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Chapter 6
A Geostatistical Approach to Measure Shrinking Cities: The Case of Taranto

Beniamino Murgante and Francesco Rotondo

Abstract Measuring shrinkage and its effects appears as a fundamental issue in cities' research. Also, shrinkage is a spatial phenomenon defined by data and information based on space dimension relying on a spatial information. The wide use of geo-information is a useful aid to extend common statistic analyses integrating data collected at different levels, comparing data at a municipal level to data referring at census area level (particularly useful for detailed analyses at a neighbourhood scale). Such analyses are particularly suitable for medium and large cities shrinkage analyses, where different neighbourhoods could have different levels of shrinkage and could need distinct strategies to face such phenomenon. Another methodological problem is the interrelation with other spatial units and nearby cities, which can have an influence on urban labour market, economic development, migration flows and housing market. Thereby, the definition of an appropriate regional context is of crucial importance. After an introduction about a comparison between common statistic analyses and geo-statistical methods, with a short literature review, the paper includes an empirical section describing the case of de-industrialized Taranto city, measuring the major indicators of shrinkage, with data referring to census area level, trying to understand if there are shrinking neighbourhoods in the city of Taranto and what is the appropriate regional shrinking context. Then, the paper continues with a section in which the theoretical knowledge is evaluated comparing theory strongholds to main features of shrinkage exemplified by the case of Taranto, trying to contribute to a better understanding of the questions addressed, highlighting the unresolved problems to address some

B. Murgante
Laboratory of Urban and Territorial Systems, University of Basilicata, Via dell'Ateneo Lucano 10, 85100 Potenza, Italy
e-mail: beniamino.murgante@unibas.it

F. Rotondo (✉)
Department of Architecture and Town Planning, Polytechnic of Bari, Via Orabona 4, 70125 Bari, Italy
e-mail: f.rotondo@poliba.it

conclusions about still open research challenges. [The contribution is the result of joint reflections by the authors, with the following contributions attributed to Rotondo (Sects. 6.1, 6.2.1 and 6.4) and the others to Murgante.]

Keywords Ecological development • Geostatistics • Socio-economic development • Urban planning strategies

6.1 Introduction

Urban planning in western countries over the past two centuries has developed with the aim of identifying territories involved in governing relentless demographic and economic growth phenomena, often involving overcrowding, traffic issues and housing tensions. Although in the contemporary most populous nations of the world (China, India, Indonesia, Brazil, Russia and Pakistan) cities continue to grow, in western countries there are numerous cities that suffer from obvious demographic and economic contraction phenomena [21]. The causes are numerous[1] and not simple to identify, yet the consequences and phenomena associated with such demographic and economic decline are often similar: increasing numbers of empty properties, stagnation and economic recession, the reduced attraction of the city. A definition of a shrinking city is required in order to better understand such a phenomenon. To date there still exists no widely accepted, unique or shared definition within the international scientific community. Indeed, the phenomenon is described along various lines, often overlapping with distinct concepts such as *urban decline* or *urban decay* [11, 14] coined or previously brought into question [15].

The term *Shrinking Cities* first entered parlance in Germany with the expression "Schrumpfende Städte" during the 1990s and defines, according to the *Shrinking Cities International Network* (SCiRN) research group, densely populated urban areas with a minimum population of 10,000 residents which have suffered a loss of population in the majority of the territory during the previous 2 years and are experiencing economic transformation demonstrating various symptoms of structural crisis [23].

Such shrinking cities have been the subject of studies on urban change in traditional research fields such as demographic and cultural change, urban social geography, suburbanization, deindustrialization and urban regeneration amongst others [30]. It is, therefore, imperative to recognize how such processes may be linked, or contribute towards the phenomenon of the contraction of cities.

Shrinking cities can take on differing characteristics according to the context in which they occur. Studies on the dynamics of growth and decline over longer periods (up to 100 years) assist in an understanding of the phenomenon and, for instance, exemplify why a period of decline may have replaced a previous period of

[1] Oswalt [22] and others have attempted to draw up a classification of shrinking cities based on possible causes.

growth, or vice versa. A generalization of the phenomenon remains problematic (as with all social phenomena), since shrinking processes occurring on similar spatial scales or in local contexts with similar characteristics may be substantially different in nature.

A loss of population is often seen as a sign of failure and may imply "losing out" in the national or global competition among cities. Research on the decline of cities across the globe [4, 7, 35] demonstrate population decline as an ancient phenomenon, linked to the natural course of events following demographic processes and economic change.

Research groups studying shrinking cities[2] are, however, highlighting the global dimension of a phenomenon often considered merely as an isolated "incident" in wealthy countries, requiring the investment of public funds and planning for a new period growth in order to resolve the issue. The inexorable decline and the relentless depopulation of cities in the USA, Japan and Western and Eastern Europe have, however, stimulated scientific research towards identifying causes and ways of thinking about urban decline and regeneration.

6.2 Methodological Framework

6.2.1 Measuring Shrinking Cities

The study of cities in contraction provides, in the current social landscape, information essential to the development of regional planning strategies. For this purpose it is important to identify which indicators may be useful in "measuring" urban shrinkage and verify, through such study, the dynamics involved.

The existing literature comparing the evolution of cities in Europe [8] provides a picture of the mode of urban decline (and/or growth) measured to date. Comparative studies are generally based on population indicators [6, 9, 32]. There are, however, numerous examples in which population and economic development do not necessarily go hand in hand. There are, for instance, cases of cities that despite a decreasing population manage to maintain solid economic structure and

[2] The first international study on the phenomenon was the shrinking cities project carried out by Kulturstiftung des Bundes in Germany with the support of architect Philipp Oswalt, the Galerie für Zeitgenössische Kunst Leipzig, the Stiftung Bauhaus Dessau and the Archplus magazine (http://www.shrinkingcities.com/, web site visited 24 May 2012). Furthermore, the shrink smart project focuses on how challenges are met by policy and governance systems in various shrinking urban regions (http://www.shrinksmart.de/, web site visited 24 May 2012). Such work is supported by the above-cited Shrinking Cities International Research Network (SCiRN™, http://www.shrinkingcities.org/Home, web site visited 24 May 2012) as well as the Cost Action TU0803: Cities Re-growing Smaller (CIRES, http://www.shrinkingcities.eu, web site visited 24 May 2012). The two authors are members of this last European research group (CIRES).

development and, in others, general demographic stability yet significant problems concerning economic activity and employment.

Population may consequently be considered as an initial premise in urban processes as well as a leading indicator, yet the study of factors in demographic decline provides only a partial view of an issue involving far more complex dynamics.

A set of criteria related to economic and social issues in the context of the development of the population must be considered in order to describe such complexities. Specifically, such indicators regard the housing market, the labour market and economy as well as the environmental and cultural fabric of the case under study.

6.2.1.1 Population Total Evolution, Age, Migration

Three aspects seems to be considered in assessing population development: total evolution, migration and ageing. Population decline may be caused by a natural reduction in the population and/or emigration that, in many cases, leads to an ageing population.

Total Evolution

The natural balance of the population (birth/death rates) provides information on natural changes. Population growth is produced by the increase in births and, therefore, fertility rates and birth rates, essential in identifying current or recent growth in the population.

A decisive role in the evolution of the population is also played by singular events, such as a war or a natural disaster (it is particularly clear observing the so defined age pyramid of a country).

The variation in birth rates in many European countries reflects a change in reproductive behaviour, primarily due to changing political-economic and socio-cultural conditions, often brought about by a new conception of the role of the family and the woman (the second demographic transition). It is also necessary to consider the evolution of women of childbearing age as an expression of the development of future births [13].

Migration

Migration flows and their development, taking into account net migration, represent, together with the natural decline in births, a key factor for the study of urban decline.

In analyzing the phenomenon of migration it is necessary to consider the age of migrants, their place of origin, the characteristics of migrants (gender, age, social status) and causes of migration that may affect such a study in a number of ways.

Immigrants and women of reproductive age produce, for example, a natural decrease in population in their area of origin while, at the same time, a possible population increase in the new place of residence. Furthermore, the age of those migrating and whether or not such movements affect entire families is an essential factor in better understanding population dynamics. Indeed, in this case such a factor does not significantly affect the percentage of births. Migrants aged between 18 and 35 years old play a particularly decisive role [33] during phases of the creation of a family, in terms of both employment and education.

Birth rates and, above all, the abandonment of a city by the young lead to changes in population structure in relation to the age of those remaining (in particular, the selectivity of migration linked to ageing is largely responsible for such phenomenon).

To better understand the dynamics of the city motives for migration must be understood; the principal grounds for such movement is the search for jobs or on educational grounds resulting in long-distance migration [33]. This is accompanied by the desire to improve the quality of life in an environmental/aesthetic sense, health or the social environment, cases which may not necessarily see long distance migration.

The separation of internal (suburbanization) and external migration can also be significant as regards the employment conditions of migrants (those moving to the suburbs and not necessarily losing their job in the city). Migration due to economic downturn tends to produce the largest occupational impact on a city, together with demographic change [13].

Migration in search of employment by those willing to relocate over long distances is, furthermore, decisive in terms of development patterns in the local area of origin that cannot compensate for the draw of employment opportunities elsewhere.

The skills of the migrant population should also be considered as this phenomenon largely affects those with high levels of education and highly qualified personnel. This would also appear to be the case for migration over short distances.

Short distance migration mainly seeks to optimize lifestyles and, in analogy with the theory of the life cycle, such migration generally involves families and the elderly [13]. This is reflected in changes to age structures in the city and surrounding areas whilst not, however, significantly affecting the labour market [10]. The impact of this type of migration may, however, be identified with the increase of the total population in surrounding areas. Such dynamics characterize established phenomena of suburbanization in towns and cities. Migration and natural population growth can occur over similar time-scales yet demonstrating completely different dynamics.

Migration may suddenly and radically change while the fertility rate is characterized by set time-scales (a set time between birth and childbearing age). In contrast to the continuous loss of population, singular events trigger a rapid decline in the birth rate or increase migration in the short to medium term and, possibly, even the long term. A decline in population may result from individual events (episodic population) as, for example, natural disasters, war and political

transformation processes such as those of 1989/1990 in Eastern Europe following the disintegration of the Soviet Union.

Ageing

Ageing increases community dependence on younger age groups resulting in a potential decrease in the per capita wealth produced [13]. The most widespread indicator in measuring such a phenomenon is the *dependency ratio*, commonly employed in reports on world population trends by the Department of Economic and Social Affairs of the United Nations.[3]

6.2.1.2 Social Indicators

Structural economic change (such as the loss of the industrial base in western countries) can provoke a loss of jobs and population, when combined with demographic changes, in a highly problematic vicious circle. Socio-demographic change plays a decisive role due to the concurrence of several demographic and economic causes and factors.

As mentioned above, migration is highly selective (mostly affecting the young and qualified), with consequences in the areas concerned; those who migrate no longer play a part in the local labour market. This favours the approach of supply towards demand for both the qualified (job vacancies) and unskilled (LTU) labour market, as well as a quantitative increase. The economy is also affected due to the remaining population (the poor, the elderly, trainees and immigrants) being frequently discriminated from the labour market (low-skilled workers, unemployment) [32].

The income of the population indicates the state of economic well-being and a reduction in wages will result in lower family incomes and an increase in economic disparity. In addition, growing unemployment could cause an increase in the number of people living below the poverty line.

The situation of the young is particularly critical. Without access to jobs their entry into the labour market is consequently delayed, accompanied by a dwindling in the creation of new families who may struggle to identify employment opportunities. Similarly, the decline in the attraction of a city as a place for education may provoke a decrease in the number of students enrolled in compulsory education and, therefore, the closure of schools (preschool and school facilities) resulting in reduced investment in education. Students are, furthermore, essential for the development of a city as they require accommodation, food, supplies and educational facilities and may increase the skill levels of the population. The

[3] The Department web site (http://esa.un.org/unpd/wpp/Excel-Data/population.htm) reports old-age dependency ratios for all nations in the world.

presence of low-skilled citizens in the labour market could result as disadvantageous for the economy of a city.

Levels of education and, in particular, labour, schools and recreational facilities are therefore crucial in the educational and cultural life of a shrinking city.

6.2.1.3 Economic Factors

Population decline reveals a strong correlation and interrelation with economic development. Indeed, economic analysis can be described by structural economic change in cities.

The central problem is not the transformation of the economic base but, rather, its extensive erosion. Traditional production may not, in this case, be replaced by modern services or other branches of the service sector [33] that have a corresponding effect on social structure and space. Structural economic crisis sees the economy as a whole shrink due to changing economic conditions, possibly followed by a long period of contraction [34]. Such circulation in economic cycles is characteristic of the theory of long waves and the duration of product life cycle. This can have global economic consequences yet may simply relate to specific areas, such as the dispersion of textile and mining towns in northern England [12] or, indeed, the present study of the crisis in the steel industry in Italy and, in particular, in Taranto [26].

The above examples relate to "single product" economic areas whose main characteristic is the long period of decline in demand resulting in a crisis that tends to spread to other companies, industries or economic sectors in the same region or city [12].

In addition to long-term processes of economic restructuring due to globalization and the destruction of the industrial base, especially in established industrial cities, economic change may also be recorded over a relatively short period. The processes of economic restructuring (globalization and de-industrialization) differ according to both regional contexts and city size [12].

The contentious parameter of gross domestic product (GDP) is often still applied in the absence of viable alternatives when describing changes in the economy (this fundamental question has been debated many times and by many authors, but yet no results have been reached in the real policies to change this insufficient indicator).

Employment dynamics provide a quantitative indication of the effects of economic changes on the population and, therefore, on society.

The study of unemployment must be analyzed in conjunction with the development or loss of jobs while taking into account the possibility of immigration movements. The indicator of unemployment is, in itself, incapable of considering this effect in its entirety. From the combination of the two indicators it is, however, possible to draw conclusions on the state of the labour market.

6.2.1.4 Housing Market Indexes

Population dynamics (whether natural or due to migration) has a significant impact on real estate market and housing development. A declining population may reflect the decrease in the number of families and it may determine a declining house's request. Socio-cultural variations in behaviour and lifestyle may also lead to changes in family structure away from a traditional multigenerational family. Indeed, many societies witness an ever-increasing number of mononuclear families. This change is reinforced by selective emigration (young singles or couples) and increased life expectancy (greater proportion of the elderly living alone). Nevertheless, the overall number of families may not, in fact, decrease, due to the growing number of smaller households (single person families). In Italy, the number of family's components has been declining from 3,3 persons for each family in the 1971 to 2,2 in 2010.[4] The family structure is changing (in terms of a transformation in household structure) and with it the needs of the family thus generating changes in demand with a consequent affect on property values (land and house prices). Contraction in cities may, moreover, involve a decrease in construction; in addition to a shift in price levels (rent, land and housing prices), financial problems can be caused by the presence of numerous vacant properties [25].

It should, however, be noted that the housing market is closely linked to the functions of a city (as, for example, the functions of a regional capital, tourist city, etc.). In order to study *housing indicators*, it is therefore necessary to examine the nature of the real estate market in question including, for example, the type and segmentation of the request or the attractiveness of the city (urban added value).

6.2.1.5 Environmental Factors

Environmental aspects could play a significant role in a shrinking city. Lower population densities may constitute the better use of the environment by citizens, reducing the environmental impact related to urbanization, thus improving the quality of life of residents.

A crucial aspect in ecological issues is that of time. Ecological changes may occur over the relatively short or medium term, while their consequences are generally medium to long term in nature.

In the case of the city of Taranto the long presence of the steel industry and the high pollution rates produced were the significant factors in the phenomena of suburbanization.

Some young couples have chosen to live near Taranto in a smaller town but with a better environment [27].

[4] Data derived from www.istat.it, web site visited 24 May 2012.

6.2.1.6 Methodological Issues

Initial difficulty lies in the fact that population decline takes on distinct characteristics from city to city; the second issue concerns the choice of indicators that may best describe the phenomenon.

Such indicators provide a starting point for the analysis of shrinking cities; yet, it is necessary to identify the relationships and interrelationships between such parameters.

Economic and demographic dynamics cannot, for example, be treated separately since they are often interrelated. The abandonment of cities could coincide with the reduction of job opportunities in highly qualified companies. Unemployment may, for example, result as the consequence of declining business, leading to emigration and increasing the dependency ratio, thus causing an aging population.

Having identified indicators of contraction study should be focused on their evolution over time in order to better understand dynamics in the medium to long term. The choice of the time intervals becomes critical as they affect results, considering that neither growth nor contractions are linear processes. Data availability is also crucial for comparative analysis and is dependent on both times and scales.

A further methodological problem occurs when comparisons are performed between countries as a result of different detection methods. The question of comparative indicators of a small European range is highly complex as even countries outside the European Union do not all possess equivalent indicators and several new Member States have not yet adopted European standards.

At the end, the majority of geo-statistical works about shrinking use data at a municipal level to measure shrinking phenomena, but, in our opinion, it seems insufficient to evaluate medium and big shrinking cities phenomena, because very often they are linked to suburbanization or changes in the neighbourhoods dimensions, caused by urban degradation or subsequent regeneration process. That is why, in the next paragraphs, we have tried to identify spatial concentration of urban shrinking in micro census zones inside a medium city such as Taranto in the Apulia Region, already evaluated as a shrinking city [26] and the nearest municipalities probably affected by phenomena of suburbanisation. These micro census zones named "sezioni" in the Italian Census survey.[5]

6.2.2 *Spatial Statistical Techniques Applied to Shrinkage Phenomena*

The identification of spatial concentration of urban shrinking has been achieved adopting spatial autocorrelation techniques.

[5] Istat, Censimento generale della popolazione, 1991, 2001, available on www.istat.it visited 24 May 2012.

The concept of spatial autocorrelation directly derives from the first law of geography by Tobler [31]: "All Things Are Related, But Nearby Things Are More Related Than Distant Things."

Analyzing the spatial dimension of statistical data it can be noticed that they are not mutually independent, values of a spatial unit phenomenon tend to influence values of contiguous spatial elements, and a certain degree of interdependency occurs in all directions due to the interaction with other neighbouring elements.

Considering two elements i and j in a set of n objects, traditional approaches to data analyses take into account the degree of similarity of attributes i and j, at the same time spatial autocorrelation considers the degree of similarity of location i and j, also. Spatial autocorrelation does not analyze a phenomenon along a single direction, but it considers all possible relationships of an element with its surrounding spatial units in all directions. This is important to understand whether a phenomenon is isolated or it has a good level of interaction with its surrounding elements.

The concept of contiguity can be defined as a usually symmetrical generalized matrix of W weight, representing the pattern of connections or ties and their intensity [5], where w_i weights denote the effect of spatial unit j on unit i. Generally a dichotomic contiguity matrix has been adopted where $w_{ij} = 1$ if the i area touches the boundary of j area, and $w_{ij} = 0$ if otherwise. Distances of centroids of spatial elements, square of distances, inverse of distance, etc. can be considered instead of value 1. In the case of point data, it is also possible to define a critical distance beyond which two events will never be adjacent. If the elements are included within this distance, i and j are contiguous, and w_{ij} will be equal to 1; otherwise, w_{ij} will be equal to 0.

Both global and local autocorrelation indexes have been adopted in analyzing urban shrinkage phenomena. Global indicators of autocorrelation are useful to identify if a spatial interdependence exists or not without describing where the phenomenon is concentrated. Local indexes of autocorrelation define where highest or lowest levels of autocorrelation are located.

In this study, Moran Index (I), corresponding Moran scatter plots and Local Indicator of Spatial Association (LISA) have been calculated. Moran I provides an overall measure of spatial autocorrelation [16], Moran scatter plot [1] allows to achieve a graphic representation of spatial relationships and enables us to investigate possible local agglomerations, whilst LISA allows us to take into account local effects of the phenomenon [2, 3].

6.2.2.1 Moran's *I* Statistic

Moran Index (1948) can be formalized as follows:

$$I = \frac{n}{s_0} = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n}(x_i - \bar{x})(x_j - \bar{x})w_{ij}}{\sum_{i=1}^{n}(x_i - \bar{x})^2} \tag{6.1}$$

where:

- x_i is the variable observed in n spatial partitions and $\bar{x}$ is variable average.
- W_{ij} is the generic element of contiguity matrix.
- $S_0 = \sum_{i=1}^{n} w_{ij}$ is the sum of all matrix elements defined as contiguous according to the distance between points-event. In the case of spatial contiguity matrix, the sum is equal to the number of non-null links.

Since the expression of spatial dependence refers to the connection between nearest units, prior of autocorrelation concept, there is the problem of expressing the degree of proximity of areas by defining the concept of spatial contiguity [20].

Index values may fall outside the range -1; $+1$. Moreover, in case of no autocorrelation the value is not 0 but it is $-1/(n-1)$. So if:

- $I < -1/(n-1) =$ negative autocorrelation,
- $I = -1/(n-1) =$ no autocorrelation,
- $I > -1/(n-1) =$ positive autocorrelation.

A positive and significant value of such statistic indicates that similar values of the variable analyzed tend to characterize contiguous localized areas. In contrast, a significant negative value of Moran-*I* indicates the presence of dissimilar values of the variable in contiguous areas. The significance of the index does not imply absence of autocorrelation, i.e. the presence of a random distribution of the variable in space.

Moran's index, however, does not allow to evaluate if the general positive spatial dependence corresponds to territorial clusters of regions with high or low level of specialization. It is also possible that the degree of spatial dependence between various different groups within the sample is characterized by the existence of a few clusters, located in specific parts of the study region. Considering these limitations, Moran scatter plot has been adopted.

6.2.2.2 Moran Scatter Plot

GEODA software [1] allows to build Moran scatter plot together with the calculation of Moran's *I*. The graph represents the distribution of the statistical unit of analysis. Moran scatter plot shows the horizontal axis in the normalized variable x, and on the normalized ordinate spatial delay of that variable (W_x).

The first and third quadrants represent areas of values with positive correlations (high–high, low–low) while the second and fourth quadrants represent areas in negative correlation.

However, Moran scatter plot gives no information on the significance of spatial clusters. The significance of the spatial correlation measured through Moran's *I* and Moran scatter plot is highly dependent on the extent of the study area.

In case of a large territory the measure does not take into account the presence of heterogeneous patterns of spatial diffusion. Moran's *I* cannot identify outliers

present in the considered statistical distribution. LISA allows to consider local effects related to the phenomenon.

6.2.2.3 Local Indicators of Spatial Association

The currently most popular index of local autocorrelation is the so-called LISA [2, 3]. This index can be locally interpreted as an equivalent index of Moran. The sum of all local indices is proportional to the value of Moran one.

The index is calculated as follows:

$$I_j = \frac{\sum_j w_{ij}(y_i - y)(y_j - y)}{\sum_i (y_i - y)^2} \tag{6.2}$$

with: $\sum_i Ii = \gamma \cdot I$.

For each location, it allows to assess the similarity of each observation with its surroundings. Five scenarios emerge:

- Locations with high values of the phenomenon and high level of similarity with its surroundings (high–high), defined as HOT SPOTS.
- Locations with low values of the phenomenon and high level of similarity with its surroundings (low–low), defined as COLD SPOTS.
- Locations with high values of the phenomenon and low level of similarity with its surroundings (high–low), defined as potential "Spatial Outliers".
- Locations with low values of the phenomenon and low level of similarity with its surroundings (low–high), defined as potential "Spatial Outliers".
- Locations devoid of significant autocorrelations.

LISA can effectively bind a measure of the degree of spatial association relative to its surroundings to each territorial unit, allowing to highlight the type of spatial concentration for the detection of spatial clusters.

6.3 The Case Study

The application has been developed in southern Italy, more particularly Taranto and its surrounding municipalities have been considered in quantifying the shrinkage (Fig. 6.1).

Taranto has 191.810 inhabitants distributed over 209.64 km^2, it was one of the main centres of Magna Grecia, it has the second Italian trading port for freight traffic, mainly connected with Asia and it has important industries in the fields of iron, steel and oil refinery. The localization of these activities generated a great dwelling demand, complied with the construction of very intensive

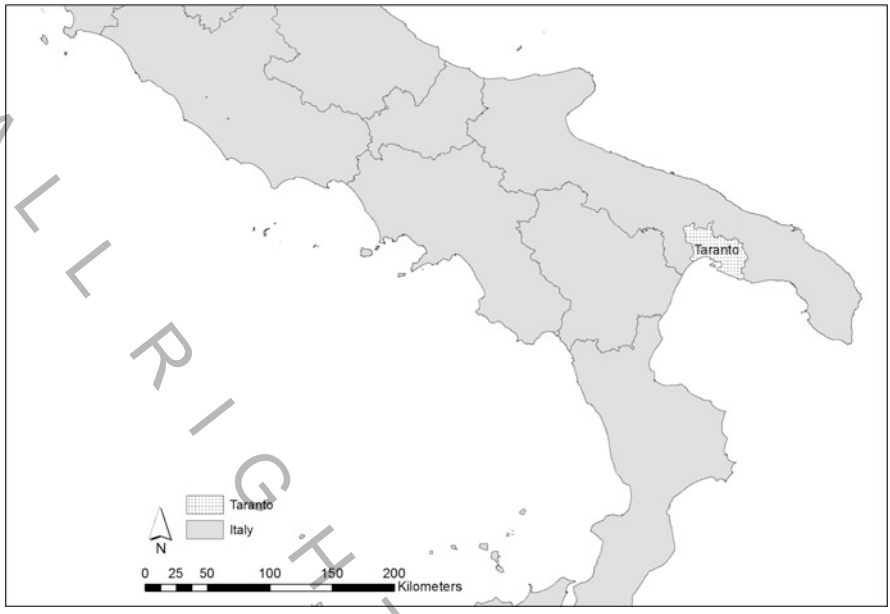

Fig. 6.1 The city of Taranto and its surrounding municipalities in the South of Italy

neighbourhoods. Such a disordered growth realized without master plan, produced urbanization in areas largely disconnected and without continuity. These activities produced a lot of health and environmental problems. Taranto is one of the most polluted cities in Western Europe due to industrial emissions. From this description it can be easily imagined that Taranto could be a very interesting case study in measuring shrinkage.

6.3.1 A Demographically Declining Territory: Taranto City

A brief analysis of the major demographic, economic and social trends at a municipal level highlights possible relations with the dynamics of urban evolution, leading to a clear understanding of the high level of shrinkage in the city. The analysis of the last available census (2008) by the Italian National Statistical Institute (ISTAT[6]) revealed the demographic dynamics (population trends, Net migration, natural balance) of the city are in a constant negative trend, from 1981 to the present. Indeed, the population of Taranto fell from 244,101 in 1981 to

[6] All the statistics cited are taken from www.istat.it.

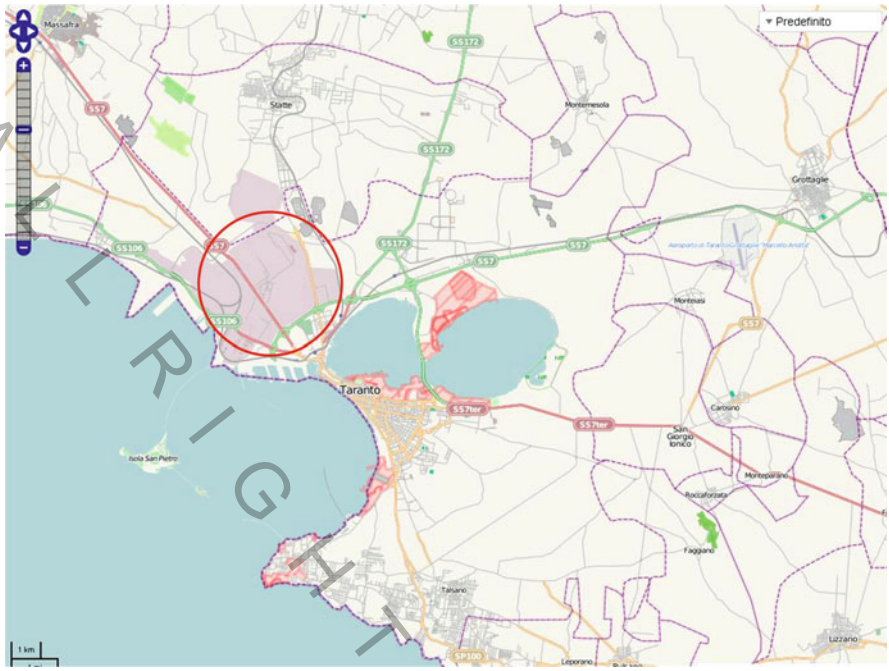

Fig. 6.2 Taranto the city of the two sea. On the *left side* of the image the whole area of the city is dedicated to the ILVA steel plant. (*Source*: OpenStreetMap.)

194,021 in 2008. Net migration is consistently negative from 2002 to 2008 and the city loses, on average, 1,123 inhabitants per year.

The natural balance (live births/deaths) has been constantly negative with the exception of the years 2004 and 2008. In these two years the natural balance is, in any case, significantly below the Net migration as previously shown, with an average of −1,123 inhabitants per year with the overall balance therefore remaining negative. Globalization and the subsequent de-industrialization of European economies is a major cause of urban shrinkage [4, 12, 21]. The relationship between the cycles of the capitalist economy, the life cycles of the city and the effects of globalization on cities and urban regions has been the subject of much study, by authors such as Saskia Sassen.

In the case of Taranto the unemployment rate for the entire Province is 4 % higher than the Apulia Region (18 % with respect to 14.7 % for the Apulia Region as a whole). Indeed, the percentage of those employed in the city of Taranto is 78 % as compared with 80 % in the Province and the Region. Moreover, the total percentage of those in search of employment in the city of Taranto is 22 %, as compared with 20 % in the Province and the Region. Taranto shows a low level of employment compared within its local region .

In the city of Taranto, as in other European cities, the service sector accounts for the largest number of those employed, although traditional industry still accounts for 25 % of total employees (13,767 employees in an industrial sector with 55,174

employees in total). The largest steel plant in Europe is located in Taranto which still employs around 13,346 workers, accounting for almost 100 % of employment within the manufacturing sector in the city. The plant was founded during the 1960s as a state-owned company, under the name "Italsider" in line with fashionable economic and industrial theories of the day regarding large industrial poles (Fig. 6.2). In 1995, after a long crisis in terms of both turnover and employment, the company was sold to the Riva Group (www.rivagroup.com), a major Italian industrial group that operates in the steel industry. Employees in the iron and steel industry are still today predominantly located within younger age groups (21–30 years) with only 23 % exceeding 40 years of age. The steel industry is still, therefore, of fundamental importance to the local labour market of the city of Taranto and its neighbouring municipalities, a plant which would seem extremely difficult to decommission given the long period of economic crisis engulfing western countries [26].

6.3.2 *Choosing Indicators for Taranto*

The following variables, previously tested in another study [19], have been considered in order to evaluate shrinkage phenomena:

- Dependency ratio is considered as an indicator of economic and social significance. The numerator is composed of people who, because of age, cannot be considered economically independent (youth and elderly), and the denominator of the population older than 15 and younger than 64, who should provide for their livelihood. This index is important in analyzing urban shrinkage because economically active population highlights a degree of vitality in city. While a low level of economically independent population coupled with low birth rate denotes a large presence of hold population.
- Foreign population per 100 residents. Normally foreign number is considered as capability attractiveness, but in southern Italy, where concealed labour rate is 22.8 % and unemployed rate is 20 %, immigration phenomena can be considered a threat and not an opportunity [17, 29].
- Unemployment rate undoubtedly is an important indicator of economic urban decay, which prospects future migration scenarios.
- People living in rented flats. In Italy dwellings ownership rate is more than 80 %; consequently, if resident population lives in rented flats this implies a low-income. In Italy the percentage of tax evasion is high; consequently dwellings ownership is an indicator of economic robustness.
- Per cent of population which had never been to school or dropped out school without successfully completing primary school programs: these indicator denotes the poor quality of social services and social programmes in education.

Table 6.1 Moran Index at 1991 and 2001

Indicator	Moran's *I* (1991)	Moran's *I* (2001)
Dependency ratio	0,4860	0,5580
Unemployment rate	0,3808	0,3427
People living in rented flats	0,1410	0,2572
Foreign population per 100 residents	0,027	0,3452
Population which had never been to school or dropped out school without successfully completing primary school program	0,2882	0,3117
Number of people per room in flats occupied by residents	0,1059	0,1515

- Number of people per room in flats occupied by residents. People living in very crowded flats is an underdevelopment indicator because a household can have a flat without respecting the minimum standards, 33 m^3 for inhabitant.

6.3.3 Spatial Distribution of Urban Shrinking

Spatial data have been considered at buildings scale and polygons have been converted in points. Attributes have been associated with such data using census data. In particular, census data of 1991 and 2001 have been adopted. As previously explained, Moran Index is a global indicator of autocorrelation, able to detect a tendency in the whole study area, without precisely defining where the phenomenon is more concentrated. Despite Moran Index lacks in giving a detailed spatial location, it is important for a general analysis of the phenomenon.

Table 6.1 highlights that autocorrelation occurs, in most cases in significant way, for great part of the considered variables. The only Moran Index value close to zero is the Foreign population in 1991, which represents the beginning period of migration phenomenon. Despite this low value, it is important to notice a large increase in transition from 1991 to 2001, where Moran Index reaches a medium level of autocorrelation. The comparison of this index between two different dates allows to assess the phenomenon trend over time.

Data concerning phenomenon concentration have to be compared with the decrease in total population; it means that despite the presence of less people, occurrences of events are more clustered. Considering that the population decrease between 1991 and 2001 in Taranto is 7.2 % and that, at the same time, this reduction arises throughout the whole province, it means that several phenomena are more concentrated in few parts of the study area, increasing the difference in urban quality.

Moran scatter plots at both dates and for all six variables (Figs. 6.3 and 6.4) have been calculated considering standardized variables as abscissa, and spatial weighted standardized variables as ordinate. In the graph, Moran Index corresponds to the direction coefficient of linear regression which represents the scatter plot.

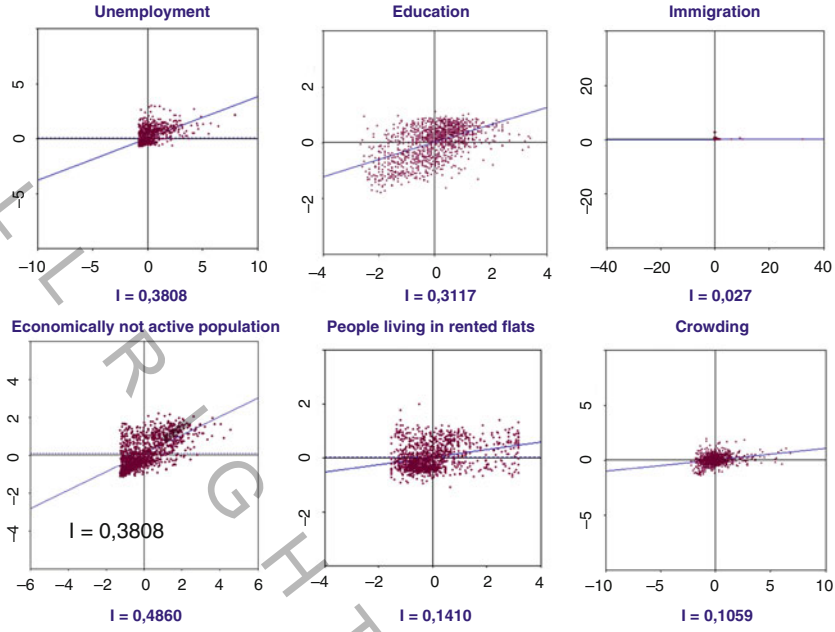

Fig. 6.3 Moran scatter plot for the six variables in 1991. (*Source*: our elaboration with GeoDa on ISTAT data.)

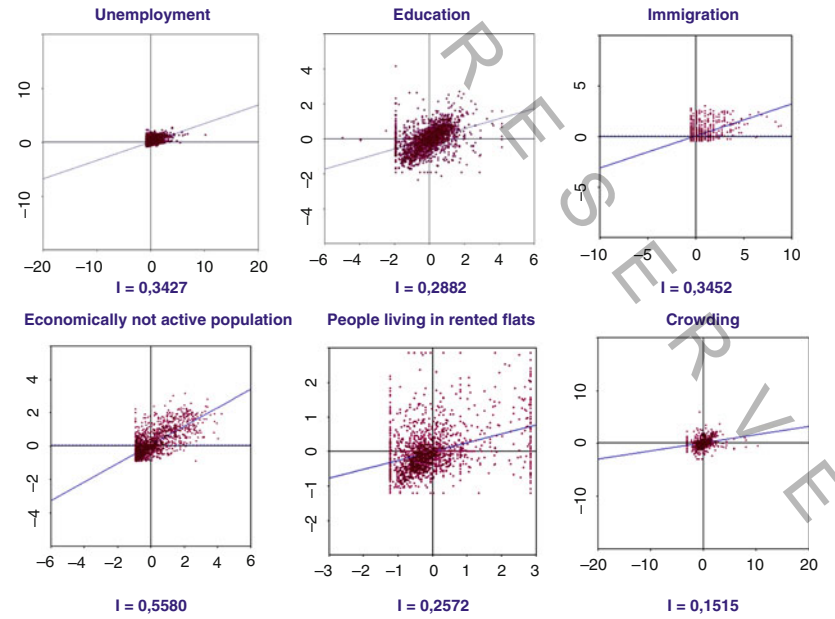

Fig. 6.4 Moran scatter plot for the six variables in 2001. (*Source*: our elaboration with GeoDa on ISTAT data.)

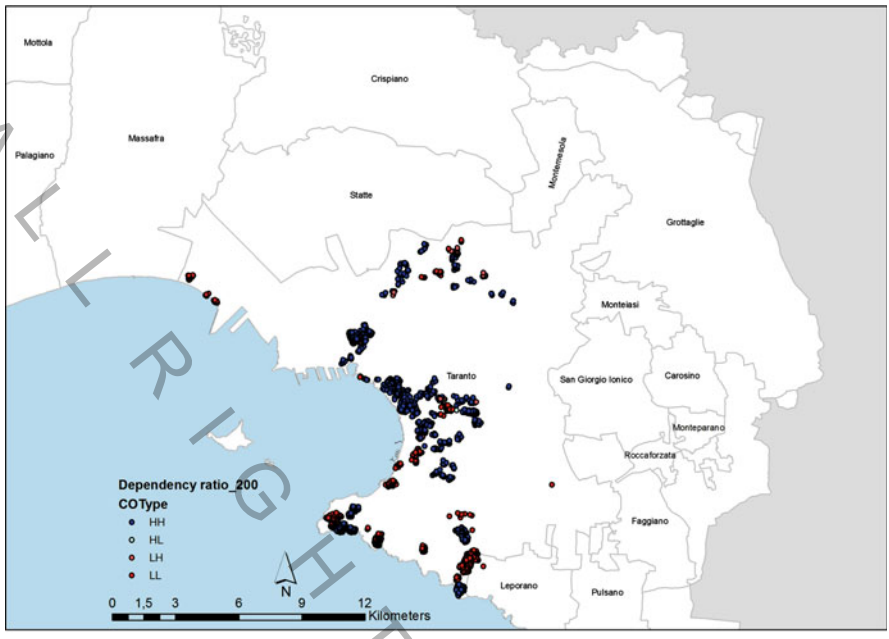

Fig. 6.5 LISA cluster map of dependency ratio, with fixed distance band of 200 m

Spatial autocorrelation has been classified according to Moran scatter plot quadrants. Positive autocorrelation corresponds to spatial clusters upper right (high–high) and lower left (low–low) quadrants. Lower right (high–low) and upper left (low–high) can be classified as spatial outliers.

Figures 6.3 and 6.4 show that the slope of Moran Index is concentrated within the first and fourth quadrants; consequently spatial autocorrelation is positive.

Despite global spatial autocorrelation analysis generates just a value which summarizes the whole study area, the significance of results encourages to apply local autocorrelation index. In many geographical applications, it is highly possible that similar values are located very close to each other. LISA Index allows to discover where the phenomenon is more clustered. After interpreting the current tendency using Moran Index for 1991 and 2001, it is important to understand the place where adopted variables have comparable values. In the study case the attention will be completely paid to 2001 data.

In results achieved adopting LISA, only "hot and cold spots" and potential "Spatial Outliers" have been visualized on the maps while elements without significant autocorrelations have not been showed in order to ensure a clearer visualization. As previously explained, the central aspect characterizing the spatial component in autocorrelation is the weight matrix W.

In the case of point data, the only possible elements of weight matrix can be calculated adopting a fixed distance band. If the spatial unit, which represents buildings, is included within this distance, elements are considered contiguous.

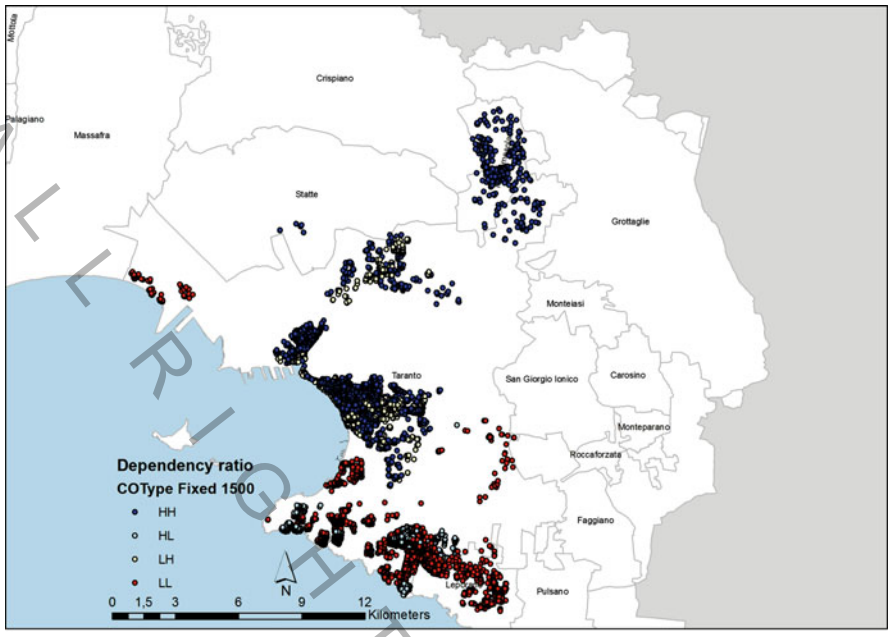

Fig. 6.6 LISA cluster map of dependency ratio, with fixed distance band of 1,500 m

Therefore the choice of such a distance is fundamental in order to achieve good results [18].

As an example, considering Figs. 6.5 and 6.6 the same variable, dependency ratio collects very different results of LISA index adopting a distance of 200 and 1,500 m, respectively.

In this case a distance of 200 m (Fig. 6.5) includes few buildings in a neighbour; consequently, it is not enough to compare the similarity of a variable of contiguous elements. In Fig. 6.6 the dependency ratio with a distance of 1,500 m collects good results, showing that the phenomenon is mainly concentrated in the old part of Taranto city, in the Talsano, Salinella, Tamburi and Paolo VI neighbourhood and in Montemesola municipality. These results highlight a concentration in the direction between Taranto and Martina Franca, the second largest and more populated city of the Province after Taranto.

Obviously, length of the distance is related to study area dimension. In the case of a small municipality, 200 m could be enough.

Analyzing the variable "number of people per room in flats occupied by residents", which can be considered as a crowding index (Fig. 6.7), it is very clear that officially this is not a problem for the area. Nevertheless, the large amount of non-regularized foreign people misrepresents the index in a conspicuous way. In Italy, a strong increase in foreign residence permits has been registered in 2002, following the approval of a law by Italian parliament, concerning immigration discipline and rules.

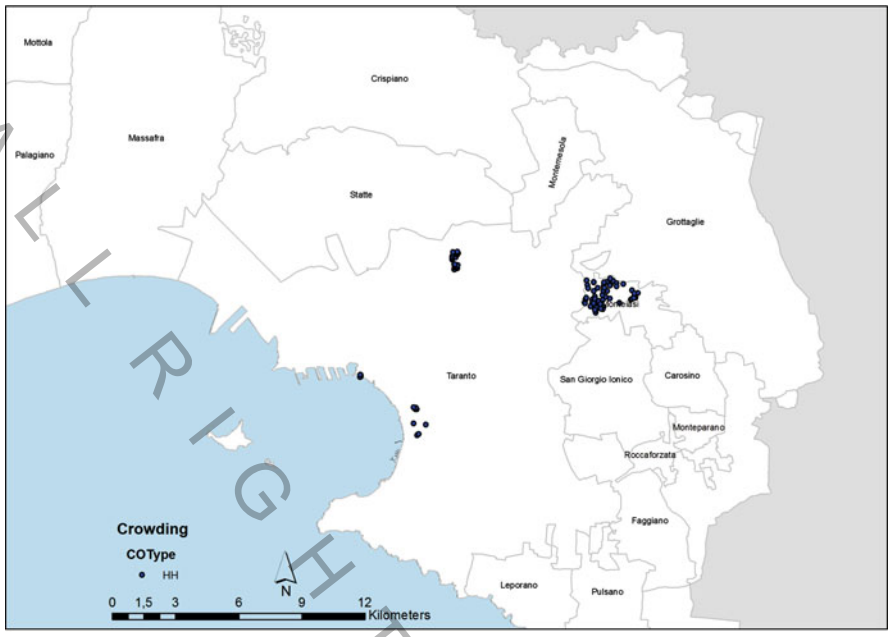

Fig. 6.7 LISA cluster map of crowding index, with fixed distance band of 1,500 m

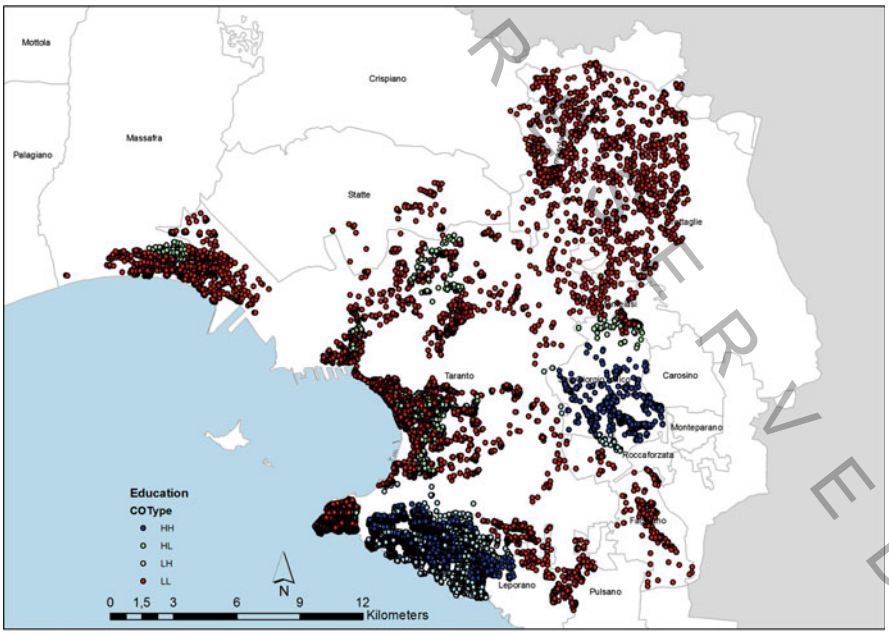

Fig. 6.8 LISA cluster map of educational level of population, with fixed distance band of 1,500 m

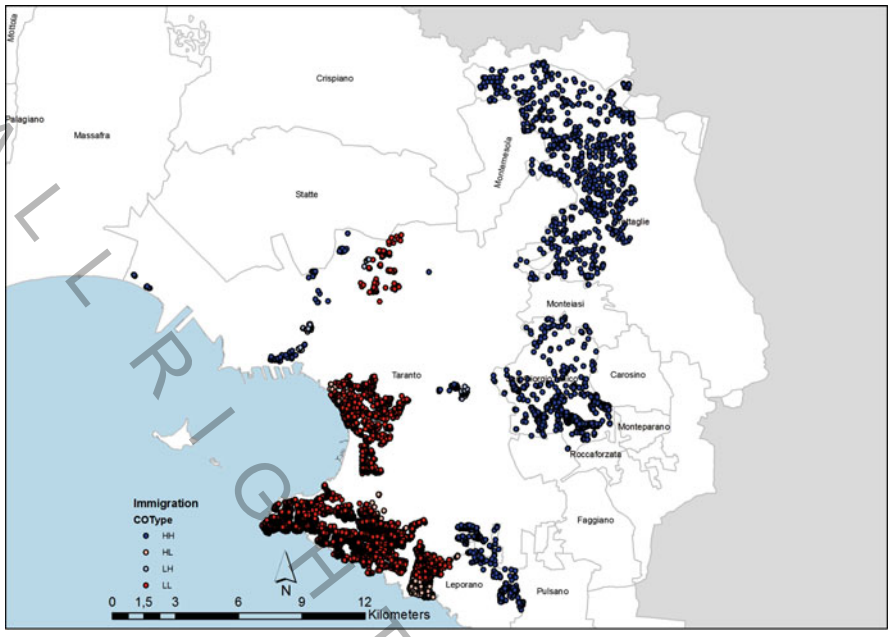

Fig. 6.9 LISA cluster map of immigration, with fixed distance band of 1,500 m

Analyzing the educational level of population (Fig. 6.8), the large clustering of "people which had never been to school or dropped out school without successfully completing primary school program" is mainly concentrated in the old part of the city with a high rate of elderly population and in the Talsano, Salinella, Tamburi and Paolo VI neighbourhood and in several municipalities surrounding Taranto (Montemesola, Grottaglie, San Giorgio Ionico, Faggiano) (Fig. 6.9).

Analyzing the cluster map of immigration the large clustering is mainly concentrated in the hold part of the city, with some hot spots in the same quarters of the city previously cited and in several municipalities surrounding Taranto (Grottaglie, San Giorgio Ionico, Leporano).

Unemployed clustering is more concentrated within the city of Taranto (Fig. 6.10).

6.4 Conclusions

This first essay to employ geo-statistical methods to identify spatial concentration of urban shrinking in micro census zones inside a medium city such as Taranto and in the nearest municipalities probably affected by phenomena of suburbanization has shown that it can be helpful to highlight quarters and directions of suburbanisation.

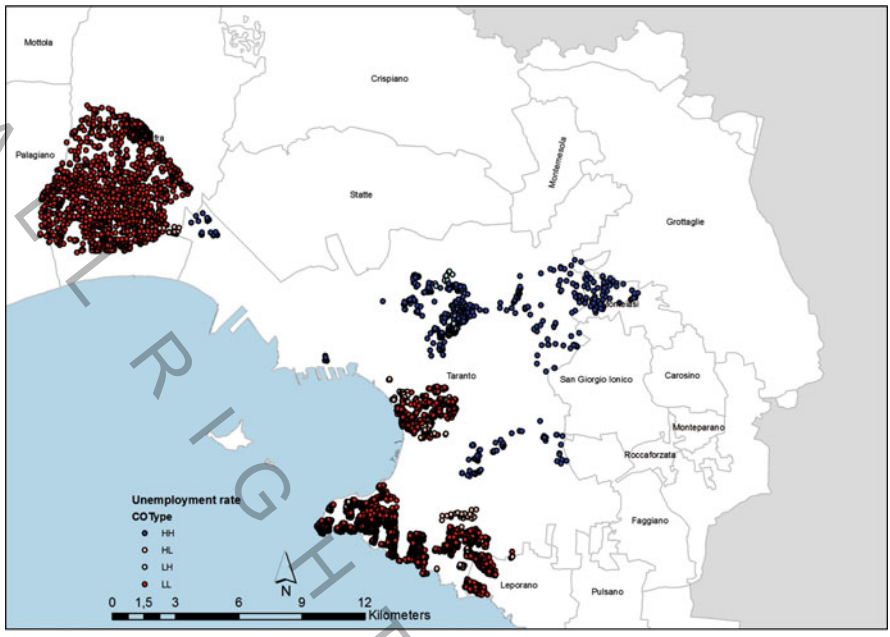

Fig. 6.10 LISA cluster map of unemployment rate, with fixed distance band of 1,500 m

It seems interesting the possibility offered by these analyses to deep the shrinking investigation inside the city, bringing out the quarters, the parts characterized by urban decline phenomena. In spite of having been used only six indicators, then a reduced number of indexes, in the case of Taranto, the study has indicated a probable presence of shrinking phenomena in the quarters which in other studies have been resulted to regenerate [26–28]. Tamburi, Paolo VI and Salinella quarters, in fact, together with old city center have all been the objective of regeneration policies.[7] In these quarters the economic situation is really difficult and the population decline is accompanied by a physical degradation, as already demonstrated in other studies [28]. It has also shown a direction for the suburbanization phenomena highlighting the census zone interested by the correlation.

The essential nature of the suburbs is that they are not constituted territories but dynamic, developing spaces undergoing slow, or even rapid transformation. Moreover, the suburbs are territories that cannot be completely remodelled: they can only be altered bit-by-bit, according to the degree of obsolescence of their different parts (uncultivated land, residual zones that can be bought up with public funds, partial

[7] The Salinella neighbourhood contract (€3 m), the Urban II program (€39 m), the Tamburi program agreement (€68 m), the Paolo VI program (€4 m), the Talsano program (€4 m) and Inner City Interventions (€6 m) are all autonomous programs with different urban objectives which are potentially useful [24].

urban renewal operations), or else according to political opportunity (planned transformation of a sector using public resources).

Geo-statistical methods could be effective to represent this suburbs dynamics, just analyzing data at a micro level. These tools could be more and more important for the larger cities where shrinking phenomena could be relevant inside the same city or the suburbanization could move inhabitants to the nearest municipalities, so increasing car mobility and in some case exalting shrinking phenomena.

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