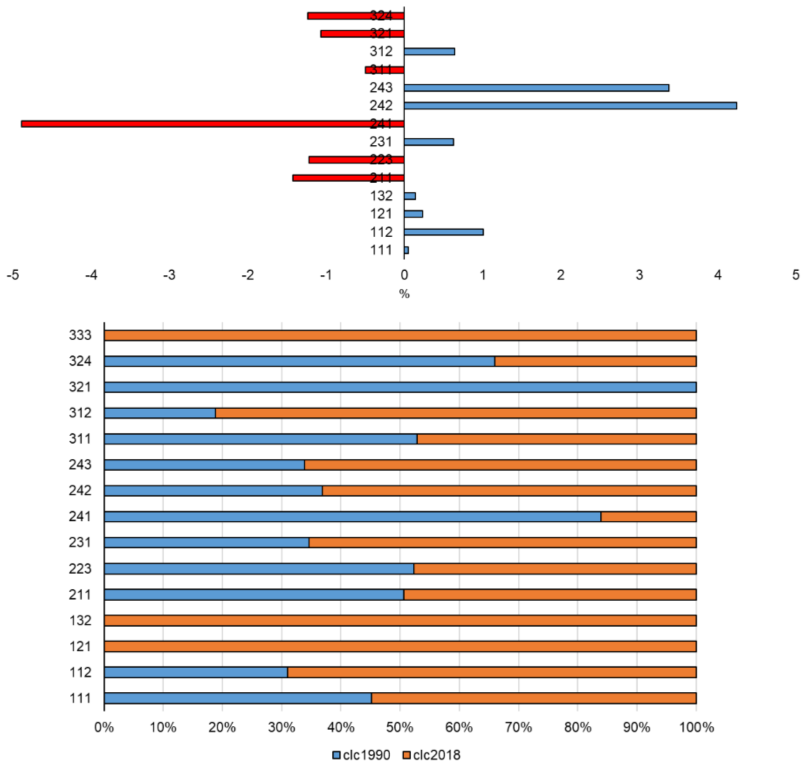


*Figure 11. Percentage differences for CLC classes (level 3) observed in the period 1990-2018 for the municipality of Ariano Irpino and percentage of CLC classes (level 3) in 1990 (in blue) and in 2018 (in orange) in the municipality of Ariano Irpino. See the legend of figure 10 to know the correct code.*

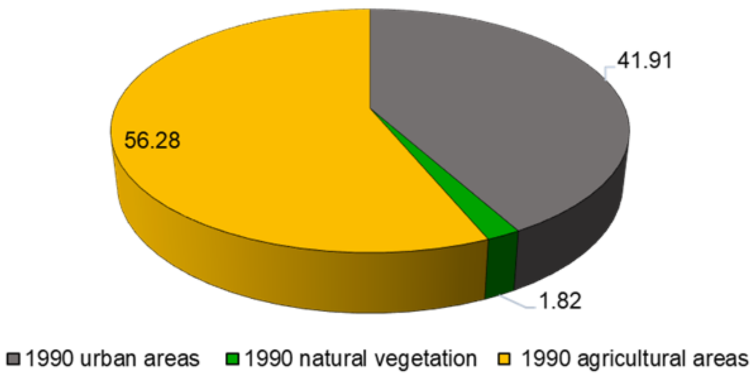


*Figure 12. 1990 land cover classes which are urban areas in 2018 in the municipality of Ariano Irpino.*

## 4. Concluding remarks

The rural-urban pattern in the provinces of Avellino and Benevento has undergone important transformations in the period 1990-2018. In a context of stagnation and demographic contraction, under the grip of an economic crisis that pervades Mediterranean regions (Gallardo *et al.,* 2023) and especially the southern regions of Italy since the mid-2000s, we observed a significant increase in sealed surfaces in these areas through processes of urban and suburban expansion recognizable as sprawl that exceeds the real demand and carrying capacity of many areas of the analyzed districts (Punzo *et al.,* 2022). In fact, the weight of the discontinuous urban fabric on the total urban areas grows consistently and becomes, even in small towns, the dominant urban form. At the same time, in the period analysed, agriculture preserves approximately the same areal extension, but shows a tendency to replace arable land with an association of covers with a greater presence of perennial crops and natural vegetation patches. The loss of arable land is clearly attributable to the ageing of population and migration flows (Cardillo and Cimino, 2022, Santelli *et al.,* 2022). From the management point of view, we observed a peculiar condition marked by the crisis of the primary sector suggesting to farmers to differentiate their production rather than risking capitals on a single type of crop (Ronza *et al.,* 2013).

Also, more profitable crops, such as vineyards and orchards, record a general stability or a very slight decline, revealing the tendency to invest capitals in tourism activities based on experiential enjoyment encompassing speciality foods, cultural identity, natural areas (Bassano *et al.,* 2019). This has favoured the maintenance of those landscapes useful for these activities (just vineyards, olive groves and some types of orchards), as well as the production of food and wine of excellence driven by DOC (Denomination of Controlled Origin) and DOCG (Denomination of Controlled and Guaranteed Origin, see e.g., Cusano *et al.,* 2022). Lands combined with agritourist facilities also fall under this process, especially in the province of Avellino. Furthermore, farm density is notable in the study areas, i.e., both the number of farms and the average UAA (Utilized Agricultural Area) per farm are higher than the regional average, and in the face of the demographic trend and the wheat crisis, this suggests that agriculture is now an entrepreneurial reality, which would also help to explain, albeit marginally, the densification of services and infrastructure (see the report of Ciaravino *et al.,* 2021). The general picture does not change when examining the case of the municipality of Ariano Irpino. Here, an impressive urban growth can be observed, with an increase of sealed surfaces of over 137% in the period 1990-2018, which becomes 184% by extending the time window to 1975. The prevailing contribution of the discontinuous urban fabric becomes even more marked (from about 80% to 90%). Moreover, land cover trajectories towards urban land use are mainly generated by soils previously devoted to agriculture, with significant losses in terms of ecosystem goods and services (Assennato *et al.*, 2022). The atypical behaviour of urban expansion in Ariano Irpino is probably due to the close presence of both the highway Napoli-Bari and, most recently, the high-capacity railway line Napoli-Bari, favouring the concentrations of buildings and further infrastructures.

In conclusion, the analysis of the study area returns a picture where the expansion of the urban fabric and the consequent loss of soil is clearly decoupled from population growth and proceeds in parallel with a transformation of the agricultural sector projected toward a greater specialization (Fichera *et al.,* 2012). This confirms the need to enforce policies to contain the phenomenon of land consumption through the adoption of more effective planning tools including subsidies and incentives for the primary sector in the perspective of a sustainable agriculture able to halt depopulation phenomena and preserve Mediterranean landscapes (Di Gennaro, 2017).

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