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

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1 **Abstract**

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

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

16

17 **Keywords (max. 10)**

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

19

20 **1 Introduction**

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

26 global scale, the share reaches only the 55 percent (United Nations, 2018). Hence, in Italy this  
27 process has become extremely evident. It is well-known that current urban policies and  
28 planning in Italy may not have been able to respond effectively to this contemporary urban  
29 transformation (Romano, Zullo, Marucci, & Fiorini, 2018; Salone, Besana, & Janin Rivolin,  
30 2015).

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

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

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

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

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

63

## 64 **2 Study approaches to medium-small shrinking urban systems**

65 Urban decline is a subject that has permeated national and international academic research.  
66 Since the late 1990s, the study on large international shrinking cities has aroused keen interest  
67 on a global scale (Bontje & Musterd, 2012), especially for the devastating effects of the  
68 massive suburbanisation in North America (Beauregard, 2009; Pallagst, Fleschurz, & Said,  
69 2017), or for the serious forms of abandonment and socio-economic degradation in Eastern  
70 Europe and in ex URSS countries (Mykhnenko & Turok, 2008; Wiechmann & Pallagst,  
71 2012).

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

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

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

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

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

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

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

122 This statement is stressed even in the outputs of the European programme COST Action C27  
123 “Sustainable Development Policies for Minor Deprived Urban Communities (MDUC)”,  
124 which largely studied Italian MDUC, i.e. very small and marginal settlements with fewer than  
125 5.000 inhabitants mainly in mountain areas (Garlanda & Tiboni, 2011). The programme  
126 especially highlights that if shrinkage causes and effects are similar both in large and small  
127 cities, the possible solutions in the latter are far more complicated. Both top-down policies  
128 and bottom-up practices are needed but the possibilities of an effective recovery in MDUC is

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

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

139

### 140 **3 A Performance-based Interpretative Model**

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

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

#### 151 *3.1 Selecting geographical entities and characterising factors*

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



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

162 Then, to better understand the processes of shrinkage in a specific region, it is necessary to  
163 bring together causes, impacts and dynamics, setting them in the context of locally-based  
164 urban trajectories (Haase et al., 2013; Haase, Rink, Grossmann, Bernt, & Mykhnenko, 2014).  
165 The conducted literature review and recent Italian Statistical Institute annual reports (Caselli,  
166 2016) suggest a set of five characterising factors which have an impact on population loss in  
167 Italy:

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

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

183 4. Unemployment (U), a factor resulting from the combination of employment and  
184 unemployment rates calculated both in the municipality and in the corresponding  
185 LMA.

186 5. Peripherization (P), another important factor that is connected both to the physical  
187 location (hilly or mountain areas are typically less accessible than plains), and to the  
188 concept of accessibility to public services (schools, railway stations and hospitals)  
189 and infrastructures. An interesting classification of the Italian municipalities on the  
190 basis of accessibility to public primary services has been set by the Italian Department  
191 for Development and Economic Cohesion (DPS, 2012).

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

### 196 3.2 *Setting a performance-based interpretative scheme*

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

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

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

<b>Ageing (A)</b>		<i>Data source: ISTAT demographic data</i>
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.
<b>Wealth/Poverty (W)</b>		<i>Data source: Il Sole 24 Ore</i>
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
<b>Business Performance (BP)</b>		<i>Data source: ISTAT SLL (Labour Market Areas) data</i>
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
<b>Unemployment (U)</b>		<i>Data source: ISTAT SLL (Labour Market Areas) data</i>
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.
<b>Peripherization (P)</b>		<i>Data source: ISPRA land consumption data</i>
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)

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

209

### 210 3.3 Performance-based interpretative model and cluster classification

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

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

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

219 • Demographic decrease dynamic: GIS database elaboration of demographic data; fast-  
220 decreasing municipalities – as EU-COST Action proposes – show an annual average  
221 population rate inferior to -0,6 percent, while stagnant municipalities decrease at a  
222 minimum rate of -0,3 percent per year.

223 • Urbanisation degree and land consumption: information retrieved from ISPRA open  
224 data platform and implemented in the GIS geodatabase;

225 • Territorial density and urban density, i.e. the ratio between population and the  
226 effectively built-up area (Caselli & Ventura, 2017) , calculated with the support of the  
227 GIS database.

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

### 232 *3.4 In-depth analysis on the environmental performances of shrinking municipalities*

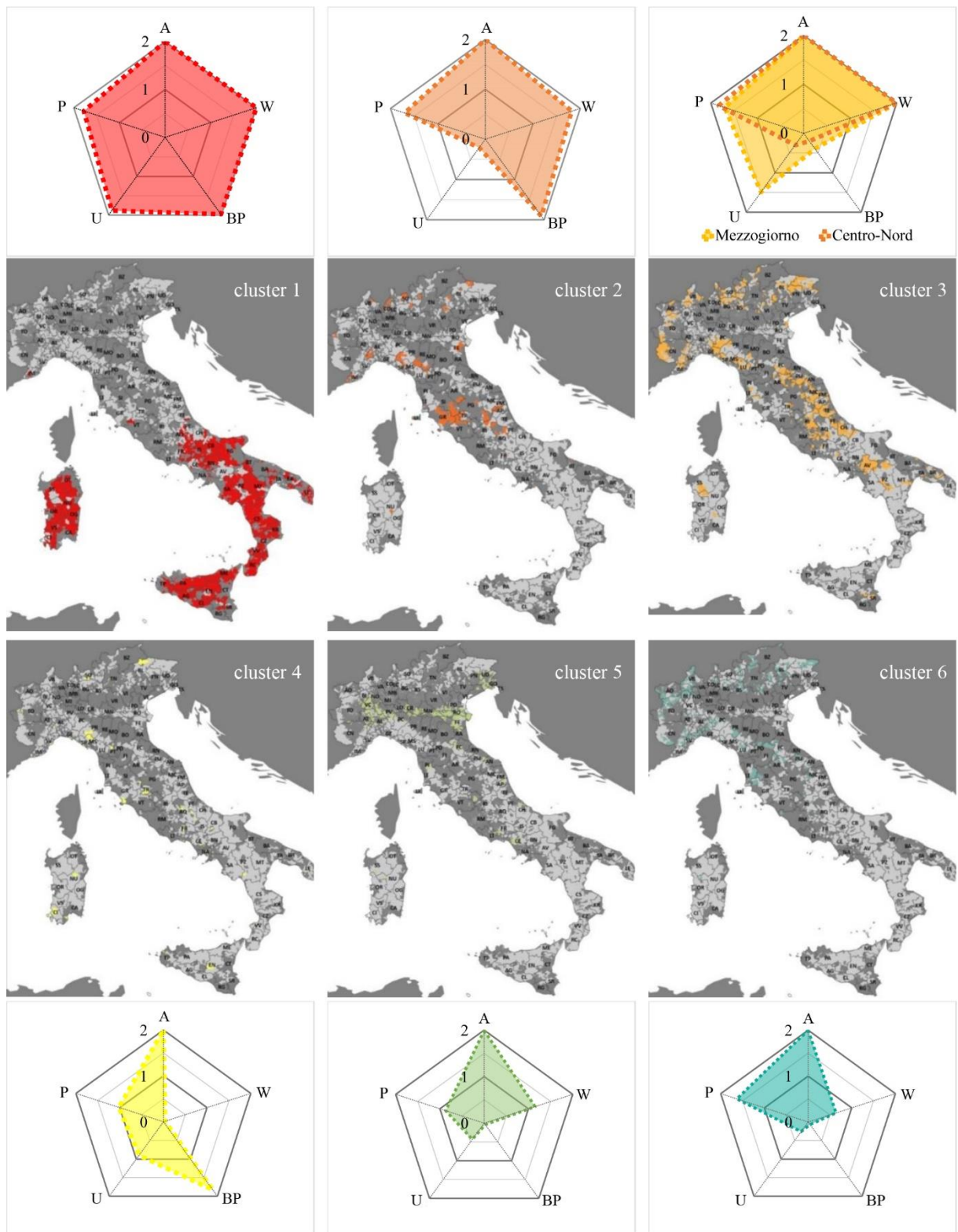
233 As many studies demonstrate (Großmann et al., 2013; Kroll & Haase, 2010; Lima & Eischeid,  
234 2017), some shrinking cities continue to grow physically. The continuous perpetration of an  
235 uncontrolled urban sprawl, despite population decline, is obviously an unsustainable  
236 phenomenon (Brueckner, Mills, & Kremer, 2001; Pileri, 2015; Ventura, 2009), especially in  
237 shrinking contexts where urban densities rapidly decrease (Angel, Parent, Civco, & Blei,  
238 2010; Caselli & Ventura, 2017). In perforated yet developing urban structures various  
239 networks of technical infrastructure, utilities, and transport become under-used and less  
240 efficient, while at the same time the demand for energy, services and infrastructures increase.

241 The in-depth assessment of environmental performances connected to urbanization processes  
242 is conducted in three case studies located in Northern Italy where anthropogenic pressure is  
243 particularly high (Caselli & Ventura, 2017), despite urban shrinkage, and it is mining the  
244 environmental system and ecosystem services (Assennato et al., 2017; Caputo, Pasetti, &  
245 Ferrari, 2019; Munafò et al., 2015). The in-depth analysis implicates the diachronic evaluation  
246 of the following indicators: a) urban density; b) land use change (Martellozzo, Amato,  
247 Murgante, & Clarke, 2018); 3) the *Urban Fragmentation Index* as calculated by Romano &  
248 Zullo (2013):  $UFI = \frac{\sum Au}{Ar} * \frac{\sum p}{2\sqrt{\pi \sum Au}}$   
249 The first term of the expression provides the share of urban areas (Au) on the municipal total  
250 extension (Ar); the second term represents the shape index, i.e. the ratio between the overall  
251 perimeter of urban areas (p) and the perimeter they would have if they were all concentrated  
252 in a single round-shaped aggregation.

253

#### 254 **4 A performance-based classification for shrinking small and medium-sized Italian towns**

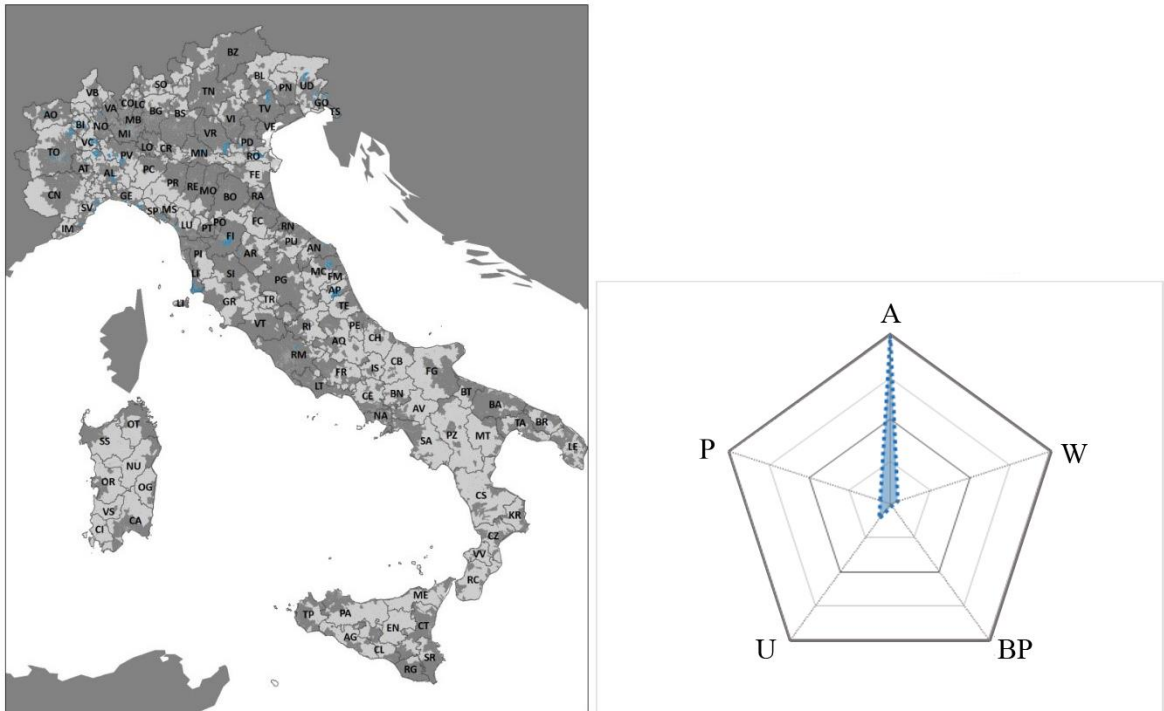
255 The application of the *Cluster Model* reveals that about 50 percent of the total medium-small  
256 Italian towns experienced a negative population change from 1991 to 2016. Disadvantaged  
257 areas are especially condensed in contexts with little appeal and less profitable economic  
258 activities,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



262

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

265



266  
 267 **Figure 2.** Cluster type 7 elaborated with the multilevel GIS-based analysis (A: ageing; W:  
 268 wealth; BP: business performance; U: unemployment; P: peripheralization).

269

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

275

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

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

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

#### 283 *4.1 Poor municipalities in economic recession in Southern Italy*

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

#### 288 *4.2 Poor municipalities economically suffering in Northern-Central Italy*

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

#### 294 *4.3 Poor and extremely peripheral municipalities*

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

#### 298 *4.4 Wealthier municipalities located in economically suffering areas*

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



304 4.5 *Small and low-dense rural municipalities in marginal plain or mountain areas*

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

312 4.6 *Municipalities densely urbanised with a stagnant growth rate*

313 Finally, the cluster type 7 points out those densely urbanised municipalities, with more than  
314 5,000 inhabitants, that are not suffering from the lack of services or socio-economic  
315 leverages. Therefore, the only negative performance is about the strong demographic ageing  
316 which is causing a continuous population loss with a stagnant trend. In all these municipalities  
317 the ageing index is higher than the national average and the number of elderly people for  
318 every 100 young people is two to five times higher than the national average.

319

320 **5 Decrease in urban density and critical land use changes**

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

	<b>Valle Camonica</b>	<b>Basso mantovano Alto Polesine</b>		<b>Medio Polesine Delta del Po</b>	
<i>Empty housing increase 2001-2010 (%)</i>	+41,69%	+74,58%		+69,01%	
	<i>Alta Valle 1999-2012</i>	<i>Basso Mantovano 1999-2012</i>	<i>Alto Polesine 2007-2012</i>	<i>Medio Polesine 2007-2012</i>	<i>Delta del Po 2003-2008</i>
<i>Urban density decrease (%)</i>	-23,86%	-30,14%	-2,79%	-7,54%	-6,74%
<i>UFI t1</i>	0,32	1,91	7,24	5,29	1,52
<i>UFI t2</i>	0,51	2,18	7,48	5,47	1,56
<i>Land use increase / decrease (%)</i>					
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%

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

332

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

- 335 1. farmlands are decreasing, due to the abandonment of rural activities and urban  
336 expansion; meanwhile isolated built-up areas are abandoned and degrade;
- 337 2. built-up areas are becoming more and more fragmented and scattered; urban sprawl  
338 aggravates the phenomenon of urban density loss, especially in rural areas  
339 (Martellozzo et al., 2018) where land values are particularly low (Caselli & Ventura,  
340 2017);
- 341 3. shrinking municipalities sometimes consume more land than growing ones.

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

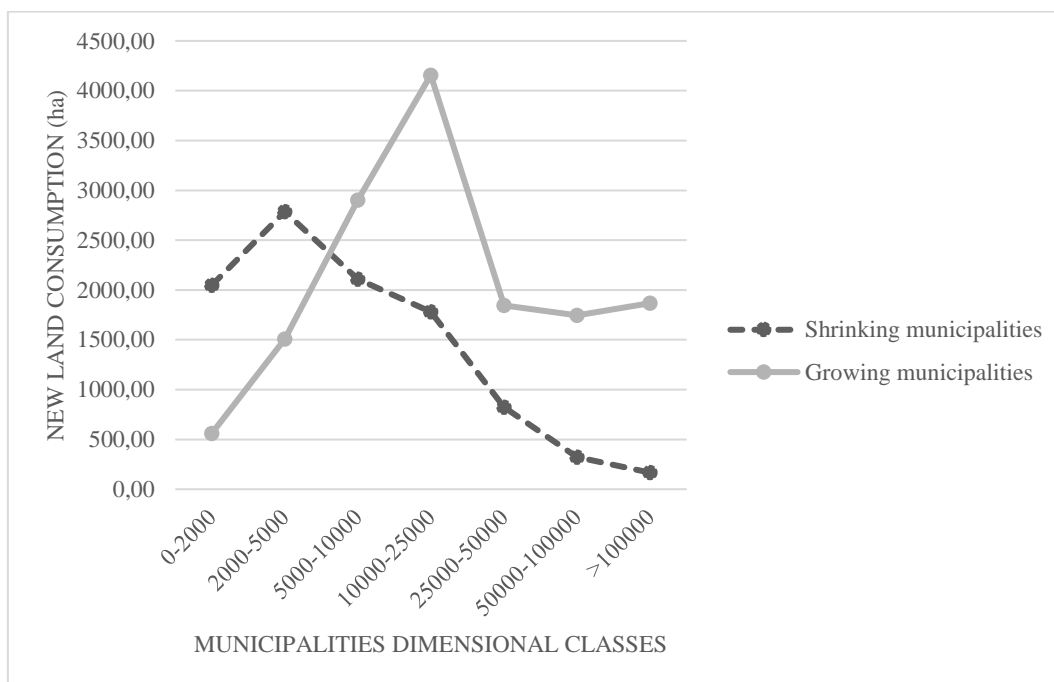
345

346

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	%
<b>&lt; 2000 inh.</b>								
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%
<b>2000-5000 inh.</b>								
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%
<b>5000-10000 inh.</b>								
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%
<b>10000-50000 inh.</b>								
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%

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

350



351

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

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

360

## 361 **6 Discussion and conclusions**

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

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

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

381 local urban transformations. The concept is shared even by Salone, Besana and Rivolin  
382 (2015), who argue that the current general urban density decline in Italian shrinking towns can  
383 be amplified by the «“conformative” model of the Italian planning system», far too influenced  
384 by ownership rights and land values.

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

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

392 The proposed *Performance-based Cluster Model*, apt at assessing different long-term patterns  
393 of shrinkage and at pointing out the main spatial performance inefficiencies, could become a  
394 useful tool to inform urban policies and assess strategic planning. Urban policies and  
395 territorial governance tools can possibly exploit this performance-based model to orient  
396 strategic spatial decision-making (Healey, 2007; Steele, 2009a, 2009b) aimed at raising  
397 attractiveness or accompanying de-growth. In cluster type 3, 5, 6 and 7 where LMAs have a  
398 positive performance and generally poverty, unemployment and peripherization have less  
399 impact, strategies may aim at promoting *sustainable local development* processes, leveraging  
400 resilient economic activities – especially related to agriculture and tourism (Ventura & Tiboni,  
401 2016). Instead, where the possibility of a decline reversing process is very low, «the  
402 development itself should be questioned» (Tira, 2011, p. 84). This is the case of cluster type 1  
403 and 2, where many more factors impact on shrinkage, hence a *smart degrowth* (Gottdiener &  
404 Hutchison, 2011, pp. 325–326; Pallagst, Fleschurz, et al., 2017, p. 11) process might be  
405 preferable. This implicates a concentration process of resources, providing communities a  
406 better quality of life and pursuing better environmental and ecological performance, e.g.

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

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

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

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

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

432 A performance-based spatial planning (Baker, Sipe, & Gleeson, 2006; Flint, 2014; Kendig,  
433 1980; Parkinson, Meegan, & Karecha, 2015; Steele, 2009a), thanks to its adaptive approach,  
434 might probably play a central role in pursuing more sustainable place-based measures despite  
435 the increasingly scarce resources. It is also to consider that in minor rural communities, strong  
436 agricultural policies with subsidy programme are also needed to pursue an environmental  
437 protection goal. In fact, the enhancement of regional policies for encouraging agricultural  
438 activities (Ventura & Tiboni, 2016) – as promoted, for instance, by the New Regional Policy  
439 (NRP) in Switzerland (OECD, 2011) – is a well-known practice to limit land consumption  
440 and hence preserve ecosystem services and traditional landscapes.

441

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