

Article

An Axiology of Weak Areas: The Estimation of an Index of Abandonment for the Definition of a Cognitive Tool to Support the Enhancement of Inland Areas in Sicily

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Abstract: The marginalization of areas due to a progressive increase in social, material, economic, and infrastructural vulnerability is a phenomenon that afflicts many countries today, and it is growing rapidly. Agenda 2030, in highlighting the need to identify measures to counter this phenomenon, has promoted the development of a growing awareness of addressing this issue that cannot be postponed. With this in mind, in Italy, a map of inland areas was produced by the Interministerial Committee for Economic Planning and Sustainable Development (ICEPSD), a publication aimed at measuring the extent of the phenomenon and support the development of specific strategies that collectively define the National Strategy for Inland Areas (NSIA). In this study, starting from a critical analysis of the classification of areas in the National Strategy for Inner Areas, we propose a new cognitive tool of the phenomenon of abandonment developed from the perspective of an axiological approach of marginal areas. This tool is based on the mapping of an abandonment index I_a on QGIS with reference to the clusters of municipalities identified based on the quartiles of its values. This index was estimated as an aggregate weighted sum of the components identified because of the Principal Component Analysis (PCA) used to analyze the indicators of different forms of territorial capital of weak areas.

Keywords: inland area; territorial capital; axiological approach; principal component analysis (PCA); abandonment index; map of abandonment; National Strategy for Inner Areas (NSIA); vulnerability of territories; resilience of territories; National Recovery and Resilience Plan (NRRP)



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1. Introduction

The marginalization of abundant areas due to the progressive increase in social, material, economic, and infrastructural vulnerability is a complex phenomenon that requires an urgent response, one which can no longer be postponed [1–8].

The 2030 Agenda for Sustainable Development [9] provides general measures on less developed areas with reference to “Goal 11: Make cities and human settlements inclusive, safe, resilient and sustainable”, and in particular, targets 11.1, 11.2, 11.4, 11.6, 11.a and 11.c [10].

The European Commission, with Europe 2020 [11], promotes “smart, sustainable and inclusive growth” and greater economic and social policy coordination between the European Union and member states. Inclusive growth must promote an economy with a high employment rate, and must foster social and territorial cohesion.

Moving in this direction is the long-term vision for the EU’s rural areas [12], an initiative that creates a new momentum for rural areas, home to 30 percent of the EU’s population, building on new opportunities created by the EU’s green and digital transitions and on lessons learned from the experience of the pandemic effects of COVID-19 [13,14].

The Commission’s communication proposes a negotiation among citizens and other stakeholders in rural areas to create a rural pact and rural action plan aimed at making them stronger, more connected, resilient, and prosperous.

Laws have been enacted in Italy to support weak areas, such as Law No. 97 “New Provisions for Mountain Areas” of 31 January 1994, for the preservation and enhancement of mountain areas, which are of preeminent national interest” [15]; Law No. 158 “Measures for the support and enhancement of small municipalities, as well as provisions for the redevelopment and recovery of the historic centers of the same municipalities” of 6 October 2017 [16], aims to support, through incentives for development, small municipalities, although, to date, it has been cumbersome to implement. In order to facilitate better implementation of the policies proposed by Law No. 158, the Italian Ministry of the Interior issued the Decree of 10 August 2020, namely “Definition of parameters for determining the types of small municipalities eligible for funding under Law No. 158” of 6 October 2017 [16].

The report “Historic Centers and the Future of the Country” by the National Association of Historic Artistic Centers (NAHAC) and the Center for Economic and Social Research of the Building Market (CESRBM) [17] provides an analysis of the vulnerability/resilience ratio of the 109 historic centers of the Italian capital province, using the rankings of the main 8000 Census indices [18] processed by National Institute of Statistics (NIS) on population dynamics, household composition, aging of residents, integration of foreigners, housing adequacy and employment.

Comparisons of key demographic indices on the built heritage and economic activities at the scale of the historic center, municipal area and related values at the national scale are offered in the report. This study identified some guidelines aimed at the defense of historic centers, their preservation and enhancement, highlighting the urgency of defining a national policy to support the regions and municipalities, and the ineffectiveness of some of the instruments aimed at small historic centers in inland areas proposed by the previously mentioned Law No. 97.

In Italy, the National Strategy for Inner Areas (NSIA), which has been promoted by the Agency for Territorial Cohesion since 2013, provides support measures for territories affected by structural processes of depopulation and abandonment (1077 Italian municipalities, and just over 2 million inhabitants) [19].

The NSIA supports fragile territories, distant from the main centers of supply of essential services and too often left to their own devices, which, however, cover a total of 60 percent of the entire surface area of the national territory, 52% of the municipalities and 22 percent of the population.

In terms of financial support for actions to support weak areas, several packages have been introduced over time.

The legislative package on cohesion policy 2014–2020 (Italy, England, France) introduces important changes: strengthened coordination of the programming of the four EU funds linked to the Common Strategic Framework 2014–2020 in a single strategy document, and close coherence with the goals of the Europe 2020 “Strategy for Smart, Inclusive and Sustainable Growth” [20]. Following this, the 2021–2027 Partnership Agreement strengthened the use of European Development and Investment Funds (EIS) in pursuit of the Union’s Strategy for Smart, Sustainable and Inclusive Growth [21].

The Italian National Recovery and Resilience Plan (NRRP) funded by the European Union-NextGeneration EU, with reference to the implementation to Mission No. 5 “Inclusion and Cohesion” [22] has provided funding of 100–400 million euros from the Fund for Development and Cohesion (FSC) for “special interventions for territorial cohesion”, “National Strategy for Inner Areas, and “strengthening of community social services and infrastructure”.

The goal is to provide social services to at least two million citizens residing in inland areas, including at least 900,000 in southern regions, for which a minimum share of 40% of the total investment is reserved.

The amount of funding allocated for inland areas in Italy represents an important opportunity to be able to significantly promote their protection, conservation, and enhancement [23].

Funding will be disbursable based on the characterization of inland areas proposed by the Interministerial Committee for Economic Planning and Sustainable Development (ICEPSD).

The map of inland areas is an important knowledge base for strategy planning and intervention planning.

In this regard, ICEPSD has updated the first version of the map of inland areas from 2014, with a new version that is from 2020, which will support the Partnership Agreement 2021–2027.

The beneficiaries of funding will be all municipalities identified as intermediate, peripheral or ultra-peripheral areas in the proposed new mapping.

The cognitive support produced by ICEPSD is based on a characterization of inland areas with reference to the distance matrix, centers of service provision, demographic indicators, and some indicators of socio-economic and structural condition of the territories. It, in classifying areas into pole, belt, peripheral, and ultra-peripheral primarily based on the distance matrix and the level of services offered, provides cognitive support for the development of the National Strategy of Inland Areas, which may be incapable of detecting the residual values of territory. As a consequence of this, it may be unable to detect the residual resilience of these areas [24,25], contributing to the selection of inefficient strategies for them.

If the basic tool for promoting the implementation of specific policies and for allocating funding is unable to capture the values and/or dis-values of areas [25], it could contribute to making the former ineffective and the latter inefficient.

In order to improve the cognitive support for the development of strategies to support weak areas, the research from a critical analysis of the ICEPSD classification of inland areas proposes to develop one from the perspective of an axiological approach.

This approach is aimed at interpreting the values and/or dis-values of abandoned areas in order to explore their residual worth and support decisionmakers in the complex process of reinterpreting their values [26].

In this regard, the research will propose a new cognitive framework of the geography of abandonment, i.e., a new map of the phenomenon based on the representation in QGIS of an index of abandonment estimated in this study for the inland areas of Sicily, Italy.

The index will be constructed based on the characterization of the main forms of territorial capital, namely, human, urban, economic, infrastructural, natural, cultural, and environmental capital. Given the numerosity of the indicators, in order to arrive at the most representative set of indicators, and thus to reduce the complexity of the representation of the different forms of territorial capital, a methodological approach widely used in the literature for this purpose will be used, namely, Principal Component Analysis [27–31]. The abandonment index will be estimated as an aggregate weighted sum of the components identified as a result of Principal Component Analysis (PCA) [4] implemented on the values of the different forms of territorial capital of weak areas.

The paper is organized in the following sections:

- Section 2 proposes a survey of the phenomenon of abandonment;
- Section 3 introduces the case study: Area Classification in the National Strategy for Inland Areas;
- Section 4 illustrates the methodological approach;
- Section 5 reports the results;
- Section 6 proposes some reflections on the results, i.e., the abandonment map based on the aggregate index estimated in this study and some comparisons with the classification of areas for the National Strategy of Inner Areas; it then identifies the limits and the lines of future development of this research;
- Section 7 proposes a summary of the proposed research.

2. A Survey of the Phenomenon of Abandonment

Abandonment, obsolescence, indifference, and disaffection pervade many aspects of our existence. They affect spaces, landscapes, territories, artifacts, emotions, technology,

consumer goods, lifestyles, and thoughts. The rapid evolution of contemporary culture increasingly results in the loss of usefulness, wear and tear, and outgrowth of places, landscapes, and territories generating the condition of abandonment and obsolescence [32,33].

The condition of abandonment can be characterized in several manners: a physical sense, i.e., when one leaves a place; virtual when it is the result of a mental and affective process; social when territories are characterized by the progressive reduction of personal services and the concentration of phenomena, such as poverty, unemployment, low education, etc.; functional as a result of the divestment of activities and functions; and political as a result of inefficient or deliberately inequitable economic-social planning and governance in favor of some territories or portions of territories and to the detriment of others. An example of the latter point could be the weakening of the welfare state, which has resulted in the dismantling of important territorial principles due to the state's inability to keep them alive because of the progressive loss of population or the absence of an adequate level of infrastructure to support them.

The process that leads to abandonment in most cases is multi-dimensional in nature, i.e., several concurring causes generate it.

Today, more than 50% of the world's population lives in urban areas, and several studies predict that this percentage will increase to 75%.

The migration of population to urban areas at the expense of less urbanized areas, a shift brought about by increased job opportunities and service provision, climate change or natural disasters, is of a significant magnitude that is expected to grow in the coming years.

The concentration of populations, functions, services, technologies, and knowledge in coastal or urbanized areas at the expense of rural and inland areas has resulted in an asymmetry of territorial values, with strong polarization toward the former and abandonment in the latter [34]. While the attractiveness of urban areas is an advantage from the standpoint of territorial competitiveness, this is leading to strong pressures that have contributed to an imbalance in urban values.

In fact, urban areas, as a result of this, are more exposed to the effects related to climate change, such as those due to the generation of heat islands [35] and are affected by real environmental emergencies such as those generated by a progressive decrease in area quality and the problematic issue of waste management [36–38].

The UN World Urbanization Prospects 2018 report highlights the worsening phenomenon of land abandonment [39]. The current geography of land abandonment, according to this report, is that about two-thirds of the world's population by 2050 will dwell in large cities, especially in countries such as India, China, and Nigeria [40]. Their locational choice will be dictated by increased access to services, education, and employment [41].

The most populated urban territories currently are North America (82%), South America (81%), Europe (74%) and Oceania (68%) [42–44].

About 50% of the world's population resides in cities with fewer than 500,000 inhabitants, while 1 in 8 people live in one of 33 cities with more than 10 million.

Four types of depopulating regions (*shrinking regions*) have been identified in Europe (Figure 1): industrial areas in economic decline, mainly in Western Europe; peripheral depopulated areas typical of Northern Europe; areas that have experienced or are experiencing political transformations such as those in Eastern Europe; and rural areas in Southern Europe that are structurally weak with sharply declining fertility rates [45–49].

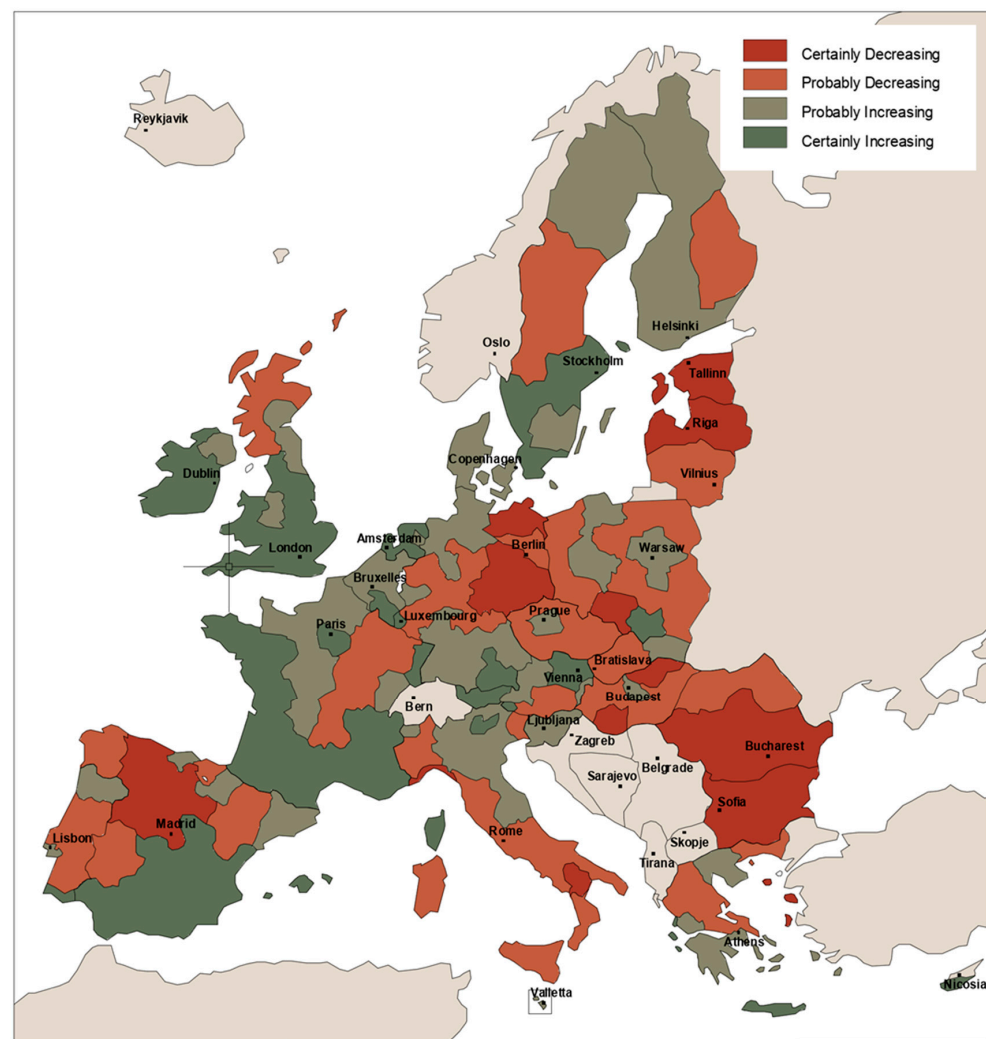


Figure 1. Typology of the “shrinking regions” (2005–2030). (Authors’ elaboration based on EURO-STAT data [50]).

In Europe, population decline is associated with internal migration, so that from the 1960s onward, the population has become increasingly concentrated in the major urban centers, while the more inland, rural areas are losing ground [51].

In addition, many European cities are undergoing a reduction in their populations, giving rise to the phenomenon of *shrinking cities* [52–57] (Figures 2 and 3).

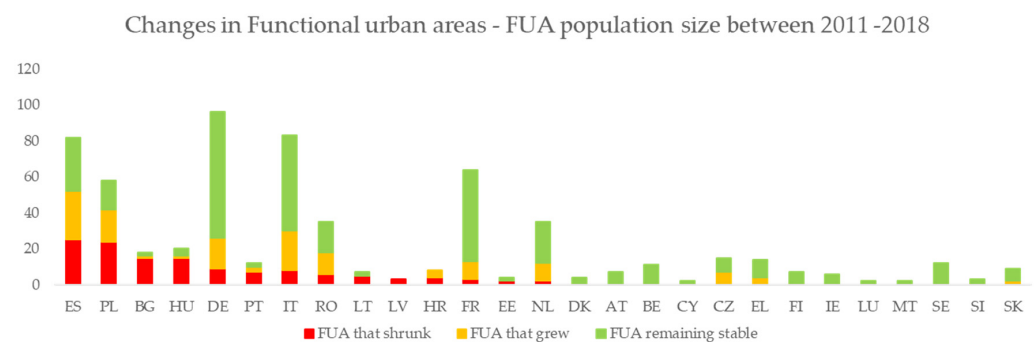


Figure 2. Changes in Functional Urban Areas-FUA population size between 2011 and 2018. (Authors’ elaboration based on Joint Research Centre data [50]).

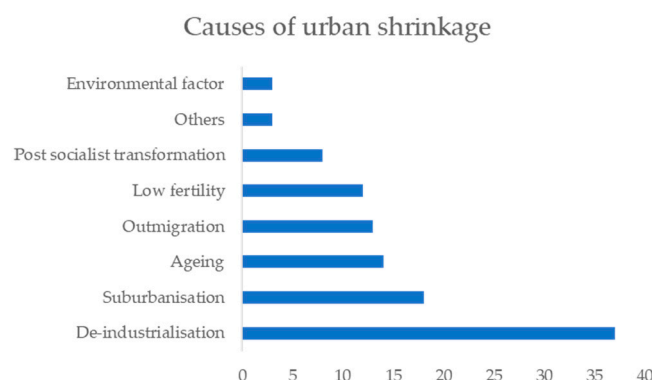


Figure 3. Causes of urban shrinkage. (Authors' elaboration based on Joint Research Centre data [58]).

Data on population decline, old-age index, birth rate, and registry de-registrants provide a mapping for Europe of the extent of the phenomenon of abandonment at the territorial and urban scale [59].

In Europe, between 2001 and 2020, the EU population (with reference to EU27) increased from 429 million to 447 million, a growth rate of 4 percent, although in 2020 [60], there was the highest rate of the population over 65 years old compared to the population aged 15–64 years old, at 32%; the number of live births in the EU has declined at a relatively constant rate from 2001 to 2020 [61].

In Italy between 2020 and 2021, the population decreased by 0.6 percent; this figure was definitely affected by the COVID-19 pandemic; the rate of over-65s compared to the population aged 15–64 is 37% [61], about five percentage points above the European average. Overall in 20 years the percentage of older Europeans has risen from representing 22.5% of the population to 32 percent [62]; the number of live births has experienced decreases of 25% between 2001 and 2020 [63]; the number of people cancelled from the civil registry for foreign countries has grown by 16.1 percent compared to 2018 [64].

During the period from 2010 to 2019, immigration of both foreign nationals (from within and outside the EU) and nationals returning to their country of origin increased in all member states except Italy, where immigration decreased during the same period.

Data show a higher level of quality of life in small Italian municipalities than in large cities, but they continue to depopulate in favor of urban areas [65].

In recent years, small municipalities have lost more than 74,000 inhabitants [66]. The entire south of Italy along with Genoa and parts of Piedmont are expected to lose population, while Emilia Romagna, Trentino and the Milan metropolitan area are expected to grow [67].

In Sardinia, National Institute of Statistics (NIS) data show a decrease in population over the past 60 years of more than 73,000 in inland municipalities, while it has grown by 293,000 in coastal municipalities. In the next 50 years, Sardinia will have 340,000 fewer inhabitants, most of which will be lost from inland municipalities [68].

The phenomenon of abandonment results in underutilization of all forms of territorial capital, namely, human, urban, economic, infrastructure, cultural, natural, and environmental capital [69–74].

The need to identify a new development process capable of interconnecting abandoned and marginalized areas with dense, attractive and congested areas meets the need for a rebalancing necessary for an improved functioning of the territorial system as a whole [75–78].

In fact, the urban areas, strong, dominant, catalysts of flows of “matter (natural resources), energy (labor) and information (technology)” have progressively extracted more and more from the weak areas, transforming them into “environment” in the Luhmanian sense [79,80].

As a result of this, weak areas have been dominated and ousted from both urban and land systems.

Urban areas now increasingly need to integrate weak areas for a twofold reason: because new flows of matter, energy and information [81,82] will have to support their development, and because they will have to manage their carrying capacity to improve their internal resilience [25,83–92].

The human, urban, natural, cultural-historical, infrastructural, and economic heritage characterized by people, housing, buildings, hamlets, resources, infrastructure and services, the small productive fabric [93] of weak areas, turns out to be in most cases looted, debased and abandoned. The heritage complex of a territory should contribute to the formation of its identity. It should represent the infrastructure supporting the very existence of a territory and that is a precondition for its development. The marginalization of weak areas and disaffection with the heritage complex that within them work together to generate the crisis of local identity and territories.

Identity is a complex issue, especially in a society such as the contemporary one marked by major upheavals and the great crises of this time, such as climate, pandemic, wars, poverty, injustice [94], and multidimensional and value dissimilarities. A reinterpretation of individual, collective and territorial identities could support overcoming these crises and promote development in contemporary societies.

In this perspective, the complex heritage of weak areas can become a resource, an opportunity for territories [95].

A reinterpretation of territorial values could reverse the gradual process that has led to disaffection and loss of identity, promoting a process of affection and renewed identity capable of interconnecting weak areas and urban areas. The creation of a territorial system in which weak areas can be included would promote not only their recovery but also the development and enhancement of urban areas. The perspective of an axiological approach [96,97] to support this study is instrumental in detecting territorial values and/or disvalues in order to support their reinterpretation.

3. Materials

The inland areas selected by the proposed classification for the NSIA are seventy-two, comprising a total of 1077 municipalities, covering approximately 2,072,718 inhabitants [19].

Inland areas are the most peripheral Italian municipalities in terms of access to essential services (e.g., health, education, and mobility). For the characterization of inland areas, “pole” municipalities are identified as a priority, i.e., those municipalities that offer the following services (alone or together with their neighbors):

- Higher education: an upper secondary school offered with at least one high school (scientific or classical) and either a technical or a vocational institute;
- Health services: at least one hospital with a Level I Emergency Department of Acceptance (EDA);
- Rail transportation services: a railway station of at least silver type, corresponding to medium-small facilities.

The data base supporting the NSIA classification contains not only information on instrumental criteria for characterizing “pole” areas, but also those on resident population, housing density per square kilometer, and some structural indicators, service supply indicators, service demand indicators, and social context indicators. A description of the indicators supporting the NSIA classification has been provided in Appendix A.

Municipalities are classified as “belt”, “intermediate”, “peripheral”, and “ultra-peripheral”, that is, with levels of peripherality gradually increasing with distance from the “pole” municipality.

In February 2022, ICEPSD updated this methodological framework, further refining the tool that serves to monitor the peripherality of the different territories that make up the country.

For the new classification, the basic approach has remained unchanged; in particular, the criterion for identifying the “pole” is the services present, but the distances from the “pole” for identifying the different types of inland areas have been reshaped, and metropolitan cities have not been assigned a priori to the “pole” category, as had happened

(although for very few cases) in the 2014 classification. There are 389 municipalities that fall under the NSIA classification for the nine metropolitan areas of Sicily (Figure 4).

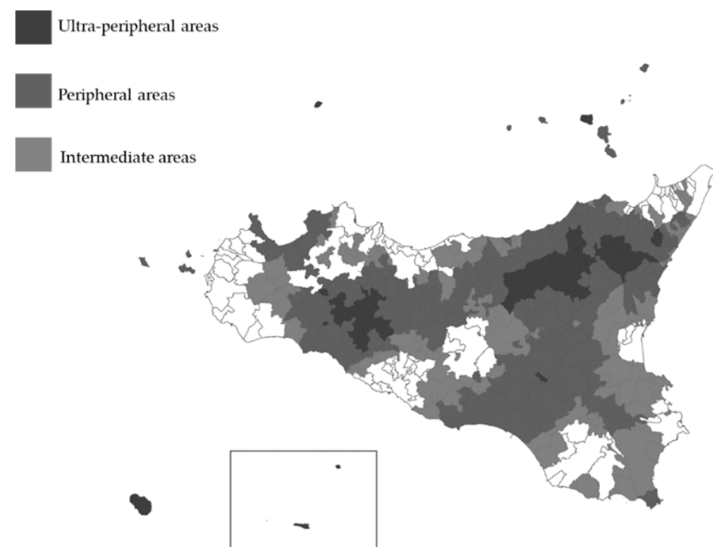


Figure 4. NSIA classification for inland areas of Sicily. (Authors' elaboration based on NSIA data).

They are characterized by 14 “pole” municipalities (4% of the total), 65 “belt” (17% of the total), 119 “intermediate” (31% of the total), 157 “peripheral” (40% of the total) and 34 “ultra-peripheral” (9 percent of the total). Intermediate, peripheral, and ultra-peripheral areas account for 80% of those falling under this classification. These areas cover a territory with an area of 19,541 square kilometers, in which 2,312,007 inhabitants reside. The percentage of municipalities falling in the NSIA classification (Figure 5) for the different metropolitan cities shows a greater concentration of the ultra-peripheral, peripheral, and intermediate typology for Messina, the absence of municipalities in the ultra-peripheral typology for Caltanissetta and Syracuse, and of municipalities falling in only intermediate areas for Ragusa.

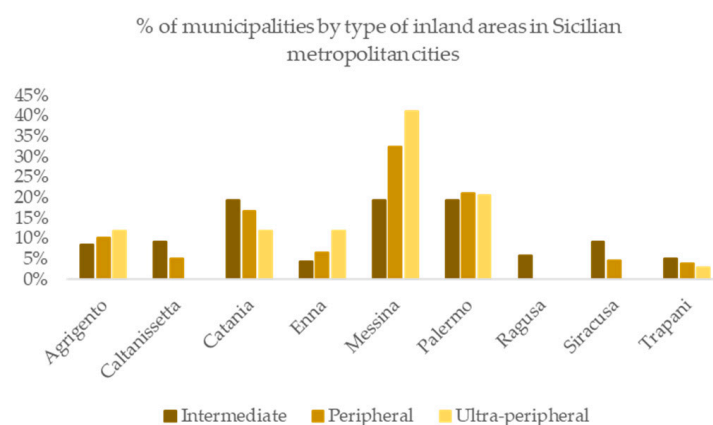


Figure 5. Percentages of municipalities by type of inland areas in Sicilian metropolitan cities. (Authors' elaboration from NSIA data).

With reference to land area, there is a greater extension of the ultra-peripheral type in the metropolitan cities of Messina and Enna, of the peripheral type in the metropolitan area of Caltanissetta, and of the intermediate type in the metropolitan area of Ragusa (Figure 6).

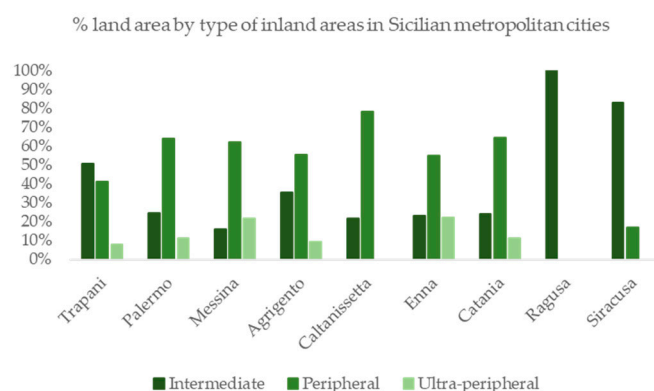


Figure 6. Percentage of land area by type of inland areas in Sicilian metropolitan cities. (Authors' elaboration from NSIA data).

There is a greater concentration of the resident population in the ultra-peripheral type in the metropolitan areas of Enna, in the peripheral type in the metropolitan area of Caltanissetta, and following almost at the same percentage of population, the metropolitan areas of Trapani, Palermo, Messina, and Agrigento, and in the intermediate type for the metropolitan area of Ragusa (Figure 7).

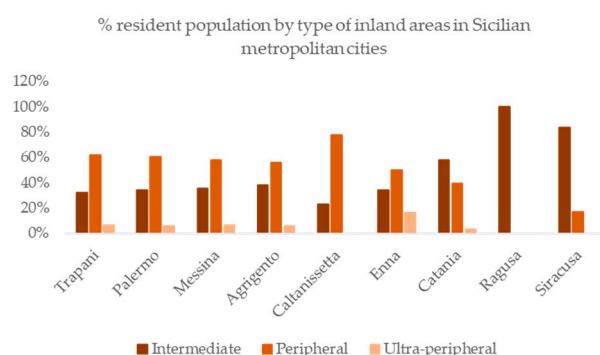


Figure 7. Percentage of resident population by type of inland areas in Sicilian metropolitan cities. (Authors' elaboration from NSIA data).

In summary, the NSIA classification identifies the most disadvantaged territory as a consequence of the number of municipalities falling in the peripheral and ultra-peripheral areas, by the extension of these areas, and by the percentage of population residing in the metropolitan area of Messina; the least disadvantaged territory with reference to the presence of only one type of area, the intermediate one, characterized by slight marginality, by its extension and by the percentage of population residing the metropolitan area of Ragusa. In terms of least disadvantage, after Ragusa is the metropolitan area of Syracuse.

The NSIA classification certainly represents a good cognitive base to support the enhancement of the territories characterized by abandonment; it has been instrumental in identifying the plan of needs, the order of priorities, the supporting policy, strategies, and funding. The different levels of remoteness/peripherality, in order to best achieve the set goal, require specific efforts of policies, from the ordinary one to rethink the organization of services (schools and health) even in the most distant, often mountainous territories, to the additional one based on conditionality, multi-level governance, participation and linkage to the result.

We question whether the cognitive framework proposed by the NSIA classification, one developed from the perspective of an approach to marginality substantiated by distance from attractive poles and the level of service provision, can effectively support the development of appropriate policies and strategies for abandonment territories. Geographic distance is certainly an important aspect of a geography of abandonment, but it is not

exhaustive. In fact, an area could be economically strong or culturally/environmentally relevant even if it is far from the main attractor, or it could be economically weak and poorly culturally/environmentally relevant even if it is close to the main attractor.

Also, it must be remembered that the level of service provision is a condition that arises from political choices, in some cases short-sighted or oriented by the hegemonic power of the strong city, or characterized by selective ignorance, generating fractures and inequality between city and territory and favoring the progressive deterioration of the latter in favor of the former. In the perspective of an axiological approach of abandoned areas, one aimed at interpreting their values and/or disvalues, the definition of a cognitive process aimed at detecting the residual capacity of worth and supporting the process of reinterpreting value is an important issue [98].

From this perspective, the cognitive framework should integrate all the components of territorial capital that represent the value and valence capacity of these areas. In this regard, we propose a cognitive process of inland areas (i.e., a mapping of the phenomenon of abandonment), aimed at generating their mapping based on the values of the different components of the forms of territorial capital. In this regard, in the following section we will introduce the different forms of territorial capital that we consider relevant to this study.

4. Methods

In order to propose a new cognitive process developed from the perspective of an axiology of abandoned areas, we propose a methodological approach consisting of the following steps (Figure 8):

- Identification of the forms of territorial capital;
- Construction of a geodatabase of variables characterizing the forms of territorial capital;
- Standardization of all input variables to z-scores (each with a mean of 0 and a standard deviation of 1);
- Mapping with QGIS support of clusters of municipalities on the basis of quartiles of values of indicators of the forms of territorial capital;
- Comparison of the clusters of municipalities based on the quartiles of the indicators of territorial capital forms and the NSIA classification;
- Principal Component Analysis;
- Estimation of an aggregate index of abandonment I_a ;
- Ranking of Sicilian municipalities based on their abandonment index;
- Cluster mapping with QGIS support of municipalities on the basis of quartiles of abandonment index I_a values.

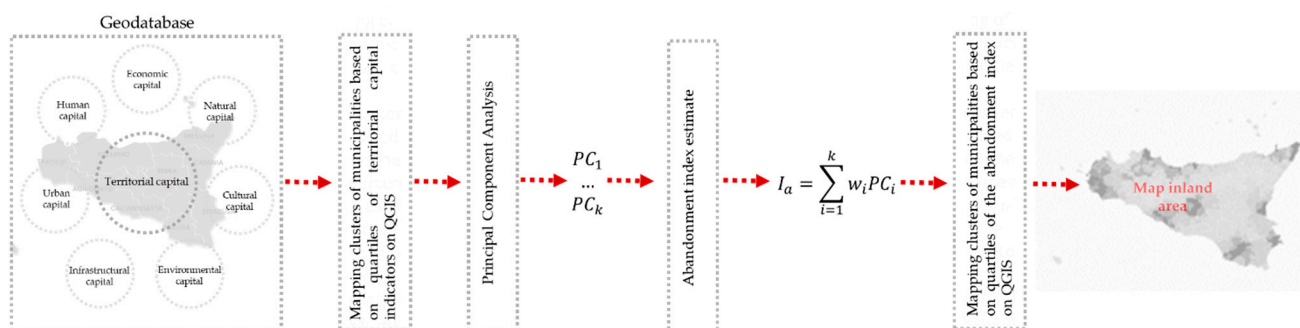


Figure 8. Flowchart of the methodological approach.

4.1. Shapes of the Territorial Capital

The concept of territorial capital was first proposed by the Organization for Economic Cooperation and Development (OECD) in the 2001 Territorial Outlook report [99] as a set of localized assets (natural, human, man-made, organizational, relational, and cognitive) that constitute the competitive potential of a given territory. It can also be considered

as the set of elements, again part of the territory itself, that can act as a constraint or strength, in direct proportion to the ideas of those who intend to act on it to make the most of its opportunities [100,101]. It can be seen as the fulcrum between forces of the past, present, and future, but one which is also affected by the inside and outside of the territory that changes due to elements from different epochs and at different times that have been created and consolidated in the territory itself. The term “territory” refers to a proximity to a system of localized externalities, both from the point of view of proximity to the market and resources and as proximity to a localized system of production, knowledge, and traditions. The term “capital” is to be understood as a set of assets that can be used to increase well-being and competitiveness [102–107].

The main forms of territorial capital can be summarized in the following forms of capital: human, urban, economic-productive, infrastructure, cultural, environmental, and social.

Human capital can be identified as an individual’s productivity potential, including health, education, work experience and skills [108].

Human capital as defined by the OECD can be regarded as a synthesis of “knowledge, skills, competencies and attributes embodied by individuals that facilitate the creation of personal, social and economic well-being” [109,110].

There are several methodological approaches in the literature for estimating the monetary value of human capital: cost-based approach [111], income-based approach [112], education-based approach [113], and the knowledge-based approach [114].

Among the best-known approaches proposed in the literature for estimating human capital is the Jorgenson-Fraumeni approach [115].

It, in fact, allows for the appropriate determination of its estimates, based on the present value of discounted income over its life cycle, taking into account possible variations in earnings (including due to experience), additional education that may be acquired, differential patterns of labor force participation and mortality [116].

Urban capital can be understood as the set of urban characteristics of the territory, i.e., the housing-city-landscape system, in which the housing stock is representative of a specific component of the social capital, i.e., the fixed capital.

Economic-productive capital can be understood as being the structure that enables the support of local economies and the productive capacity of a territory.

Infrastructural capital can be understood as the fixed capital accumulated in infrastructure and facilities, considered as a whole and with reference to the externalities arising from them [117–119].

Environmental capital can be understood as the set of conditions and resources of the natural environment, including geographical location [120–122].

Cultural and identity capital can be understood as the set of historical-cultural heritage, both tangible (monuments, landscapes, etc.) and intangible [123].

Social capital with reference to the definition proposed by Putman can be understood as “trust, norms governing coexistence, networks of civic associationism, elements that improve the efficiency of social organization by promoting initiatives taken together” [124]. Referring to Coleman’s definition, social capital would consist of the “set of social relationships that the individual is able to use in order to achieve a goal of his or her own” [125,126].

Based on these definitions, the indicators represented of the different components of territorial capital, namely human, urban, economic, infrastructure, natural, cultural, and environmental capital, were selected.

The Geodataset of the Territorial Capital

The variables selected to characterize the different forms of territorial capital with reference to the different official databases are presented below, in Table 1 for human capital, Table 2 for urban capital, Table 3 for economic capital, Table 4 for infrastructural capital, Table 5 for natural capital, Table 6 for cultural capital, and Table 7 for environmental capital.

Table 1. Human capital indicators.

Ref.	Variable	Definition	U. m.	Data Sources
1	HC1	Resident population 15–64 years	Pop.	a
2	HC2	Annual average change rate of resident population	%	b
3	HC3	Average 10-year change rate of resident population	%	c
4	HC4	Old age index	Index	c
5	HC5	Index of structure of the working population	Index	d
6	HC6	Employment rate	%	d
7	HC7	Index of employment turnover	%	c
8	HC8	Incidence of young people outside the labor market and training	%	c
9	HC9	Percentage of foreign population	%	a
10	HC10	Italian/foreign employment ratio	%	c
11	HC11	Italian/foreign school attendance ratio	%	c
12	HC12	Italian/foreign independent employment relationship	%	c
13	HC13	Male/female employment ratio	%	c
14	HC14	Percentage of population with average income	%	e
15	HC15	Graduate rate	%	f
16	HC16	High school graduate rate	%	f

Table 2. Urban capital indicators.

Ref.	Variable	Definition	U. m.	Data Sources
17	UC1	Degree of urbanization according to Eurostat classification	Index	g
18	UC2	Change in the unused rate of buildings	points %	c
19	UC3	Change in the index of under-utilisation of dwellings	points %	c
20	UC4	Change in the unused rate of dwellings in built-up areas	points %	c
21	UC5	Percentage change in average house purchase price	points %	c
22	UC6	Human density	pop/s.k.	h
23	UC7	Incidence of resident population in scattered households	%	c
24	UC8	Index of dispersion of dwellings	Index (0–1)	h
25	UC9	Concentration index of the typologies of use of the buildings	Index (0–10,000)	d
26	UC10	Compactness index of urban areas	%	i
27	UC11	Fragmentation index of the urban landscape	m./s.m.	i
28	UC12	Index of under-utilisation of dwellings	%	c
29	UC13	Index of building expansion in towns and villages	%	c
30	UC14	Index of residential attractiveness	Index	h
31	UC15	Urban green (non-agricultural) per capita	s.m./inhab.	d
32	UC16	Index of crowding of dwellings	%	c
33	UC17	Unused buildings rate (Potential use of buildings)	%	c
34	UC18	Unused rate of dwellings in built-up areas	%	c
35	UC19	Housing exclusion index (Incidence of improper housing)	%	c
36	UC20	Incidence of residential buildings in a poor state of preservation	%	c
37	UC21	Index of availability of services in the dwelling	%	c
38	UC22	Average age of recent housing stock	n. of years	c

Table 3. Economic capital indicators.

Ref.	Variable	Definition	U. m.	Data Sources
39	EC1	Change in unemployment rate	points %	c
40	EC2	Change in economic dynamism index	Index	g
41	EC3	Index of economic dynamism	Index	g
42	EC4	Unemployment rate	%	c
43	EC5	Youth unemployment rate	%	c
44	EC6	Concentration index of employees in economic sectors	Index (0–10,000)	d
45	EC7	Gini index	Index (0–1)	h
46	EC8	Number of agricultural and zootechnical holdings	n.	l
47	EC9	Number of active enterprises	n.	l
48	EC10	Number of agricultural holdings and production of animal products, hunting and related services	n.	l

Table 4. Infrastructural capital indicators.

Ref.	Variable	Definition	U. m.	Data Sources
49	IC1	Average travel time		
50	IC2	Private mobility (private use)	%	c
51	IC3	Density of fixed retail trade	Local units/s.k.	d
52	IC4	Daily mobility for study or work	%	c
53	IC5	Mobility index (commuting for work)	Index	h
54	IC6	Self-containment index (commuting for work purposes)	Index	h
55	IC7	Residential mobility	%	c
56	IC8	Rate of compound accommodation function	Index	h
57	IC9	Number of stadiums	Number	h
58	IC10	Number of amusement and entertainment hubs	Number	h
59	IC11	Number of commercial hubs	Number	h
60	IC12	Digital divide from fixed and mobile network	%	d
61	IC13	Road accessibility index for shopping centres	Ranking (0–4)	d
62	IC14	Rail index	Track (0/1)	d
63	IC15	Accessibility index at railway stations	Ranking (0–4)	h
64	IC16	Ordinary hospital beds per 10,000 inhabitants	n. per 10,000 inhab.	d
65	IC17	Dynamism of public institutions	Index	h
66	IC18	Ordinary pharmacies per 10,000 inhabitants	n. per 10,000 inhab.	d
67	IC19	Public mobility	%	c
68	IC20	Pre-school, primary and secondary school buildings	n.	n
69	IC21	Health facilities	n.	o

Table 5. Natural capital indicators.

Ref.	Variable	Definition	U. m.	Data Sources
70	NC1	Protected areas	yes/no	p
71	NC2	Natura 2000 network (SCI/SAC/SPZ)	yes/no	p
72	NC3	Number of parks and gardens	n.	p
73	NC4	Average agricultural value	n.	q
74	NC5	Percentage of utilized agricultural area (AA) in total agricultural area	%	r

Table 6. Cultural capital indicators.

Ref.	Variable	Definition	U. m.	Data Sources
75	CC1	Number of state cultural sites	n.	h
76	CC2	Total number of cultural assets	n.	s
77	CC3	Total number of architectural assets	n.	s
78	CC4	Number of historical parks and gardens	n.	s
79	CC5	Number of museums, galleries, and archaeological sites	n.	s

Table 7. Environmental capital indicators.

Ref.	Variable	Definition	U. m.	Data Sources
80	EVC1	Seismic hazard	Index	t
81	EVC2	Surface of soil consumed in areas of high and very high seismic hazard	ha	i
82	EVC3	High and very high proportion of the municipal surface is hazardous due to landslide HP-H3 + H4	%	i
83	EVC4	Resident population at risk in high and very high landslide hazard areas-H3 + H4	Pop	i
84	EVC5	Soil surface consumed in areas with high and very high landslide hazards-H3 + H4	ha	i
85	EVC6	Percentage of municipal area with high hydraulic hazard H3	%	i
86	EVC7	Resident population at risk in areas of high hydraulic hazard-H3	Pop	i
87	EVC8	Soil surface consumed in areas with high hydraulic hazard-H3	ha	i
88	EVC9	Soil consumed per capita	s.m./inhab.	i
89	EV10	Altitude of the center	m.	g

The official databases from which data on different forms of territorial capital were extracted are as follows:

- (a) National Institute of Statistics dataset: Population and households 2022 [127];
- (b) National Institute of Statistics dataset: Demo.ISTAT 2002–2019 [128];
- (c) National Institute of Statistics dataset: 8 milaCensus [129];
- (d) Dataset of the Department of Economic Planning and Policy Coordination: Urban Index [130];
- (e) National Institute of Statistics dataset: Economic conditions of households [131];
- (f) National Institute of Statistics dataset: Education, work and travel for work [132];
- (g) National Institute of Statistics dataset: Main geographical statistics of municipalities [133];
- (h) “PRIN Postmetropolitan Atlas” dataset [134];
- (i) Superior Institute for Environmental Protection and Research dataset [135];
- (l) National Institute of Statistics dataset: Statistical atlas of municipalities. [136];
- (m) Agency for Territorial Cohesion Dataset. National Strategies for Internal Areas: Classification Internal Areas [19];
- (n) Italian Municipalities Dataset: Schools [137];
- (o) Italian Ministry of Health Dataset [138];
- (p) National Institute of Statistics dataset: Indicators [139];
- (q) Income revenue authority dataset: Average Agricultural Value [140];
- (r) National Institute of Statistics dataset: Census of agriculture [141];
- (s) Sicilian Region Dataset: Museums galleries and archaeological sites [142];
- (t) National Institute of Geophysics and Volcanology dataset [143];
- (v) National Institute of Statistics dataset: Territorial bases and census variables [144];

4.2. Principal Components Analysis

Principal component analysis (PCA) is a statistical technique for dimension reduction. It is a technique aimed at deriving, from a set of correlated numerical variables, a smaller set of “artificial” orthogonal variables” [145]. It is used when there are many interrelated variables within a dataset and the analyst would like to reduce their number, losing the least amount of information possible.

The PCA aims to maximize variance by calculating the weight to be given to each starting variable in order to concentrate them into one or more new variables (called principal components) that are formed of linear combinations of the starting variables.

In PCA we denote by the term “information” the total variability of the original input variables, that is, the sum of the variances of the original variables. The central point of PCA is the so-called spectral decomposition (or decomposition into eigenvalues and eigenvectors, or eigen decomposition) of the sample variance/covariance matrix. This decomposition makes it possible to calculate the eigenvalues and eigenvectors of the covariance matrix. The eigenvalues (in descending order of value) represent the amount of total variability observed on the original variables, “explained” (or “expressed”) by each principal component; the eigenvectors, on the other hand, represent the corresponding (orthogonal) directions of maximum variability extracted from the principal components.

PCA is a widely used technique. The main steps of the variable reduction process are as follows:

1. Standardization of all input variables into z-scores (each with a mean of 0 and standard deviation 1)
2. Selection of the number of components based on the unrotated solution, i.e., the initial solution using the Kaiser Criterion (all components corresponding to an eigenvalue equal to or greater than 1 should be included in the final model) [146] or the screen plot (the number of components to be extracted is that which coincides with the change in slope, i.e., the elbow of the curve, after which the break generally tends to flatten) [147];
3. Rotation of the initial PCA solution (Varimax rotation);

4. Selection of the number of components based on the rotated solution, according to the Kaiser or screen plot criterion;
5. Interpretation of the resulting components;
6. Combination of the selected component scores into a univariate score;
7. Standardization of the resulting scores to a mean of 0 and a standard deviation of 1.

Simulation Software

There are several software applications used to process PCA. We used the statistical software SPSS. This software allows us to select the number of significant components with the help of the screen plot.

4.3. Abandonment Index- I_a

In this study, PCA will allow the identification of indicators, that is, of a reduced set of those originally selected for the characterization of different forms of territorial capital. The new indicators will make it possible to identify an index of abandonment for marginal areas of Sicily through the following formula (Equation (1)):

$$I_a = \sum_{i=1}^k w_i PC_i \quad (1)$$

where w_i represent the weights of the components identified with PCA, PC_i the value of the i -th component, and k the number of components identified.

By means of the neglect index estimated with Equation (1), it will be possible to rank Sicilian municipalities from best to worst.

4.4. The New Cognitive Tool of the Abandonment Phenomenon

A mapping of clusters of municipalities with QGIS support on the basis of quartiles of aggregate I_a index values will make it possible to represent the phenomenon of abandonment at the regional scale.

The new map of the phenomenon of abandonment for Sicilian municipalities will be able to be compared with the map of Internal Areas produced by the NSIA classification.

5. Results

Data on indicators for different forms of territorial capital were extracted from the official databases previously referred to, and an instrumental geo-database was constructed for them for the analyses that will lead to the definition of an index of abandonment and a mapping of the abandonment phenomenon.

5.1. Cluster of Municipalities Based on Quartiles of Indicator Values of Different Forms of Territorial Capital

The indicators selected for characterizing the different components of territorial capital were normalized and with QGIS support, cluster maps of municipalities were generated based on the quartiles of these indicators. This made it possible to highlight the performance of each municipality for the different indicators of the different forms of territorial capital. The municipalities for which the analysis was conducted are those that fall within the Intermediate, Peripheral and Ultra-peripheral areas in the NSIA classification.

Clusters of municipalities based on quartiles of indicators on human capital and cultural capital are shown in Figure 9. In the box in Figure 9 and for all the figures that will be presented subsequently regarding the indicator maps for the different forms of territorial capital, the Pelagic Islands are shown.

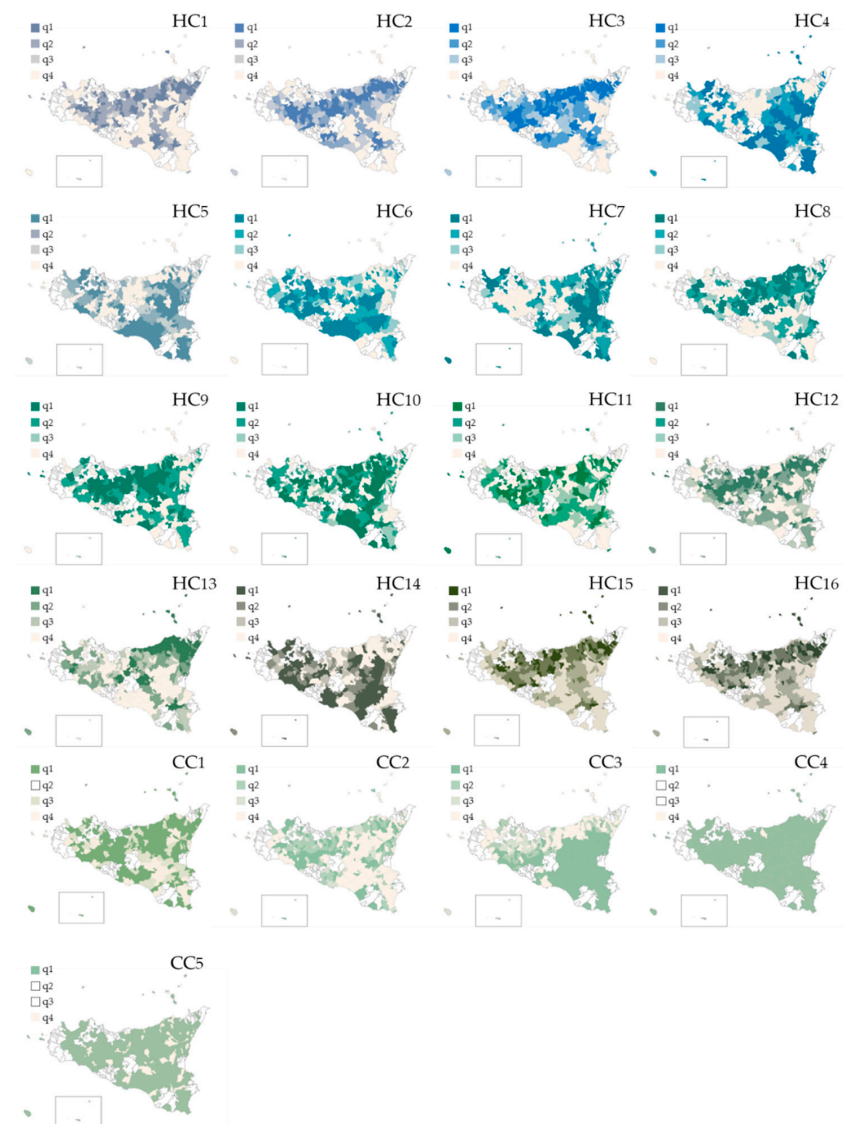


Figure 9. Mapping Human and Cultural Capital Indicators. (Authors' elaboration).

With reference to the first quartile, Figure 9 shows: the presence of small clusters of municipalities predominantly falling in the north-central area of Sicily for HC1, HC2, and HC3; clusters of municipalities predominantly falling in the south-eastern area of Sicily for HC4, and HC5; clusters of municipalities predominantly falling in the south-central area of Sicily for HC6; clusters of municipalities predominantly falling in the eastern area of Sicily for HC7; clusters of municipalities predominantly falling in the north-eastern area of Sicily for HC8; clusters of municipalities predominantly falling in the north-central area of Sicily for HC9; clusters of municipalities predominantly falling in the eastern area of Sicily for HC10; clusters of municipalities predominantly falling in the north-central area of Sicily for HC11 and HC12; clusters of municipalities predominantly falling in the northeastern area of Sicily for HC13; clusters of municipalities predominantly falling in the southern and east-central areas of Sicily for HC14; and small clusters of municipalities predominantly falling in the north-central and northeastern areas of Sicily for HC15 and HC16.

With reference to the second quartile, Figure 9 shows: the presence of clusters of municipalities predominantly falling in the north-central area of Sicily for HC1, HC2, and HC3; clusters of municipalities predominantly falling in the east-central area of Sicily for HC4, HC5, HC6, and HC7; clusters of municipalities predominantly falling in the north-eastern area of Sicily for HC8; clusters of municipalities predominantly falling in the central and eastern areas of Sicily for HC9; small clusters of municipalities predominantly falling in the

central-northern area of Sicily for HC10; clusters of municipalities predominantly falling in the southeastern area of Sicily for HC11; clusters of municipalities predominantly falling in the central and southeastern areas of Sicily for HC12; small clusters of municipalities predominantly falling in the central and southeastern areas of Sicily for HC13 and HC14; and clusters of municipalities predominantly falling in the central-northern and northeastern areas of Sicily for HC15 and HC16.

With reference to the third quartile, Figure 9 shows: the presence of small clusters of municipalities falling in the central area of Sicily for HC1; clusters of municipalities predominantly falling in the central area of Sicily for HC2, HC3, HC4, HC5, and HC6; clusters of municipalities predominantly falling in the south-central area of Sicily for HC7 and HC8; small clusters of municipalities falling in the central area of Sicily for HC9; clusters of municipalities predominantly falling in the central and eastern areas of Sicily for HC10 and HC11; clusters of municipalities predominantly southern and central-eastern areas of Sicily for HC12; clusters of municipalities predominantly falling in the central and eastern-southern areas of Sicily for HC13; small clusters of municipalities predominantly falling in the central-northern area of Sicily for HC14; and clusters of municipalities predominantly falling in the central and northern-eastern areas of Sicily for HC15 and HC16.

With reference to the fourth quartile, Figure 9 shows: the presence of clusters of municipalities predominantly falling in the south-central and eastern areas of Sicily for HC1 and HC2; clusters of municipalities predominantly falling in the south-eastern and north-western areas of Sicily for HC3; clusters of municipalities predominantly falling in the central-northern area of Sicily for HC4, HC5, HC6, and HC7; clusters of municipalities predominantly falling in the central-southern area of Sicily for HC8; clusters of municipalities predominantly falling in the southern and northeastern areas of Sicily for HC9; clusters of municipalities predominantly falling in the central and northeastern area of Sicily for HC10; clusters of municipalities predominantly falling in the eastern area of Sicily for HC11 and HC12; clusters of municipalities predominantly falling in the central-southern area of Sicily for HC13; clusters of municipalities predominantly falling in the northern and southeastern areas of Sicily for HC14; and clusters of municipalities predominantly falling in the central-southern and eastern areas of Sicily for HC15 and HC16.

With reference to the first quartile, Figure 9 shows the presence of clusters of municipalities predominantly falling in the north-central area and partially in the southern area of Sicily for CC1; small clusters of municipalities predominantly falling in the central and southeastern areas of Sicily for CC2; clusters of municipalities falling in almost all of Sicily except the metropolitan area of Trapani and (partially) in those of Agrigento, Ragusa and Palermo for CC3; and clusters of municipalities falling in almost all of Sicily for CC4 and CC5.

With reference to the second quartile, Figure 9 shows: no clusters of municipalities for CC1; small clusters of municipalities mainly falling in the north-central area of Sicily for CC2; small clusters of municipalities mainly falling in the west-central area of Sicily for CC3; no clusters of municipalities for CC4 and CC5.

With reference to the third quartile, Figure 9 shows: the presence of small clusters of municipalities falling in the central area of Sicily for CC1; small clusters of municipalities predominantly falling in the central area of Sicily for CC2; small clusters of municipalities predominantly falling in the central-western area of Sicily for CC3; and no clusters of municipalities for CC4 and CC5.

With reference to the fourth quartile, Figure 9 of small clusters of municipalities falling in almost the entire territory of Sicily with a higher concentration in the central-southern-eastern area for CC1 and CC2; clusters of municipalities predominantly falling in the northern area of Sicily for CC3; two small clusters of municipalities falling in the metropolitan cities of Palermo and Catania for CC4; and small clusters of municipalities falling in almost the entire territory of Sicily for CC5.

With reference to the first quartile, Figure 10 shows clusters of municipalities predominantly falling in the south-eastern area of Sicily for UC1; small clusters of municipalities

predominantly falling in the east-central area of Sicily for UC2, UC3, and UC4; clusters of municipalities predominantly falling in the central area of Sicily for UC5; clusters of municipalities predominantly falling in the north-central and east-central areas of Sicily for UC6; small clusters of municipalities falling mainly in the southern and eastern areas of Sicily for UC7, UC8; small clusters of municipalities falling mainly in the north-central area of Sicily for UC9; clusters of municipalities falling mainly in the eastern area of Sicily for UC10; clusters of municipalities falling mainly in the southern and eastern areas of Sicily for UC11; clusters of municipalities falling mainly in the eastern area of Sicily for UC12; clusters of municipalities predominantly falling in the central-northern area of Sicily for UC13; clusters of municipalities predominantly falling in the central area of Sicily for UC14; clusters of municipalities predominantly falling in the central and northern-eastern area of Sicily for UC15; small clusters of municipalities predominantly falling in the central-northern area of Sicily for UC16; clusters of municipalities predominantly falling in the central and southern-eastern areas of Sicily for UC17; clusters of municipalities predominantly falling in the central-eastern area of Sicily for UC18; small clusters of municipalities predominantly falling in the central-northern area of Sicily for UC19; small clusters of municipalities predominantly falling in the eastern area of Sicily for UC20; small clusters of municipalities predominantly falling in the central-northern and southern areas of Sicily for UC21; small clusters of municipalities predominantly falling in the central area of Sicily for UC22.

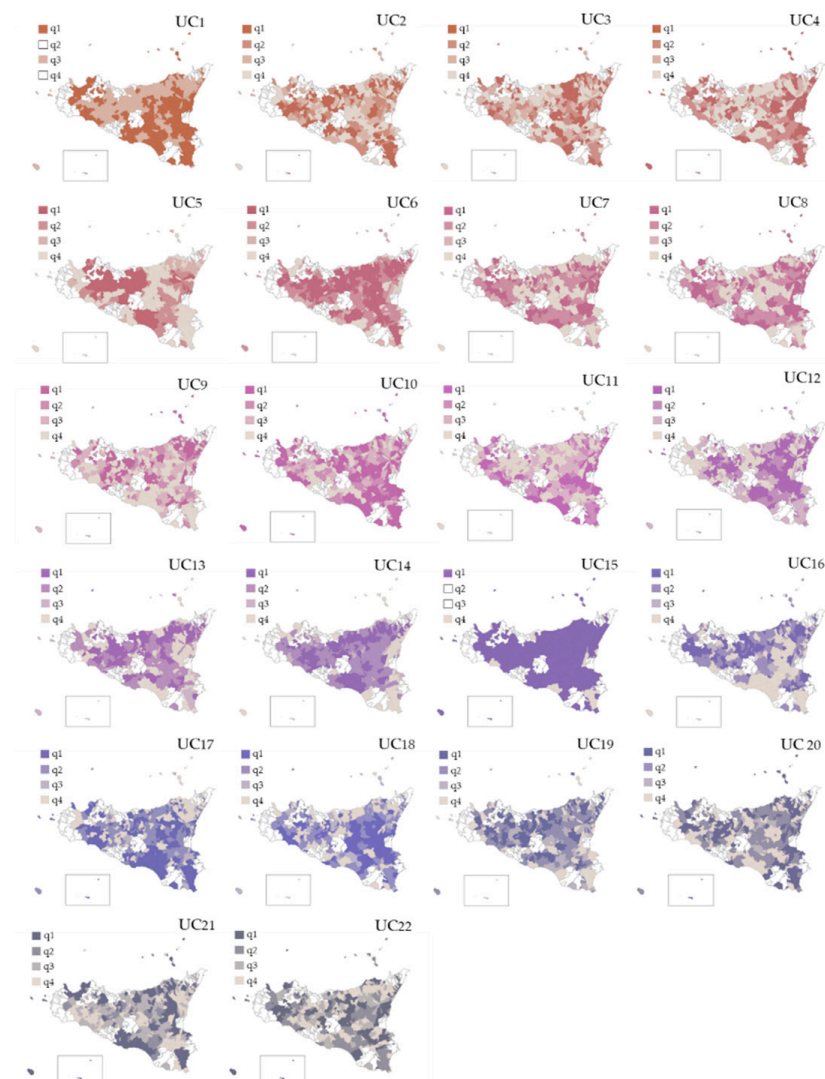


Figure 10. Mapping Urban Capital Indicators. (Authors' elaboration).

With reference to the second quartile, Figure 10 shows: the presence of clusters of municipalities predominantly falling in the north-central area of Sicily for UC1; small clusters of municipalities predominantly falling in the northern and southern areas of Sicily for UC2; small clusters of municipalities predominantly falling in the eastern area of Sicily for UC3, UC4 and UC5; clusters of municipalities predominantly falling in the central area of Sicily for UC6, UC7 and UC8; small clusters of municipalities predominantly falling in the central area of Sicily for UC9 and UC10; small clusters of municipalities predominantly falling in the southern area of Sicily for UC11; clusters of municipalities predominantly falling in the central area of Sicily for UC12, UC13, and UC14; no municipalities in the second quartile for UC15; and small clusters of municipalities predominantly falling in the north-central area of Sicily for UC16, UC17, UC18, UC19, UC20, UC21, and UC22.

With reference to the third quartile, Figure 10 shows: no municipalities in the third quartile for UC1; small clusters of municipalities predominantly falling in the central area of Sicily for UC2, UC3, UC4, and UC5; small clusters of municipalities predominantly falling in the southern area of Sicily for UC6; small clusters of municipalities predominantly falling in the central area of Sicily for UC7, UC8, UC9, UC10, and UC11; small clusters of municipalities predominantly falling in the southern and eastern area of Sicily for UC12; small clusters of municipalities predominantly falling in the eastern area of Sicily for UC13; small clusters of municipalities predominantly falling in the central area of Sicily for UC14; no municipalities in the second third for UC15; small clusters of municipalities predominantly falling in the central area of Sicily for UC16, UC17, UC18, UC19, UC20, UC21, and UC22.

With reference to the fourth quartile, Figure 10 shows: no municipalities in the second quartile for UC1; clusters of municipalities predominantly falling in the central and north-eastern areas of Sicily for UC2, UC3 and UC4; clusters of municipalities predominantly falling in the eastern and southwestern areas of Sicily for UC5; small clusters of municipalities predominantly falling in the eastern area of Sicily for UC6; clusters of municipalities predominantly falling in the eastern and central coastal areas of Sicily for UC7, UC8, and UC9; small clusters of municipalities predominantly falling in the central and eastern-northern coastal areas of Sicily for UC10; clusters of municipalities predominantly falling in the central and eastern-northern coastal areas of Sicily for UC11 and UC12; clusters of municipalities predominantly falling in the central and eastern coastal areas of Sicily for UC13; clusters of municipalities predominantly falling in the eastern coastal area of Sicily for UC14; small clusters of municipalities predominantly falling in the southern and eastern coastal areas of Sicily for UC15; clusters of municipalities predominantly falling in the central-eastern area of Sicily for UC16; clusters of municipalities predominantly falling in the central-northern area of Sicily for UC17 and UC18; clusters of municipalities predominantly falling in the eastern area of Sicily for UC19; clusters of municipalities predominantly falling in the central area of Sicily for UC20; clusters of municipalities predominantly falling in the central-eastern and southern-western areas of Sicily for UC21; and clusters of municipalities predominantly falling in the central area of Sicily for UC22.

With reference to the first quartile, Figure 11 shows the presence of clusters of municipalities predominantly falling in the central area of Sicily for EC1; small clusters of municipalities predominantly falling in the north-eastern and south-central areas of Sicily for EC2, EC3, and EC4; clusters of municipalities predominantly falling in the north-eastern and south-eastern area of Sicily for EC5; clusters of municipalities predominantly falling in the central and southeastern area of Sicily for EC6; small clusters of municipalities predominantly falling in the north-eastern area of Sicily for EC7 and EC8; and small clusters of municipalities predominantly falling in the central and north-eastern areas of Sicily for EC9 and EC10.

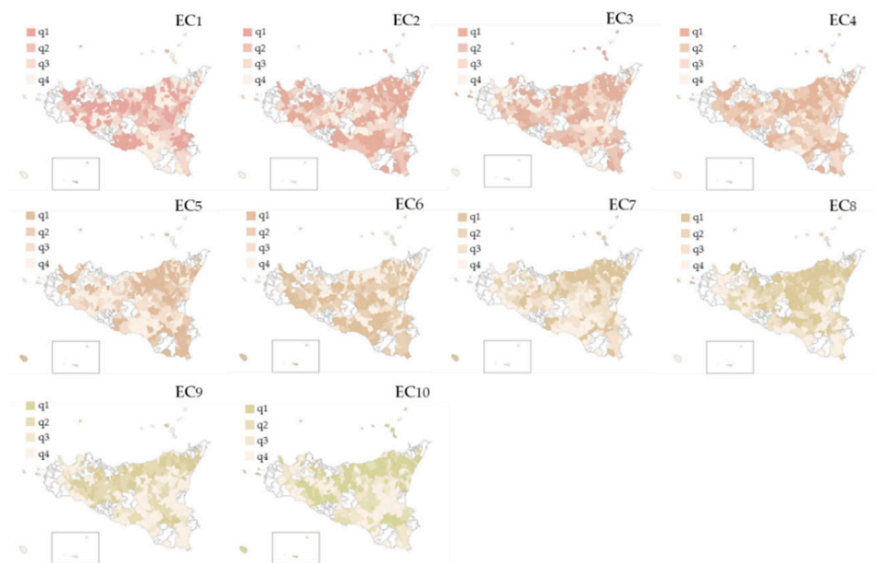


Figure 11. Mapping Economic Capital Indicators. (Authors' elaboration).

With reference to the second quartile, Figure 11 shows clusters of municipalities predominantly falling in the central area of Sicily for EC1; small clusters of municipalities predominantly falling in the central and southern areas of Sicily for EC2; clusters of municipalities predominantly falling in the central and southeastern areas of Sicily for EC3; clusters of municipalities predominantly falling in the central and northeastern areas of Sicily for EC4; clusters of municipalities predominantly falling in the north-eastern area of Sicily for EC5; clusters of municipalities predominantly falling in the central and south-eastern areas of Sicily for EC6; small clusters of municipalities predominantly falling in the central area of Sicily for EC7; and clusters of municipalities predominantly falling in the central and north-eastern areas of Sicily for EC8, EC9 and EC10.

With reference to the third quartile, Figure 11 shows: the presence of small clusters of co-municipalities predominantly falling in the central area of Sicily for EC1, EC2, EC3, EC4, and EC5; small clusters of municipalities predominantly falling in the central and eastern-southern areas of Sicily for EC6; clusters of municipalities predominantly falling in the central and eastern areas of Sicily for EC7 and EC8; small clusters of municipalities predominantly falling in the central area of Sicily for EC9; and clusters of municipalities predominantly falling in the central and eastern-southern areas of Sicily for EC10.

With reference to the fourth quartile, Figure 11 shows: the presence of clusters of municipalities predominantly falling in the southern and northeastern areas of Sicily for EC1; small clusters of municipalities predominantly falling in the central area of Sicily for EC2, EC3, and EC4; clusters of municipalities predominantly falling in the central-southern area of Sicily for EC5; clusters of municipalities predominantly falling in the north-central area of Sicily for EC6; clusters of municipalities predominantly falling in the central and southern areas of Sicily for EC7; clusters of municipalities predominantly falling in the south-central area of Sicily for EC8; and clusters of municipalities predominantly falling in the east-central area of Sicily for EC9 and EC10.

With reference to the first quartile, Figure 12 shows: the presence of clusters of municipalities predominantly falling in the central-southern and eastern areas of Sicily for IC1; small clusters of municipalities falling mainly in the central area of Sicily for IC2; clusters of municipalities predominantly falling in the eastern and western areas of Sicily for IC3; clusters of municipalities predominantly falling in the central-southern and eastern areas of Sicily for IC4; clusters of municipalities falling predominantly in the north-eastern and southern areas of Sicily for IC5; clusters of municipalities falling predominantly in the eastern area of Sicily for IC6; clusters of municipalities falling predominantly in the north-central area of Sicily for IC7; clusters of municipalities falling in almost all of Sicily

except the metropolitan area of Trapani and partially in those of Agrigento, Ragusa and Palermo for IC8, IC9, IC10 and IC11; small clusters municipalities predominantly falling in the southern, north-central and east-central areas of Sicily for IC12; clusters of municipalities predominantly falling in the south-central and northeastern areas of Sicily for IC13; clusters of municipalities falling in almost all of Sicily except the metropolitan area of Trapani and partially in those of Agrigento, Ragusa and Palermo for IC14; clusters of municipalities predominantly falling in the south-central and northeastern areas of Sicily for IC15; clusters of municipalities predominantly falling in the north-central and eastern area of Sicily for IC16; small clusters of municipalities falling predominantly in the central and northeastern areas of Sicily for IC17; clusters of municipalities falling predominantly in the central and southern area of Sicily for IC18 and IC19; small clusters of municipalities falling predominantly in the central and southeastern areas of Sicily for IC20; and clusters of municipalities falling in almost all of Sicily except the metropolitan area of Trapani and partially in those of Agrigento, Ragusa and Palermo for IC21.

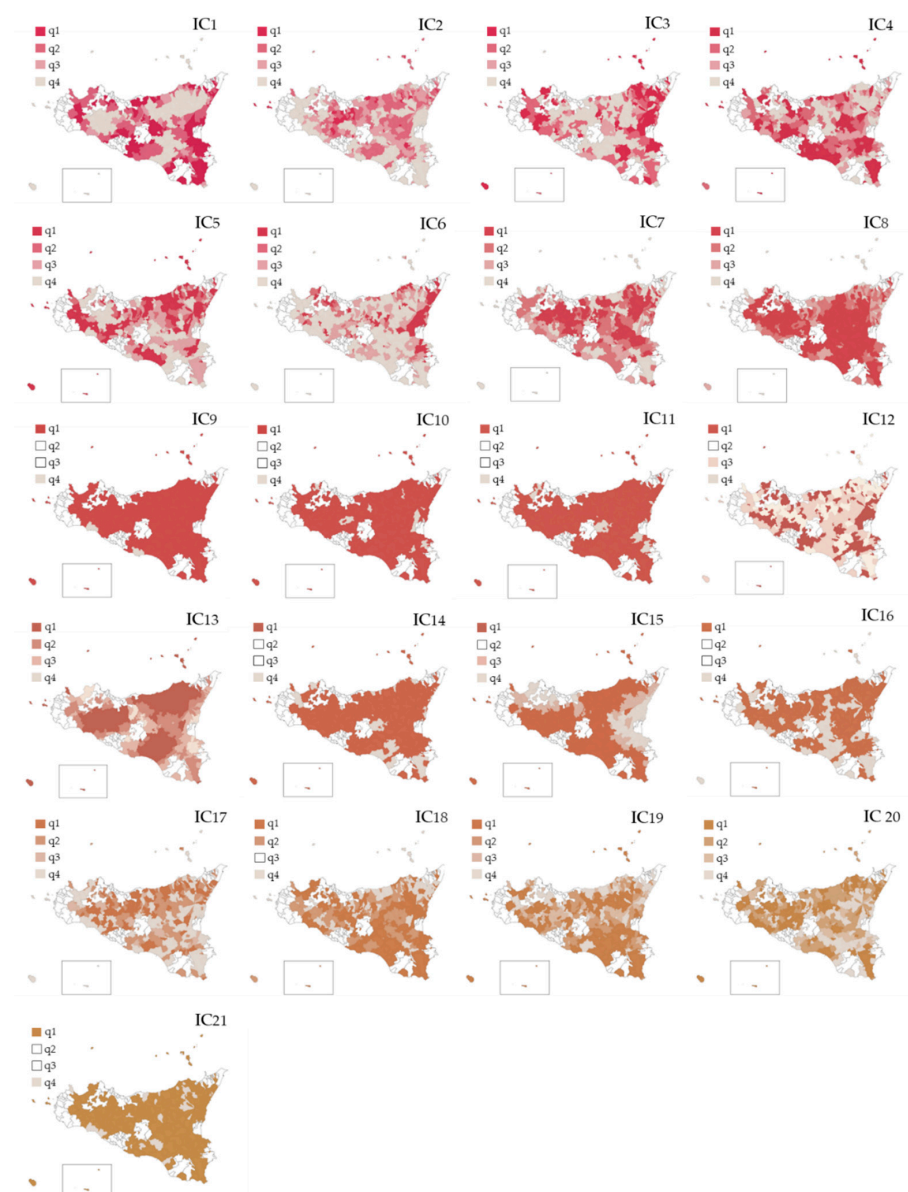


Figure 12. Mapping of Infrastructure Capital indicators. (Authors' elaboration).

With reference to the second quartile, Figure 12 shows: clusters of municipalities predominantly falling in the central and eastern areas of Sicily for IC1; small clusters

of municipalities predominantly falling in the central area of Sicily for IC2; clusters of municipalities predominantly falling in the central-western and eastern areas of Sicily for IC3; clusters of municipalities predominantly falling in the central area of Sicily for IC4; small clusters of municipalities predominantly falling in the north-central area of Sicily for IC5; small clusters of municipalities predominantly falling in the north-western area of Sicily for IC6; clusters of municipalities predominantly falling in the central and southern areas of Sicily for IC7; clusters of municipalities predominantly falling in the southern and northern area of Sicily for IC8; no municipalities falling in the second quartile for IC9, IC10, and IC11; no municipalities falling in the second quartile for IC12; clusters of municipalities falling in the central and eastern area of Sicily for IC13; no municipalities falling in the second quartile for IC14, IC15, and IC16; clusters of municipalities predominantly falling in the central-northern and southern areas for IC17; small clusters of municipalities predominantly falling in the central area for IC18 and IC19; small clusters of municipalities predominantly falling in the central-western and eastern-northern areas of Sicily for IC20; and no municipalities falling in the second quartile for IC21.

With reference to the third quartile, Figure 12 shows: the presence small clusters of municipalities predominantly falling in the central area of Sicily for IC1; small clusters of municipalities predominantly falling in the central and north-eastern areas of Sicily for IC2, IC3 and IC4; clusters of municipalities predominantly falling in the central and eastern-southern areas of Sicily for IC5; small clusters of municipalities predominantly falling in the central and eastern areas of Sicily for IC6; small clusters of municipalities predominantly falling in the central and southern-eastern areas of Sicily for IC7; small clusters of municipalities predominantly falling in the northern-eastern area of Sicily for IC8; no municipalities in the third for IC9, IC10 and IC11; clusters of municipalities predominantly falling in the central-southern area of Sicily for IC12; small clusters of municipalities predominantly falling in the central-southern and eastern areas of Sicily for IC13; no municipalities in the third for IC14; clusters of municipalities predominantly falling in the central-western and eastern areas of Sicily for IC15; no municipalities in the third for IC16; small clusters of municipalities predominantly falling in the central-southern area of Sicily for IC17; small clusters of municipalities predominantly falling in the northern-eastern and southern-western areas of Sicily for IC18; small clusters of municipalities predominantly falling in the northern area of Sicily for IC19; small clusters of municipalities predominantly falling in the central-eastern area of Sicily for IC20; and no municipalities in the third for IC21.

With reference to the fourth quartile, Figure 12 shows: clusters of municipalities predominantly falling in the north-central, south-eastern and west-central areas of Sicily for IC1; clusters of municipalities predominantly falling in the southern and eastern areas of Sicily for IC2; clusters of municipalities predominantly falling in the central area of Sicily for IC3; clusters of municipalities predominantly falling in the central-northern area of Sicily for IC4; clusters of municipalities predominantly falling in the central-southern area of Sicily for IC5; clusters of municipalities predominantly falling in the central-southern and northeastern areas of Sicily for IC6; small clusters of clusters of municipalities predominantly falling in the northern-eastern and southern areas of Sicily for IC7; small clusters of municipalities predominantly falling in the northern-eastern area of Sicily for IC8; small clusters of municipalities predominantly falling in the southern-western area of Sicily for IC9; small clusters of municipalities predominantly falling in the central area of Sicily for IC10; small clusters of municipalities predominantly falling in the central and eastern areas of Sicily for IC11; small clusters of municipalities predominantly falling in the central and northeastern areas of Sicily for IC12; small clusters of municipalities predominantly falling in the central and eastern areas of Sicily for IC13; small clusters of municipalities predominantly falling in the southern-eastern and northern area of Sicily for IC14; and clusters of municipalities predominantly falling in the central-eastern and northwestern area of Sicily for IC15; clusters of municipalities predominantly falling in the central and southern areas of Sicily for IC16 and IC17; small clusters of municipalities predominantly

falling in the northern-eastern and central-western areas of Sicily for IC18 and IC19; clusters of municipalities predominantly falling in the central-eastern area of Sicily for IC20; and small clusters of municipalities predominantly falling in the northern-eastern and southern areas of Sicily for IC21.

With reference to the first quartile, Figure 13 shows: the presence of clusters of municipalities predominantly falling in the central and northeastern areas of Sicily for NC1; small clusters of municipalities predominantly falling in the central and northeastern areas of Sicily for NC2; clusters of municipalities falling in almost all of Sicily with the exception of the Trapani metropolitan area and partially in those of Agrigento, Catania, Messina, Palermo, and Ragusa for NC3; clusters of municipalities predominantly falling in the central and southeastern central areas of Sicily for NC4; and small clusters of municipalities predominantly falling in the northern, eastern, and south-central area of Sicily for NC5.

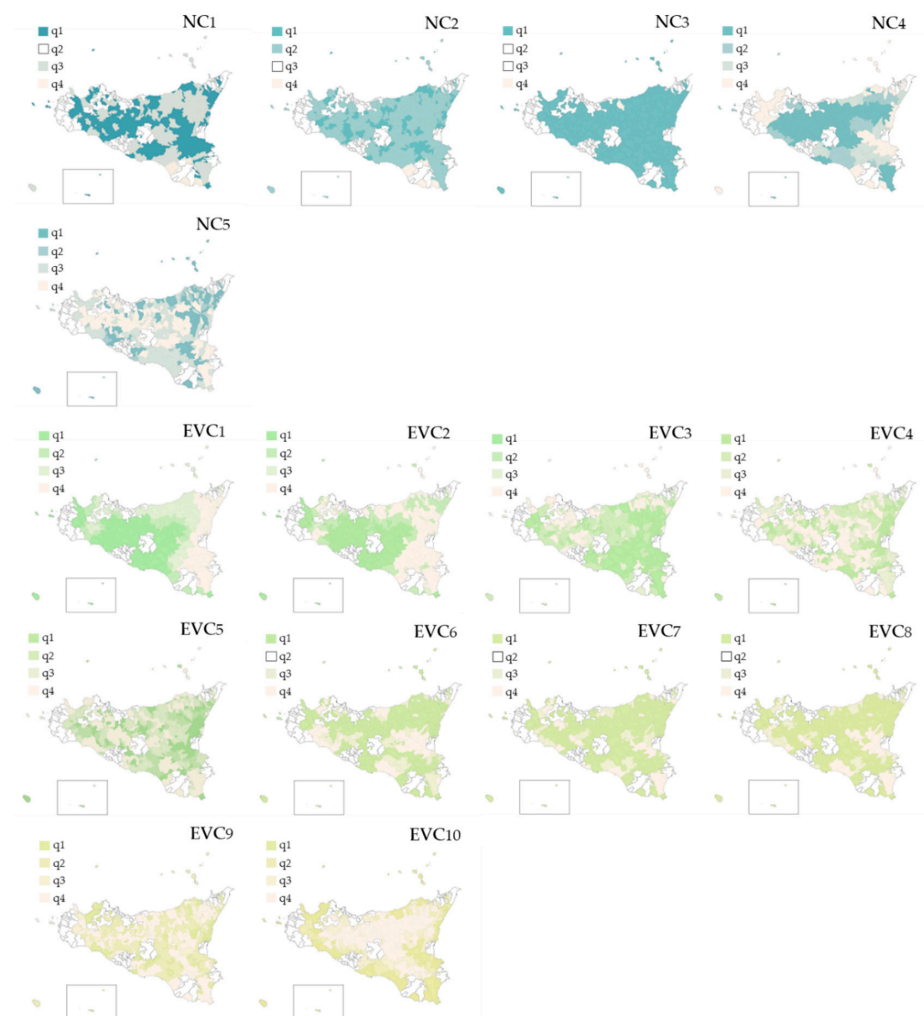


Figure 13. Mapping of Natural and Environmental Capital indicators. (Authors' elaboration).

With reference to the second quartile, Figure 13 shows: no municipalities falling in the second quartile NC1; clusters of municipalities falling throughout Sicily with a lower concentration in the metropolitan cities of Agrigento, Palermo, Ragusa, and Trapani and NC2; no municipalities falling in the second quartile for NC3; clusters of municipalities falling in the central and southeastern areas of Sicily for NC4; and small clusters of municipalities predominantly falling in the northern, eastern, and south-central areas of Sicily for NC5.

With reference to the third quartile, Figure 13 shows: no municipalities falling in the second quartile for NC1; no municipalities falling in the third quartile for NC2 and NC3; clusters of municipalities falling in the eastern area of Sicily for NC4; and small clusters

of municipalities predominantly falling in the southern and north-central areas of Sicily for NC5.

With reference to the fourth quartile, Figure 13 shows: clusters of municipalities predominantly falling in the southern-eastern area of Sicily for NC1 and NC2; small clusters of municipalities predominantly in the metropolitan cities of Messina and Catania for NC3; clusters of municipalities in the eastern and northwestern areas of Sicily for NC4; and small clusters of municipalities predominantly falling in the central and eastern areas of Sicily for NC5.

With reference to the first quartile, Figure 13 shows: clusters of municipalities predominantly falling in the central and southern areas of Sicily for EVC1 and EVC2; clusters of municipalities predominantly falling in the eastern and central-western areas for EVC3; small clusters of municipalities predominantly falling in the eastern and central areas of Sicily for EVC4 and EVC5; clusters of municipalities predominantly in the north-central and east-south areas for EVC6, EVC7 and EVC8; small clusters of municipalities predominantly falling in the eastern, south-central and north-western areas of Sicily for EVC9; and small clusters of municipalities predominantly falling in the coastal area of Sicily for EVC10.

With reference to the second quartile, Figure 13 shows: the presence of small clusters scattered predominantly in the central area of Sicily for EVC1; small clusters of municipalities scattered predominantly in the north-central and south-central areas of Sicily for EVC2; clusters of municipalities falling predominantly in the central area of Sicily for EVC3; small clusters of municipalities predominantly falling in the north-central and eastern areas of Sicily for EVC4 and EVC5; no municipalities falling in the second quartile for EVC6, EVC7, and EVC8; small clusters of municipalities predominantly falling in the central and eastern area of Sicily for EVC9; and small clusters of municipalities predominantly falling in the south-central and eastern areas of Sicily for EVC10.

With reference to the third quartile, Figure 13 shows: the presence of clusters of municipalities predominantly falling in the northern and central-eastern areas of Sicily for EVC1; small clusters of municipalities scattered predominantly in the northern-eastern and southern-eastern areas of Sicily for EVC2; small clusters of municipalities of municipalities falling predominantly in the central and northern-eastern areas of Sicily for EVC3; small clusters of municipalities in the central and eastern areas of Sicily for EVC4; the presence of clusters of municipalities falling in the central and northeastern areas of Sicily for EVC5; small clusters of municipalities predominantly falling in the central area of Sicily for EVC6; no municipalities falling in the second quartile for EVC7 and EVC8; small clusters of municipalities predominantly falling in the central and eastern areas of Sicily for EVC9; and small clusters of municipalities predominantly falling in the central-southern and eastern areas of Sicily for EVC10.

With reference to the fourth quartile, Figure 13 shows: the presence of clusters of municipalities predominantly in the eastern area of Sicily for EVC1; clusters of municipalities predominantly falling in the northern and eastern areas of Sicily for EVC2; clusters of municipalities predominantly falling in the central-western and north-central-eastern areas of Sicily for EVC3; clusters of municipalities predominantly falling in the central area of Sicily for EVC4; clusters of municipalities predominantly falling in the southern and north-central areas of Sicily for EVC5; clusters of municipalities predominantly falling in the southern and east-central areas of Sicily for EVC6; small clusters of municipalities predominantly falling in the southern, west-central, and east-central areas of Sicily for EVC7 and EVC8; clusters of municipalities predominantly falling in the eastern and west-central areas of Sicily for EVC9; clusters of municipalities falling in the central area of Sicily for EVC10.

5.2. Comparison of Clusters of Municipalities Based on the Quartiles of Territorial Capital Indicators and the Types of Areas in the NSIA Classification

Clusters of municipalities with reference to indicator quartiles for different forms of territorial capital were compared with the different types of areas proposed by the NSIA classification, particularly with peripheral, intermediate, and ultra-peripheral areas.

Municipalities, according to the NSIA classification, are characterized on the basis of their marginality, graded with reference to certain socio-economic indicators and distance from the reference pole.

The analysis proposed in this study is based on the indicators representing the level/value of different forms of territorial capital, and also including those supporting the NSIA classification, including distance to the pole, and shows substantial differences in municipalities clustered based on indicator performance and the characterization of municipalities by levels of marginality.

With reference to the types of areas in the NSIA classification, the intermediate one is characterized by lower marginality, and therefore municipalities falling under it should show the best indicator performance, the ultra-peripheral one the worst performance, and the peripheral one an intermediate performance between the two.

Comparing the performance of the indicators of territorial capital forms for the nine metropolitan areas in Sicily and the types of areas in the NSIA classification, it is possible to always highlight municipalities belonging to the clusters by quartiles that fall into the different types of NSIA areas.

An example may better clarify what we have noticed. We highlight in this section the comparison between clusters of municipalities based on quartiles of human and natural capital indicators, and the NSIA classification (Figure 14), and propose the same comparison for indicators of all other forms of capital in Appendix A.2.

With reference to the HC1 indicator, the municipalities for the different metropolitan areas of Sicily falling in the fourth quartile are those characterized by a higher level/value of the indicator; we would have expected to find these municipalities among those characterized by less marginality, but this is not the case, as the municipalities belonging to this cluster can be classified according to NSIA as intermediate, peripheral and ultra-peripheral areas.

From this, it is possible to highlight that even municipalities with high HC1 performance may fall with reference to NSIA classification into areas characterized by high marginality, such as ultra-peripheral areas.

Again, with reference to HC1, we detect the highest percentage of municipalities falling in the third quartile of the indicator that with reference to the NSIA classification fall in ultra-peripheral areas, which are characterized by high marginality. In addition, there is a high percentage of municipalities falling in the second and first quartiles of the indicator that with reference to NSIA fall in intermediate and peripheral areas, thus characterized by low or medium marginality.

In general, for all indicators considered to characterize the different forms of capital it is possible to find that the municipalities in the quartile clusters can always be classified according to the three types of NSIA areas. From this it is possible to show that in most cases high performance of indicators could correspond to high marginality for NSIA classification, or, vice versa, low performance of indicators could correspond to low marginality, and again medium-low and medium-high performance of indicators could correspond to low, medium, and high marginality.



Figure 14. Cont.



Figure 14. Cont.

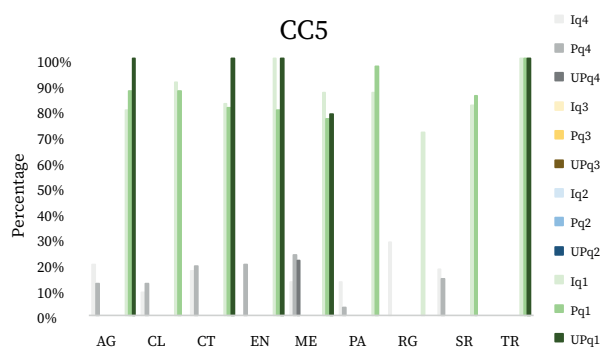


Figure 14. Comparison of the percentages of municipalities for different metropolitan cities in Sicily based on the quartiles of indicators for human and cultural capital, and the NSIA classification. (Authors' elaboration).

The absence of total convergence between the classifications, the NSIA one, and the one with reference to clusters of municipalities on the basis of quartiles of indicators for different forms of capital, highlights the former's inability to be able to capture the values of different areas.

The approach underlying the attribution in a certain level of marginality to areas proposed by the NSIA classification fails to capture the distinctiveness of their values and/or dis-values. There is a risk that it provides a mapping of abandonment incapable of adequately supporting the planning of interventions aimed at reducing their marginalization and promoting the development of strategies aimed at enhancing the areas.

In this regard, this research proposes a new mapping of abandonment based on an index estimated with reference to the values and/or dis-values of indicators of different forms of territorial capital.

5.3. Principal Component Analysis of Territorial Capital Indicators

We selected 89 indicators for the characterization of different forms of territorial capital. Given the presence of many interrelated variables, PCA can be used. PCA was conducted with the help of SPSS statistical software, and it is instrumental in reducing the dimension and arriving at the estimation of the abandonment index more efficiently.

With the help of the statistical software, the non-rotated solution was produced and then the rotated solution using the Rotation-Varimax method with Kaiser normalization, and the components were selected based on the screen plot (Figure 15).

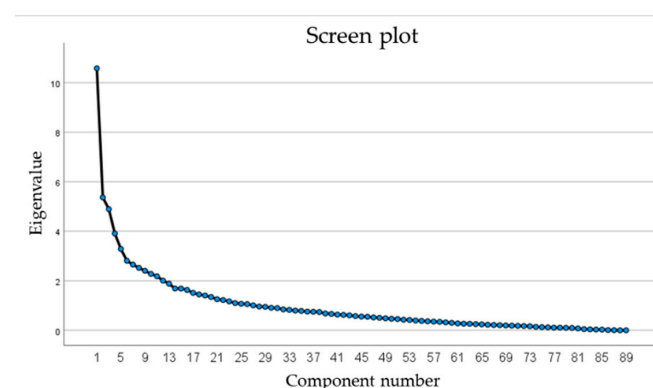


Figure 15. Screen plot rotated solution using the Rotation-Varimax method.

The rotated solution was obtained after 34 iterations and identified 27 components that in total explained 73.5 % of the total variance (Table A1 in Appendix B).

For each component, based on the variables in it, we gave a name. The 27 components and their designations are given below:

- PC1 (HC2, HC3, UC13, UC14, IC8) called Attractiveness 1;
- PC2 (HC1, UC6, EC9, IC17) called Attractiveness 2;
- PC3 (EC2, EC3, EC4, EC8, IC1) called Economy 1;
- PC4 (HC6, HC14) called Economy 2;
- PC5 (IC6, IC16, CC1) called Facilities 1;
- PC6 (UC21, IC13, IC15) called Facilities 2;
- PC7 (EC10, NC1, NC2, NC4) called Natural heritage and agricultural activity;
- PC8 (UC7, UC8, UC11) called Urbanization 1;
- PC9 (IC2, IC4, IC5) called Mobility;
- PC10 (HC9, HC11, HC12) called Foreigners;
- PC11 (NC3, CC2, CC3, CC4) called Cultural heritage;
- PC12 (UC9, UC15, IC3) called Functional mix;
- PC13 (EVC1, EVC2, EVC6, EVC7, EVC8) called Hydraulic and seismic hazards;
- PC14 (HC4, HC5, HC7, UC1, IC18, EVC9) called Population and urbanization;
- PC15 (HC15, HC16) called Education;
- PC16 (EVC3, EVC4, EVC5) called Landslide Hazard;
- PC17 (UC12, UC16, UC17) called Dwellings 1;
- PC18 (UC17, IC12) called Facilities 3;
- PC19 (UC4, UC18, UC20, UC22, EVC10) called Urbanization 2;
- PC20 (IC10, IC11, IC20) called Facilities 4;
- PC21 (HC8, HC13) called Employment 1;
- PC22 (HC10, EC6) called Employment 2;
- PC23 (IC9, IC21, CC5) called Facilities 5;
- PC24 (UC3, UC5, UC19) called Dwellings 2;
- PC25 (UC10, EC1, EC5, EC7) called Economy 3;
- PC26 (IC7, IC14, IC19) called Transport;
- PC27 (UC2, NC5) called Urban and agricultural land use.

The PCA made it possible to reduce the number of variables representing the different forms of territorial capital from 87 to 27. The new variables considered next in the analysis are: Attractiveness 1, Attractiveness 2, Economy 1, Economy 2, Facilities 1, Facilities 2, Natural heritage and agricultural activity, Urbanization 1, Mobility, Foreigners, Cultural heritage, Functional mix, Hydraulic and seismic hazards, Population and urbanization, Education, Landslide Hazard, Dwellings 1, Facilities 3, Urbanization 2, Facilities 4, Employment 1, Employment 2, Facilities 5, Dwellings 2, Economy 3, Transport, and Urban and agricultural land use.

5.4. Estimated Aggregate Index of Abandonment- I_a

Based on the components identified with the help of the PCA and through Equation (1) previously presented, the abandonment index I_a was estimated for the marginal areas of Sicily

Based on this calculation, all Sicilian municipalities under study were ranked, i.e., those falling in the intermediate, peripheral, and outermost NSIA areas. The ranking of the municipalities is shown in Table A2 in Appendix B. The clusters of municipalities based on quartiles, for the different metropolitan areas in Sicily are presented in Table A3 in Appendix B. Based on the quartiles of the estimated abandonment index, four classes of abandonment were defined, low, medium, medium-high and high. Municipalities falling into the fourth quartile are those characterized by a low level of abandonment, those falling into the third quartile are characterized by a medium level of abandonment, those falling into the second quartile are characterized by a medium-high level of abandonment, and those falling into the first quartile are characterized by a high level of abandonment.

Figure 16 shows the number of municipalities for the nine Sicilian metropolitan cities that fall into the different classes of abandonment. Figure 16 shows a high number of municipalities falling in the high I_a class for the metropolitan cities of Palermo and Messina. The latter also has the highest number of municipalities falling in the medium-high I_a class.

From this it can be inferred that these two metropolitan cities are those most affected by the phenomenon of abandonment. The Ragusa metropolitan area is the only one that has no municipalities in the medium-high and high class.

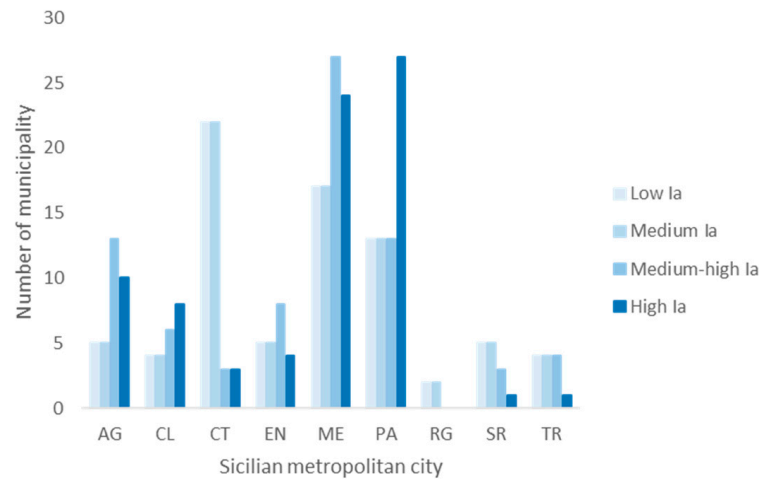


Figure 16. Number of municipalities by class of abandonment in Sicilian metropolitan cities. (Authors' elaboration).

In order to highlight the areas most affected by the phenomenon of abandonment, a map of clusters of municipalities defined on the basis of quartiles of the abandonment index was produced with QGIS (Figure 17).

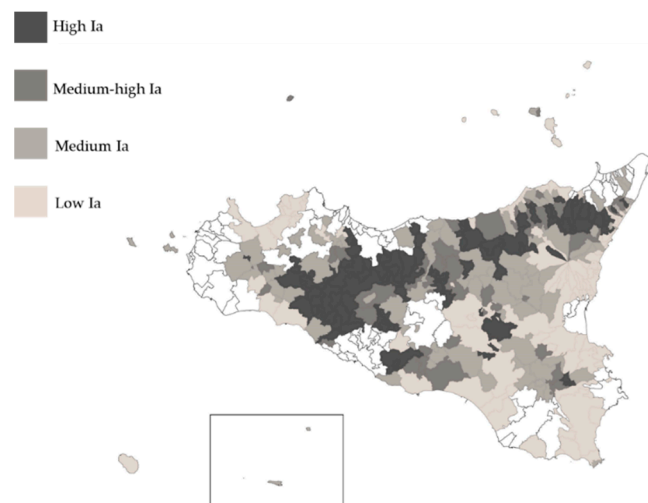


Figure 17. Abandonment map for municipalities in Sicilian metropolitan cities. (Authors' elaboration).

The map shows clusters of municipalities with a low level of abandonment in the central-eastern and western areas of Sicily; clusters of municipalities with a medium level of abandonment in the central and northeastern areas of Sicily; clusters of municipalities with a medium-high level of abandonment in the central and northeastern areas of Sicily; and clusters of municipalities with another level of abandonment in the central-northern area of Sicily. The abandonment mapping produced in this study on the basis of the estimated abandonment index will be compared in the following section with those of inland areas according to SNAI. The purpose is to highlight the convergences and divergences of the two classifications. The purpose of this comparison is to test whether abandonment mapping, i.e., the cognitive support of abandonment adopted so far, is able to effectively support policies and strategies aimed at reducing and containing this phenomenon.

6. Discussion

By comparing the two maps, the one of the classifications of inland areas according to SNAI and the one obtained as a result of this study on the basis of the estimated abandonment index I_a in the perspective of an axiology of weak areas, marked differences can be highlighted.

In the map according to the NSIA classification (Figure 18a) the ultra-peripheral areas highlighted by the darker gray color, to which correspond the areas characterized by the highest level of marginality, fall in the central and northern areas of Sicily, the Pelagic islands, and the island of Pantelleria and Salina. In the new map (Figure 18b) the areas characterized by an I_a belonging to the high class, highlighted by darker gray, fall in the central and northern areas of Sicily. Between the two maps there is a convergence for the location of the areas affected by the phenomenon of abandonment, but divergences with reference to the extent of the areas affected, more extensive in the case of the new map and a different characterization for the Pelagic islands, the island of Pantelleria and Salina.

In the map according to the NSIA classification (Figure 18a) the peripheral areas highlighted by gray, to which correspond the areas characterized by an intermediate level of marginality, affect large portions of the Sicilian territory mainly in the central, eastern-northern, and western-northern areas and in the southern areas of Sicily, the Aeolian and Egadi islands. In the new map (Figure 18b) the areas characterized by an I_a belonging to the medium-high class, highlighted by gray, fall in the central and northern areas of Sicily, the Aeolian and Egadi islands. Between the two maps there is still a convergence for the location of the areas affected by the abandonment phenomenon, as well as divergences with reference to the extent of the areas affected, which are smaller in the case of the new map and a different characterization of the Aeolian and Egadi.

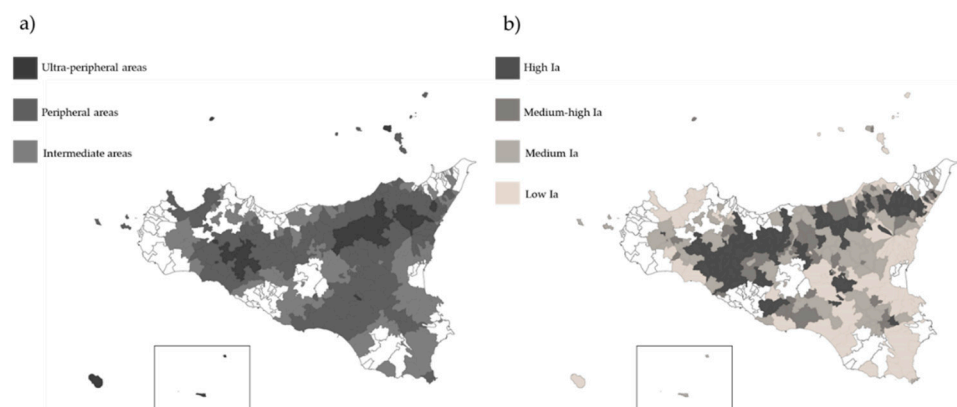


Figure 18. Comparison between the NSIA classification of inland areas and that based on the abandonment index I_a . (a) highlights the map of interen areas based on the classification of the NSIA; (b) highlights the map constructed based on the abandonment index. (Authors' elaboration).

In the map according to the NSIA classification (Figure 18a) the intermediate areas highlighted by the light gray color, to which correspond the areas characterized by a low level of marginality, cover large portions of the Sicilian territory, mainly in the central and eastern areas of Sicily. In the new map (Figure 18b) the areas characterized by an I_a belonging to the medium class, are highlighted by lighter gray, and fall in the central area of Sicily, the Pelagic and Egadi islands. Between the two maps there is still a partial convergence for the location of the areas affected by the phenomenon of abandonment with reference to the central areas, but also divergences with reference to the extent of the areas affected, smaller in the case of the new map and a different characterization of the Pelagic and Egadi islands.

Based on the fourth class of I_a , i.e., the low class, highlighted by very light gray, the new map (Figure 18b) highlights extensive portions of Sicilian territory predominantly falling in the eastern, southern and northern areas, the island of Pantelleria and the Aeolian

Islands. These areas are identified in the NSIA classification as intermediate and peripheral, while the former characterization could be considered congruent with the low class of I_a , the latter certainly highlights a discordance between the two maps.

Going into more detail, a comparison of the percentages of municipalities between the two classifications, the one with reference to I_a , and the NSIA classification, reveals strong divergences. The municipalities falling in the fourth quartile of I_a , and thus belonging to the high class of abandonment, in the NSIA classification can be classified as intermediate, peripheral, and ultra-peripheral areas, as is highlighted in Figure 19a. In particular, it is noted that: the metropolitan cities of Agrigento, Enna and Messina are characterized by municipalities that can be classified in the three types of NSIA areas; the metropolitan cities of Caltanissetta, Catania and Palermo are characterized by municipalities that can be classified in two types of NSIA areas; and the metropolitan cities of Syracuse and Trapani are characterized by municipalities that according to the NSIA belong to the peripheral area for the former and to the intermediate area for the latter.

This detects a divergence, in that areas with profoundly different levels of marginality for the NSIA classification fall in the same class of I_a high. More importantly, it is possible to highlight municipalities with high levels of marginality, such as those falling in the ultra-peripheral areas of the NSIA classification, while falling in the fourth quartile in the estimated I_a index. This highlights a criticality of the NSIA classification in detecting the actual status in terms of marginality of municipalities.

A convergence between the two classifications is detectable for the Ragusa metropolitan area, which for the NSIA classification is characterized only by intermediate areas and for which no municipality falling in I_a high can be detected.

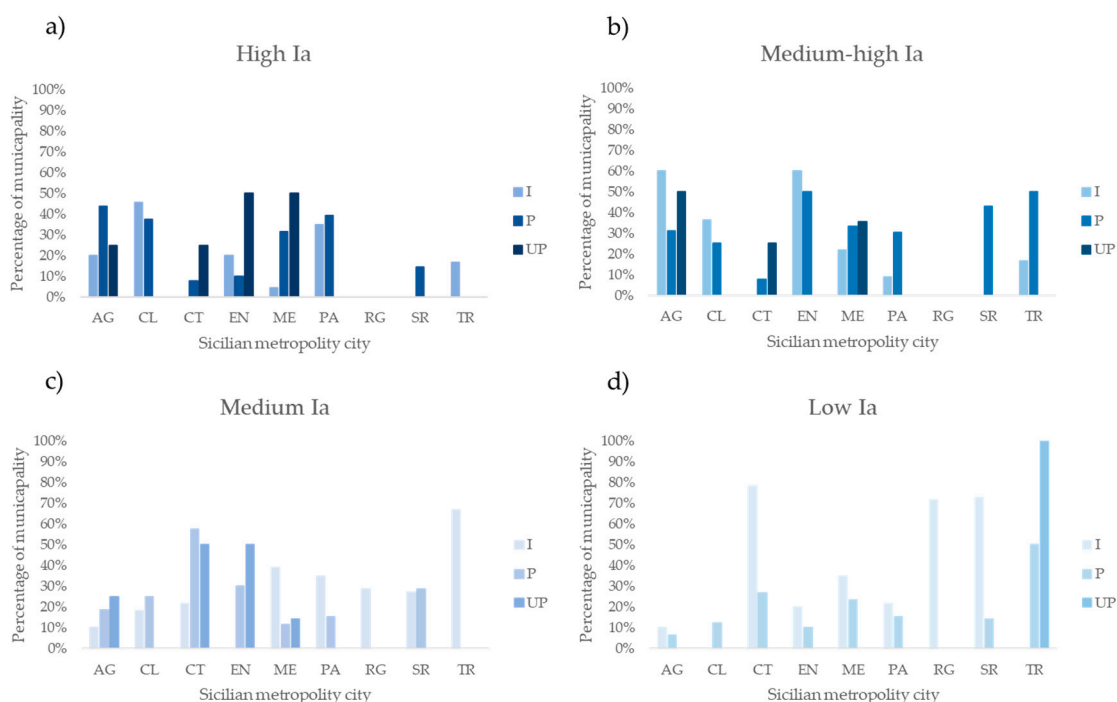


Figure 19. Percentage of municipalities in Sicilian metropolitan cities by classes of abandonment and membership in SNAI internal area types: (a) Low I_a ; (b) Medium I_a ; (c) Medium-high I_a ; (d) High I_a . (Authors' elaboration).

The same divergences can be detected by comparing the NSIA classification with that for I_a Medium-high, Medium and Low (Figure 19a–d). Again, the only convergence detected between the two classifications still concerns the Ragusa metropolitan area, for which there are absent municipalities falling in the I_a Medium-high class, and present municipalities falling in the Medium and High class, considering the latter range of values

likely to be similar to those of an intermediate area, which is the only type of area provided for Ragusa in the SNAI classification.

For the Region of Sicily, four areas have been identified for which an area strategy has been identified in order to counter the phenomenon of abandonment and promote measures aimed at territorial rebalancing. The proposed supporting policies are place-based and provide directions for promoting the SDGs [9] in these areas. The strategies are mainly based on Citizen Empowerment for Health, Active Land Protection, Renewable Energy Production, Rural System Development, Supporting Local Businesses and Crafts to Promote Employment, Enhancing Territorial Accessibility and Mobility, Improving Tourism Supply, Reducing Digital Divide, Promoting Local Community Participation, Community Services and Social Infrastructure, Enhancing Human Capital, Partnerships, Sustainable Communities [148,149].

The four areas identified according to the NSIA classification of inland areas are Catlatino, Madonie, Nebrodi and Val Simeto. These areas are characterized by the territorial contiguity of municipalities that have joined the Framework Program Agreements. The different areas include municipalities that can be classified according to NSIA as intermediate areas, peripheral and ultra-peripheral, and in some cases, as in the case of the Madonie and the Val di Simeto even those falling within the belt areas. For example, with reference to the case of the Nebrodi area strategy (Table 8), it includes nineteen municipalities falling within the Messina metropolitan area. The municipalities in the Messina metropolitan area adhering to the Framework Agreement with reference to the NSIA classification are characterized: four as intermediate areas, thirteen as peripheral areas, and two as ultra-peripheral areas. With reference to the abandonment index estimated in this study, four of them fall in the first quartile; eleven in the second quartile; three municipalities fall in the third quartile and only one municipality falling in the quartile.

Table 8. The municipalities belonging to the Nebrodi area strategy.

Metropolitan Area	Nebrodi Area Strategy	NSIA	Ia
ME	Tusa	I	q2
ME	Pettineo	I	q1
ME	Castel di Lucio	P	q1
ME	Mistretta	P	q2
ME	Reitano	I	q2
ME	Santo Stefano di Camastra	I	q3
ME	Caronia	P	q2
ME	San Fratello	P	q3
ME	Militello Rosmarino	P	q2
ME	Sant'Agata di Militello	P	q4
ME	Alcara Li Fusi	UP	q1
ME	Longi	UP	q2
ME	San Marco D'Alunzio	P	q3
ME	Mirto	P	q2
ME	Naso	P	q2
ME	San Salvatore di Fitalia	P	q1
ME	Castell'Umberto	P	q2
ME	Tortorici	P	q2
ME	Galati Marmettino	P	q2

Again, as in all the other areas identified, the municipalities participating in the area strategy are characterized by territorial contiguity. They belong to the same territorial sub-area as the metropolitan area of Messina.

The NSIA Classification can be seen as a cognitive tool to support networking among municipalities, in this case supported the identification of a mix of municipalities characterized by different levels of marginality, in which 21 percent fall in intermediate areas, 685 in peripheral areas and 11 percent in ultra-peripheral areas. The network selected in this case integrates municipalities with strongly marked marginalities, others with less

marked marginalities, and still others with small marginalities. If strategies were effectively selected for this network, it could foster those complementarities among municipalities capable of generating a territorial unity that could achieve greater enhancement than a single municipality could achieve.

The classification according to the index of abandonment estimated in this study developed from the perspective of an axiological approach highlights, in a more pronounced way the possibility of generating a network on the basis of the complementarity of municipalities. For the case of the Nebrodi area, we show that 21% of the municipalities fall in the first quartile of I_a , 58% in the second quartile of I_a , 16% in the third quartile and 5% in the fourth quartile of I_a . Again, a main pole is detected, which is represented by the municipality or municipalities with the highest I_a performance on the base are connected those with progressively worse performance thus defining the network.

According to this perspective, the measure of the values and/or disvalues of municipalities, i.e., the measure of their residual worthiness identified in the index I_a is possible to more effectively support the selection of municipalities that will be able to fall within a functional area and to support the creation of a network. Classification on the basis of the abandonment index I_a will be able to support the decision maker in identifying an area unit and creating specific development strategies.

The mapping of inland areas proposed by NSIA represents the official cognitive tool to counter the marginalization and abandonment of territories. Italy among European countries is the first country that has produced a reconnaissance of the state of abandonment of the territory, proposing a unified framework to develop strategies to counter this phenomenon. This mapping is the basis for the allocation of financial resources provided in Mission 5, Component 3, Investment 1 of the Italian National Recovery and Resilience Plan (NRP) [22]. It represents the financial tool to support the implementation of policies aimed at reducing social distress and fragility, increasing the number of service recipients, increasing the quality of supply, and facilitating connections and accessibility to territories and services.

In Europe, other countries have promoted policies aimed at territorial rebalancing and finding funding to support it. For example, France promoted in 2014 “*Revitalisation des centres-bourges*” [150] which represents the first national program aimed at intervening in the imbalances that affected small and medium-sized cities, which until then had been excluded from national urban policies that were mainly directed at *grandes villes*. Later, in order to improve the level of policy implementation with reference to the peculiarities of the areas of action, France proposed other programs such as the “*Action Coeur de Ville*” in 2018 [151], which is aimed at improving the living conditions of the inhabitants of medium-sized centers and consolidating the leading role of these centers in the development of the territory. In 2020, France proposed the program “*Petites villes de demain*” nel 2020 [152], aimed at improving the living conditions of the inhabitants of small towns and surrounding areas by supporting communities in identifying dynamic trajectories for their ecological transition.

Other countries, such as Switzerland, adopted a New Regional Policy (NRP) in 2008 [153] to support mountain and border regions and rural areas, promoting improved hard and soft location factors of regions, promotion of innovation, value creation and competitiveness in a sustainable way [154–157].

In this way, the NRP contributes to the creation and retention of jobs in the targeted areas, to compensate for regional disparities, and to maintain decentralized settlement structures in Switzerland. The NRP also promotes European territorial cooperation in line with the Interreg, ESPON, URBACT and INTERACT programs [158].

In Spain, the issue of depressed areas due to their depopulation and socio-economic decline was initially addressed by some regions, such as Castilla-La Mancha, which in 2016 approved the definition of five geo-graphic areas with specific development needs [159], as well as the initiation of procedures for the implementation of integrated territorial investments, i.e., tools to facilitate support for integrated actions in an area, allowing the

combination of funding related to different thematic objectives and various operational programs supported by the various European Structural and Investment Funds (EIFs).

Subsequently, the Spanish Council of Ministers on March 29, 2019 approved the General Guidelines for a National Strategy to Address the Demographic Challenge by mapping demographic depopulation, aging, and the effects of population fluctuation and setting the following goals [160]: ensure full territorial connectivity; ensure adequate provision of basic services to the entire population; incorporate demographic impact and perspective in the preparation of laws, plans and investment programs; regulatory and administrative simplification, for small municipalities; enhance the image and reputation of territories most affected by demographic risks; strengthen public-private collaboration; and align the Strategy's action lines with the achievement of the Sustainable Development Goals and Agenda 2030.

Other interventions in favor of marginal areas are being planned in Spain under the impetus of a debate on the subject (which is quite heated), such as the program “El plan de España para evitar la despoblación rural”, which is still being structured.

The mapping of inland areas proposed by NSIA to support the development of strategies aimed at combating abandonment of territories is a tool that as highlighted in this study has ample room for improvement. In this regard, our proposal for a new mapping based on an abandonment index moves in the direction of improving the formation of a knowledge base of the phenomenon of abandonment, instrumental in identifying strategies and improving the effectiveness of policies.

The main limitations of this study are mostly due to the quality of the data used in the analysis, which although extracted from official datasets, unfortunately refer to different periods. This factual criticality is also detectable for the data used to develop the NSIA classification of inland areas.

With this in mind, we will estimate the abandonment index again in the future once NSIA makes data on the 2021 Permanent Population and Housing Census available.

But more significantly, possible developments of this study will address the question of how this cognitive tool can support decision makers in generating the network of municipalities and supporting strategies in order to achieve more effective implementation of policies in favor of a rebalancing of the territory [161–163].

Future studies will look at the potential of this approach in supporting a territorial values-network-based pattern that can be developed with the support of network analysis, neural network or specific genetic algorithms, aimed at optimizing the selection of areas, strategies and improving the allocation of budgets to those areas.

The estimation of an abandonment index for marginal areas was developed from the perspective of a formative model, in which individual indicators are seen as the “cause” of the latent variable.

PCA for the construction of formative composite indices, as highlighted by Mazzotta and Pareto [164], is a good approach, as it is a powerful tool for complexity reduction and supports data visualization by supporting the researcher in identifying units of analysis with the same characteristics and allows for comparing empirical dimensions (factors) with theoretical dimensions (pillars) while highlighting redundant indicators [165].

Future developments in the estimation of an abandonment index for marginal areas will concern the estimation of weights for the aggregation of the different components. A sensitivity analysis of the index based on the different approaches to estimating the weights may improve its estimation. Further development may concern uncertainty analysis (UA) [166].

7. Conclusions

The marginalization of areas due to progressively increasing social, material, economic, and infrastructural vulnerability is a phenomenon that afflicts many countries today and is growing rapidly [167,168]. The 2030 Agenda highlighted the need to identify measures to support the least developed areas, particularly with reference to Goal 11 of the SDGs [9].

Under the impetus of the sustainability goals set by the 2030 Agenda, there has been a growing awareness among researchers and policymakers that this issue is no longer deferrable, and that it will have to be addressed while being aware of the complexity of the phenomenon. The debate on the issue of abandonment has developed mainly from the perspective of characterizing the phenomenon of abandonment, resulting in actions to measure its magnitude and determine its causes, and on identifying strategies and measures to counter it, and the related sources of funding to be allocated. In this perspective, Italy has equipped itself with a cognitive tool created by the Interministerial Committee for Economic Planning and Sustainable Development, namely the map of inland areas, aimed at to measure the extent and determine the causes of the phenomenon; an operational tool aimed at combating the phenomenon of abandonment aimed at identifying the strategies and interventions to be developed within the framework of the National Strategy for Inland Areas; and a financial tool aimed at supporting the implementation of the specific measures identified, namely the NRRP.

In this study starting from a critical analysis of the NSIA classification of inland areas, we have proposed a new cognitive tool of the phenomenon of abandonment, developed from the perspective of an axiological approach of marginal areas, which led to a mapping of the phenomenon of abandonment on the basis of an index of abandonment I_a . This index was defined on the basis of the value of the different forms of territorial capital of marginal areas, i.e., with reference to human, urban, economic, infrastructure, natural, cultural, and environmental capital. Given the large number of indicators of territorial capital, in order to arrive at the most representative set of indicators, and thus to reduce the complexity of representing the different forms of capital, it was necessary to resort to Principal Component Analysis. The latter supported the identification of twenty-seven components for the characterization of the abandonment index, which was estimated as an aggregate weighted sum of the different components.

The mapping of the abandonment index I_a on QGIS made it possible to identify a new cognitive tool of the abandonment phenomenon, capable of highlighting the values and/or dis-values of areas. The map provides clusters of municipalities based on quartiles of estimated index values. Mapping, in identifying the residual worthiness of areas, can be used for the development of strategies to support their resilience, improve the effectiveness of policies, and promote the efficient use of financial resources to be allocated. It, as amply evidenced in the proposed comparisons with the NSIA classification, can identify itself as a more effective cognitive tool to support the development of strategies to reduce abandonment and promote rebalancing. Certainly, in order to improve the result, we have arrived at, the limitations of this study will have to be overcome.

These limitations are mostly related to the quality of the data, which due to difficulties related to their retrievability refer to different periods, is an issue that can be resolved as soon as NIS makes available the data on the 2021 Permanent Population and Housing Census. Possible developments of this study will address the question of how this cognitive tool can support decision-makers in generating the network of municipalities and identifying strategies, supporting more effective implementation of policies aimed at reducing territorial imbalances.

Subsequent work, therefore, will address the potential of this approach to support a territorial values network-based pattern that can be developed with the support of network analysis, neural networks or specific genetic algorithms aimed at optimizing the selection of areas and strategies and improving the allocation of budgets to different areas.

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Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Appendix A.1. Details of the Indicators Supporting the NSIA Classification

Structure indicators:

- Housing structure: this indicator was chosen as a summary measure of the prevailing housing type: population centers, cores and scattered houses, and thus considered a proxy for the degree of urbanization;
- Population rate over 65 years old: this indicator was considered a proxy for the demographic environment.

Indicators of supply for services:

- Presence and type of upper secondary schools (varies between “No offer” and “Full offer”, full offer includes high schools, technical and vocational colleges, and other types of high schools);
- Presence of banking services (no. bank branches $\times$ 1000 inhabitants);
- Presence of financial services for the citizens;
- Presence of health and emergency room facilities (varies between “No facilities” to “More than one facility”);
- Presence of health facilities with at least 250 beds;
- Presence of health facilities with at least 120 beds;
- Presence of health facilities that are home to Level I EDA;
- Presence of a railway station of at least “Silver” type;
- Presence of state and non-state museums.

Indicators of demand for services:

- High school enrollment out of population aged 14–18 years.
- Context indicators (Source: Istat):
- Share of motor vehicle accidents $\times$ 1000 vehicles on the road (proxy for congestion level).

Appendix A.2. Comparison of the Performance of Indicators of Territorial Capital Forms by Sicilian Metropolitan Cities and the Types of Areas in the NSIA Classification

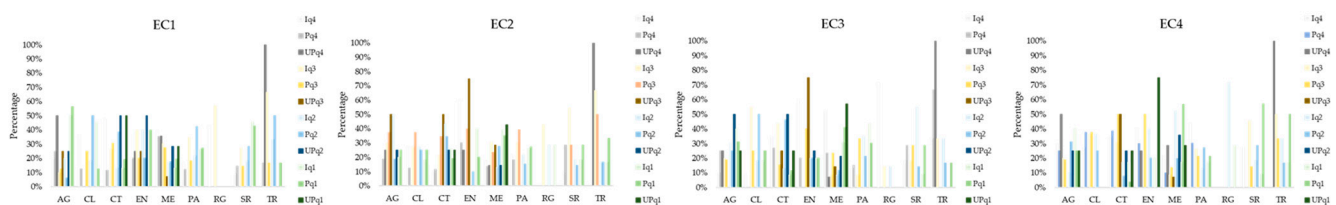


Figure A1. Cont.

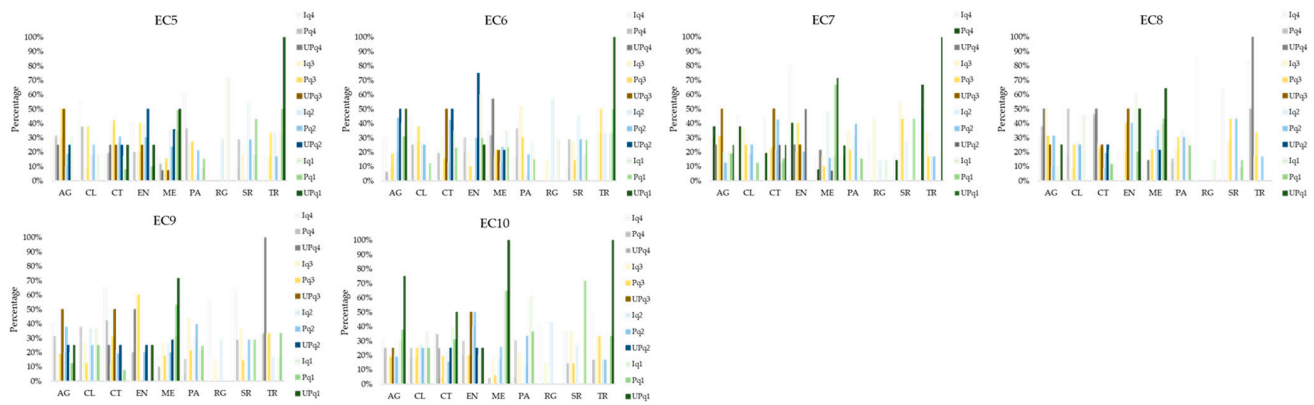


Figure A1. Comparison of the percentages of municipalities for different metropolitan cities in Sicily based on the quartiles of indicators for economic capital, and the NSIA classification. (Authors' elaboration).



Figure A2. Comparison of the percentages of municipalities for different metropolitan cities in Sicily based on the quartiles of indicators for urban capital, and the NSIA classification. (Authors' elaboration).



Figure A3. Comparison of the percentages of municipalities for different metropolitan cities in Sicily based on the quartiles of indicators for infrastructural capital, and the NSIA classification. (Authors' elaboration).

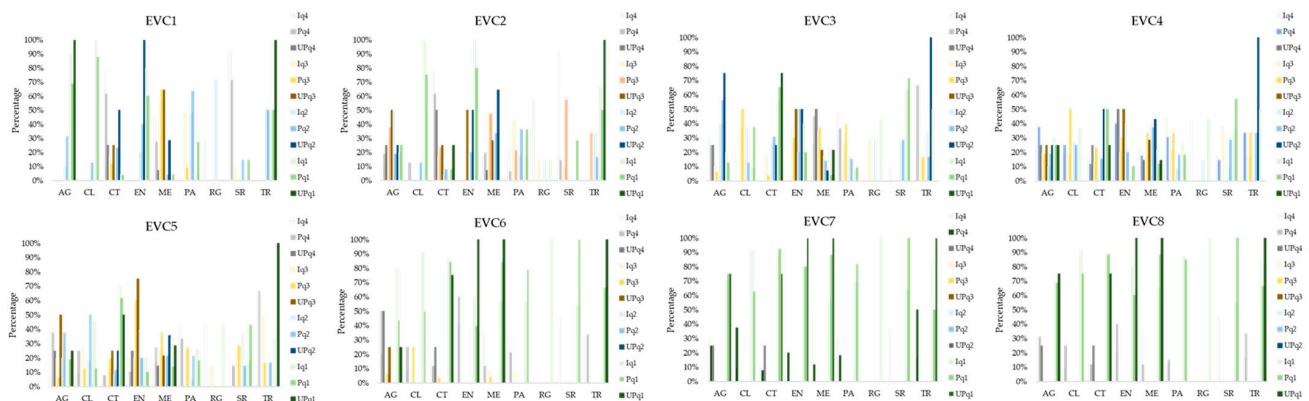


Figure A4. Cont.

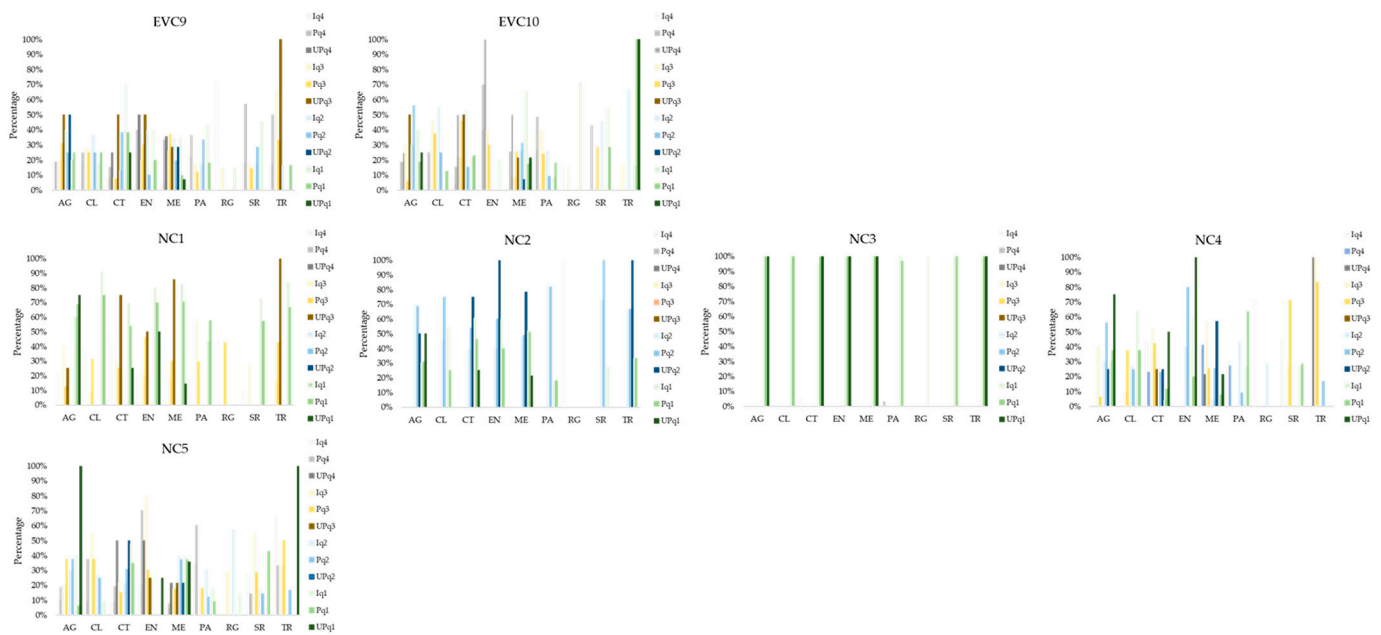


Figure A4. Comparison of the percentages of municipalities for different metropolitan cities in Sicily based on the quartiles of indicators for environmental and natural capital, and the NSIA classification. (Authors' elaboration).

Appendix B

Results on PCA: Total Variance Explored

Table A1. Ranking of municipalities based on abandonment index for nine metropolitan cities in Sicily.

Component	Total Variance Explained								
	Eigenvalues			Sums of Extraction Squares			Sums of Squares of Rotation		
	Total	% Variance	% Cumulative	Total	% Variance	% Cumulative	Total	% Variance	% Cumulative
1	10.582	11.890	11.890	10.582	11.890	11.890	5.207	5.851	5.851
2	5.368	6.032	17.922	5.368	6.032	17.922	4.693	5.273	11.123
3	4.894	5.498	23.420	4.894	5.498	23.420	4.240	4.764	15.888
4	3.907	4.390	27.811	3.907	4.390	27.811	3.950	4.439	20.327
5	3.286	3.692	31.503	3.286	3.692	31.503	2.989	3.359	23.685
6	2.811	3.158	34.661	2.811	3.158	34.661	2.959	3.325	27.010
7	2.653	2.981	37.642	2.653	2.981	37.642	2.922	3.284	30.294
8	2.522	2.833	40.476	2.522	2.833	40.476	2.770	3.112	33.406
9	2.404	2.701	43.177	2.404	2.701	43.177	2.434	2.735	36.140
10	2.279	2.560	45.737	2.279	2.560	45.737	2.362	2.654	38.795
11	2.181	2.450	48.187	2.181	2.450	48.187	2.308	2.593	41.388
12	2.006	2.254	50.441	2.006	2.254	50.441	2.264	2.544	43.932
13	1.883	2.116	52.558	1.883	2.116	52.558	2.220	2.495	46.427
14	1.687	1.896	54.454	1.687	1.896	54.454	2.220	2.495	48.922
15	1.684	1.892	56.346	1.684	1.892	56.346	2.148	2.413	51.335
16	1.632	1.834	58.179	1.632	1.834	58.179	2.097	2.356	53.691
17	1.511	1.698	59.877	1.511	1.698	59.877	2.003	2.251	55.942
18	1.448	1.626	61.504	1.448	1.626	61.504	1.941	2.181	58.123
19	1.405	1.579	63.083	1.405	1.579	63.083	1.661	1.867	59.989
20	1.344	1.510	64.593	1.344	1.510	64.593	1.627	1.828	61.818
21	1.254	1.409	66.002	1.254	1.409	66.002	1.599	1.796	63.614
22	1.222	1.373	67.375	1.222	1.373	67.375	1.558	1.750	65.364
23	1.169	1.313	68.688	1.169	1.313	68.688	1.530	1.719	67.083
24	1.100	1.236	69.924	1.100	1.236	69.924	1.503	1.689	68.772
25	1.070	1.202	71.126	1.070	1.202	71.126	1.483	1.666	70.438
26	1.057	1.188	72.314	1.057	1.188	72.314	1.389	1.560	71.998
27	1.006	1.130	73.445	1.006	1.130	73.445	1.288	1.447	73.445

Table A2. Ranking of municipalities based on abandonment index for nine metropolitan cities in Sicily.

Ranking	Metropolitan City	Municipality	Ranking	Metropolitan City	Municipality	Ranking	Metropolitan City	Municipality
1	Ragusa	Vittoria	104	Messina	Itala	207	Palermo	Mezzojuso
2	Palermo	Carini	105	Siracusa	Sortino	208	Agrigento	Montallegro
3	Trapani	Pantelleria	106	Catania	Maniace	209	Caltanissetta	Resuttano
4	Catania	Acireale	107	Trapani	Calatafimi-Segesta	210	Messina	Mirto
5	Ragusa	Acate	108	Trapani	Salemi	211	Messina	Longi
6	Catania	Belpasso	109	Messina	Forza d'Agrò	212	Palermo	Castellana Sicula
7	Ragusa	Scicli	110	Palermo	San Cipirello	213	Palermo	Baucina
8	Catania	Camporotondo Etneo	111	Messina	Rometta	214	Messina	Moio Alcantara
9	Catania	Aci Castello	112	Catania	Piedimonte Etneo	215	Messina	Ali
10	Siracusa	Augusta	113	Palermo	Marineo	216	Messina	Mistretta
11	Catania	Mascalucia	114	Catania	Adrano	217	Caltanissetta	Milena
12	Palermo	Isola delle Femmine	115	Messina	Motta Camastra	218	Enna	Gagliano Castelferrato
13	Messina	Taormina	116	Palermo	Piana degli Albanesi	219	Messina	Santa Domenica Vittoria
14	Siracusa	Noto	117	Enna	Nicosia	220	Messina	Librizzi
15	Catania	San Giovanni la Punta	118	Messina	Montagnareale	221	Messina	Reitano
16	Catania	Pedara	119	Catania	Licodia Eubea	222	Agrigento	Lucca Sicula
17	Catania	Aci Sant'Antonio	120	Messina	Scaletta Zanclea	223	Siracusa	Ferla
18	Catania	Caltagirone	121	Palermo	Castelbuono	224	Catania	Maletto
19	Siracusa	Melilli	122	Messina	Nizza di Sicilia	225	Enna	Valguarnera Caropepe
20	Siracusa	Lentini	123	Messina	Leni	226	Agrigento	Santo Stefano Quisquina
21	Catania	Viagrande	124	Catania	Vizzini	227	Messina	Galati Mamertino
22	Catania	San Pietro Clarenza	125	Catania	Randazzo	228	Messina	Antillo
23	Catania	Giarre	126	Palermo	Corleone	229	Agrigento	Camastra
24	Catania	Aci Catena	127	Enna	Agira	230	Agrigento	Naro
25	Catania	Trecastagni	128	Messina	Roccavaldina	231	Messina	Gallodoro
26	Ragusa	Ispica	129	Messina	Sant'Angelo di Brolo	232	Messina	Francoavilla di Sicilia
27	Messina	Letojanni	130	Caltanissetta	Niscemi	233	Palermo	Gratteri
28	Catania	Tremestieri Etneo	131	Trapani	Santa Ninfa	234	Enna	Villarosa
29	Catania	Gravina di Catania	132	Agrigento	Lampedusa e Linosa	235	Palermo	Contessa Entellina
30	Caltanissetta	Gela	133	Ragusa	Giarratana	236	Agrigento	Cattolica Eraclea
31	Catania	Mascali	134	Enna	Troina	237	Palermo	Ventimiglia di Sicilia
32	Palermo	Cinisi	135	Messina	San Fratello	238	Palermo	Bompietro
33	Messina	Capo d'Orlando	136	Palermo	San Giuseppe Jato	239	Catania	San Cono
34	Messina	Torrenova	137	Siracusa	Francofonte	240	Palermo	Ciminna
35	Messina	Patti	138	Ragusa	Monterosso Almo	241	Siracusa	Cassaro
36	Catania	Aci Bonaccorsi	139	Catania	Grammichele	242	Messina	San Salvatore di Fitalia
37	Catania	Valverde	140	Catania	Mineo	243	Palermo	Caltavuturo
38	Palermo	Capaci	141	Messina	Monforte San Giorgio	244	Palermo	Bisacquino
39	Trapani	Alcamo	142	Caltanissetta	Mussomeli	245	Agrigento	Calamonaci

Table A2. Cont.

Ranking	Metropolitan City	Municipality	Ranking	Metropolitan City	Municipality	Ranking	Metropolitan City	Municipality
40	Messina	Acquedolci	143	Agrigento	Santa Margherita di Belice	246	Palermo	Vicari
41	Palermo	Partinico	144	Messina	San Marco d'Alunzio	247	Trapani	Vita
42	Palermo	Borgetto	145	Palermo	Cefalà Diana	248	Messina	Alcara li Fusi
43	Catania	Nicolosi	146	Palermo	Villafrati	249	Palermo	Campofiorito
44	Enna	Enna	147	Catania	Linguaglossa	250	Palermo	Castrotonovo di Sicilia
45	Siracusa	Avola	148	Enna	Leonforte	251	Messina	Cesarò
46	Messina	Lipari	149	Catania	Sant' Alfio	252	Palermo	Blufi
47	Messina	Santa Teresa di Riva	150	Enna	Nissoria	253	Messina	Novara di Sicilia
48	Palermo	Torretta	151	Caltanissetta	Serradifalco	254	Palermo	Isnello
49	Messina	Giardini-Naxos	152	Catania	Castel di Iudica	255	Messina	Roccella Valdemone
50	Siracusa	Carlentini	153	Siracusa	Portopalo di Capo Passero	256	Agrigento	Caltabellotta
51	Catania	Ragalna	154	Caltanissetta	Delia	257	Agrigento	Burgio
52	Agrigento	Sciacca	155	Catania	Raddusa	258	Palermo	Lercara Friddi
53	Messina	Sant'Agata di Militello	156	Palermo	San Mauro Castelverde	259	Messina	Castel di Lucio
54	Catania	Riposto	157	Messina	Castell'Umberto	260	Messina	Casalvecchio Siculo
55	Messina	Sant' Alessio Siculo	158	Messina	Castroreale	261	Agrigento	Bivona
56	Catania	Ramacca	159	Palermo	Collesano	262	Palermo	Roccapalumba
57	Agrigento	Canicatti	160	Trapani	Poggioreale	263	Agrigento	Villafranca Sicula
58	Trapani	San Vito Lo Capo	161	Agrigento	Sambuca di Sicilia	264	Messina	Pettineo
59	Palermo	Terrasini	162	Trapani	Salaparuta	265	Messina	Montalbano Elicona
60	Messina	Brolo	163	Trapani	Favignana	266	Messina	Fondachelli-Fantina
61	Messina	Piraino	164	Palermo	Petralia Sottana	267	Caltanissetta	Montedoro
62	Messina	Ali Terme	165	Palermo	Pollina	268	Palermo	Polizzi Generosa
63	Messina	Furnari	166	Enna	Centuripe	269	Enna	Sperlinga
64	Trapani	Castellammare del Golfo	167	Messina	Naso	270	Caltanissetta	Vallelunga Pratameno
65	Ragusa	Pozzallo	168	Caltanissetta	Mazzerano	271	Messina	Frazzanò
66	Messina	Gaggi	169	AG	San Giovanni Gemini	272	Palermo	Roccamena
67	Enna	Piazza Armerina	170	Palermo	Camporeale	273	Caltanissetta	Campofranco
68	Siracusa	Rosolini	171	Enna	Regalbuto	274	Palermo	Giuliana
69	Messina	Savoca	172	Agrigento	Palma di Montechiaro	275	Palermo	Alia
70	Catania	Santa Venerina	173	Caltanissetta	Riesi	276	Messina	Malvagna
71	Catania	Santa Maria di Licodia	174	Messina	Sinagra	277	Caltanissetta	Sutera
72	Messina	Capri Leone	175	Agrigento	Cammarata	278	Palermo	Palazzo Adriano
73	Siracusa	Solarino	176	Palermo	Ustica	279	Messina	Basicò
74	Messina	Gioiosa Marea	177	Enna	Assoro	280	Messina	Raccuja
75	Siracusa	Pachino	178	Messina	Graniti	281	Enna	Aidone
76	Messina	Roccalumera	179	Siracusa	Buccheri	282	Palermo	Alimena
77	Palermo	Bolognetta	180	Catania	Militello in Val di Catania	283	Messina	Ucria
78	Palermo	Giardinello	181	Trapani	Gibellina	284	Enna	Cerami
79	Siracusa	Palazzolo Acreide	182	Messina	Santa Marina Salina	285	Palermo	Valledolmo
80	Catania	Palagonia	183	Palermo	Petralia Soprana	286	Caltanissetta	Acquaviva Platani

Table A2. Cont.

Ranking	Metropolitan City	Municipality	Ranking	Metropolitan City	Municipality	Ranking	Metropolitan City	Municipality
81	Palermo	Trappeto	184	Messina	Ficarra	287	Palermo	Campofelice di Fitalia
82	Messina	Furci Siculo	185	Enna	Catenanuova	288	Palermo	Montemaggiore Belsito
83	Palermo	Balestrate	186	Messina	Caronia	289	Messina	Tripi
84	Catania	Fiumefreddo di Sicilia	187	Enna	Calascibetta	290	Caltanissetta	Villalba
85	Catania	Zafferana Etnea	188	Enna	Barrafranca	291	Agrigento	Sant'Angelo Muxaro
86	Agrigento	Menfi	189	Siracusa	Buscemi	292	Catania	Mirabella Imbaccari
87	Palermo	Santa Cristina Gela	190	Messina	Tortorici	293	Messina	San Teodoro
88	Catania	Mazzarrone	191	Agrigento	Campobello di Licata	294	Palermo	Prizzi
89	Catania	Biancavilla	192	Messina	Mazzarrà Sant'Andrea	295	Agrigento	San Biagio Platani
90	Catania	Bronte	193	Agrigento	Montevago	296	Caltanissetta	Bompensiere
91	Palermo	Montelepre	194	Catania	Castiglione di Sicilia	297	Agrigento	Cianciana
92	Agrigento	Licata	195	Caltanissetta	Sommatino	298	Palermo	Aliminusa
93	Trapani	Partanna	196	Palermo	Godrano	299	Messina	Mongiuffi Melia
94	Catania	Milo	197	Caltanissetta	Butera	300	Messina	Mandanici
95	Messina	Santo Stefano di Camastra	198	Agrigento	Ravanusa	301	Messina	Capizzi
96	Messina	Castelmola	199	Messina	Militello Rosmarino	302	Palermo	Chiusa Sclafani
97	Catania	Scordia	200	Messina	Fiumedinisi	303	Catania	San Michele di Ganzaria
98	Siracusa	Canicattini Bagni	201	Agrigento	Casteltermini	304	Messina	Roccafiorita
99	Palermo	Belmonte Mezzagno	202	Palermo	Geraci Siculo	305	Messina	Floresta
100	Agrigento	Ribera	203	Messina	Tusa	306	Caltanissetta	Marianopoli
101	Messina	Malfa	204	Messina	San Piero Patti	307	Messina	Limina
102	Catania	Paternò	205	Palermo	Gangi	308	Palermo	Sclafani Bagni
103	Catania	Calatabiano	206	Messina	Pagliara	309	Messina	Motta d'Affermo
						310	Agrigento	Alessandria della Rocca

Table A3. Cluster of municipalities based on quartiles of the abandonment index for nine metropolitan cities in Sicily.

Metropolitan City	q1	Metropolitan City	q2	Metropolitan City	q3	Metropolitan City	q4
AG	Cattolica Eraclea	AG	Camastra	AG	Menfi	AG	Canicattì
AG	Sant'Angelo Muxaro	AG	Campobello di Licata	AG	Licata	AG	Sciacca
AG	Alessandria della Rocca	AG	Casteltermini	AG	Ribera	CL	Gela
AG	Burgio	AG	Montallegro	AG	Santa Margherita di Belice	CT	Aci Bonaccorsi
AG	Calamonaci	AG	Naro	AG	Lampedusa e Linosa	CT	Aci Castello

Table A3. Cont.

Metropolitan City	q1	Metropolitan City	q2	Metropolitan City	q3	Metropolitan City	q4
AG	Caltabellotta	AG	Palma di Montechiaro	CL	Delia	CT	Aci Catena
AG	Cianciana	AG	Cammarata	CL	Serradifalco	CT	Acireale
AG	San Biagio Platani	AG	Montevago	CL	Mussomeli	CT	Aci Sant'Antonio
AG	Villafranca Sicula	AG	Ravanusa	CL	Niscemi	CT	Belpasso
AG	Bivona	AG	Sambuca di Sicilia	CT	Biancavilla	CT	Camporotondo Etneo
CL	Acquaviva Platani	AG	San Giovanni Gemini	CT	Licodia Eubea	CT	Gravina di Catania
CL	Bompensiere	AG	Lucca Sicula	CT	Paternò	CT	Mascalucia
CL	Campofranco	AG	Santo Stefano Quisquina	CT	Scordia	CT	San Giovanni la Punta
CL	Montedoro	CL	Milena	CT	Mazzarrone	CT	San Pietro Clarenza
CL	Sutera	CL	Resuttano	CT	Adrano	CT	Santa Maria di Licodia
CL	Marianopoli	CL	Riesi	CT	Bronte	CT	Santa Venerina
CL	Vallelunga Pratameno	CL	Sommatino	CT	Calatabiano	CT	Trecastagni
CL	Villalba	CL	Butera	CT	Castel di Iudica	CT	Tremestieri Etneo
CT	San Cono	CL	Mazzarino	CT	Fiumefreddo di Sicilia	CT	Valverde
CT	San Michele di Ganzaria	CT	Maletto	CT	Grammichele	CT	Viagrande
CT	Mirabella Imbaccari	CT	Militello in Val di Catania	CT	Linguaglossa	CT	Ragalna
EN	Villarosa	CT	Castiglione di Sicilia	CT	Milo	CT	Caltagirone
EN	Aidone	EN	Barrafranca	CT	Mineo	CT	Giarre
EN	Cerami	EN	Calascibetta	CT	Palagonia	CT	Mascali
EN	Sperlinga	EN	Catenanuova	CT	Piedimonte Etneo	CT	Nicolosi
ME	Pettineo	EN	Assoro	CT	Raddusa	CT	Pedara
ME	Basicò	EN	Centuripe	CT	Sant'Alfio	CT	Ramacca
ME	Casalvecchio Siculo	EN	Gagliano Castelferrato	CT	Vizzini	CT	Riposto
ME	Castel di Lucio	EN	Regalbuto	CT	Zafferana Etnea	EN	Enna
ME	Fondachelli-Fantina	EN	Valguarnera Caropepe	CT	Randazzo	EN	Piazza Armerina
ME	Frazzanò	ME	Castroreale	CT	Maniace	ME	Alì Terme
ME	Limina	ME	Mazzarrà Sant'Andrea	EN	Agira	ME	Brolo
ME	Mandanici	ME	Pagliara	EN	Leonforte	ME	Furnari
ME	Mongiuffi Melia	ME	Reitano	EN	Nissoria	ME	Letojanni
ME	Montalbano Elicona	ME	Tusa	EN	Nicosia	ME	Patti
ME	Motta d'Affermo	ME	Alì	EN	Troina	ME	Roccalumera

Table A3. Cont.

Metropolitan City	q1	Metropolitan City	q2	Metropolitan City	q3	Metropolitan City	q4
ME	Novara di Sicilia	ME	Caronia	ME	Furci Siculo	ME	Santa Teresa di Riva
ME	Raccuja	ME	Castell'Umberto	ME	Itala	ME	Taormina
ME	Roccafiorita	ME	Ficarra	ME	Monforte San Giorgio	ME	Acquedolci
ME	San Salvatore di Fitalia	ME	Fiumedinisi	ME	Montagnareale	ME	Capo d'Orlando
ME	Tripi	ME	Francavilla di Sicilia	ME	Nizza di Sicilia	ME	Capri Leone
ME	Ucria	ME	Galati Mamertino	ME	Roccavaldina	ME	Gaggi
ME	Alcara li Fusi	ME	Gallodoro	ME	Rometta	ME	Giardini-Naxos
ME	Capizzi	ME	Graniti	ME	Santo Stefano di Camastra	ME	Gioiosa Marea
ME	Cesarò	ME	Librizzi	ME	Scaletta Zanca	ME	Lipari
ME	Floresta	ME	Militello Rosmarino	ME	Castelmola	ME	Piraino
ME	Malvagna	ME	Mirto	ME	Forza d'Agrò	ME	Sant'Agata di Militello
ME	Roccella Valdemone	ME	Mistretta	ME	Motta Camastra	ME	Sant'Alessio Siculo
ME	San Teodoro	ME	Naso	ME	San Fratello	ME	Savoca
PA	Alimena	ME	San Piero Patti	ME	San Marco d'Alunzio	ME	Torrenova
PA	Aliminusa	ME	Sinagra	ME	Sant'Angelo di Brolo	PA	Bolognetta
PA	Caltavuturo	ME	Tortorici	ME	Leni	PA	Borgetto
PA	Gratteri	ME	Antillo	ME	Malfa	PA	Capaci
PA	Isnello	ME	Longi	PA	Belmonte Mezzagno	PA	Isola delle Femmine
PA	Montemaggiore Belsito	ME	Moio Alcantara	PA	Castelbuono	PA	Torretta
PA	Ventimiglia di Sicilia	ME	Santa Domenica Vittoria	PA	Marineo	PA	Carini
PA	Blufi	ME	Santa Marina Salina	PA	Piana degli Albanesi	PA	Cinisi
PA	Alia	PA	Collesano	PA	San Cipirello	PA	Giardinello
PA	Bompietro	PA	Pollina	PA	San Giuseppe Jato	PA	Partinico
PA	Campofelice di Fitalia	PA	Baucina	PA	Santa Cristina Gela	PA	Terrasini
PA	Castronovo di Sicilia	PA	Camporeale	PA	Villafrati	RG	Acate
PA	Ciminna	PA	Castellana Sicula	PA	Balestrate	RG	Ispica
PA	Contessa Entellina	PA	Gangi	PA	Cefalà Diana	RG	Pozzallo
PA	Lercara Friddi	PA	Geraci Siculo	PA	Corleone	RG	Scicli
PA	Polizzi Generosa	PA	Godrano	PA	Montelepre	RG	Vittoria
PA	Roccamena	PA	Mezzojuso	PA	Trappeto	SR	Augusta
PA	Roccapalumba	PA	Petralia Soprana	RG	Giarratana	SR	Avola

Table A3. Cont.

Metropolitan City	q1	Metropolitan City	q2	Metropolitan City	q3	Metropolitan City	q4
PA	Sclafani Bagni	PA	Petralia Sottana	RG	Monterosso Almo	SR	Carlentini
PA	Valledolmo	PA	San Mauro Castelverde	SR	Canicattini Bagni	SR	Lentini
PA	Vicari	PA	Ustica	SR	Francofonte	SR	Melilli
PA	Bisacquino	SR	Buccheri	SR	Sortino	SR	Noto
PA	Campofiorito	SR	Buscemi	SR	Palazzolo Acreide	SR	Rosolini
PA	Chiusa Sclafani	SR	Ferla	SR	Portopalo di Capo Passero	SR	Solarino
PA	Giuliana	TP	Gibellina	TP	Calatafimi-Segesta	SR	Pachino
PA	Palazzo Adriano	TP	Favignana	TP	Partanna	TP	Alcamo
PA	Prizzi	TP	Poggioreale	TP	Salemi	TP	Castellammare del Golfo
SR	Cassaro	TP	Salaparuta	TP	Santa Ninfa	TP	San Vito Lo Capo
TP	Vita					TP	Pantelleria

AG-Agrigento; CL-Caltanissetta; CT-Catania; EN-Enna, PA-Palermo; ME-Messina; RG-Ragusa; SR-Siracusa; TP-Trapani.

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