



**Politecnico
di Torino**

POLITECNICO OF TURIN

Interuniversity Department of Regional and Urban Studies and Planning (DIST)

MSC Territorial, Urban, Environmental and Landscape Planning

Curriculum: Planning for the Global Urban Agenda

MASTER DEGREE'S THESIS

**A QUANTITATIVE SPATIAL
MULTIVARIATE CLUSTER
ANALYSIS OF ITALIAN
SMALL VILLAGES**

Supervisor

Prof.ssa Patrizia Lombardi

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ABSTRACT ITALIANO

Il progressivo spopolamento delle aree interne, le consolidate dinamiche territoriali e l'instabilità creata dalla pandemia Covid-19 possono offrire un'opportunità per ridefinire i nuovi approcci per lo sviluppo di diversi scenari territoriali. Il Progetto di Ricerca "Rinascita dei villaggi per la rivitalizzazione delle aree marginali", approvato dall'Osservatorio EURISPES, intende creare le condizioni per ripopolare e riequilibrare questi territori consolidati, stabilendo nuovi centri di attrattività e prevedendo un coinvolgimento attivo degli enti locali con l'obiettivo di aiutarli attraverso la promozione di un dashboard interattivo per creare un ambiente di apprendimento e un sistema di supporto decisionale spaziale per le future azioni politiche locali. La domanda che sorge spontanea è: perché ripopolare questi territori meno abitati? L'obiettivo è quello di rimpossessarsi di questi territori e delle realtà che li caratterizzano, cercando di creare un valore identitario, il quale, al momento, non è adeguatamente riconosciuto. Infatti, è indispensabile attuare politiche indirizzate ad una pianificazione attiva di questi luoghi, creando posti di lavoro, realizzando una rete infrastrutturale adeguata, fornendo servizi essenziali di base, come la sanità e l'istruzione, senza dimenticare le aree verdi. Questi sono gli elementi che possono offrire condizioni di vita attrattive in generale per i piccoli comuni che stanno vivendo una situazione di disinteresse.

In questa prospettiva, viene proposta una metodologia funzionale con un approccio basato sulla complessità territoriale esistente. In particolare, questo lavoro di tesi contribuisce alla definizione degli archetipi dei villaggi italiani attraverso la multivariate cluster analysis, formata da sei variabili chiave, le quali sono state identificate, valutate e mappate. Inoltre, è stato investigato un esempio di analisi morfologica, place syntax analysis, la quale ha l'obiettivo di valutare la distribuzione spaziale delle amenities ricreative pubbliche. Un caso di studio è stato selezionato dai piccoli villaggi italiani e utilizzato come esempio di applicazione della metodologia delle Isobenefit Lines.

I risultati di questi due primi approcci hanno l'intento di essere un punto di partenza per futuri aggiornamenti sulla definizione degli archetipi dei cluster e per futuri studi sugli aspetti morfologici di queste aree marginali.

ABSTRACT ENGLISH

The progressive depopulation of inland area consolidated territorial dynamics and the instability created by the Covid-19 pandemic can offer opportunities in order to redefine new approaches for developing different territories' scenarios. The Research Project "Renaissance of villages for the revitalization of marginal areas", approved by the EURISPES Observatory, intends to create the conditions to repopulate and rebalance shrinking territories by establishing new centers of attractiveness, expecting an active involvement of local authorities with the aims at helping them by the promotion of an interactive web dashboard provided to create a learning environment and a spatial decision support system for future local policy actions. The question arises is: why repopulate these less inhabited territories? The objective is to regain possession of these territories and the realities that characterize them, while trying to create an identity value that is not currently properly recognized. In fact, it is essential to implement policies aimed at an active planning of these places, creating jobs, providing an adequate infrastructure network, offering basic essential services, such as health and education, without forgetting green areas. These are the elements which can provide attractive living conditions in general for small municipalities experiencing a situation of abandon.

In this perspective, a functional methodology with a place-based approach to managing the existing territorial complexity is proposed. Into specifics, this thesis work contributes to the definition of Italian villages' archetypes through the quantitative spatial cluster multivariate analysis, formed by the six key variables which have been identified, assessed, and mapped. Additionally, the morphological analysis has been explored, which has the aims of assessing the spatial distribution of urban centralities throughout the city representing the quality of life of it. A case study has been selected from the small Italian villages and employed as an example of Isobenefit Lines' methodology application.

The results of these two first approaches have the intent to be a starting point for future upgrades about the definition of cluster's archetypes and for future study about the morphological aspects of these marginal areas.

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INTRODUCTION

1.1. PROBLEM STATEMENT

The increasing urbanization, enhanced by the counter-urbanization dynamics of the 1980s (Dematteis, 1986), has meant that small urban areas far from the main urban centers have established trends that have led to the current situation: negative demographic trends, reduction of economic activities, progressive closure of essential services, social marginality, increased costs in terms of land management (Bertolini and Pagliacci, 2017). Additionally, the territorial transformation processes and socio-economic dynamics that took place in Italy after World War II have brought about an inexorable change in the country's morphology, its production systems, and consequently, the distribution of resources (Barca, F., Casavola, P. and Lucatelli, 2014). Besides these problems, also the progressive depopulation of inland areas and urban polarization such as consolidated territorial dynamics are difficult to dampen and adapt to the new paradigms of sustainable territorial development (Salvia, Salvati and Quaranta, 2021), although they have been abruptly redirected by the Covid 19 pandemic and it is now a clear the disparity between major cities and villages located in marginal areas that have started lagging (OECD, 2020).

This instability created by the pandemic offers the opportunity to redefine new parameters of intervention and new scenarios for the development of territories in relation to the new needs of decentralization and physical distancing (Leach et al., 2021). Consequently, the interest in villages has grown, since the pandemic has highlighted the objective need to safeguard and recover inland areas.

Actually, the main objective to redirect and diversify the supports of local development in order to reduce the gap between large cities and small towns creating efficient polycentric systems. At international level, Green Deal and Next Generation EU tools are strengthening this vision creating an active economy that puts people and the planet first, create jobs, and foster social inclusion while promoting digitalization, innovation, competitiveness, culture, and sustainable tourism for villages and shrinking territories, and providing them with adequate infrastructure and services. At the Italian level, these strategic guidelines have been included in the National Recovery and Resilience Plan (PNRR). Among the 6 missions of the PNRR, the Plan takes action on the regeneration and enhance-

ment of smaller sites, specifically, the villages. The initiatives in favor of the villages will be implemented through the ‘Piano Nazionale Borghi’ (National villages Plan), a program supporting the economic and social development of shrinking areas based also on the cultural regeneration and the construction of a new type of tourism. This Plan wants to ensure the basic services maintenance and reactivation where they are no longer present and provides an equitable infrastructure for telework’s provision and physical infrastructure in order to ensure the accessibility to services.

In this perspective, people choose the city where they want live and elapse their time, therefore, building pleasant cities improves the quality of life for people which are living it. It is taking place a progressive realizing to a greater extent the value of the quality of urban environment that will mitigate¹ the problems such as population density, traffic, lack in housing resources, noise, air and water pollution, etc (Li et al., 2009). These improvements are directly linked to the urban planning because, giving importance to the quality of places, it might be an attractiveness’ growing of marginal areas. To know better which is the quality of life in cities, it could interesting focus on how the factors inducing a pleasant life are spatially distributed throughout the city, and to develop this kind of study, the analysis morphological is the required tool. Indeed, the final purpose of this cities’ science is to understand them and make cities efficient and attractive to please lives².

1 Shear et al., 2006; Jenny and Ericson, 2006; Romano & Ercolano, 2012

2 D’Acci, “Mathematize urbes by humanizing them: cities as isobenefit landscapes. Psycho-economical distances and personal isobenefit lines”, 2015

1.2. “RINASCITA DEI BORGHI” PROJECT

The origins of this project can be found both in the economic and social changes that occurred from the postwar period to the eighties, and in the needs of decentralization and physical distancing imposed by the pandemic from Covid-19. In this period there have been radical changes in the Italian production system, which involve various transformations concerning the spatial distribution of the population, the poles of cultural life and a different concentration of housing and urban planning. Furthermore, the post-COVID-19 future involved questioning the certainties of the territories that were supposed to be acquired and consolidated. The purpose of this research project is to create the conditions to repopulate and balance the internal zones of the country and to build new centers of attractiveness.

Currently, there is a gradual depopulation of the country’s interior regions in favour of a concentration of housing in medium-large cities. This reality can offer the opportunity to define new and different interventions for the development of marginalized territories, the latter considered as an obvious strength in the post-emergency transformation process, thus changing the future scenarios due to the pandemic. The aim is to repossessthe local areas and realities that can offer more attractive, functional and interesting living conditions. At the same time, restocking villages would make it easier to decongest major centres, reducing the pressure on infrastructure and health. Further, the interest towards the “Borghi” has grown more generally highlighting the objective need to safeguard and recover materially and socially the internal areas, which constitute a unique heritage in the world. In this perspective, the country should be prepared to respond to this change by defining new interventions for the development of its territories. Innovative instruments and new methods of interinstitutional cooperation are the basis for making use of these new opportunities, which aim at sustainable and balanced local territorial development, a reduction in disparities between territories and the elimination of social inequalities. In order to create the conditions for the repopulation of the territories in question, public investment would be needed to activate virtuous projects to relaunch local and decentralized economies through the involvement of public-private cooperation

models. All this requires the preparation of plans and synergistic programs defined at central level but in cooperation with the local authorities who follow the lines of common and shared actions. In order to be eligible for public funding, these plans will have to meet precise technical requirements defined in the guidelines of the financing plan according to the evaluation methodologies found in national and European best practices.

In the light of the purposes described, the objective of the Project is to define a planning tool for effective and participatory decision support for the rebirth of the Italian Borghi, aiming at an inclusive governance and an effective policy making to stimulate the development of a detailed mapping of these disadvantaged areas of the country in order to seize development opportunities. Consequently, the Project will allow, through the activation and implementation of an interactive dashboard, to facilitate the decision-making processes for the Public Administration, to innovate the traditional planning processes including the social component of territorial policy decisions, making planning choices efficient through an approach that previously assesses the impacts of policies on the various components of a territory. Obviously, these benefits of the project are closely linked to the intent to relaunch the marginal areas and encourage the rebirth of the villages through the enhancement of their social, cultural, economic and tourist components.

The structure of this project can be divided in phases as outlined below.

Step 1 - Background: the work begins through in-depth bibliographic research that varies from issues concerning the complexity of the territories, the management of sustainable local territorial development, the planning support system, the villages and their opportunities. Subsequently, it is necessary to identify a method of selecting villages, mapping of these places throughout the Italian territory and then carry out an analysis of the data to build a unique and accessible database.

Step 2 - Developing the Decision Support Tool: at this stage, first of all, it is appropriate to define a set of indicators and a selection of KPIs suitable for the synthetic interpretation of the territory through a SWOT analysis. Afterwards, it is possible to define the structure of the territorial analytical frameworks by processing the data through the GIS (Geographical Information System), multivariate software and techniques that lead to the realization of the interactive multicriteria dashboard.

Step 3 - Validation and implementation: this part is linked to the definition of strategies and actions to plan territorial development, carrying out an implementation of the platform on case studies and developing scenario-building participated in creative workshops.

Step 4 - Dissemination of results and publication: The last step involves the definition of a monitoring and evaluation program in progress and ex post of the results obtained, seeking the involvement of local authorities for an effective and innovative approach.

1.3. RESEARCH OBJECTIVES

The contribution of this thesis is part of a wider and starting research context within the project “Renaissance of Villages” approved by the EURISPES Observatory.

The purpose of the activity is to define the Italian villages archetypes that contributes mainly to the first phase-construction of the knowledge framework, this because it is increasing awareness of the opportunities of marginal areas, and it is essential to implement the multi-sectoral analysis of the tangible and intangible values of these territories. In fact, the project, as the final aim, envisages active involvement of municipalities and local authorities which are the main stakeholders handle the marginal areas through a more correct decision support system for future policy actions.

Therefore, territorial analysis is fundamental to study the existing local complexity of these areas through an integrated knowledge based on a multidisciplinary and multi-objective approach: analysis, application, and implementation. The purposed methodology has the aim of investigating a knowledge framework, in order to analyze the territorial dynamics of marginal areas. This first approach has played a role in the drafting of the paper entitled “Renaissance of villages for the revitalization of marginal areas” written by Sara Torabi Moghadam, Maurizia Pignatelli, Alice Collin and Patizia Lombardi for SBFin 2022 Conference.

Another objective of this thesis, in addition to providing a knowledge framework of marginal areas’ Project, is to offer an example of morphological analysis through the Isobenefit Lines’ methodology, which allows to analyze the spatial distribution of urban centralities. Generally speaking, this approach is considered a new way of mapping cities according to the benefit they give residents has the potential to change the way planners think about city design (MIT Technology Review 2012).

Important to remember, this example of analysis must be considered as a simple study on how morphology can affect in terms of the capability for analyzing a place, so how it can be useful in preparation for a decision support system.

1.4. METHODOLOGICAL FRAMEWORK

The proposed methodology is structured in relation to the objectives proposed above, which the thesis paper aims to achieve, trying to build a clear, effective and shareable method.

Starting from the literature review and from the research objectives, the methodological framework is structured in main two phases, the territorial analysis and the morphological analysis, which are structured in other levels.

Within the territorial analysis environment, the data collection, the KPIs selection, and the definition of actions and strategies will take place. This reasoning base is necessary to create a supportive spatial database for each archetype. In fact, for each archetype identified will be collected the data, assigned a set of variables and a package of actions based on their characteristics and territorial dynamics. The aim of archetype’s identification is related to the implementation of the interactive dashboard, which it will be tested by developing participatory scenario-building workshop and setting pilot projects related to each type of archetype. The definition of Italian villages archetypes has been developed by the Multivariate Cluster Analysis which is the basis for the construction of the dashboard.

While in the morphological analysis, the selection of a case study and the Isobenefit Lines’ approach will elaborate in order to study the spatial distribution of urban centralities. The Isobenefit approach aims to design cities where each dweller enjoys a walkable access dynamically and flexibly to the main daily services, job locations, urban centers and nature (D’Acci 2019). This methodology includes the Urban Matrix’s using and the formula given by the Distributed Benefit of a point “k” received from an amenity “i”, distant “d”, and with a level “A” of attractiveness (D’Acci, 2015).

These phases establish the basis for the future development and upgrades about the research project, and also because the results of the morphological analysis have to be considered an input for future studies.

1.5. THESIS STRUCTURE

The thesis work is organized in five chapter to be read in sequence in order to understand all the general concepts before working towards a more detailed description of actions. This document is the result of a research work that shows the actual contest of marginal areas in Italy, which is trying to address their actions to recovery these territories. The methodology formulated and the instruments adopted are illustrated.

Furthermore, for each of the phases, which make up the analyses, the result and potential future developments of the research are explained.

INTRODUCTION

The introduction presents the statement of the problem and the motivation that led to the need to address the issue to acquire knowledge and information about the internal territories. In this context, the theme of the importance of the activities of analysis and evaluation of places, as its essential components, is introduced. The objectives of the thesis and a methodological note of the contribution offered to the research work and then to the collaboration of the research project “Renaissance of Borghi” are reported.

LITERATURE REVIEW

The second chapter represents the introductory part of the research thesis, in which the knowledge framework begins to be presented showing different matter. The literary review has the task of highlighting, following a careful reading of the previously research developed, the necessity to seek for a new topic to be addressed.

METHODOLOGICAL FRAMEWORK

In this chapter the methodological complexity of the work is presented following the order in which it was applied and according to the diversified objectives. This methodological complexity is due to a multidisciplinary and multi-objective structure of the project: the definition of Italian small villages archetype and, in addition, the investigation about the spatial distribution of urban centralities.

RESULTS AND DISCUSSION

This chapter sets out the results of the selection process about small villages and the variables used for the

cluster analysis. 5.532 municipalities have been selected and the six key variables were identified and mapped. Thanks to these data and the cluster analysis, five Italian villages archetypes were classified. Moreover, in this section the Castel del Piano’s case study selected for the morphological analysis is illustrated and final graph of Punctual Benefit and Isobenefit Lines is explained.

CONCLUSIONS AND FUTURE DEVELOPMENT

In this last chapter the conclusive reflections of the entire research work on the activity carried on and on the final results obtained are reported. The main challenge is related to the identification of a common definition of “village”, in fact there is not yet a univocal and shared definition of this term. The innovation of the proposed methodology is relied on its place-based approach driven GIS environment and the advanced tools that ArcGIS Pro has recently made available. The use of spatial analysis combined with the statistical analysis of data is fundamental to better addresses future sustainable development policies, particularly from the point of view of this project to recovery the villages and marginal areas of Italy.

The morphological analysis elaborates in this Thesis has to be considered an example for future development of the project, at the moment in which the designing of city will be required, the Isobenefit Lines’ approach will be useful.

LITERATURE REVIEW

2.1. GLOBAL POPULATION'S TREND AND URBANIZATION'S ISSUE

The world population from 10.000 BCE to today increased and a mind-boggling change is that the world population today is 1.860 times the size of what it was 12.000 years ago. What is remarkable is that almost all of this growth happened very recently. "Historical demographers estimate that around the year 1800 the world population was only around 1 billion people. This implies that on average the population grew very slowly over this long time from 10,000 BCE to 1700 (by 0.04% annually). After 1800 this changed fundamentally: the world population was around 1 billion in the year 1800 and has increased 7-fold since then"¹.

In terms of recent development and according to the 2019 review of the World Population Prospects by the United Nations Population Division "the world's population reached 7.7 billion in mid-2019, having added one billion people since 2007 and two billion since 1994" besides the global population will reach 8.5 billion in 2030 and 9.7 billion in 2050. Around 2100, the size of the global population is expected to stabilize and complete the era of rapid growth began in 1800. This is the direct consequence of the process known as "demographic transition", series of stages in which population growth accelerates and then slows down. (UNDESA, 2021 GLOBAL POPULATION GROWTH). For many countries, this transition has already ended, in this way the population is no longer growing, while for other countries the demographic transition is at an early stage, it means that the population is projected to growth rapidly.

The growth rate of the world's population reached a peak between 1965 and 1970 and the global population growth is projected to continue slowing down throughout the current century, reaching an annual rate of increase of about 0.5 per cent by 2050 and less than 0.03 per cent by 2100. "After 1950, it took around 37 years for the world's population to double, surpassing 5 billion inhabitants in 1987. Thereafter, it is estimated that more than 70 years will be required for the global population to double again, rising to over 10 billion by 2060" (UNDESA, 2021 GLOBAL POPULATION GROWTH).

¹ Max Roser, Hannah Ritchie and Esteban Ortiz-Ospina (2013) - "World Population Growth". Published online at OurWorldInData.org. Retrieved from: 'https://ourworldindata.org/world-population-growth' [Online Resource]

According to the DESA, during 2020, the world's population increased by 81 million people, connecting to the demand for food, housing, infrastructure, services and decent work, causing as a result the increasing pressure on the environment. By comparison, the annual growth of the global population is projected to decline to 70 million persons in 2030 and to continue declining throughout the remainder of the twenty-first century, declining to around 48 million persons in 2050 and 4 million in 2100, so there is roughly a 27 per cent chance that the size of the world's population will stabilize or begin to decrease before 2100. Despite these future scenarios, the size of the world population is almost certain to rise over the next few decades. The spatial distribution of the world's population continues to change². In 2000, around 47 per cent of the world's population lived in urban areas, a proportion that had increased to 55 per cent in 2018 (United Nations, 2018). By 2030, the global share of the urban population is projected to rise further to 60 per cent. By then, one third of the global population is estimated to be living in cities with at least half a million inhabitants³. This process shows no sign of slowing down and it could be considered the most powerful and visible anthropogenic influence which has brought fundamental changes in land cover around the globe.

Urbanization is recognized as a crucial phenomenon in economic and social issues, since it offers increased opportunities for employment, production and goods and services, in this manner large numbers of people migrate from rural to urban areas. Cities are growing faster, also from the physical dimension's point of view, becoming a huge center for residence, industry, trade, communications, infrastructure, social services, etc... Sure enough, "Urban areas are expected to absorb virtually all of the future growth of the world's population (United Nations, 2018). Urbanization is strongly linked to the allocation and distribution of resources, from housing and transport access to healthcare, education and employment opportunities which should be dependent on where people live: understanding the distribution of people is essential to guarantee the availability of resources and services where they are needed. Consequently, this rapid urban growth could be considered an oppor-

2 United Nations, Department of Economic and Social Affairs, Population Division (2020). Population Facts. December 2020

3 Idem

tunity for improve some aspects of spatial planning, but it creates challenges to the implementation of making cities and human settlements inclusive, safe and sustainable, referring to the eleventh sustainable development goal. This means that a timely and accurate population estimate, and projections allow Government to anticipate future demographic trends, incorporating that into development policies and planning actions.

The quality of estimates and projections are addicted to quality of the basic information. In the case of cities across countries, the definition and the criteria to delimitate cities, urban agglomeration and metropolitan area change. So, the first problem linked to the urbanization's topic is the definition of "urban area", so what defines an urban area? Actually, there is no universal definition of what urban means and the problem is that countries decide to adopt very different definitions of urbanization using different thresholds like the minimum population, the population density, the infrastructure development, etc... In Italy, to describe the phenomenon of urbanization is used the scheme proposed by the European Environment Agency, which identifies three types of "urban areas" (Istat, 2017): the first is based on an administrative approach taking the urban area as a territorial expression of the political and administrative structure; while, the second employs a morphological approach where the shape of the urban area is defined in purely physical terms (population density, extension of the building, networks and infrastructure, presence of industrial and commercial zones, etc.); lastly, the third type uses a functional approach where the shape of the urban area is defined by the influence that the city exerts on the surrounding territory in socioeconomic, productive, service delivery, etc. This continuous growth of cities has led the cities themselves to extend their functions beyond the physical perimeter, transforming into a continuum that encompasses the neighboring territories, disrupting cultural features, social profiles, economic structures (Gottmann, 1983). Moreover, the emergence of new phenomena, such as the globalization of markets, leads cities to transform again, up to elaborate the concept of a global city (Sassen, 1991) according to which it has the ability to perform cer-

tain specific functions: “Button room” of the world economy, financial headquarters, place of production and innovation. In this way, the city assumes the role of a place where the key structures of the economy must necessarily be located. In fact, the reasons for the “race to the city” are linked to the relationships that exist between economic development and urban growth, relationships that would explain that the growth takes place with different intensities and deadlines, considering this a very complex issue (Istat 2017).

2.2. RURAL AND URBAN RELATION

While the world is rapidly urbanizing, the development gap between rural and urban areas tends to increase. Urbanization has been widely recognized for its transformative power, but even though urban and rural areas depend on each other⁴. In both the 2030 Agenda for Sustainable Development (SDGs)¹ and the New Urban Agenda (NUA), United Nations Member States agreed to support an integrating urban and territorial planning and developing new, inclusive approaches, in order to enhance synergies between urban and rural communities and spaces. UN-Habitat introduced and convened the process to develop “Urban-Rural Linkages: Guiding Principles and framework for Action” which is based on the premise that urban and rural areas should not be treated as separate entities when development plans, policies and strategies are made.

Rather, the aim is to harness the potential that their combined synergy generates, so that everyone benefits from the circular flow along the urban-rural continuum⁵. What is important to underline is that “the reciprocal and repetitive flow of people, goods and financial and environmental services (defining urbanrural linkages) between specific rural, peri-urban and urban locations are interdependent (URBAN RURALLINKAGES: GUIDING PRINCIPLES, 2019). Indeed, creating a strong and mutually supportive connectionsbetween rural and urban areas is the key to ROBUST European Project, which it believes in realizing smart, circular and inclusive development for a sustainable Europe. Rural-Urban Europe explores how synergies between the two areas can be applied in practice to strengthen regional collaboration, interdependence and interconnectivity⁶.

The need to have synergies between rural and urban areas is linked to the existing gap between them: cities are often seen as the economic engines, forging ahead through agglomeration, industry, creative capital, and innovation; meanwhile, the countryside gets viewed as a place for food production,

4 <https://unhabitat.org/topic/urban-rural-linkages>

5 Idem

6 <https://rural-urban.eu/>

resource extraction and recreation, at worst, left behind⁷.

According to Conticelli et al (2020), place-strengths of rural areas, such as quality of life, landscape peculiar culture and heritage, can attract and retain workers. However, most of rural areas deal with economic, social and environmental problems, resulting in unemployment, disengagement, depopulation, marginalization or loss of cultural, biological and landscape diversity. Despite this, developing in rural areas there is the potential to generate sustainable high-quality enterprise and employment opportunities, contributing to the rural diversification [White 2013; Selada et al. 2011].

The current COVID-19 pandemic has exacerbated the dichotomy, and on the one hand, rural areas have been threatened even more than urban areas, because of less available resources, but on the other hand, the need of social distancing, the lack of adequate open public green areas in bigger cities and the possibility of remote and teleworking have started to be claimed as drivers for people living in densely populated settlements to move towards inner and rural areas (De Luca et al, 2021).

Across the world, Covid-19 took root and strongly affected areas with diverse geographic, climatic and demographic conditions⁸. Rural areas have been less impacted so far, but controversies were raised in several countries (Asquith, 2020) because of people that wanted to move to second houses to move from most hit cities and to enjoy calmer and more natural areas (Hart, 2020). Indeed, partial social restrictions or total lockdown experienced in some countries could have reverted citizens' priorities⁹. According to the conclusion of Claudia De Luca et al (2020) rural areas would assume a central role in developing sustainable and resilient communities and this is cannot be seen as a spontaneous process, since it requires local authorities to improve basic infrastructures and services, but also properly plan future development of the areas, to repopulate ageing and uninhabited rural areas avoiding unplanned gentrification issues.

⁷ <https://rural-urban.eu/learning-hub/three-keys-unlocking-rural-urban-synergies>

⁸ TeMA Journal of Land Use Mobility and Environment. C. De Luca, S. Tondelli, H.E. Åberg - The Covid-19 pandemic effects in rural areas

⁹ Idem

2.3. URBAN MORPHOLOGY AND QUALITY OF LIFE

Most of the planetary problems, such as the climate change, the biodiversity loss, the ecological degradation, the pollution, as well as the humans psychological and physical well-being are linked with degenerative urban design (D'Acci, 2019). In this perspective, it is necessary to think new typologies of cities, assuming that in future there will still be cities which need to be livable, especially if the current rate of urbanization will not reverse (Merrifield, 2013). As mentioned previously, the urban population of the world has grown rapidly, and this is sufficient to underline the urgency for an economic paradigm shift but also a drastic urban model shift, because even under this stabilized world population size, the pressure is still to dramatically change the city shapes, structure and link with natural lands. Additionally, "the physical growth, urban forms and structure of the city cannot be completely left to the *laissez-faire* because the contemporaneity of two events: the rapidity and the magnitude of this urban unprecedented growth which does not allow, as the pre-industrial time efficiently and pleasantly often did, a spontaneous bottom-up emergence of somehow liveable and sustainable evolution of our cities and of the global environment" (D'Acci, 2019). Despite the increasing importance of cities, there are difficulties to understand them: cities change forms over a huge range of scales, from the small town to the megacities, but now it is important to understand them and make the urban shift in terms of form and structure.

In this way, it is necessary to introduce the concept of "urban morphology", the study of physical form of settlement. Alain J.F. Chiaradia define it as "the study of the formation of urban fabric components and the relationship of these components, which describe their compositions and configurations through time. These complex phenomena can be analyzed at different spatial scales and across disciplinary boundaries". This set of urban components gave a form to the city, so the urban form evolves constantly in relation to social, environmental and economic development.

According to Brenda C Scheer (2015), over the years there have been many attempts to merge numerous conceptions of urban morphology and the first one is within the history of ISUF (International Seminar on Urban Form)

throughout the Anne Vernez Moudon's article. She identified three principles on which urban morphology is based (A. Vernez Moudon, 1994):

1. Urban form is defined by three fundamental physical elements: buildings and their related open spaces, plots or lots, and streets.
2. Urban form can be understood at different levels of resolution. Commonly, four are recognized, corresponding to the building/ lot, the street/block, the city, and the region.
3. Urban form can only be understood historically since the elements of which it is comprised undergo continuous transformation and replacement.

Thus form, resolution and time are the essential components of urban morphological research. Tied to this morphological analysis there are some other notions which are significant for this approach. The first one is the formal typology of settlements and the territorial and urban structure of settlements. Antonio Cappuccitti (2008a) indicates that the classification by formal typology is a distinction of the different types of settlement aggregations in the territory, which is based on the reading of geometric conformation of the settlements. These elementary formal typologies of settlements are referred to as linear, reticular, radial, ring or concentric, galactic. In addition to this type of classification, there are two other classifications: the geographical typology that concerns the location of the settlement distinguishing settlements of plain, valley floor, plateau, hilly, slope, mountain, ridge, river tops, lake, coastal (Cappuccitti, 2008b); and the functional typology which is focused on the prevailing function of the settlement, being a residential type, productive both from the artisanal and industrial, commercial, service and tourist point of view.

The other notion, indicated by Cappuccitti (2008b), is that linked to the structure of the settlement which can be described as a system of principal elements of primary interest of the settlement, and the connections between the above elements. Indeed, the basic constituent components of the urban form are solid volumes, as buildings and gear for services, and open spaces, like streets, squares, parks and gardens, which juxtaposing in the urban landscape gave rise to forms of settlement. Always according to Cappuccitti (2008b), the close correlation between the shape of the space's road and buildings it can be named "urban fabric".

Studying these concepts, it is possible to focus the attention on those places,

areas, centers and respective connections between these (i.e. the roads and pedestrian connecting those places), which are certainly element of particular and overriding importance in defining the layout of the establishment and the perception of this by citizens.

Concerning this knowledge about the urban form, the space syntax is often regarded as a morphological approach (Whitehand 2018) because it does not focus on the shapes of physical objects but on the spaces between these physical objects and how these are connected to all other spaces in the built environment, describing and quantifying the spatial properties of the built environment that shape socio-economic activities (Akkelies van Nes et al., 2021). The book "The Death and Life of Great American Cities" by Jane Jacobs is an important contribution for understanding the relationship between physical components of the built environment and social life in cities. According to the Akkelies van Nes et al.¹⁰, understanding a society's effect on the built environment and vice versa requires a concept of physical space. If human activities manifest in space, then the organization of these activities affects a settlement's spatial organization. Thus, social activities can be understood with a reference to the physical structure of the built environment. On the other hand, if the physical structure and organization of architectural space influences human behaviors, it will impact social activities.

In this perspective, citizens choose the city, and they select the location for their residences by following some balanced comparative factors: location of work, family and friends, housing cost, quality of the area, distance from the city center and from other city centralities, public services, public goods, urban amenities (D'Acci, 2012). According to the conclusion of Luca D'Acci (2020), by planning better cities, territories and socio-economic daily lifestyles, such as teleworking plus flexible working times, weekly working hour national reductions, greening cities and radically transforming the physical structures, forms and functioning of current urban environments it would have an enormous potential economic impact environmentally, infrastructurally, but also psychologically speaking. Throughout the concept of Urban Isobenefit Lines it is possible to analyze the spatial equilibrium involving by cities, so it can evaluate the Urban Quality of Life and "The quality of the urban environment as a living space for the peoples of the world is an issue of

10 Akkelies van Nes, Claudia Yamu. Introduction to Space Syntax in Urban Studies. 2021

fundamental concern for academic researchers, policy makers and citizens” (Pacione, 2003).

Recently, the quality of life has become a commonly used term among researchers working in different fields and the list of specific issues to be included in a definition of quality of life varies between studies, such as the physical environment, housing, climate, pollution or social facilities linked to education and health (Royuela et al., 2007). The Quality of Life represents the goal of human existence, concerning both the individual and society, and it is made up of both a subjective dimension and an objective dimension (Petrović, F.; Maturkanić, P., 2022). In the past, researchers investigating Quality of Life in municipalities focused primarily on cities (Petrović, F.; Maturkanić, P., 2022) and this priority is related to the fact that rural development has lagged behind urban development (Sánchez-Sellero, M., 2021). In order to address rural challenges, OECD (2020a) suggests a new “Well-being Policy Framework,” in which the economic approach to countryside is extended to include the environmental and social dimensions of wellbeing of rural populations, connecting rural development to cities.

The number of papers focused on the quality of rural life is increasing, and in 2018, the European Countryside journal¹¹ focused the issue on the quality of urban and rural life, which explains peculiarities in the rural space. As indicated by Batty (2018), many surveys about quality of life in cities invariably suggest that it is in smaller cities that the highest quality of life is achieved.

11 Vaishar, A.; Vidovićová, L.; Figueiredo, E. Quality of Rural Life. Editorial 16 June 2018. *Eur. Countrys.* 2018, 10, 180–190.

2.4. ACTUAL DEBATE ON ENHANCING VILLAGES

The theme of territorial imbalance, that is, the phenomenon according to which, as a result of economic development and market forces, some geographical areas tend to develop and grow demographically at the expense of other areas which are consequently subject to impoverishment and depopulation, had already been analyzed by geographers and scholars of the late nineteenth century (Secchi 1976). Even in Italy, a dense network of relationships between urban, rural and smaller centres defines an interdependent space in which the larger centres act as attractors for the population and tend to grow, feeding at the expense of the territory that surrounds them, causing the depletion of the same and deep territorial imbalances (Daniele, Malanima 2011).

What are the most appropriate economic and territorial policies to overcome this gap has been discussed for some time now and over the last 40-50 years different hypotheses have been developed, producing different policies and strategies for intervention (Lombardo, 2018). In the first phase of these strategies, the aim was to promote the development of inland areas on the basis of typical economic activities (forestry, animal husbandry, agriculture, etc.) without promoting a decisive integration with the “strong” areas (Capello, Hoffman 1998). Only more recently, it has been started to focus on “integrated” development, that is, the development of joint policies and programs. In fact, since the 1990s with the introduction of the Leader Projects, there has been a change of strategy, so that it has moved to the consideration of the concept of rural area in which agriculture certainly plays an important role but not the only most important (Lombardo, 2018).

The increasing urbanization, enhanced by the counter-urbanization dynamics of the 1980s (Dematteis, 1986), has meant that small urban areas, far from the main urban centers, have established trends which have led to the current situation: negative demographic trends, reduction of economic activities, progressive closure of essential services, social marginality, increased costs in terms of land management (Bertolini and Pagliacci, 2017). It is clear the disparity between major cities and villages located in marginal areas that have started lagging (OECD, 2020). Moreover, interest in the villages has grown: the pandemic has highlighted the objective need to safeguard and re-

cover marginal areas.

In Italy, small municipalities (less than 5.000 inhabitants) are more than 5.500 and represent around 70% of the total Italian municipalities and recovering a place in a state of neglect means turning a vague trace of the past into a new possibility, present and future. So, this to happen, a simple renovation is not enough, but a redevelopment's project that covers the architectural, urban and cultural aspects is needed (UNCCEM, 2020).

According to the UNCCEM Journal (Comunità Montagna, 2019), thanks to EU funds, some regions have allocated resources to maintain essential services, but that is not enough. To repopulate these places and create a future there is still a lot to do, starting with the recovery of abandoned buildings. In an interview reported in the Journal "Rivista di Approfondimento" a cura di Uncem (rivista n.2 del 2020) called "Comunità Montagna. Montagna, Ambiente, Territori, Ecologia Integrata, Energie", Marco Mari, Vice President of GBC Italy, and member of the Scientific Committee of Fondazione Montagne Italia, is focused on the theme of redevelopment to revive communities, explaining: "The problem of the repopulation of internal areas is not only linked to the development of real estate assets, but it is the respect of culture and the vocation of territories and communities to be fundamental. [...] Even more in the case of historic buildings or villages, it means talking about communities and the choice to put people at the center, even more so if it is a postearthquake recovery. Experience teaches us that it is not enough to rebuild houses, it is necessary to rebuild communities. Sustainable regeneration has everything to do with restoring confidence in the future, both economically, culturally, and environmentally". Consequently, both the need to revive communities and the healthcare emergency are imposing new solutions: upgrading the ultra-broadband infrastructure, choosing local shops, reducing energy consumption to improve the ecosystem-environmental services expressed by the territories (UNCCEM, 2020).

The recent debate is focused on why and how the Local Government should take care of small villages. Always Uncem (National Union Municipalities Communities Mountain Authorities), in the last three year, he concentrated a lot on this current topic, in fact, through the magazine CM in 2019 approaches this debate.

The current paradox whereby people avoid from places where water, clean

air, space and time are available to move where they are lacking and this paradox, which over the decades has been increasingly strengthened, seems to have reached a breaking point and a consequent turnaround¹².

Small municipalities should not be seen as a problem but must represent a gamble for the entire country as it would be not forward-looking to leave places that have an identity imprinted in time, in which reside important values that represent an important piece of Italy, and that the State and local authorities must protect. In order to avoid depopulation, essential services must be maintained, for example, by preventing the closure of post offices and schools. Equally important is to make safe roads and buildings, focusing on zero-impact redevelopments, ensure residents to have an internet connection and transform abandoned properties into multifunctional center: revitalizing a village means creating the conditions for living it.

In fact, as Roberto Colombero, President of Uncem Piemonte, explains in the Magazine of Deepening CM of December 2020 that repopulating a village does not mean creating the conditions for a place to spend a few days in a dimension of leisure and relax, but consider these territories where to live all year and do business.

The President Uncem continues by clarifying that "creating villages that have all the services, school, good connectivity and a welcoming community means commitment, first and foremost by the municipalities, both to map opportunities on the ground and to draw up a pact of solidarity between territories, which together must find the balance for a new dimension of society".

All over the world, rural areas tell us the story of a thousand of years long collaboration between nature and human society. These places embody unique examples of cultural and natural heritage, which not only needs to be safeguarded but also recognized as communities of sustainable development¹³.

The European Network for Rural Development (ENRD) in the 2014-2020 programming period is focused on one of the broad themes called "Smart and Competitive Rural Areas" which links three policy priorities of EU Rural

12 Tesi di Laurea Magistrale, Patrimonio (in)Aspettato. "Ricerche sul territorio che cambia. La circolarità applicata ad un progetto di recupero architettonico per le aree interne". Politecnico di Torino, 2018/2019

13 <https://www.ruritage.eu/project/>

Development¹⁴: fostering knowledge transfer and innovation in agriculture, forestry, and rural areas; enhancing farm viability and competitiveness of all types of agriculture in all regions and promoting innovative farm technologies and the sustainable management of forests; promoting food chain organization, including processing and marketing of agricultural products, animal welfare and risk management in agriculture. The theme “Smart and Competitive Rural Areas” 2014-2020 worked on the subtheme “Smart Villages”, concept based on a participatory approach, including all local and non-local stakeholders, with the aim of bringing benefits to the quality of life in these territories and putting more emphasis on the potential for social innovation, while seeking to exploit the possibilities offered by new technologies¹⁵.

In this perspective, as explained by Stefano Sala Ricercatore UNIMONT (Università degli Studi di Milano) in “Rivista di Approfondimento “Comunità Montagna”, Dicembre 2020”, the Smart Villages outlined by European policies can therefore constitute an important asset to be capitalized in small municipalities, allowing communities to face and transform into benefits the current challenges of decarbonization, resilience to climate change, digitization, generational change and social innovations.

2.4.1. PLANS AND STRATEGIES IN ITALY

In Italy, the recent approval of Law n. 158 of 6 October 2017, called Salva Borghi Law, is a fundamental recognition of the strategic importance of the Small Municipalities, which seeks to restore vitality and attractiveness to these territories, making them involved in a development project. The attention on these municipalities seems necessary because it attributes a collective responsibility that aims to give substance to a national strategy, trying to define a policy of intervention targeted at small municipalities. This measure is due to an alarming demographic decline resulting in a progressive abandonment of places that puts at risk the survival of many small municipalities, thus triggering a decline in the housing stock and a loss of arable land. Indeed, at a time characterized by emerging economic needs, the revitalization and potential of small municipalities in terms of tourism and hospitality, recovery of ancient traditions and crops, respect for the environment and unique landscapes represent real strengths in which to invest.

From a legislative and strategic point of view, there are several instruments dealing with small municipalities. As mentioned above, the Salva Borghi Law contains “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”. This law, therefore, aims to combat the depopulation of smaller municipalities, considering those small municipalities with a resident population of up to 5,000 inhabitants. The first aspect referred by the law to ensure sustainable development and balanced territorial government is to promote the efficiency and quality of essential services: education, health, social welfare services, transport, roads, environment and postal services.

Another tool is the National Strategy for Internal Areas (SNAI) a territorial policy that is aimed at improving the quality of services to citizens and economic opportunities in the internal territories at risk of marginalization. The “inner areas” are considered to be those areas characterized by a significant distance from the main centres of service offered, but also by a high availability of environmental and cultural resources. This strategy has both short-term objectives, therefore to adjust the quantity and quality of citizen-

14 https://enrd.ec.europa.eu/enrd-thematic-work/smart-and-competitive-rural-areas_en

15 Rivista di Approfondimento “Comunità Montagna”, Dicembre 2020

ship services, also promoting development projects that enhance the cultural heritage, is long-term, trying to reverse the territorial dynamics of the internal areas of the country. More recently, in 2021, the “National Recovery and Resilience Plan - PNRR” was approved as an implementing instrument of the strategy developed by the European Union to allow Member States to relaunch their economy after the Covid-19 pandemic. Specifically, the PNRR is characterized by missions, components and investment and these classifications have the purpose to identifying the destinations of the different investments, placing the “National Village Plan” within the investment 2.1 “Attractiveness of historic villages” of Mission 1 - Component 3 of the PNRR. The Piano Borghi, also known as the Extraordinary National Plan for the Restoration, Security and reuse of the Historical, Architectural, Urban Planning of Villages and Historic Centers, has been developed before the growing interest in the villages caused by the pandemic and is aligned to the “Agenda 2030”, through the implementation of the 17 Sustainable Development Goals. In fact, that plan can define itself as a short-, medium- and long-term programme whose objective is the preservation and restoration of the historical, architectural and landscape heritage and the virtuous revival of the economy. These actions are applied to these territories because they witness a progressive depopulation and urban polarization, considered as consolidated territorial dynamics which are difficult to dampen and adapt to the new paradigms of sustainable territorial development. Furthermore, the instability created by this pandemic offers the opportunity to redefine new parameters of intervention and new scenarios for the development of territories in relation to the new needs of decentralization and physical distancing, in this way the interest in the villages has grown: the pandemic has highlighted the objective need to safeguard and recover inland areas.

Actually, the objective is to redirect and diversify the pillars of local development in such a way as to reduce the gap between large cities and small towns creating efficient polycentric systems. Green Deal and Next Generation EU tools are supporting this vision, in order to create an active economy that puts people and the planet first, creating jobs, and fostering social inclusion while promoting digitalization, innovation, competitiveness, culture, and sustainable tourism for villages and shrinking territories, and providing them with adequate infrastructure and services.

2.5. MORPHOLOGICAL AND ANALYTICAL TOOLS FOR UNDERSTANDING VILLAGES

Actually, the National Recovery and Resilience Plan (PNRR) has assigned significant financial resources to promote the attractiveness of villages and also the “Piano Nazionale Borghi” is providing huge funds to encounter the challenge of repopulation of marginal areas. Consequently, Public Administrations, in order to have the resources and to finance territorial development projects, is facing with the to promote new planning tools with innovative solutions and inter-institutional cooperation on the development front, the reduction of territorial disparities and social inequalities, turning around virtuous projects involving public and private resources (Klopp J M and Petretta D L, 2017).

Furthermore, the National project “Rinascita dei Borghi” promoted by “Osservatorio per lo Sviluppo dei Territori” and approved by EURISPES¹⁶ Institute, intendsto create the conditions to repopulate and rebalance shrinking territories by establishing new centers of attractiveness, conforming to the PNRR instrument which want to guarantee the implementation of the project on both a policy and financial way. This Project, envisaging the active involvement of municipalities and local authorities, is focusing on the implementation of multi-sectoral analysis of the tangible and intangible values of territories and developing an economic and spatial impact assessment of future scenarios and the related implementation measures. Its intent is to develop an interactive web dashboard to be provided to municipalities, in order to create both a learning environment and a decision support system for local policy actions towards a sustainable participatory local development. This tool must simplify the collaboration among central levels of government, communities, and local administrations as an innovative planning approach. Recent research findings highlight that decisions on urban and regional planning should be supported by collaborative and inclusive processes, otherwise they will fail, moreover, the current methods and tools for supporting decisions in the field of urban planning and design seem unable to challenge the problem because they cannot take a full account of actors (Lombardi and Ferretti, 2015).

16 Istituto di Ricerca degli Italiani. Istituto di Studi Politici, Economici e Sociali

In the field of local sustainable transition, Spatial Decision Support System can facilitate the decision-making processes through the combination of Multicriteria Analysis and Geographic Information Systems (CoutinhoRodrigues, Simão and Antunes, 2011; Dionisio et al., 2016; Torabi Moghadam et al., 2019). As Multicriteria Analysis includes various evaluation methodologies able to reflect multiple stakeholders' points of view, GIS tools simplify data visualization and distribution (Carver, 1991; Torabi Moghadam et al., 2018). According to Lombardi et al., (2017), among the main advantages of employing multicriteria Spatial Decision Support System there are: (i) the use of visual tools which can facilitate decision making; (ii) the possibility to include simultaneously multiple criteria (e.g., economic, environmental, technical, social); (iii) the capacity to manage a large number of georeferenced data; (iv) a clear and understandable visualization of results. GISbased methodologies able to support decision-making in the sustainable urban planning sector have been increasingly employed in different contexts.

Consequently, a dashboard is an interactive report that updates in real time and allows you to visualize data from a variety of sources, and it represents one of the main outputs of the digital analytics process¹⁷. Often, DSS are built and used for ad hoc analyses, but increasingly, decision support is integrated into business processes and information systems (Eom, 2000) and it includes many activities in order to create solution's alternatives: e.g., analysis, deduction, projection, comparison, simulation, optimization etc. (Sprague, et al., 1982). Dashboards allow users to "analyze the root cause of problems by exploring relevant and timely information from multiple perspectives and at various levels of detail, providing a display of information to improve decisions, efficiency, streamline workflow, and reduce oversight (Abd-Elahattah et al., 2014).

The Decisional Support System's database is a collection of current or historical data which are usually extracts or copies of operational databases (Abd-Elahattah et al., 2014), so, one of the first steps of creating a dashboard for Decisional Support System is to collect available data, considered at the basis of the structure.

According to De Waal and Ritchey (2007), the Morphological Analysis is a method for defining, linking and evaluating problem spaces. The Morpho-

¹⁷ <https://www.digitalpills.it/cosa-e-la-dashboard>

logical Analysis was developed by Zwicky (1967, 1969), the Swiss American astrophysicist and aerospace scientist, as a general method for structuring and investigating the total set of relationships contained in multi-dimensional problem complexes that can be parameterized. (De Waal and Ritchey, 2007). Despite this type of approach, more recently, morphological analysis has been extended and applied in the field of policy analysis and futures studies (Rhyne 1981, 1995a, 1995b; Coyle, 1995, 1996). The method used and explained by Tom Ritchey (2004) began by identifying and defining the most important dimensions of the problem complex to be investigated and assigning each parameter a range of relevant "values". A morphological field – also fittingly known as a "Zwicky box" – is constructed by setting the parameters against each other in an n-dimensional configuration space. Each configuration contains one particular "value" from each of the parameters, and thus marks out a particular state or (formal) solution within the problem complex. In this perspective, the Urban Morphology is a combination of physical description, gradual formation, and the interaction between the components of the urban tissue, defining specific compounds and urban places, such as streets, squares, and other public spaces¹⁸. Always according to El-Essawy et al. (2018), urban elements are considered the most important in giving the city its identity, playing a key role with their connection, cohesion, and coherence and, they help in improving the relation between humans and the environment, hence achieving identity is one of the essential goals for the future of a good environment. Urban identity can be defined as the process of interaction between people and places, where humans describe themselves in terms of belonging to a specific place (Hidalgo and Hernandez, 2001). There is a range of methods that have been used in previous studies in urban, heritage and other topics to measure a place's identity, aiming to survey people's perception and feelings of a place¹⁹.

¹⁸ El-Essawy, S.S., Abulnour, A.M., & Wissa, M.W. (2018). Quantifying the City's Identity a Morphological Analysis of the Historic Rue Rosette. *International journal of engineering research and technology*, 7.

¹⁹ Idem

03

CLUSTER AND MORPHOLOGICAL ANALYSIS: METHODOLOGICAL STEPS

This section will present the working methodologies in the order in which they were used during the research activity.

The methodology of the project is based on the multidisciplinary and multi-objective framework that will shape interactive dashboard. The methodological framework of the entire project is divided into three main environments: analysis, application, and implementation.

Hence, the focus of this specific methodology is to illustrate how the village archetypes have been defined and which variables have been considered to develop the cluster analysis. This method was developed in three operational steps, which used both the quantitative and qualitative methodologies.

This research work proposes a simple investigation methodology, which is overall structured in 3 phases.

These steps provide to integrate the knowledge framework of the Research Project, as mentioned in paragraph 1.2.

1

The first step is the selection of “villages” according to the literature review carried out on the existing instruments concerning the theme of shrinking internal area. Consequently, the sample of the selected municipalities is mapped. This phase is important because the definition of villages influences the entire following work.

2

The second step is the choice about the five significant variables: these were identified by bibliographic research in order to select the appropriate variables, providing the groundwork of the subsequent cluster analysis.

3

The third step is referring to the Multivariate Cluster Analysis using the Kernel K-means algorithm using the ArcGis Pro software. In this way, it was possible to define the villages archetypes and create five different clusters.

4

The fourth step is the selection of the case study in order to carry out the morphological analysis.

This choice was characterizing also by the limit of the villages' form.

5

The fifth step is the morphological analysis using the Isobenefit Lines' method, this makes it possible to evaluate the spatial distribution of urban centralities in the small municipality selected.

3.1. SELECTION OF SMALL VILLAGES

In order to select the “small villages”, the fundamental step is to examine the bibliography review carried on investigating the definition of villages. In this investigation, it has been studied the existing instruments concerning the development of shrinking internal areas, in this way all the definitions of “small villages” used in institutional, planning, and legal documents were collected. After that, to provide a sort of common definition, it was necessary to mediate between the following definitions:

- The National Strategy for Villages (Strategia Nazionale per i Borghi), which states that a village is: “...intermediate municipality which has less than 10,000 inhabitants. Villages are rural or peri-urban municipalities, small points of reference because of proximity services”.
- The Extraordinary National Plan for the Restoration, Securing and Reuse of the Historic, Architectural and Urban Heritage of Villages and Small Historic Centres (PNRB), according to: “...a village refers not only to a small size settlement, but also to its distinctly rural character (...). We can assume the definition provided by ISTAT of ‘nuclei abitati’”.
- Salva Borghi Law 158/2017, which promotes the sustainable economic, social, environmental, and cultural development of small municipalities (Article 1(1)), considering those with a resident population of up to 5,000 inhabitants (Article 1(2)).
- The National Recovery and Resilience Plan (PNRR) explicit the concrete political and financial commitment in the relaunch of borghi and internal areas, inserting the National Villages Plan in Mission 1, which identifies the municipalities receiving funding from those with a population of up to 5000 inhabitants.

In this sense, it was agreed to take the municipality as a territorial reference and the selection was carried on considering all the municipalities with a population of less than or equal to 5.000 inhabitants.

This part of the work was carried out using data from the National Statistical Data Institute – ISTAT and the ArcGis software. From the ISTAT website it has been downloaded the spatial territorial base of the municipalities' administrative boundaries in shapefile format¹ and the exce file “statistical classifications and municipalities' size –

¹ <https://www.istat.it/it/archivio/222527>

2017-2021”² including a set of attributes corresponding to the physical and/or anthropological characteristics: altitude zone, altitude of the main town (m.s.l.m.), land area (sq km), level of urbanization and coastal areas, this is supplemented by size information in terms of area and population (both legal at 2011 and resident at 2019). This dataset is not complete, so it was necessary add the resident population in 2021³ because it was useful to select the small villages.

Having downloaded the data, it has been created a single .csv file exploitable in ArcGis software containing the statistical codes of territorial administrative units at municipal, metropolitan, provincial and regional level⁴ and correspondent name of municipalities, land area, legal population at 2011, resident population at 2021 and the altitude zone. This file was upload on ArcGis and joined with the shapefile territorial base, in this way it was possible to know, in term of spatial location, the specific information needs for the corresponding towns.

Consequently, on ArcGis, it was possible to select all the municipalities with a population of less than or equal to 5.000 inhabitants on data updated to 2021. In total have been selected 5.532 municipalities, considered as “small villages”, which are georeferenced and mapped to visualize their spatial distribution. This mapping was possible because inside the shapefiles and the table in.csv format there was the same “field” containing the Istat code of each municipality, which was used as a link field between the two formats. Joining it was created a new shapefile with only small municipalities up to 5000 inhabitants and related information, previously mentioned.

3.2. MAPPING VARIABLES

This phase is referring to the definition of six key variables and their measurement. Further investigation was deemed necessary to provide an accurate cluster analysis possible and in accordance with the research objective. Variables were identified though bibliography research on methodological approaches which can be coherent with the project issues.

In the first instance, all the 5.532 italian small villages were taken into account in order to have an analysis available throughout these territories.

Based on the research projects examined, the key variables chosen as relevant to examine the state of contraction are:

1. Variation of population
2. Geographic location
3. Municipal area
4. Average collective income
5. Availability and variety of essential services
6. Richness of the infrastructure network

For all these six variables, it has been performed a specific data collection in order to analyze, normalize and spatialized on GIS. All the data representing the different variables were made through the natural breaks (Jenks) distribution technic, this means that the break class are created in a way that best groups similar values together and maximizes the differences between classes.

² <https://www.istat.it/it/archivio/156224>

³ <https://www.istat.it/it/popolazione-e-famiglie>

⁴ <https://www.istat.it/it/archivio/6789>

3.2.1. VARIATION OF POPULATION

The first variable taken into account for the qualitative analysis is the variation of the population over a 10-year period. This variable aims to measure the impact from Covid-19 pandemic had on the demographic dynamics in the Italian territory, that is why it has been calculate the percentage variation of population from 2011 to 2021. The source used for calculating this variation is the resident population in 2011 and 2021, using data from ISTAT database. On ArcGis software, it was possible to calculate the key variable, and this has been done using the previously shapefile created. For the calculation of the variable, it was used the formula represented by the difference between the population of 2021 and that of 2011, divided by the oldest population one, and all multiplied percent. This was possible by creating, within the shapefile's attribute table, a new field of type "double", which allows calculations to be made using the other fields present in tables, and then to proceed with the calculation.

3.2.2. GEOGRAPHIC LOCATION

This typology of variable allows to recognize the type of territory characterizing the small municipalities. The National Statistical Data Institute divides the national territory into homogeneous zones⁵ resulting from the aggregation of contiguous municipalities on the basis of altimetric threshold values. Mountain, hill, and plain areas are distinguished. The altitude zones of mountain and hill have been divided, to take into account the moderating action of the sea on the climate, respectively, in altimetric zones of internal mountain and internal hill and coastal mountain and coastal hill, including in the latter territories, border with the sea or close to it.

These data are contained in the initial excel file downloaded from the file "statistical classifications and municipalities' size - 2017-2021", and also in

⁵ Istat publication "Circoscrizioni statistiche" - metodi e norme, serie C, n. 1, agosto 1958

the last shapefile created, so each single municipality is referred to the specific different classification represented by numbers:

- 1=internal mountain
- 2= coastal mountain
- 3=internal hill
- 4=coastal hill
- 5=plain area

As a result, the unique work done for this variable was to export the five classifications into different shapefiles.

3.2.3. MUNICIPAL AREA

This variable observes how the size of the area can influence the territorial dynamics and whether this can be a reason for differentiating the development strategies to be implemented.

Always on ArcGis software and using the last shapefile, this area has been calculated applying the "calculate geometry" tool. As for the first variable, also in this case a new column, "double" type, has been added in the table of the attributes in which it has been used the mentioned tool's calculation. This tool allows to automatically define the area of all municipalities in square kilometers, starting from the territorial base obtained from the ISTAT website, as indicated in the section 3.1. "Selection of small villages".

3.2.4. AVERAGE COLLECTIVE INCOME

The fourth key variable is related to the economic situation for each small municipalities, sure enough the collective income represents the degree of prosperity of the resident population in that municipality. The data using for this variable are referring to the total income by amount classes of taxpayers residing in 2019, which are the last year of ISTAT updated. These data were related to all Italian municipalities, consequently it was necessary to restrict

the data to the selected small villages. This has been done using the excel files: the first file used is that one including the municipalities' Istat code, while the other one is the income's file. Then a third excel file has been created containing, in a sheet the database of the 5.532 small municipalities and in the other sheet all the Italian municipalities with their relative values of collective income, in this way and through the excel command "SEARCH.VERT" it was possible to locate in the income sheet the small municipalities selected with their values. Finally, then it has been created the last excel file useful to be joined with the shapefile on ArcGIS and see how the distribution of the collective income in small municipalities is present.

3.2.5. AVAILABILITY AND VARIETY OF ESSENTIAL SERVICES

As regards the variable of essential services, it has been decided to consider the "essential services" indicated by the ASviS⁶ literature: school, health, banking services, financial and postal services, broadband.

Consequently, to observe the distribution of these services, the data provided for Italy have been downloaded from the OpenStreetMap website⁷, downloading the data divided into areas: North-West, North-East, Center, South and Islands. Within each data set by area, there were several shapefiles and to understand what they contained, as well as to being uploaded to ArcGIS, description metadata was also studied to understand which codes represented the essential services useful for the variable. Reading the metadata, it was possible to choose the correct shapefile, including the one containing the "points of interest": gis_osm_pois_free_1. shapefile. Always reading the description of the shapefile, the points of interest present are divided into categories and sub-categories, those useful and selected for the analysis are divided into the following ways:

CATEGORIES	SUB-CATEGORIES
Health – 21xx	Pharmacy – 2101
	Hospital – 2110
Public – 20xx	School – 2082
	Post Offices – 2005
Money – 26xx	Bank – 2601
	ATM – 2602

Table 1. Categories and Sub-categories of OSM data. Source: Author, 2022

After identifying the representative's code of the essential services, the identified shapefile was loaded on the software and each code was exported to a new shapefile through the function of ArcGIS "select by attribute". After this, the "merge" analysis tool was used for each code, so as to have a unique shapefile for essential service present throughout Italy. For each newly created shapefile was made the operation "intersect", always an ArcGIS analysis tool, between the last-mentioned shapefile and the shapefile containing all 5.532 small municipalities. In this way, it is possible to check the distribution of essential services in the selected small municipalities. Finally, to make all these data readable, they were normalized and 5 classes from 0 to 5 were established, where 0 represents the absence of at least one type of the services considered.

3.2.6. RICHNESS OF THE INFRASTRUCTURE NETWORK

In order to quantify and summarize the 'Richness of the infrastructure network' the main road and rail infrastructures were extracted from the Open Street Map databases and spatialized on ArcGIS. For this analysis, these typologies of infrastructures were hierarchically subdivided: railways, motorway, primary network consisting of national roads, secondary network consisting of regional roads, and then the tertiary network characterized by local roads.

⁶ <https://asvis.it/rapporto-asvis-2021/>

⁷ <https://download.geofabrik.de/europe/italy.html>

Always from the previous OpenStreetMap website, in the data set were including also the shapefiles called “gis_osm_roads_free_1” and “gis_osm_railways_free_1”. The same previous work was done for this variable, so for each type of infrastructure was created a new shapefile, then be intersected with the shapefile of small municipalities. In this case too, the variety and quantity of these linear infrastructures were measured for each municipality, defining five classes where 0 represents the absence of at least one type of infrastructures.

3.3. CLUSTER ANALYSIS AND DEFINING ARCHETYPES

Following the calculation of the six key variables, it was possible to proceed with the Multivariate Cluster Analysis, which it has been developed in GIS environment, using the ArcGis Pro software. In this process, the definition of Italian village archetypes has been performed which is based on the six relevant variables.

The Multivariate Clustering Analysis has been accomplished with the kernel k-means algorithm, which is an exclusive clustering algorithm. Clustering is concerned with grouping similar objects together and dissimilar to the objects belonging to other clusters. Kernel k-means uses kernels to estimate the distance between objects and clusters.

In particular, the spatial analysis tool “Multivariate Clustering” of ArcGIS Pro software has processed the final shapefile through the clustering method ‘K means’ and the initialization method “Optimized seed locations”.

Thus, the K-Means algorithm divided the six variables dataset into k (a hyperparameter) clusters using an iterative optimization strategy: the main outcomes of this process show five rather uniform clusters. Now, from this Clusters Analysis and from the scatter plots showing the distribution statistics’ graphs of the data, it is possible to outline the characteristics of the identified archetypes of the 5.532 small municipalities, which will be explained in the next chapter regarding the results obtained.

3.4. MORPHOLOGICAL ANALYSIS

As mentioned in the Literature Review, the urban elements are considered the places that give identity to the city. In line with the Research Project, it is proposed a basic example of morphological analysis using the Isobenefit Lines methodology, which has the aim to study the spatial distribution of urban centralities.

3.4.1. CASE STUDY

In order to develop the morphological analysis, it has been chosen one case study used as a simple example of how can be made this type of study.

The selection of the case study has been done with regard to two aspects: the first one is related to the urban dimension, in terms of the resident population, this means that it was necessary to choose a village which have around 5.000 inhabitants. In this way, pointing out a municipality with a high number of inhabitants, compared to the selected municipalities, the urban dimension is bigger than others small villages, always, in terms of urban dimension, consequently, there is a significant number of urban points, which are the studied elements in the Isobenefit Lines’ method.

The own preference in choosing a small village, as the case study, is the subjective aspect applied.

Agreeing on these two aspects, the selection of the case study has been done on ArcGis. On this software, it has been uploaded two different shapefiles: the first one is that one realized at the beginning of the work, so related to the small villages having a resident population by 2021 up to 5,000 inhabitants information, used to identify the biggest municipalities in term of population; the second one is the Base Map from the Satellite’s image, which lets observe the municipality’s shape and, consequently the urban fabric and open spaces.

In short, combining these two aspects, the case study has been selected and it is the Municipality of Castel del Piano, in Tuscany.

3.4.2. METHODOLOGY OF ISOBENEFIT LINES

According to the concept of Urban Isobenefit Lines and their relative studies⁸, applying a function to analyze the spatial equilibrium within cities is the methodology of this tool.

The Urban Quality of Life can be defined by specific attributes, like environmental quality, air quality, social conditions, urban quality, pedestrian areas, etc. These attributes have a weight, which indicates the influence on the overall value of ULQ, so the attributes' weight of ULQ estimates how much each attributes influences the level of quality in urban life⁹.

Connected to this issue, the National Innovative Program for Living Quality (in italian PINQuA)¹⁰ indicates the three principles at the base of a smart city: liveability, functionality, and sustainability. Always according the the Italian PINQuA, the key and representative elements of the liveability's principle are the pedestrian areas, common public spaces, and green areas, consequently for the morphological analysis, have been considered pedestrian areas (if they are present), central street, squares, gardens, and parks. These elements are the urban points necessary for the Isobenefit Lines' methodology which asses the spatial distribution of them and how the effects, of this distribution, are intersecting in the city.

In order to assess the distribution of urban point, as mentioned above, it is necessary to use the following formula which allows to calculate the "Distributed Benefit":

$$B_{ij} = A_i \cdot E / (d_{i_j} + E)$$

⁸ D'Acci L. (2013 a, b. 2015

⁹ Monetary, subjective and quantitative approaches to assess urban quality of life and pleasantness in cities (HedonicPrice, Willingness-to-pay, Positional Value, life satisfaction, Isobenefit lines) / D'Acci, Luca. - In: SOCIAL INDICATOR SRESEARCH. - ISSN 1573-0921. - 115:2(2014), pp. 531-559. [10.1007/s11205-012-0221-7]

¹⁰ Unità di Missione PNRR del Ministero delle Infrastrutture e della Mobilità Sostenibili. 2022. Programma Innovativo Nazionale per la Qualità dell'Abitare

The function proposesthe distinction between the “Punctual Benefit (A)” which is the benefit obtained when the citizens use the “i” amenity (pedestrian areas, squares, parks), while the “Distributed Benefit (B)” is the benefit of every urban point given from the “i” attraction. As specified by D’Acci¹¹, the “Distributed Benefit” is associated to the Benefit in a “j”urban point, generated by an “i” attraction having an (A) level of Punctual Benefit, and “d i-j” is their distance.

After this brief introduction about the methodology used by Isobenefit Lines, it has been possible to focus on the case study. First, must be individuated all the urban points present in the municipality and must be gave a value for each of them depending on the Personal Isobenefit Lines: one of many possible criteria for assigning a value is to quantify it in a scale from 1 to 3 the urban points, considering the current status of these places and the relative level of attractiveness. The value 1 is corresponding to a low level of attractiveness, while the value 2 is attractive enough and the values 3 equivalent a high level.

Consequently, on Google Maps and using the Street View it has been possible to identify and quantify all the urban points of the Castel del Piano’s municipality, giving for each urban points the value using the as mentioned criterion. Recognizing all the urban point in the municipality’s planimetry, the isobenefit scenarios and the distribution of the attraction throughout the city have been developed, so the “Isobenefit orography” has been obtained. In order to quantify the uniformity of the urban points’ spatial distribution, it is necessary to create and overlay a “Urban Matrix” formed by the number of cells which divide the city and study where exactly the urban points are located. The Matrix is made by “m” elements in the y-axis and “k” elements in x-axis, moreover the dimension of cells is 50x50 meters.

Having identified the distribution of the urban points, it has been calculated the standard deviation of every urban point by using the axis’ values of each of them. In this sense, the standard deviation of every urban point in the Matrix is divided by the medium value of the Matrix.

This ratio shows the “Uniformity Dispersion (U)” and it is a number less or equal to 1, where 1 indicates the maximum uniform distribution, thus this relative result measures the uniformity of the social benefit’s orography rising from the selected urban attractions.

11 D’Acci, L. (2013). “Monetary, Subjective and Quantitative Approaches to Assess Urban Quality of Life and Pleasantness in Cities”. Social Indicators Research, February 2013.

RESULTS AND DISCUSSION

4.1. ITALIAN SMALL VILLAGES

As described in the previous section, bibliography research was carried on in order to investigate about the villages’ definition. After this investigation, it was agreed that for this first approach the definition was concerning all the municipalities with a population of less than or equal to 5.000 inhabitants. As shown on the image (Figure 1), the mapping of the 5.532 small municipalities was suggested and it is possible to observe the distribution of these municipalities throughout Italy. To understand this distribution, an example table (Table 2) has been created:

REGIONS	N. MUNICIPALITIES	N. MUNICIPALITIES up to 5.000 inhabitants	% MUNICIPALITIES up to 5.000 inhabitants in total municipalities	% MUNICIPALITIES up to 5.000 inhabitants in single Regions
PIEMONTE	1.181	1.046	13,23	88,57
VALLE D'AOSTA	74	73	0,92	98,65
LOMBARDIA	1.506	1.039	13,15	68,99
TRENTINO ALTO ADIGE	282	241	3,05	85,46
VENETO	563	291	3,68	51,69
FRIULI VENEZIA GIULIA	215	153	1,94	71,16
LIGURIA	234	184	2,33	78,63
EMILIA ROMAGNA	330	133	1,68	40,30
TOSCANA	273	119	1,51	43,59
UMBRIA	92	63	0,80	68,48
MARCHE	225	162	2,05	72,00
LAZIO	378	255	3,23	67,46
ABRUZZO	305	252	3,19	82,62
MOLISE	136	128	1,62	94,12
CAMPANIA	550	343	4,34	62,36
PUGLIA	257	87	1,10	33,85
BASILICATA	131	107	1,35	81,68
CALABRIA	404	327	4,14	80,94
SICILIA	391	211	2,67	53,96
SARDEGNA	377	318	4,02	84,35
TOTAL	7.904	5.532	70	

Table 2. Distribution of Italian small villages. Source: Author, 2022

From this table it is noted that the two regions that have the highest number of small municipalities are Piedmont and Lombardy, respectively 1.046 and 1.039 small municipalities, which contribute to form about the 25 percent of small municipalities throughout Italy. On the contrary, the Region of Umbria has the least number of small municipalities, only 63, but also the Aosta Valley Region and Puglia Region have a low number of small municipalities. The difference is that the Aosta Valley Region has all its municipalities since they all have a population of less than 5,000 inhabitants, except the city of Aosta. While the Puglia Region lacks small municipalities, in fact it has only 87, which affect the region for 33 percent. In general, the other Italian regions have a fairly proportional distribution of small municipalities across all municipalities

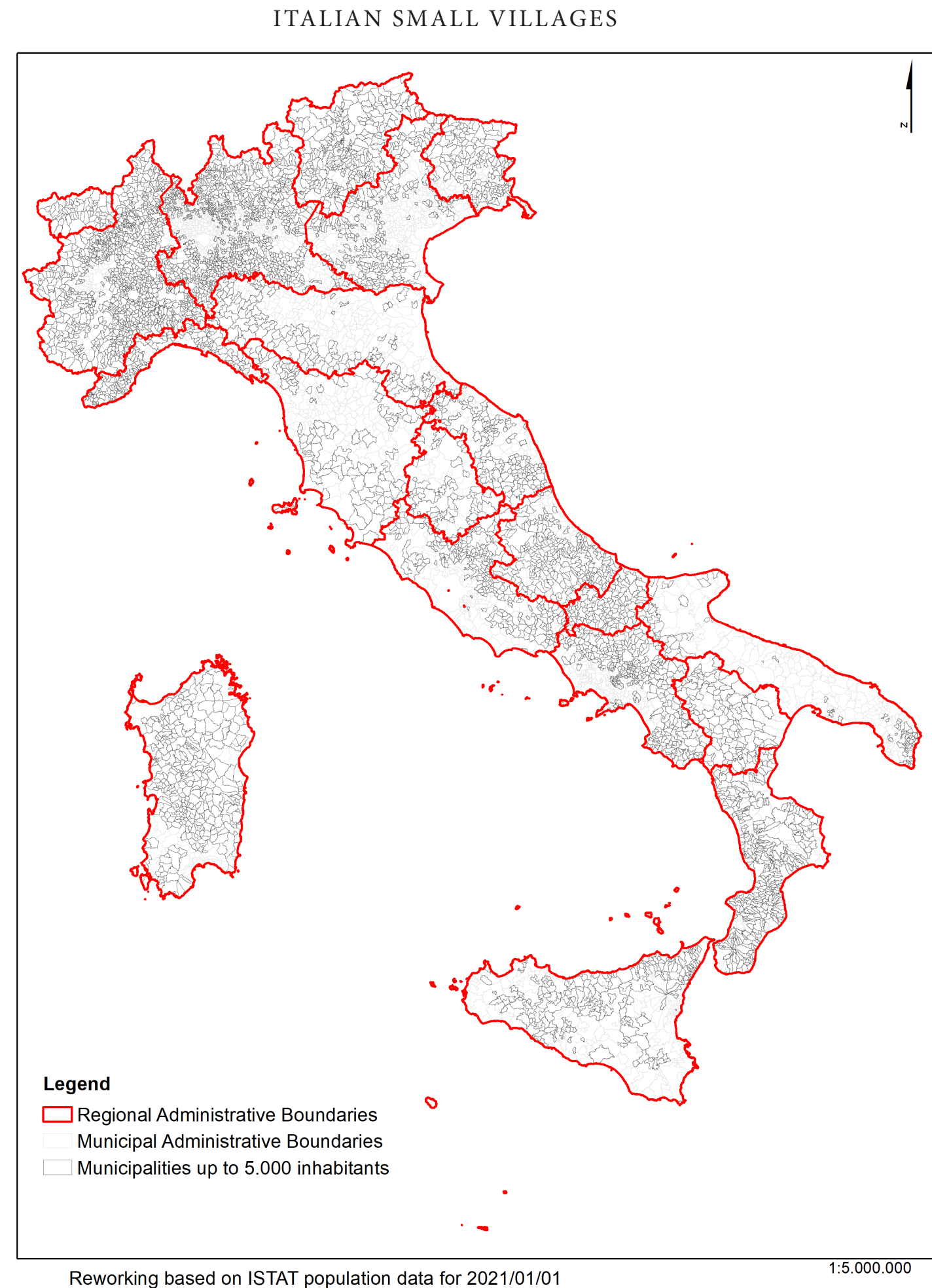


Figure 1. Distribution of Italian small villages. Source: Author, 2022

4.2. SIX KEY VARIABLES' ANALYSIS

The quantitative analysis and the relative outputs have been conducted to highlight the villages' current situation. The individual and relevant variables were measured through a spatial quantitative assessment with which the archetypes have been defined employing the Cluster Multivariate technic. The materials produced by the quantitative analysis of the variables will be presented below.

Variation of population: the cartography shows a consistent and generalized depopulation over the whole Italian territory. In the south of Italy and in the islands, very few are the small municipalities that record a stable variation or an increase. This negative trend seems to change in Northern Italy, but most municipalities do not show better situations. The only exception is the Trentino Alto Adige Region, which highlights a modest demographic increase. The other Another Alpine Region, Valle d'Aosta, does not show a negative but rather stable variation during these ten years. In general, it seems to note that in the Alps the population has always remained stable.

Geographic location: this data provides for each municipality the elevation threshold values which identify different elevation zones. The result of this analysis is that most of the small municipalities are type of inner mountain municipalities, while the coastal hill's type appears to be the least present. The plain typology can only be found in the North of Italy, in the correspondence of Po Valley and in some small areas of Sardinia and Puglia region. Finally, the coastal hills type is only found in certain parts of Calabria and Sicily region.

Municipal area: this variable provides information about the dimensions of the municipality, in term of area encompassing its administrative territory. It is possible to notice the smallest municipal areas are distributed between the following region: Piemonte, Lombardia, Abruzzo, Molise and Calabria. By contrast, the largest municipalities are those along the Alps and the Apen-

nines. This is certainly due to the fact that the presence of large areas dedicated to forests is limiting the expansion of settlements but at the same time fall within the administrative border.

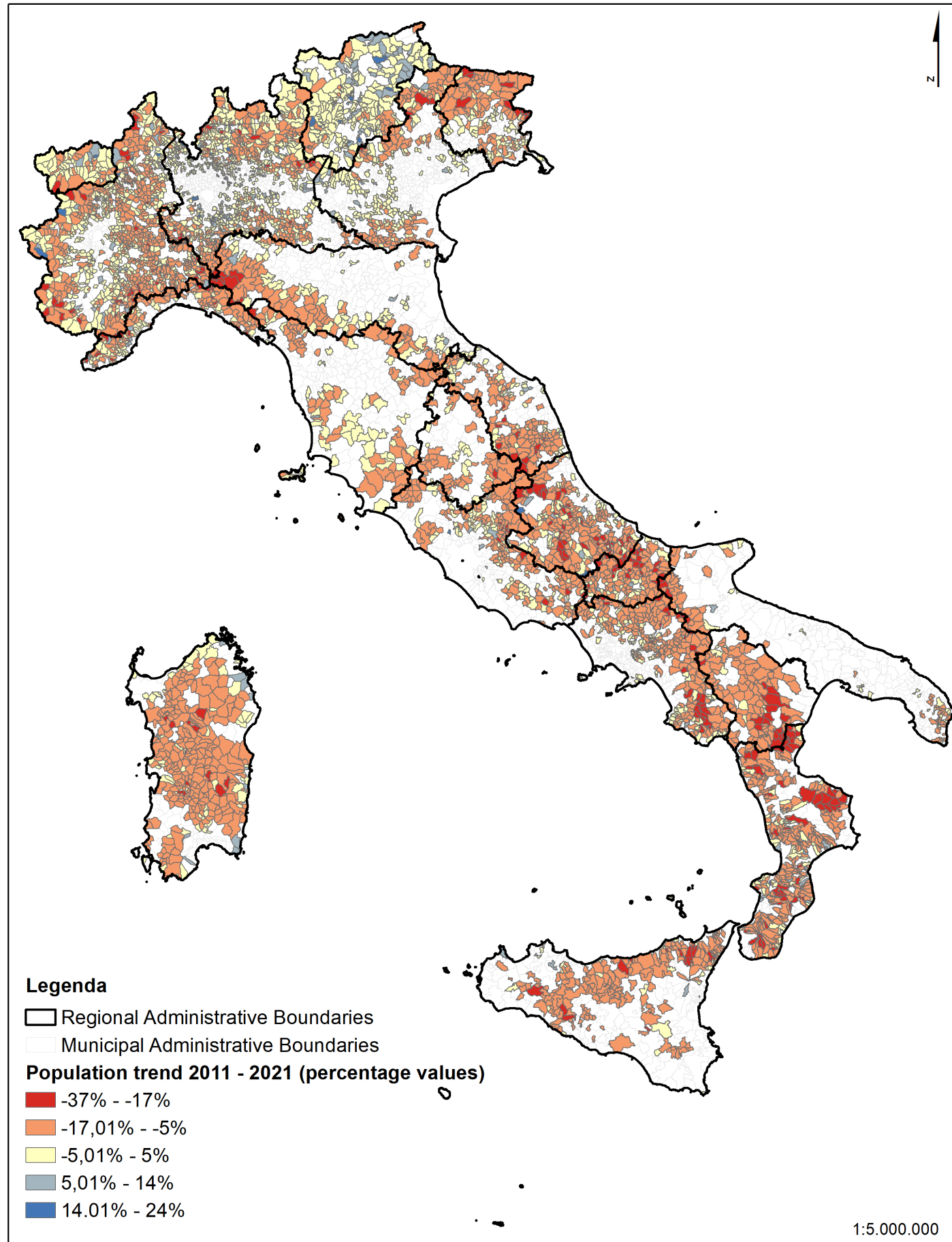
Average collective income: the results of the variable were obtained by calculating the average value between the sums of gross incomes that ISTAT reports by income classes. The statistical distribution of the data collected for the 5.532 municipalities shows that a large part of the sample is at the lowest income levels. High values emerge in isolated cases, in particular in the North-East of Italy.

Availability and variety of essential services: for this variable, different maps were produced in order to show exactly where the essential services are located. Furthermore, another map was produced to better read these data, as mentioned, and it was possible to observe the significant lack of equipment in municipalities in central and southern Italy, as well as in Sardinia.

Richness of the infrastructure network: the variety and quantity of these linear infrastructures was measured and, as for the previous variable, different maps were produced to know where and how often the infrastructure are present. The map underlines a lack of connections throughout Italy, but more stresses next the Alps. It is no coincidence that these municipalities predominantly correspond to the so-called inland areas characterized by poor accessibility, on which it is necessary to intervene.

Hereinafter, the different materials produced concerning the six key vari

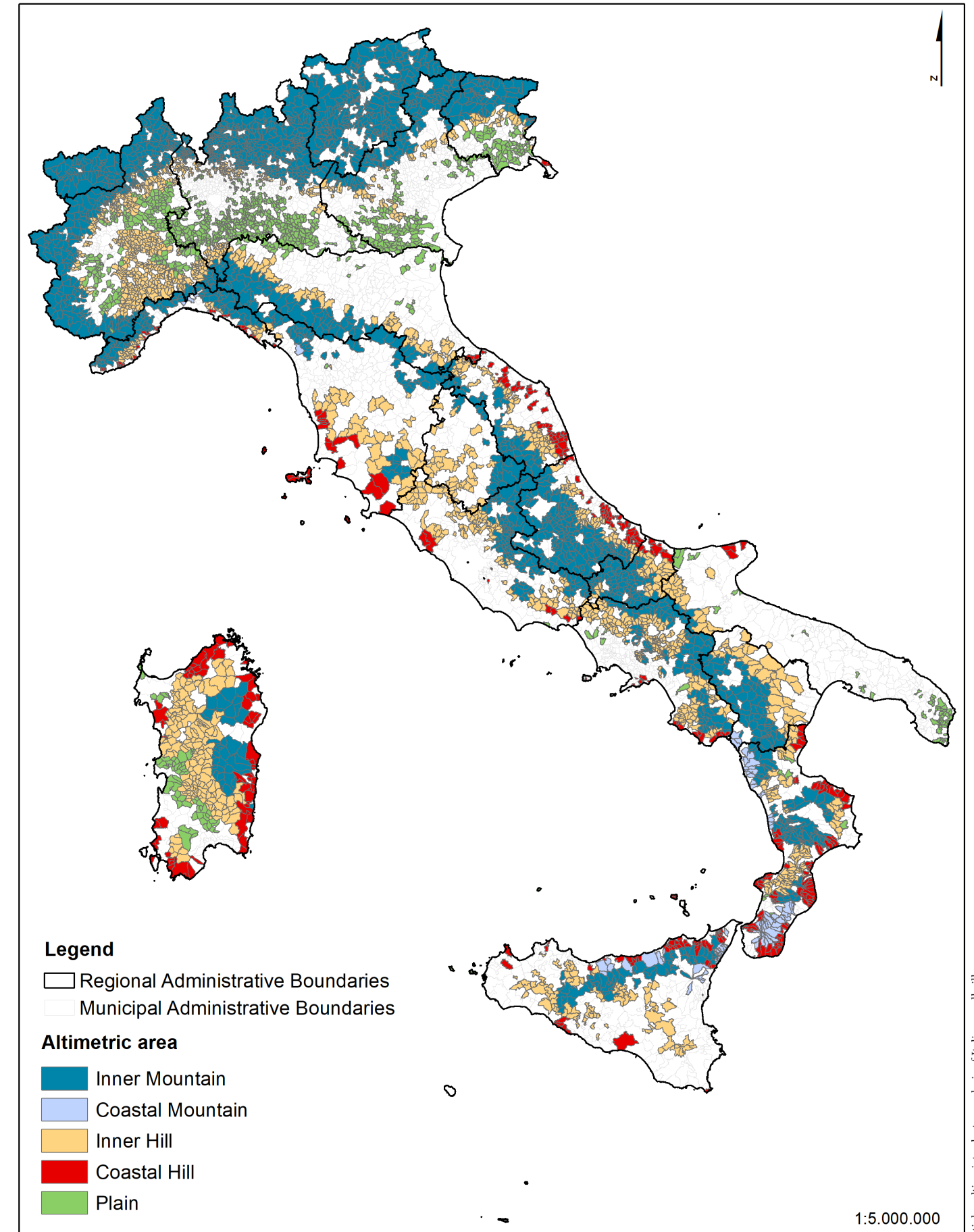
POPULATION TREND PERIOD 2011 - 2021



Reworking based on ISTAT data of the 15° general population census (2011) and the resident population on 01/01/2021

Figure 2. Variation of population 2011-2021 of Italian small villages. Source: Author, 2022

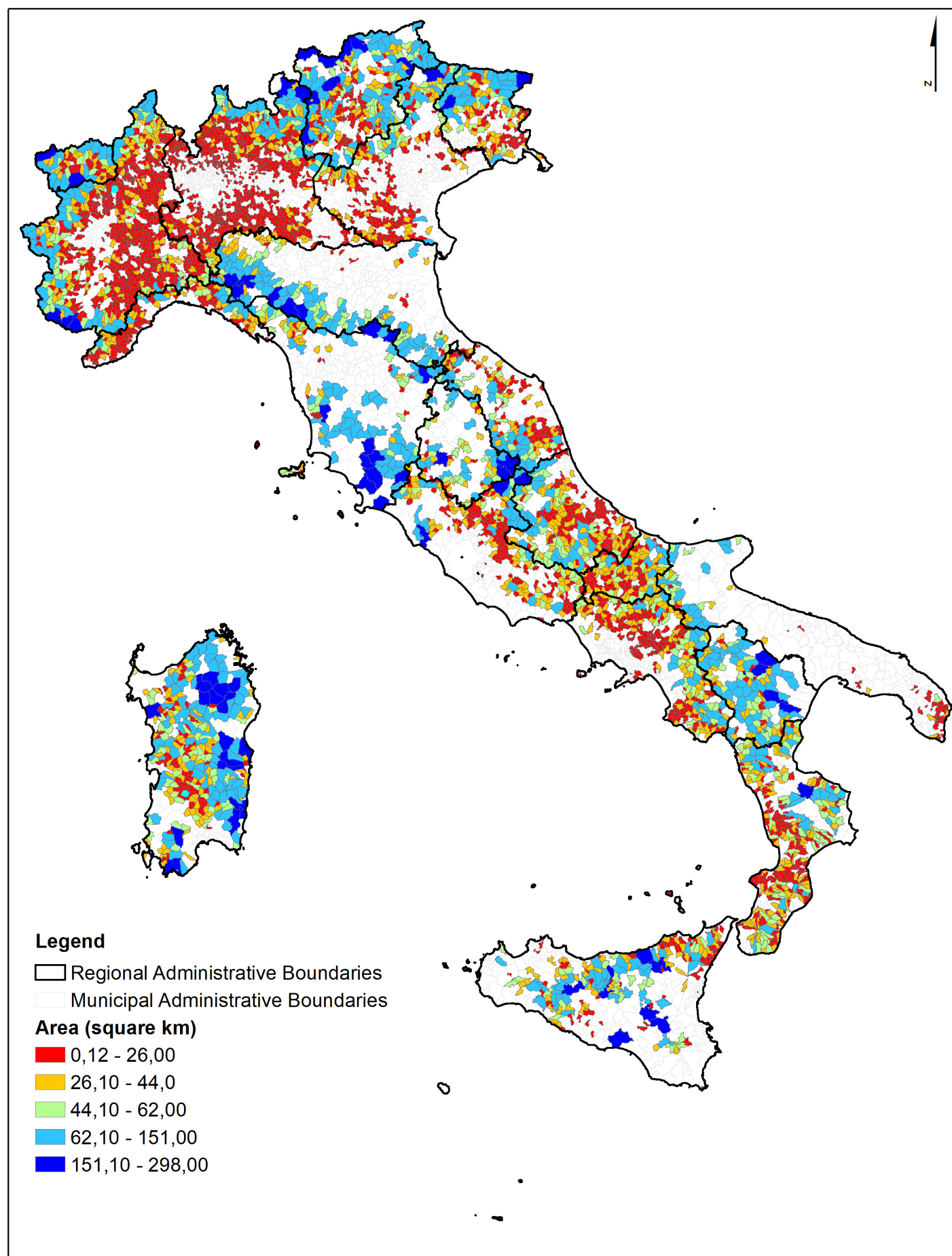
ITALIAN SMALL VILLAGES BASED ON HOMOGEOUS ZONE



Reworking based on ISTAT data for 2020 (publication "Circoscrizioni statistiche")

Figure 3. Distribution of Italian small villages into homogeneous zones on the basis of elevation thresholds. Source: Author, 2022

SURFACE AREA

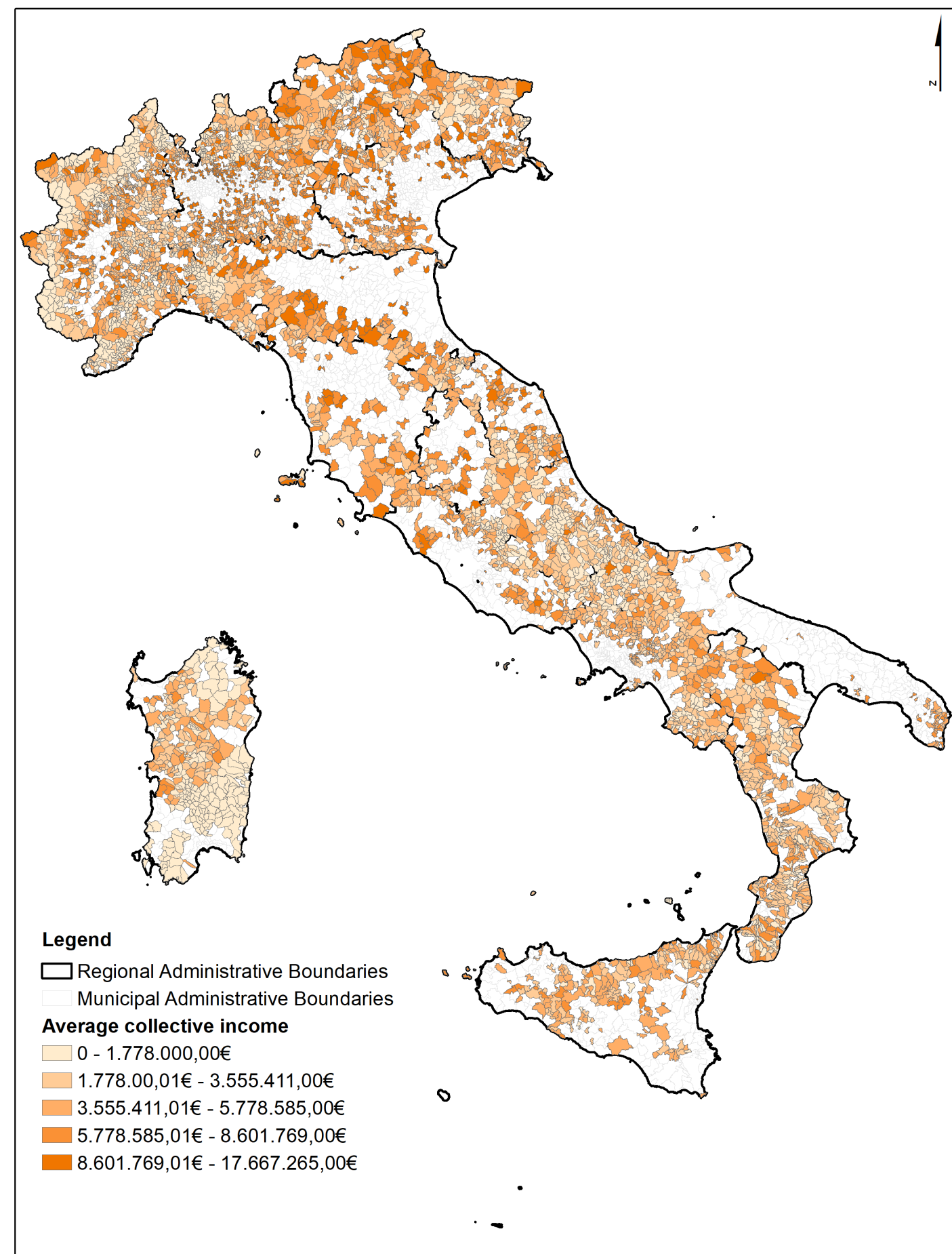


Reworking based on ISTAT surface area data for 2020/01/01

1:5.000.000

Figure 4. Surfaces areas of Italian small villages. Source: Author, 2022

AVERAGE COLLECTIVE INCOME

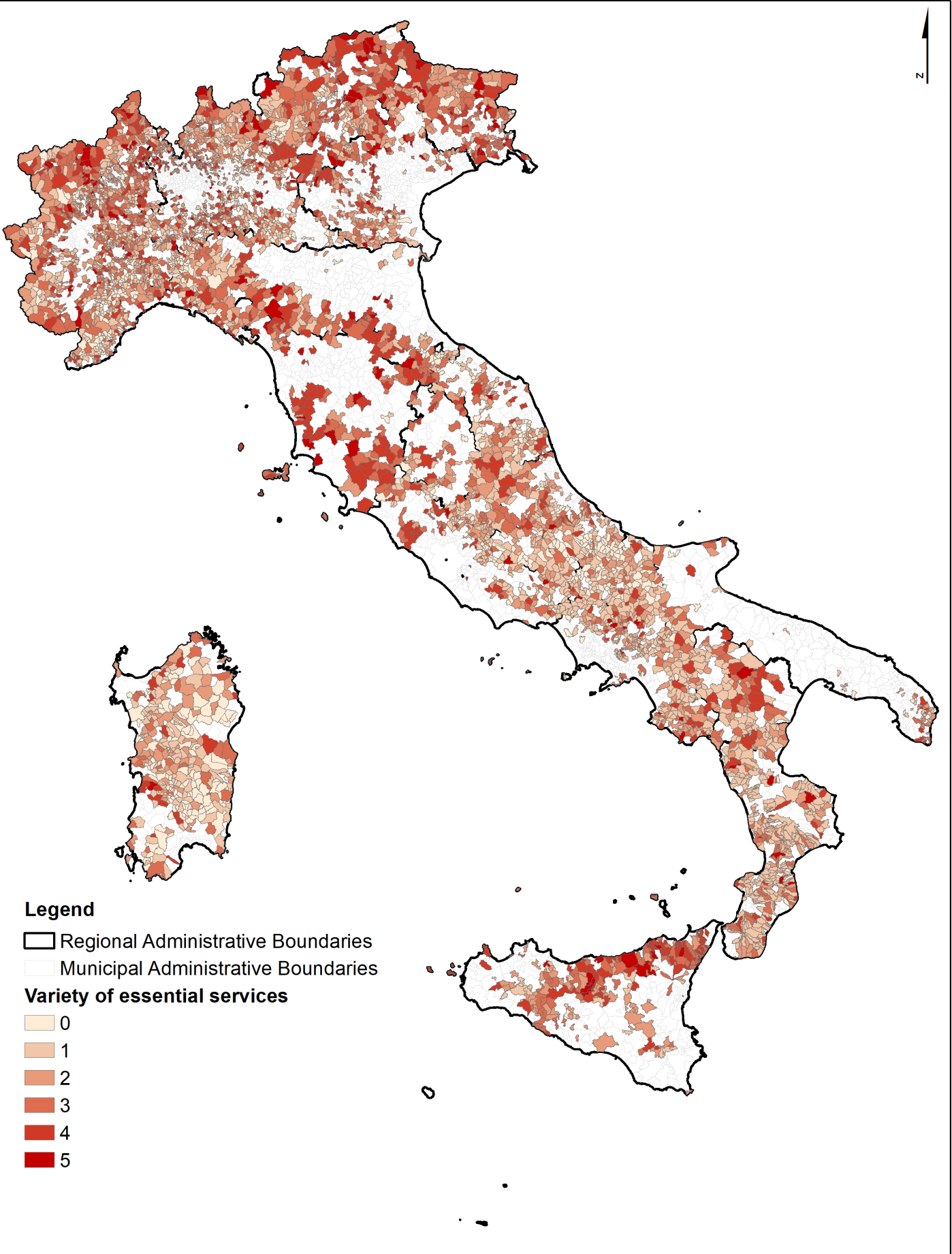


Reworking based on ISTAT total income by amount classes of taxpayers residing in 2019 data

1:5.000.000

Figure 5. Average collective income of Italian small villages. Source: Author, 2022

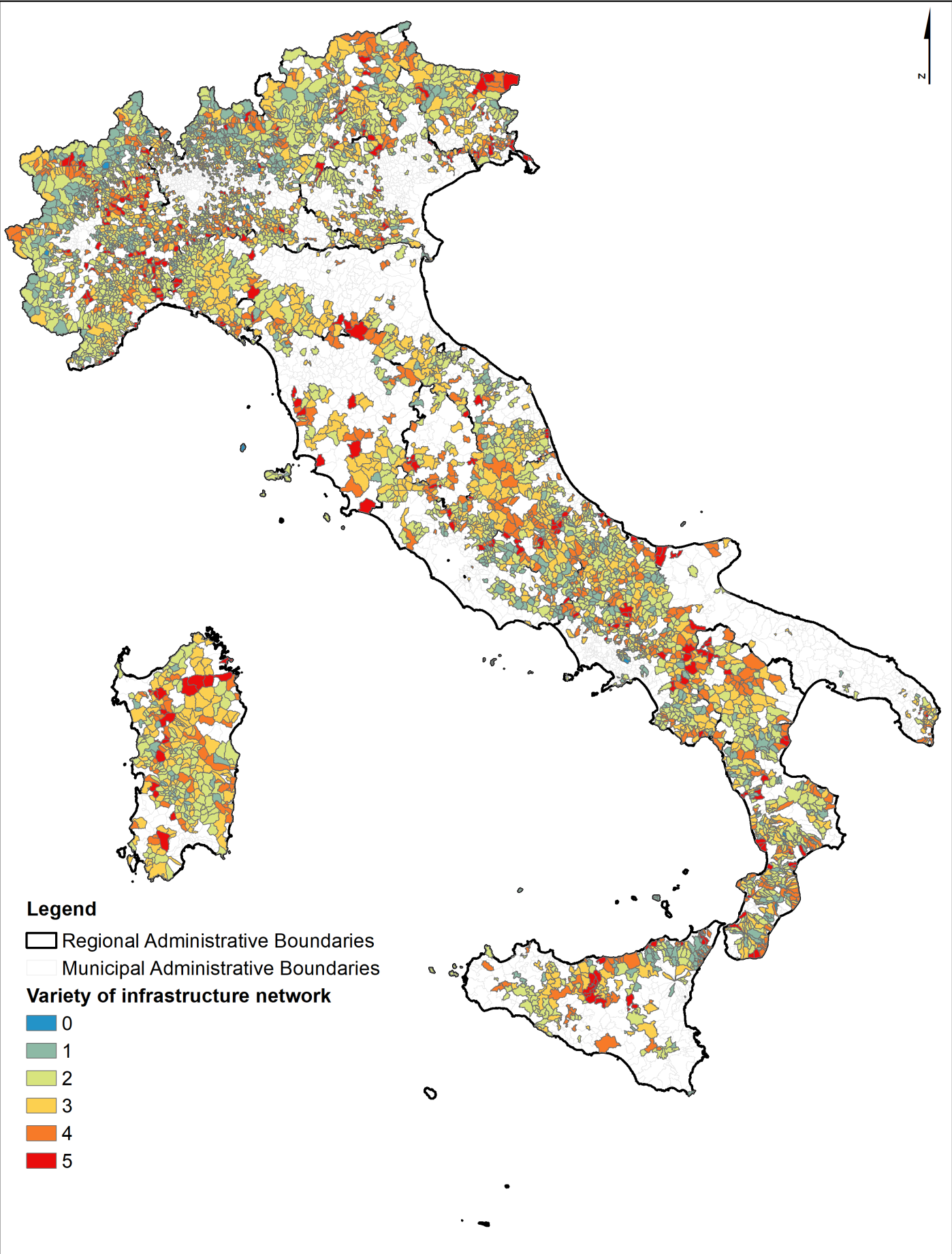
AVAILABILITY AND VARIETY OF ESSENTIAL SERVICES



Reworking based on OpenStreetMap data

Figure 6. Availability and variety of essential services. Source: Author, 2022

RICHNESS OF THE INFRASTRUCTURE NETWORK



Reworking based on OpenStreetMap data

Figure 7. Richness of the infrastructure network. Source: Author, 2022

4.3. CLUSTER ANALYSIS AND ARCHETYPES

The main outcomes of the Multivariate Cluster Analysis show five uniform clusters. It is possible to outline the characteristics of the identified archetypes from the cartography and the scatter plot charts, which shows the statistical distribution of the data for each cluster.

The five cluster are organized in the following manner¹:

Cluster 1 includes mainly mountain and hill municipalities with a small size on average. On a socioeconomic level, these municipalities are characterized by a marked depopulation, where average income values are among the lowest. The lack of availability and variety of services and infrastructures are signaled by the distributions of values that for both variables do not exceed class 2.

Cluster 2 represents small municipalities located in geomorphologically plain, in some cases internal, areas.

They are representative of a slightly growing demographic trend, the average incomes are the highest, and the presence and variety of services is also medium-high: values are distributed over classes 2 to 4.

Cluster 3 includes all the larger municipalities, which are mainly located in inland mountainous areas. Within them it is possible to find a wide variety of income categories and heterogeneous demographic trends that are positioned in an almost zero range, with a slight tendency of decrease and, in other cases, a timid recovery. As in Cluster 2, the variety of services and infrastructure is medium to high.

A comparison of the line and distribution graphs shows that **Clusters 4 and 5** are similar in several aspects: first of all, they represent the smallest municipalities where, however, the population shows a general upward trend. The recorded incomes are medium-low and there are never more than two

types of infrastructures crossing them. What really differentiates these two archetypes is the geographical position: the sample of Cluster 4 is represented by mountain municipalities mainly in the Alpine arc where the availability of services is varied and present; Cluster 5, on the contrary, is defined by smaller municipalities in plain and coastal areas where, unlike Cluster 4, the variety of services is very reduced.

¹ Torabi Moghadam S., Pignatelli M., Collin A., Lombardi P., “Renaissance of villages for the revitalization of marginal areas”, 2022

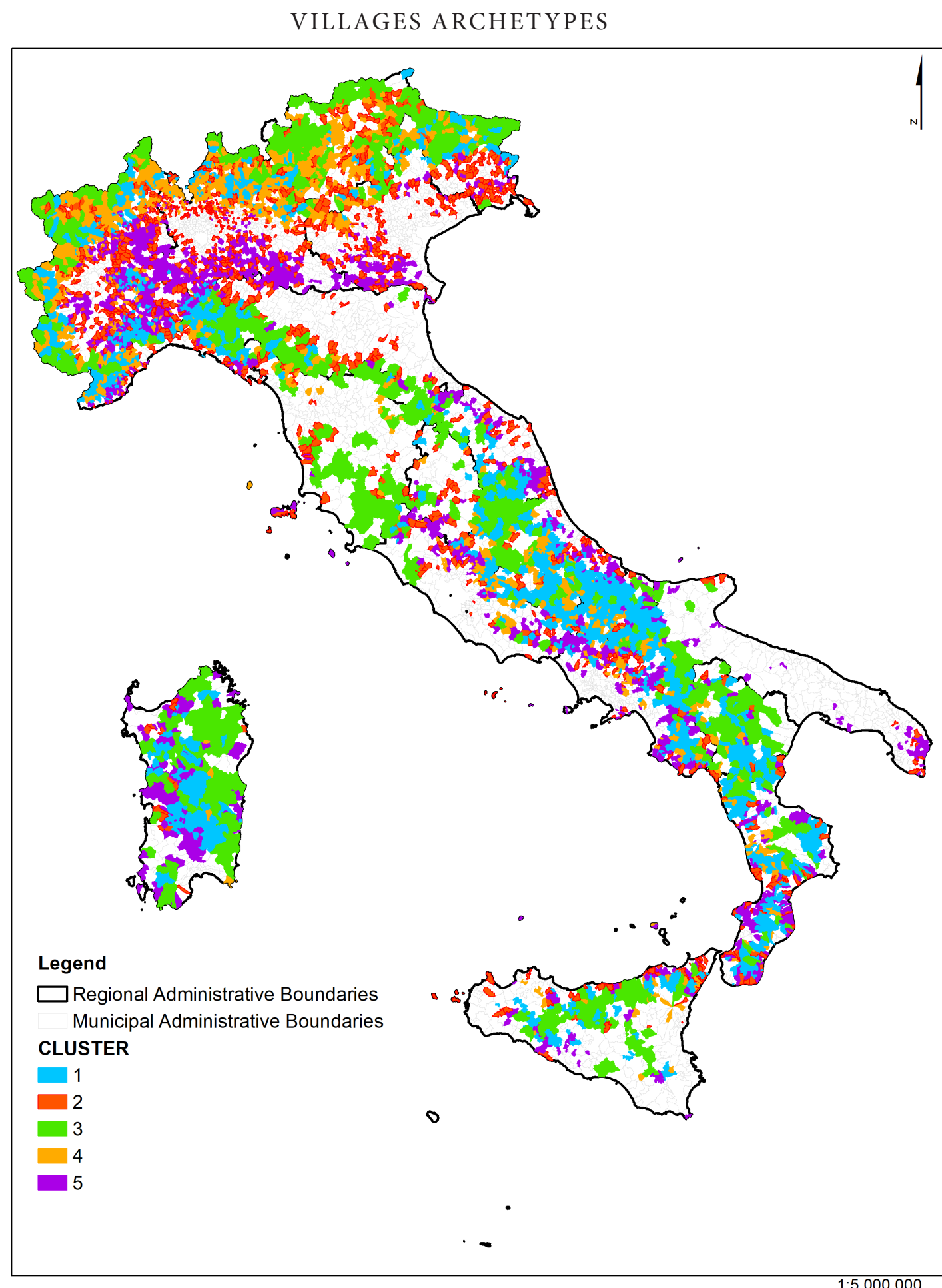


Figure 8. Italian small villages' archetypes. Source: Author, 2022

4.4. MORPHOLOGICAL ANALYSIS

The selected case study is the Municipality of Castel del Piano, near Grosseto in Tuscany. This municipality is part of the Cluster 2 and it will be analysed from the morphological point of view.

In the following satellite image of Castel del Piano are indicated the urban points (squares and parks) present in all the municipality, and this image help to know where they are located.

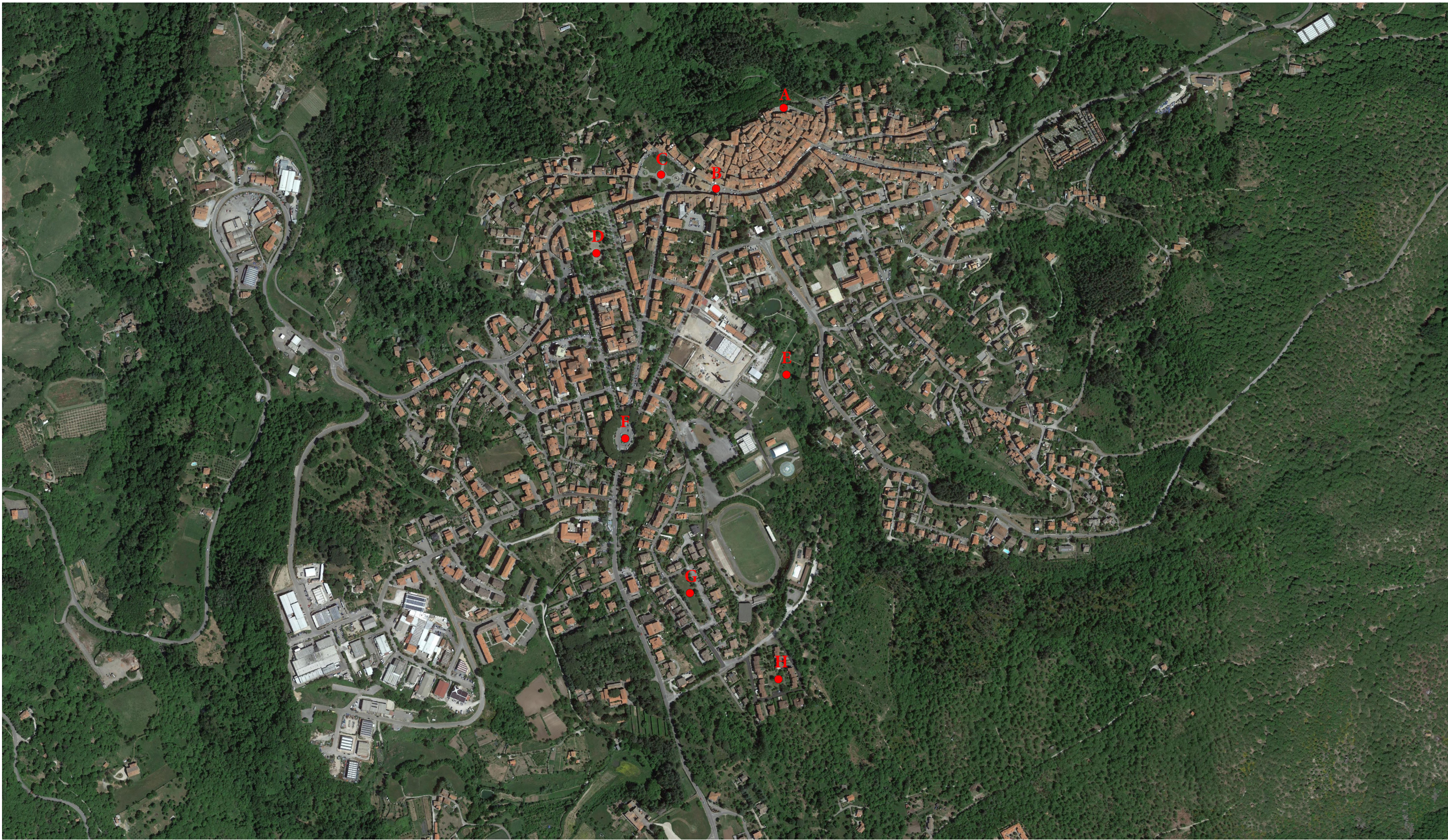


Figure 9. Municipality of Castel del Piano. Extract from QGis Satellite Base Map. Source: Author, 2022

As said before, the choice was made combining the objective and subjective aspects of the two different types of clusters and morphological analysis.

Applying the methodology explain in the previous chapter, using Google Maps and Street View, it has been identified in Castel del Piano's Municipality 8 different urban points, which the different values from 1 to 3 have been assigned. In the following table, urban points and values are precised.

LOCALIZATION	URBAN POINTS	VALUE
A	Bellavista Square	2
B	Madonna Square	2
C	Garibaldi Square	3
D	Rosa Tiberi Guarnieri Carducci Square	3
E	Public Park	3
F	Rimembranza Square	3
G	Sant'Angelo Garden Square	1
H	Green Public Area	1

Table 4. Name of Urban Points in Castel del Piano and relative values. Source: Author, 2022

The value reported in the table is corresponding to the “Punctual Benefit (A)” used in the formula to calculate the distribution of urban points. Thus, for each urban point has been calculated the “Isobenefit Orography” and the “Isobenefit Lines” in the Octave Sftware, which gave the following representation's graph:

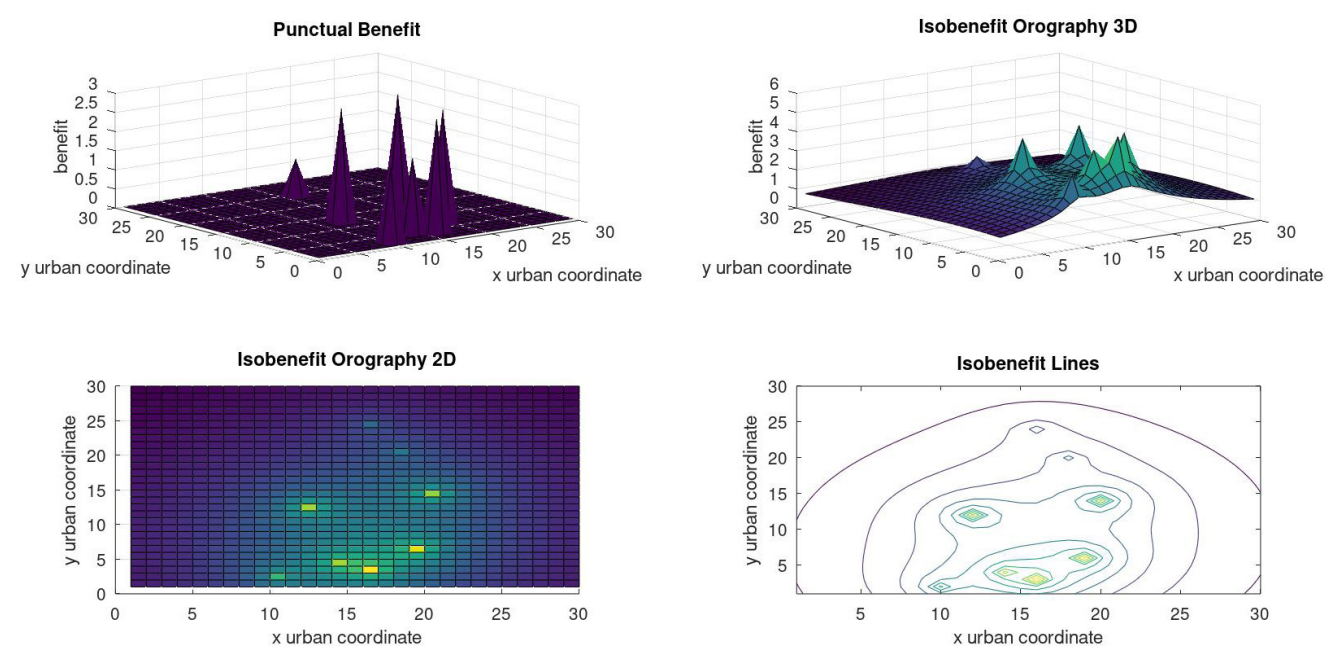


Figure 10. Isobenefit Lines' graphs as the result from Octave software. Source: Luca D'Acci, 2022

The Isobenefit Orography shows how the Punctual Benefit flows in all the planimetry, and this is depending on how far it is and how comfortable, speedy, pleasant, and inexpensive it is to reach it from that point to another. The same focus is about the Isobenefit Curves but done via contour lines, and as for the Isobenefit Orography, if the distance between line is larger, it means that the distance from that point to another is higher, so each of these lines has a type of benefit that derives from the value of the city's amenity. Based on the calculation of each item and as provided in the methodology, it was possible to calculate the standard deviation and therefore the U-value, which represent the “Uniformity Dispersion”, always using Octave software. For the selected case study, the U-value is 0.57.

Consequently, it can be said that citizens who are not living in front of an urban point, but they are more distant from their closest amenity which have a higher attractiveness, means that the weakness to live not in front of an urban point is balanced from the higher benefit, “Punctual Benefit (A)”, that the inhabitant appreciates when reaching it. Finally, closer it is, easier it is to get there, so the getting benefit is greater, but such thinking may not always effective. In fact, the true core of the Isobenefit Lines is to evaluate and transform the geometric distances, between urban points, in psycho-economic distances. Therefore, it can be said that the benefit that derives from an amenity is higher even if it is more distant but more easily, pleasantly, and economically accessible of another physically nearer amenity.

CONCLUSIONS AND FUTURE DEVELOPMENTS

The need to know the general framework of the Italian situation on the areas considered marginal is a first objective of the Research Project “Renaissance of Borghi”. This project has the intention to create the conditions in order to repopulate and rebalance the shrinking territories, trying to create an identity value that is not currently properly recognized throughout an active planning process which creates jobs, provides an adequate infrastructure network, offers basic essential services, such as health and education and green areas. This main Research Project’s objective is in accordance with the PNRR National Instrument and the National Borghi Plan, which, through “Mission 1” expresses the concrete political and financial commitment in relaunching the “Borghi” and internal areas, with the aim of hindering depopulation and encouraging the sustainable economic growth, full and productive employment, and decent work.

The first central challenge was related to the recognition of a common and shared definition of “villages”, so in order to carry on the thesis work, it has been decided to focus, not on “borghi” but on what are defined by the existing literature the “small villages”. After having defined the real objective, it has been developed the data collection about these territories, which required long time due to the heterogeneity of the sources and variables. The innovation of this suggested method is based on a place-based approach using the Geographic Information System technology and the progressive tools that ArcGIS Pro has recently made available. The use of spatial analysis combined with the statistical analysis of data is fundamental to better addresses future sustainable development policies, in particular from the point of view of this project to recovery the villages and marginal areas of Italy.

Thanks to this collection and processing of data, the five Italian villages archetypes have been defined throughout the Multivariate Cluster analysis developed on GIS environment which allowed to create clusters with large dataset and through the k-means algorithm to define similar data categories. The result of the archetypes analysis is showing the variety and heterogeneity of the Italian territory, since this study allows to differentiate the different dynamics and in similar geomorphologically territories, in the most correct way.

These clusters are contributing to identifying the different archetypes, according to whom set of Key Performance Indicators to assess and monitor the

territorial developments implementing a specific package of strategies will be given.

Focusing on the Isobenefit Lines, this is a new approach on mapping cities and understanding them according to the benefits given to inhabitants. This type of analysis is linked to the Research Project why it is necessary to assess the pleasantness of small villages in order to understand better which could be the policies decisions to take into account by the governance, in a revitalization perspective.

In this sense, the Isobenefit Lines is offering a tool to identify, visualize and quantify urban centralities, which are intended the most interesting urban places where ordinary people prefer to visit. In other words, the Isobenefit Lines' method indicates that these urban centralities are the most agreeable urban points (punctual benefit) and the most reachable in term of cost, time and appeal (distributed benefit) and which is the uniformity dispersion of them in the municipality.

Combining the morphological analysis and the Research Project, it has been selected a case study in order to illustrate a simple applied example of the methodology. This example of morphological analysis aims to be an in-depth analysis of how morphology can affect in terms of the ability to analyze a small municipality, and therefore to be considered as a beginning on which to be based for future studies.

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