

EXAMINATION OF SMART VILLAGE POTENTIAL IN TÜRKİYE

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ABSTRACT

EXAMINATION OF SMART VILLAGE POTENTIAL IN TÜRKİYE

With the development and effective use of technology in urban areas, rural areas have been left behind, and the imbalance between rural and urban areas has increased. The concept of smart village, a new rural development tool, is thought to be understood theoretically and practically. This study aims to contribute to the smart village literature, investigate local scale indicators, and provide a methodological perspective by analyzing the smart village potential of Türkiye at the rural settlement scale. MCDM (Multi-Criteria Decision-Making) methods are used in the study to analyze the smart village potential. The suitability values of rural settlements are analyzed by weighting the variables. Finally, spatial changes that may arise with the application of the smart village concept to existing rural settlements are evaluated, and a model for smart village plan is developed. As a result, the potential of the Smart Village concept in Türkiye has been revealed spatially. It is observed that the potential is particularly high in the Central Anatolia region and some settlements in the Aegean and Marmara regions. While performing the analysis, it is observed that there are significant differences between objective and subjective results. In particular, the variables *presence of agricultural production* and *population change rate between 2018-2022* are the variables with the most differences. According to the results of the observations made in rural settlements with high potential, it is determined that reaching a certain population size and the presence of cooperatives in the settlement are variables that will positively influence the concept.

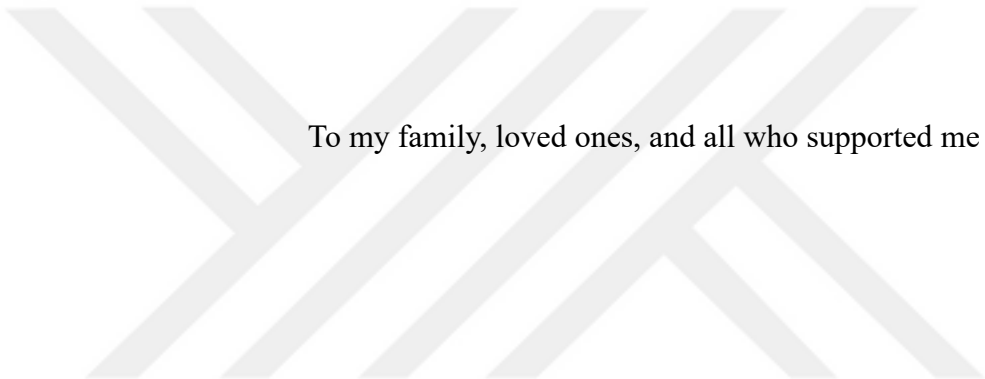
Keywords: MCDM, rural development, smart village, YER-SİS

ÖZET

TÜRKİYE’DE AKILLI KÖY POTANSİYELİNİN İNCELENMESİ

Teknolojinin gelişip kentsel alanlarda etkin şekilde kullanılmasıyla kırsal alanlar geride kalmış ve kır-kent arasındaki dengesizlik artmıştır. Yeni bir kırsal kalkınma aracı olan akıllı köy bu kavramın teorik ve pratikte eksikliklerinin giderilip anlaşılması gerektiği düşünülmektedir. Bu çalışma akıllı köy literatürüne katkı sunmayı, alt ölçek indikatörlerini araştırmayı ve Türkiye’nin akıllı köy potansiyelini kırsal yerleşim ölçeğinde analiz ederek metodolojik bir bakış sunmayı amaçlamaktadır. Akıllı köy potansiyeli analiz etmek için çalışmada ÇKKV (Çok Kriterli Karar Verme) yöntemleri kullanılmıştır. Değişkenler ağırlıklandırılarak kırsal yerleşimlerin uygunluk değerleri analiz edilmiştir. Son olarak, akıllı köy konseptinin mevcut kırsal yerleşimlere uygulanması ile ortaya çıkabilecek mekânsal değişiklikler değerlendirilmiş ve akıllı köy planı için konsept geliştirilmiştir. Sonuç olarak, Akıllı Köy konseptinin Türkiye’deki potansiyeli mekânsal olarak ortaya konmuştur. Özellikle iç anadolu bölgesi ile ege ve marmara bölgesinin bazı yerleşimlerinde potansiyelin yüksek olduğu görülmüştür. Analiz gerçekleştirilirken objektif ve subjektif sonuçlar arasında önemli farklılıklar olduğu gözlemlenmiştir. Özellikle *tarımsal üretim varlığı* ve *2018-2022 yılları arası nüfus değişim oranı* değişkenleri en fazla farklılığın olduğu değişkenlerdir. Yüksek potansiyele sahip kırsal yerleşmelerde yapılan gözlem sonuçlarına göre, belirli bir nüfus büyüklüğüne ulaşmanın ve yerleşmede kooperatiflerin varlığının kavramı olumlu yönde etkileyecek değişkenler olduğu tespit edilmiştir.

Anahtar Kelimeler: ÇKKV, kırsal kalkınma, akıllı köyler, YER-SİS



To my family, loved ones, and all who supported me till the end.

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LIST OF SYMBOLS

ABPRS: Address Based Population Registration System

AHP: Analytic Hierarchy Process

ANP: Analytic Network Process

CAGR: Compound Annual Growth Rate

CAP: Common Agricultural Policy

CRITIC: Criteria Importance Through Inter-criteria Correlation

DVI: Digital Village Index

ENRD: European Network for Rural Development

EU: European Union

FUCOM: Full Consistency Method

GIS: Geographical Information Systems

ICT: Information and Communications Technology

KDD: Knowledge Discovery and Data Mining

MCDM: Multi Criteria Decision Making

OECD: Organization for Economic Co-Operation and Development

OSM: OpenStreetMap

PROMETHEE: Preference Ranking Organization Method for Enrichment Evaluation

R&D: Research and Development

SARS: Spatial Address Registration System

SDGs: Sustainable Development Goals

SEGE. Socio-Economic Development Ranking of Provinces and Regions

SVR: Smart Village Readiness

TOPSIS: Technique for Order Preference by Similarity to Ideal Solution

TurkStat: Turkish Statistical Institute

VIKOR: ViseKriterijumska Optimizacija I Kompromisno Resenje

YER-SIS: Urban and Rural Settlement Systems in Turkey

WSM: Weighted Sum Method



CHAPTER 1

INTRODUCTION

Although cities date back to BC, the concept of urbanization emerged a long time later (Lowry 1990). The emergence of capitalism in different forms is among the reasons that triggered spatial change. Over time, the emergence of surplus products with advances in technology increased the commercial value of agriculture and the feudal order changed (Clark 1998). Small settlements, which were initially based on agriculture, developed over time and turned into cities. In this transformation process, various changes such as spatial, economic, cultural, etc. were experienced (Davis 1955). As the development of industry created job opportunities in cities, the rural population started to migrate to the city (Clark 1998) and the concept of urbanization emerged. The concept of urbanization simply refers to the process by which urban areas spread and the surrounding areas undergo functional, economic, social and spatial changes (Balta and Atik 2022). While some sources claim that this transformation and urbanization is caused by an increase in job opportunities (Clark 1998), there are also sources that interpret urbanization as a result of demographic changes rather than economic changes (Dyson 2011).

After rural settlements began to change and urbanize, it became necessary to develop definitions for rural and urban areas. Many studies have been carried out on the definition of these concepts (Davis 1955). At the end of the 1800s, settlements over 8000 inhabitants were defined as urban settlements in the United States. Later, different population thresholds were defined for towns and population density started to be taken into account (Census Bureau 1964). In the following years, the complexity of defining settlements was understood and the classification was further elaborated. In the 2011 UK census, urban areas were defined as interconnected settlements with a population of more

than 10,000 people, as defined on maps produced by the government. Rural areas are defined as non-urban settlements with fewer than 10,000 inhabitants, or open countryside. These classes are further subdivided into subclasses and a total of ten classes are defined (Office for National Statistics 2019). One of the current definitions is the definition calculated by the European Union based on population density by creating 1 km² grids. According to this definition, urban areas are settlements with a minimum density of 300 people per km² and a population of at least 5000. All non-urban settlements are considered as rural settlements (Eurostat n.d.). The definition of urban area varies from country to country and is still not clear. Variables such as administrative boundaries, population size, settlement functions and distance are some of the data used to define urban areas (Reba, Reitsma, and Seto 2016). Urbanization can be difficult to define due to spatial and temporal variations (Narain 1960). It is possible to say the same for the definition of rural areas. Geographical, social and cultural factors and the variability of rural areas are among the other issues to be taken into consideration when defining rural areas (Halfacree 2009). The definitions developed for rural areas have for a long time dealt with the social dimension in a limited way (Halfacree 1993). In addition, dividing settlements into rural and urban areas leads to rural areas being considered as “non-urban settlements”. Defining rural areas in this way is not seen as a correct approach (Census Bureau 2024). While all these definitional efforts continue, the definitions of rural and urban have become more ambiguous as cities have developed and expanded, the differences between rural and urban have diminished, and new transition zones between rural and urban have emerged. While all these definitional efforts continue, the definitions of rural and urban have become more ambiguous (Eversole 2018) with the development and expansion of cities, the decrease in the differences between rural and urban (Delgado-Viñas and Gómez-Moreno 2022) and the formation of new transition zones between rural and urban (Delgado-Viñas and Gómez-Moreno 2022; Nishant Sharma et al. 2023).

Due to the controversial and ambiguous nature of the concept of “rural”, the concept of “rural development” has emerged in order to solve rural problems and understand the countryside. In addition, rural areas, which are structurally different from urban areas, also differ from urban areas in terms of their problems, needs, and the solutions required (Eversole 2018). Unlike urban areas, rural areas are characterized by problems such as inadequacies and deficiencies in public services, outward migration of the educated and young population, low levels of economic progress or economic

decline(Ward and Brown 2009). The concept of rural development is considered as a set of efforts aimed at solving problems in rural areas and creating a positive impact (Eversole 2018). In Türkiye, various projects have been realized and implemented with the emphasis on rural development studies. In the post-1950 period, the approach in these studies is generally based on the implementation of urban features in settlements with rural character, which are located in urban areas and cause rural-urban migration (Başbüyük 2011; Marin 2005).

In recent decades, settlements have undergone significant transformations. Especially in recent years, many sources in the rural literature emphasize the declining agricultural activities and increasing sectoral diversification in rural areas, in contrast to the agricultural sector-dominated situation in the past (Delgado-Viñas and Gómez-Moreno 2022). In addition, with increased accessibility, human mobility has increased, and rural areas have become attractive for different economic sectors (OECD 2006). This has led to the development of industry and services sectors in rural areas. However, the continued decline of the agricultural sector is still an important issue that needs to be addressed. In a report published in 2006, the OECD outlines four important issues in the integrated rural development model. The first is the provision of basic public services, the second is the highlighting and valorization of the values of rural areas, the third is the encouragement of entrepreneurship instead of direct financial support, as mentioned in the new rural development model, and the last and important item for this study is the development of ICT (Information and Communications Technology) infrastructure, which is a transportation and technological infrastructure (OECD 2006).

Various changes such as the development of technology, increased accessibility, the emergence of rural-urban transition zones, transformations in rural areas and changes in working habits have enabled the development of a new era in rural development. With the change in the perspective on rural development, new concepts called “new rural paradigm” (OECD 2006) and “new rurality” (Delgado-Viñas and Gómez-Moreno 2022) started to emerge. In the new approach, rural settlements are considered spatially rather than sectorally, focusing on the full potential of the region. According to this approach, financial support is provided on the basis of investment rather than direct financial support (OECD 2006).

Advancements in technology have had a profound impact on settlements, leading to the emergence of new concepts in both theory and practice. The rise of technology has brought about innovative approaches to urban planning, with the concept of the "Smart City (Akıllı Şehir)" gaining popularity (Yang and Zhen 2024). As interest in smart cities grows, attention is now turning to how technology can address the needs of rural areas. This has given rise to the concept of the "Smart Village (Akıllı Köy)", which differs from a smart city in various ways such as unique challenges faced by rural communities and different demographic profiles. The idea of a "smart village" is different from that of a "smart city" in several ways. Firstly, urban and rural communities face different challenges (Bokun and Nazarko 2023; Imron and Nababan 2022). Secondly, the demographics of urban and rural areas vary significantly and requiring different perspectives. Lastly, villages are unique, regional communities, requiring a tailored approach to the smart village concept (Zhang and Zhang 2020). The concept was first encountered in the literature in N. Viswanadham and Sowmya Vedula's study, titled "Design of Smart Villages," which was published in 2010 (Viswanadham and Vedula 2010). The objective of this report is to elucidate the ecosystem of the smart village concept. Prior to this report, numerous organizations and projects had been engaged in the development of smart villages. However, the first academic study on the subject was not published until 2010 (Bokun and Nazarko 2023). In 2015, T. van Gevelt and J. Holmes conducted a study analyzing the potential of technological innovation to support social and economic development in rural areas (Van Gevelt and Holmes 2015). The Cork 2.0 Declaration document published by the European Commission in 2016, under the theme "A Better Life in Rural Areas", addresses the concept of smart villages as a means of improving the quality of life and sustainable development of rural areas (Martinez Juan and McEldowney 2021). This document emphasizes the importance of rural areas by referring to the United Nations Sustainable Development Goals and the outcomes of the Framework Convention on Climate Change.

This study is expected to contribute to the concept of smart village which is seen as a new rural development tool. The fact that rural areas differ in terms of sectoral structure, social structure, and the problems rural areas face and have a heterogeneous structure shows the necessity of a comprehensive study on a local scale (Özden 2022). The main purpose of the study is to contribute to the concept of smart village, which has the principle of ensuring development in rural areas through technology, and to try to

increase opportunities in rural areas by understanding the place of the concept in our country. With spatial analyses, it is aimed to reveal the applicability of the smart village concept in our country and to determine the multidimensional location-specific indicators of the smart village concept, which has location-specific characteristics. With this study, it is attempted to contribute to the development of policies and strategies to be implemented in rural areas in a more location-specific and effective manner by using integrated analyses. This is important in terms of better understanding rural development processes and finding solutions to local needs. The fact that potential investments that will contribute to rural development are based on developed settlements further increases the existing development gap and increases inequality between settlements. In this study, it is attempted to contribute to reducing the development gap between rural settlements by focusing on regions with development potential instead of currently developed regions. The results of the analysis and the approaches used in this study will help policymakers and local governments make more effective decisions by providing a framework for determining the development potential and appropriate strategies for development in rural areas. With integrated analyses and innovative approaches, it provides an important roadmap for better understanding the social, economic, and technological transformations in Türkiye's rural areas and strengthening development efforts in these areas. In this way, it is thought to guide all policymakers and researchers who want to use the smart village concept as a rural development tool. The research questions of the study are structured as follows:

- How can the applicability of the smart village concept be assessed in different rural areas of Türkiye?
- What is the impact of subjective and objective weighting methods on the results?
- Which dimensions and indicators can be used to determine the applicability of the smart village concept in rural areas?

In the first part of this study, the emergence of the urban-rural distinction is discussed and the concept of rurality, which is important for the study, is introduced. The formation of cities and the historical development of the distinction between urban and rural areas are discussed. In this process, a better understanding of the current situation is provided by addressing the problems that rural areas have started to experience. In addition to the problems faced by rural areas, the concept of rural development, which

has become increasingly important over time in order to develop solutions to these problems and the problems of excessive urbanization in cities, has been introduced. However, concepts such as the definition of rural areas, the definition of urban areas, the concept of rural development and urbanization are topics that require more detailed research. The first chapter aims to provide an overview of these concepts. At the end of the first chapter, the emergence process of the smart village concept, which has increased in importance in the last period of rural development studies and is the research subject of this study, is mentioned. In the second part of the study, the definitions of rural areas in the world and the process Türkiye have gone through in the development of the definition of rural and urban areas are presented. The practices that have a significant impact on rural areas of Türkiye have been evaluated and their current results have been mentioned. The problems experienced in rural areas in Türkiye and around the world are presented and the interrelatedness of these problems is tried to be understood. In order to better understand the development process of rural development practice, development plans and development strategy reports from past to present have been evaluated. Finally, the literature on the concept of smart village is discussed in detail and the development of the concept, the variables discussed in the literature, the benefits and challenges of the concept are discussed. In the third section, the dataset and methodology of the study are presented. In addition, the methodology of the study and the MCDM methods used in the study are discussed. The fourth section presents the results of the study. Initially, the data of the variables are spatialized and interpreted. In the next stage, the weighting results and potential analysis results of the variables obtained in the methods used are given. After the results are evaluated, the results of the study carried out in the selected sample area are given. In the fifth section, the results obtained are discussed together with the literature and a new evaluation is presented. The aspects of the findings that support and differ from the literature are evaluated. In the sixth section, the results are interpreted according to the research results and the main conclusions are given.

CHAPTER 2

LITERATURE REVIEW

2.1. Change in the Definition of “Rural”

Today, population density, administrative boundaries and total population are among the commonly used methods of definition. However, over time, these definitions were considered to be non-functional. Apart from these methods, different definitions are also being developed (Moreddu 2008). The “Everyday Approach to Rurality” [EAR] is one of the approaches used to define rurality (Johansen and Nielsen 2012). Johansen and Nielsen (2012), utilize the spatial distribution of open land to define rurality. Rural areas are classified as the settlement core and the open land around it, while urban settlements are classified as the settlement core and its sub-settlements. Rural settlements around sub settlement centers are considered “more” rural than rural settlements around the urban settlement core. In addition, the number of rural settlements along the route from the urban center to the rural settlement is used as a second criterion. Passing through more rural settlements means that the destination settlement is more rural (Johansen and Nielsen 2012). Some studies measure lighting with remote sensing to analyze urban areas (Wineman, Alia, and Anderson 2020). Through the index created with this method, results can be obtained beyond just rural-urban analysis (Roca and Arellano 2017).

The initial definition of rural and urban areas in Türkiye was established in 1924, based on population size. In Article 1 of the Village Law No. 442 (1924), settlements with a population of less than 2,000 were designated as "village(köy)" localities with a population between 2,000 and 20,000 were designated as "town(kasaba)," and localities

with a population of more than 20,000 were designated as "urban(şehir)". In 2012, with the Law No. 6360 on the Establishment of Metropolitan Municipalities in Fourteen Provinces and Twenty-Seven Districts and Amendments to Certain Laws and Decrees with the Force of Law, which entered into force during the Ninth Development Plan period, rural settlements in a certain number of provinces were transformed into neighborhoods. According to the results of the Address Based Population Registration System (ABPRS), the “rural” population rate, which was 27.7 percent in 2012, dropped to 13.3 percent in 2013 after this regulation. With the regulation, cities without rural population were formed and the definition of rural-urban became unclear (Republic of Türkiye Ministry of Agriculture and Forestry 2021). The Figure 2.1 is created according to TurkStat data clearly shows the change in the number of villages after this law. In 2012, in the context of this uncertainty, the Presidency of Türkiye, Presidency of Strategy and Budget, assigned the responsibility of revising the rural-urban definition to TurkStat with the Eleventh Development Plan (2019-2023). In 2023, TurkStat published a new rural-urban definition based on the OECD (Organisation for Economic Co-Operation and Development) definition (TurkStat 2023b). The revised definition distinguishes between three categories of settlements: dense urban, medium-dense urban, and rural.

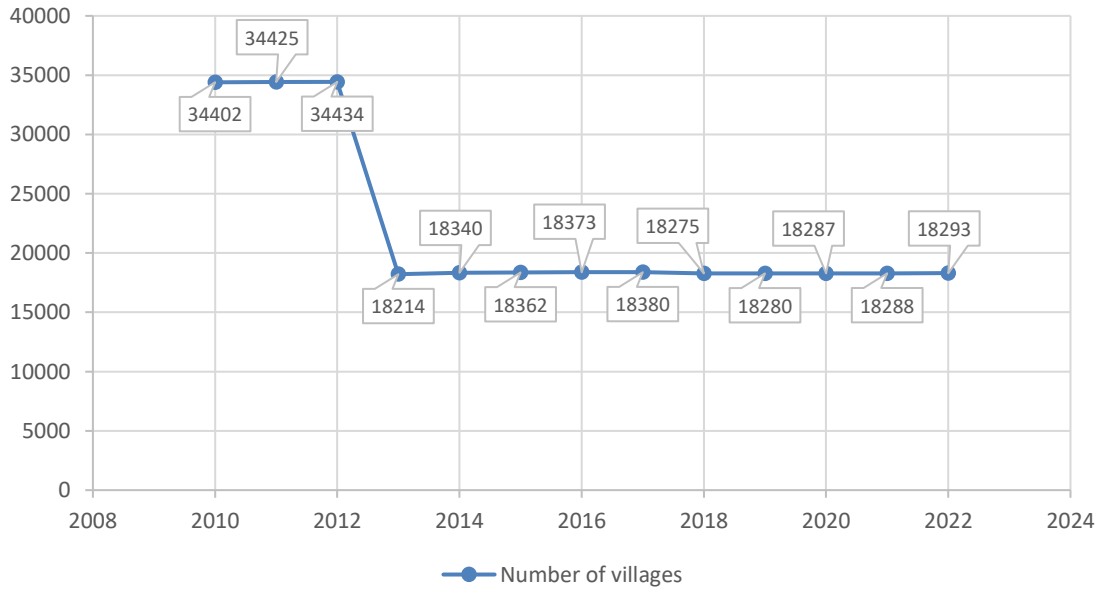


Figure 2.1. Number of Villages by years in Türkiye (Source: Author work based on Address Based Population Registration System (ABPRS) Results)

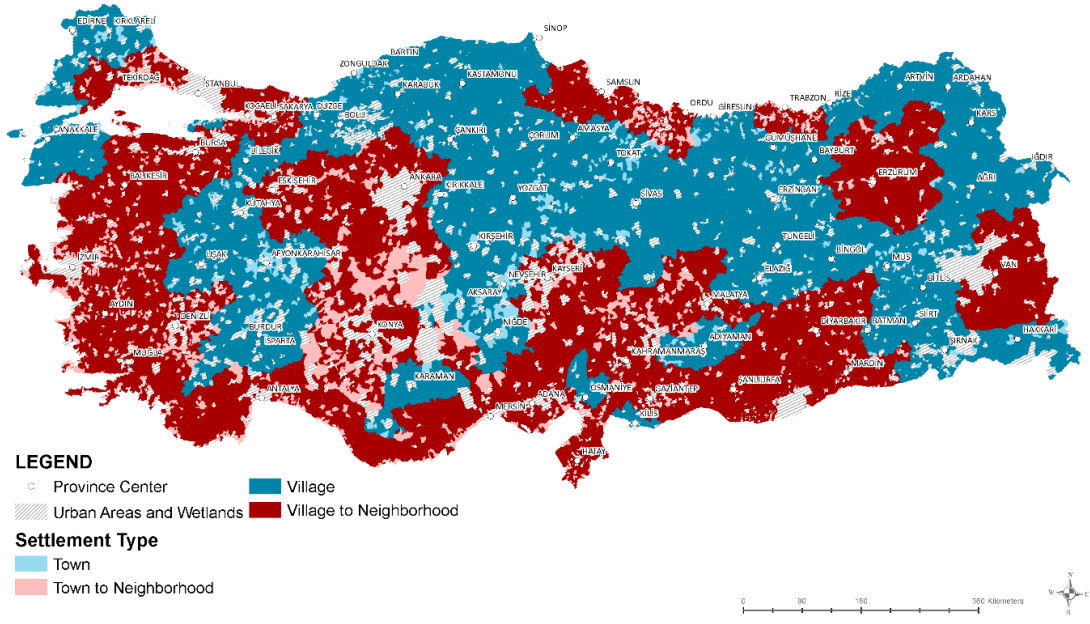


Figure 2.2. Rural Settlements Status According to YER-SİS (Source: Author work based on YER-SİS)

The studies carried out in the YER-SİS (Urban and Rural Settlement Systems in Turkey - Türkiye'de Kentsel ve Kırsal Yerleşim Sistemleri Araştırması Projesi) project included the villages that were transformed into neighborhoods within the scope of No. 6390 within the scope of rural settlements. The status of rural settlements in the YER-SİS project is given in Figure 2.2. According to the project, four statuses were determined as town (belde), town to neighborhood (beldeden mahalle), village (köy), and village to neighborhood (köyden mahalle).

In order to eliminate the uncertainty in the rural-urban definition created by Law No. 6360, which entered into force in 2012, the responsibility of creating a definition in the Eleventh Development Plan was assigned to TurkStat. In 2023, according to the definition of rural-urban developed by TurkStat, settlements are divided into 3 classes: dense urban, medium dense urban, and rural. This division aims to create statistics in line with international standards. According to this new definition made by TurkStat (2023b), *Dense urban refers to settlements where at least 50% of the population lives in urban center grids, while medium dense urban refers to settlements that do not meet the conditions of being dense urban and rural, dense urban and rural.* According to TurkStat

(2023b) data, settlements defined as dense settlements represent 1.6% of the country's surface area and 67.9% of the population lives in these areas. Settlements defined as rural areas have an area of 93.5% and only 17.3% of the population lives in these areas.

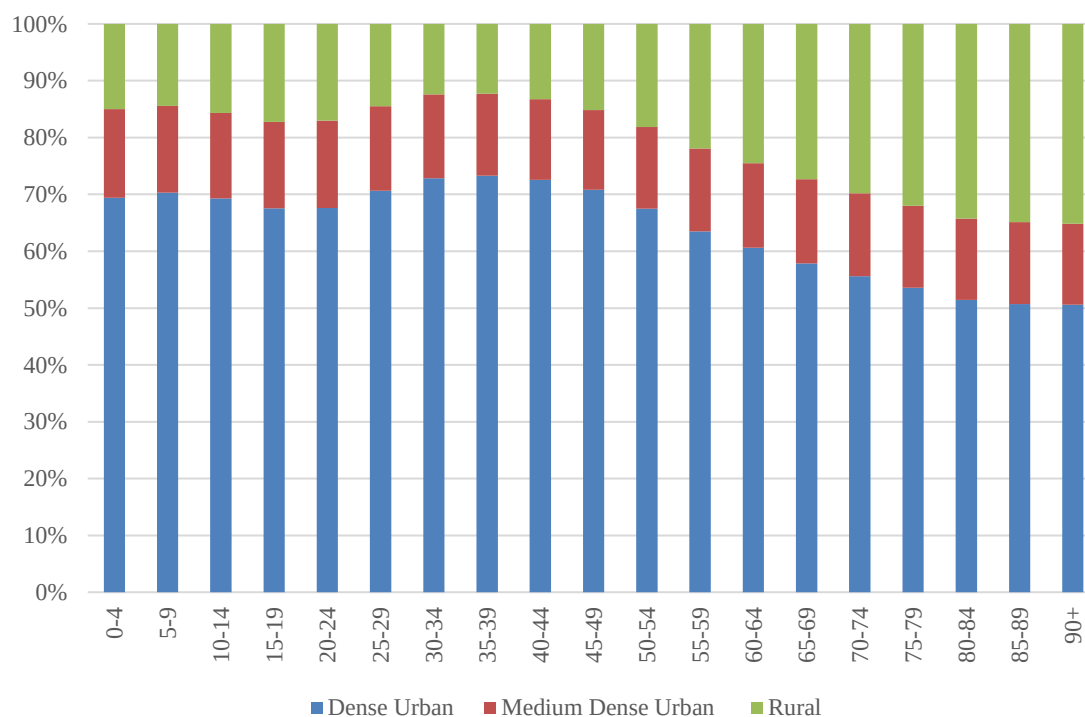


Figure 2.3. Population by urban-rural classification, age group, 2022 (Source: Author work based on TurkStat, Urban-Rural Population Statistics, 2022)

TurkStat analyzed the distribution of population groups according to the newly defined classes in the rural-urban divide (Figure 2.3). In general, the majority of all age groups live in dense urban areas. The proportion of the population aged 35-39 and above is higher in rural areas than in other population groups. In this case, it can be interpreted that the average age is high in rural areas. The aging of the population in rural areas and the migration of the young population to urban areas feed the cycle of rural decline. Considering the uncertainties of definition and status in rural areas, the disadvantages caused by this situation, and the current problems faced by rural areas, the necessity of effective tools emerges.

2.2. The Cycle of Decline in Rural Areas

Since the rapid growth of industrialization and urbanization, rural areas have not been at the center of these processes and have lagged behind in terms of economic development and social progress. While population growth and related issues persist in urban areas, rural areas are experiencing a rapid decline in population. The population decline trend in rural areas is illustrated in Figure 2.4 (United Nations 2018).

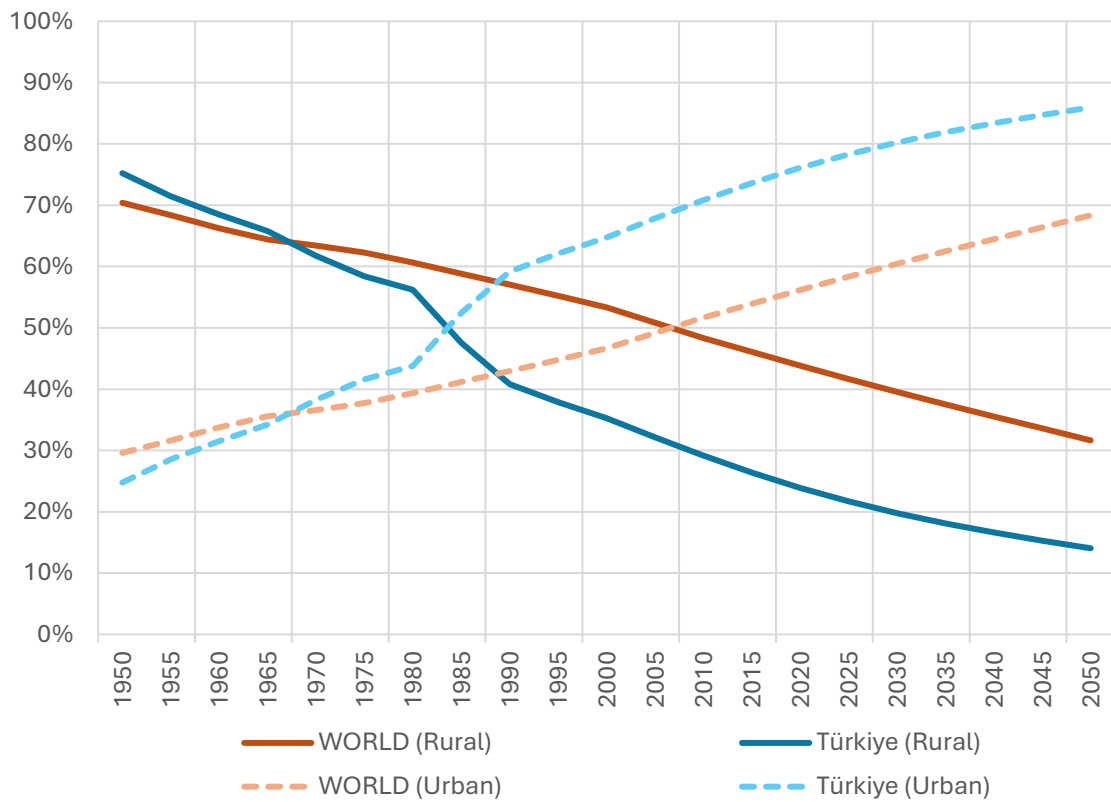


Figure 2.4. Rural Population Change Between 1950-2050 (Source: United Nations, (2018))

This recession has caused various social and demographic problems. In particular, factors such as the abandonment of rural areas by young people, increased outward migration and the increase in the proportion of the elderly population have led to a deterioration in the social balance in rural areas (Martinez Juan and McEldowney 2021). This has further weakened local economies. Due to economic decline and low population

density, access to services, infrastructure and markets in rural areas has not been sufficiently developed and this has developed as a push factor for rural areas (World Bank 2021). Limited access to basic infrastructure and services disadvantages young people living in rural areas compared to those living in urban areas (Şerban and Brazienė 2021). The European Network for Rural Development (ENRD), refers to this situation, in which negative conditions in rural areas feed each other, as the “circle of rural decline” (ENRD 2018). The cycle of decline in rural areas and the problems faced by rural areas mentioned in the literature are given in Figure 2.5. The problems in the literature cover 6 dimensions as spatial, demographic, social, economic, service and management. Relationships between these dimensions in terms of causality are not included in the diagram. The rural decline cycle is observed to address four dimensions including spatial, demographic, economic and service. These unfavorable conditions in rural areas increase the pressure on urban areas as the population migrates to cities (Eversole 2018; Şerban and Brazienė 2021) That is because rural and urban areas are mutually feeding and constantly interacting with each other (Górecka, Ježić, and Kardum 2021). Various rural development activities are being carried out in order to break this vicious cycle that started with the attraction of cities and the decline of the economy and production in rural areas and to redevelop rural areas (Martinez Juan and McEldowney 2021). In recent years, issues such as environmental problems and food security have also encouraged the acceleration of rural development efforts. The global demand for food and the necessity for the efficient use of resources are intensifying the pressures on sustainable agricultural activities and proper food production in rural areas. (Giller et al. 2021). The Food and Agriculture Organization (FAO), an agency of the United Nations that works on issues such as food security, published the report *The Future of Food and Agriculture: Trends and Challenges* in 2017. This report mentions the challenges that have been identified in the field of food and agriculture (Food and Agriculture Organization 2017). Consequently, rural development initiatives should be accorded greater priority in the context of environmental and agricultural sustainability objectives.

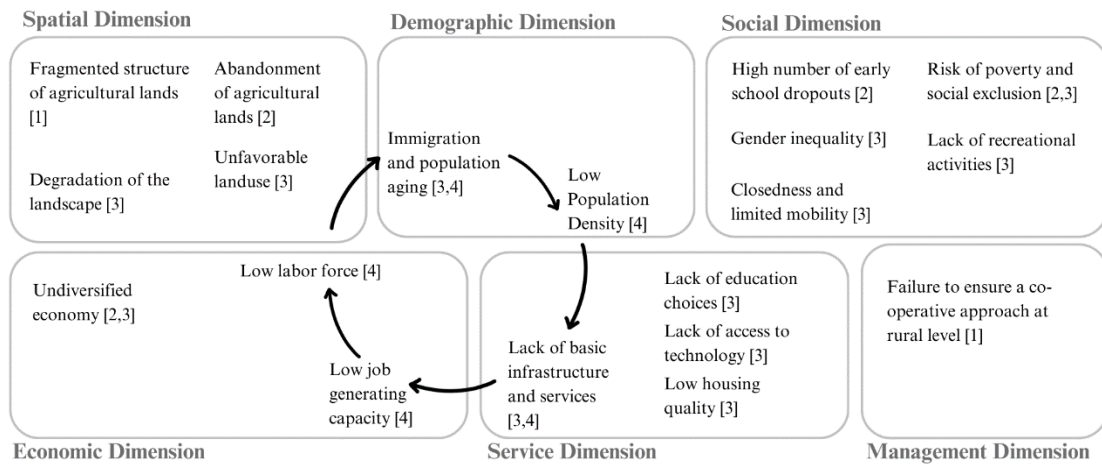


Figure 2.5. Issues in Rural Areas (Source: [1] (Çelik 2005) , [2] (Martinez Juan and McEldowney 2021), [3] (Adamowicz and Zwolińska-Ligaj 2020), [4] (ENRD 2018)).

Türkiye's rural areas face similar problems as other rural areas around the world. In the Türkiye National Rural Development Strategy (2021-2023) Report, these problems are analyzed in two categories: internal parameters and external parameters. The term "internal parameters" are used to describe the repulsive aspects of rural areas, whereas "external parameters" are applied to the attractive aspects of urban areas. In addition to the problems mentioned in the report, rural communities in Türkiye also face different difficulties. These include carrying out rural development initiatives using a top-down methodology, ignoring the critical stages of monitoring and evaluation, and failing to take into account the distinctive qualities of each settlement (Yılmaz et al. 2010). In addition, the large number and spatial dispersion of rural settlements, the fragmentation of agricultural lands due to inheritance, etc., and the lack of cooperative understanding affect the economic development of rural areas, and these situations trigger rural-urban migration (Çelik 2005).

2.3. The Evolution of Rural Development in the Legislation of Türkiye

Comprehensive policies and strategies need to be developed to solve problems in rural areas and ensure economic, social and environmental sustainability. In order to fully

utilize the potential of rural areas, there is a need for comprehensive and long-term development projects and policies that encourage local participation, strengthen local resources and capabilities, and focus on the needs of rural communities. Therefore, rural development is indispensable for supporting the development of rural areas, increasing the welfare of rural communities, and reducing inequalities between rural and urban areas. However, during the implementation of rural development initiatives, financial resources and investment are frequently directed to developed rural areas rather than underdeveloped regions. This can lead to a widening of the development gap between rural areas (Górecka et al. 2021).

Various policies and strategies are being developed to address these problems in rural areas. The spread of technology in the contemporary era has led to technological developments and innovations not only in agriculture, but also in every aspect of our lives. Policies have also been affected by this change and have included technology in their strategies. In this sense, it is important to examine and observe the ongoing policies. Development plans and strategic reports were examined in order to observe policy changes in the use of technology in rural areas. In the Eighth Five-Year Development Plan covering the years 2001-2005, the use of technology for agricultural areas has started to be considered. According to Article 1279, under the title of General Agricultural Policies, it is stated that "*...measures to accelerate technological development...*" will be implemented. It is also indicated that information systems such as the "*Farmer Registration System, Land Registry and Cadastral System, Geographical Information System and Farm Accounting Data Network...*" will be developed.

Although it is not possible to mention digitalization in agriculture exactly in the articles mentioned here, it will be useful to take into consideration as it deals with the use of information systems in rural areas. The Ninth Five-Year Development Plan (2007-2013) refers to e-commerce activities to provide development in rural areas. Article 752 of the Tenth Five-Year Development Plan covering the years 2014-2018 mentions the works carried out in the field of agriculture, such as the establishment of agricultural technoparks and studies on renewable energy in the past period. In Article 756, it is stated that it is aimed to create an agricultural sector based on advanced technology. In the Eleventh Development Plan (2019-2023), the agriculture sector is identified as a priority development area. Article 416.4 states that smart agricultural technologies will be developed and supported. In the recently published Twelfth Development Plan (2024-

2028), which covers the current period, the agriculture sector maintains its status as a priority development area. The report includes articles on establishing the necessary infrastructure for the use of technology in the agricultural sector and rural areas (Presidency of the Republic of Türkiye Presidency of Strategy and Budget 2023).

The Rural Development Action Plan (2015-2018), which is prepared based on the National Rural Development Plans, underlines public-private co-operation in the technological field and practices that will increase productivity in agricultural production. Within the scope of the measure 3.1.4, project targets related to technological infrastructure works are included. In the 2014-2020 National Rural Development Strategy, the use of technology is mentioned in the measures to be taken for "Physical Infrastructure Development". On the other hand, the National Rural Development Strategy (2021 - 2023) has reflected the use of technology in the agricultural field and sustainability in the strategies and addressed it in more detail. The development of information technologies in rural areas is among the main objectives of the document. Unlike previous periods, this report includes the title "Agriculture and Technology". Under this heading, the current situation and projects are mentioned. In the measures to be taken for the determined strategies, the steps to be taken on the development of agricultural technology and technological infrastructure are mentioned. The fact that the researches, official reports, and projects in the field of rural development have been targeting the same items for a long time shows that the desired development in the field of rural development has not yet been achieved. According to the research results, new approaches, policies, models and tools are needed (Republic of Türkiye Ministry of Agriculture and Forestry 2021).

2.4. Smart Village Concept

The Smart Village concept, which has recently gained popularity, has begun to be accepted and adopted by many organizations. ENRD (European Network for Rural Development), supported by the European Commission and coordinating efforts for sustainable development in rural areas, focuses on the development and implementation of the smart village concept. These actions aim to promote the use of innovative technologies and digital solutions in rural areas. ENRD offers policy recommendations for rural communities and businesses to adapt to and make the most of the digital

transformation (ENRD n.d.). The Bled Declaration, published by the European Parliament in 2018, proposes smarter solutions for the future of the EU's rural areas. It emphasizes that rural areas should be supported by sustainable development, digital transformation, and innovation (European Commission 2018a). The “Smart Rural 21 project”, supported by DG AGRI, the European Commission responsible for rural areas, was launched between 2019 and 2022. The aim of the project is to promote the use of digital technologies in rural areas. Smart Rural 21 has implemented various activities to develop smart villages and increase innovation capacity in rural areas. Launched in 1962 and continuing until today, the CAP (Common Agricultural Policy) is an agricultural policy implemented by the European Commission, the last of which entered into force on January 1, 2023. The CAP plans to support the sustainability and competitiveness of the agricultural sector. Based on the smart village concept, the policy promotes digital transformation in the agricultural sector and aims to preserve the economic, environmental, and social diversity of rural areas.

The concept of smart village emerged from the concept of smart city and its theoretical definition is still under development. First of all, it should be noted that this concept is not a solution to all obstacles to rural development, but a tool developed as an alternative to existing solutions (Atkočiūnienė and Vaznonienė 2019; X. Zhang and Zhang 2020). Viswanadham and Vedula (2010) defines a smart village as "*a bundle of services provided effectively and efficiently to its residents and businesses*". According to ENRD definition:

Smart Villages are communities in rural areas that use innovative solutions to improve their resilience, building on local strengths and opportunities. They rely on a participatory approach to develop and implement their strategy to improve their economic, social and/or environmental conditions, in particular by mobilizing solutions offered by digital technologies.
(European Commission 2019)

The EU Action defines smart villages as:

... rural areas and communities which build on their existing strengths and assets as well as new opportunities to develop added value and where traditional and new networks are enhanced by means of digital

communications technologies, innovations and the better use of knowledge for the benefit of inhabitants.” (European Commission 2018b).

Zhang and Zhang (2020) define the smart village concept as a rural development model in which ICT is effectively utilized in order for the village to achieve its sustainable development goals.

The Smart Village concept focuses on creating effective solutions that meet the needs of society and make efficient use of available resources. Many authors in the literature advocate the Smart Village concept and highlight key strategies for successful implementation. These strategies include prioritizing a local (Nieto and Brosei 2019) bottom-up and collaborative approach to building and advancing smart villages. It is critical that smart villages are tailored and operated to meet the specific needs and preferences of the local community. The local approach ensures that solutions are consistent with local traditions and beliefs by involving residents in decision-making and implementation processes (Zavratnik et al. 2018). Rural heterogeneity is mentioned as a challenge in China's smart village implementation initiatives. Challenges arise due to differences in villages' existing problems and economic models (X. Zhang and Zhang 2020). As a result, in order to successfully implement the smart village concept, different methods should be created according to the benefits, challenges, opportunities, and characteristics of each village. (Visvizi and Lytras 2018). Before the implementation phase, it is important to assess and identify communities using a comprehensive database. It is also believed that the Smart Village concept can be implemented more effectively through the development of local policies. These policies should be appropriately formulated by rural development experts and developed in consultation with local stakeholders. In this way, Smart Village applications are intended to achieve better results in terms of sustainability and success (Anastasiou et al. 2021; Atkočiūnienė and Vazonienė 2019; X. Li et al. 2022; Pérez-delHoyo and Mora 2019). The bottom-up approach allows policymakers and decision-makers to base their actions on the views and needs of local people. The importance of the bottom-up planning approach has been emphasized many times in the literature. This technique is based on the idea of a practice in which stakeholders in rural areas interact, exchange, and integrate information (Górecka et al. 2021). In addition, the importance of rural community participation in smart village projects is emphasized. As a result, it is recognized that policies in smart village applications are holistic, community-oriented, bottom-up approaches that promote

social innovation (Fernández and Peek 2023). It is essential that rural communities actively participate in the implementation processes and guide the process by sharing their preferences and needs (Zavratnik et al. 2018). A collaborative approach is an approach that allows multiple stakeholders to work together to achieve common goals by sharing their expertise, resources, and experience. Many stakeholders, including local communities, government agencies, the commercial sector, civil society organizations, and academic institutions, need to collaborate on smart village projects (Viswanadham and Vedula 2010; World Bank 2021). Wolski and Wójcik (2019), in its recommendations for the implementation of the smart village approach at the local level, refers to cooperation as horizontal relationships (other villages) and vertical relationships (other institutions managing development at other levels). The collaborative approach plays a critical role in achieving the goals of smart villages such as sustainable development, social inclusion, and quality of life. In particular, it is essential that this concept is supported by policy. Therefore, policymakers have an important role in co-operation. A study conducted in China revealed that DVI (Digital Village Index) tends to increase thanks to the political support of the local government (X. Li et al. 2022).

2.4.1. Dimensions and Variables

Effective monitoring and assessment are essential for the design, implementation, and assessment of smart villages. Indicators offer a strong and quantifiable foundation for examining these smart village projects' effectiveness, sustainability, community involvement, and environmental impact from an academic and professional standpoint. A smart village project's planning, design, implementation, and management are all guided by indicators, which also help to enlighten decision-makers, governments, civil society organizations, and other interested parties. In this context, the literature review concentrates on the creation, application, and evaluation of indicators utilized in smart village monitoring and assessment. There is no standard measurement system because the idea is novel and place specific. Every study might have unique indicators (Atkočiūnienė and Vazonienė 2019). Smart village dimensions in the literature are given in Table 2.1.

Table 2.1. Smart Village Main Dimensions in Literature

Source	Main Dimensions
(Viswanadham and Vedula 2010)	Resources
	Institutions
	Service Delivery Technologies and Mechanism
	Service Chains
(Ramachandra et al. 2015)	Resources
	Institutions
	Technology
	Sustainability
(Maja et al. 2020)	Energy
	Telecommunication
	Culture
	Economy
	Environment&Safety
	Housing
	Education
	Healthcare and Recreation
	Finance
	Transportation
(Adamowicz and Zwolińska-Ligaj 2020)	Management
	Life Quality
	Economy
	Society
	Natural Environment
	Mobility
(World Bank 2021)	Economic Sources for Local Development
	Infrastructure and Services
	Human Capital
	Economic potential
	Governance

Viswanadham and Vedula (2010) created a ‘Smart Village Ecosystem Diagram’ by evaluating stakeholders, resources, necessary services and technologies to be provided for the service together. Necessary sub-headings are given under four main headings that need to be integrated for the smart village system to work. Indicators related to spatial structure such as agricultural structure, water resources, energy resources, power resources, and educational institutions are evaluated under the heading ‘resources. Ramachandra et al. (2015) adds the dimension of ‘sustainability’ instead of ‘service

chains’ and includes concepts such as decentralized approach, zero pollution, long-term planning, efficiency, and feasibility as sub-headings. In the ‘technology’ dimension, it emphasized sustainability by addressing the user-friendly approach. In addition, under the heading of technology, topics such as low budget, efficiency, ease of maintenance are included, emphasizing the features that support the sustainability of the concept.

Maja et al. (2020) developed indicators for smart rural villages using existing research in the literature and the ISO 37122 smart cities indicator standard. Smart village targets belonging to each dimension are listed and sub-indicators that can be used in their measurement are defined. The indicators created as a result of the research are evaluated in three categories: smartness, sustainability and technology. It was stated that the ‘energy’ dimension, which is also among the sustainable development goals (SDGs), is important because it ensures the applicability of technological solutions. As a result of all the researches carried out, six main dimensions, namely management, quality of life, economy, society, natural environment, and mobility, and 24 sub-indicators belonging to these six dimensions are identified. The World Bank aimed to create SVR (Smart Village Readiness) Index by conducting a spatial study for Azerbaijan in 2021. In the study, 5 main dimensions, namely ‘Economic Resources for Local Development, Infrastructure, and Services, Human Capital, Economic Potential, Governance’ were evaluated (World Bank 2021).

The local scale indicators obtained from the literature are analysed through the following four dimensions: ‘spatial structure’, ‘social capital’, ‘economic structure’ and ‘services and infrastructure’. First of all, spatial structure is a dimension that is a direct factor in rural development since it also affects economic activities. It may be necessary to determine different strategies to ensure the development of regions that are disadvantaged in terms of spatial area. According to a study conducted in Poland, agricultural and spatial structure are the main factors that have a significant impact on rural economic conditions. This structure includes elements such as farm size and distribution, ownership structure, land use and soil quality (Bielska et al. 2021). In addition, proximity to big cities is considered as an important requirement for rural Development (Bielska et al. 2021). The National Rural Development Strategy for rural areas in Türkiye (2021-2023) report also emphasizes the importance of distance from urban areas in the transformation of rural areas due to the impact of the rural-urban relationship. The report states that settlements far from urban areas will undergo a slower

socioeconomic transformation, while settlements close to urban areas will undergo a faster socioeconomic transformation. This is because the ability to obtain specialized services, information technologies, institutions and other resources necessary for network development decreases with distance from urban areas (Adamowicz and Zwolińska-Ligaj 2020). In this context, the further rural communities are geographically removed from urban centers, the more challenging they find it to meet their needs. Rural communities depend on urban areas to provide them with essential services (such as education and healthcare) and economic opportunities (Boncinelli et al. 2015; Górecka et al. 2021). While distance to urban areas is considered an important parameter in most sources, H. Li et al. (2022) states that development of cities in close proximity to rural areas will have a negative impact on rural settlements. It is stated that rural areas near developed cities may become less rural and more urbanized over time. It can also create the risk of attracting the rural population to the city (OECD 2006). Boncinelli et al. (2015) found that the distance to the provincial center is not important in the analysis results. Since provincial centers are likely to be used only for the provision of missing services, this criterion is considered as a secondary factor (Boncinelli et al. 2015). Considering the place-based characteristics of rural areas, it is reasonable to foresee that the importance of indicators will differ between geographies. The second criterion considered in the spatial structure is agricultural characteristics. In particular, it is important to recognize the structure of agriculture, and the economic structure associated with it before applying the concept. Bielska et al. (2021) is stated that many criteria related to agricultural structure such as areas where regional products are produced, areas where family farms are located, soil quality should be taken into consideration. In addition, settlements located on plains are more advantageous in terms of socio-economic development than settlements located on slopes or mountainous regions (Özden 2022). The existence of alternative income opportunities is also an important parameter in terms of development as it will contribute positively to the economic vitality of a settlement (Özden 2022). As a result, agricultural and spatial structure analysis is an important component that should be included in decision-making processes in initiatives such as smart rural development projects. These variables affect the rural development potential of a settlement in many ways.

One of the important criteria for the successful implementation of the Smart Village concept is social capital. Smart village projects are not limited to the

establishment of technological infrastructure and the development of the information environment. The capacity of villagers to adopt and use these technologies, the level of digital technology and economic development capacity should also be considered (X. Li et al. 2022). In this context, the success of Smart Village projects depends on the social capital of the villagers (Komorowski et al. 2020; Slee 2019). Strong relationships, co-operation and social solidarity among villagers can ensure the successful continuation of projects. In addition, the age factor should also be considered as a sub-criterion of social capital. The age factor can significantly affect the rate of technology adoption (Satola et al. 2022). In addition to the importance of social capital in the creation and maintenance of smart villages, existing literature suggests that community size should also be considered. The reason for this is the idea that the manageability of large communities may decrease, and coordination may weaken during the implementation phase (Zavratnik et al. 2020). Population density parameter is also shown as an important parameter (X. Li et al. 2022).

Current situation analyses are important in terms of supporting economic development, which is one of the main objectives of the smart village concept, one of the rural development tools. Evaluating the investment environment before the implementation phase is seen as an important step in the literature (Viswanadham and Vedula 2010). In the study conducted by the World Bank on Azerbaijan, the 'Economic Potential' dimension is addressed with 3 different variables: market access, access to financial services and concentration of enterprises (World Bank 2021). It is seen that the variables addressed in the economic dimension related to smart villages are based on revealing the place-specific economic potential of the rural settlement, determining the sectoral trend and evaluating the existing problems.

Another dimension evaluated in the smart village concept is basic services and infrastructure. When the service dimension is analyzed in the literature, it is seen that the existence of basic services such as education, health, etc. in rural settlements is considered as a potential. The accessibility of education is an important criterion especially in this concept where social capital is important (Viswanadham and Vedula 2010). Boncinelli et al. (2015) concludes that limited access to health services and kindergarten has a significant impact on the proportion of the young population, but access to middle and high school does not. In addition, the services and infrastructure dimension include indicators such as infrastructure, access to clean water, electricity, transport and internet

(World Bank 2021). High accessibility positively affects the applicability of the smart village concept, as it affects many situations such as transport, access to services, market access and rural-urban interaction. It is stated in the literature that the differences in infrastructure affect the development of smart villages and especially the internet infrastructure studies are in parallel with the clustering of smart village development (X. Li et al. 2022). The internet infrastructure, which has become indispensable today, also positively affects this concept, which has an innovative structure and addresses the information society. A study conducted in rural settlements in Poland, suggested that there is a positive relationship between internet access and development level. According to the research, it is observed that internet access is also high in regions with high level of development (Komorowski et al. 2020). It is stated that there are studies in Europe to consider internet infrastructure as basic infrastructure (Dobrotă, Simescu, and Turek-Rahoveanu 2020). In the National Rural Development Strategy (2021-2023) report puts practice in Türkiye, it is stated that digital infrastructures such as broadband internet should be established in rural areas within the scope of ‘Improving the Social and Physical Infrastructure of Rural Settlements’. While evaluating the infrastructure dimension, energy criterion has been considered as a basic requirement by many studies. Zavrtnik et al. (2018) stated that access to energy resources is an important issue when creating development strategies. The existence of energy resources can be considered as a potential variable in terms of facilitating the implementation of technologies belonging to the smart village concept, contributing to access to basic services, etc. (Fernández and Peek 2023). It is stated that solar energy is used as the main energy source in these studies that attach particular importance to sustainable energy (Watson and Watson 2019)

2.4.2. Benefits and Challenges

Solutions to long-standing problems in rural areas are attempted to be produced with various policies and tools. Smart village concept is one of these tools. It is thought that the driving factors of rural areas are effective on the agglomeration in urban areas. In this case, this concept has the potential to reduce the impact of push factors by developing solutions to the problems experienced in rural areas. Despite the rapidly developing digital transformation in cities with the smart city concept, it is seen that an equal development cannot be achieved in rural areas and in this sense, rural areas continue to

lag behind urban areas (Roidatua and Purbantara 2022). In addition to developing the capacity of rural areas, it can also be a solution to the problems arising from the intense interest in cities (Ploder et al. 2022). Studies have shown that rural settlements that use technology show rural economic development and entrepreneurship activities carried out in digital areas contribute to this development (Mei et al. 2022). In order to evaluate the effectiveness of smart villages in the process of achieving balance in urban and rural areas, a study in China is carried out by evaluating the data of 31 provinces between 2015-2020. According to the results of the study, smart villages are effective in the process of achieving balance in urban and rural areas over time, but they need to be developed continuously as some challenges are encountered (Cao et al. 2022).

Table 2.2. Experienced/Expected Benefits of Smart Village Concept

Dimension	Experienced/Expected Benefit	Source
Ecological	Positive impact on the environment	(Kasinathan et al. 2022) (ENRD 2018) (Chowdhury et al. 2023) (Bielska et al. 2021)
	Raising awareness of farmers and reducing food waste	(Ilham et al. 2022)
	Increased entrepreneurship activities and investments	(Mei et al. 2022)
Economic	Increased investments	(World Bank, 2021)
	Increased efficiency in production	(Hackfort 2021) (Ilham et al. 2022) (Górecka et al. 2021)
	Increase in producer profits and market growth	(Górecka et al. 2021) (Bielska et al. 2021) (World Bank 2021)
	Data collection	(X. Zhang and Zhang 2020)
	Improving services and increasing access	(World Bank 2021) (ENRD 2018) (Fernández and Peek 2023)
Demographic	Young population staying in rural areas	(Satola et al. 2022) (World Bank 2021)

In order to understand how this concept will play a role in breaking the chain of ongoing problems in rural areas, it is necessary to address the benefits and solution potentials of the concept (Table 2.2). Various existing benefits and potential benefits of

the concept are mentioned in the literature. Firstly, digital agriculture, which is considered as a subheading of the smart village concept, increases productivity in agriculture through the use of technology (Hackfort 2021). Digital agriculture studies used in the smart village concept include applications such as monitoring climate conditions, greenhouse automation, crop management, animal monitoring and management, soil quality control, pest control, end-to-end farm management systems, smart irrigation (Chowdhury et al. 2023). It is stated that an increase in product yield is achieved in the applications put forward with digital agriculture (Ilham et al. 2022). Another benefit of digital agriculture is that it ensures proper management of resources (Chowdhury et al. 2023). Kasinathan et al. (2022), states that the concept may have a positive impact on climate change. The concept is expected to have positive effects on climate change thanks to the methods developed on issues such as reducing greenhouse gas emissions caused by the agricultural sector, ensuring waste management, ensuring water management, and using renewable energy sources. Górecka et al. (2021) states that *'the digital transformation brought by the smart village concept produces the greatest added value in the field of agriculture'*. In addition, another benefit brought by technology is the potential of the effective use of the internet and digital marketing to offer a wide market area to rural communities (Górecka et al. 2021). The potential for producers to market their products directly to consumers represents a significant opportunity for increased profits and economic returns (Bielska et al. 2021). It is also estimated that the reduction in the supply chain will lead to a reduction in the emission of environmentally harmful gases (Bielska et al. 2021). An Indonesian study suggests that data collected by digital tools in rural areas can encourage farmers to take more informed actions, and that these informed actions can reduce food waste (Ilham et al. 2022). In addition, policymakers, researchers, and other stakeholders will be able to conduct more coherent studies in the light of data collected through digital transformation (X. Zhang and Zhang 2020). Factors such as the increase in productivity, proper management of resources, and the wide digital marketing area accessed, which are thought to be provided by the concept in the short term, will provide added value in agriculture in the long term and will enable the development of the economy in rural areas (Górecka et al. 2021). It is foreseen that the rate of rural-urban migration can be reduced by alleviating the push factors through the increase in service quality provided by technology and economic improvement in rural areas (Fernández and Peek 2023). Keeping the young population in rural areas and increasing the migration of young population to rural areas is of great importance in terms of agricultural production. It is

thought that the smart village concept, which uses technology as a tool, can be an attractive element for the young population that forms the technology age (Satola et al. 2022). Factors such as the increase in the use value of agricultural land thanks to digital transformation, increased labor opportunities, and higher living standards will enable the young population to create a future in rural areas (World Bank 2021). One of the benefits of this concept in the literature is its capacity to increase access to basic services such as education and health by increasing access to digital tools in rural areas and to increase welfare in rural areas (World Bank 2021).

2.4.3. Practical Challenges and Suggestions

Despite the benefits that the smart village concept is thought to provide, some difficulties encountered in the implementation phase of the concept are mentioned in the literature. Bielska et al. (2021) lists the obstacles to the realization of smart villages as the low level of awareness of the local people living in the region and the low participation rate accordingly, the lack of infrastructure in some regions, the existence of regions with low accessibility and the lack of cooperation between stakeholders. According to the research conducted by the World Bank, the difficulties experienced in Azerbaijan are the lack of skills of the local population in using technology, the high cost of technological tools, inadequate internet infrastructure, inadequate digital networks and logistics (World Bank 2021). The development of the Internet infrastructure is also among the factors that have an impact on the concept. This is also supported by the findings of Komorowski et al. (2020), who analyzed the link between internet access and rural development. According to the findings, internet access and socioeconomic development will increase in direct proportion, and the applicability of the smart village concept will be more difficult in regions where internet infrastructure is lacking. Another challenge to be addressed in smart village applications is the cost of digital tools (Adesipo et al. 2020; Satola et al. 2022). A study conducted in Canada and developed through surveys with academics revealed that respondents are particularly concerned about the costs of digital agriculture. One of the key issues to be addressed in this concept is the risk that family farms with insufficient financial means will be deprived of these technologies (Soma and Nuckchady 2021). One of the main difficulties experienced in the concept where bottom-up planning approach is adopted is the lack of sufficient co-operation with the public.

According to the studies in the literature and the results of application examples, public participation and co-operation are of great importance in the smart village concept (Satola et al. 2022). Budziewicz-Guźlecka (2019) revealed the reasons why the public did not participate in the voting in the project area. According to the research, the reasons why people did not participate in the voting are; lack of belief based on past experiences, lack of a sense of belonging and lack of information. In the ‘Vodafone Smart Village’ project carried out in Türkiye, it was stated that reasons such as the resistance of the people to innovations, the desire to adhere to traditions and production methods negatively affected the success of the project (Öztaş 2019).

When the literature is analyzed, it is seen that similar problems are encountered in different geographies. Based on the above-mentioned difficulties, it can be said that some criteria such as social awareness and social capacity, infrastructure and accessibility should be provided at a sufficient level in order to realize smart village projects. Just as smart solutions cannot be achieved only with a society without technology, success cannot be achieved without societies realizing smart solutions. Another challenge is the low rate of technology adoption of individuals living in rural areas and the possibility that the technical suggestions put forward as a result of the data collected may not be implemented. Today, the increase in the ability to use technology and interest in technology with the developing technology can be considered as a good development in terms of the implementation of the concept (Komorowski et al. 2020). In addition to the basic education provided in rural areas, training on ICT technologies can increase the level of awareness (Vaishar et al. 2019). In addition, technical support and information provided to farmers during the implementation process can contribute to the adoption of the technology (Tümen and Özertan 2020). Since the smart village concept is a multi-disciplinary concept, applications should be created by adopting a collaborative approach, creating a consultation environment and exchanging ideas (Atkočiūnienė and Vazonienė 2019). In order to provide an investment environment in rural settlements, access to basic services such as education, health and infrastructure should be provided. Therefore, it is an important point to provide these basic services before the smart village application. A sustainable economic environment in the settlement should be ensured by developing economic strategies for the future of the settlement before implementation (Viswanadham and Vedula 2010). It is recommended that settlements be analyzed in advance in order to identify potential development directions and rural development needs, and economic

strategies be developed accordingly (Pérez-delHoyo and Mora 2019). It is similarly important to consider political support and strategy in the development of the concept, as these can also influence its implementation. In particular, the concept may face various political obstacles during the implementation phase (Hlaváček et al. 2023). It is crucial to provide support for smart village projects in rural areas through the implementation of special policies and financial assistance (X. Zhang and Zhang 2020). In addition to vertical relations from the community to high-level decision-makers, it is postulated that the development of horizontal relations, such as municipalities working in partnership with each other, can have a positive impact (Hlaváček et al. 2023).

As a result, the current situation is revealed by examining the literature on the smart village concept. The theoretical shortcomings of the concept have been highlighted. Considering the changes in the definition of rural areas, it is possible to say that the definitional development of the concept continues. New definitions will be developed in time with practices and academic studies. When the variables defining the concept are analyzed in different studies, firstly, the limitation of the literature is observed. Secondly, it is observed that the variables differ at the scale of country, region and settlement, which reveals the unique structures of rural settlements. In this sense, it is necessary to identify and include place-specific variables in the studies. By identifying place-specific strategies, the likelihood of success of the concept will increase. When the benefits of the concept are examined in the literature, it is seen that especially its economic benefits are emphasized. However, there are limited studies on possible damages. With the development of the concept and the increase in applications, a more detailed literature on possible damages and necessary precautions will be formed. The spatial strategies required to ensure spatial continuity in the implementation phase and to implement the concept successfully are not included in the literature. In this context, the absence of a study on the spatial requirements and important design tools of the concept, which is a whole with its strategies and applications, can be characterized as an important finding. When assessing the limitations of the relevant literature, not only theoretical but also methodological shortcomings should be considered.

CHAPTER 3

MATERIALS AND METHODS

3.1. Study Area

In order to contribute to the limited literature of smart village studies, an overview is presented by making an evaluation at the country scale in the first stage. In this way, the status of the concept in Türkiye was evaluated. Considering the regional differences and location-specificity of the concept, it was deemed necessary to make sub-scale evaluations in the study. Therefore, the sample area was selected, and country and location-specific indicators were examined.

In order to determine the sub-scale indicators, the following criteria were evaluated when selecting the provinces to be examined in the sample areas:

- Having sectoral diversity
- According to the results of the analysis, having several potential rural settlements
- Diversity of spatial characteristics
- Being a developed settlement
- Being within the scope of Law No. 6360

Sectoral diversity was considered as an important factor in order to analyze the effects of different sectors. In this way, the impact of sectors on the smart village potential could be observed. The high number of potential settlements was considered as an advantage in order to have more options in rural settlement selection. The other criterion

is the diversity of spatial characteristics such as slope and height. This provided the opportunity to compare settlements with different characteristics to evaluate the impact of spatial characteristics. Since it is a settlement with a high level of urban development, the effects of urbanization were evaluated and its possible effects on the concept were observed. The last criterion is that it is among the provinces evaluated within the scope of Law No. 6360. In this way, the impact of the law on rural settlements and the concept was evaluated at a lower scale.

Considering the criteria, Izmir province was selected as the study area. Izmir province is in the west of Türkiye and is the third province in terms of population with a population of 4.479.525 (TurkStat, 2023a). In 2012, villages and towns in Izmir province were granted neighborhood status under Law No. 6360. The province is located on the Aegean Sea and is actively involved in activities such as port trade and tourism.

3.2. Data

The smart village concept is a relatively new concept in the literature and is still being developed. Therefore, although there is no specific set of variables, each study carries out studies uniquely on its own behalf (Atkočiūnienė and Vazonienė, 2019). While creating the data set of this study, the variables in the literature and the data obtained in rural settlement scale in Türkiye are taken into consideration. In the data collection phase of the study, official institutions are used.

In order to analyze the impact and importance of population on the concept, total population data for 2018 and 2022 were obtained from TurkStat (Turkish Statistical Institute - Türkiye İstatistik Kurumu) on the basis of neighborhoods/villages. In addition, in the second stage, neighborhood/village-based age group data for the years 2018 and 2021 were obtained for use in sample area selection. In the data obtained from TurkStat, there are 3260 neighborhoods and 18195 villages in total. The data about educational institutions, health institutions and economic data for settlements are obtained from the YER-SİS database created by the Republic of Türkiye Ministry of Industry and Technology (T.C. Sanayi ve Teknoloji Bakanlığı) in 2018 by conducting surveys in the field and working with various official institutions. The dataset obtained from YER-SİS contains 37036 spatial unit, including villages (köy) (18186), settlements transformed from villages to neighborhoods (köyden mahalle) (17118), towns (belde) (386) and

settlements transformed from towns to neighborhoods (beldeden mahalle) (1346). These statuses represent the rural settlements in Türkiye whose status has changed under the Law No. 6360. With the implementation of the law, rural settlements that were previously towns and villages in some provinces were given neighborhood status. Spatial Address Registration System (SARS – Mekansal Adres Kayıt Sistemi) database is obtained from the Ministry of Interior (T.C. İçişleri Bakanlığı), General Directorate of Population and Citizenship Affairs (Nüfus ve Vatandaşlık İşleri Genel Müdürlüğü) for the digital boundary data of the rural settlements. In the obtained dataset, there are a total of 50686 border data, including 32386 neighborhood borders and 18300 village borders. Urban socioeconomic development levels are obtained from the Socio-Economic Development Ranking of Provinces and Regions (SEGE - Sosyo-Ekonomik Gelişmişlik Sıralaması Araştırmaları) report published by the Republic of Türkiye Ministry of Industry and Technology in 2017. The types and numbers of rural settlements in the obtained datasets are given in Table 3.1.

Table 3.1. Number of Rural Settlements in Collected Data

Source	Qualification	Settlement Types	Number of Settlements		2022 Population (%)
YER-SiS	Rural Settlements	Town (<i>Belde</i>)	37,036	386	6.90%
		Town to Neighborhood (<i>Beldeden Mahalle</i>)		1,346	22.31%
		Village (<i>Köy</i>)		18,186	26.59%
		Village to Neighborhood (<i>Köyden Mahalle</i>)		17,118	44.20%
TurkStat	Neighborhood	Town	50,255	1,587	1.37%
		Neighborhood/Town (<i>Belde</i>)			
		Metropolitan District Neighborhood (<i>Büyükşehir Belediyesi Mahallesi</i>)		25,842	78.16%

(cont. on next page)

Table 3.1 (cont.).

		Province Center		1,468	9.07%
		Neighborhood			
		(İl Merkezi Mahallesi)			
		District Center		3,163	6.13%
		Neighborhood			
		(İlçe Merkezi Mahallesi)			
	Village	Village		18,195	5.28%
SARS	Neighborhood	Neighborhood	50,686	32,060	94.72%
	Village	Village		18,195	5.28%

Table 3.2 shows the dataset used in the study. In the study, 5 dimensions, namely Services, Demographic Structure, Sectoral Dimension, Marketing Methods and Spatial Structure, are considered to perform the analysis. As sub-indicators, 27 variables are included in the analysis. (+) represents the variables where the value should be high. (-) represents the variables that should not be high. The data obtained for the first phase of the study are edited and matched using Microsoft Office Excel software. Neighborhoods that have changed in nature and name have been edited and matched in TurkStat, YER-SIS and SARS neighborhoods. After matching the data, a total of 37020 settlements had an exact match. The new dataset created is spatialized with the ArcGIS program. GIS (Geographic Information System) analyzes are used for spatial analysis of the settlements. After this stage, the final dataset including all variables is obtained.

Table 3.2. Dimensions and Variables Used in Study

Dimension	Indicator	Year	Source	Scale	Format
Services	Primary School (+)	2018	YER-SiS	Village/Neighborhood	Table
	Secondary School (+)	2018	YER-SiS	Village/Neighborhood	Table
	Highschool (+)	2018	YER-SiS	Village/Neighborhood	Table
	Family Health Center (+)	2018	YER-SiS	Village/Neighborhood	Table
	Pharmacy (+)	2018	YER-SiS	Village/Neighborhood	Table
	Hospital (+)	2018	YER-SiS	Village/Neighborhood	Table
Demographic Structure	2018 Total Population (+)	2018	TurkStat	Village/Neighborhood	Table
	2022-2018 Population Change Rate (+)	2018, 2022	TurkStat	Village/Neighborhood	Table
	2018 Population Density (+)	2018	TurkStat	Village/Neighborhood	Table

(cont. on next page)

Table 3.2 (cont.).

Sectoral Dimension	Agricultural Production (+)	2018	YER-SiS	Village/Neighborhood	Table
	Livestock Farming (+)	2018	YER-SiS	Village/Neighborhood	Table
	Factory Labor(-)	2018	YER-SiS	Village/Neighborhood	Table
	Forestry (+)	2018	YER-SiS	Village/Neighborhood	Table
	Service Activities (+)	2018	YER-SiS	Village/Neighborhood	Table
	Mining (+)	2018	YER-SiS	Village/Neighborhood	Table
	Agricultural Sector Diversity (+)	2018	YER-SiS	Village/Neighborhood	Table
Marketing Methods	Direct Market/Factory/Mill (+)	2018	YER-SiS	Village/Neighborhood	Table
	Direct End Consumer (+)	2018	YER-SiS	Village/Neighborhood	Table
	Through the Internet (+)	2018	YER-SiS	Village/Neighborhood	Table
	Cooperative/Trade Exchange/ Turkish Grain Board (+)	2018	YER-SiS	Village/Neighborhood	Table
	Wholesaler/Trader/Agent (-)	2018	YER-SiS	Village/Neighborhood	Table
Spatial Structure	Distance to Coastal(-)	2022	AuthorWork	Pixel	Raster
	Elevation (-)	2022	AuthorWork	Pixel	Raster
	Slope (-)	2022	AuthorWork	Pixel	Raster
	Agricultural Area Rate (+)	2022	CORINE	Pixel	Raster
	Distance to Main Roads (-)	2022	OSM	Pixel	Raster
	Distance to First Stage City Centre (-)	2022	SEGE	Pixel	Raster

In the service dimension, six institutions providing services in the fields of education and health were evaluated. Rural settlements with institutions are evaluated as 1, while rural settlements without institutions are evaluated as 0. Only in the variable “Presence of High Schools”, according to the number of high schools, 1 and 2 are used in settlements with institutions and 0 in settlements without institutions. In the sectoral dimension, settlements with “Agricultural Production”, “Livestock Farming”, “Factory Labor”, “Forestry” and “Service Activities” sectors are evaluated as 1 and settlements without sectors are evaluated as 0. In marketing methods, the most used marketing methods in Türkiye and the marketing methods included in the smart village literature are tried to be evaluated together. “Marketing through Direct Market/Factory/Mill”, 'Marketing through Direct End Consumer' and 'Marketing through Internet' methods are also considered, which are related to the literature on the benefits of the smart village concept. To assess the potential of cooperatives to increase the adoption of agricultural technologies (Manda et al. 2020; S. Zhang et al. 2020), the variable “Marketing through Cooperative/Trade Exchange/ Turkish Grain Board” is considered. “Wholesaler/Trader/Agent” is included in the study as one of the most used marketing methods in Türkiye. In order to analyze which variable is more important in the

demographic dimension, 3 different variables are used: population density, population change rate and total population. Population data is based on the year 2018, when the YER-SIS data is collected, and the year 2022, which is the most recent year obtained from TurkStat. In the spatial dimension, “Elevation” and “Slope” variables are created using dem data obtained from EarthData (2023). Maximum values within the neighborhood boundary are taken and added to the dataset. For the “Distance to Coastal” variable, the distance of the coastline to the settlement, and for the “Distance to Main Roads” variable, the distance of the first and second stage transportation roads obtained from OpenStreetMap to the settlement are analyzed and added to the dataset. For the variable “Distance to First Stage City Center”, the settlement levels obtained from SEGE are taken into consideration and the distances of the cities in the first stage are analyzed. Finally, the land use data obtained from CORINE were organized and divided into two classes as agricultural and non-agricultural areas. The ratio of these two classes to each other within the neighborhood boundary was calculated and the variable “Agricultural Area Rate” is created. After the data editing phase is completed, the data is brought together in Excel environment. In this way, all data are included in the analysis in a holistic manner.

3.3. Methodology

In order to analyze the settlements in the study, MCDM (Multi Criteria Decision Making) method is used in studies with more than one criterion is available. Indicators obtained from literature research and available data are used to evaluate the smart village potential of settlements in Türkiye. However, it has been stated that some indicators are more dominant in determining the smart village potential. Since each criterion is not of equal importance, weighting methods are utilized when applying the MCDM method.

Table 3.3. Methodologies Used in Literature about Smart City and Smart Village

Concept					
	Article Name	Year	Scale	Variables	Methodology
Smart City	(Ozkaya and Erdin 2020)	2020	Province	47 indicators	ANP, TOPSIS

(cont. on next page)

Table 3.3 (cont.).

	(Ünal and Işıklar Alptekin 2023)	2023	Province	34 indicators	Entropy Weight Method, TOPSIS
	(Hajduk 2021)	2021	Province	21 indicators	TOPSIS
	(Ye et al. 2022)	2022	Province	9 indicators	WSM, TOPSIS, and VIKOR, Shannon entropy method
	(Koca et al. 2021)	2021	Province	33 dimension	Dematel
	(Aytaç Adali et al. 2022)	2024	Province	70 indicators	TOPSIS-G, CODAS-G and MARCOS-G
	(Yaşar et al. 2022)	2022	Province	19 indicators	ANP, PROMETHEE
	(Hajduk 2020)	2020	Province	100 indicators	Factor analysis, cluster analysis
	(Stanković et al. 2017)	2017	Province	26 indicators	AHP, TOPSIS
	(Rana et al. 2019)	2019	Province	31 indicators	Fuzzy AHP
	(Fang and Shan 2022)	2022	Province	-	PCA, k-means clustering
Smart Village	(Fahmi Mislahudin et al. 2021)	2021	Village	-	AHP, KDD
	(X. Li et al. 2022)	2022	Province	15 indicators	Entropy Weight Method, Dagum Gini Coefficient, Spatial Autocorrelation Analysis, Spatial Convergence Model
	(World Bank 2021)	2021	Cells	53 indicators	-

In Table 3.3, studies related to smart city and smart village potential in the literature are analyzed in terms of methodology. Although the studies based on smart cities are also very new, they are discussed more than the studies related to smart villages. Therefore, it can be said that there is a lack of potential analysis on the smart village concept. There are also two main differences in the analyses: scale and weighting. When

the studies are evaluated in terms of scale, it is seen that the studies on the smart city concept are conducted at the urban scale since they investigate cities. However, due to the lack of data, rural studies can also be conducted at the urban scale. This may lead to

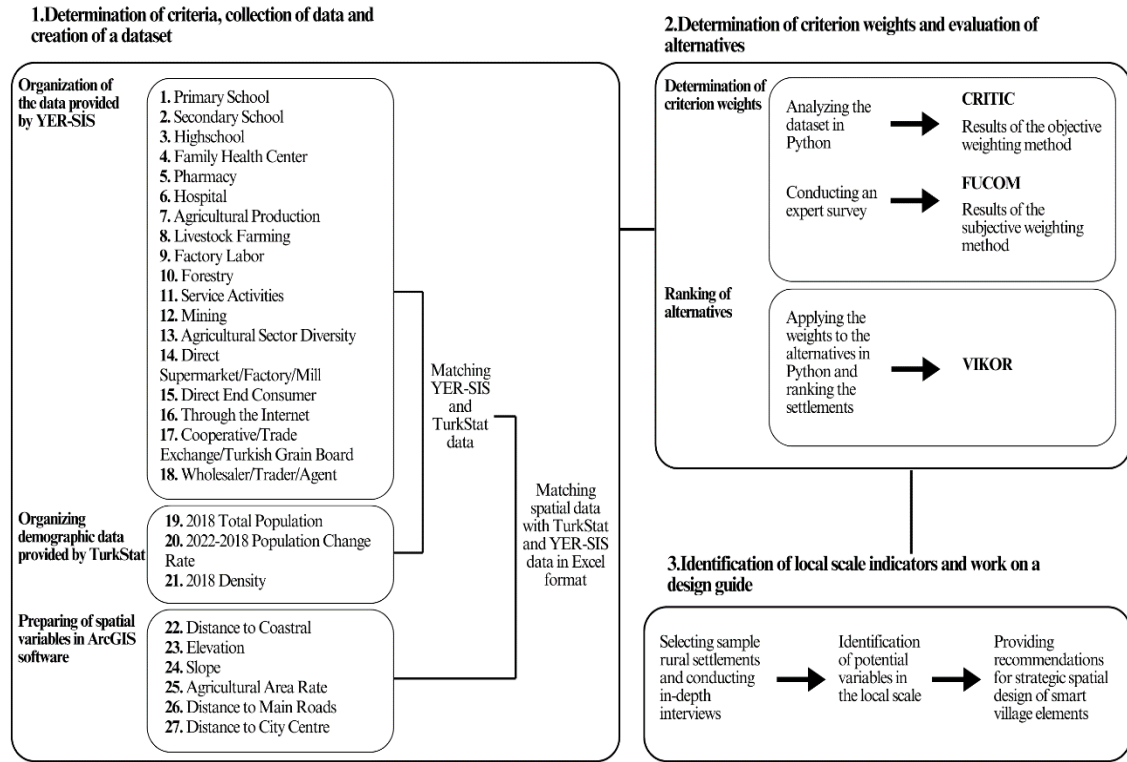


Figure 3.1. Methodology Scheme of the Study

ineffective results. In this sense, the World Bank has revealed the “smart village readiness index” by investigating the smart village potential in Azerbaijan in 2021. The scale of the study was determined as 100 square meter cells. The other study for potential analysis (Fahmi Mislahudin et al. 2021) performed the study at the village scale and assigned a score for each village. While some studies spatialize the results, others include tables and graphs. When the studies are evaluated in terms of variable weighting, it is seen that there are limited studies that use criteria weighting (Fahmi Mislahudin et al. 2021; X. Li et al. 2022). Most studies proceed on the assumption that the criteria have equal weight (Adamowicz and Adamowicz 2021).

MCDM methods allow analyzing more than one criterion for many alternatives and determining the most appropriate one. In this respect, these methods are among the

preferred methods in the literature. Studies using MCDM methods especially used AHP, TOPSIS and Entropy methods. In addition, the necessity of hybrid approaches is emphasized in the literature (Yuan et al. 2022). In this study, a two-stage analysis was carried out and both objective and subjective evaluations are included. MCDM methods are implemented in Python environment. (Kizielewicz et al. 2023).

The methodology used in the study is given in Figure 3.1. Weighting methods are divided into two as subjective weighting methods, which are formed by the scores given by decision makers and experts, and objective weighting methods, which are formed by using completely obtained numerical data. In this study, both objective and subjective weighting methods are considered in order to compare the results obtained. In the Entropy method, which is one of the most widely used methods in the literature, it is stated in the literature that it is sensitive to extreme values since the logarithm of the dataset is taken (Mukhametzyanov 2021). Due to the large number of alternatives and outliers, CRITIC method is used as an objective weighting method in this study (Diakoulaki et al. 1995). The FUCOM method is used as the subjective weighting method (Pamučar, Stević, and Sremac 2018). For the method, a survey is conducted with experts in the fields of urban planning, technological rural entrepreneurship and rural development. A total of 12 expert opinions are included in the expert survey. The responses of each participant are analyzed separately for each dimension using the FUCOM method and weights are obtained. By averaging the weight values calculated for the variables, the weights of the dimensions and variables according to the FUCOM method are determined. Then, the criteria weights obtained with these methods are analyzed with the VIKOR (Opricovic and Tzeng 2000). The VIKOR method applies the criteria weights to the alternatives and ranks them according to their suitability values.

The second stage of the study comprises the selection of sample areas. Data is collected through on-site observation and in-depth interviews and is subsequently included in the study. Rural settlements and cooperatives were visited as part of the field research. During the observation phase, factors such as the technologies used in the settlement, socialization areas, spatial uses, spatial structure, and community reactions were observed. In the in-depth interview phase, local administrators (muhtar) and cooperative managers of rural settlements were interviewed. In the interview with local administrators, questions were asked in various fields to obtain information about the settlement. The main purpose of the questions was to measure the perspective of the

concept, to determine the variables that may affect the concept and to understand the current situation of the villages. First, in order to understand the government-community relationship in the settlement, the level of involvement of individuals living in the village in decision-making processes was asked. Secondly, in order to understand the social structure, information was obtained about the education level of individuals living in the village, the perspectives and participation of current students in education, library use, the level of technological aptitude of individuals, and the rate of use of technological devices. Access to highly educated individuals and existing education projects were also discussed. The third issue addressed was the technical infrastructure in the village. Existing infrastructure problems, technologies used in the village, transportation facilities, access to financial services, access to health and education services, use of renewable energy infrastructure, internet infrastructure were discussed. Finally, in order to obtain information on the economic potential of the village, interviews were conducted on job opportunities in the village, young people's perspective on agriculture, production and marketing processes, availability of financial support, and active cooperatives. Within the scope of the field research, in-depth interviews were conducted with the heads of cooperatives in the sample rural areas. Information was obtained on the historical development of the cooperative, current situation, production and marketing processes, problems experienced, technologies used in production, planned projects, the contribution of technology to production, the relationship of individuals living in the village with the cooperative, and the relationship of individuals with the technologies used in the cooperative.

Consequently, a more comprehensive examination of the economic, social, and spatial characteristics of the selected areas is conducted. Local-scale indicators that may be significant for the smart village concept are evaluated. Ultimately, recommendations for a smart village planning proposal have been developed to offer insight into the potential spatial transformations that may emerge with the actualization of the smart village concept.

3.2.1. CRITIC Method

The CRITIC (Criteria Importance Through Inter-criteria Correlation) method was introduced in 1995 by Danae Diakoulaki to determine objective weights (Diakoulaki et

al. 1995). The CRITIC method is a method used for criteria weighting. In this method, the criteria weights are evaluated objectively using the dataset. The steps of the method are given below.

$$x = [x_{ij}]_{m \times n} = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \quad (i = 1, 2, \dots, m \text{ and } j = 1, 2, \dots, n) \quad (3.1)$$

In the above formula, x is the decision matrix, x_{ij} is the value of the i -th alternative in the j -th criterion, m is the number of alternatives, n is the number of criteria. The analysis is carried out by applying the following steps on the decision matrix.

Step 1: Normalization of the decision matrix

At this stage, a normalized decision matrix is obtained by normalizing the decision matrix. The min-max normalization method is used to normalize the decision matrix and bring the values to the range $[0,1]$.

$$x_{ij}^{norm} = \frac{x_{ij} - \min(x_j)}{\max(x_j) - \min(x_j)} \quad (3.2)$$

x_{ij}^{norm} stands for the normalized value of alternative i for criterion j , x_{ij} stands for the original value of alternative i for criterion j , $\min(x_j)$ stands for the minimum value in the data set for criterion j , $\max(x_j)$ stands for the maximum value in the data set for criterion j .

Step 2: Calculation of standard deviation

When calculating criterion weights, the standard deviation of the criterion is evaluated. The following formula is used to calculate the standard deviation.

$$\sigma_j = \sqrt{\frac{1}{n-1} \sum_{i=1}^n (x_{ij} - \bar{x}_j)^2} \quad (3.3)$$

The symbol σ_j represents the standard deviation of criterion j , n represents the number of alternatives, x_{ij} represents the normalized value of alternative j and $\bar{x}_j$ represents the average value of criterion j .

Step 3: Calculating the correlation matrix

While calculating the criteria weights, the correlation between the criteria and other criteria is calculated. The following formula is used to calculate the correlation.

$$r_{jk} = \text{corr}(x_j, x_k) \quad (3.4)$$

The symbol r_{jk} represents the correlation coefficient between criteria j and k . The correlation coefficient indicates the degree of dependency between these two criteria.

Step 4 : Calculation of the amount of information

$$C_j = \sigma_j \sum_{k=1}^m (1 - r_{jk}) \quad (3.5)$$

C_j stands for the amount of information of criterion j , σ_j stands for the standard deviation of criterion j and r_{jk} stands for the correlation coefficient between criteria j and k .

Step 5: Calculation of criteria weights

In this step, the weight of each criterion is calculated using the formula below.

$$w_j = \frac{C_j}{\sum_{j=1}^m C_j} \quad (3.6)$$

In the above formula, the symbol w_j represents the weight of criterion j and the symbol C_j represents the amount of information of criterion j . As a result of this process, weight values are obtained for each criterion.

3.2.2. FUCOM

The FUCOM (Full Consistency Method) is one of the subjective weighting methods (Pamučar, Stević, and Sremac 2018). This method is applied by taking expert opinion and is a completely subjective method. A pairwise comparison scale of 1-9 is used for comparison. The steps of the FUCOM method are given below:

Step 1: Ranking of criteria

In the first step, decision makers rank the criteria from most important to least important.

$$C_{j(1)} > C_{j(2)} > \dots > C_{j(k)} \quad (3.7)$$

k represents the number of observed criteria.

Step 2: Comparison of criteria

In the second step, the comparative priorities of the ranked criteria are determined. Comparative priority represents the advantage of ranking $C_{j(k)}$ over ranking $C_{j(k+1)}$.

$$\Phi = (\varphi_{1/2}, \varphi_{2/3}, \dots, \varphi_{k/(k+1)}) \quad (3.8)$$

Step 3: Calculating Weight Coefficients

In this step, the final values of the weight coefficients of the evaluation criteria $\{w_1, w_2, \dots, w_n\}$ are calculated. The final values of the weight coefficients should satisfy the following two conditions:

1. Condition 1: The ratio of the weight coefficients is equal to the comparative priority among the observed criteria $\left(\frac{\varphi_k}{\varphi_{k+1}}\right)$ defined in Step 2:

$$\frac{\omega_k}{\omega_{k+1}} = \frac{\varphi_k}{\varphi_{k+1}} \quad (3.9)$$

2. Condition 2: The final values of the weight coefficients should also satisfy the condition of mathematical transitivity:

$$\frac{\varphi_k}{\varphi_{k+1}} \cdot \frac{\varphi_{k+1}}{\varphi_{k+2}} = \frac{\varphi_k}{\varphi_{k+2}} \quad (3.10)$$

Based on these conditions, the final model for determining the weight coefficients of the evaluation criteria can be defined as:

$$\min X$$

subject to:

$$\begin{aligned} \left| \frac{w_{j(k)}}{w_{j(k+1)}} - \frac{\varphi_k}{\varphi_k + 1} \right| &\leq X, \forall j \\ \left| \frac{w_{j(k)}}{w_{j(k+1)}} \cdot \frac{\varphi_{k+1}}{\varphi_{k+2}} - \frac{\varphi_k}{\varphi_{k+2}} \right| &\leq X, \forall j \\ \sum_{j=1}^n w_j &= 1 \\ w_j &\geq 0, \forall j \end{aligned} \quad (3.11)$$

The FUCOM method simplifies the decision-making process by making $(2n-1)$ comparisons. For this reason, it provides more consistent results than AHP and BWM methods (Pamučar et al. 2018).

3.2.3. VIKOR Method

The VIKOR (VlseKriterijuska Optimizacija I Komoromisno Resenje) method is a method used for ranking alternatives by applying weighted criteria to alternatives. In the method developed by Serafim Opricovic in 1998, the calculation is performed by measuring the closeness to the ideal alternative (Opricovic and Tzeng, 2000).

Step 1: Construct the Decision Matrix and Determine Ideal Solutions

The decision matrix F is created by evaluating n criteria for m alternatives.

$$F = \begin{bmatrix} f_{11} & f_{12} \cdots & f_{1n} \\ f_{21} & f_{22} \cdots & f_{2n} \\ \vdots & \vdots & \vdots \\ f_{m1} & f_{m2} \cdots & f_{mn} \end{bmatrix}$$

$$i = 1, 2 \cdots m, \quad j = 1, 2 \cdots n \quad (3.12)$$

$i = 1, 2 \cdots m$ represent alternatives, $j = 1, 2 \cdots n$ represent criteria.

Then the positive ideal solution F^* and the negative ideal solution F^- are determined by the formulas given below.

$$F^* = (f_1^*, f_2^*, \cdots f_n^*)$$

$$= \left\{ \left(\max_i f_{ij} \mid j \in PA \right), \left(\min_i f_{ij} \mid j \in NA \right) \mid j = 1, 2 \cdots n \right\} \quad (3.13)$$

$$F^- = (f_1^-, f_2^-, \cdots f_n^-)$$

$$= \left\{ \left(\max_i f_{ij} \mid j \in PA \right), \left(\min_i f_{ij} \mid j \in NA \right) \mid j = 1, 2 \cdots n \right\} \quad (3.14)$$

f_n^* , represents the value of the best performing alternative for n criteria. f_n^- , represents the value of the worst performing alternative for n criteria. PA (Positive

Attributes), represents positive criteria. *NA* (Negative Attributes), represents negative criteria.

The positive optimal solution evaluates the performance of the alternatives with maximum performance in each criterion, while the negative optimal solution evaluates the performance of the alternatives with minimum performance in each criterion.

Step 2: Calculate the S and R values

$$S_i = \sum_{j=1}^n W_j (|f_j^* - f_{ij}|) / (|f_j^* - f_j^-|) \quad (3.15)$$

$$R_i = \max_j \{W_j (|f_j^* - f_{ij}|) / (|f_j^* - f_j^-|)\} \quad (3.16)$$

S_i represents the sum of the weighted average differences of alternative i with the weights of the criteria. R_i represents the highest weighted difference of alternative i with the weights of the criteria. The norm, which generalizes these distance measures, is given by:

$$Lp = \left\{ \sum_{j=1}^n [(f_j^* - f_{ij}) / (f_j^* - f_j^-)]^p \right\}^{1/p} \quad (3.17)$$

$$1 \leq p \leq \infty, j = 1, 2, \dots, n$$

Step 3: Calculate the Q Values

In the VIKOR method, the “Q” value is a parameter used to measure the performance of an alternative. In VIKOR analysis, the alternative with the lowest Q value is considered as the best performing alternative.

$$Q_i = v \left(\frac{S_i - S^*}{S^- - S^*} \right) + (1 - v) \left(\frac{R_i - R^*}{R^- - R^*} \right) \quad (3.18)$$

$$S^* = \min S_i$$

$$S^- = \max S_i$$

$$R^* = \min R_i$$

$$R^- = \max R_i$$

v determines the weight of the maximum group utility strategy. It is usually taken as $v = 0.5$. In this study, v is also taken as 0.5.

Step 4: Rank the Alternatives

In Step 4, the alternatives are ranked by sorting their Q_i , S_i , and R_i values in ascending order. The best-ranked solution, denoted as $Q[1]$, is determined based on the minimum Q_i value, taking into account the following two conditions:

Condition 1: Acceptable Advantage The difference between the Q values of the best-ranked alternative ($Q[1]$) and the second-best alternative ($Q[2]$) should be greater than or equal to $\frac{1}{m-1}$, where m is the number of alternatives. This condition ensures that there is a significant advantage of the best-ranked alternative over the second-best alternative.

Condition 2: Acceptable Stability in Decision Making The best-ranked alternative ($Q[1]$) should also be the best-ranked alternative based on either S or R values. This condition ensures that the selected alternative maintains stability within the decision-making process and is ranked consistently across different evaluation criteria.

If either of these conditions is not satisfied, compromise solutions are proposed as follows:

Condition 3: If only Condition 2 is not satisfied, both alternatives $Q[1]$ and $Q[2]$ are considered compromise solutions.

Condition 4: If only Condition 1 is not satisfied, alternatives $Q[1]$, $Q[2]$, ..., $Q[k]$ are considered compromise solutions, where the difference between the Q values of these alternatives satisfies $Q[k] - Q[1] \leq \frac{1}{m-1}$. These compromise solutions are ranked closely to the best-ranked alternative.

The results lie between the values 1 and 0, and in the VIKOR method the results are sorted in reverse order. This means that the smallest value represents the most suitable placement. By following these procedures, a set of compromise solutions is obtained using the VIKOR method, ensuring a balanced approach to decision-making even in cases where a single optimal solution cannot be identified.

In summary, the methodology of this study involves 3 different steps: data collection, country scale analysis and rural settlement scale analysis. The data obtained in the data collection phase are adapted to MCDM methods. The criteria are weighted by CRITIC and FUCOM methods and ranked by the same method in order to reveal the method differences. There are many MCDM methods in the literature. These methods have some advantages and disadvantages. The most used methods in objective weighting methods are entropy (Ersoy 2022). Since the entropy method takes the logarithm of the values in the dataset, this method may give errors in negative values. CRITIC method is used in this study since it can include negative data in the analysis and is considered to give consistent results (Maruf 2021). In this study, FUCOM method is preferred for subjective weighting. This method requires less selection than the AHP and BWM methods and has the capacity to provide more consistent results (Pamučar et al. 2018). For ranking, the alternatives are scored using the VIKOR method. The results are used for site selection in the next stage.

CHAPTER 4

RESULTS

4.1. Spatialization and Interpretation of Variables of the Study

After the legal regulation in Türkiye in 2012, the villages in the provinces are transformed into neighborhoods. However, these settlements continue their rural activities. In the YER-SIS project, these settlements are considered as settlements that turned from villages to neighborhoods and from towns to neighborhoods. In this study, the data of 37020 rural settlements in four types, namely neighborhood from village,

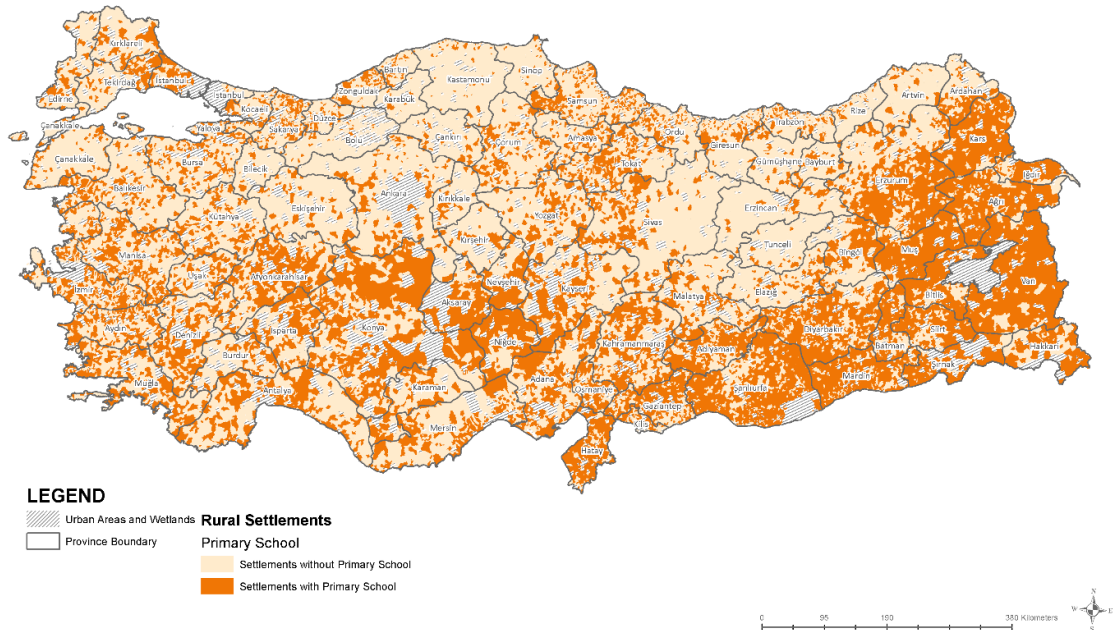


Figure 4.1. Presence of Primary School in Rural Settlements (Source: Author Work based on YER-SİS)

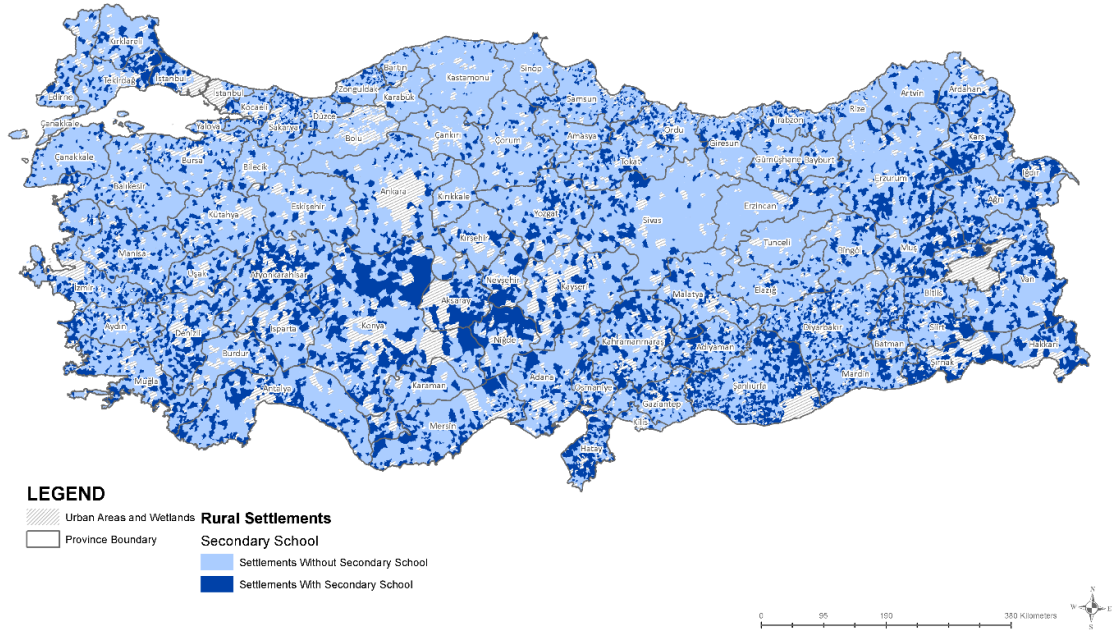


Figure 4.2. Presence of Secondary School in Rural Settlements (Source: Author Work based on YER-SİS)

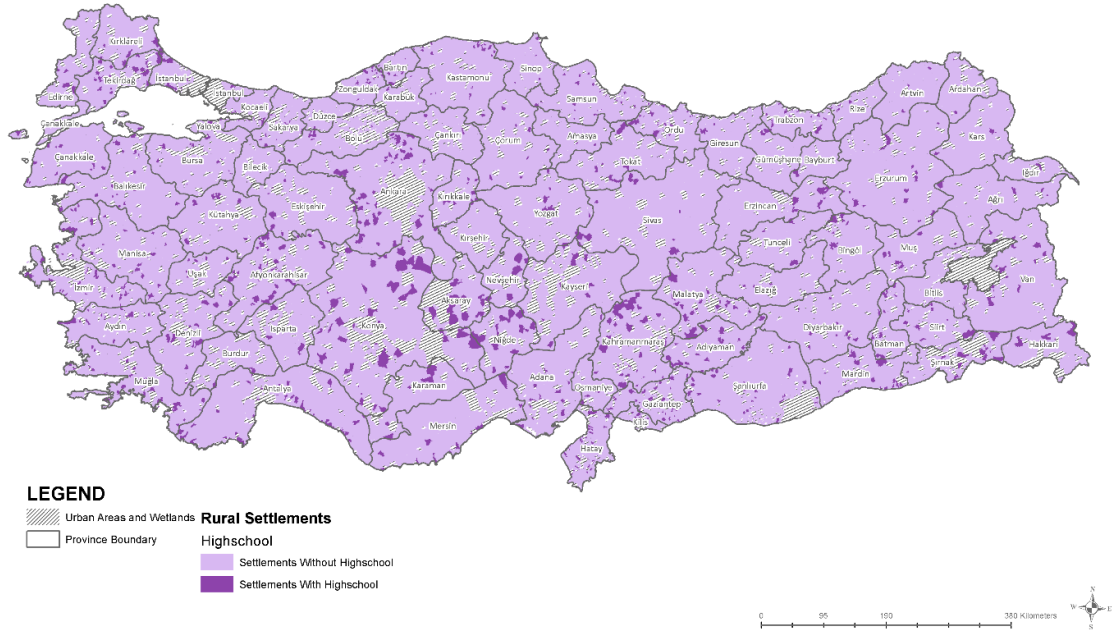


Figure 4.3. Presence of Highschool in Rural Settlements (Source: Author Work based on YER-SİS)

village, neighborhood from town and town, are matched and included in the analysis. In this way, the settlements that became neighborhoods within the scope of the law are included in the study as rural settlements. The rural settlement analysis in this section is spatialized using the neighborhood boundary data obtained from the SARS dataset and the coloring refers to the neighborhood boundaries. In studies on smart villages, each country has used its own unique dataset. In this study data such as current economic structures, demographic structures, spatial structures and infrastructure conditions of settlements are analyzed.

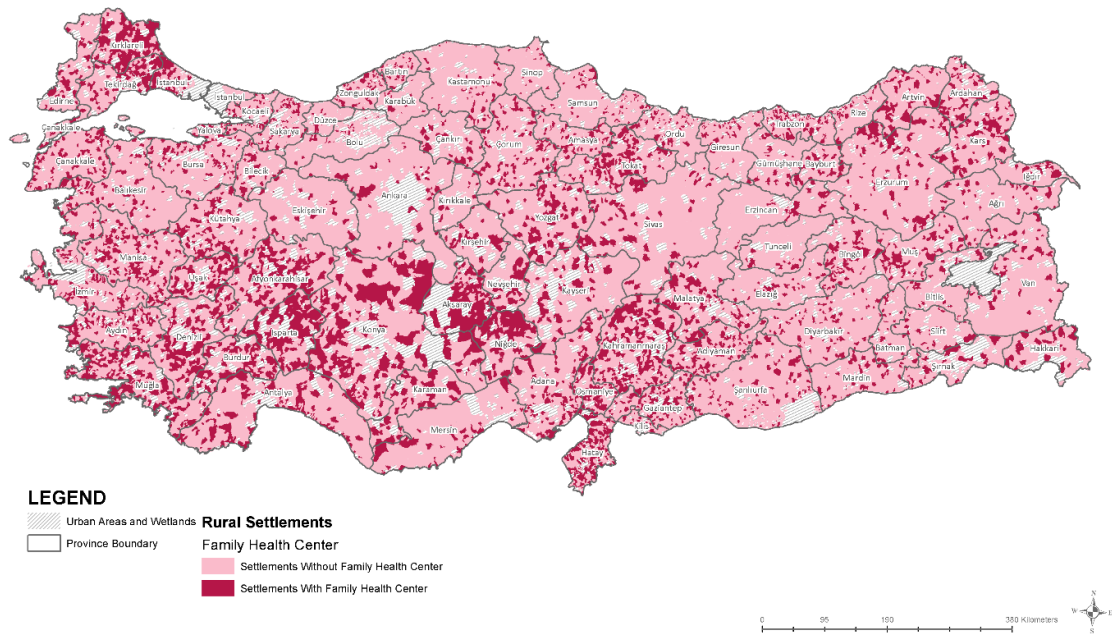


Figure 4.4. Presence of Family Health Center in Rural Settlements (Source: Author Work based on YER-SİS)

In the service dimension, 3 different variables are considered for educational services: presence of primary school, presence of secondary school and presence of high school. When the spatial analysis of the presence of primary schools is examined, it is seen that the presence of primary schools is limited in rural neighborhoods in some provinces (Figure 4.1). In the east of the country and in the Central Anatolia region, the presence of primary schools is intensified. Secondary school presence is found in fewer rural neighborhoods compared to the primary school presence variable (Figure 4.2).

Highschool is the least common basic education institution in rural settlements (Figure 4.3).

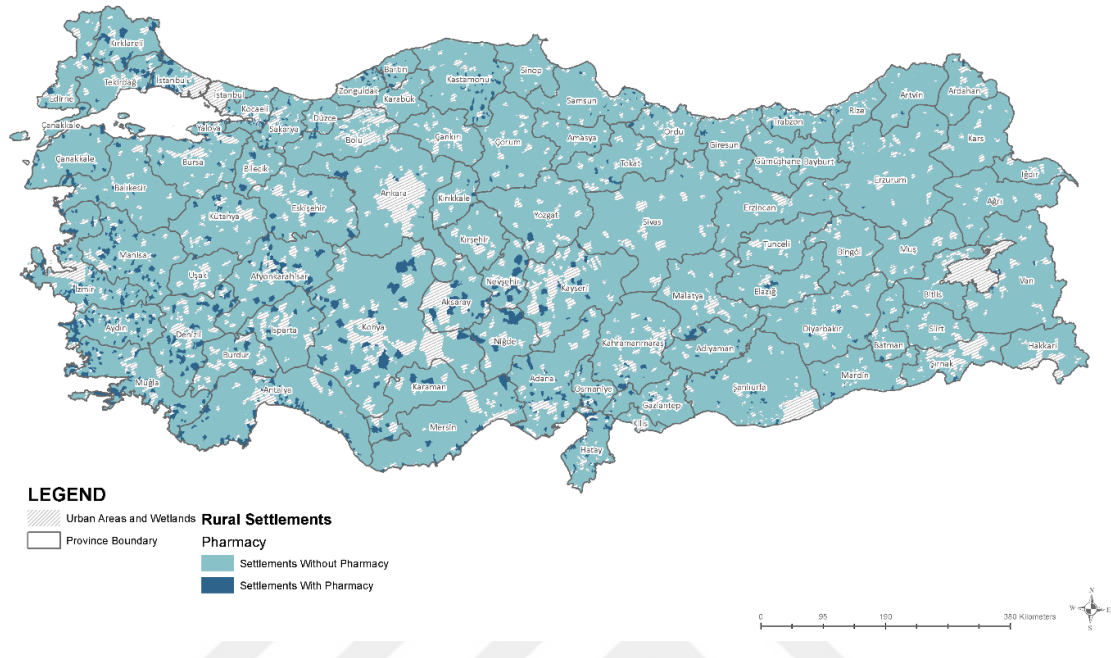


Figure 4.5. Presence of Pharmacy in Rural Settlements (Source: Author Work based on YER-SİS)

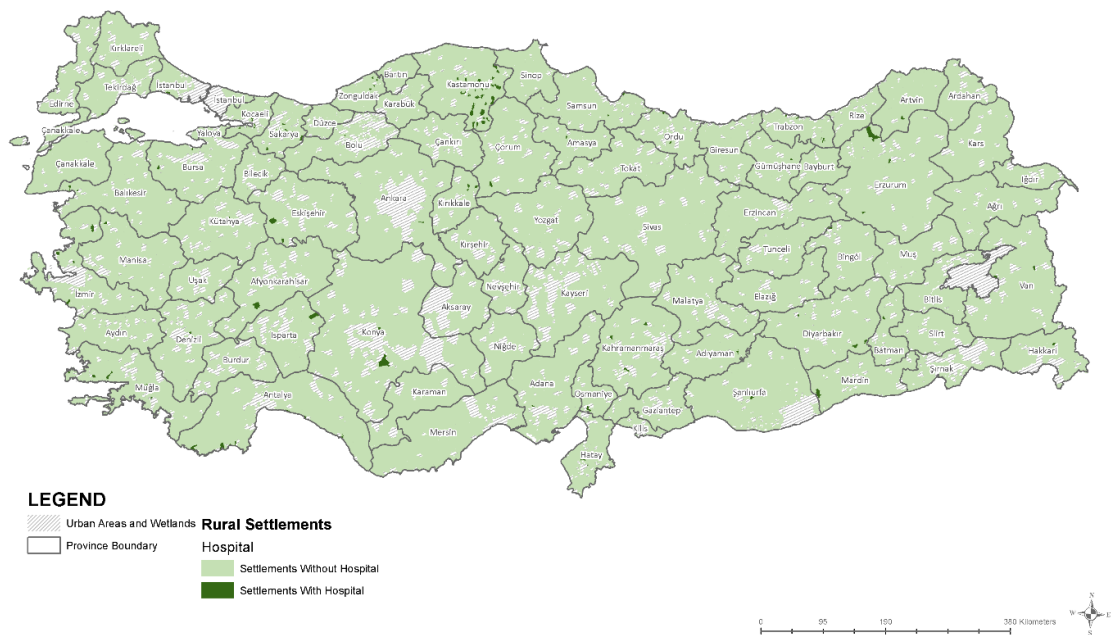


Figure 4.6. Presence of Hospital in Rural Settlements (Source: Author Work based on YER-SİS)

In the service dimension, 3 different variables are considered for health services: the presence of family health center, the presence of pharmacy and the presence of hospital. When health services are examined, it is seen that the most common health service in rural settlements is family health center (Figure 4.4). When the spatial data are analyzed, it is observed that the presence of family health centers is concentrated in the west, in the Central Anatolia region and in some provinces in the Marmara region. Pharmacy is located in very few rural settlements and is concentrated in some provinces (Figure 4.5). The number of rural settlements with a hospital, which is a higher level health service, is very limited (Figure 4.6).

For the demography dimension, the population dataset is organized in 3 different ways and included in the analysis. Population change rate and population density maps are classified using natural break points. Since the service, marketing method and sector dimensions addressed within the scope of the YERSIS project belong to 2018, the demography dimension is based on 2018. For the annual interval, the year 2022, which is the last year of the population data obtained from TurkStat, is taken as the basis. Using these data, the total population in 2018, the settlement density in 2018 and the population change rate between 2018 and 2022 are evaluated through three variables. The 2018 density variable is found by dividing the total population data of 2018 by the rural settlement area. The rate of population change between 2018-2022 is found with the CAGR (Compound Annual Growth Rate) formula. The spatial form of the population change rate variable between 2018-2022 is shown in Figure 4.8. As can be seen in the analysis, it is observed that there is a population increase in four years in some settlements around Istanbul, the coasts of the Aegean region and the Mediterranean region and in the east of the country. In the Eastern Black Sea region, Central Anatolia region and rural areas of some provinces in the east, the population tends to decrease. Population density is particularly high on the coasts of the Black Sea region, the Aegean region, the coasts of the Mediterranean region and the Southeastern Anatolia region (Figure 4.9). In the Central Anatolia region and some parts of the Eastern Anatolia region, population density is lower than in other regions. According to the spatial data of the total population of rural settlements in 2018, it is observed that the total population is lower in the Black Sea region, Central Anatolia region and part of the Eastern Anatolia region compared to other regions (Figure 4.7).

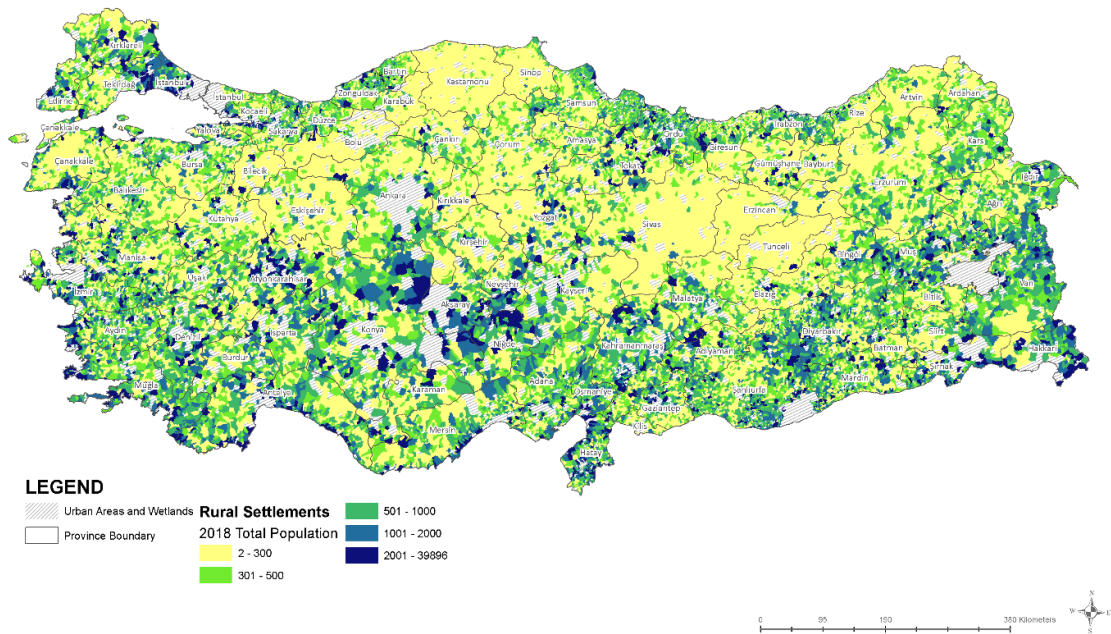


Figure 4.7. Total Population in 2018 in Rural Settlements (Source: Author Work based on TurkStat)

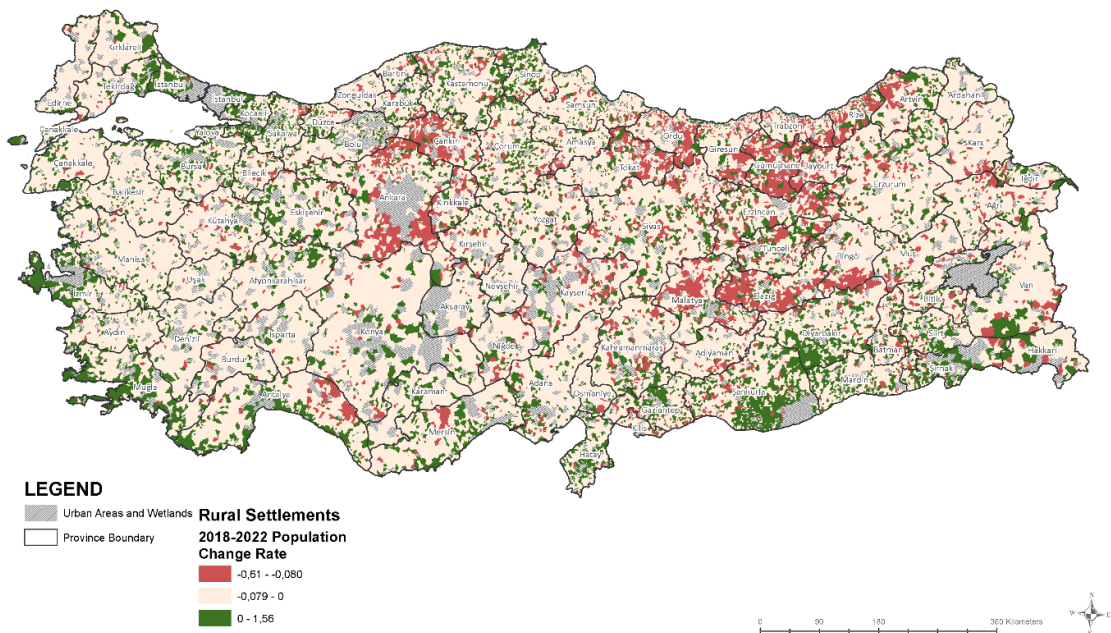


Figure 4.8. Population Change Rate Between 2018-2022 in Rural Settlements (Source: Author Work based on TurkStat)

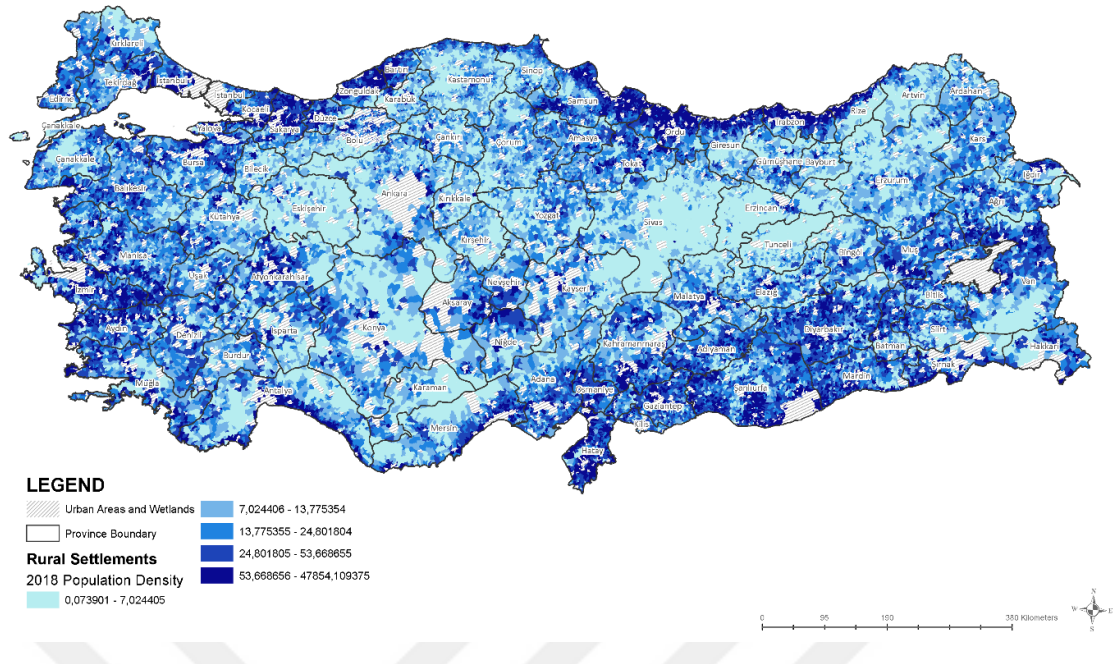


Figure 4.9. Population Density in 2018 in Rural Settlements (Source: Author Work based on TurkStat)

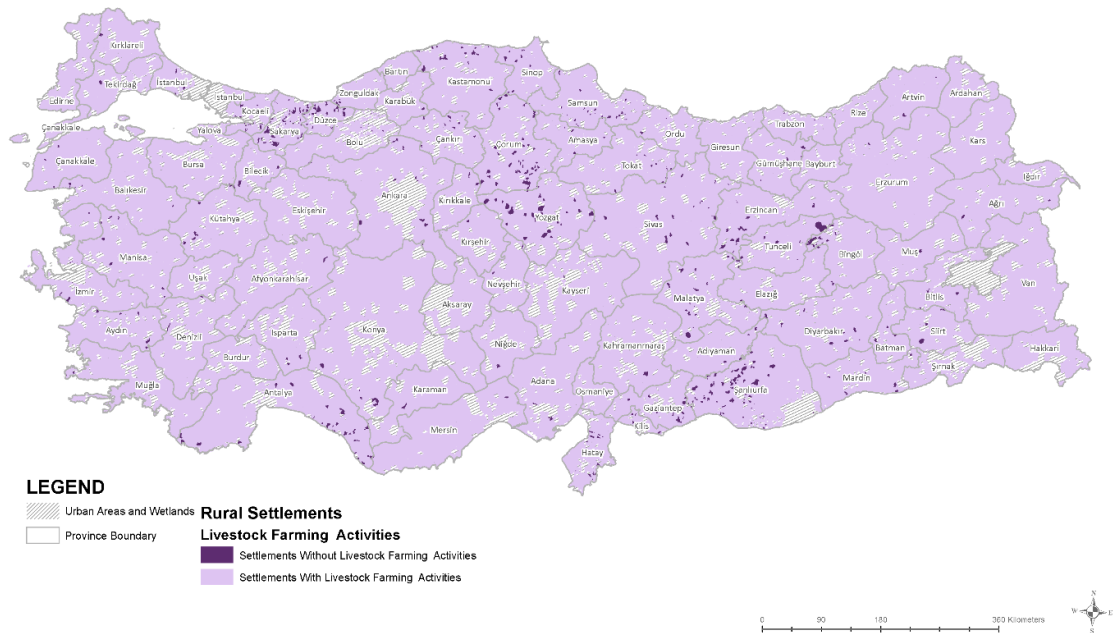


Figure 4.10. Presence of Livestock Farming Activities in Rural Settlements (Source: Author Work based on YER-SİS)

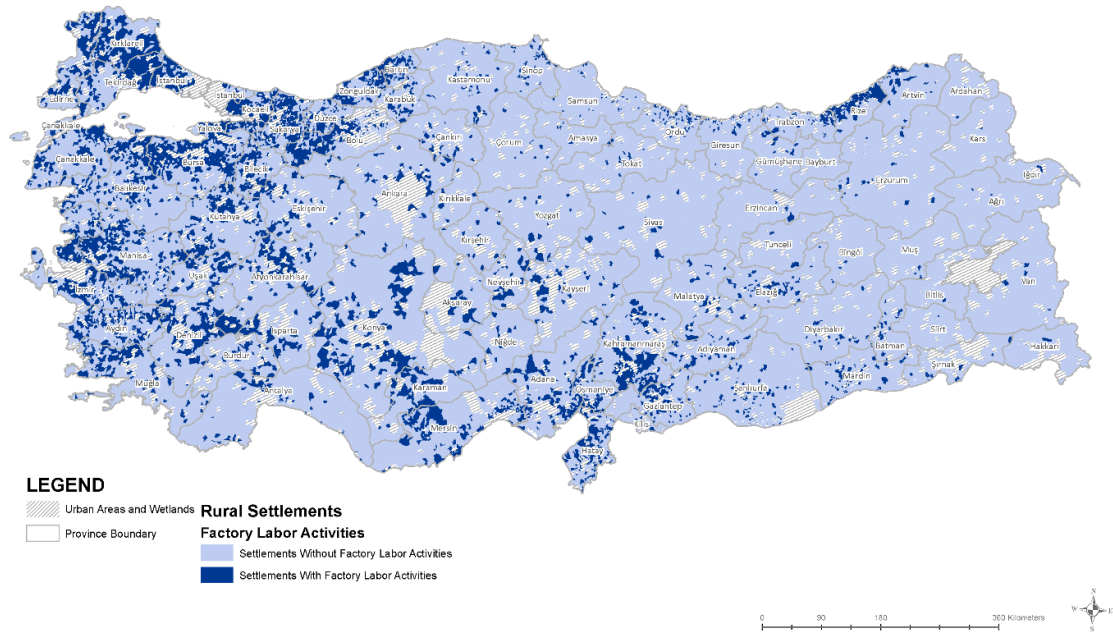


Figure 4.11. Presence of Factory Labor Activities in Rural Settlements (Source: Author Work based on YER-SİS)

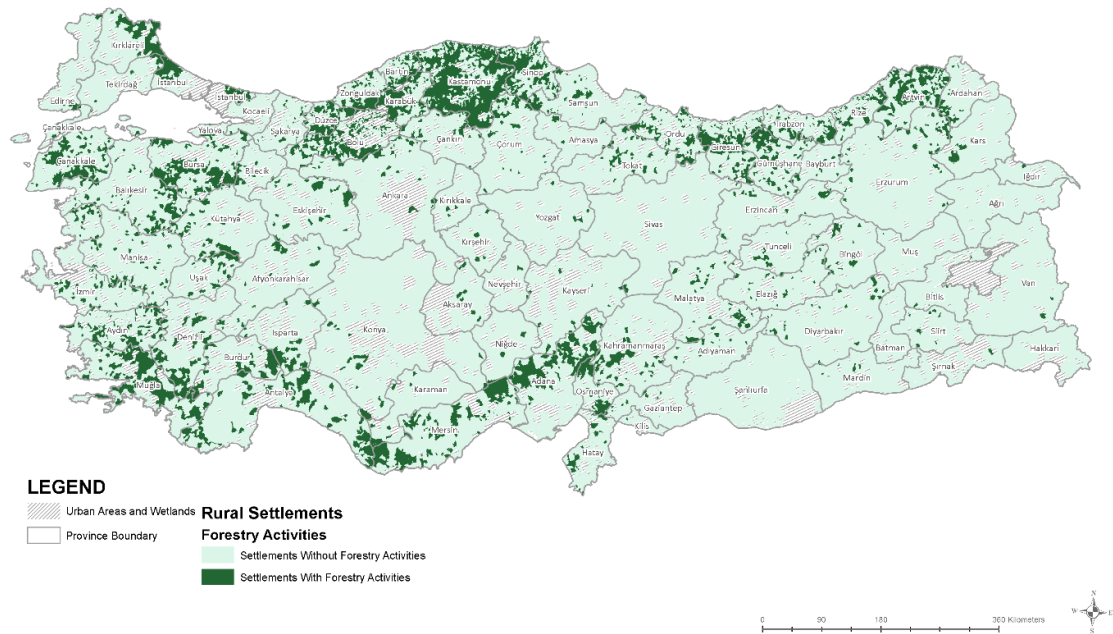


Figure 4.12. Presence of Forestry Activities in Rural Settlements (Source: Author Work based on YER-SİS)

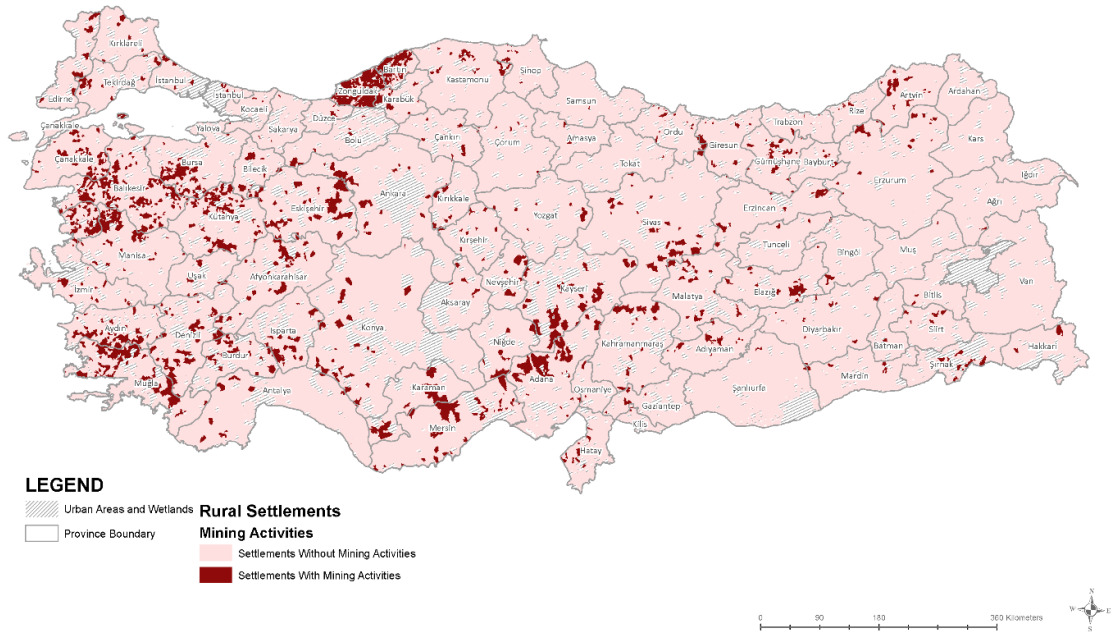


Figure 4.13. Presence of Mining in Rural Settlements (Source: Author Work based on YER-SİS)

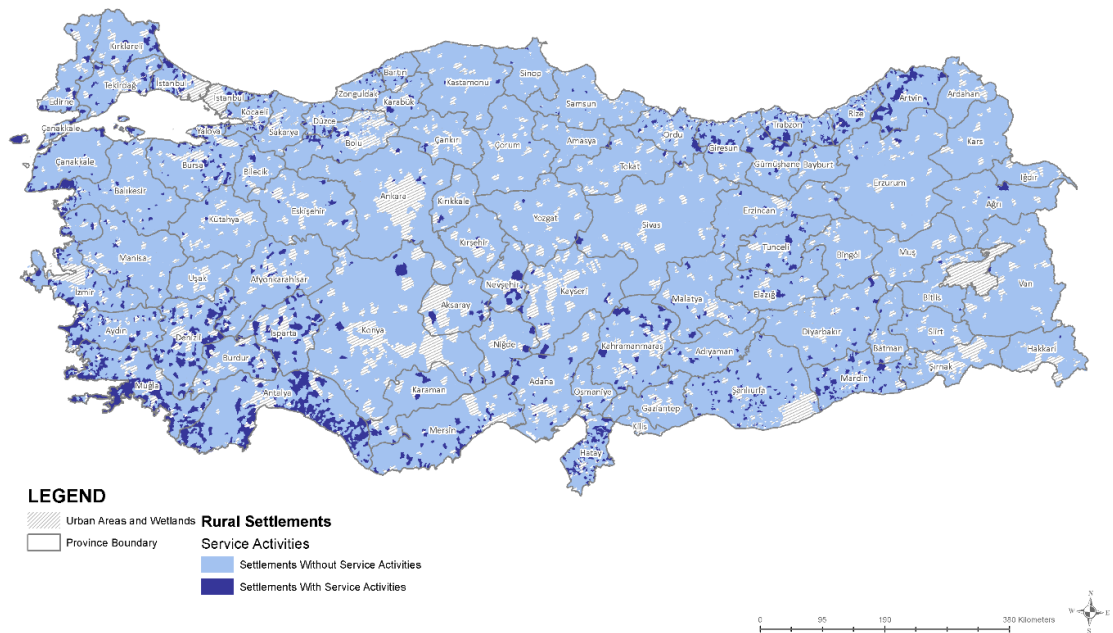


Figure 4.14. Presence of Service Activities in Rural Settlements (Source: Author Work based on YER-SİS)

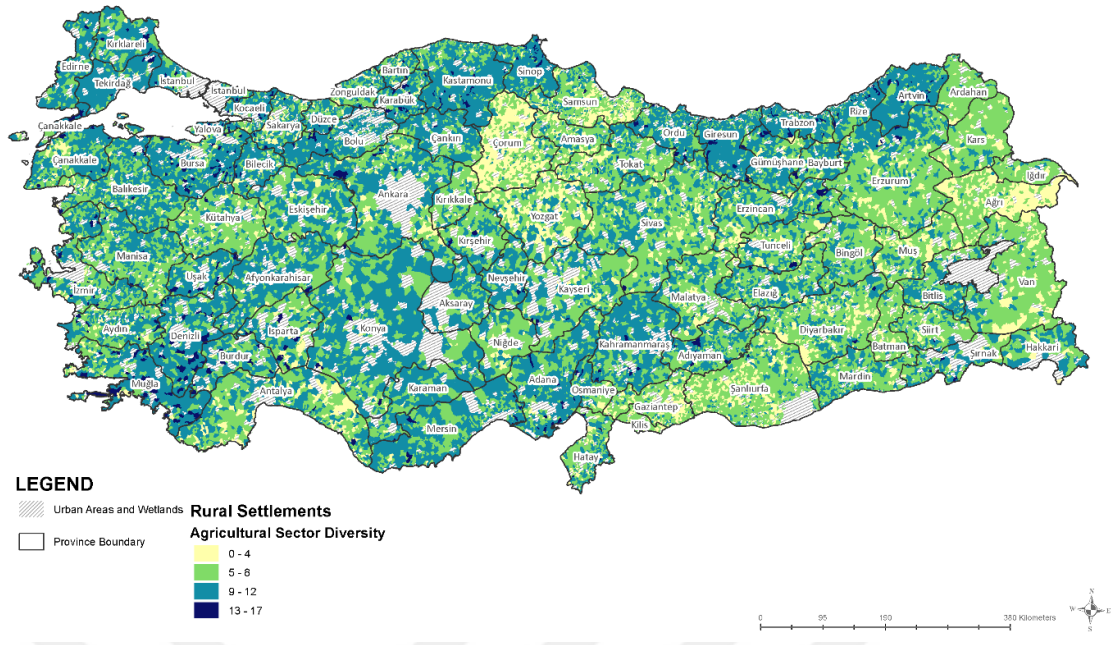


Figure 4.15. Agricultural Sector Diversity in Rural Settlements (Source: Author Work based on YER-SİS)



Figure 4.16. Presence of Agricultural Production Activities in Rural Settlements (Source: Author Work based on YER-SİS)

In the sectoral dimension, different sectors in rural areas are taken and the sectors affecting the economy and demography are tried to be evaluated. Agricultural production, livestock farming, factory labor, forestry, service activities, and mining variables reveal whether there is a sector in the settlement based on the rural settlement scale surveys carried out in the YER-SIS project. In the agricultural production activities variable, rural settlements without agricultural production are shown in dark color (Figure 4.16). It is seen that agricultural production is present in most of the rural settlements. In the livestock farming activities variable, settlements without livestock farming activities are shown in dark color (Figure 4.10). It is seen that the majority of rural settlements in the country have livestock farming activities. Settlements with factory labor (settlements indicated in dark color) are concentrated especially in the Marmara region, Aegean region, some parts of the Mediterranean region and some parts of the Eastern Black Sea region (Figure 4.11). Forestry activities are mainly concentrated in the Black Sea region, the Mediterranean region and parts of the Marmara region (Figure 4.12). The service activities variable, which includes activities such as restaurants and hotels, is found more in the Eastern Black Sea and Mediterranean coasts, where tourism is intensively seen, compared to other regions (Figure 4.14). Although the settlements with mining activities are limited, they are concentrated in some provinces and regions (Figure 4.13). Agricultural product diversity variable is obtained by summing the types of products produced in the agricultural area (Figure 4.15). This variable shows how many types of agricultural products are grown in a rural settlement based on the survey conducted by YER-SIS. Although diversity shows average values throughout the country, some provinces have very low diversity.

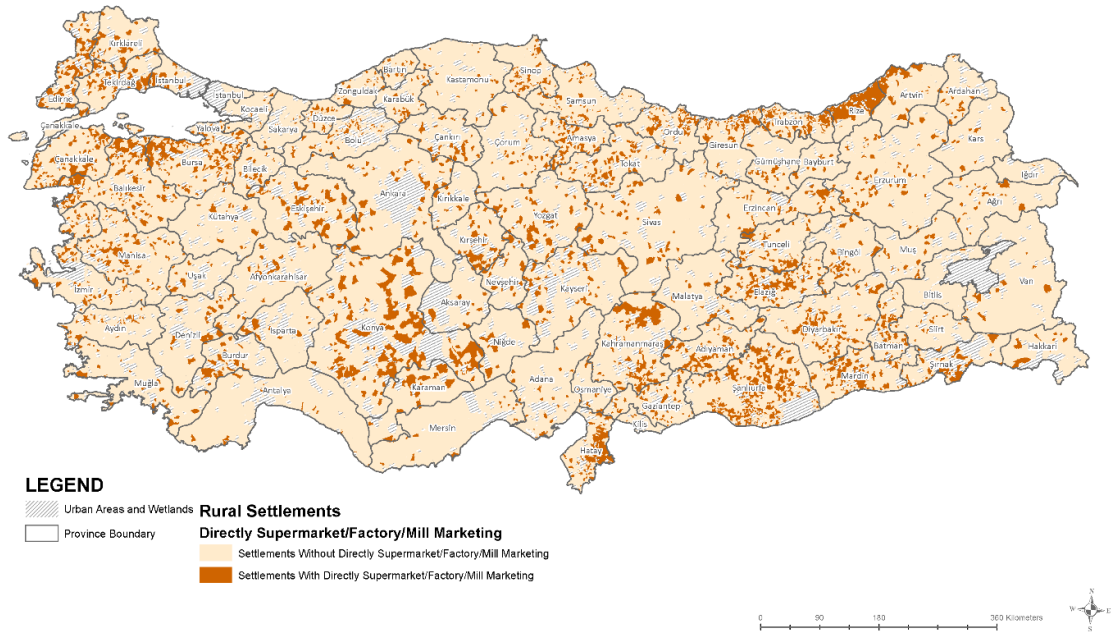


Figure 4.17. Presence of Direct Supermarket/Factory/Mill Marketing in Rural Settlements (Source: Author Work based on YER-SİS)

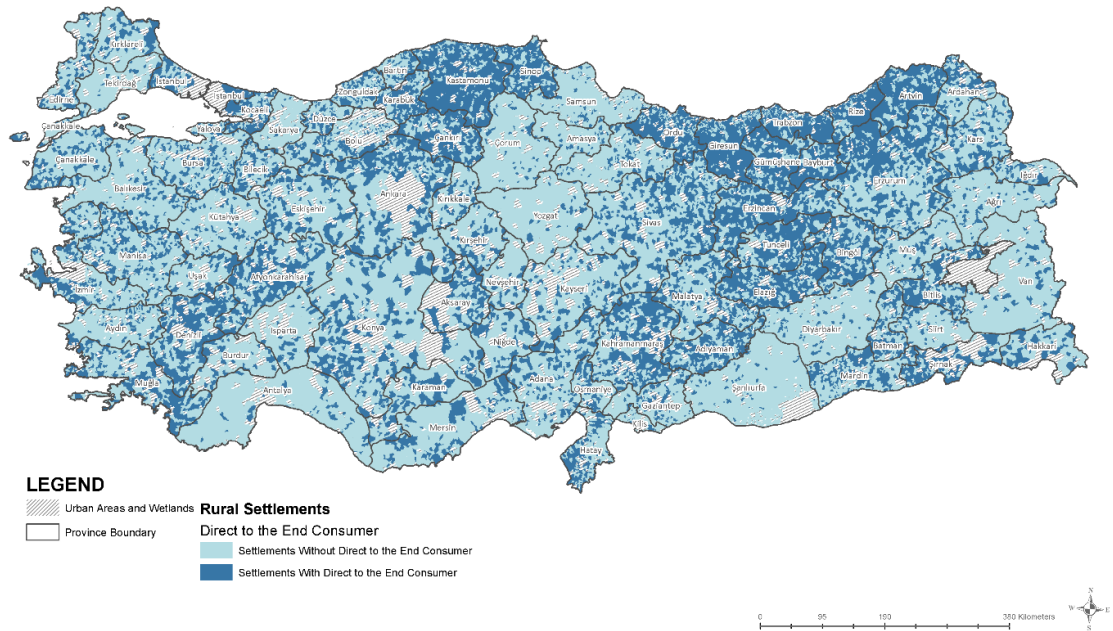


Figure 4.18. Presence of Direct End Consumer Marketing in Rural Settlements (Source: Author Work based on YER-SİS)

Supply chain in agricultural production is an effective factor in terms of costs. Marketing methods of the products are among the factors that significantly affect the market and producer profit. Therefore, marketing methods are considered as a separate dimension in the study. In order to create the marketing methods dimension, the data obtained from YER-SIS are spatialized. In the marketing methods dimension, five variables are considered as direct supermarket/factory/mill, direct end consumer, through the internet, cooperative/trade exchange/Turkish grain board, wholesaler/trader/agent. When the spatial data are analyzed, it is seen that the most used method is wholesaler/trader/agent (Figure 4.21). Except for some provinces, agricultural products are marketed with this method in most of the country. Other highly preferred methods are direct end consumer (Figure 4.18) and cooperative/trade exchange/Turkish grain board (Figure 4.20). Direct supermarket/factory/mill is a less favored marketing method in general but is concentrated in some regions (Figure 4.17). The least preferred or applied method is through the internet (Figure 4.19).

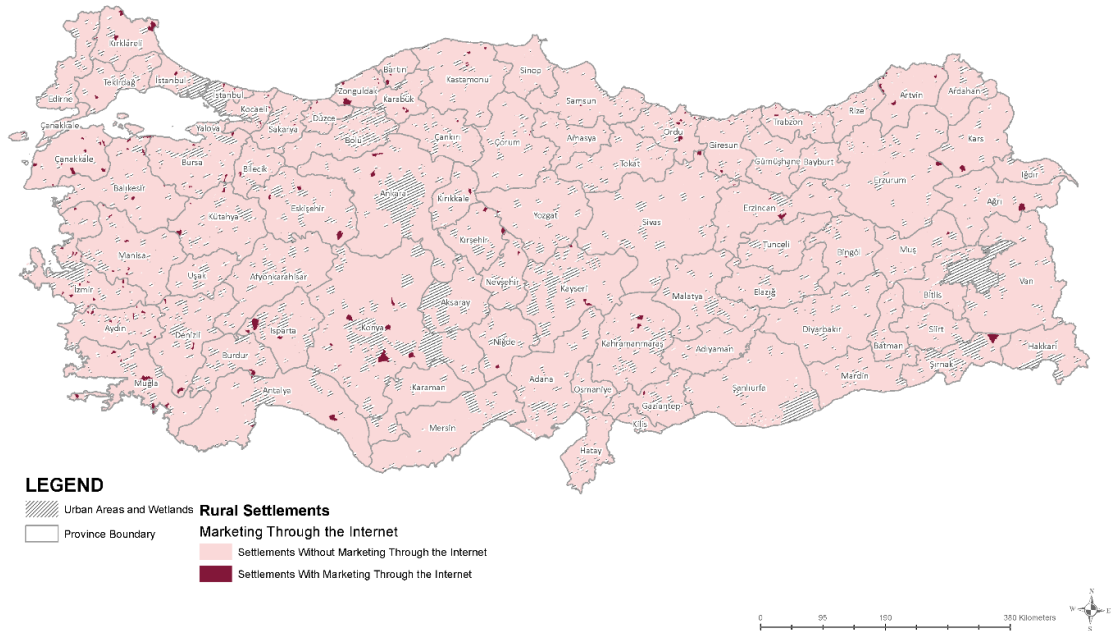


Figure 4.19. Presence of Through the Internet Marketing in Rural Settlements (Source: Author Work based on YER-SİS)

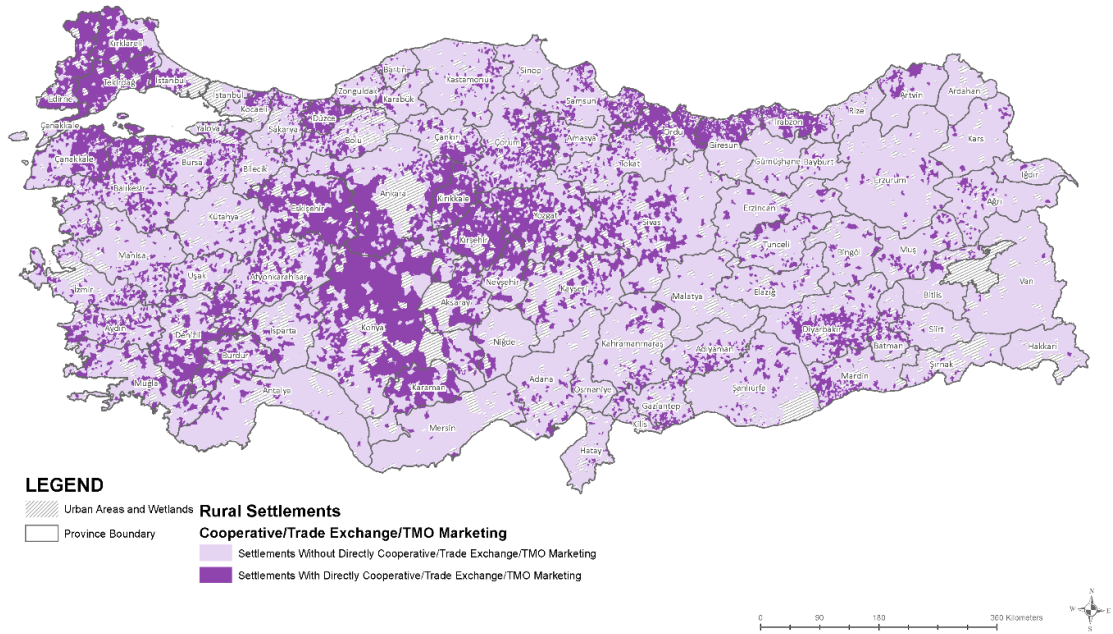


Figure 4.20. Presence of Cooperative/Trade Exchange/Turkish Grain Board Marketing in Rural Settlements (Source: Author Work based on YER-SİS)

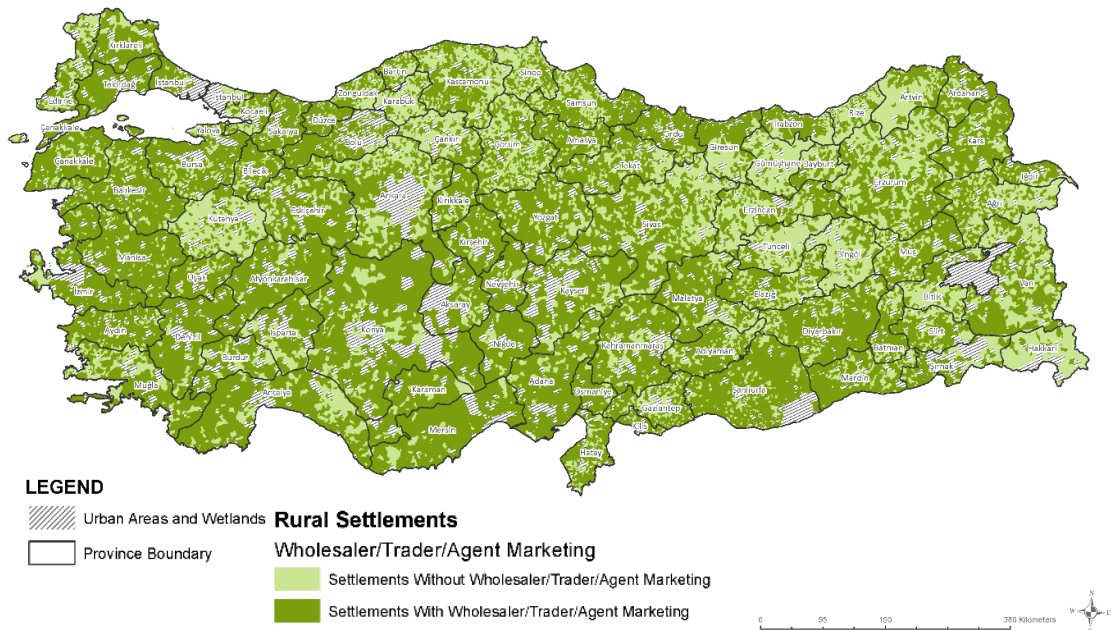


Figure 4.21. Presence of Wholesaler/Trader/Agent Marketing in Rural Settlements (Source: Author Work based on YER-SİS)

The spatial dimension is evaluated with six variables: distance to the coast, elevation, slope, agricultural area ratio, distance to main roads and distance to the first-tier city center. The incorporation of topographical features of settlements into the analysis is achieved through the consideration of elevation (Figure 4.22) and slope (Figure 4.25). In slope analysis, the intervals are created using natural breaks, while in elevation analysis intervals are created manually. The agricultural area ratio of the settlements is calculated through the ArcGIS program using CORINE data (Figure 4.24). Intervals are created using natural breaks. Upon analysis of these three spatial analyses, it is observed that there are regional differences. Three distance data is considered as spatial data in the study. The first is the distance of rural settlements to the coast (Figure 4.23). The southeastern region of the country has the greatest distance to the coast. The second distance analysis examines the distance of rural settlements to provincial centers with the highest socioeconomic development (Figure 4.26). Socioeconomic development data from the SEGE is utilized to create this data. The distance of rural settlements to the provinces with the highest socioeconomic development is calculated. The final distance data is the distance of rural settlements to mainroads (Figure 4.27). This variable is obtained by analyzing the distance of settlements to primary and secondary roads obtained from the Open Street Map (OpenStreetMap, 2023).

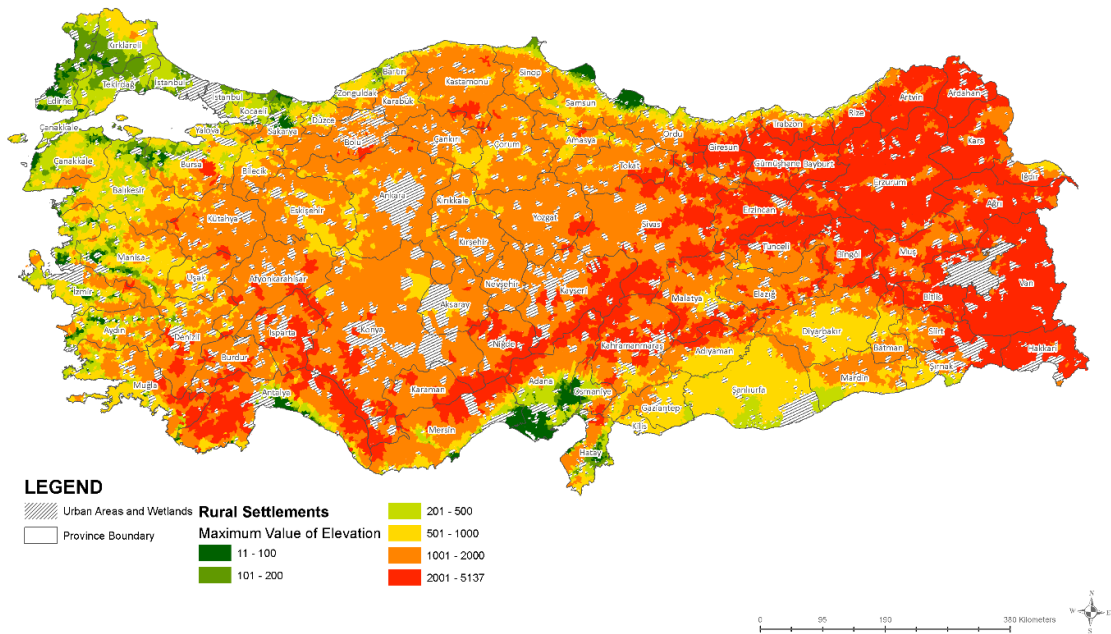


Figure 4.22. Maximum Elevation Value in Rural Settlements (Source: Author Work based on EarthData (2023))

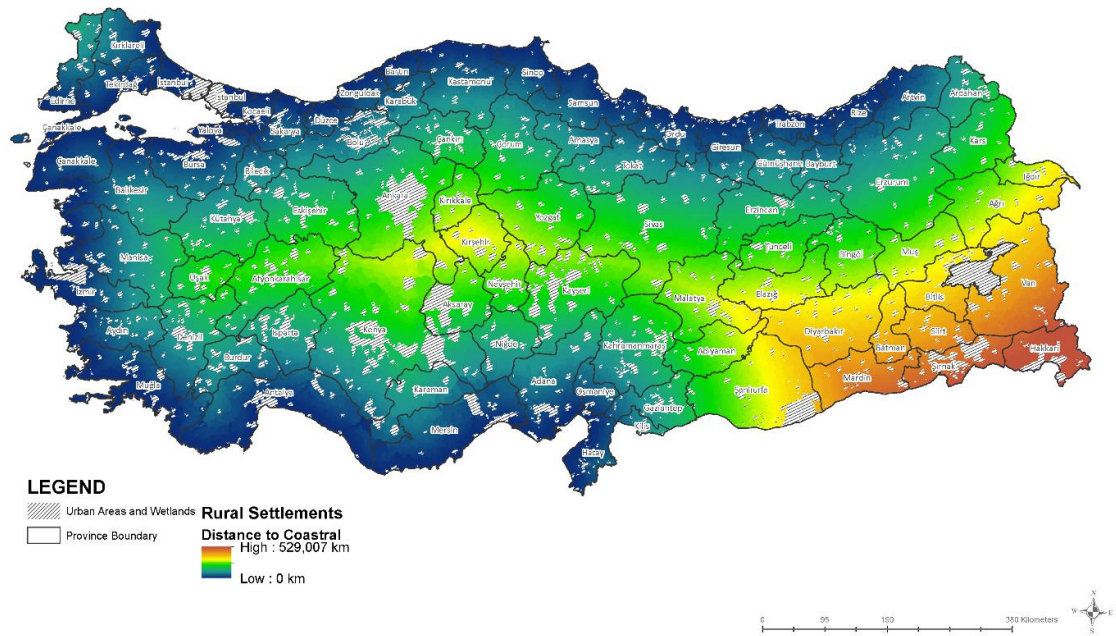


Figure 4.23. Maximum Distance to Coastal in Rural Settlements (Source: Author Work)

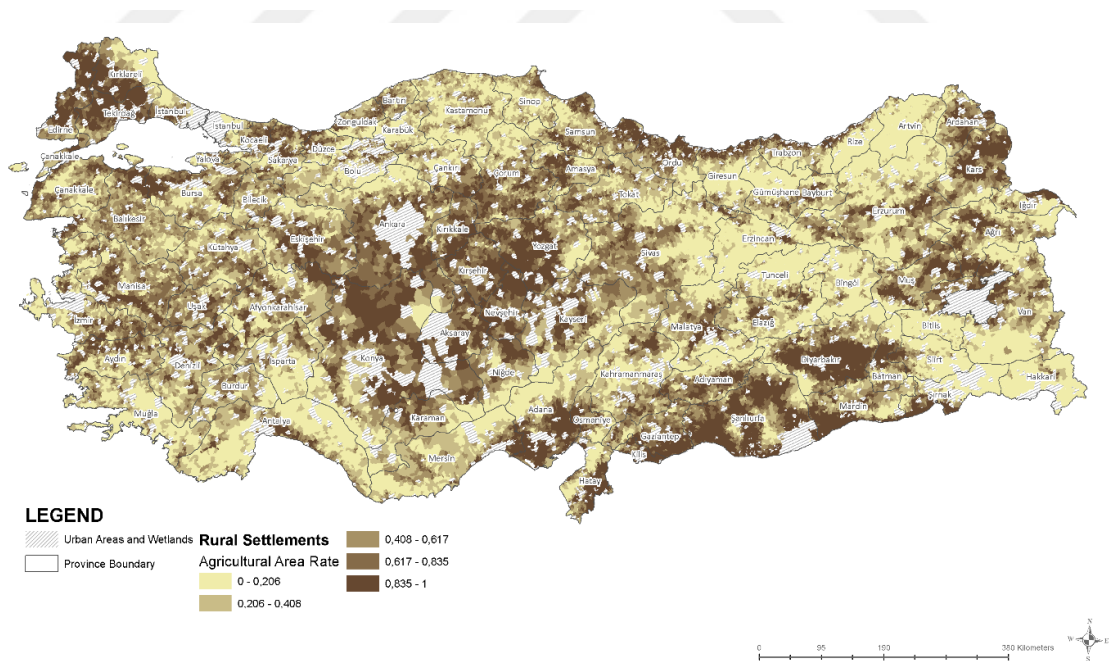


Figure 4.24. Agricultural Area Rate in Rural Settlements (Source: Author Work based on CORINE)

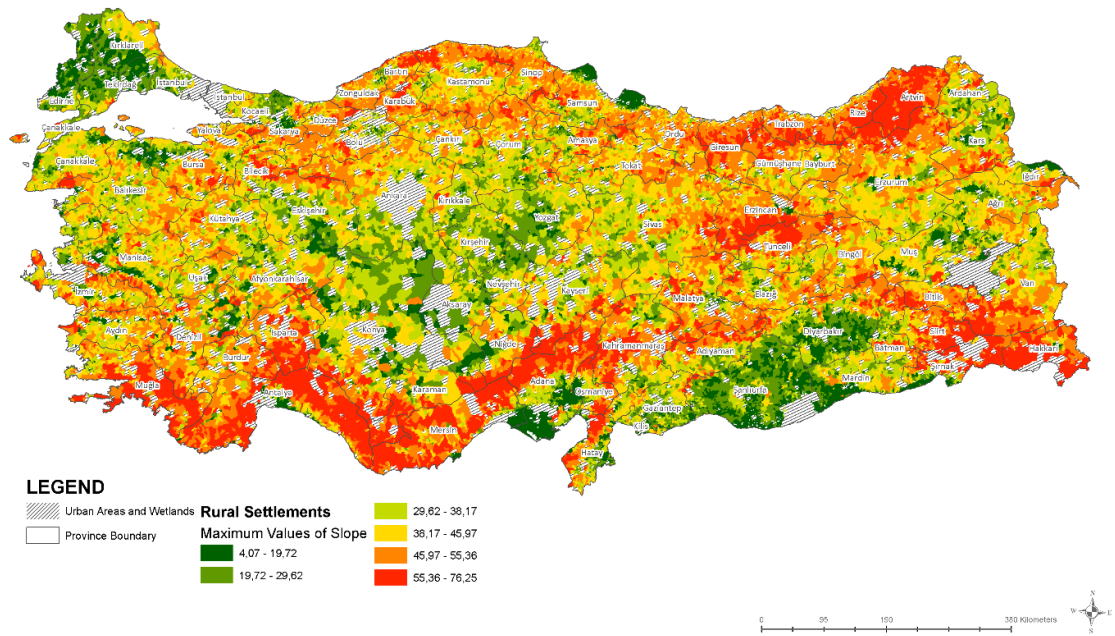


Figure 4.25. Maximum Slope Value in Rural Settlements (Source: Author Work based on EarthData (2023))

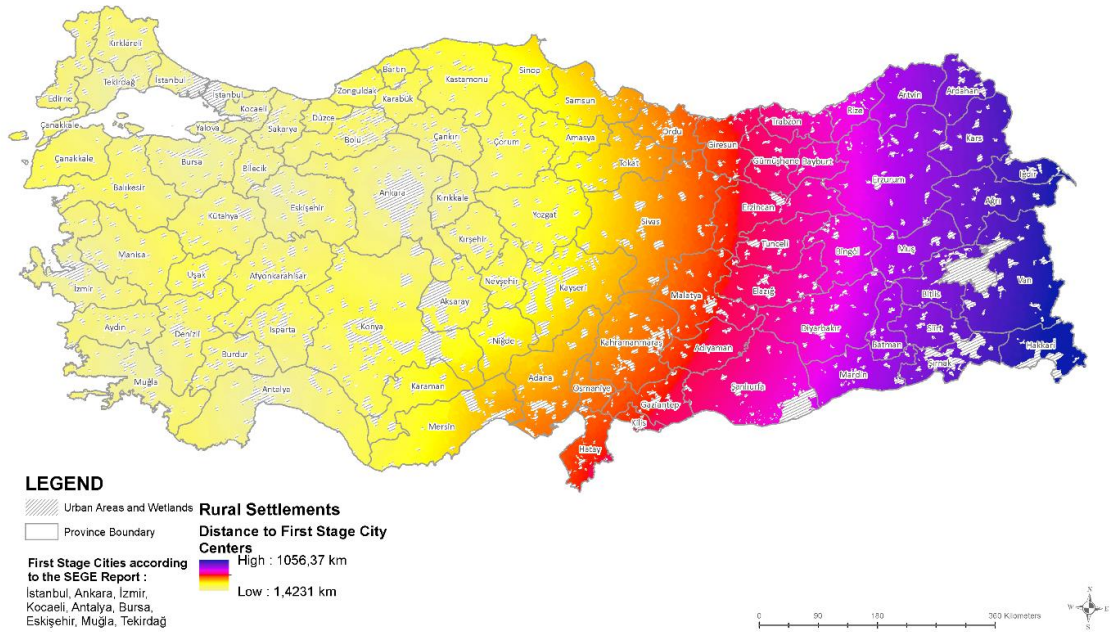


Figure 4.26. Average Distance to First Stage City Centre in Rural Areas (Source: Author Work based on SEGE)

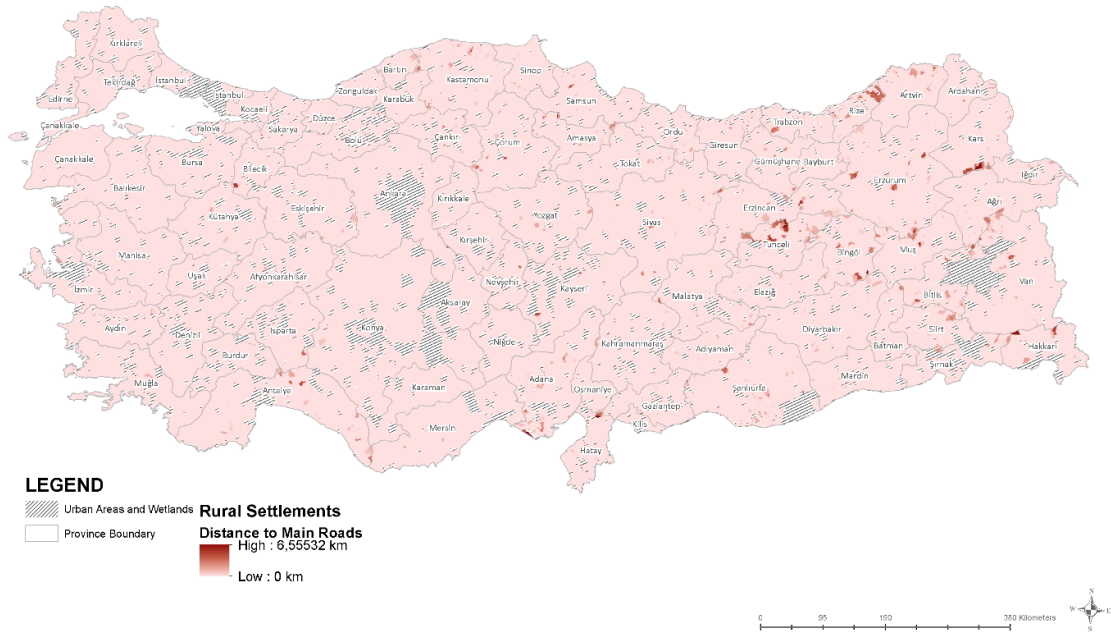


Figure 4.27. Average Distance to Main Roads in Rural Settlements (Source: Author Work based on OpenStreetMap (2023))

4.2. Weighting of Variables with CRITIC and FUCOM Methods

After the data are collected and all data are quantified in tables, the stage of determining the criteria weights is applied. In criterion weighting, two different weighting methods, subjective and objective, are used to measure the effect of the applied methods on the result. At this stage, the CRITIC method, which is an objective weighting method, and FUCOM method, which is a subjective weighting method, are applied.

When applying the CRITIC method, the dataset containing the criteria and alternatives is used as the decision metric, and the weights are calculated entirely from this dataset. The analysis is performed using Python software. The min-max normalization method is chosen for the normalization of the dataset. Each dimension is analyzed separately, and weights are obtained. The variable weights obtained are divided by the number of dimensions and the sum of all variable weights is equal to "1". The weights obtained as a result of the application of the CRITIC method are given in Table 4.1.

Table 4.1. Variable Weights Determined According to CRITIC and FUCOM Methods

Dimensions	Variables	CRITIC Dimension Weights	CRITIC Variable Weights	FUCOM Dimension Weights	FUCOM Variable Weights
Services	Primary School	0.200	0.063	0.298	0.0844
	Secondary School		0.046		0.0457
	Highschool		0.017		0.0370
	Family Health Center		0.043		0.0599
	Pharmacy		0.020		0.0465
	Hospital		0.010		0.0241
Demographic	2018 Total Population	0.200	0.071	0.150	0.0493
	2022-2018 Population Change Rate		0.096		0.0487
	2018 Density		0.033		0.0525
Sectoral	Agricultural Production	0.200	0.018	0.223	0.0676
	Livestock Farming		0.017		0.0333
	Factory Labor		0.048		0.0176
	Forestry		0.040		0.0231
	Service Activities		0.029		0.0261
	Mining		0.031		0.0122
	Agricultural Sector Diversity		0.017		0.0431
Marketing Methods	Direct Supermarket/Factory/Mill	0.200	0.036	0.197	0.0423
	Direct End Consumer		0.056		0.0433
	Through the Internet		0.008		0.0356
	Cooperative/Trade		0.047		0.0535
	Exchange/Turkish Grain Board		0.053		0.0225
	Wholesaler/Trader/Agent		0.053		0.0225
Spatial	Distance to Coastal	0.200	0.031	0.132	0.0185
	Elevation		0.022		0.0129
	Slope		0.034		0.0172
	Agricultural Area Rate		0.071		0.0352
	Distance to Main Roads		0.005		0.0237
	Distance to City Centre		0.037		0.0245

An expert questionnaire is created for the FUCOM method, and subjective criteria weights are created according to the responses of 12 experts. Among the experts, there are individuals from many different sectors working on rural areas such as urban planners,

social entrepreneurs working on rural development, agricultural engineers. 8 participants stated that they work in the private sector, 3 in academia and 1 in both academia and public sector. The average professional experience of the participants is 14.08 years. The participant with the least experience has two years of experience and the participant with the most experience has 45 years of experience. Participants are asked to rate each dimension and each dimension's variables on a scale of 1-9. The responses of the participants are analyzed using the FUCOM method and variable weights are determined. The average weight values given to the variables are obtained by averaging the determined weights. The final weight results are obtained by multiplying the average weight values of the variables by the average weight values of their own dimension. According to the results of the survey, the most important dimension among the 5 dimensions determined for smart villages is the “Services” dimension and the least important dimension is the “Spatial” dimension. The weights obtained are given in Table 4.1. The graph of the weights determined for the variables belonging to the demography dimension is given in Figure 4.28. According to the FUCOM method, the most important variable in the demography dimension is determined as the Population Density in 2018. However, the weight differences between the variables are not high. The weights determined by the CRITIC method differ from each other. According to the method, the most important demographic indicator is the population change rate between 2018-2022, while the least important variable is the density in 2018.

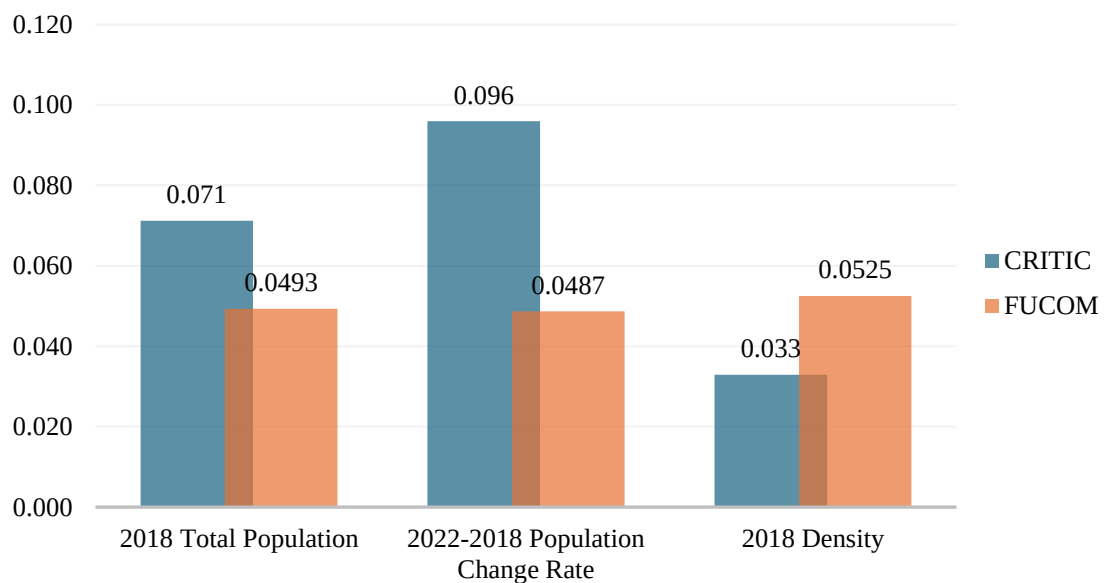


Figure 4.28. Demographic Dimension Weights

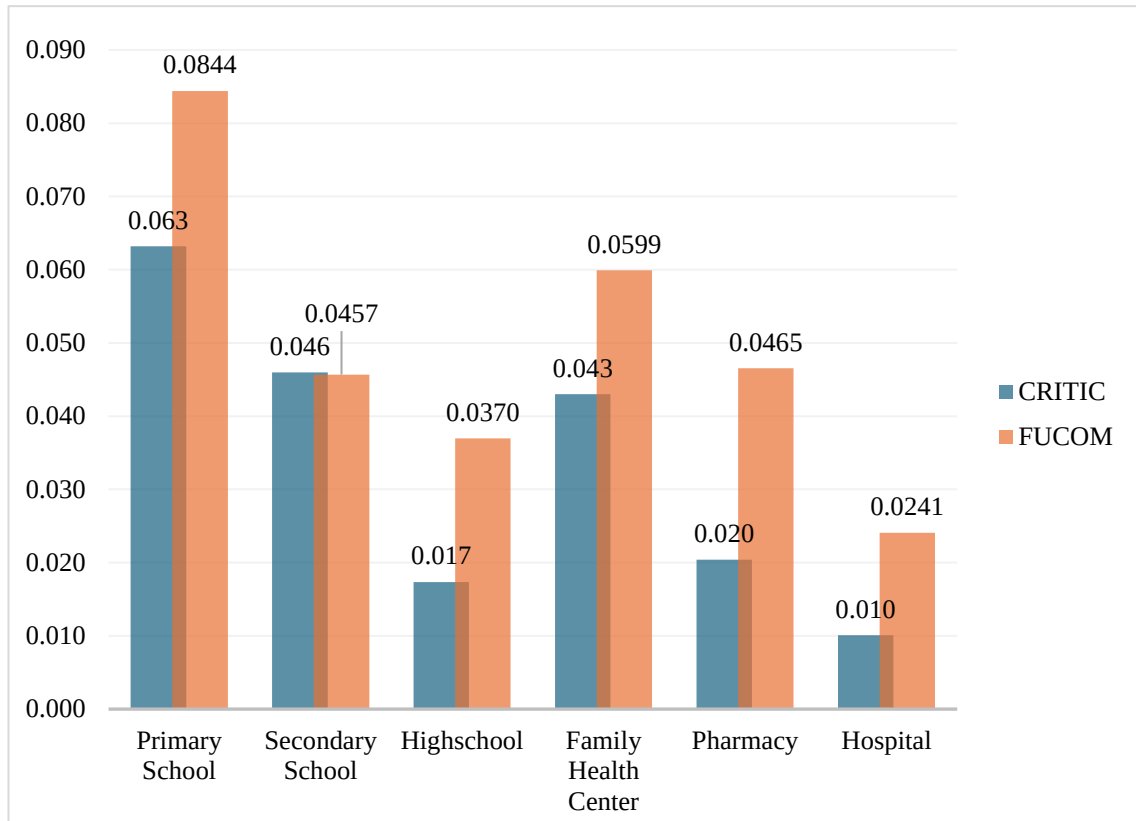


Figure 4.29. Services Dimension Weights

When the sub-indicators of the services dimension are evaluated within themselves, the results obtained by CRITIC and FUCOM methods are given in Figure 4.29. When the variables belonging to the services dimension are evaluated, the primary school presence variable is determined as the most important variable in both methods. While the second most important variable in FUCOM method is the presence of Family Health Centre, it is determined as the presence of secondary school in CRITIC method. The least important variable in both methods is the presence of hospital.

In the dimension of marketing methods, the difference between the results of the two methods in the variable of marketing through internet is remarkable. In the FUCOM method, it is seen that the degree of importance of the variable marketing via internet is higher. According to the results of this method, the most important variable is marketing through cooperative/trade exchange/Turkish grain board, while according to the results of CRITIC method, the most important variable is determined as marketing directly to the end consumer (Figure 4.30).

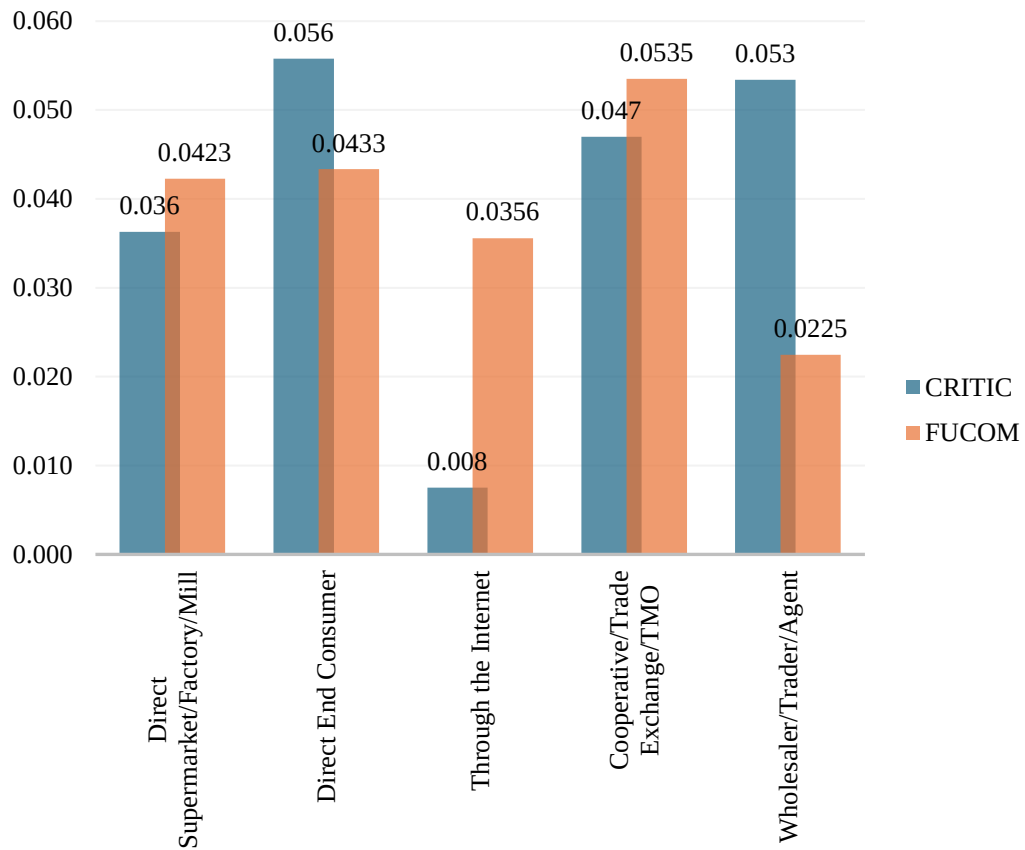


Figure 4.30. Marketing Methods Dimension Weights

In the sectoral dimension, selected sectors and agricultural products in rural settlements are considered. According to the results of the FUCOM method, the presence of agricultural production and high diversity of agricultural production in settlements are considered as important variables. According to the values determined by CRITIC method, it is important to have factory labor, forestry and service activities in rural settlements. The presence of agricultural production, animal husbandry and agricultural production diversity are considered less important than other sectoral variables. When the results of the two methods are compared in the sectoral dimension, it can be said that opposite results are obtained (Figure 4.31).

In the spatial dimension, which is the last dimension of the study, the importance of the agricultural area ratio is found to be high in both methods. While the most insignificant variable according to the CRITIC method is the distance of rural settlements to the main road, the most insignificant variable according to the FUCOM method is the height variable (Figure 4.32).

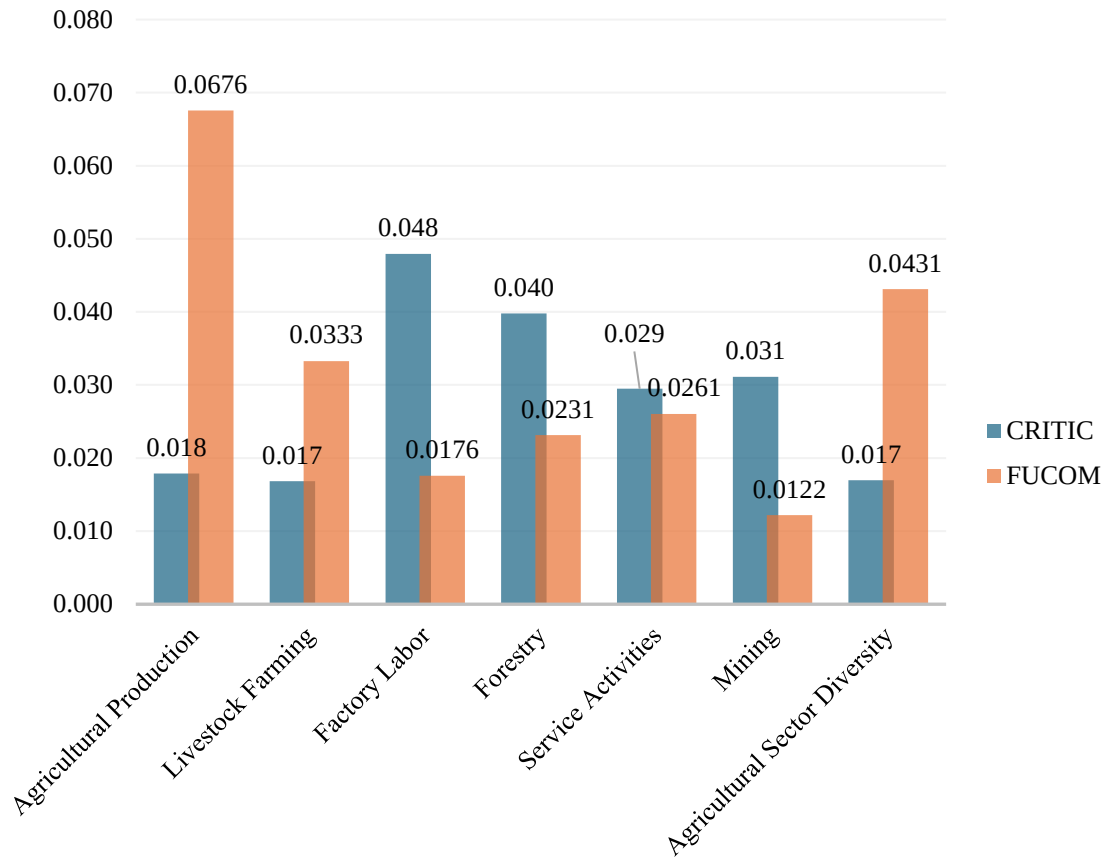


Figure 4.31. Sectoral Dimension Weights

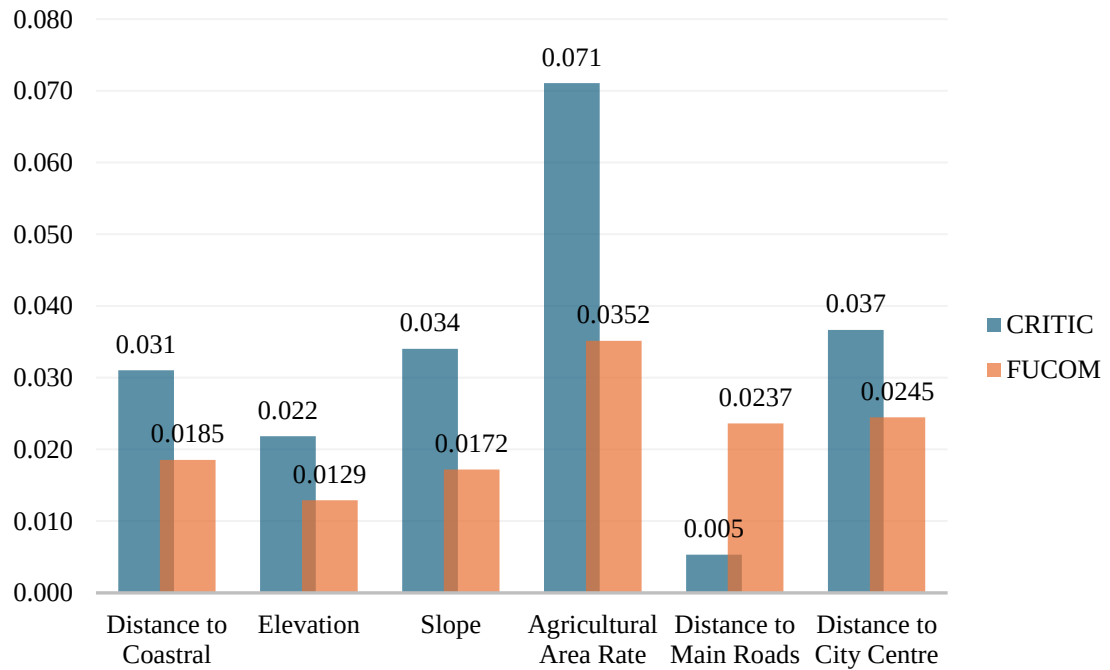


Figure 4.32. Spatial Dimension Weights

In order to evaluate the weight differences between the two methods, the absolute values of their differences are taken. When these differences are evaluated, it is seen that the variable of the presence of agricultural production in a rural settlement is the variable with the highest difference. The other variables with a high difference between the values between the two methods are the total population trend between 2018 and 2022, the marketing method through wholesaler/trader/agent, factory labor and marketing through the internet. The variable with the least weight difference is the presence of secondary school. Other variables with little difference are service activities, marketing through direct supermarket/factory/mill, marketing through cooperative/trade exchange/Turkish grain board and height.

4.3. Ranking of Rural Settlements Using VIKOR Method

In the next stage of the analysis, it is necessary to apply the variables whose weights are determined to the alternatives. With this stage, the most appropriate alternatives will be determined. There are many methods in the literature for ranking alternatives. Excel-based methods are preferred in this study since they offer detailed scoring and provide more effective results by making ranking possible. In this sense, TOPSIS is one of the most widely used methods. However, due to some disadvantages of the TOPSIS method, the VIKOR method is preferred in this study (Bhole, 2018).

After the criteria weights are determined by subjective and objective weighting methods, the VIKOR method is used to rank the alternatives according to the criteria weights. In the VIKOR method, assigning benefit/harm values to variables enables to determine whether the variable plays a positive or negative role in the alternative selection. As the value increases in the variables assigned a benefit value, the ideal solution is approached. For the variables assigned a harm value, the ideal solution is approached as the value decreases. Using the weights determined by CRITIC and FUCOM methods, 37020 settlements analyzed in the study are ranked by VIKOR method. Subjective and objective scores are obtained for each rural settlement.

Table 4.2. Objective Weighted (CRITIC) VIKOR Results Top 30 Rural Settlements in Türkiye

	Province	District	Rural Settlement	Rural Service Degree	Settlement Type	2018-2022 Population Change Rate	Maximum Elevation
1	İstanbul	Silivri	Selimpaşa	3A	Town to Neighborhood	0.045	185
2	İstanbul	Büyükçekmece	Kumburgaz	3A	Town to Neighborhood	0.044	134
3	Çanakkale	Merkez	Kepez	4A	Town	0.060	195
4	Trabzon	Yomra	Kaşüstü	4A	Town to Neighborhood	0.117	447
5	Diyarbakır	Yenişehir	Üçkuyu	3A	Village to Neighborhood	0.165	754
6	İstanbul	Büyükçekmece	Güzelce	4B	Town to Neighborhood	0.081	148
7	Manisa	Soma	Turgutalp	1	Town to Neighborhood	0.053	296
8	Antalya	Alanya	Oba	4A	Town to Neighborhood	0.073	317
9	Balıkesir	Edremit	Kadıköy	4B	Town to Neighborhood	0.099	283
10	İstanbul	Büyükçekmece	Celaliye	1	Town to Neighborhood	0.056	220
11	Diyarbakır	Kayapınar	Talaytepe	Non-Serving	Village to Neighborhood	0.207	826
12	Tokat	Merkez	Emirseyit	Non-Serving	Town	0.007	1615
13	İstanbul	Silivri	Gümüşyaka	1	Town to Neighborhood	0.039	123
14	Afyonkarahisar	Merkez	Erkmen	1	Town	0.087	1523
15	Çanakkale	Ezine	Geyikli	4A	Town	0.006	94
16	Aydın	Didim	Ak-Yeniköy	3A	Town to Neighborhood	0.012	861
17	Erzincan	Tercan	Çadirkaya	2	Town	0.022	2424
18	Muğla	Fethiye	Yeşilüzümlü	4A	Town to Neighborhood	0.032	1423
19	Ordu	Perşembe	Medreseönü	3A	Town to Neighborhood	-0.010	477
20	Muğla	Bodrum	Çiftlik	3B	Town to Neighborhood	0.018	575

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Table 4.2. (Cont)

21	Tekirdağ	Ergene	Ulaş	4A	Town to Neighborhood	0.028	163
22	Denizli	Acıpayam	Kelekçi	4A	Town to Neighborhood	-0.024	1083
23	Tekirdağ	Çerkezköy	Kızılıpınar	Non- Serving	Town to Neighborhood	0.092	232
24	Bursa	Mustafakemalpaşa	Tatkavaklı	2	Town to Neighborhood	0.040	147
25	Aksaray	Eskil	Eşmekaya	3B	Town	-0.019	1040
26	Çanakkale	Ayvacık	Küçükkuyu	4A	Town	0.013	343
27	İzmir	Urla	Kuşçular	1	Village to Neighborhood	0.062	285
28	Muğla	Fethiye	Çamköy	3A	Town to Neighborhood	0.080	125
29	Muğla	Bodrum	Akyarlar	2	Village to Neighborhood	0.033	381
30	İstanbul	Arnavutköy	Deliklikaya	Non- Serving	Village to Neighborhood	0.092	173

Table 4.2 shows the ranking obtained by using the VIKOR method to rank the weights derived from the CRITIC method, which is an objective weighting method. According to the results, it is seen that most of the settlements with high potential are settlements transformed from towns to neighborhoods. It is seen that there is a population increase in the settlements. In the YER-SIS project, rural settlements are categorized into seven rural service categories (non-serving, 1, 2, 3B, 3A, 4B and 4A) according to their degree of service provision to other settlements (Republic of Türkiye Ministry of Industry and Technology, 2020). Rural settlements that do not provide services to any other settlement are categorized as "non-serving". According to the table, it is seen that settlements with low rural service levels are also among the suitable settlements. As a final product, Figure 4.33 shows the results of the potential analysis obtained by spatially applying CRITIC weights.

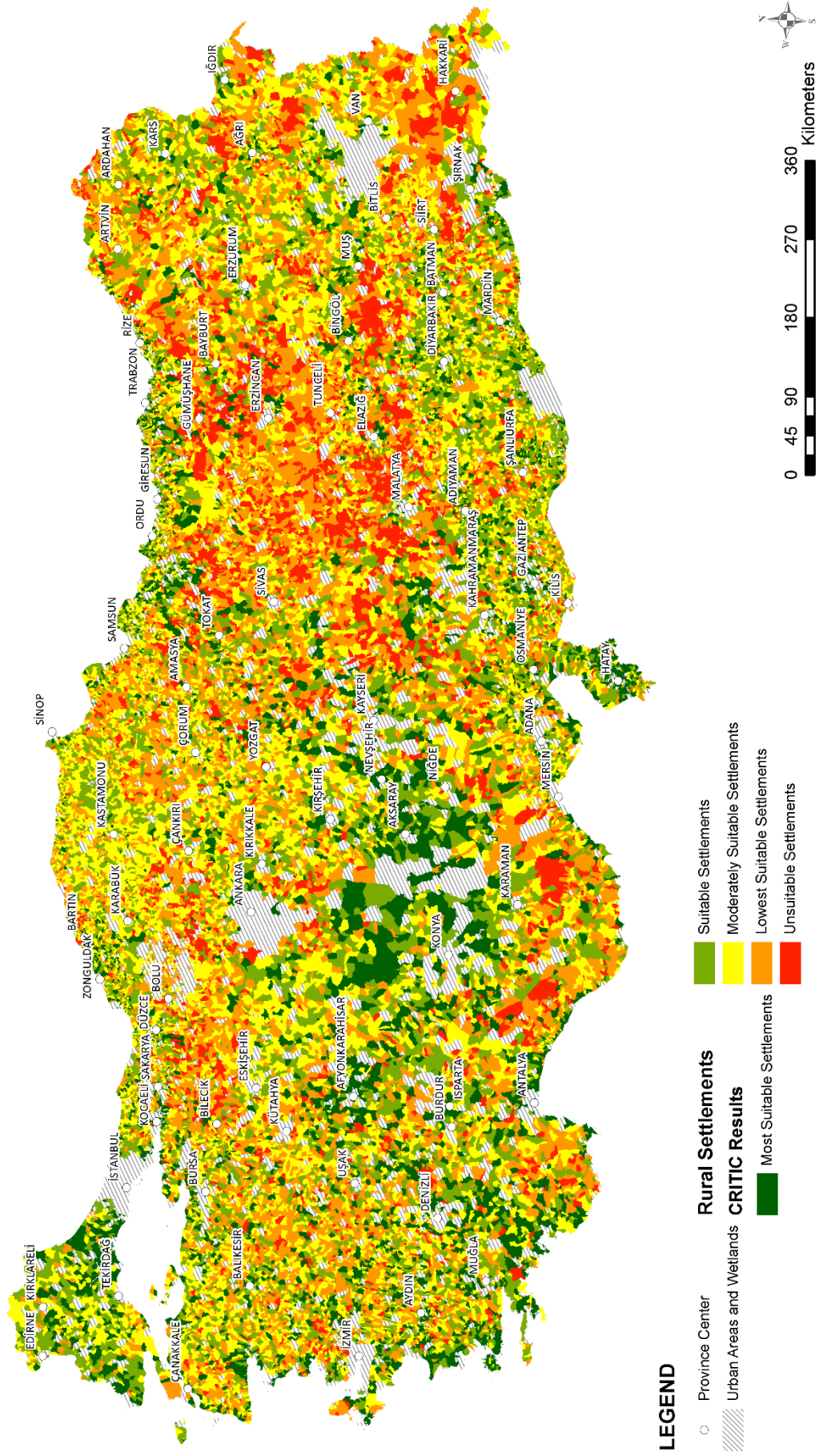


Figure 4.33. Smart Village Potential Objective Weighted Results in Türkiye

Table 4.3. Subjective Weighted (FUCOM) VIKOR Results Top 30 Rural Settlements in Türkiye

	Province	District	Rural Settlement	Rural Service Degree	Settlement Type	2018-2022 Population Change Rate	Maximum Elevation
1	Çanakkale	Merkez	Kepez	4A	Town	0.060	195
2	İstanbul	Silivri	Selimpaşa	3A	Town to Neighborhood	0.045	185
3	Konya	Çumra	İçerichumra	2	Town to Neighborhood	-0.014	1094
4	İstanbul	Büyükçekmece	Kumburgaz	3A	Town to Neighborhood	0.044	134
5	Çanakkale	Ezine	Geyikli	4A	Town	0.006	94
6	Trabzon	Yomra	Kaşüstü	4A	Town to Neighborhood	0.117	447
7	Bursa	Mudanya	Güzelyalı Eğitim	4B	Town to Neighborhood	0.054	141
8	Diyarbakır	Bismil	Tepe	4A	Town to Neighborhood	0.004	635
9	Zonguldak	Çaycuma	Saltukova	4A	Town	-0.018	29
10	Aydın	Germencik	Ortaklar	4A	Town to Neighborhood	-0.002	389
11	Trabzon	Akçaabat	Söğütlü	3B	Town to Neighborhood	0.056	697
12	İstanbul	Arnavutköy	Hadımköy	4A	Town to Neighborhood	0.044	182
13	Aksaray	Eskil	Eşmekaya	3B	Town	-0.019	1040
14	Afyonkarahisar	Merkez	Erkmen	1	Town	0.087	1523
15	Tekirdağ	Ergene	Ulaş	4A	Town to Neighborhood	0.028	163
16	Antalya	Alanya	Oba	4A	Town to Neighborhood	0.073	317
17	Muğla	Bodrum	Çiftlik	3B	Town to Neighborhood	0.018	575
18	Aydın	Sultanhisar	Atça	4A	Town to Neighborhood	-0.004	344
19	Ordu	Perşembe	Medreseönü	3A	Town to Neighborhood	-0.010	477
20	Muğla	Fethiye	Yeşilüzümlü	4A	Town to Neighborhood	0.032	1423

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Table 4.3. (Cont.)

21	İstanbul	Büyükdere	Güzelce	4B	Town to Neighborhood	0.081	148
22	Edirne	Uzunköprü	Kırcasali	3B	Town	-0.030	133
23	Çanakkale	Yenice	Pazarköy	4A	Village	-0.017	524
24	İzmir	Ödemiş	Birgi	3A	Town to Neighborhood	-0.008	2130
25	Zonguldak	Çaycuma	Nebiöğlü	4B	Town	-0.020	257
26	İzmir	Dikili	Çandarlı	4A	Town to Neighborhood	0.035	740
27	Bursa	Mustafakemalpaşa	Tatavaklı	2	Town to Neighborhood	0.040	147
28	Balıkesir	Gönen	Sarıköy	4A	Town to Neighborhood	-0.013	445
29	Eskişehir	Tepebaşı	Aşağı Söğütözü	Non- Serving	Village to Neighborhood	-0.229	854
30	Adıyaman	Besni	Şambayat	4B	Town	-0.027	738

Table 4.3 presents the rankings generated by applying the VIKOR method to the weights determined through the FUCOM method, a subjective weighting approach. According to the results, it is seen that most of the settlements with high potential are settlements that have been transformed from towns into neighborhoods. Unlike the results of the CRITIC method, FUCOM results show that settlements with declining population are also among the potential settlements. Settlements have a high level of rural services. Figure 4.34 shows the potential analysis results obtained by spatially applying FUCOM weights. According to the VIKOR results obtained by using FUCOM weights, it is seen that there are the most suitable settlements in certain settlements of the Aegean, Mediterranean, Marmara and Eastern Anatolia regions and in the Central Anatolia region. However, in some parts of Eastern Anatolia and in the part of the region extending towards the Black Sea region, it is noticeable that unsuitable settlements increase. In addition, it is seen that the settlements characterized as unsuitable in the Mediterranean region and some parts of the Marmara region are more than the other regions. It is seen that most of the Southeastern Anatolia region consists of suitable settlements. When the results weighted with CRITIC are compared with the results weighted with FUCOM, it is seen that the number of medium suitable settlements decreases in the results generated with FUCOM weights. The settlements with medium suitability in CRITIC are distributed to lower and upper levels in FUCOM results.

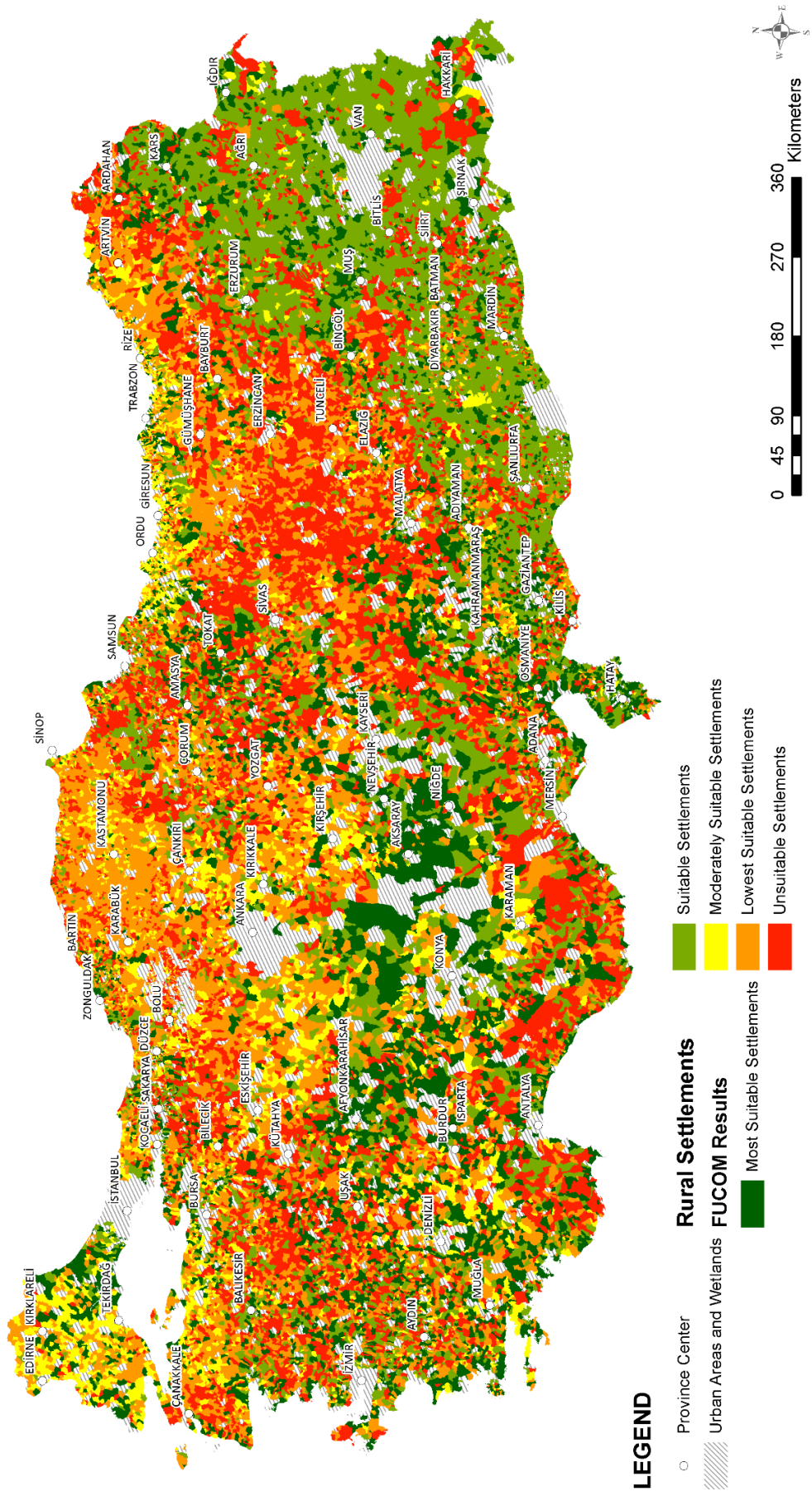


Figure 4.34. Smart Village Potential Subjective Weighted Results in Türkiye

4.4. Local Scale Evaluations: Bademler (Urla District) and Bademli Village (Ödemiş District) in İzmir Province

In the next stage of the study, the results of the suitability analysis are examined in İzmir Province. Settlement potential analyses determined by objective (Figure 4.35) and subjective (Figure 4.36) weights are compared. In this context, it is possible to examine the results of the analysis of rural settlements in İzmir Province in more detail. When the results are analyzed, it is observed that there are common results in some settlements. On the other hand, the results differ in most settlements.

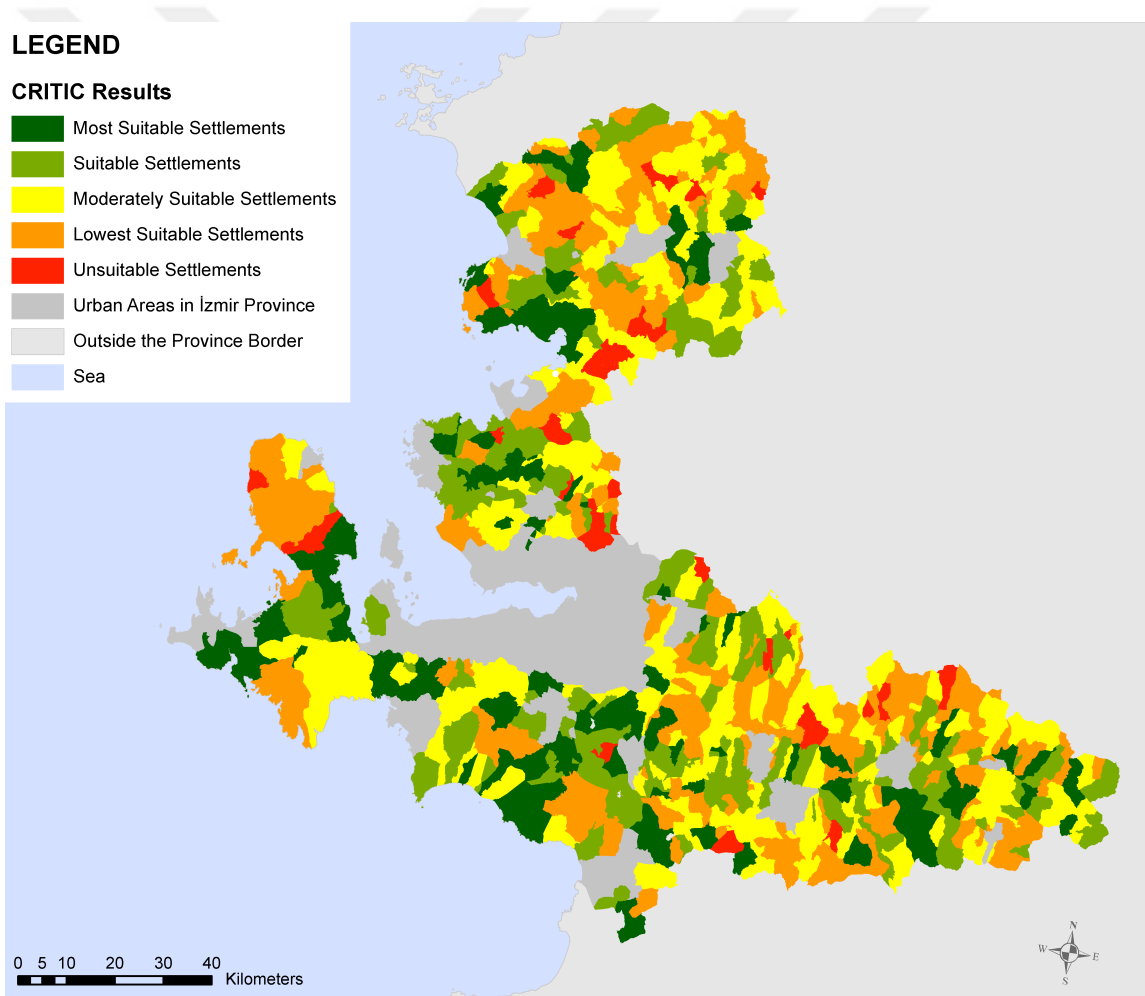


Figure 4.35. Smart Village Potential Objective Weighted Results in İzmir

Table 4.4. The 20 Most Suitable Rural Settlements in Izmir According to Objective Weighting Results

	District	Rural Settlement	Rural Service Degree	Settlement Type	2018-2022 Population Change Rate	Maximum Elevation
1	Urla	Kuşçular	1	Village to Neighborhood	0.061634	285
2	Torbalı	Fevzi Çakmak	2	Town to Neighborhood	0.067619	291
3	Dikili	Çandarlı	4A	Town to Neighborhood	0.035179	740
4	Urla	Balıklıova	1	Village to Neighborhood	0.02983	638
5	Menderes	Ataköy	4B	Village to Neighborhood	0.015612	632
6	Ödemiş	Birgi	3A	Town to Neighborhood	-0.00829	2130
7	Urla	Gülbahçe	1	Village to Neighborhood	0.062317	473
8	Torbalı	Bahçelievler	2	Town to Neighborhood	0.07949	98
9	Seferihisar	Ulamış	3A	Village to Neighborhood	0.033705	387
10	Menemen	Ulus	4B	Town to Neighborhood	0.109273	25
11	Bergama	Aşağıbey	3A	Village to Neighborhood	0.004885	771
12	Çeşme	Alaçatı	3A	Town to Neighborhood	0.008005	231
13	Bergama	Aşağıcuma	2	Village to Neighborhood	-0.03	576
14	Foça	Kazım Dirik	4B	Town to Neighborhood	0.099764	97
15	Urla	Bademler	1	Village to Neighborhood	0.024803	374
16	Kiraz	İğdeli	3B	Village to Neighborhood	-0.00222	1172
17	Torbalı	İnönü	4A	Town to Neighborhood	0.082625	145
18	Torbalı	Yazıbaşı	4B	Town to Neighborhood	0.013535	224
19	Menemen	9 Eylül	1	Town to Neighborhood	0.083091	96
20	Kınık	Yayakent	3A	Town to Neighborhood	-0.01742	321

According to the objective weighting results, the 20 most suitable rural settlements in Izmir are given in Table 4.4. Considering the rural service levels, it is seen that there are settlements belonging to all rural service degrees. When settlement types are examined, it is seen that there are two types of settlements: village to neighborhood and township to neighborhood. Among the eligible settlements, there are settlements that experienced a population decline between 2018 and 2022, but the population of most settlements is increasing. It is observed that there are not many settlements with high altitude.

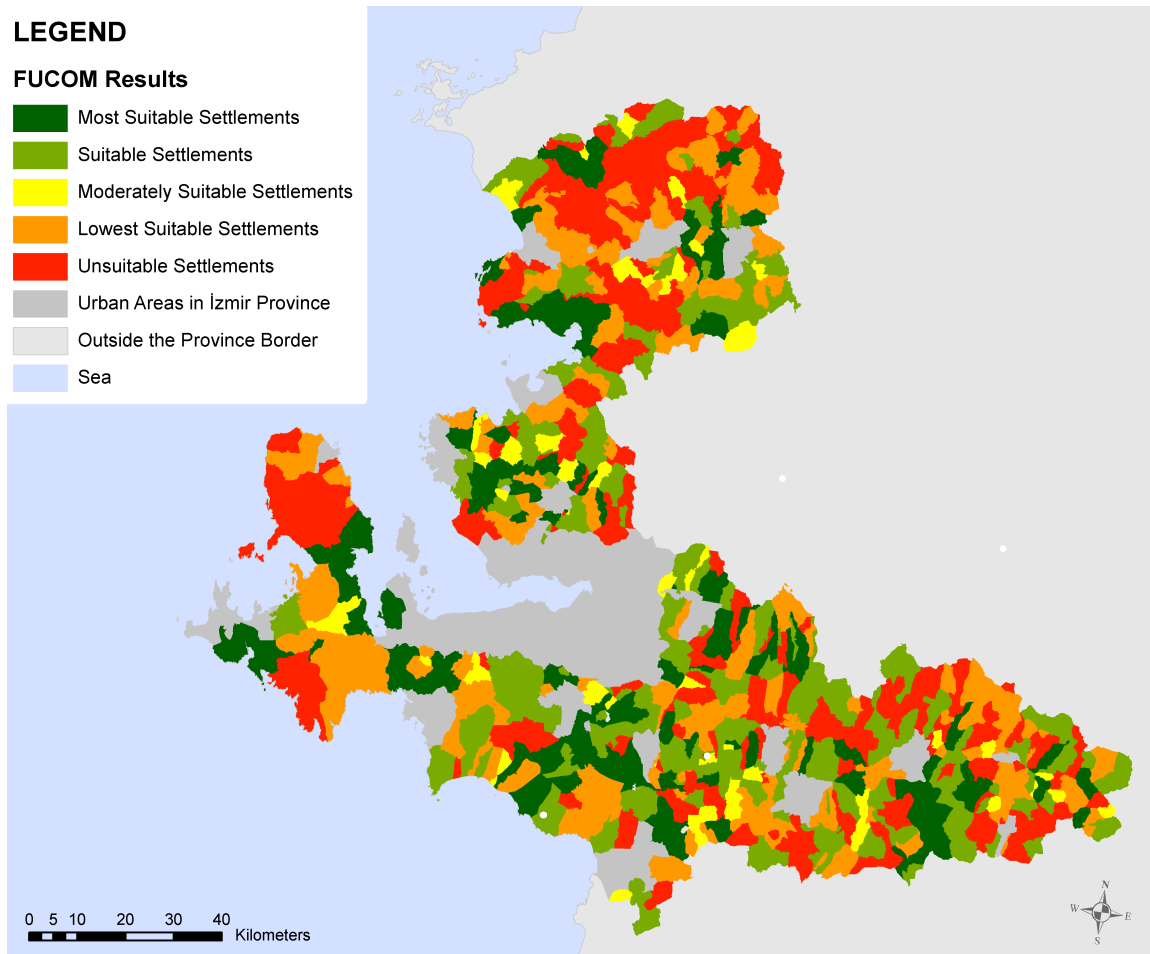


Figure 4.36. Smart Village Potential Subjective Weighted Results in İzmir

Table 4.5. The 20 Most Suitable Rural Settlements in Izmir According to Subjective Weighting Results

	Province	District	Rural Settlement	Rural Service Degree	Settlement Type	2018-2022 Population Change Rate	Maximum Elevation
1	İzmir	Ödemiş	Birgi	3A	Town to Neighborhood	-0.00829	2130
2	İzmir	Dikili	Çandarlı	4A	Town to Neighborhood	0.035179	740
3	İzmir	Urla	Balıkliova	1	Village to Neighborhood	0.02983	638
4	İzmir	Menderes	Ataköy	4B	Village to Neighborhood	0.015612	632

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Table 4.5 (cont.).

5	İzmir	Urla	Kuşçular	1	Village to Neighborhood	0.061634	285
6	İzmir	Foça	Fevzi Çakmak	3A	Town to Neighborhood	0.028301	388
7	İzmir	Seferihisar	Ula	3A	Village to Neighborhood	0.033705	387
8	İzmir	Ödemiş	Kaymakçı	4A	Town to Neighborhood	-0.00825	699
9	İzmir	Çeşme	Alaçatı	3A	Town to Neighborhood	0.008005	231
10	İzmir	Kınık	Poyracık	3A	Town to Neighborhood	0.00092	613
11	İzmir	Torbalı	Yazıbaşı	4B	Town to Neighborhood	0.013535	224
12	İzmir	Selçuk	Belevi	2	Town to Neighborhood	-0.00358	771
13	İzmir	Torbalı	Subaşı	4A	Town to Neighborhood	0.009177	28
14	İzmir	Kiraz	Karaburç	2	Village to Neighborhood	-0.00168	1516
15	İzmir	Kınık	Yayakent	3A	Town to Neighborhood	-0.01742	321
16	İzmir	Bergama	Zeytindağ	3A	Town to Neighborhood	-0.01986	298
17	İzmir	Ödemiş	Bademli	4B	Town to Neighborhood	-0.01653	1822
18	İzmir	Kiraz	İğdeli	3B	Village to Neighborhood	-0.00222	1172
19	İzmir	Bergama	Göbeller	Non-Serving	Village to Neighborhood	-0.0421	830
20	İzmir	Menderes	Çileme	1	Village to Neighborhood	0.007432	271

According to the subjective weighting results, the 20 most suitable rural settlements in İzmir are given in Table 4.5. In terms of rural service degrees, it is observed that settlements belonging to rural service classes 4A, 4B and 3A are in the majority. When settlement types are examined, it is seen that there are two types of settlements: village to neighborhood and township to neighborhood. Among the eligible settlements, there is a combination of settlements that experienced population decline and population growth between 2018 and 2022. It is observed that there are not many settlements with high altitude.

The diversification of suitable settlements in terms of population change, elevation and settlement type shows how much rural settlements can differentiate at the local scale. For instance, while the rate of population change is generally positive in the analyses, the presence of settlements in decline indicates that other variables may provide advantages. Similarly, although the high elevation variable is considered a disadvantage, some potential settlements are located at high elevations. This suggests that while high elevation may be a challenge, these settlements may have significant potential based on other factors. According to the results, the effective role of MCDM analyses in multi-criteria and multi-alternative decision making has been observed.

4.5. Bademler Village (Urla District) and Bademli Village (Ödemiş District)

In the next stage of the study, technical visits are made to the sample areas determined and place-specific indicators are tried to be revealed. The sectoral structure, demographic structure, geographical structure, etc. of the settlement are taken into consideration in the selection of the sample area. In order to make comparisons and to reveal the factors affecting the smart village potential, settlements with different characteristics are taken into consideration.

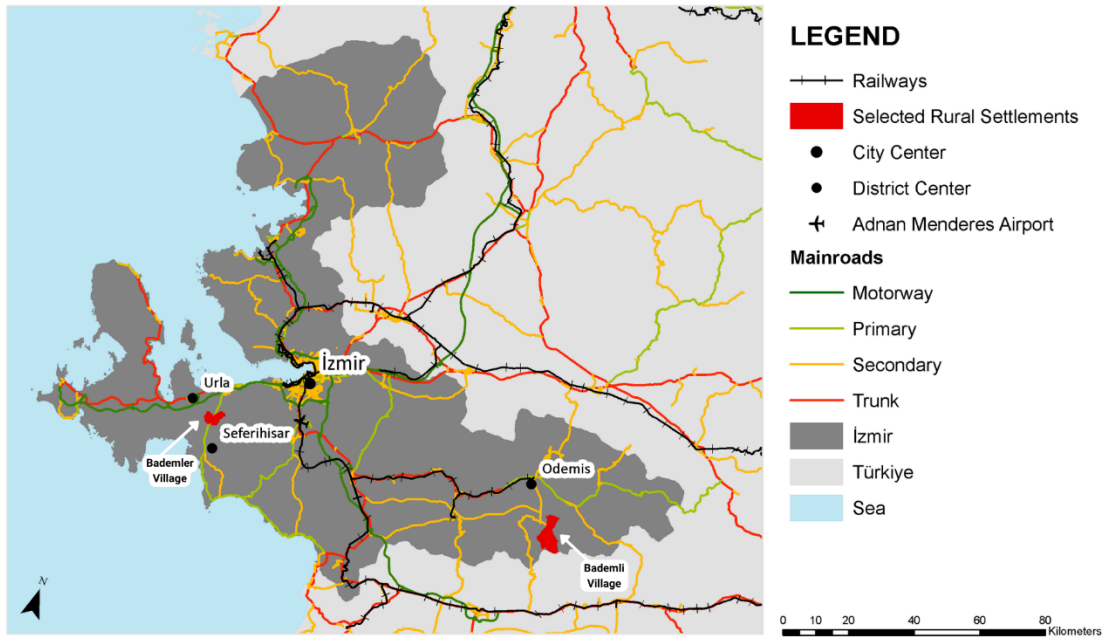


Figure 4.37. Selected Rural Settlements in İzmir Province (Source: Author work based on (OpenStreetMap 2023))

According to the results of the analysis, İzmir-Urla- Bademler and İzmir-Ödemiş- Bademli settlements, which have high potential and different characteristics, are selected as the study area. In the report published by the İzmir Development Agency, the districts where the selected sample settlements are located are characterized as transition regions (T.C. Sanayi ve Teknoloji Bakanlığı 2021). Figure 4.31 shows the location of the selected settlements within İzmir province and their transportation connections. Transportation

links are shown as mainroads (motorway), generally divided roads (trunk), national roads (primary) and regional roads (secondary) (OpenStreetMap 2023).

Bademler village (Urla District) is in the southwest of Izmir province center. It is located 39.5 km from Izmir province, 9.4 km from Urla district and 15.8 km from Seferihisar district. The distance to Adnan Menderes Airport in Izmir province is 48.2 km. The highest elevation value within the settlement boundaries in Bademler village (Urla District) is analysed as 374 meters. It differs from the other sampled village as the height value is not very high. The settlement is transformed from a village to a neighborhood with the Law No. 6360 after 2012. According to the YER-SIS data, the rural service degree of Bademler village (Urla District) is stated as "1". This indicates that the village has the lowest service rating among the rural settlements that provide services to outsiders. There are primary and secondary school education institutions. For high school education, students go to Urla district. Health services are provided by the family health center in the settlement. The center provides service 1 day a week. During the interviews, it is stated that this service is insufficient. Transportation is provided to Urla district for hospital and pharmacy services. Public transport is provided from the settlement to Izmir province, Seferihisar district and Urla district. Some necessary services (shopping etc.) can be provided by these centers. Although there are no problems with telephone networks, there is a lack of internet service. In addition, it is stated in the interviews that there is a problem with water and sewerage infrastructure. There are no banks or ATMs in the village for financial services. The population of the settlement shows a continuous upward trend (Table 4.6). While there is limited data on the social dimension at the upper scale, information on the social dimension is obtained at the lower scale. The settlement hosts the first village theatre in Türkiye. Local people are keen and conscious to participate in local governance. While the use of technology is limited in the upper age group, it is widespread among young people. Technology is widely used for education. While the young population uses areas such as parks and schools to socialize, adults have adopted cafes and street culture to socialize. Economically, it makes a living with agriculture and tourism activities. Primary agricultural activities are floriculture and olive cultivation. Livestock activities and vegetable production activities are not very common. Agricultural areas are generally family-owned. Local people either give their products to the co-operative or sell them in the neighborhood market established in the settlement. In the interviews, it is stated that agricultural production has been abandoned

due to costs and individuals who have abandoned production have started to work as laborers in someone else's place. It is stated that there are problems in benefiting from agricultural subsidies, especially due to complex procedures. There is one cooperative in the settlement. Bademler Village Agricultural Development Cooperative was established in 1962 and currently has an area of 315 decares. In this area, there are greenhouses, open agricultural areas, cold storage (3 units), and tourism areas. There is also an olive oil factory actively operated by the cooperative. Some of the people living in the village work for the co-operative. The products of the co-operative are generally marketed to municipalities and landscapers. Heat curtain technology is used in the greenhouses of the cooperative. Energy is provided by solar panels. The cooperative, which has an international partnership, continues its efforts to increase efficiency by using agricultural technology. As a disadvantage of tourism, agricultural areas are under construction pressure. There are new housing estates within the borders of the village and when analyzed spatially, it is seen that agricultural areas and settlements contrary to the village typology are intertwined.

Bademli village (Ödemiş District), the second sample area of the study, is in the southeast of Izmir province center. The village is located 129 km from İzmir province and 21.9 km from Ödemiş district. The distance to Adnan Menderes Airport is 113 km. In the village the highest altitude within the settlement boundaries is 1822 meters and it is defined as a mountain village. Although the village is in a mountainous area, it carries out most of its agricultural activities in the plain that is located adjacent to the settlement. The settlement was transformed from a town into a neighborhood with Law No. 6360 after 2012. In YER-SIS data, the rural service grade is indicated as "4B". There are primary and secondary school education institutions. Students go to Ödemiş district for high school education. Health services are provided by the family health center and pharmacy in the settlement. Transportation to Ödemiş district is provided for hospital services. Public transport service is not provided by the municipality. Transportation is generally carried out by private vehicle. It is stated that the cost of the shuttle services from the village to Ödemiş district center is high and there is a need for transportation services. There may be problems with telephone networks and there is a lack of internet service. It is stated that water is provided by the dam located near the village. For financial services, there is a Post Office Department and an ATM in the village. The population of the settlement shows a decreasing trend (Table 4.6). Local people do not participate in

local governance and have a low level of education. The use of technology is limited in the older age group and widespread among young people. The use of technology for education is not sufficient due to a lack of services. There are not enough socialization areas for the young population. While adult men adopt the culture of cafes for socializing, women generally socialize at home or in front of their houses. Economically, agricultural activities are adopted as the main source of livelihood. Many agricultural products are produced, especially nursery, animal husbandry, ornamental plant production, and olive cultivation. Agricultural areas are generally family-owned. Local people is marketing their products to traders or wholesalers. In the interviews, it is stated that laborers come from outside since the village population is not sufficient. The income level is high due to the presence of agricultural areas in the plain. There are two cooperatives in the settlement: Bademli Cooperative and Yeşil Bademli Agricultural Development Cooperative. Bademli Co-operative was established in 1968. It is active in olive cultivation, fruit sapling cultivation, ornamental plant cultivation, and animal products. Products are generally marketed to municipalities. There is an R&D unit within the cooperative. Dairy products are produced in the Milk Processing Plant established with institutional support. Milk purchased from villagers is analyzed and processed. The processed products are marketed to municipalities and supermarkets. The cooperative also has a tissue culture laboratory. With the studies carried out with experts, healthy rootstocks are produced, and healthy, disease-free saplings are produced. There are technologies such as solar panels, heating systems and irrigation systems in the facilities of the co-operative. It is stated that currently semi-automated air-conditioned greenhouses are used, and fully automated greenhouses are not used due to cost reasons. The co-operative is working at international level for marketing. In the interviews, it is stated that the co-operative has projects related to agricultural technology in the following periods. The other cooperative in Bademli village (Ödemiş District) is the Green Bademli Agricultural Development Cooperative. Certified fruit saplings are produced in the co-operative. There is also a cold storage of the co-operative. It is stated that the co-operative has renewable energy projects such as solar energy for the future.

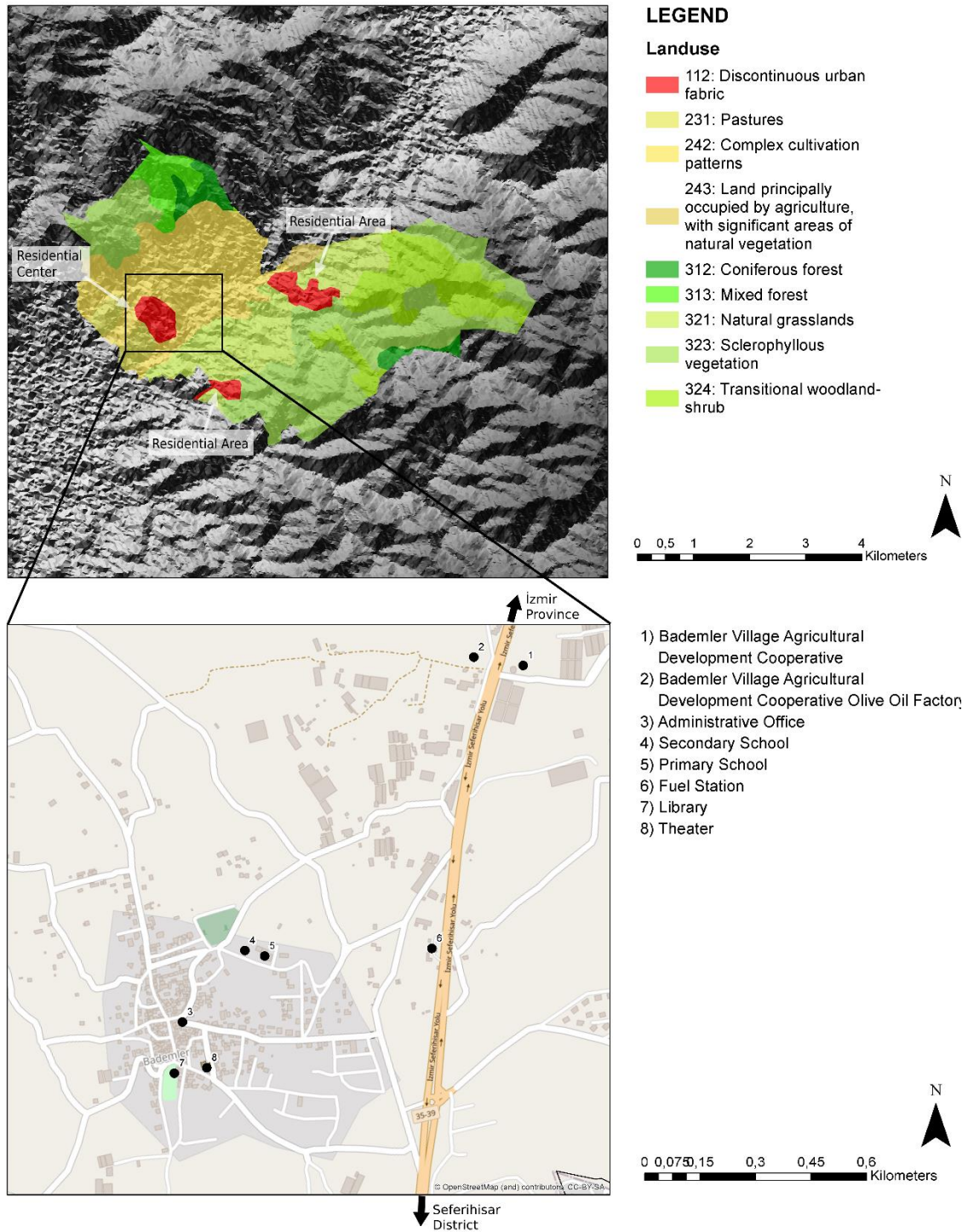


Figure 4.38. Spatial Features of Bademler Village (Urla District) (Source: Created by the author using ESRI Basemap)

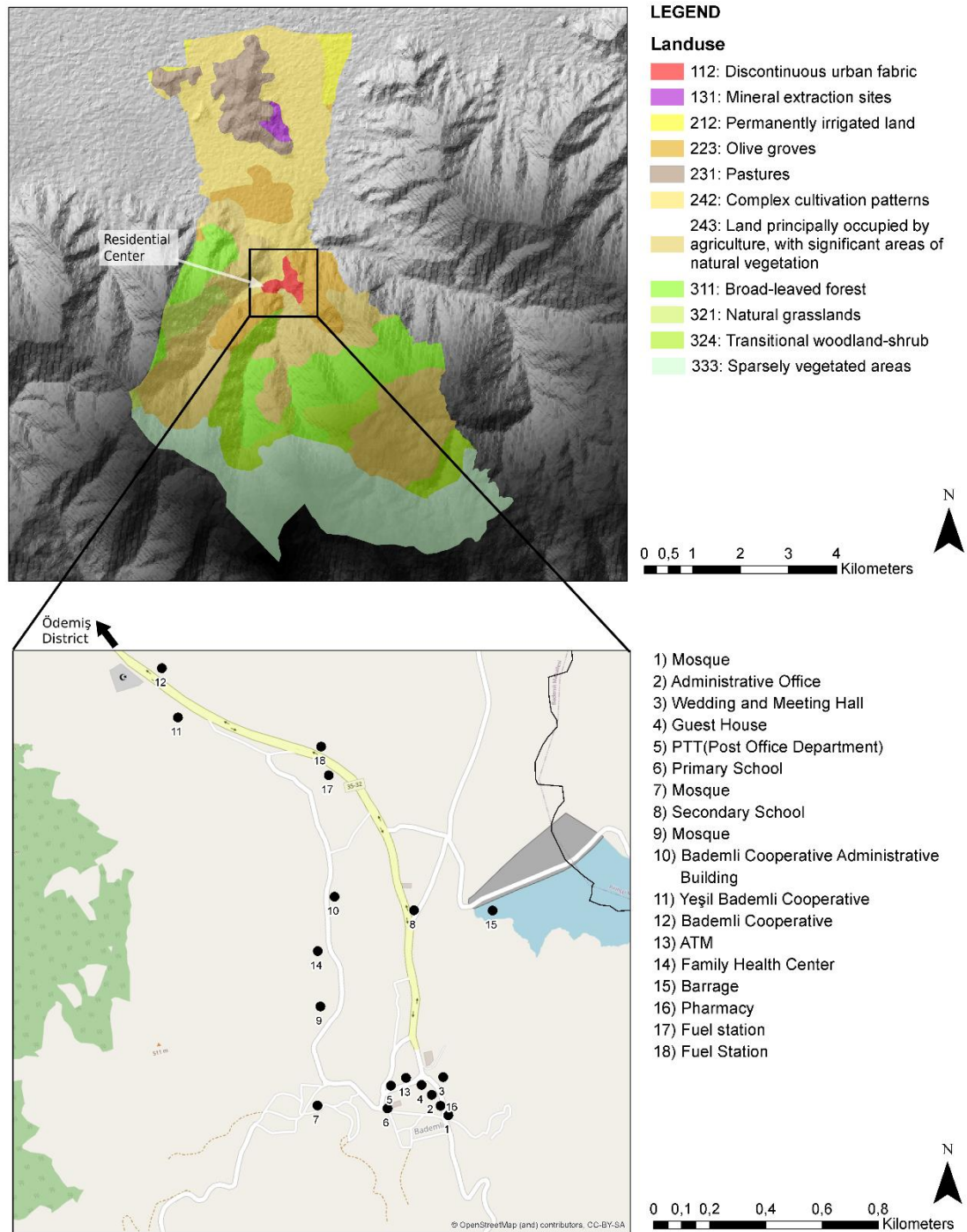


Figure 4.39. Spatial Features of Bademli Village (Ödemiş District) (Source: Created by the author using ESRI Basemap)

Table 4.6. Local Scale Data of Selected Rural Settlements

		İzmir Ödemiş Bademli (Ödemiş District)	İzmir Urla Bademler (Urla District)
Rural Service Degree		4B	1
Settlement Type		Township to Neighborhood	Village to Neighborhood
Education Services	Primary School	1	1
	High School and Vocational High School	0	0
	Middle School	1	1
Health Services	Family Health Center	1	1
	Pharmacy	1	0
	Hospital	0	0
Demographic Data	2022 Total Population	2422	2196
	2018-2022 Population Change Rate	-0.017	0.025
	2022 Population Density	52.856	122.255
	0-14 Years (2018)	427	271
	Ages 15-64 (2018)	1674	1435
	Age 65+ (2018)	488	285
	0-14 Years (2021)	384	318
	15-64 Years (2021)	1637	1527
	Age 65+ (2021)	473	362
Sectoral Diversity	Agricultural Production	1	1
	Livestock Farming	1	1
	Transfer Expenditures	1	1
	Factory Labor	1	0
	Construction Labor	0	1
	Service Activities	1	0
	Lease Activities	1	0
Agricultural Product Diversity	Cattle Husbandry	1	1
	Root and Tuber Cultivation	1	0
	Small Ruminant Livestock	1	1
	Fruit Cultivation	1	1
	Vegetable Cultivation	1	1
	Ornamental Plant and Sapling Growing	1	1
	Milk and Dairy Products	1	1
	Cereal and Legume Cultivation	0	1
	Forage Crops	1	0

(cont. on next page)

Table 4.6. (Cont.)

Marketing	Direct to End Consumers	0	1
Methods	Through the Internet	0	0
	Cooperative/Trade Exchange/ Turkish Grain Board	1	1
	Bazaar/Livestock Market	1	0
	Wholesaler/Trader/Agent	1	1
Spatial Data	Distance to First Tier City	82.535	29.481
	Area	45.830	17.973
	Seaside Distance	66.770	6.252
	Minimum Elevation	118	34
	Maximum Elevation	1822	374
	Minimum Slope	0	0
	Maximum Slope	55.639	34.326
	Agricultural Area Ratio	0.555	0.271
VIKOR	CRITIC-VIKOR Score	0.345	0.273
Results	FUCOM-VIKOR Score	0.229	0.237
Observations	Cooperative	2	1
Made in the	Library	1	1
Local Scale	Post Office Department	1	0
	ATM	1	0
	Theater	0	1
	Public Transportation	0	1

When we compare the two settlements (Table 4.6), it is seen that there are spatial, demographic, economic and status differences. First, although their total populations are close, Bademli village (Ödemiş District) experiences a population decrease with a rate of -0.017, while Bademler village (Urla District) experiences a population increase with a rate of 0.025. When the change by age group between 2018-2021 is analyzed, it is seen that the population increase of Bademler Village (Urla District) is valid for all age groups. When education and health services are analyzed, it is seen that there is no difference except for the presence of a pharmacy in Bademli village (Ödemiş District). In both settlements, hospital and high school services are provided from nearby districts. In social terms, it is observed that Bademler village (Urla District) is more social and open to the outside world due to its high literacy rate and its favorable location for tourism. Due to its location, Bademler village (Urla District) is more advantageous in terms of access to Izmir city center and access to the seacoast. In addition, its slope and elevation are lower

than Bademli village (Ödemiş District). On the other hand, the agricultural area ratio is higher in Bademli village (Ödemiş District).

Once the fundamental requirements have been met, the smart village concept will be more likely to succeed. Nevertheless, it is important to recognize that rural sociology must be considered for the successful implementation of the concept. It is believed that the spatial changes that the concept will cause and the impact of these changes on the individuals living in the village are important. In consideration of this situation, the final phase identified several key points to be considered when implementing the smart village concept in existing rural settlements. A solution has been developed through the application of design principles, resulting in the creation of an integrated model for implementation.

CHAPTER 5

DISCUSSION

This study aims to contribute to development studies in rural areas and the concept of smart village. The smart village concept is a tool for rural development. Smart villages basically refer to rural settlements that effectively use technology to solve their problems. The concept is thought to be beneficial in terms of revitalizing the economy by increasing rural productivity and income, preventing outward migration by providing economic returns to the young population, and increasing the welfare level of rural areas by providing basic services. However, the concept needs to be researched and developed with various applications.

In this study, 37020 settlements in Türkiye are analyzed with 27 variables to understand the current potential of the smart village concept. In their study conducted in China, X. Li et al. (2022), highlight the limitations of the sample size and the necessity of a comprehensive analysis. This study contributes to the existing literature by providing a detailed analysis of the entire country with a vast spatial unit. When the spatial maps of the variables at the rural settlement scale are examined, it is seen that they differ significantly from each other. This situation supports the view that each rural settlement has its own unique characteristics and place-specific strategies should be followed. Özden (2022) and Zhang and Zhang (2020) highlight the heterogeneous structure of smart villages, findings that align with those of this study. Determining strategies and taking steps accordingly will contribute to the development of more effective and sustainable practices.

Considering that the variables have different impacts, CRITIC and FUCOM methods, which are variable weighting methods, are used in the study. X. Li et al. (2022) highlighted the necessity of evaluating subjective methods together with objective

methods and integrating them. This study makes a significant contribution to the existing literature on the subject by providing a comparative analysis of the various methods employed. Some studies in the existing literature analyse the variables and dimensions in use with equal weighting (Adamowicz and Adamowicz 2021). However, according to the results, it is understood that not all criteria are of equal importance when determining the potential of a smart village. Adamowicz and Zwolińska-Ligaj (2020) conducted one of the studies considering variable and dimension weights. According to the weighting, the most important dimension is evaluated as the economic dimension. According to the results of the FUCOM analysis conducted by taking expert opinion in this study, the most important dimension is found to be “Services”. Adamowicz and Zwolińska-Ligaj (2020) did not consider services as a dimension in their study. Although the studies on the dimensions and variables of the concept are limited in the literature, studies are still in the development stage.

Using the determined variable weights, the potential of the concept is analyzed at the neighborhood scale in the whole country. According to the results, there are significant differences between the two methods. There is a significant majority of unsuitable settlements in the subjective weighting results. In the objective weighting results, there are more less suitable settlements than in the subjective results. In both analyses, unsuitable settlements are grouped in certain parts of the eastern region. These settlements extend linearly towards the Mediterranean region. In addition, in both analyses, a part of the Central Anatolia region is in the most suitable settlement class. Apart from this, there is an increase in the proportion of suitable areas in the Mediterranean coast, Aegean region and Marmara region.

Because of the local approach it is important to conduct analyses on local scale (Wolski and Wójcik, 2019). Local scale indicators have been identified in the studies conducted in Bademler (Urla District) and Bademli villages (Ödemiş District) in Izmir province. First, interviews with agricultural cooperatives indicate that there is a predisposition to the use of agricultural technology and that the use of technology in rural areas is a necessity. Renewable energy sources, biotechnological applications and semi-automated greenhouses are among the technologies already in place. Interviews with cooperatives indicated that more technological applications are targeted and needed. It would be useful to cooperate with cooperatives that include experts in the field of technological adaptation of individuals living in rural areas. Studies in the literature also

support this finding (Manda et al. 2020; S. Zhang et al. 2020). Therefore, the fact that rural areas have agricultural cooperatives is considered as an important variable in the local scale.

The distance between rural and urban areas is one of the spatial variables discussed in the literature. X. Li et al. (2022) highlight the negative impact of urbanization on rural areas over time. Additionally, it is stated that the spatial separation of rural and urban areas is decreasing over time, leading to a loss of rural identity due to factors such as sectoral diversification (Delgado-Viñas and Gómez-Moreno, 2022). Observations made in the subscale within the scope of this study have shown that rural settlements close to developed urban centers or the coast are at risk of losing their identity over time and moving away from agricultural production. The village of Bademler (Urla District), which is closer to the city center and the coast, has experienced a shift towards the tourism sector, while the agricultural sector is still dominant in Bademli Village (Ödemiş District), which is far from the city center. Considering this situation, the city center variable can be handled differently. In summary, while some studies consider proximity to the city as a positive parameter (Bielska et al. 2021), some studies consider it negatively (Bielska et al. 2021). In this study, the distance to the city variable is treated positively. The distance to the first-degree developed city variable ranked eighteenth in the subjective weighting analysis with a score of 0.02450, while it ranked twelfth in the objective weighting analysis with a score of 0.03668.

Evaluation of the social dimension is one of the important issues when measuring the potential of a smart village. As stated in many studies in the literature (X. Li et al. 2022; Komorowski et al. 2020; Slee, 2019) the importance of social structure was understood in the in-depth interviews and on-site observations conducted in this study. Characteristics such as individuals' age (Satola et al. 2022), and education level can affect the capacity of communities to adopt technology. Considering that community size also affects the concept (Zavratnik et al. 2020), it may be necessary to determine a specific population range in potential analyses. Finally, it is stated in the literature that the population density variable is important (X. Li et al. 2022). According to the results of this study, the population density variable ranked fifth with a value of 0.05251 in subjective weighting, while it ranked fifteenth with a score of 0.03289 in objective weighting. Although different results were obtained in both methods, it can be said that population density has a significant importance compared to other variables.

The services dimension is also one of the most frequently discussed dimensions in the literature. Most studies in the literature emphasize the importance of services and infrastructure in the implementation of the concept (Viswanadham and Vedula 2010; World Bank 2021). Boncinelli et al. (2015), stated in their study that health services and kindergarten are important variables, but access to middle and high school is not important. In this study, when the services variable was evaluated within itself, it was determined that the most important variables were the presence of primary school and family health center. When all variables are evaluated together in objective weighting, the presence of primary school ranks fourth, the presence of middle school ranks ninth, the presence of high school ranks twenty-second, and the presence of family health center ranks tenth. When all variables are evaluated together in subjective weighting, the variable of primary school presence ranks first, the variable of secondary school presence ranks ninth, the variable of high school presence ranks thirteenth, and the variable of family health center ranks second. As a result of the evaluation of the variables, different results from the literature are observed. It is predicted that this result, which emphasizes the differentiation of settlements, may cause differentiation in spatial implementation. In order to refer to the spatial differentiation and impact that may arise during the implementation phase, this study introduces the concept to spatial planning design. In this context, integrable abstract models have been created.

Some spatial changes may be required to integrate the smart village concept into an existing rural settlement, such as the creation of areas for socialization, the establishment of facilities for agricultural production, and the establishment of an administrative unit for data management. While determining these facilities, the current situation and needs of the rural settlement should be analyzed. Factors such as accessibility and design should be considered in the location and layout of facilities. It is important that individuals living in the village embrace these changes. For this reason, an architecturally appropriate design should be developed in accordance with the village texture. In the spatial layout of the facilities, a design that integrates with the village should be determined instead of a design that creates the perception of being separate and inaccessible from the village. It is considered necessary to have a smart campus within the village.

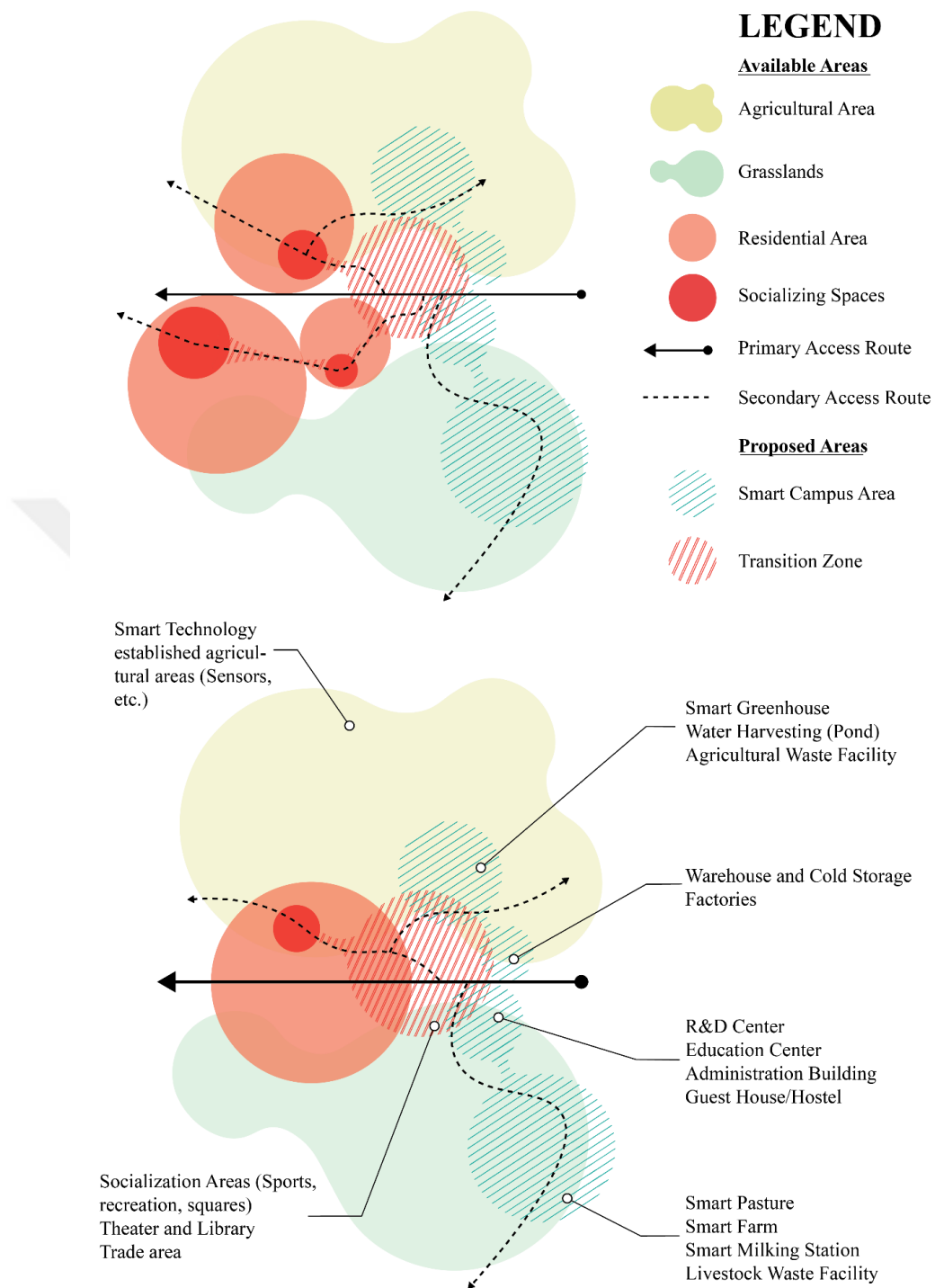


Figure 5.1. Proposal of Smart Village Plan Models (Source: Author work inspired by Yi & Son (2022))

Considering the diversity of rural areas, the smart village models developed will also vary. Variables such as spatial structure, economic structure and social structure differences will also have an impact on the models. In this study, basic models are tried to be put forward by considering spatial differences. Considering the spatial distribution of the settlement, 2 models are developed. The first model is developed for holistic rural settlements with single-centered development. The second model represents rural

settlements with dispersed and fragmented development. These models are given in Figure 5.1. Three basic principles are adopted for model design.

- High smart campus accessibility
- The existence of a transition zone between the smart campus and the existing village settlement
- Establishing a connection between the transition zone and existing socialization areas

The first of these models is that the smart campus, which is considered as the smart village component, is located at the entrance of the settlement. This will provide a favorable environment in terms of accessibility. The smart campus is divided into 4 interrelated zones. The administrative area is where the R&D center, training center, administration building, and guesthouse are located. The other zone is where the warehouses and factories are located. These two zones are proposed to be at the entrance of the village and close to the main transportation road for accessibility. The area where livestock facilities such as smart pasture, smart farm, smart milking station and animal waste facility are located is recommended to be located close to the pastures. The smart pasture, smart farm and smart milking station can be located close to the village, but the waste facility should be located far away. The last zone is where the smart greenhouse, water harvesting, and agricultural waste facility units are located. This zone is recommended to be located close to the agricultural areas. The second principle is to provide a transition zone between the smart campus and the village. This area will include socialization areas (square, park, sports fields, etc.), cultural development areas (theater, library, etc.) and a sales area. With this step, a connection between the smart campus structure and the village will be established. The third principle is that it is also important to connect this area with existing squares. In scattered settlements, it is recommended to

establish connections between the centers of all settlement groups and to develop connections with the transition zone.



CHAPTER 6

CONCLUSION

The long-standing rural-urban divide has become more complicated with the emergence of new transition zones. Over time, this theoretical confusion has also affected space. In addition to this ongoing definitional complexity, rural areas face different problems. In order to find solutions to these problems and to stop the rural decline that started with the industrialization, rural development studies have been going on for a long time. At this point, the concept of smart village emerges as a current rural development tool. The smart village concept is an integrated rural development plan that addresses many dimensions in rural settlements at the same time. In this respect, it is an approach with a high probability of success compared to the development tools applied in the past. It also offers an innovative perspective on rural development approaches by making technology a tool. The research on the problems of rural areas and the cycle of rural decline refer to economic problems. The economic dimension is also prominent in the benefits of the concept experienced and expected to occur in current practices. This shows the potential of the concept to alleviate the cycle of decline.

In the study, inferences are made at two different spatial scales: country scale and rural settlement scale. This approach allowed the concept to be analyzed from different spatial perspectives. At the country scale, a comprehensive data set is considered. At the rural settlement scale, settlements with high potential are examined and the requirements of the concept are analyzed on site. The results are evaluated according to the research questions.

The first research focus is to analyze the potential of the concept in Türkiye and to provide a perspective on the current situation for future studies. In this direction, CRITIC and FUCOM methods are used for criteria weighting and VIKOR method is used

to rank the alternatives. Due to the different weights of the variables, the potential analysis results of rural settlements also differed. When the results of the VIKOR analysis are analyzed across Türkiye, it is seen that the settlements with the lowest potential are concentrated in a part of the Eastern Anatolia region. The regions with the highest potential are concentrated in the Marmara region, especially in the regions close to Istanbul, on the coasts of the Aegean and Mediterranean regions and in Central Anatolia. However, settlements with a medium degree of suitability in CRITIC-VIKOR method are observed to shift towards suitable or unsuitable settlement types in FUCOM-VIKOR results. As a result, in this study, the variables obtained in different dimensions are analyzed with CRITIC methods to evaluate the potential of rural settlements to be suitable for smart villages.

The second research focus is to reveal the differences between objective and subjective methods by comparing CRITIC and FUCOM methods. The differences between CRITIC and FUCOM results in country-level analyses show that subjective and objective methods differentiate and the importance of method selection. When the methods are compared, it is determined that the three variables with the highest difference are Agricultural Area Rate, 2022-2018 Population Change Rate, Presence of Agricultural Production, while the three variables with the least difference are Marketing through Cooperative/Trade Exchange/Turkish Grain Board, Marketing through Direct Supermarket/Factory/Mill and Presence of Service Activities. Presence of Secondary School is the only variable that has the same weight in both methods.

In order to identify the sub-indicators, which is the third research focus of the study, it has been observed that the potential areas are diversified in the local scale. According to the results, the differences between the two settlements, which are among the most suitable settlements, are evaluated through in-depth interviews and observations made on-site. One of the important conclusions obtained at this stage is that the social dimension should be measured for a successful implementation. Because it is important to work in partnership with individuals living in the settlement. According to the conclusions drawn from local scale studies, it is important to understand rural sociology in order to work in cooperation with the local community. Local-scale variables related to rural sociology will greatly contribute to effectively measuring the applicability of the concept. The second important implication is the existence of cooperatives. Based on the observations and interviews, cooperatives can be useful in enabling individuals to adapt

to technology, increase access to experts, provide a collaborative approach, and implement a bottom-up approach by involving individuals in horizontal (between similar institutions) and vertical (between hierarchical institutions) political communication. The third implication is related to population, which is considered as an important variable. Setting a certain lower and upper population limit in the settlement where the concept will be implemented will increase the chances of success. Considering the closed and conservative nature of rural societies, the chances of cooperation with individuals living in settlements with low populations will be lower than in settlements with high populations. A certain level of population will increase the chances of accessing individuals with high cooperation capacity. However, it is important to keep in mind that overpopulated rural settlements may have problems such as loss of rural identity or lack of community governance during implementation.

When applying the smart village concept to an existing settlement, several factors may need to be considered. Firstly, it is important to understand the opportunities and challenges in the settlement and identify the needed applications. In addition, the spatial, economic, social, ecological and demographic characteristics of the settlement should be assessed and the applications should be customized for each rural settlement. Since rural settlements are heterogeneous, it would not be effective to recommend a single design or method. However, it would be useful to consider some basic requirements. Most importantly, it is necessary to ensure the adoption of spatial changes in rural settlements, which can be introverted and closed to innovation. The smart village concept aims to develop and improve a village in many dimensions, including spatial, economic, ecological, social and administrative. In this process, it is important not to disrupt the rural structure and to ensure development in accordance with this structure. As a result of the research, interviews and observations, it is seen that one of the biggest obstacles to the smart village concept is the social structure. It is important to consider rural sociology and the spatial structure of rural areas when implementing this concept, where a bottom-up planning approach is important. Therefore, at the end of this study, smart village planning strategies are developed with a holistic approach to protect rural areas.

There are some limitations of the study. First of all, the limited data available at the rural settlement scale may be a disadvantage in terms of comprehensiveness of variables and more accurate results. Another limitation is the lack of data especially on the social dimension. It is important to include the social dimension when analyzing the

potential of this concept, which emphasizes the role of the community. Considering this situation in future studies, the inclusion of social variables in the study will make the results more consistent and take the study to the further level. In addition, improving the dataset by adding variables such as solar energy potential areas, wind energy potential areas and agricultural data will provide effective results. Our study has shed light on future studies by classifying potential areas. Developing local-specific policies by elaborating the studies carried out at the local scale will contribute to rural development studies. In this sense, this study is expected to guide decision makers, researchers and policy makers.



REFERENCES

- Adamowicz, Mieczysław, and Mieczysław Adamowicz. 2021. "The Potential for Innovative and Smart Rural Development in the Peripheral Regions of Eastern Poland." *Agriculture*. <https://doi.org/10.3390/agriculture11030188>.
- Adamowicz, Mieczysław, and Magdalena Zwolińska-Ligaj. 2020. "The 'Smart Village' as a Way to Achieve Sustainable Development in Rural Areas of Poland." *Sustainability* 12 (16): 6503. <https://doi.org/10.3390/su12166503>.
- Adesipo, Adegbite A, Oluwaseun Fadeyi, Kamil Kuca, Ondrej Krejcar, Ondrej Krejcar, Petra Maresova, Ali Selamat, and Mayowa Adenola. 2020. "Smart and Climate-Smart Agricultural Trends as Core Aspects of Smart Village Functions." *Sensors*. <https://doi.org/10.3390/s20215977>.
- Anastasiou, Evgenia, Stella Manika, Konstantina Ragazou, and Ioannis Katsios. 2021. "Territorial and Human Geography Challenges: How Can Smart Villages Support Rural Development and Population Inclusion?" *The Social Sciences*. <https://doi.org/10.3390/socsci10060193>.
- Atkočiūnienė, Vilma, and Gintarė Vaznonienė. 2019. "Smart Village Development Principles and Driving Forces: The Case of Lithuania." *European Countryside*. <https://doi.org/10.2478/euco-2019-0028>.
- Aytaç Adali, Esra, Gülin Zeynep Öztaş, Tayfun Öztaş, and Ayşegül Tuş. 2022. "Assessment of European Cities From a Smartness Perspective: An Integrated Grey MCDM Approach." *Sustainable Cities and Society* 84 (September). <https://doi.org/10.1016/j.scs.2022.104021>.
- Balta, Sıla, and Meryem Atik. 2022. "Rural Planning Guidelines for Urban-Rural Transition Zones as a Tool for the Protection of Rural." *Land Use Policy*.
- Başbüyük, Adem. 2011. "Mesudiye (Ordu) Köy Kent Projesi." *Doğu Coğrafya Dergisi* 9 (11).
- Bhole, Girish P. 2018. "Multi Criteria Decision Making (MCDM) Methods and Its Applications." *International Journal for Research in Applied Science and*

- Bielska, Anna, Małgorzata Stańczuk-Gałwiazek, Katarzyna Sobolewska-Mikulska, and Robert Mroczkowski. 2021. “Implementation of the Smart Village Concept Based on Selected Spatial Patterns – A Case Study of Mazowieckie Voivodeship in Poland.” *Land Use Policy* 104 (May). <https://doi.org/10.1016/j.landusepol.2021.105366>.
- Bokun, Katarzyna, and Joanicjusz Nazarko. 2023. “Smart Villages Concept — A Bibliometric Analysis and State of the Art Literature Review.” *Progress in Planning* 175 (September). <https://doi.org/10.1016/j.progress.2023.100765>.
- Boncinelli, Fabio, Gabriele Pagnotta, Francesco Riccioli, and Leonardo Casini. 2015. “The Determinants of Quality of Life in Rural Areas from a Geographic Perspective: The Case of Tuscany.” *Review of Urban and Regional Development Studies* 27 (2): 104–17. <https://doi.org/10.1111/rurd.12035>.
- Budziejewicz-Guźlecka, Agnieszka. 2019. “Smart Village as a Direction for Rural Development.” In *20th International Scientific Conference "Economic Science for Rural Development"*. <https://doi.org/10.22616/esrd.2019.100>.
- Cao, Lingling, Huawei Niu, and YiFeng Wang. 2022. “Utility Analysis of Digital Villages to Empower Balanced Urban-Rural Development Based on the Three-Stage DEA-Malmquist Model.” *PLoS ONE* 17 (8). <https://doi.org/10.1371/journal.pone.0270952>.
- Çelik, Zühre. 2005. *Planlı Dönemde Türkiye’deki Kırsal Kalkınma Politika ve Uygulamaları Üzerine Bir Değerlendirme. Planlama*.
- Census Bureau. 1964. “The Development of the Urban-Rural Classification in the United States: 1874 to 1949.”
- . 2024. “Defining Rural.” June 3, 2024. www.ers.usda.gov/topics/rural-economy-population.
- Chowdhury, Mohammad Raziuddin, Md Sakib Ullah Sourav, and Rejwan Bin Sulaiman. 2023. “The Role of Digital Agriculture in Transforming Rural Areas into Smart Villages.” In *Technology and Talent Strategies for Sustainable*

- Smart Cities*, 57–78. Emerald Publishing Limited.
<https://doi.org/10.48550/arxiv.2301.10012>.
- Clark, David. 1998. “Interdependent Urbanization in an Urban World: An Historical Overview.” *Source: The Geographical Journal*. Vol. 164.
<https://www.jstor.org/stable/3060547?seq=1&cid=pdf->.
- Davis, Kingsley. 1955. “The Origin and Growth of Urbanization in the World.” *Source: American Journal of Sociology*. Vol. 60. The University of Chicago Press.
- Delgado-Viñas, Carmen, and María Luisa Gómez-Moreno. 2022. “The Interaction between Urban and Rural Areas: An Updated Paradigmatic, Methodological and Bibliographic Review.” *Land*. <https://doi.org/10.3390/land11081298>.
- Diakoulaki, Danae, Georges Mavrotas, and Lefteris Papayannakis. 1995. “Determining Objective Weights in Multiple Criteria Problems: The CRITIC Method.” *Computers & Operations Research* 22 (7): 763–70.
- Dobrotă, Liviu-Marian, Laura-Maria Simescu, and Maria-Magdalena Turek-Rahoveanu. 2020. “Sustainability of Rural Areas Through Innovative Actions.” *Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development* 20 (2).
- Dyson, Tim. 2011. *The Role of the Demographic Transition in the Process of Urbanization. Population and Development Review*. Vol. 37.
<https://doi.org/10.1111/j.1728-4457.2011.00377.x>.
- EarthData. 2023. “Digital Elevation Model (DEM) Data.” March 6, 2023.
[https://search.earthdata.nasa.gov/search?fs10=terrain%20elevation&fsm0=topography&fs20=digital%20elevation/terrain%20model%20\(dem\)&fst0=land%20surface](https://search.earthdata.nasa.gov/search?fs10=terrain%20elevation&fsm0=topography&fs20=digital%20elevation/terrain%20model%20(dem)&fst0=land%20surface).
- ENRD. 2018. “Smart Villages Revitalising Rural Services.”
<http://ec.europa.eu/ecolabel/>.
- . n.d. Accessed June 5, 2024. <https://ec.europa.eu/enrd/index.html>.

- Ersoy, Nazlı. 2022. "Kriter Ağırlıklandırma Yöntemlerinin ÇKKV Sonuçları Üzerindeki Etkisine Yönelik Gerçek Bir Hayat Uygulaması." *MANAS Sosyal Araştırmalar Dergisi* 11 (4): 1449–63. <https://doi.org/10.33206/mjss.1026666>.
- European Commission. 2018a. "Bled Declaration for a Smarter Future of the Rural Areas in EU." Bled. <https://pametne-vasi.info/wp-content/uploads/2018/04/Bled-declaration-for-a-Smarter-Future-of-the-Rural-Areas-in-EU.pdf>.
- . 2018b. "Smart Villages: 'Revitalising Rural Services through Social and Digital Innovation.'" 2018. <https://digital-strategy.ec.europa.eu/en/events/smart-villages-revitalising-rural-services-through-social-and-digital-innovation>.
- . 2019. "Pilot Project: Smart Eco-Social Final Report." <https://doi.org/10.2762/100370>.
- Eurostat. n.d. "Methodology." Accessed August 5, 2024. <https://ec.europa.eu/eurostat/web/rural-development/methodology>.
- Eversole, Robyn. 2018. "Rural Development." In *The International Encyclopedia of Anthropology*, 1–10. Wiley. <https://doi.org/10.1002/9781118924396.wbiea2213>.
- Fahmi Mislahudin, Muhamad, Fauzan Azmi Alfiansyah, Maudy Khairunnisa Maisun Taqiyyah, and Eneng Tita Tosida. 2021. "Potential Classification of Smart Village-Smart Economy with Deep Learning Methods." *International Journal of Quantitative Research and Modeling* 2 (3): 147–62.
- Fang, Yufei, and Zhiguang Shan. 2022. "How to Promote a Smart City Effectively? An Evaluation Model and Efficiency Analysis of Smart Cities in China." *Sustainability* 14 (11). <https://doi.org/10.3390/su14116512>.
- Fernández, C, and Daniël Peek. 2023. "Connecting the Smart Village: A Switch towards Smart and Sustainable Rural-Urban Linkages in Spain." *Land*. <https://doi.org/10.3390/land12040822>.
- Food and Agriculture Organization. 2017. "The Future of Food and Agriculture and Challenges."

- Gevelt, Terry Van, and John Holmes. 2015. "A Vision for Smart Villages." www.saanjhi.gov.in/.
- Giller, Ken E, Thomas Delaune, João Vasco Silva, Katrien Descheemaeker, Gerrie van de Ven, Antonius GT Schut, Mark van Wijk, et al. 2021. "The Future of Farming: Who Will Produce Our Food?" 13:1073–99. <https://doi.org/10.1007/s12571-021-01184-6/Published>.
- Górecka, Aleksandra, Zoran Ježić, and Benjamin Kardum. 2021. "Smart Villages and Rural Development." <https://doi.org/10.22630/aspe.2021.20.2.14>.
- Hackfort, Sarah. 2021. "Patterns of Inequalities in Digital Agriculture: A Systematic Literature Review." *Sustainability*. MDPI. <https://doi.org/10.3390/su132212345>.
- Hajduk, Slawomira. 2020. "Using Multivariate Statistical Methods to Assess the Urban Smartness on the Example of Selected European Cities." *PLoS ONE* 15 (December). <https://doi.org/10.1371/journal.pone.0240260>.
- Hajduk, Slawomira. 2021. "Multi-Criteria Analysis of Smart Cities on the Example of the Polish Cities." *Resources* 10 (5). <https://doi.org/10.3390/resources10050044>.
- Halfacree, Keith. 1993. "Talking About Rurality: Social Representations of the Rural as Expressed by Residents of Six English Parishes." *Journal of Rural Studies* 11 (1): 1–20.
- . 2009. "Rurality and Post-Rurality." In *International Encyclopedia of Human Geography*, 449–56.
- Hlaváček, Petr, Miroslav Kopáček, Lucie Kopáčková, and Vladan Hruška. 2023. "Barriers for and Standpoints of Key Actors in the Implementation of Smart Village Projects as a Tool for the Development of Rural Areas." *Journal of Rural Studies* 103 (October). <https://doi.org/10.1016/j.jrurstud.2023.103098>.
- Ilham, Andi, Ahmad Munir, Ambo Ala, and Andi Amran Sulaiman. 2022. "The Smart Village Program Challenges in Supporting National Food Security through the Implementation of Agriculture 4.0." In *IOP Conference Series*:

Earth and Environmental Science. Vol. 1107. Institute of Physics.
<https://doi.org/10.1088/1755-1315/1107/1/012097>.

Imron, Dian Karinawati, and Febrina Elia Nababan. 2022. "Integrating Smart City to Smart Village Initiation: Potential and Aspiration." In *Proceedings of the 2nd International Conference on Rural Socio-Economic Transformation: Agrarian, Ecology, Communication and Community Development*. EAI.
<https://doi.org/10.4108/eai.14-9-2021.2317196>.

Johansen, Pia Heike, and Niels Christian Nielsen. 2012. "Bridging Between the Regional Degree and the Community Approaches to Rurality - A Suggestion for a Definition of Rurality for Everyday Use." *Land Use Policy* 29 (4): 781–88. <https://doi.org/10.1016/j.landusepol.2011.12.003>.

Kasinathan, Padmanathan, Rishi Pugazhendhi, Rajvikram Madurai Elavarasan, Vigna Kumaran Ramachandaramurthy, Vinoth Ramanathan, Senthilkumar Subramanian, Sachin Kumar, et al. 2022. "Realization of Sustainable Development Goals with Disruptive Technologies by Integrating Industry 5.0, Society 5.0, Smart Cities and Villages." *Sustainability* 14 (22).
<https://doi.org/10.3390/su142215258>.

Kizielewicz, Bartłomiej, Andrii Shekhovtsov, and Wojciech Sałabun. 2023. "The Universal Library for Solving Multi-Criteria Decision-Making Problems." *SoftwareX* 22 (May). <https://doi.org/10.1016/j.softx.2023.101368>.

Koca, Gozde, Ozum Egilmez, and Onur Akcakaya. 2021. "Evaluation of the Smart City: Applying the Dematel Technique." *Telematics and Informatics* 62 (September). <https://doi.org/10.1016/j.tele.2021.101625>.

Komorowski, Łukasz, Monika Stanny, and Monika Stanny. 2020. "Smart Villages: Where Can They Happen?" *Land*. <https://doi.org/10.3390/land9050151>.

Li, Hongbo, Yuan Yuan, Xiaolin Zhang, Zhi Li, Yahua Wang, and Xiaoliang Hu. 2022. "Evolution and Transformation Mechanism of the Spatial Structure of Rural Settlements from the Perspective of Long-Term Economic and Social Change: A Case Study of the Sunan Region, China." *Journal of Rural Studies* 93 (July):234–43. <https://doi.org/10.1016/j.jrurstud.2019.03.005>.

- Li, Xiaojing, Raj Bahadur Singh Chandel, and Xianli Xia. 2022. "Analysis on Regional Differences and Spatial Convergence of Digital Village Development Level: Theory and Evidence from China." *Agriculture*. <https://doi.org/10.3390/agriculture12020164>.
- Lowry, Ira S. 1990. "Supplement: Resources, Environment, and Population: Present Knowledge." *Development Review*. Vol. 16. <https://about.jstor.org/terms>.
- Maja, Pontsho William, Johan Meyer, and Suné von Solms. 2020. "Development of Smart Rural Village Indicators in Line With Industry 4.0." *IEEE Access*. <https://doi.org/10.1109/access.2020.3017441>.
- Manda, Julius, Makaiko G. Khonje, Arega D. Alene, Adane H. Tufa, Tahirou Abdoulaye, Munyaradzi Mutenje, Peter Setimela, and Victor Manyong. 2020. "Does Cooperative Membership Increase and Accelerate Agricultural Technology Adoption? Empirical Evidence from Zambia." *Technological Forecasting and Social Change* 158 (September). <https://doi.org/10.1016/j.techfore.2020.120160>.
- Marin, Mehmet C. 2005. "A Retrospective View of the Turkish Rural Urban Development Policies and the Case of the Village Towns." *Urban Policy and Research* 23 (4): 497–518. <https://doi.org/10.1080/08111470500354331>.
- Martinez Juan, Ana, and James McEldowney. 2021. "Smart Villages Concept, Issues and Prospects for EU Rural Areas."
- Maruf, Muhammed. 2021. "Çok Kriterli Karar Problemlerinde Yaygın Şekilde Kullanılan Subjektif ve Objektif Kriter Ağırlıklandırma Yöntemlerinin Karşılaştırılması." In *Sosyal, Beşeri ve İdari Bilimlerde Yeni Arayışlar ve Çalışmalar*. İzmir.
- Mei, Yan, Jingyi Miao, and Yuhui Lu. 2022. "Digital Villages Construction Accelerates High-Quality Economic Development in Rural China through Promoting Digital Entrepreneurship." *Sustainability* 14 (21). <https://doi.org/10.3390/su142114224>.
- Moreddu, Catherine. 2008. "Data Issues and Information Gathered on the Role of Agriculture in Rural Areas in OECD Countries."

- Mukhametzhanov, Irik Z. 2021. "Specific Character of Objective Methods for Determining Weights of Criteria in MCDM Problems: Entropy, CRITIC, SD." *Decision Making: Applications in Management and Engineering* 4 (2): 76–105. <https://doi.org/10.31181/DMAME210402076I>.
- Narain, D. 1960. "Urbanization and Some Social Problems." *Sociological Bulletin* 9 (2): 1–6. <https://about.jstor.org/terms>.
- Nieto, Enrique, and Pedro Brosei. 2019. "The Role of LEADER in Smart Villages: An Opportunity to Reconnect with Rural Communities." *Smart Villages in the EU and Beyond*. <https://doi.org/10.1108/978-1-78769-845-120191006>.
- Nishant Sharma, Shashikant, Kavita Dehalwar, Gopal Kumar, and Supriya Vyas. 2023. "Redefining Peri-Urban Urban Areas." *Thematics Journal of Geography*. <https://doi.org/10.5281/zenodo.7832656>.
- OECD. 2006. "Rural Policy Reviews The New Rural Paradigm POLICIES AND GOVERNANCE."
- Office for National Statistics. 2019. "2011 Rural/Urban Classification." 2019. <https://www.ons.gov.uk/methodology/geography/geographicalproducts/ruralurbanclassifications/2011ruralurbanclassification>.
- OpenStreetMap. 2023. "OpenStreetMap Road Data." 2023. <https://download.geofabrik.de>.
- Opricovic, Serafim, and Gwo-Hshiung Tzeng. 2000. "Multicriteria Scheduling in Water Resources Engineering Using Genetic Algorithm." In *Computing in Civil and Building Engineering*, 1434–41.
- Özden, Fatih. 2022. "Kırsal Kalkınmada Etkili Sosyo-Ekonomik Değişkenlerin Analizi ve Mekânsal Farklılaşması." *Adnan Menderes Üniversitesi Ziraat Fakültesi Dergisi* 19 (1): 121–30. <https://doi.org/10.25308/aduziraat.1058858>.
- Ozkaya, Gokhan, and Ceren Erdin. 2020. "Evaluation of Smart and Sustainable Cities Through a Hybrid MCDM Approach Based on ANP and TOPSIS Technique." *Heliyon* 6 (10). <https://doi.org/10.1016/j.heliyon.2020.e05052>.
- Öztaş, Rukiye Gizem. 2019. "Planlamada Bit Destekli Yenilikçi Çözümlerin Kırsal Alana Entegrasyonu: Vodafone Akıllı Köy Örneği." Gazi University.

- Pamučar, Dragan, Željko Stević, and Siniša Sremac. 2018. "A New Model for Determining Weight Coefficients of Criteria in MCDM Models: Full Consistency Method (FUCOM)." *Symmetry* 10 (9). <https://doi.org/10.3390/sym10090393>.
- Pérez-delHoyo, Raquel, and Higinio Mora. 2019. "Toward a New Sustainable Development Model for Smart Villages." <https://doi.org/10.1108/978-1-78769-845-120191005>.
- Ploder, Christian, Reinhard Bernsteiner, Thomas Dilger, Reinhard Bernsteiner, and Stephan Schlögl. 2022. "Future Is S.M.A.R.T. - Development of a 'Smart Village' Project Framework." *INTED Proceedings*. <https://doi.org/10.21125/inted.2022.0144>.
- Presidency of the Republic of Türkiye Presidency of Strategy and Budget. 2023. "On İkinci Kalkınma Planı (2024-2028)." Ankara.
- Ramachandra, T V, Ganesh Hegde, M D Chandran, Tejaswini Kumar, Vishnumayananda Swamiji, and Sahyadri Envis - Environmental Information System. 2015. "Smart Village Framework."
- Rana, Nripendra P., Sunil Luthra, Sachin Kumar Mangla, Rubina Islam, Sian Roderick, and Yogesh K. Dwivedi. 2019. "Barriers to the Development of Smart Cities in Indian Context." *Information Systems Frontiers* 21 (3): 503–25. <https://doi.org/10.1007/s10796-018-9873-4>.
- Reba, Meredith, Femke Reitsma, and Karen C. Seto. 2016. "Spatializing 6,000 Years of Global Urbanization from 3700 BC to AD 2000." *Scientific Data* 3 (June). <https://doi.org/10.1038/sdata.2016.34>.
- Republic of Türkiye Ministry of Agriculture and Forestry. 2021. "Ulusal Kırsal Kalkınma Stratejisi (2021-2023)." Ankara.
- Republic of Türkiye Ministry of Industry and Technology. 2020. "Urban and Rural Service Centers in Turkey." Ankara: T.C. Sanayi ve Teknoloji Bakanlığı. Kalkınma Ajansları Genel Müdürlüğü.

- Roca, Josep, and Blanca Arellano. 2017. "Defining Urban and Rural Areas: A New Approach." In *Remote Sensing Technologies and Applications in Urban Environments*. <https://doi.org/10.1117/12.2277902>.
- Roidatua, M R, and A Purbantara. 2022. "Collaborative Governance in Developing Smart Village." *Proceedings of the 2nd International Conference on Rural Socio-Economic Transformation: Agrarian, Ecology, Communication and Community Development Perspectives, RUSSET 2021, 14-15 September 2021, Bogor, West Java, Indonesia*. <https://doi.org/10.4108/eai.14-9-2021.2317180>.
- Satola, Lukasz, Łukasz Satoła, and Anna Milewska. 2022. "The Concept of a Smart Village as an Innovative Way of Implementing Public Tasks in the Era of Instability on the Energy Market—Examples from Poland." *Energies* 15 (14). <https://doi.org/10.3390/en15145175>.
- Şerban, Adina Marina, and Rūta Brazienė. 2021. "Young People in Rural Areas: Diverse, Ignored and Unfulfilled."
- Slee, Bill. 2019. "Delivering on the Concept of Smart Villages – in Search of an Enabling Theory." *European Countryside*. <https://doi.org/10.2478/euco-2019-0035>.
- Soma, Tammara, and Bhoosun Nuckchady. 2021. "Communicating the Benefits and Risks of Digital Agriculture Technologies: Perspectives on the Future of Digital Agricultural Education and Training." *Frontiers in Communication* 6. <https://doi.org/10.3389/fcomm.2021.762201>.
- Stanković, Jelena, Marija Džunić, Željko Džunić, and Srđan Marinković. 2017. "A Multi-Criteria Evaluation of the European Cities' Smart Performance: Economic, Social and Environmental Aspects." *Proceedings of Rijeka Faculty of Economics* 35 (2): 519–50. <https://doi.org/10.18045/zbefri.2017.2.519>.
- T.C. Sanayi ve Teknoloji Bakanlığı. 2021. "İzmir İli Kırsal Ve Kentsel Tespitine Yönelik Analiz Çalışması."
- Tümen, Semih, and Gökhan Özertan. 2020. "Katma Değerin Artırılması, İnovasyon Ve Dijital Tarım." www.tusiad.org.

- TurkStat. 2023a. "Population of Province/District Centers, Towns/Villages and Annual Growth Rate of Population by Provinces and Districts."
- . 2023b. "Urban-Rural Population Statistics, 2022." 2023. <https://data.tuik.gov.tr/Bulten/Index?p=Urban-Rural-Population-Statistics-2022-49755>.
- Ünal, Mert, and Gülfem Işıklar Alptekin. 2023. "Using Multi-Criteria Decision-Making for Smart City Evaluation and Ranking." *Kent Akademisi* 16 (4): 2538–52. <https://doi.org/10.35674/kent.1287759>.
- United Nations. 2018. "World Urbanization Prospects - Population Division." 2018. <https://population.un.org/wup/Download/>.
- Vaishar, Antonín, Antonín Vaishar, and Milada Šťastná. 2019. "Smart Village and Sustainability. Southern Moravia Case Study." *European Countryside*. <https://doi.org/10.2478/euco-2019-0036>.
- Visvizi, Anna, and Miltiadis D Lytras. 2018. "It's Not a Fad: Smart Cities and Smart Villages Research in European and Global Contexts." *Sustainability*. <https://doi.org/10.3390/su10082727>.
- Viswanadham, N, and Sowmya Vedula. 2010. "Design of Smart Villages."
- Ward, Neil, and David L. Brown. 2009. "Placing the Rural in Regional Development." *Regional Studies* 43 (10): 1237–44. <https://doi.org/10.1080/00343400903234696>.
- Watson, James K R, and James K R Watson. 2019. "Energy Diversification and Self-Sustainable Smart Villages." *Smart Villages in the EU and Beyond*. <https://doi.org/10.1108/978-1-78769-845-120191008>.
- Wineman, Ayala, Didier Yélognissè Alia, and C. Leigh Anderson. 2020. "Definitions of 'Rural' And 'Urban' and Understandings of Economic Transformation: Evidence from Tanzania." *Journal of Rural Studies* 79 (October):254–68. <https://doi.org/10.1016/j.jrurstud.2020.08.014>.
- Wolski, Oskar, and Marcin Wójcik. 2019. "Smart Villages Revisited: Conceptual Background and New Challenges at the Local Level." *Smart Villages in the EU and Beyond*. <https://doi.org/10.1108/978-1-78769-845-120191004>.

- World Bank. 2021. "Smart Villages in Azerbaijan : A Framework for Analysis and Roadmap." <https://documents.worldbank.org/en/publication/documents-reports/documentdetail/850411618551167188/smart-villages-in-azerbaijan-a-framework>.
- Yang, Runlin, and Feng Zhen. 2024. "Smart City Development Models: A Cross-Cultural Regional Analysis From Theory to Practice." *Research in Globalization* 8 (June). <https://doi.org/10.1016/j.resglo.2024.100221>.
- Yaşar, Senanur, Zümra Poyraz, Rabia Yumuşak, and Tamer Eren. 2022. "Smart City Analysis with ANP and PROMETHEE: A Case in Ankara." *Gazi Journal of Engineering Sciences* 8 (1): 15–28. <https://doi.org/10.30855/gmbd.2022.01.02>.
- Ye, Fei, Yingying Chen, Lixu Li, Yina Li, and Ying Yin. 2022. "Multi-Criteria Decision-Making Models for Smart City Ranking: Evidence from the Pearl River Delta Region, China." *Cities* 128 (September). <https://doi.org/10.1016/j.cities.2022.103793>.
- Yi, Dong Yoon, and Yonghoon Son. 2022. "What Is New Ruralism and Why It Is Needed for Spatial Planning?" *International Review for Spatial Planning and Sustainable Development* 10 (4): 7–28. https://doi.org/10.14246/irspsd.10.4_7.
- Yılmaz, Bülent, İsmet Daşdemir, Erdoğan Atmış, and Wietze Lise. 2010. "Factors Affecting Rural Development in Turkey: Bartın Case Study." *Forest Policy and Economics* 12:239–49. <https://doi.org/10.1016/j.forpol.2010.02.003>.
- Yuan, Zheng, Baohua Wen, Cheng He, Jin Zhou, Zhonghua Zhou, and Feng Xu. 2022. "Application of Multi-Criteria Decision-Making Analysis to Rural Spatial Sustainability Evaluation: A Systematic Review." *International Journal of Environmental Research and Public Health*. MDPI. <https://doi.org/10.3390/ijerph19116572>.
- Zavratnik, Veronika, Andrej Kos, and Emilija Stojmenova Duh. 2018. "Smart Villages: Comprehensive Review of Initiatives and Practices." *Sustainability*. <https://doi.org/10.3390/su10072559>.
- Zavratnik, Veronika, Dan Podjed, Jure Trilar, Nina Hlebec, Andrej Kos, and Emilija Stojmenova Duh. 2020. "Sustainable and Community-Centred Development of

Smart Cities and Villages.” *Sustainability* 12 (10).
<https://doi.org/10.3390/SU12103961>.

Zhang, Shemei, Zhanli Sun, Wanglin Ma, and Vladislav Valentinov. 2020. “The Effect of Cooperative Membership on Agricultural Technology Adoption in Sichuan, China.” *China Economic Review* 62 (August).
<https://doi.org/10.1016/j.chieco.2019.101334>.

Zhang, Xiaojuan, and Zhengang Zhang. 2020. “How Do Smart Villages Become a Way to Achieve Sustainable Development in Rural Areas? Smart Village Planning and Practices in China.” *Sustainability* 12 (24): 10510.
<https://doi.org/10.3390/su122410510>.

