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Design of a Development Index for Spanish Municipalities

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Abstract: Currently, the demographic vacuum and poor development suffered by most areas of Spain are some of the most worrying issues from a territorial point of view, which is why this study is necessary. In this paper, the objective is to create a Development Index with which to study the different realities of rural and urban spaces through demographic and socioeconomic variables of the Spanish municipalities. Principal Component Analysis is carried out, with whose results the index has been prepared. This is then explored with a Spatial Autocorrelation Analysis. The results show that most developed Spanish municipalities and most of the population are concentrated in coastal areas and in the main cities of the country. In opposition, there are interior rural areas with less developed municipalities at risk of disappearance due to their increasing ages and levels of depopulation. Thus, in this paper, new variables and methods are used in the study of the social and economic diversity of rural and urban areas, verifying the inequality that still exists between both.

Keywords: development index; demography; economy; principal component analysis; spatial autocorrelation analysis

1. Introduction

For decades, different organizations, such as the World Bank Data, the International Monetary Fund, and the United Nations Development Program (UNDP), have classified the different levels of economic development [1–3] and demographic behaviours in different places (developed or underdeveloped countries), at different scales (national, regional, or local scales) [4], and in diverse time spaces (current moment, evolution from the 21st century, etc.) in order to achieve territorial cohesion and demographic balance [5–7]. The studies carried out by these organizations are mainly related to the delimitation of rural and urban spaces, establishing that rural spaces are territories with a low level of development, high demographic losses, and a fundamentally agrarian sector [8,9]. On the other hand, urban spaces are areas of growth and development (both demographic and economic) whose economic sectors are more focused on industry or services [10,11]. Due to these differences, a rural–urban exodus has taken place since the first decades of the second half of the 20th century, especially in Europe. Young people have migrated to cities in search of better job opportunities (higher wages than in the countryside or less seasonal work), better living conditions, and access to higher-level educational and health facilities [12,13]. As a consequence, ageing has increased in rural areas [14,15], which has produced an intensification of negative natural growth, an unstoppable dynamic of population decline with a trend toward the depopulation and abandonment in many of these rural territories [16,17], which are classified as "spaces in crisis" [18,19]. In Europe, this phenomenon mainly occurs in the Southern Mediterranean countries (Greece, Portugal, Bulgaria, Romania, and southern Italy) [20–26] and in northern Eastern European areas, such as the Baltic States.

In Spain, the areas that suffer the most are those in the interior of the peninsula, such as Castilla-La Mancha and Castilla y León, and those in the north, such as Galicia, Asturias, and Aragón [27–30]. Moreover, in Spain, the main urban centres are concentrated in coastal areas and industrial centres enhanced by the development plans of the Franco dictatorship [31,32]. To alleviate the problem and reduce imbalances between rural and urban spaces, in the EU, for example, different political institutions have been implementing initiatives for decades through the EII Funds, specifically through funds such as the Cohesion Fund [33] and the European Agricultural Fund for Rural Development (EAFRD) with the LEADER method [34]. However, for now, it seems that current political efforts are still insufficient given that the Spanish reality continues to present areas in danger of depopulation, so that, in the coming decades, the design of cohesion policies should be rethought.

In recent decades, the conception of the rural world in some spaces has been modified by introducing new economic systems that are changing people's ways of life [35,36], such as tourism and agribusiness [37,38] (or other new services), since many of these areas became leisure spaces [39] and are generating economic development and demographic growth [40].

This research studies the above phenomenon from the geographical perspective of the Spanish territory. First, a review of the large body of existing literature on this subject was carried out. The OECD (Organisation for Economic Cooperation and Development) (2004–2010) divided space while only considering population density (OECD 2004–2010) and thereby determined that areas with a lower density are more at risk. Moreover, this organization established the difference between rural and urban areas to be 150 inhabitants/km^2. However, this value is meaningless in agrarian regions with a very high occupation, such as those that exceed 700 or 800 inhabitants/km^2, mainly in South and East Asia [41]. In the Spanish case, the opposite occurs, since there are urban areas that can be considered rural due to their wide municipal extension (some municipalities in southern regions) and because they have population densities of less than 150 inhabitants/km^2 [42].

EUROSTAT and DG-REGIO established a population grid with a resolution of 1 km^2, delimiting three classes: (1) urban agglomerations, which are the 'Urban clusters'; (2) clusters of contiguous grid cells of 1 km^2 with a density of at least 300 inhabitants per km^2 and a minimum population of 5000; (3) and rural areas. At the same time, rural areas are divided into three classes: (1) 'Predominantly rural', if the share of the population living in rural areas is higher than 50 inhabitants per km^2; (2) 'Intermediate', if the share of the population living in rural areas is between 20 and 50; and (3) 'Predominantly urban', if the share of the population living in rural areas is below 20 [43]. The problem with this delimitation is that the unit of analysis is the NUTS (Nomenclature of Territorial Units for Statistic) 3, which coincides with the Autonomous Communities in countries like Spain that are too large to hide the differences and various realities within themselves. With this methodology, Goerlich and Cantarino [44] delimited the rural areas at the municipal level (LAU 1) in the Spanish state, forming three classes: Urban, Intermediate, and Rural. Thus, 89% of the Spanish surface is considered rural, but only 20.3% of the population live in those spaces.

At the Spanish level, the definitions made by both the National Statistics Institute (NSI) and Law 45/2007, of 13 December, for the Sustainable Development of Rural Areas [45] should be highlighted. The NSI established the degree of rurality depending only on the size of the population, thereby establishing three classes: Rural (agglomeration of less than 2000 inhabitants), Semirural (between 2000 and 10,000 inhabitants), and Urban (more than 10,000 inhabitants). On the other hand, Law 45/2007 defines a rural environment as a space formed by municipalities or smaller local entities with a population of less than 30,000 inhabitants and a population density of less than 100 inhabitants/km^2, which represented 82% of Spanish municipalities and 18% of the total population in 2007 [30]. In this classification, the size of the population is prioritized so that smaller municipalities can benefit from economic aid from the Spanish state covered by Law 45/2007. However, this law was not applied due to the lack of economic implementation and its abandonment by the central government and Autonomous Communities.

In the scientific field, some authors have chosen to create composite indexes that can obtain results from multiple variables to establish the limit between rural and urban spaces, as well as the demographic or economic conditions that define them. See, for example, the work carried out in the United States to define the Scale Measure of Urbanity [46], which relates quality of health (life expectancy and typology of diseases) with the urban–rural typology and presents a classification that does not always coincide with the erroneous divide of the urban–rural dichotomy, where economic and urban development reflect high sanitary quality. The General Practice Rurality Index from Canada [47] establishes different classes in rural areas. These classes also depend on the quality of medical services. In Australia, accessibility and distance to economic development centres are the variables used for the creation of the Accessibility/Remoteness Index [48]. In addition, the Rurality Index of England and Wales [49–51] was developed using demographic data from the population census on employees by sectors, unemployment status, and accessibility to nuclei for more than 50,000 inhabitants in 1981 and 1991; this index also carried out a Principal Component Analysis (PCA). Clout [52] determined that, in Europe, rural areas are related not only to a small population with a low infrastructure endowment, but also to a low proportion of workers in tertiary and secondary activities and represents a domain of agricultural or forestry land use. For this reason, Clout divided rural areas into three classes following the conceptual lines defined in the European Parliament's communication on the Future of the Rural World (1988). These three classes are as follows: (1) Dynamic or economically integrated rural areas with a high degree of economic growth and social welfare. These areas are characterized by strong pressure from urban areas, high population density, and land use struggles. Here, agriculture has been modernized and intensified at the expense of the environment, generating problems of landscape degradation, resource pollution, and the destruction of natural space. People can also construct their first or second homes in such areas, which necessitates a great deal of infrastructure to serve the increase in population. (2) Peripheral rural areas or intermediate rural areas. These areas feature low levels of economic and social development but great potential for the future. They have a decadent tone and present symptoms of a rural exodus, either towards a metropolis or towards the regional capital. Agriculture is important in such areas but often insufficient, which forces agriculture to be complemented by unstable and poorly paid jobs. Most marginal agricultural land is being abandoned. In some areas, the exodus of the population has caused the loss of some basic services (school, health, public transport, etc.). (3) Abandoned or remote rural areas with very low population densities and environmental resources unsuitable for agriculture. Rural decline, population exodus, and limited possibilities to diversify the economy are more pronounced realities here than in intermediate areas. This makes the degradation of the rural nucleus and natural areas very high in some areas.

Another relevant analysis was developed by Ballas et al. [12], who calculated various rurality indices in all European regions, using the NUTS3 scale for socioeconomic and demographic variables along with PCA and cluster analysis (Ward's method).

In Spain, Prieto-Lara and Ocaña-Riola [53] developed a Rurality Index for the municipalities of Spain using demographic variables, first from the Population Census of 1991 and then, in a second work, from the Census of 2001, both via PCA. The regional works of López and Santiago [54] further estimated a Rurality Index with 15 variables based on the 2001 Census of Galician municipalities (north Spain), with the variables referring to agrarian activity and the ageing of the population being the most important to determine the rurality degree. Moreover, in Galicia, López et al. [55] created an index with 46 variables, as did Lois [56] and Armas et al. [57]. The Mora case study used 56 variables for Extremadura [58] with demographic, territorial, and economic variables, while another study used only demographic variables in Galicia [59].

The first objective of this paper is to study this phenomenon from a geographical perspective in the Spanish territory and at the municipal level by delimiting the areas and the demographic and socioeconomic characteristics that condition them. Thus, several research questions were developed:

(1) Can the characterization of Spanish municipalities lead us to identify the existence of significant demographic and socioeconomic disparities between the spatial groups formed?
(2) Can we determine, through a spatial analysis, which municipalities have the worst values for the most representative variables?
(3) Are there spatial groups of municipalities with negative values in certain regions? Could these negative values be associated with such areas being rural spaces?
(4) Is it possible to determine which municipalities are at the highest risk of disappearance by combining regressive variables for their demographic (population loss), economic (low income), or social characteristics (high unemployment rates), as well as if they are related to fundamentally agrarian production structures or a poor accessibility?

The second objective of this research is to create a Development Index using the results of the Principal Component Analysis of 45 demographic and socioeconomic variables of the Spanish municipalities that will determine their different realities. Principal Components were obtained through the PCA, which interrelate (by cause–effect relationships) the demographic and socioeconomic, giving scores to each municipality depending on the influence exerted by the variables in each one of them. Then, the results were entered into a GIS to be located directly "on the territory" [60] and geostatistically analysed via Moran's I to check for spatial concentrations (clusters). This allows one to study the existence (or not) of areas with large populations and adequate socioeconomic development, as well as rural areas conditioned by demographic losses and low economic profitability. Applications of this technique can be found in many fields, including economics, resource management, biogeography, political geography, and demography.

Numerous studies have characterized territorial spaces through a division between the rural and the urban in the Spanish territory. However, this study presents a more complete approach by identifying homogeneous spaces with common characteristics in their demographic, economic, and social aspects through new variables based on income, structures of the agrarian sector, aid to the Common Agricultural Policy (CAP) or jobseekers. These variables were not analysed in previous works focused on demographic variables and accessibility that employed multicriteria analyses [61] or those that only applied demographic variables and their relationship with landscape units [62].

The materials and methods of the paper are next presented in Section 2, followed by Section 3, which presents the results obtained. Then, the results are discussed in Section 4, and, finally, the conclusions are provided in Section 5.

2. Materials and Methods

2.1. Study Area

This study analyses the 8205 municipalities of Spain, whose territory covers 506,000 km^2 with a population of 47,188,759 inhabitants in 2018 (49.3% men and 50.6% women). The population density (93 inhabitants/km^2) is lower than the European Union average, which is currently around 117 inhabitants/km^2. Spanish municipalities are grouped into 50 provinces that form 17 autonomous regions (Figure 1). Thus, Spain is a country with strong physical contrasts (inland–coast and mountain–valley). The peninsular relief is characterized by more than 9000 km of coastline with an average altitude of 660 m above sea level. This relief is articulated around a large central plateau surrounded by a mountain belt formed by the Central System. The rest of the peninsular interior features coastal strips, the depressions of the Ebro and Guadalquivir rivers, the outer mountain systems of the Pyrenees, and the systems of southern Andalusia. In addition, there are two archipelagos: the Balearic Islands, which are closely related to the Peninsula due to their proximity, and the Canary Islands, which are completely independent both due to their geographical location and due to their volcanic character.

The characteristics described above have conditioned the ways of life in, and the development of, Spanish regions. Thus, the coastline presents greater economic development and demographic dynamism due to its strategic location, which has been linked to maritime industrial and commercial

development for centuries. This development has increased with the Spanish tourist boom since the mid-twentieth century, derived from so-called sun and beach tourism. On the other hand, the interior and mountain areas have suffered greater isolation due to their less favourable orographic conditions. However, there are also significant internal contrasts. In this way, in the Northern subplateau, there is a predominance of medium-sized farms traditionally dedicated to the cultivation of winter cereals in the extensive rain-fed regime and sunflower and rapeseed, currently. In the Southern subplateau and the valleys of the Ebro and Guadalquivir rivers, landowner farms dedicated to the so-called Mediterranean trilogy of wine, olive, and wheat stand out in the extensive dryland regime. In the peninsular areas of the western space (Zamora, Salamanca, Cáceres, etc.) the large estates have traditionally been dedicated to extensive livestock farming due to the poverty and weakness of the soils in the area.

Figure 1. Relief map of Spain. Source: the authors based on the National Download Center (NDC) of the National Geographic Institute (NGI).

2.2. Selection of Variables

First, an alphanumeric and cartographic database that collects characteristic variables (demographic, economic, agricultural, accessibility, etc.) related to the territories of Spain was constructed. The variables are as follows:

- Agricultural Census. This is a periodic statistical operation carried out by the Spanish National Statistics Institute since 1962 and offers a ten-year investigation of agricultural farms. The last agricultural census was carried out in 2009, and the 2019 census is currently being prepared for publication, albeit with no scheduled date.
- Demographic variables. These variables were obtained from the Spanish National Statistics Institute. Three relevant dates for their study were determined: 2001, as the beginning of the 20th century; 2011, during the full economic crisis; and 2018, as the last year for which data on the natural movements of the population could be obtained
- Economic variables are published in the Experimental Atlas of the National Statistics Institute and in the Public Service of State Employment (PSSE).
- Common Agricultural Policy (CAP) investments. Spain is one of the EU countries that have received the most aid from the CAP. This policy has benefited a significant number of Spanish farmers, especially in regions with a high degree of rurality (Castilla y León, Castilla-La Mancha, Extremadura, and Aragón) [63,64] and, therefore, the investments per 1000 inhabitants (2018).

- Accessibility variables. We chose to calculate the time taken to move from the rural municipalities (less than 10.000 inhabitants) to the main urban areas (more than 10,000 inhabitants), as well as from all municipalities to the main and national roads. We used the cartography of the main road network of Spain as our basis. These data were obtained from the National Download Center (NDC) of the National Geographic Institute (NGI) in 2018. For this process, it was necessary to transform the polygonal layer of the municipalities (without taking into account the disseminated municipalities) into a dot layer that represents the centroids in order to later calculate their distance to the closest urban centre (using the vertices generated). Importantly, the study of accessibility is based on graph theory [65,66]. These nodes correspond to the centroids of the population centres, which are connected by edges that are all communication paths. Thus, it is possible to determine what node is attached to each edge to calculate the travel time between both nodes. Considering this, we calculate the minimum travel time of each population centre to the nearest urban centre point, the nearest main road, and the national road. For this, it is necessary to know the hierarchy of the network and rely on impedance, which is a fundamental element in the study of accessibility [67].

The expression is (1):

$$MATi = min\ (IRij)\ \forall j \quad (1)$$

The impedance is obtained in minutes, and the minimum time for a vehicle (in this case, a car) from a population centre to the nearest urban centre or road is then obtained with the network analysis tools from a GIS, attending to the Formula (2):

$$[length/(velocity * 1000/60)] \quad (2)$$

By calculating the accessibility, it will be possible to obtain the time to travel from the rural centres to the main urban areas that offer employment and equipment because optimal accessibility to the supply of goods, services, or jobs is an important potential boost to the maintenance of the population and economic development in rural areas [68,69]. As stated by Dijkstra and Poelman [70], proximity to cities influences the economic behaviour and income of rural regions close to the city, compared to more remote ones. Access to the main and national roads has also been measured, which allows small population centres not to be isolated due to rapid access to an optimal communication system. This favours the economic development and demographic dynamics of the most ruralized areas. Actually, the proximity to the road network has been a stimulating factor for the development of small municipalities in Spain in recent decades [71,72].

The variables entered are (Table 1):

Table 1. Variables.

Useful agricultural area: (% to the total of the municipality.)	Population density (2001, 2011, and 2018).
Hectares of rain-fed crops (% of useful agricultural area)	Old-age index (2001, 2011, and 2018).
Irrigated hectares (% of useful agricultural area)	Youth index (2001, 2011, and 2018).
Rain-fed crops (% of the total agricultural holdings).	Population growth (% of 2001–2011 and % of 2011–2018).
Irrigated crops (% of the total agricultural holdings).	Gross birth rate (2001, 2011, and 2018).
Percentage of the number of farms with less than 50 hectares with respect to the total farms.	Gross mortality rate (2001, 2011, and 2018).
Percentage of the number of farms with more than 50 hectares with respect to the total farms.	Vegetative growth rate (2001, 2011, and 2018).
Number of farms for every 100 hectares of Useful Agricultural Area (UAA).	Marriage rate (2001, 2011, and 2018).
Common Agricultural Policy (CAP	Average income per capita in 2016.
Accessibility to towns	Average income per home in 2016.
Accessibility to main roads	Unemployment rate in 2018.
	Percentage of unemployment by activity sector in 2018 (agricultural, secondary, and tertiary).

Subsequently, the Inverse Distance Weight (IDW) method is used to capture the minimum travel time on a map, which allows the interpolation of cell values by combining a set of points to determine the inverse distance of the values [73–75].

We selected these variables because organizations such as the Spanish NSI or the OECD only define the rural and the urban by population size and density. Thus, this work introduces variables that define the productive, demographic, and economic structures of these territories to explore the processes that affect the degradation of rural areas and differentiate them from urban ones. For example, the agrarian sector continues to be significant in rural areas [76], unlike urban areas, which have a highly developed service sector. Further, population density is important because it shows the degree of occupation of the population of a territory and helps differentiate between systems with low concentrations (rural systems) and high concentrations (urban systems). Furthermore, it is interesting to analyse the ageing index compared to the youth index since ageing is the main problem in rural areas [77]. Ageing is also closely related to the demographic variables of birth, mortality, vegetation growth, and marriage. In addition, it is considered necessary to study the problems that derive from accessibility, especially in marginal areas with problems accessing first-rate public goods and services, such as hospitals or educational centres, as well as other variables that characterize rural spaces, such as little wealth and employment due to a regressive economic situation [7,8,12]. Definitely, the variables chosen to be analysed and to construct the Development index for Spanish municipalities are demographic, economic, and accessibility, that is, they are variables related to human aspects. The variables of a physical nature (relief, climatology, or edaphology) can be considered in the future as new context variables that expand and complete the index, as well as complements of other variables already used, such as those of the agricultural census. In addition, other interesting variables for future studies may be those referring to Corine Land Cover or SIOSE (the Spanish acronym of Information System on Land Cover of Spain).

Finally, the database (created with the demographic and socioeconomic variables) was joined to a cartographic database in a polygonal shape featuring the 8205 municipalities of Spain from the National Topographic Base (1:100,000). Next, using a GIS, the alphanumeric information was associated with a set of graphical information on the maps to visualize the data or variables "on the territory" [78]. A GIS is one of the most useful information management tools since it allows one to associate alphanumeric variables with a set of cartographic information. This is the perfect tool to study the spatial location [79–81], distribution, association, interactions, and evolution [82] of the Spanish population, as well as a suitable analysis tool for multiple conditions [83,84].

2.3. Principal Component Analysis

PCA is applied to obtain a territorial model of Spain in which the country's demographic and socioeconomic substructures are represented and correlated in different municipalities. This method offers a multivariate analysis that can explain the relationships between the variables chosen (here as a representation of Spain's reality). PCA is an explanatory method for variables that involves external factors [32] and allows for the identification of latent dimensions in a set of variables and reduction of the vector space, which is defined by a broad set of original variables, to a smaller number of factors independent of each other, which are ordered by explanatory power [85,86].

This technique obtains new sets of variables, the principal components, as a result of a combination of interrelated variables [87]. These components represent the homogeneous behaviours in different entities or elements (municipalities of Spain in this case) that allow one to identify territorial substructures, since PCA also represents the patterns of similarity among the inter-correlated variables observed [88,89]. In essence, the objective of PCA is to extract a reduced set of variables of m components, or underlying factors that explain most of the variance from a set of p variables [85].

The underlying factors are obtained through the correlation between the variables and are calculated as a weighted sum of those variables. For example, factor *i* is

$$F_i = W_{i1}X_1 + W_{i2}X_2 + \ldots + W_{ip}X_p. \quad (3)$$

In this sense, for social sciences and humanities research, PCA is suitable for studying complex structures due to its ability to reduce a large amount of information [78,90,91]. PCA is probably the most popular multivariate statistical technique and is used by almost all scientific disciplines [92].

The 45 most representative variables of Spanish municipalities are shown in Table 2.

Table 2. Variables analysed.

Population density 2001, 2011, 2018
Young-age index 2001, 2001, 2019
Old-age index 2001, 2011, 2018
Agricultural unemployment 2018
Industrial unemployment 2018
Building unemployment 2018
Service sector unemployment 2018
Jobseeker without previous job 2018
Unemployment rate 2018
Population growth 2001–2011
Population growth 2011–2018
Per capita income 2015
Per capita income 2016
Household income 2015
Household income 2016
Accessibility to towns
Accessibility to main roads
Percentage of rain-fed crops in hectares
Percentage of the number of rain-fed crop farms
Percentage of the number of irrigated crop farms
Percentage of irrigated hectares
Percentage of agricultural holdings with less than 5 hectares
Percentage of agricultural holdings with more than 50 hectares
Number of farms for every 100 hectares of Useful Agricultural Area
Common Agricultural Policy (Investments per 1000 inhabitants) in 2018
Gross birth rate 2001, 2011, 2018
Gross mortality rate 2001, 2011, 2018
Vegetative growth rate 2001, 2011, 2018
Marriage rate 2001, 2011, 2018

However, to perform PCA, the variables must be unbiased. Therefore, all the variables were relativized by their rates or percentages, collinearities were avoided, and all necessary prospective analyses were carried out until reaching an initial matrix that was considered optimal. Variables with a coefficient less than 0.3 were removed because they were not statistically explanatory in the group.

Two control tests were implemented to verify Factor Analysis to be the most appropriate method: Bartlett's Sphericity Test and Kaiser–Meyer–Olkin (KMO), which are the most applied control tests by the scientific community [93,94]. The first test ensures that the matrix correlation is not an identity matrix, while the second is a measure of the correlation matrix's ability to perform the Factor Analysis, so that the closer the KMO score is to 1, the greater the sufficiency of the matrix will be. The KMO is expressed as:

$$\text{KMO} = \sum i{+}j \text{ r } 2\ ij \sum i{+}j\ r\ 2\ ij + \sum i{+}j\ r\ 2\ ij.m \quad (4)$$

where *rij* represents the simple correlation coefficient between the variables *i* and *j*, and *rij.m* represents a partial correlation between the variables *i* and *j* once the effect of the remaining m variables included

in the analysis is eliminated. The KMO statistic varies between 0 and 1. Thus, if the KMO result is ≥0.75, the suitability of performing the analysis with the chosen variables is good; if it is ≥0.5, the suitability is acceptable; and if it is <0.5, the suitability is unacceptable. In this case, the result is 0.761. Thus, the decision to perform PCA with the 16 variables (Table 3) is good. In addition, the results of Bartlett's Sphericity Test (0.105) and the high value of the KMO statistic (0.761) show the adequacy of the Factor Analysis performed (Table 3).

Table 3. PCA technical characteristics.

Characteristics	
Number of variables	16
Number of elements	8205
Factor procedure	Principal Component Analysis
Extraction rule	Roots greater than 1
Number of factors	6

A PCA was undertaken to provide a summary of the information on the variables in a single component (the principal component) for all Spanish municipalities. In this paper, the principal component was called the *Development Index*. Using this index, a value for each municipality was normalized in such a way that a classification was established from the minimum and the maximum with 4 classes: two with negative values and two with positive values. The statistical analysis was performed through various consultations and operation in spreadsheets, as well as using statistical software (SPSS) and a GIS (ArcGIS 10.5) for the cartographic representations.

2.4. Cluster Analysis

The Global Moran's I statistic was used [95,96] to determine whether or not there is a spatial correlation of the development index among the Spanish municipalities, as well as the concentration patterns of homogeneous or opposite values, and the Local Moran's I for the spatial representation of the results [97].

Moran's I is a statistic that lets one analyse the existence of concentrations (cluster) and outliers in a set of units (in this case, Spanish municipalities), as well as in an analytical field (in this case, the development index). To determine the existence of correlations between groups of territorial units, first, one must evaluate whether the expressed pattern is clustered, dispersed, or random by calculating the Global Moran's I to reject the null hypothesis and determine whether the spatial pattern is likely or unlikely to present random results. Small p values and very high or very low z scores should be obtained for the null hypothesis to be rejected. Secondly, to identify the existing correlations in the territory, the Local Moran's I was used.

Values were obtained for each municipality and are represented with statistical significance according to the following code:

- High–High (a cluster of high values surrounded by high values).
- High–Low (an outlier where a high value is predominantly surrounded by low values).
- Low–High (an outlier where a low value is mainly surrounded by high values).
- Low–Low (a cluster of low values surrounded by low values).

This indicator shows whether there are clusters with extreme values in both positive (High) and negative (Low) data.

3. Results

3.1. Characteristics of Spanish Municipalities

This section analyses the descriptive statistical results obtained from the variables used in the PCA. For the most current demographic variables (2018), the old-age index has a very high average

value when compared to the youth index. The former presents an average of 29.24% of inhabitants over 65 years, while the latter indicates that 9.71% of the population is under 14 years old (Table 4). The data show an average of 8.64% of the population employed in agriculture, livestock, or professions related to fishing but with a very high standard deviation compared to the average (13.04). This shows that some municipalities have a high degree of occupation in the primary sector. There are higher unemployment rates in the service sector (60%) because this is the predominant sector in the Spanish economy, especially in urban areas. The primary sector employs almost 5% of the Spanish active population (SNSI), while the service sector employs 70%. Therefore, if the data is standardized, there is a greater demand for employment in the agricultural sector than in the service one.

Table 4. Descriptive statistics of the Spanish municipalities.

	Average	Standard Deviation	Number
Young-age index 2018	9.71	5.63	8205
Old-age index 2018	29.24	11.95	8205
Agricultural unemployment 2018	8.60	13.04	8205
Service sector unemployment 2018	60.81	24.92	8205
Population growth 2001–2011	−0.11	24.53	8205
Population growth 2011–2018	−11.62	16.51	8205
Unemployment rate 2018	8.87	5.23	8205
Accessibility to towns	19.36	14.48	8205
Per capita income 2016	8302.56	4321.25	8205
Accessibility to main roads	12.36	14.97	8205
Gross mortality rate 2018	14.68	12.55	8205
Vegetative growth rate 2018	−9.68	14.25	8205
Percentage of irrigated hectares	12.02	20.61	8205
Percentage of the number of rain-fed crop farms	67.20	19.35	8205
Percentage of agricultural holdings with more than 50 hectares	74.58	24.40	8205
Common Agricultural Policy (Investments per 1000 inhabitants)	170,819.83	411,995.36	8205

Source: the authors.

In the last decade, demographic variables show that, due to the effects of the 2008 global economic crisis, population losses have been significant. An average population loss of 11.62% was obtained (2018–2011), while in the previous decade (2011–2001), this loss was 0.11%. In Spain, from 2001 to 2008, the population increased from 40 to 46 million inhabitants because of the increase of population in urban areas (municipalities with more than 10,000 inhabitants). Starting in 2008, population growth slowed down, even in urban areas (from 2008 to 2018, Spain remained at 46 million inhabitants with small variations depending on the year). Increases in population in urban areas are produced by positive migratory balances rather than by vegetative growth, which continues to be negative in Spain due to low birth rates. In rural municipalities, demographic losses are observable in both periods, but they have been more pronounced since 2008, as vegetative growth continues to be negative; in addition, due to the economic crisis in the last decade, the emigration of younger and more qualified personnel has increased further.

Another variable of interest is the per capita income, whose average is 8300 euros. This varies from the richest areas, with amounts greater than 25,000 euros, to the most impoverished, with less than 6500 euros per inhabitant.

For the agrarian structure, there are a greater number of farms dedicated to rain-fed cultivation than to irrigated land. Further, the great extension of the plateau is notable. The plateau's farms are mainly dedicated to rain-fed and livestock exploitation on large properties of land, except in some river valleys, such as the Guadiana river.

Finally, accessibility pertains less to cities than to fast roads (main roads). Accessibility to national roads is not statistically decisive, so it was ultimately removed from the analysis.

3.2. Results of the Principal Component Analysis

After numerous exploratory analyses, the greatest number of determining and more defining variables was 16 (Table 5). All the variables with a sum of 100 were removed (percentages of jobseekers), leaving only the most representative ones (jobseekers in the agricultural and service sectors) and those whose explanatory factors in their communalities were less than 0.3, as their values were very coincident with those of subsequent years (i.e., the demographic variables of 2001 and 2011, and the gross birth rate of 2018).

Table 5. Communalities.

Variables	Initial	Extraction
Vegetative growth rate 2018	1	0.922
Gross mortality rate 2018	1	0.903
Percentage of the number of rain-fed crops farms	1	0.825
Percentage of irrigated hectares	1	0.820
Young-age index	1	0.795
Agricultural unemployment	1	0.786
Accessibility to towns	1	0.760
Accessibility to main roads	1	0.760
Old-age index	1	0.757
Service sector unemployment	1	0.756
Unemployment rate	1	0.694
Population growth 2001–2011	1	0.631
Percentage of agricultural holdings with less than 50 hectares	1	0.576
Per capita income 2016	1	0.531
Population growth 2011–2018	1	0.515
Common Agricultural Policy (Investments per 1000 inhabitants)	1	0.321

Table 4 shows how the demographic variables produce a greater explanatory factor. The most fundamental variables are the vegetative growth rate 2018 and gross mortality rate 2018 (both present an explanatory factor greater than 0.9). Related to these two variables, albeit with a lower value, are youth and ageing rates.

The variables referring to rain-fed crop farms and irrigated areas also have determining factors, both exceeding 0.8, as well as agricultural unemployment, with 0.786. Thus, the agrarian sector continues to be a determining factor in the delimitation between rural and urban spaces. Therefore, this sector is either dynamic or regressive in its demographics. Accessibility also presents a significant explanation with 0.760, especially for towns and, to a lesser degree, for main roads. Unemployed people, in general (and in the service sector in particular) provide an explanation of around 0.7, which is a conjectural aspect of the economy of Spanish municipalities, both rural and urban. Lastly, CAP investments (0.3) and per capita income, which, despite being higher than 0.5, do not differentiate much between rural from urban areas, are less determining variables. Some rural areas are depopulating and are very agrarian but have, at the same time, a high volume of pensioners with higher retirement funds than many of the worker salaries in urban or intermediate rural areas. Population growth also shows a low score (0.5). During the time of the crisis, population growth decreased throughout Spain (even in cities) because the migratory balance was negative (fewer immigrants arrived due to a lack of labour opportunities and lower wages).

The PCA extracted six principal components (with 100% of the total variance explained). Within these six components, the first one (with an initial eigenvalue greater than 1) represented 31.78% of the variance and was thus chosen to establish the *Development Index*. A value of 31.78% is not very high. This is due to the complexity of the variables and the situation of the Spanish municipalities. In this first component, no greater explanatory factor is obtained because 40% of the total Spanish municipalities do not have very significant values and do not clearly belong to either of the two established classes. In some cases, these areas are intermediate municipalities that do not present worrisome demographic figures, and in other cases, they are semi-urban municipalities that neither

generate high rates of income nor have gained considerable numbers of residents in recent years. Accordingly, Component 1 correctly differentiates between municipalities with the worst demographic and economic conditions (and at risk of depopulation) and the most economically and demographically dynamic areas.

In Table 6, the weights of the variables are outlined, divided into two blocks: positive and negative. Table 7 shows the development index.

Table 6. Factor weights of the variables in Component 1.

Variables	Weights	
Young-age index	0.839	POSITIVE VARIABLES
Population growth 2001–2011	0.742	
Vegetative growth rate 2018	0.681	
Population growth 2011–2018	0.669	
Percentage of irrigated hectares	0.461	
Per capita income 2016	0.460	
Percentage of crop farms with less than 50 hectares	0.428	
Service sector unemployment	0.235	
Unemployment rate	0.169	
Common Agricultural Policy (Investments per 1000 inhabitants)	0.137	
Agricultural unemployment	−0.040	NEGATIVE VARIABLES
Accessibility to town	−0.433	
Percentage of agricultural holdings with less than 50 hectares	−0.437	
Gross mortality rate 2018	−0.584	
Accessibility to main roads	−0.704	
Old-age index	−0.838	

Table 7. Development index with respect to the Spanish municipalities and their characteristic variables.

Development Index	Number of Municipalities	%	Characteristic Variables
−4.1–−1.0	1284	15.65	Gross mortality rate 2018 Accessibility to main roads Old-age index
−0.9–0.0	2486	30.30	Agricultural unemployment Accessibility to town Percentage of the number of rain-fed crop farms
0.1–1.0	3215	39.18	Percentage of irrigated hectares Per capita income 2016 Percentage of agricultural holdings with less than 50 hectares Service sector unemployment Unemployment rate Common Agricultural Policy (Investments per 1000 inhabitants)
1.1–3.1	1219	14.85	Young-age index Population growth 2001–2011 Vegetative growth rate 2018 Population growth 2011–2018

Table 7 shows the development index, and it can be seen that there are two opposite structures, one with positive values and the other with negative values, higher and lower than 1, respectively. Demographic variables are the most decisive, so the behaviour of the population is what seems to really condition and act as a key factor in the Spanish territorial situation. The economic variables are more ambiguous and define intermediate spaces. Therefore, with this index, the existence of a dichotomy is found between the most dynamic and living spaces with demographic growth and the spaces in demographic and economic regression with high mortality rates and aging that are causing significant population losses and in which poor accessibility is contributing negatively.

3.2.1. Positive Variables of Component 1

Component 1 correlates variables that explain the level of rurality or the urban type of Spanish municipalities based on demographic and economic factors. Hence, this measure presents variables with factorial weights that oscillate between +0.839 (young-age index) and −0.838 (old-age index) (Table 6).

For the positive values of Component 1, the dynamic demographic variables appear with a greater explanatory factor; these variables include population growth in the two periods analysed (0.742 during the first decade of the 20th century and 0.669 in the second decade) and the young-age Index (0.839). These variables are also related to vegetative growth (0.681), which is conditioned by birth rates higher than those of mortality.

In the group of positive variables, there is a second block with the per capita income for 2016, the percentage of irrigated hectares (this type of crop is the most economically productive and, around it, urban areas have proliferated in traditionally agrarian regions with lower population densities, such as Andalusia, Extremadura, or the two Castillas) and (albeit with a lower factor weight) percentage of the farms with less than 50 hectares, and unemployment—both in general and specifically in the service sector—as well as CAP investments per inhabitant.

Thus, this first group correlates variables with positive factor weights that characterise the most economically and demographically dynamic municipalities. In total, there are 1219 municipalities with values between 1.1 and 3.1 that belong to the following Autonomous Communities: Catalonia, with 472 municipalities (50% of total Catalan municipalities); Madrid, with 125 municipalities (70% of the total); the Basque Country, with 113; Navarra, with 90; the Balearic Islands, with 47; the Valencian Community, with 29; Cantabria, with 22; and La Rioja, with 14. The provincial capitals and main urban population nucleus of more rural regions like Andalusia (Figure 2) also appear. These 1219 municipalities represent 14% of the total municipalities and 30% of the Spanish population. Only 200 municipalities have more than 10,000 inhabitants (the urban ones); the rest are located in the areas of influence of these 200 core municipalities (with a population of between 5000 and 10,000 inhabitants) or close to large Spanish cities such as Madrid, Barcelona, Valencia, or Bilbao but with a smaller population. Thus, we located not only the main urban and dynamic Spanish nucleus but also the nearby municipalities. These areas act, in many cases, as second homes and are positively affected in terms of income and demographic growth, since most of their residents commute daily to work in nearby urban municipalities.

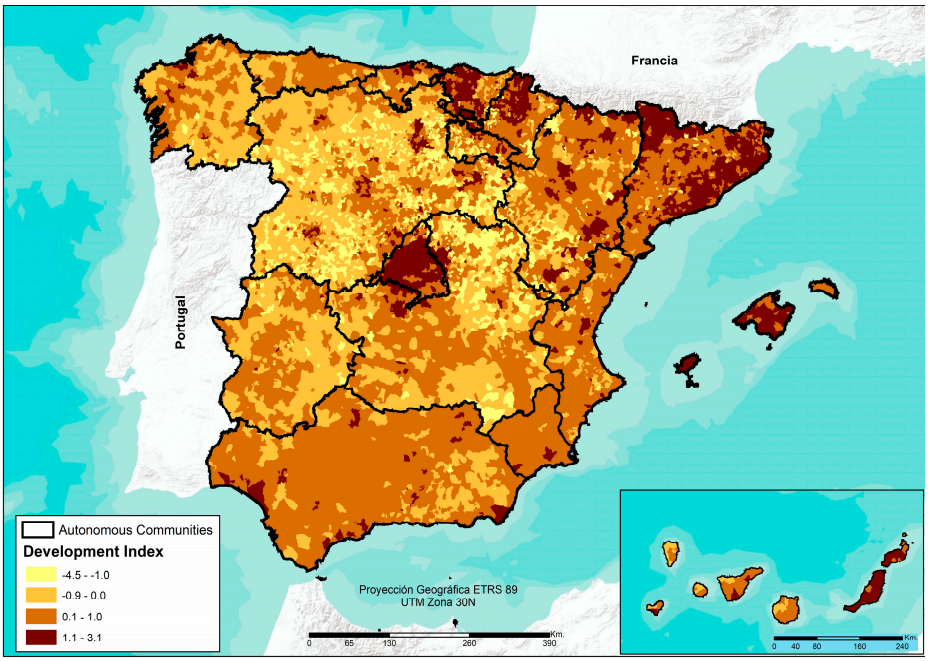

Figure 2. Development index of the Spanish municipalities. Source: the authors.

With nonsignificant positive values between 0.1 and 1, 3215 municipalities represent 39% of the total and house 67% of the Spanish population. These municipalities are intermediate areas but are correlated through positive demographic and socioeconomic variables. They are also more strongly

related to other variables, such as the percentage of irrigated hectares, percentage of agricultural holdings with less than 50 hectares, or service sector unemployment.

Thus, we obtained results similar to those of other authors [32,63]. The main axes of Spanish development are located in the main urban agglomerations and in their areas of influence. These Spanish regions are located in eastern Spain (a region with a strong tourist sector) and in the coastal areas of the north that feature developed industrial activity.

3.2.2. Negative Variables of Component 1

With negative values, demographic regressive variables, such as the old-age index (−0.838) and gross mortality rate (−0.584), appear, along with agricultural employment (−0.040), accessibility to main roads (−0.704), accessibility to towns (−0.433), and percentage of the number of rain-fed farms (−0.437), which are large properties dedicated to products such as cereals or extensive livestock farming, which are neither very economically profitable nor generate enough income to support the young population.

In total, 1284 municipalities (with values below −1) are considered to be opposed to the demographic and economic dynamism previously described. These areas are located in Castilla y León (702), Castilla-La Mancha (248), Aragón (128, with the majority in Teruel), La Rioja, Extremadura, and Galicia, with fewer than 40 municipalities. These municipalities are located in rural areas where the agricultural sector is still key and thus an excessive dependence on agriculture, despite its inability to produce high enough incomes to sustain the population.

Finally, there are also intermediate rural areas correlated through ageing and population loss, as well as the agricultural structures described above with negative values. These areas include 2486 municipalities that are located in Castilla y León (1024, 50% of its municipal terms), Asturias (28), Aragón (207), Galicia (151), in small northern municipalities, and in the border areas of Castilla–La Mancha (351) and Extremadura (227).

3.3. Results of Moran's I Statistic

Figure 3 shows the results obtained by calculating the autocorrelation index of Global Moran's I. Based on the obtained *p* and z values (0.00 and 466.22 respectively), the null hypothesis is rejected. Moreover, the groupings are random, so the Local Moran's I statistic can be calculated, and its results can be represented by territory (Figure 4).

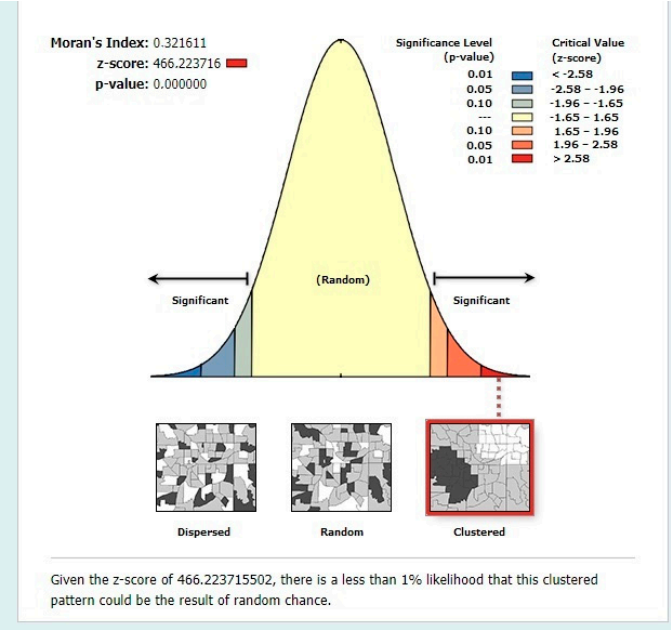

Figure 3. Spatial autocorrelation report. Source: the authors based on the Global Moran's I results.

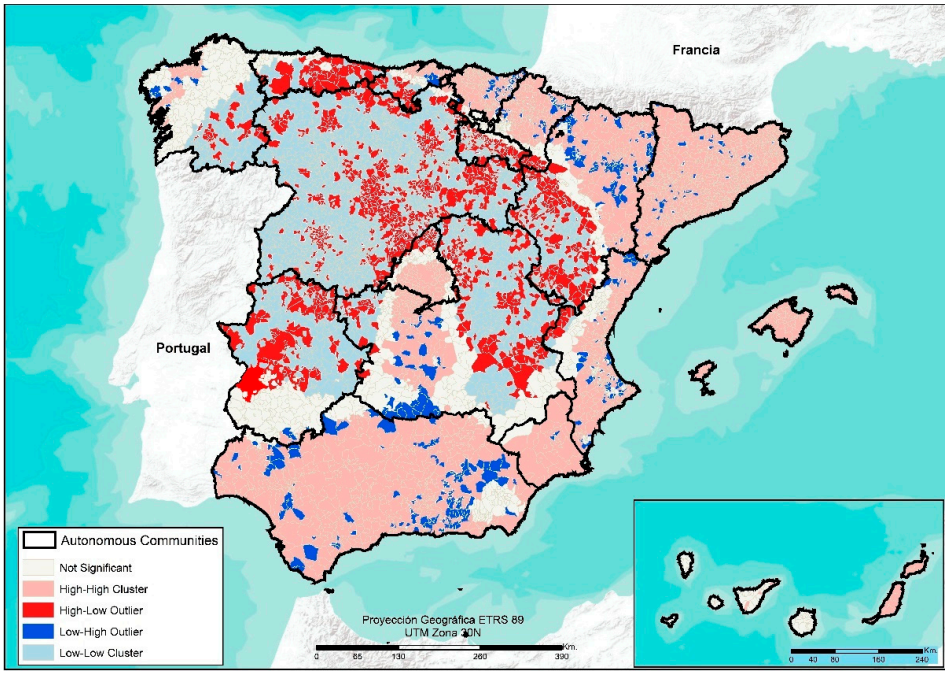

Figure 4. Local Moran's I results by territory.

In total, 2763 municipalities were obtained with concentrations of high values surrounded by high values (HH). These areas are located on the Mediterranean coast (from Catalonia to Murcia) and throughout the entire region of Andalusia, to the NW of the Cantabrian coast (Basque Country and Cantabria) and its extension to Navarra, and to the north of Aragón, as well as in Madrid and its extensive area of influence, which covers practically the entire Autonomous Community and the areas bordering the two Castillas. As a complement to these data, there are 1352 municipalities in the clusters with high values surrounded by low values (HL). As can be seen in Figure 4, these areas are more dispersed throughout the territory and have positive values (albeit not very significant) in their development indexes. These municipalities are located in the interior of Spain with lower values in their development indexes; thus, their areas of urban influence are smaller, and they are also surrounded by municipalities with low values. These are the main municipalities of the two Castillas, Extremadura, and the provinces of Zaragoza and Huesca in Aragón.

Conversely, there are 2916 municipalities in the clusters with low values surrounded by low values (LL). These are the areas with the worst conditions for development and demographic growth with the highest risk of disappearing, as neither their population nor their wealth increase since they are located in isolated areas far from the main centres of population, economic activity, infrastructure, equipment, and services. These areas are located in inland Spain—that is, in Castilla-La Mancha, Castilla y León, inland Galicia and Asturias, Northern Extremadura, and Aragón, comprising more than half of their municipalities. Compared to these, there are 486 municipalities in clusters with low values surrounded by high values (LH) in the limits of the high value areas.

Hence, using this analysis, the current situation of Spanish municipalities relative to their demographic and economic variables was delimited. On the one hand, some territories located on the coast and in Madrid (with HH values) share the characteristics of population growth, high incomes, lower unemployment rates, and intensive irrigated agricultural areas. These areas cover 33% of Spanish municipalities and 72% of the population. There is also a group of urban municipalities located in the interior regions of the country with less demographic and economic dynamism but not sufficient. Because of this, the municipalities bordering on these areas have low values. These are small cities with a minor development, comprising 47% of Spanish municipalities and 81% of the population (more than 38 million inhabitants).

On the other hand, there are 3311 municipalities located in areas of decline (with low values) that represent 40% of the total of municipalities and just 5% of the population (2.5 million). This area is inland Spain, whose municipalities have a low population, poor accessibility due to being located far from the great poles of Spanish development, high ageing, and declining agricultural structures related to rain-fed production and large livestock farms. Finally, approximately 1000 municipalities did not achieve representative values.

4. Discussion

In this work, we showed that the Spanish reality is complex and that the economic and demographic development level of the municipalities in a country such as Spain cannot be determined only by differentiating between rural and urban areas based on purely demographic variables such as size or population density. This is what official statistical agencies (such as the OECD at the global level, EUROSTAT and DG REGIO at the European level, and the NSI at the Spanish level) seem to do, despite the information they have; they analyse the physical, demographic, and socioeconomic factors of the territories they represent. Goerlich and Cantarino [98] also followed these methodologies, although these authors only sought to estimate the rural and urban population in Spain, without characterizing it.

From a scientific point of view (as in this paper), more complex and complete methods and classifications are used to analyse multiple geographic variables. Thus, already in 1993, Clout [52] or Ballas et al. [12] in 2003, stipulated that, for Europe, rural areas will have a low endowment of infrastructures and that, consequently, accessibility will be low. Moreover, tertiary and secondary activities provide few workers, prioritizing primary activities among them. Although in our research the road infrastructures were not exhaustively examined, the representative variables of accessibility were analysed and were also taken into account by De Cos et al. [61], for whom this variable and ease of travel are determining factors in the development of a region. De Cos et al. also noted that a high degree of ageing and depopulation are characteristic elements of most rural areas because of the ecological problems derived from a low demographic density, representing a vicious circle. In contrast, the most developed areas (urban) concentrate the largest number of inhabitants, whose mobility depends on their daily needs. Likewise, for López and Santiago [54], agrarian activity and ageing, together with low population density (both a cause and consequence of low birth rates and high mortality rates) are determining factors of the most disadvantaged areas, which are also key factors for Serrano and Aparicio [99]. These authors, using their disadvantage index for Castilla-La Mancha, determined that there is a clear dependence between rural areas and the agricultural sector supported by tourism exploiting protected natural resources, as happens in some provinces of Andalucía [100] and in Extremadura [101], where such activities are, sometimes, the only option to generate complementary income. Thus, these demographic and socioeconomic variables are also a key factor in our work for the design of an index that characterizes the different Spanish regions according to their level of development through the PCA, backed by good results in various fields of knowledge. However, unlike other existing studies, our research introduces new variables such as income, activity sector, unemployment, the structure of agricultural property, and CAP investments, as well as a spatial autocorrelation analysis, which is also new for this type of study. Nevertheless, at the same time, this research presents limits in terms of environmental indicators and certain public services (for example, access to clean water, waste management service, etc.) due to the lack of them at the municipal level. The management of these public services in Spanish rural areas is through associations of municipalities and/or through services offered by the provincial councils to the municipalities of minor population entity. In the future, it is intended to insert this type of variables in other analyses at the regional or functional partnership scale. It would also be interesting to introduce variables of environmental impact and quality, such as level of pollution, noise, etc., but it is difficult to find homogeneous variables at the municipal level in Spain. In any case, the objective of this first work is to focus on demographic and economic variables and, later, in future research and having a first approach to

territorial structures, it is intended to add other variables that may give a more complete vision of the structure of the Spanish municipalities and the components that influence it.

The index created in this work is a first approximation to delimit the areas with the greatest economic inequalities and demographic imbalances (ageing and very high mortality) and to locate their spatial concentration through clustering. Furthermore, thanks to this type of analysis, it has been possible to verify that, today, there remain spatial concentrations that divide Spanish municipalities into two opposite realities based on development.

The objectives of this research, which arise from the research questions, have been accomplished. Thus, there are demographic and socioeconomic disparities between Spanish municipalities; it is possible to see which municipalities have the worst values in the variables studied and that there are spatial concentrations that show which areas are at the risk of disappearance. Undoubtedly, accessibility is shown as one of the most defining variables in the economic development of Spanish municipalities. It is clear that the municipalities with the worst accessibility are the most ruralized and the least developed demographically and economically.

In future works, it is intended to add other types of variables that may also be conditioning social inequalities, such as access to essential public services (health, educational, and social-health), access to drinking water supplies, electricity, urban waste management, and, very important in recent decades, Internet connection. It will be interesting to compare the results, between rural and urban areas, of the application of public policies (of European, national, or regional administrations) in decentralization of these facilities and in equitable access, in recent decades. Moreover, variables that represent the physical characteristics, such as the relief (altitude), climate, edaphology, or land cover, would be interesting to analyse.

5. Conclusions

Currently, the demographic vacuum is one of the major political and social concerns in Spain, given that depopulation in most rural areas leads not only to a significant loss of the culture, ethnography, and folk traditions of these spaces, but also to important environmental deterioration. This occurs due to the disappearance of traditional agrarian spaces, as can be seen in the pasturelands in the Southwest of the Iberian Peninsula, where the abandonment of farms has led to the proliferation of scrubland and fires, thereby changing the environmental structure.

This work showed how the Spanish population tends to locate itself in coastal areas due to the proximity of water (which offers employment linked to the tourism sector) and maritime trade, as well as in large cities, such as Madrid, Barcelona, Valencia, Bilbao, or Sevilla, alongside the previous industrial development of the second half of the 20th century. These areas are characterized both by a greater supply of labour and by a greater endowment of public services such as hospitals, universities, schools, theatres, cinemas, etc. All this development has negatively affected rural areas, which lack equipment and services or powerful and diversified labour offers to attract a young population. Therefore, it is necessary to carry out such studies to understand the reality of Spanish municipalities.

The results obtained allowed us to determine that the variables with the greatest significance are positive demographic variables, such as positive population growth, high vegetative growth rates, the youth index, and the economic dynamism of irrigated areas, even those with a small size. In addition, thanks to the analyses carried out, intermediate municipalities were highlighted, including some considered to be rural but close to large cities; therefore, little by little, they have become second homes. Accessibility is key for population maintenance and is demonstrated in areas with a lower density but located in an optimal range of influence from urban areas or main roads.

The elaborated index, based on previous works but updated and expanded with new variables, advances one of the most important present-day topics in the field. The results obtained indicate that the number of municipalities at risk of disappearing is increasing due to their increasingly pronounced demographic trends.

In short, thanks to the current concern for rural areas, there is greater visibility of demographic problems in Spain, as well as greater social sensitivity in trying to reverse this worrying situation.

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