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Performance-based spatial monitoring. An interpretative model for long-term shrinking medium-small Italian towns

Barbara Caselli[a] *, Paolo Ventura[a], Michele Zazzi[a]

[a] Department of Engineering and Architecture, University of Parma, Parco Area delle Scienze 181/A, 43124 Parma, Italy

Corresponding Author:

Barbara Caselli, PhD

Department of Engineering and Architecture,

University of Parma

Parco Area delle Scienze 181/A,

43122 Parma, Italy

E-mail: barbara.caselli@unipr.it

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Abstract

The paper illustrates a GIS-based methodology to identify, among medium-small Italian towns, shrinking clusters characterised by homogeneous shrinking patterns in a 25-year-time frame. This methodology main goal is to act as a preliminary cognitive tool to which urban policies may refer to, providing support in the related decision-making process and encouraging an efficient management of social, economic and environmental resources in small deprived contexts.

The definition of the methodology foresees the following three main steps: 1) The mapping of demographic decline dynamics in a 25-year-time frame. 2) The identification of performance-based indicators which are involved in population loss in medium-small Italian towns. 3) The setting up of a performance-based interpretative scheme for classifying medium-small Italian towns in clusters having similar decline patterns. This contribution finally suggests a possible further application of the illustrated methodology as an urban planning efficiency monitoring tool, highlighting the main unsustainable trends connected to urban sprawl and to the continuous decrease in urban densities.

Keywords (max. 10)

urban shrinkage; medium-small towns; land management; performance-based indicators; GIS.

1 Introduction

Over the years, the polarization of the world urban system has greatly increased: on the one hand the large and dense urban agglomerations and metropolitan areas, where economic flows and people gravitate, on the other the most marginal and fragmented rural areas characterized by abandonment and impoverishment (Caselli, 2018, pp. 81–83; Ventura, 2018, pp. 51–76). Approximately, the 70 percent of the national population lives in urban areas while, on a

global scale, the share reaches only the 55 percent (United Nations, 2018). Hence, in Italy this process has become extremely evident. It is well-known that current urban policies and planning in Italy may not have been able to respond effectively to this contemporary urban transformation (Romano, Zullo, Marucci, & Fiorini, 2018; Salone, Besana, & Janin Rivolin, 2015).

Moreover, since 2016, the Italian Statistical Institute has registered an evident turnaround in the traditional national demographic growth as a result of a rapid population ageing and a long term economic stagnation (ISTAT, 2016) after the 2008 crisis. Trends are aggravated by numerous incoherent or incomplete administrative and territorial transformations, due to a general political uncertainty, which further complicate the governance system.

This is especially prominent in the case of small and medium-sized Italian municipalities subject to a medium-long term shrinkage. Small and mid-sized Italian towns are meant as municipalities with less than 50.000 inhabitants (ANCI-IFEL, 2011, 2013; Cancellieri, 2014; ESPON, 2006) which in Italy are about the 98 percent of the total and cover almost the 92 percent of the national area.

This paper describes a GIS-based methodology aimed at identifying, through a multivariate analysis, clusters of medium-small shrinking municipalities subject to population loss in a 25-year-time frame on the basis of performance indicators. These towns, which can be considered “not relevant to the system” (Bernt & Rink, 2010), in a global perspective, are the most affected by the general national crisis, showing decreasing socio-economic performances, demographic ageing and peripherization that freeze development opportunities, albeit with different dynamics. Italian urban policies consider all these processes but rarely the different factors involved in urban shrinkage have been combined to get a more comprehensive and integrated vision. Furthermore, Italian urban planning has often been characterised over the decades by excessive localism, and by the lack of a supra-local perspective, especially in small and mid-sized municipalities; this approach and the conflicts

between the public and private sphere have often produced urban forecasts not respectful of actual dynamics. In small and mid-sized municipalities, local authorities often have modest competencies and technical skills than in larger ones, the distance between developers and administrators is far more reduced and private interests may prevail over public ones (Tira & Zanon, 2011), resulting in a scattered and disorganized urban expansion despite the freezing of demographic and economic growth.

The novel *Performance-based Cluster Model* could become a relevant tool for informing and assessing urban policies related to urban decline management, and also for accurately monitoring spatial planning efficiency at a supra-local level, providing decision-makers useful suggestions to single out intervention priority strategic tasks on the basis of medium or long-term trends.

2 Study approaches to medium-small shrinking urban systems

Urban decline is a subject that has permeated national and international academic research. Since the late 1990s, the study on large international shrinking cities has aroused keen interest on a global scale (Bontje & Musterd, 2012), especially for the devastating effects of the massive suburbanisation in North America (Beauregard, 2009; Pallagst, Fleschurz, & Said, 2017), or for the serious forms of abandonment and socio-economic degradation in Eastern Europe and in ex URSS countries (Mykhnenko & Turok, 2008; Wiechmann & Pallagst, 2012).

Three main International programmes have set the methodological basis for studying urban shrinkage causes and effects. Firstly, the German Federal Cultural Foundation *Shrinking Cities* programme (Kulturstiftung des Bundes, 2005) pointed out the main patterns of decline of large cities on a global scale (Oswalt, 2005, 2006), secondly, the *Shrink Smart* programme focused on the comparative analysis of different European large and medium-sized cities, trying to identify different patterns of decline and related suitable planning practices (Rink,

Haase, & Bernt, 2009; Shrink Smart, 2009). Finally, the EU COST Action "Cities Regrowing Smaller" (CIRES), has introduced an innovative methodology apt at mapping and classifying European shrinking cities and regions through a rigorous quantitative analysis, dealing with municipalities of more than 5.000 inhabitants (COST CIRES, 2009; De Sousa et al., 2011; Musterd, 2013). This programme has provided the main interpretative keys for studying shrinkage even in less populated environments, and it is based on a GIS elaboration of statistical data, collected from national and municipal statistical offices datasets.

Many definitions have been given to urban shrinkage (Bernt, 2016) which generally identify population loss as the primary symptom. Some researchers argue that population is also a major factor determining a city economic condition (Mykhnenko & Turok, 2007). In addition to population loss, other conceptual frameworks in the debate on shrinking cities identify a more complex and multidimensional set of mega-trends, including the social, economic and structural decline (Audirac, Fol, & Martinez-Fernandez, 2010; Bontje & Musterd, 2012; Pallagst et al., 2009), the crisis of the political system (Rink et al., 2011), the demographic change and the settlement system changes in the form of suburbanization processes and urban sprawl (Großmann, Bontje, Haase, & Mykhnenko, 2013; Haase, Bernt, Grossmann, Mykhnenko, & Rink, 2013; Nefs, Alves, Zasada, & Haase, 2013); i.e. the COST Action CIRES methodology uses a refined set of indicators such as: population, natality/mortality rates, migration and ageing rates, GDP, number of enterprises, employment/unemployment rates, average incomes, population education and qualification, housing (vacant or occupied), real estate values, land consumption and urban density.

Many authors identify also the process of globalization as one of the factors involved in producing urban inequalities, which in many countries have stressed the disparity between relevant urban areas, able to generate wealth and innovation, attracting capital and investments, and marginal areas hit even more severely by the crisis (Hollander, Pallagst,

Schwarz, & Popper, 2009; Martinez-Fernandez, Audirac, Fol, & Cunningham-Sabot, 2012; Newman & Thornley, 2011).

In the Italian urban system, over the past twenty-five years, the uneven development of urban settlements has become more and more evident. Some recent studies, such as the *PRIN-Postmetropoli* programme (2010-2011), single out urban shrinkage in Italy while mapping the overall Italian urban system in the post metropolitan era (Balducci, Fedeli, & Curci, 2017). An open source geo-database (PRIN-Postmetropoli, 2015) has been produced and then transposed into the *Urban Index database*, i.e., a potential instrument for central government urban policies. Among other topics, this database maps shrinking territories on the basis of a series of factors analysed diachronically (between 2001 and 2011), such as population, economic dynamism, unemployment, housing purchase price and housing underutilization.

In Italy small and mid-sized towns seem to be the most affected by shrinkage, nevertheless, the overall attention to urban policies and spatial planning in these deprived contexts have been extremely weak on the national political agenda (Salone et al., 2015). Aiming for economic growth in order to regain population growth is generally the most typical response of planners and politicians, even if this strategy rarely leads to success anywhere (Hollander et al., 2009) if it is not supported by coordinated actions both on the national and local level (Kremer, Haase, & Haase, 2019; Pallagst, Fleschurz, et al., 2017; Pallagst, Mulligan, Cunningham-Sabot, & Fol, 2017).

This statement is stressed even in the outputs of the European programme COST Action C27 "Sustainable Development Policies for Minor Deprived Urban Communities (MDUC)", which largely studied Italian MDUC, i.e. very small and marginal settlements with fewer than 5.000 inhabitants mainly in mountain areas (Garlanda & Tiboni, 2011). The programme especially highlights that if shrinkage causes and effects are similar both in large and small cities, the possible solutions in the latter are far more complicated. Both top-down policies and bottom-up practices are needed but the possibilities of an effective recovery in MDUC is

very low in absence of some basic conditions for development, such as economically attractive neighbouring territories, and National or European funding (Ventura, Calderòn, & Tiboni, 2011).

In Italy, since 2014, the Inner Areas National Strategy has been engaged for this purpose, providing financial support and promoting local development in specifically selected declining inner communities (Barca, Casavola, & Lucatelli, 2014), though sometimes adjacent shrinking areas have been left behind. In fact, inner areas in Italy are only a part of a more complex declining system which covers more or less one-sixth of the national area and for which a convincing national strategy has not been developed yet (Calza Bini, Violante, & Cortese, 2010).

3 A Performance-based Interpretative Model

The proposed novel methodology does not study phenomena typical of the "shrinking cities" as other previously illustrated methodologies, but tries to reverse the study approach by understanding, which combinations of contextual factors in small and mid-sized Italian shrinking towns affect the actual dynamics of population loss and decline. Moreover, it aims at pointing out the main urban policies and spatial planning inefficiencies in providing high-performance resource management in declining territories.

The methodology uses a multilevel and multiscale analysis, which involves multiple variables investigated both on the local scale (municipalities) and on the supra-local scale (Labour Market Area, Province, Region). GIS technology supports the entire process: from data collection to data management and modelling.

3.1 Selecting geographical entities and characterising factors

The proposed methodology firstly maps all the medium-small Italian municipalities with fewer than 50,000 inhabitants, which show a consolidated and persistent shrinking dynamic both in the medium-long term and short term. In Italy, depopulation has generally occurred

mostly with a slow or stagnant dynamic, its effects are thus more noticeable in the medium-long term. The selection has been carried out with the support of GIS technology and open data from the Italian Statistical Institute (ISTAT) in particular, population data associated with ISTAT Administrative Boundaries. The observation starts from the 1991 census considering both the 25-year time frame (1991-2016) and the 5-year time frame (2011-2016) before the national population started to decrease. 3,511 municipalities record population loss in both time frames.

Then, to better understand the processes of shrinkage in a specific region, it is necessary to bring together causes, impacts and dynamics, setting them in the context of locally-based urban trajectories (Haase et al., 2013; Haase, Rink, Grossmann, Bernt, & Mykhnenko, 2014). The conducted literature review and recent Italian Statistical Institute annual reports (Caselli, 2016) suggest a set of five characterising factors which have an impact on population loss in Italy:

1. Population ageing (A), summarized by two indicators: the ageing index (the share of elderly people aged 65 and over) and the old age index (the number of elderly people aged 65 and over every 100 young people aged 0-14); this demographic phenomenon is quite relevant in Italy (Caselli, 2018), in fact the average share of older people exceeded 22 percent in 2017 and it will probably exceed 30 percent in the next twenty years (ISTAT, 2017). The mortality rate is higher than the birth rate and the migration rate is not enough to counterbalance the decreasing trend.
2. Wealth/Poverty (W): this factor considers the uneven spatial distribution of average per capita incomes; in 2014 about 72 percent of the considered municipalities records lower per capita incomes than the national average.
3. Business Performance (BP): a factor that combines indices of labor productivity, trade openness and export performance; these indices refer to the Labor Market Area (LMA) in which each municipality is located; LMAs are mostly permanent territorial

elements that have established a network of socio-economic relations and stable commuting flows over the past 25 years (ISTAT, 2015).

4. Unemployment (U), a factor resulting from the combination of employment and unemployment rates calculated both in the municipality and in the corresponding LMA.
5. Peripherization (P), another important factor that is connected both to the physical location (hilly or mountain areas are typically less accessible than plains), and to the concept of accessibility to public services (schools, railway stations and hospitals) and infrastructures. An interesting classification of the Italian municipalities on the basis of accessibility to public primary services has been set by the Italian Department for Development and Economic Cohesion (DPS, 2012).

Current methodologies apt at mapping shrinking cities hardly take into account peripherization indicators, aimed at explaining the disadvantaged positions of localities, and multi-scalarity which is also important to better understand the «relations between centres and periphery/margins» (Bernt, 2016).

3.2 Setting a performance-based interpretative scheme

To quantify these five characterizing factors that significantly affect the process of decline, a performance-based interpretative scheme has been defined as explained in Table 1.

Each factor is determined by the combination of several indicators and then each spatial unit (municipality) is assigned an integer value from 0 to 2. This value describes how much that factor possibly impacts on the municipal demographic decline: the lower the value, the lower the impact. Data necessary to set indicators in the spatial units have been retrieved from official open data platforms and then collected and managed in a GIS relational database. Demographic trends, socio-economic indices, employment rates and accessibility indices are investigated with a diachronic perspective. The positive or negative performance of many

indicators is not determined on absolute terms but on the basis of average values on the national or provincial scale.

Ageing (A)		*Data source: ISTAT demographic data*
0	Low	Ageing index and old age index below average
1	Medium	Ageing index below average and old age index above average
2	High	Ageing index and old age index above average.
Wealth/Poverty (W)		*Data source: Il Sole 24 Ore*
0	Low	Per capita incomes above national and provincial average
1	Medium	Per capita incomes above national average and below provincial average
2	High	Per capita incomes below national and provincial average
Business Performance (BP)		*Data source: ISTAT SLL (Labour Market Areas) data*
0	Low	Good labour productivity and export performance in the LMA
1	Medium	Average labour productivity and export performance in the LMA
2	High	Bad labour productivity and export performance in the LMA
Unemployment (U)		*Data source: ISTAT SLL (Labour Market Areas) data*
0	Low	Medium-high LMA employment rate and medium-low LMA unemployment rate; municipality unemployment rate below average.
1	Medium	Medium-high LMA employment rate and medium-high LMA unemployment rate; municipality unemployment rate above average.
2	High	Medium-low LMA employment rate and medium-high LMA unemployment rate; municipality unemployment rate above average.
Peripherization (P)		*Data source: ISPRA land consumption data*
0	Low	Predominantly lowland or hilly areas with a high-level of accessibility to services
1	Medium	Predominantly mountain areas with a high-level of accessibility to services
2	High	Areas with a low-level of accessibility to services (extremely marginal inner areas)

Table 1. Performance-based interpretative scheme defining each performance indicator.

3.3 Performance-based interpretative model and cluster classification

The different combinations of the characterising factor values result in the identification of different performance-based interpretative models which describe the main critical processes affecting shrinking small and mid-sized municipalities. The GIS tool has made it possible to evaluate, among the various possible solutions, the most frequent combinations of variables.

The resulting seven performance-based interpretative models have been used to classify medium-small Italian towns in *Cluster Types* having equal patterns of decline.

Each cluster has been further analyzed by comparing additional complementary performance indicators:

- Demographic decrease dynamic: GIS database elaboration of demographic data; fast-decreasing municipalities – as EU-COST Action proposes – show an annual average population rate inferior to -0,6 percent, while stagnant municipalities decrease at a minimum rate of -0,3 percent per year.
- Urbanisation degree and land consumption: information retrieved from ISPRA open data platform and implemented in the GIS geodatabase;
- Territorial density and urban density, i.e. the ratio between population and the effectively built-up area (Caselli & Ventura, 2017) , calculated with the support of the GIS database.

The assessment, conducted through the cluster comparative analysis, shows how rapidly depopulation is linked to the number of factors involved, and it also highlights which territories require further attention by strategic policies and planning to pursue a more compact and sustainable urban development.

3.4 In-depth analysis on the environmental performances of shrinking municipalities

As many studies demonstrate (Großmann et al., 2013; Kroll & Haase, 2010; Lima & Eischeid, 2017), some shrinking cities continue to grow physically. The continuous perpetration of an uncontrolled urban sprawl, despite population decline, is obviously an unsustainable phenomenon (Brueckner, Mills, & Kremer, 2001; Pileri, 2015; Ventura, 2009), especially in shrinking contexts where urban densities rapidly decrease (Angel, Parent, Civco, & Blei, 2010; Caselli & Ventura, 2017). In perforated yet developing urban structures various networks of technical infrastructure, utilities, and transport become under-used and less efficient, while at the same time the demand for energy, services and infrastructures increase.

The in-depth assessment of environmental performances connected to urbanization processes is conducted in three case studies located in Northern Italy where anthropogenic pressure is particularly high (Caselli & Ventura, 2017), despite urban shrinkage, and it is mining the environmental system and ecosystem services (Assennato et al., 2017; Caputo, Pasetti, & Ferrari, 2019; Munafò et al., 2015). The in-depth analysis implicates the diachronic evaluation of the following indicators: a) urban density; b) land use change (Martellozzo, Amato, Murgante, & Clarke, 2018); 3) the *Urban Fragmentation Index* as calculated by Romano & Zullo (2013): $UFI = \frac{\sum Au}{Ar} * \frac{\sum p}{2\sqrt{\pi \sum Au}}$

The first term of the expression provides the share of urban areas (Au) on the municipal total extension (Ar); the second term represents the shape index, i.e. the ratio between the overall perimeter of urban areas (p) and the perimeter they would have if they were all concentrated in a single round-shaped aggregation.

4 A performance-based classification for shrinking small and medium-sized Italian towns

The application of the *Cluster Model* reveals that about 50 percent of the total medium-small Italian towns experienced a negative population change from 1991 to 2016. Disadvantaged areas are especially condensed in contexts with little appeal and less profitable economic activities, such as Southern Italy, the Insular hinterlands and the inner areas of the Centre-North. In the same time frame, 42 percent of shrinking medium-small Italian towns suffered a rapid contraction, 27 percent a slow contraction and the remaining 31 percent underwent stagnation.

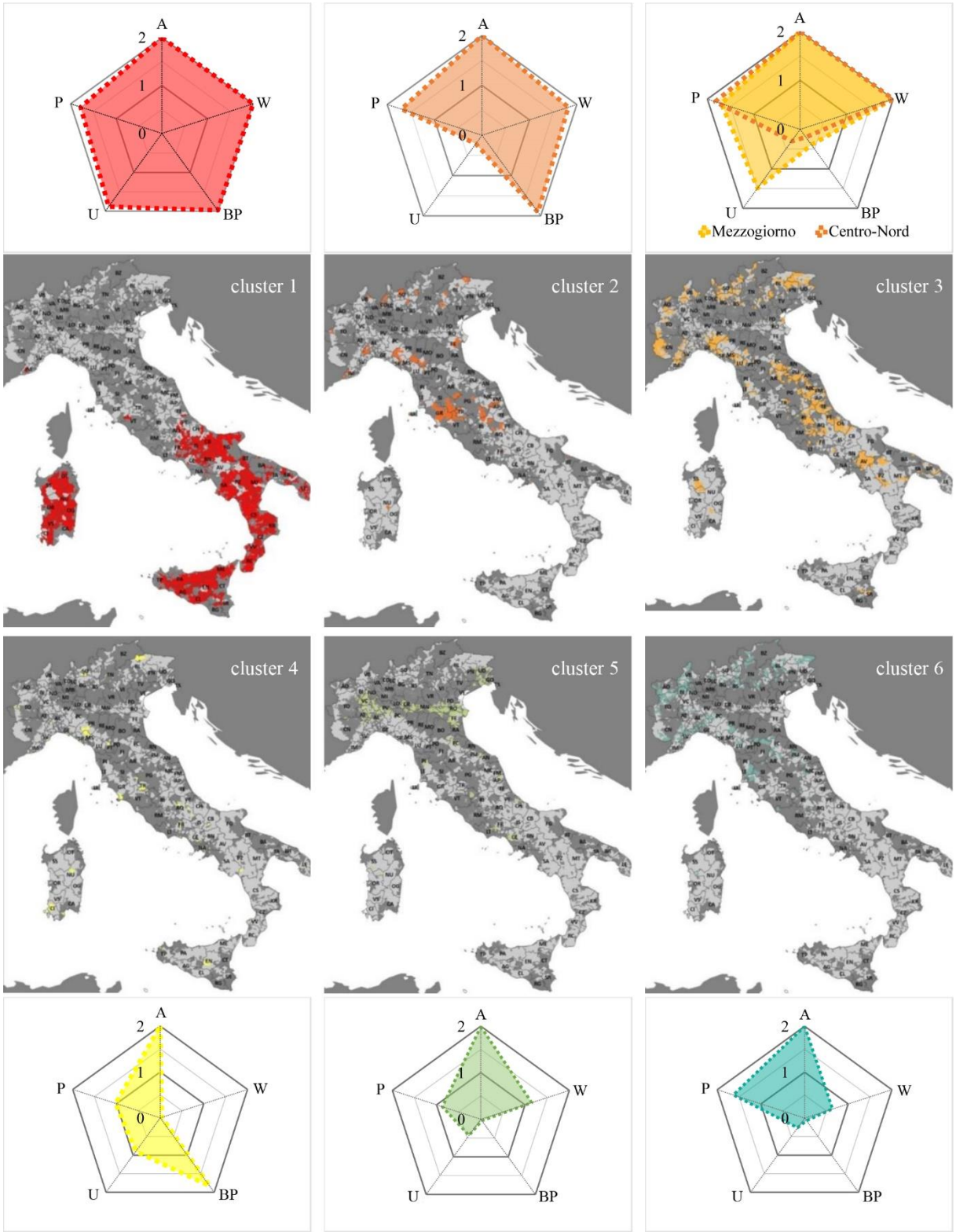

Figure 1. First six cluster types elaborated with the multilevel GIS-based analysis (A: ageing; W: wealth; BP: business performance; U: unemployment; P: peripheralization).

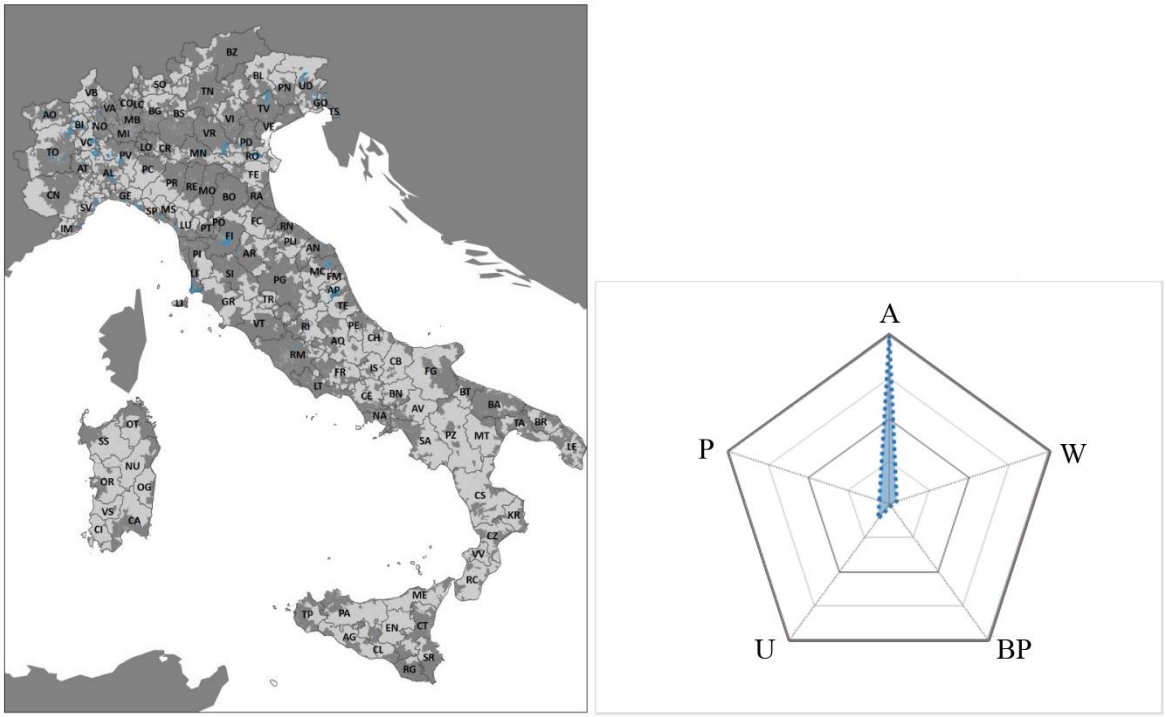

Figure 2. Cluster type 7 elaborated with the multilevel GIS-based analysis (A: ageing; W: wealth; BP: business performance; U: unemployment; P: peripheralization).

A total amount of seven interpretative models has been identified, with the support of the GIS database, combining differently the five factors of the interpretative scheme (Table 1) and highlighting their different impact on depopulation processes. The seven models, then, lead to the geographical identification of seven clusters (Figure 1 and 2). In each cluster, shrinking municipalities are characterised by similar patterns of decline (Table 2).

Clusters		**Municipalities %**	**Population %**	**Area %**	**Shrinking dynamic**
1	Poor municipalities in economic recession in Southern Italy	39,6	42,4	53,8	Mainly rapid
2	Poor municipalities economically suffering in Northern-Central Italy	5,9	3,6	8,6	Medium-rapid
3	Poor and extremely peripheral municipalities	22,8	12,6	8,6	Mainly rapid
4	Wealthier municipalities located in economically suffering areas	2,2	7,8	3,3	Slow or stagnant
5	Small and low-dense rural municipalities in marginal plain areas	14,4	10,2	10,1	Slow or stagnant
6	Small and low-dense rural municipalities in marginal hilly or mountain areas	13,2	9,3	13,8	Slow
7	Municipalities densely urbanised with a stagnant growth rate	2,6	14,0	1,9	Stagnant

Table 2. Medium-small Italian towns classification in clusters: quantity and shrinking dynamism.

The *Cluster Model* brings out an incredible urban system complexity in which, sometimes, exceptions occur in contexts considered homogeneous from a morphological and socio-economic point of view. Still a shared trend has been detected: all cluster types are characterised by high population ageing values, once again demonstrating how relevant this demographic phenomenon is in Italy.

4.1 Poor municipalities in economic recession in Southern Italy

The cluster type 1 shows the most serious depopulation dynamics in mainly Southern municipalities and two little isolated clusters in the Centre-North. All five indicators have poor performances and, in fact, more than 50 percent of the total municipalities are characterised by rapid population decline with an average rate of -1.04 percent per year.

4.2 Poor municipalities economically suffering in Northern-Central Italy

The cluster type 2 contains municipalities characterised by four to five low-performance indicators. Municipalities are predominantly located in inner areas where incomes are low, and Labor Market Areas are economically suffering. Compared to the previous cluster and despite the poor business performance and high degree of peripherality, the municipalities have an unemployment rate that remains at medium-low levels.

4.3 Poor and extremely peripheral municipalities

The cluster type 3 has low performances in the ageing, wealth and peripherality indicators, but resilient economies. As for unemployment, it shows accentuated differences between the Center-North and the South, since the Center-North is less affected by it.

4.4 Wealthier municipalities located in economically suffering areas

The cluster type 4, on the other hand, points out the few isolated inner areas with medium-higher incomes which generally suffer either from an economic and structural crisis or from an extreme marginalization. In 20,000 to 50,000-inhabitant municipalities the business performance is not always positive and unemployment rate is high, while in small municipalities, where unemployment is less influential, peripherization is extremely high.

4.5 Small and low-dense rural municipalities in marginal plain or mountain areas

The cluster type 5 and 6 specifically represent smaller municipalities, with fewer than 15,000 inhabitants, and in which territorial density is very low (fewer than 150 inhabitants / sq km). They are both characterized by peripherization. Type 6 groups mainly hilly or mountainous municipalities classified as marginal inner areas, while type 5 groups mainly lowland municipalities with a slight increase in accessibility performance. The relevance of the other performance factors is substantially similar in both clusters: they generally belong to LMAs with a positive economic performance and record high employment rates.

4.6 Municipalities densely urbanised with a stagnant growth rate

Finally, the cluster type 7 points out those densely urbanised municipalities, with more than 5,000 inhabitants, that are not suffering from the lack of services or socio-economic leverages. Therefore, the only negative performance is about the strong demographic ageing which is causing a continuous population loss with a stagnant trend. In all these municipalities the ageing index is higher than the national average and the number of elderly people for every 100 young people is two to five times higher than the national average.

5 Decrease in urban density and critical land use changes

A relevant issue that emerges from the clusters comparative analysis is related to the physical-morphological dimension of the urban settlements. Population loss, triggered by various factors, and the continuous urban expansion are both aggravating the perforation of the built environment and the rapid urban density decrease. Many municipalities, especially in the North, register almost no population change, while their land consumption increases with values close to the national average. In this regard, other serious environmental critical issues arise from the in-depth comparative analysis on three case studies located in Northern Italy (Table 3) where anthropogenic pressure is particularly high.

	Valle Camonica	**Basso mantovano Alto Polesine**		**Medio Polesine Delta del Po**	
Empty housing increase 2001-2010 (%)	+41,69%		+74,58%		+69,01%
	Alta Valle *1999-2012*	***Basso Mantovano*** *1999-2012*	***Alto Polesine*** *2007-2012*	***Medio Polesine*** *2007-2012*	***Delta del Po*** *2003-2008*
Urban density decrease (%)	-23,86%	-30,14%	-2,79%	-7,54%	-6,74%
UFI t1	*0,32*	*1,91*	*7,24*	*5,29*	*1,52*
UFI t2	*0,51*	*2,18*	*7,48*	*5,47*	*1,56*
Land use increase / decrease (%)					
Artificial surfaces	+28,77%	+14,44%	+5,07%	+5,32%	+3,97%
Urban fabric	+17,35%	+6,47%	+1,80%	+2,02%	+2,27%
Industrial, commercial and transport units	+35,09%	+21,45%	+13,91%	+15,70%	+3,83%
Agricultural areas	-9,04%	-1,33%	-0,33%	-0,06%	-0,56%
Forest and seminatural areas	+0,34%	+3,24%	-11,86%	-8,28%	+3,72%
Wetlands and water bodies	-0,77%	-3,56%	+2,40%	+2,75%	+4,90%

Table 3. Three case study comparative analysis on vacant properties, urban density, urban fragmentation index (UFI) and land use transformation (Re-elaboration of Regional land use data and national statistical data).

The diachronic evaluation (Table 3) of the following indicators: a) urban density b) land use variation, 3) the *Urban Fragmentation Index*, rises three main critical issues:

1. farmlands are decreasing, due to the abandonment of rural activities and urban expansion; meanwhile isolated built-up areas are abandoned and degrade;
2. built-up areas are becoming more and more fragmented and scattered; urban sprawl aggravates the phenomenon of urban density loss, especially in rural areas (Martellozzo et al., 2018) where land values are particularly low (Caselli & Ventura, 2017);
3. shrinking municipalities sometimes consume more land than growing ones.

The last two issues can easily be verified at a national level elaborating diachronically more recent land consumption data (collected from ISPRA's open-data platform) and demographic data collected from ISTAT datasets (Table 4 and Figure 2).

Municipalities	Total area	Land consumption 2012	Land consumption 2017	Land consumption increase	Population growth/ decline	Urban density 2012	Urban density 2017	Density increase/ decline
	ha	%	%	%	%	ab/ha	ab/ha	%
< 2000 inh.								
Total	8.426.492	3,57%	3,60%	*0,80%*	*-3,19%*	10,98	10,55	*-3,96%*
Shrinking	6.999.682	3,37%	3,39%	*0,76%*	*-5,30%*	10,71	10,07	*-6,01%*
2000-5000 inh.								
Total	7.681.744	5,56%	5,62%	*1,04%*	*-0,86%*	15,81	15,52	*-1,88%*
Shrinking	5.775.983	4,85%	4,90%	*1,00%*	*-3,51%*	14,99	14,32	*-4,46%*
5000-10000 inh.								
Total	4.701.147	8,75%	8,87%	*1,28%*	*0,71%*	20,40	20,29	*-0,57%*
Shrinking	2.674.906	7,30%	7,39%	*1,15%*	*-2,44%*	19,40	18,71	*-3,55%*
10000-50000 inh.								
Total	8.898.430	12,69%	12,84%	*1,12%*	*2,93%*	36,11	36,75	*1,79%*
Shrinking	3.247.418	8,70%	8,80%	*1,12%*	*-1,75%*	29,91	29,06	*-2,84%*

Table 4. Land consumption and urban density monitoring (2012-2017). Data source: Italian Institute for Environmental Protection and Research (ISPRA), Italian Statistical Institute (ISTAT).

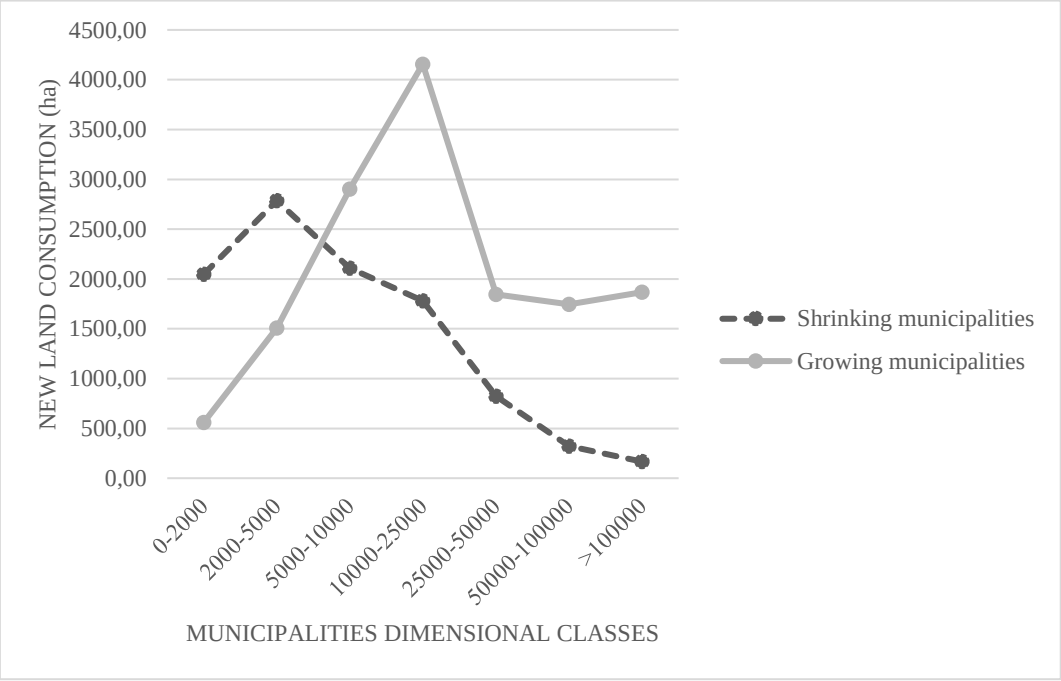

Figure 2. Land consumption absolute value diachronic trend (2012-2017). Data source: Italian Institute for Environmental Protection and Research (ISPRA), Italian Statistical Institute (ISTAT).

In medium-small Italian shrinking municipalities urban densities are decreasing from 2 to 5 times faster than the national average and the smaller ones (with fewer than 5,000 inhabitants), in particular, have consumed more land in absolute terms than growing municipalities of similar dimension. These outcomes highlight the almost paradoxical results of traditional planning inefficiency.

6 Discussion and conclusions

These assumptions increase the concern over shrinking medium-small Italian municipalities, where economic resources are scarce, and the environmental and ecological component undoubtedly plays a fundamental counterbalance role to high-anthropogenic pressure areas, i.e. the fast-growing agglomerations (Assennato et al., 2017; Docchio & Pezzagno, 2011).

The Italian urban system seems to have adopted, since 2016, a general "shrinking dynamic". The change in the demographic structure towards ageing, the substantial economic and structural decline, the physical marginalization from public services and infrastructural axes and the loss of wealth have been freezing the development opportunities in about a half of the small and mid-sized Italian municipalities. In addition, the detected worrying decreases in urban density, especially in small cities, suggest a priority for action in pursuing more compact and sustainable urban morphologies. Local urban planning has repeatedly proven to be unable to successfully pursue this goal over the long term; also national and regional policies have not yet managed to generate an overall visible effect of improved urban performance even if they are attempting to set limits to land consumption and encouraging the reuse of existing buildings and built-up areas.

Private interests in current land management (Tira, 2011) may have led urban communities to oversize urban planning expansion forecasts despite the actual needs. Furthermore, local public administrations in medium-small Italian towns often lack strength and competences (Tira & Zanon, 2011) and supra-local administrations are not able to control effectively all the

local urban transformations. The concept is shared even by Salone, Besana and Rivolin (2015), who argue that the current general urban density decline in Italian shrinking towns can be amplified by the «"conformative" model of the Italian planning system», far too influenced by ownership rights and land values.

These assumptions do not imply that urban policies and spatial planning have generated criticalities everywhere, but rather that they have not been able to adapt themselves, introducing more flexible tools respectful of the real legible territorial trends.

Anyway, policies and planning tools might play a central role in dealing with shrinking cities, as many studies suggest (Großmann et al., 2013; Hollander et al., 2009; Pallagst, Fleschurz, et al., 2017) and the complexity of shrinkage enhances the need to embed policies that address it into local planning instruments and regulations (Pallagst, Mulligan, et al., 2017).

The proposed *Performance-based Cluster Model*, apt at assessing different long-term patterns of shrinkage and at pointing out the main spatial performance inefficiencies, could become a useful tool to inform urban policies and assess strategic planning. Urban policies and territorial governance tools can possibly exploit this performance-based model to orient strategic spatial decision-making (Healey, 2007; Steele, 2009a, 2009b) aimed at raising attractiveness or accompanying de-growth. In cluster type 3, 5, 6 and 7 where LMAs have a positive performance and generally poverty, unemployment and peripherization have less impact, strategies may aim at promoting *sustainable local development* processes, leveraging resilient economic activities – especially related to agriculture and tourism (Ventura & Tiboni, 2016). Instead, where the possibility of a decline reversing process is very low, «the development itself should be questioned» (Tira, 2011, p. 84). This is the case of cluster type 1 and 2, where many more factors impact on shrinkage, hence a *smart degrowth* (Gottdiener & Hutchison, 2011, pp. 325–326; Pallagst, Fleschurz, et al., 2017, p. 11) process might be preferable. This implicates a concentration process of resources, providing communities a better quality of life and pursuing better environmental and ecological performance, e.g.

planning more compact settlements, improving resource sharing between neighboring territories, improving public space quality and public services provision, limiting urban sprawl.

In conclusion, the *Performance-based Cluster Model*, might become a valid tool for orienting urban policies towards shared performance goals and for comparing alternative improvement scenarios apt at identifying strategic unitary priority axes for intervention. An economic sustainable development, the social disparity management, employment equity policies and an accessibility level improvement are all possible strategic measures aimed at enhancing, with different priorities, the most critical issues concerning shrinking medium-small Italian towns. It is also possible to set thresholds for each one of the five indicators in each cluster, depending on the performance standards decision-makers/planners want to achieve in the medium-long term.

As a multilevel and multiscale analysis tool, set with the support of a GIS-database, the Model tends to simplify the urban complexity in a series of performance indicators, and despite the limits generally imposed by spatial data modelling (Murgante, 2011) – selecting a defined set of indicators might be a limit in itself – the monitoring of actual trends is crucial to set up urban policies and spatial planning on a more efficient management of living spaces and environmental resources (FHWA, 2013).

The research could further deepen the survey on land management sustainability by possibly testing trends in a more comprehensive set of case studies. This exercise could help to associate each shrinking cluster with more appropriate performance goals.

Finally, the contribution suggests the possible employment of the *Performance-based Cluster Model* also as a monitoring tool to support spatial planning. Being an updatable system, it can be used both as preliminary cognitive framework to support decision-making processes and as a tool to track decision-making results over time.

A performance-based spatial planning (Baker, Sipe, & Gleeson, 2006; Flint, 2014; Kendig, 1980; Parkinson, Meegan, & Karecha, 2015; Steele, 2009a), thanks to its adaptive approach, might probably play a central role in pursuing more sustainable place-based measures despite the increasingly scarce resources. It is also to consider that in minor rural communities, strong agricultural policies with subsidy programme are also needed to pursue an environmental protection goal. In fact, the enhancement of regional policies for encouraging agricultural activities (Ventura & Tiboni, 2016) – as promoted, for instance, by the New Regional Policy (NRP) in Switzerland (OECD, 2011) – is a well-known practice to limit land consumption and hence preserve ecosystem services and traditional landscapes.

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