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Polycentric Urban System, Territorial Development and Resilience of the Rural Population (Extremadura, Spain)

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Abstract: Over the last several decades, cities have seen concentrated development and population increase. It is a global process, still unfinished, that has simultaneously generated strong territorial imbalances because of socioeconomic backwardness and depopulation of rural areas. The alternative proposed by all institutions is a polycentric urban system, so that cities contribute to decentralizing this development towards their respective areas of influence, thus stabilizing the populations in them. Extremadura is a paradigmatic example, since it has a polycentric system of small cities that have been able to retain half of the population in rural areas. The objective of this article, first, is to define the urban structure and, based on this, typify the range, the hierarchy of the system and its territorial distribution, for which a multivariate analysis is applied. Secondly, a series of isochrones and displacement ranges are defined to analyze urban accessibility, which is key to determining the degree of decentralization of development and population stability. However, a wide peripheral and remote strip remains in the region, for which a concrete proposal is finally made for discussion.

Keywords: polycentric urban system; rural–urban transformation; rural revitalization; territorial cohesion; Extremadura Region (Spain)

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1. Introduction

The concentration of development in cities has generated profound territorial, economic, social, demographic and environmental imbalances on a global scale. It is the response of current standards of quality of life and well-being of the population compared to the centuries-old ways of life of subsistence agrarian economies, unchanged in many regions and countries until the middle of the twentieth century and, in Asia and Africa, until today. As Goerlich and Reig indicate, the process of urbanization is inexorably linked to economic development. It is therefore not only a process of concentration of the population in certain places, but also a concentration of production, industry and services, talent, innovation, and, consequently, income. It follows that urbanization and the economy are therefore parallel processes [1].

In this context, Ortega points to cities as the key elements for understanding and resolving territorial imbalances, which constitute the centers of activity, population and employment, becoming the driving force of development. He also argues that the future of rural areas depends on the development of cities [2].

Europe has been considering this problem for several decades, given its intense economic concentration since the late 1950s. In fact, the preamble to the Treaty of Rome proposed strengthening the unity of its economies and ensuring their harmonious develop-

ment by reducing the gap between the different regions and the backwardness of the less favored ones [3].

This is also recognized by the Council of Europe, which is concerned about the intense concentration of populations and development in Central European cities, which generates strong imbalances with peripheral rural areas. For this reason, a European land-use planning policy is needed to pursue the harmonious development of the continent [4]. It also warns of the necessary balance between towns and countryside, whose development must be complementary. The 3rd Conference proposed the promotion of intermediate cities [5], and the 4th Conference emphasized the serious problems of intense rural exodus, growing territorial concentration, disparities and the necessary decentralization of activities [6].

Subsequent conferences of this organization stressed the need to correct the imbalances between cities and rural areas [7]. The need for urban and rural planning to ensure balanced territorial development aimed at creating a homogeneous, complementary and efficient entity capable of self-development was also stressed. At the same time, cooperation, coordination and dialogue between cities and adjacent rural areas were proposed as ways of achieving harmonious development of the European territory [8]. The Guiding Principles for Sustainable Territorial Development were also established, among which a polycentric urban model was proposed to achieve sustainable and balanced socioeconomic development and greater social and territorial cohesion, intensifying urban–rural relations with improved accessibility [9]. This and subsequent conferences stressed the need to promote networks of cities, especially small and medium-sized cities in rural areas through a polycentric system, which was dealt with more specifically at the 14th Conference [10]. And, in the last one, the 17th, functional areas were proposed as tools to promote sustainable territorial development [11].

The Council of Europe Conference of Ministers responsible for Spatial/Regional Planning (CEMAT) was therefore three decades ahead of EU territorial policy, as it was not until the European Territorial Strategy (ETA) [12] that all these approaches and recommendations of the Council of Europe were included. However, there are some precedents [8,12], which included these agreements and recommendations of CEMAT, including polycentrism and urban–rural relations.

The first European Territorial Strategy (ETA, 1999) began by recognizing the "serious imbalances" and "territorial disparities" and the role attributed to land-use planning in correcting them from a global perspective and with the aim of achieving balanced and sustainable development, as well as greater economic and social cohesion [12]. To this end, a polycentric model of cities was promoted to avoid the concentration of development in a central area and to extend it throughout the territory as the only possibility of correcting the imbalances. This model must be complemented by networks of small cities in the less developed rural regions, since only these cities are able to provide infrastructure and services for the economic activities of the region and to facilitate access to larger labor markets. Therefore, it is advisable to pay special attention to rural cities in the design of integrated rural development strategies [12].

In the Leipzig Charter, the Ministers of Urban Development committed themselves to promoting the creation of a balanced territorial organization based on a polycentric European urban structure [13]. However, this Charter leans more towards the internal aspects of the city and its sustainable development, as did the New Leipzig Charter [14].

These same themes were reiterated at the Informal Meeting of Ministers in Marseille, where it was stated that rural and urban areas are interdependent and that relations between rural and urban territories must be considered as functional zones to ensure balanced development of all areas [15].

The urban dimension must be an integral part of the concept of territorial cohesion [16] and rural–urban relations must be articulated, promoting regional clusters of cooperation and innovation, ensuring the contribution of territorial economic growth as a driving force for the strengthening of a polycentric structure [17].

In parallel, the EU continues to reiterate that its priority is to promote a polycentric and balanced territorial development, for which it considers it important to improve the accessibility of urban centers from rural areas to ensure the necessary availability of employment opportunities and services of general interest [18].

Oliveira-Martins defends a functional approach, indicating that the traditional concepts of cities and rural areas, based on administrative borders, are no longer consistent with the current economic and social organization of the territory, since from the socioeconomic point of view, the territory is organized into functional regions [19].

Similarly, the European Parliament and Council also emphasize this same approach, when they point out that within the framework of sustainable urban development, it is considered necessary to support integrated measures to address the challenges affecting urban areas, including functional urban areas, while taking into account the need to promote links between urban and rural areas [20].

The European Spatial Planning Observation Network (ESPON) underlines the fundamental contributions of these polycentric systems, in the sense that they can add value and greater competitiveness and provide economies of scale and more balanced and sustainable growth [21]. In a very similar line, the Riga Agenda insists on the relevance of the polycentric urban structure of the EU and its contribution to the achievement of the objectives of the Territorial Agenda 2020. In the same way, it also underlines the importance of all types of urban settlements as centers of services, economic opportunities and culture for their surroundings [22]. Even the Committee of the Regions proposes the development of a polycentric system of cities in Europe for an integral regional development through urban–rural relations [23]. In addition, both the UN and the EU defend polycentric systems and urban–rural cooperation to achieve an integral, intelligent, innovative, balanced and sustainable development [24,25].

The latest Territorial Agenda 2030 is more oriented towards achieving the Sustainable Development Goals, thus expressing its commitment to the challenge of climate change and sustainable development through a circular economy. It also continues to insist on the opportunities of polycentric networks, specifying that small and medium-sized cities harbor an underused potential to mitigate polarization. They play a vital role in regional economic development and social well-being, and policymakers are invited to promote polycentric development models [26].

In the European Commission's Reports on Economic, Social and Territorial Cohesion, references to these issues are continuous and frequent. The Second Report notes an increase in disparities, proposing urban centers as centers of growth to achieve polycentric development [27]. The Third Report emphasizes urban systems as drivers of regional development and the challenge of rural areas based on their location and proximity to cities [28]. The Fifth Report states that urban areas should be the drivers of greater economic, social and territorial cohesion, as objectives of the Europe 2020 Strategy [29]. The Seventh Report includes integrated territorial strategies and investments (ITIs), most of them under functional urban approaches [30]. The Eighth Report is fundamental, as it questions cohesion in Europe in the 2050 horizon. This document promotes the reinforcement of urban–rural links and the role of cities in supporting rural areas. It also indicates that regional centers can play an important economic and social role. They could become concentration centers for future investments and economic development [31]. Finally, the Ninth Report recognizes that socioeconomic disparities persist and that an increasing number of regions are at risk of facing new challenges. It also mentions that territorial imbalances could be mitigated through a more polycentric development model: developing small and medium-sized cities and promoting the provision of public services in areas far from large urban centers [32].

Dirk Ahner mentions that urban–rural cooperation leads to more efficient land-use planning, maintenance of basic services and public transport and better management of natural resources and claims that EU policy, with its separate LEADER and URBAN programs, does not facilitate this integrated urban–rural approach [33].

In fact, this is a problem that continues to persist today. Rural development programs (LEADER, until 2027) and urban development programs (pilot projects, Urban I and II and Urbact I, II, III and IV, until 2027) specifically target rural and urban areas separately. In both programs, there are some cases where work is carried out in functional areas, but these are very specific and isolated examples. In Urbact IV, there are some references to this, such as mobility in functional urban areas and the development of strategies for greater urban–rural integration, but we will have to wait for results.

In Spain, three successive calls for proposals on Integrated Sustainable Urban Development Strategies (EDUSIs) have been launched since 2015. This was a missed opportunity. Reference is made to functional areas to refer to different areas within the same city and even polycentric systems are mentioned, but the program is aimed at cities and, in the best of cases, at cities with other neighboring towns, whether rural or not. In Extremadura, all the larger cities have received EDUSI Funds, as in the rest of the regions.

From a regional perspective, the autonomous government of Extremadura mentions Coworking and Networking Rurubano, indicating that the purpose is to advance a territorial strategic vision on the consideration of rural–urban spaces. It advocates adjusting the geographic space and applying solutions adapted to the needs of both under the same vision, being able to reduce the depopulation of rural and urban areas [34]. Despite this, nothing has been done about it.

The Extremadura region, in the southwest of Spain, is an inland region bordering Portugal, very isolated due to its location and the serious deficiencies of the transport system. It has traditionally had an agrarian economy, with a strong dichotomy between large properties (latifundia) and small properties (minifundia), in which landless workers dominated until the middle of the 20th century, subject to seasonal work and miserable wages. Poverty was widespread. Therefore, as soon as the process of industrialization and Spanish development began, from the beginning of 1960, emigration was massive during the following two decades, with population losses of between 40% and 60% in most rural areas. Only the cities and the most productive agricultural areas have undergone a positive evolution. However, since the fall of the Dictatorship in 1975, the rural population has tended to stabilize, although with a slightly negative general trend. The economic structure has also evolved from the agrarian subsistence economy to a service economy, although without going through the industrial stage that drove Spanish development.

Currently, this region has incomes below 75% of the European average, making it the only region in Spain that still receives ERDF funds from the EU. It has a service sector with 73% of the population employed, very close to the Spanish average. However, it has an agricultural sector close to 10%, three times the national average, and an underdeveloped industrial sector which is very limited and restricted to the agri-food industry and a construction subsector that has not emerged from the crisis of 2008.

However, it is the region with the largest rural population in Spain, as more than half of its inhabitants still live in rural areas, compared to the Spanish average of 16–17%. It is therefore a paradigmatic region, the example to follow for European policies of cohesion and territorial development, as recommended by the OECD and the UN.

The different administrations have a clear and common theoretical approach on the need to articulate a polycentric urban system. In doing so, they seek to promote both a more harmonious socioeconomic development and the resilience of the less favored rural areas, achieving a more homogeneous environment, while at the same time contributing to the achievement of the Sustainable Development Goals.

These approaches—promoted by European and even global institutions—are complemented by the commitment to scientific postulates present in the literature, which is not alien to this issue. It addresses numerous problems arising from urban growth, often disorderly and poorly planned in previous stages, from its economic restructuring and the need to reduce the impacts caused by transport, both at an economic and an environmental level [35].

There is a marked antagonism between metropolization and polycentrism in the context of the European urban system [36], also at national and regional levels. This is the result of the voracious growth of large cities, which has attracted populations, investment, facilities, industry and development, in short. However, this macrocephaly has caused serious imbalances with the environment, so it is obvious that there is a need to strengthen territorial cohesion and competitiveness in a context of old settlements, which have evolved due to the technological, social and economic transition. This evolution has always tended towards metropolization, although recent approaches address polycentrism at different scales [36–39] to tackle imbalances and harmonize growth, democratizing development.

Between these two antagonistic conceptions, the rural world remains affected at all levels by the metropolises, which absorb their populations, emptying their towns and depriving them of basic services, and sees polycentrism as a way to survive, as an alternative, showing its resilience [40–42]. In many cases, the intense depopulation [43] of rural environments has been seen as a problem that must be approached by territories and addressed from a territorial perspective [44].

The main metropolitan areas of Spain are well described in the literature [45], where mobility patterns have been analyzed [46] because of their being the major poles of attraction for employment and investments. However, in some of these areas, such as Madrid, they have been defined as metropolises lacking territorial planning and without a metropolitan culture [47]. On the other hand, when analyzing interior environments, where intermediate or small-sized cities predominate, polycentrism is not explored in depth. It is precisely in these spaces, where the rural world and small-sized nuclei predominate, that the territory requires clear studies that serve to articulate and organize its territory.

However, although the Spanish Urban Agenda (AUE) aims to guide the adoption of public policies that are applicable in towns and cities based on criteria of sustainability, transversality and improvement of governance through Local Action Plans [48], only in a few cases has it been carried out.

On the other hand, many conceptual problems persist and different regulations have to be adapted to new situations. In fact, Law 11/2018, of 21 December, on sustainable territorial and urban planning in Extremadura, does not even allude to the concept of "polycentrism" [49].

The very concept of the rural environment, often located in the hinterland of metropolises, also presents some controversies, despite the existence of legislation that delimits it. In this sense, Law 45/2007, of 13 December, for the sustainable development of the rural environment, defines it as the geographic space formed by the aggregation of municipalities or smaller local entities defined by the competent administrations that have a population of less than 30,000 inhabitants and a density of less than 100 inhabitants per km^2, while small rural municipalities must have a resident population of less than 5000 inhabitants and be integrated into the rural environment [50].

Two poles as opposed as the rural, disadvantaged world and the urban, developed world require joint actions to obtain a mutual benefit. To achieve this, one of the keys is to propose balanced territorial development between urban centers and their areas of influence as a fundamental objective of polycentrism, for which an integration of urban functions is necessary. In other words, it pursues a more efficient and sustainable territorial organization than the dominant unicentric one, where the urban core clearly prevails over small, dispersed settlements [51]. It is not enough to have a large city on which the entire territory hinges; rather, other cities of smaller rank and size must play a decisive role in articulating the entire territory. To achieve this, good communication infrastructures are needed, which shorten travel times to access work, education, health and any other type of service.

The difficult balance between the harmonious development of a territory and the excessive growth of cities encourages the emergence of different models of governance [52–54] that concern both urban areas and their surroundings, their exchanges and relations, in which rural areas appear clearly disadvantaged. Despite this, certain trends are emerging

that advocate inclusion and see polycentrism as an opportunity for these territories, at least those that are close to cities [55]. At the same time, polycentrism is beginning to be seen as a sustainable development strategy [56].

In this sense, polycentrism has been analyzed in numerous countries and at different scales, each with its peculiarities, although those referring to large metropolitan areas predominate, in which socioeconomic dynamics affect mobility, whether labor or commercial, which implies articulating subcenters that ensure the efficiency and homogenization of the system [57,58].

In Spain, the discussion on polycentrism has followed the same pattern as at the international level, focusing on the extent of polynucleation [59]. Thus, for more than a decade, studies have emerged that analyze urban agglomerations based on the existence of several centers [60]. In many cases, the studies deal with the main metropolitan areas of the country, where density and labor flows are analyzed to define a typology. In this sense, they conclude that the most complex polycentric models reduce time and energy expenditure, thus proving to be more efficient [35,61,62].

These approaches pursue three fundamental objectives: first, to analyze the regional structure of the set of cities and to verify that a polycentric system exists; second, to verify that demographic and economic variables progressively deteriorate with distance and inaccessibility to the cities; and third, to demonstrate that this polycentric system contributes to increasing the resilience and permanence of the population in rural areas through the diffusion of a more balanced territorial development.

To achieve these objectives, two hypotheses have been put forward: first, that the cities of Extremadura form a polycentric system capable of spreading the development and consequent permanence of the rural population; second, that the cities constitute limited areas of influence, due to their small size and offerings, with a very marked degradation depending on their accessibility, which also generates important peripheral and remote rural areas.

To this end, a database including all the municipalities in the region was created, to which a multivariate analysis was applied to obtain a characterization of the cities, their typification and, ultimately, an explanatory model of the regional polycentric system. Once the network of cities was analyzed, four territorial ranges were delimited in successive 15 min bands (up to 45 and more) in the surroundings of the network of cities. The aim was, firstly, to confirm the possible degradation of the demographic and socioeconomic variables in relation to accessibility and, secondly, to verify that this polycentric system explains the high percentage of the rural population and the territorial imbalances in the region.

2. Materials and Methods

The characteristics of cities and rural areas were clearly differentiated in the past because, in contrast to the diversification of activities, employment and income in the industrial and service sectors, which have a higher added value, rural areas were characterized by a dominant agrarian economy, often based on subsistence, with little diversification. This agricultural sector has been in an uninterrupted decline in recent decades. The EU rural development programs have achieved little since 1991 in terms of diversifying activities and the reconversion of the agricultural sector. With this dynamic of crisis and abandonment, the agricultural sector has therefore become a factor of permanent rejection by the rural population.

Cities in Extremadura, despite their constant growth, are small and medium-sized and have not followed the same pace of concentration of activities and population as in other European countries and even at a national level. The population can live in rural areas and, due to proximity, participate in the urban offerings. Even in the most productive irrigated areas, the agricultural sector is no longer the main activity, it is an increasingly secondary activity, complementary to other income obtained in the surrounding cities and in other sectors of activity. Daily mobility has become an inherent characteristic of rural ways of life. Although they are small cities, they nevertheless play a fundamental role, as indicated

in the Riga Agenda [22]: "SMUAS fulfil important economic and social functions being centers for jobs, public and private services, nodes of local transport, as well as centers for local and regional knowledge production, innovation and infrastructure for a large share of the European population".

According to the Ministry of Agriculture, Fisheries and Food [63], "The changes that have occurred in the Spanish population during the last decades have altered the classic separation between urban and rural areas. The economic diversification of rural populations, and the establishment of increasingly efficient communication networks with cities, have in many cases blurred the existing border between the two".

Differentiating between cities and rural areas is not easy now. Because of these difficulties, a multivariate analysis of principal components has been applied to respond to the objective of unraveling the structure that defines cities and, based on this structure, classify their size, rank and hierarchy, as well as the conformation of the urban system in relation to the territorial distribution of the corresponding cities.

For this purpose, a database with 74 variables from each of the 388 municipalities in the region, corresponding to the years 2021–2022, has been created (Table A1). The demographic variables were obtained from the National Institute of Statistics (INE) [64] and the socioeconomic variables from the Institute of Statistics of Extremadura (IEEx) [65]. In turn, a set of natural variables (altitudes, slopes, soils, vegetation, etc.) is available from the University Institute of Research for Sustainable Territorial Development (INTERRA) of the University of Extremadura. Initially, all the variables that could be collected at the municipal level were included, without any restrictions.

Based on these data, a first exploratory multivariate analysis was carried out with the aim of identifying the variables that were most defining of the cities and eliminating those that introduced greater complexity, with more diffuse and blurred results due to different cases and peculiarities, often local. In short, those variables that do not currently specifically characterize either cities or rural areas, or are characteristics that they share and are not distinctive.

Multivariate analysis allows for a comprehensive interpretation of large territorial databases, reducing the information to a readable format and enabling an explanatory model.

As a result of the exploratory analysis, all physical variables (altitudes, slopes, soil and biogeographic characteristics) were omitted, since most of the main cities have the largest municipal areas in Spain, which introduces a great deal of natural variability. In fact, although most of them are located in sedimentary depressions, they also have peneplain and mountain areas. For the same reason, the variables most characteristic of the agricultural sector were omitted, with a certain weight still in the cities, since almost all of them are in the most productive irrigated areas.

And others were omitted, such as industrial ones, which are currently delocalized and expanding to rural areas, ceasing to be exclusive characteristics of cities and, therefore, are not so defining, hence the difficulties in differentiating cities and rural environments on many occasions given that they are on a continuum.

Once this exploratory analysis was carried out, the 19 variables with indices greater than ± 0.500 (out of a maximum of ± 1.000) in one of the two principal components were selected. This was not random, since the coefficient of determination of the same (R squared) was ± 0.250, very low, considering that this coefficient indicates the degree of explanation of the variable in the linear regression model and, to a large extent, also indicates the degree of adequacy of the variable to the real data.

Both this initial exploratory analysis and the final analysis were subsequently carried out with the IBM SPSS Statistics 25.0 system, through a Factor Analysis, with a principal components (PC) extraction method and a Varimax rotated solution method with Kaiser normalization.

The final multivariate analysis was carried out on this database of 19 variables for all the municipalities in the region. The result was an explanation of 82% of the variance in this database, with two components: the first contributed 56.7% and the second 25.4%

(Table 1). Components could have continued to be included until 100% was explained, but—as can be seen in the table—the components lost weight, with very low values, below 5%. Undoubtedly, there was an unexplained percentage of the variance, there was a loss of information, which in any case may have been due to the idiosyncrasies and isolated peculiarities of each of these 388 municipalities.

Table 1. Total variance explained.

Comp.	Initial Eigenvalues			Sums of Squared Charges of Rotation		
	Total	% Variance	% Accumulated	Total	% Variance	% Accumulated
1	11.845	62.341	62.341	10.782	56.749	56.749
2	3.777	19.881	82.222	4.840	25.473	82.222
3	0.897	4.720	86.942			
4	0.664	3.495	90.437			
5	0.583	3.068	93.506			
6	0.400	2.106	95.612			

Extraction method: principal component (PC) analysis.

The formation of these two principal components allowed us to specify the structure of the cities and, based on this, to rank them later. To this end, the analysis assigned a "factor score", using the regression method, to each of the population centers. All the cities appeared with a positive sign and the rural centers with a negative sign, with higher or lower values depending on their adaptation to the structure of the two components.

Once the structure, the hierarchy of the cities and their territorial distribution through cartography had been determined, an attempt was made to analyze and explain the role that this urban system is playing in the decentralization of development and its irradiation to its respective rural areas of influence. If this approach and hypothesis were confirmed, the urban system would explain the high percentage and resilience of the rural population.

To this end, a series of borders or bands were established around these cities based on travel times. These ranges were established on the isochrone of 45 min, the maximum distance to consider acceptable accessibility. As indicated by the CES [66], "a rural municipality is accessible in the sense of having the services associated with a city in a reasonable time and if the travel time is less than 45 min, while otherwise the rural municipality is remote". This same threshold was used by Reig et al. [67] in reference to the distance established for Europe. However, the European Commission [32] considers a "nearby population" and an "accessible population" to be one which is within 120 km of the main cities, with a maximum travel time of 90 min, which we believe to be excessive, especially in these more rural areas. Later, however, it uses as a reference the distance of 45 min for access to university studies and 35 min for access to health centers.

Four isochrones were considered, with 15 min intervals, which determined four other territorial bands in the vicinity of the main cities, from less than 15 min to more than 45. These intervals were too small to detect substantial differences, but on the other hand, greater precision could be achieved.

According to Rieutort [68], we assumed that "gradient-type forms of interaction" develop, specifying that "Le <gradient> signale une transition régulière, décroissant linéairement d'un point à un autre dans l'espace, pouvant déboucher sur une form d'homogénéisation (la notion de continuum), même si cette aproche linéaire et hiérarchisante manque de nuance et introduit une form de déterminisme liée á la distance à la métrópole".

Travel times were obtained using the Michelin Guide method, which considers standard times according to the speed limits established on the routes of each road. Other systems, such as Google Map, which calculates travel times at the time of each query based on the traffic situation and the specific conditions of each road, and is therefore highly variable, were not considered. Other systems that consider distance and speed as constant were not used either.

3. Results

3.1. The Urban System: Structure and Ranking

The results of the multivariate analysis provide an answer to the characterization of the cities and, based on this, to their classification and hierarchization.

Table 2 shows the different variables used and the weights they have in the definition of each of the two components. The first contains the economic variables and the second the demographic ones. The indices range between 0 and ±1. These two signs only express the direct or inversely proportional relationships within each of the CPs.

Table 2. Rotated component matrix *.

Period 2021–2022	Components/Factors	
	1	2
Average net income per household	0.430	0.442
Market share	0.981	0.158
Industrial entrepreneurs	0.930	0.257
Construction entrepreneurs	0.954	0.227
Business services	0.986	0.134
Wholesale trade	0.966	0.184
Retail trade	0.978	0.178
Hospitality	0.981	0.139
Transportation	0.974	0.144
Social services	0.980	0.094
Business activities	0.982	0.172
National highways, Kms.	0.835	0.149
Regional highways, Kms.	0.485	0.112
Population 2023–1950	0.397	0.577
CN 2016-20	0.111	0.797
Young group (0–15 years)	0.184	0.870
Middle-age group	−0.142	−0.963
Total dependency	−0.040	−0.868
Senile dependency	−0.082	−0.949

Extraction method: principal component analysis. Rotation method: Varimax with Kaiser normalization. * Rotation converged in 3 iterations.

In short, each component defines a substructure, made up of a set of variables, closely interrelated and by causal relationships. These two substructures, in turn, are interrelated, giving rise to the urban structure. It could be summarized that cities concentrate activities and entrepreneurship, the knowledge economy and innovation, and development, in short, according to the first component (CP1). This concentration of development acts as an attraction for the population, which is included in Component 2 (CP2). Demographic dynamics, therefore, are relegated to this second component, with an explanation of the variance much lower than the first, since this component is not exclusively urban, which also introduces difficulties in characterizing cities. This is because there are also other rural centers with positive or stabilized demographic dynamics. This is the case with those rural centers that have intensive, highly productive irrigated agriculture, associated with the corresponding agro-industry, or with those that are very close to the cities, where they become integrated, not only for work reasons but also for access to services.

The first component is defined by an economic structure that encompasses a large part of business activity, basically services. Within this last sector, trade (wholesale and retail), social services, hospitality and transport stand out. All these variables have very high values, above 0.9. This economic development gives them a very high market share. Although the cities are well connected by the motorway network, the regional road network only reaches a medium–low value. This network is what should facilitate the movement of passengers and goods and the accessibility between the cities and the rural centers of their functional areas, which will need to be improved in the future to facilitate exchanges and strengthen the areas of influence.

On the other hand, average household income is not a characteristic exclusive to cities, since, as with population, there are other rural areas that also have acceptable levels of development, which is why this variable is quite divided and interrelated in the two components. It is evident that those areas that are in productive sedimentary basins, both irrigated and dry, if they are accompanied by agro-industrial development, also achieve acceptable incomes and dynamic or, at least, stable demographics, with population densities close to the national averages.

On the other hand, rural areas close to or well-connected to cities have a diversified range of employment and income in industry and services, as well as other agricultural income, in their places of residence. This creates a set of complementary incomes between the three sectors of activity, which give rise to significant incomes, both active and passive (pensions for retirees, unemployment benefits, CAP aid, etc.). These workers in rural areas with good access to cities have, to a certain extent, higher incomes than the residents of those cities.

The agricultural sector, although irrigated and productive, is increasingly being relegated to a secondary or part-time activity, more extensive and mechanized, with the main resources being obtained in other sectors of activity in the cities. This is made clear by Collantes [69], who mentions "the increase in part-time agriculture and the intensification of commuting", "commuters" in both directions, which have caused the "occupational transformation" of the rural environment in Spain.

Component 2 shows the evolution of the absolute population from 1950 to the present with a positive sign, with positive natural growth until very recently and with a more reinforced young group. These variables have an inverse relationship (with a negative sign) with the average age and with dependency (senile and overall), since greater demographic dynamism corresponds to a lower average age (younger) and lower dependency rates, especially senile dependency, due to less aging.

According to this structure, defined by the two CPs, the multivariate analysis then classified the 388 municipalities in the region, which were assigned a score based on their greater or lesser participation or characterization in each of these two substructures. The highest scores correspond to the cities in Component 1, with a significant oscillation between 1 and 13 (Table 3). And with a negative sign appear all the rural centers without exception, except for some centers with between 5000 and 10,000 inhabitants, with slightly positive indices, but with few urban functions and without commercial or functional areas, either because they are around other cities of higher rank or because they have lost them due to their peripheral location.

Table 3. Urban rank and hierarchy.

Basic Network	CP Points (19-FAC1) *	CP Points (19-FAC2) *	Inhabitants
Badajoz	13.58575	1.09123	150.190
Caceres	9.35485	1.08666	96.215
Merida	5.56230	1.16130	59.461
Don Benito-Villanueva	5.46547	2.87639	63.236
Serena	(3.56375 + 1.90172)	(1.43425 + 1.44214)	37.485 + 25.751
Complementary Network			
Plasencia	3.65673	1.02570	39.412
Almendralejo	3.60970	1.34876	33.948
Secondary Network			
Harvest	1.30114	1.60990	16.672
Trujillo	1.02408	0.65143	8.605
Navalmoral de la Mata	0.93826	1.93283	16.895
Coria	0.89686	1.37160	12.166

(*) Principal components score (Factor 1 and Factor 2). Source: Prepared by the authors based on data from the Statistical Institute of Extremadura (IEEX).

Based on this, the cities of the "basic network" were classified, which would be made up of the two provincial capitals, Badajoz and Cáceres (with indices of 13.5 and 9.3, respectively), and the regional capital, Mérida (with 5.5), in addition to Don Benito-Villanueva de la Serena (with 5.4). These last two cities are in the process of integration, as they are very close; hence, they have been considered together. Except for Cáceres, the other four are in the Vegas del Guadiana.

With lower indices, there is what could be considered a "complementary network", with Plasencia and Almendralejo (indices of 3.6), to the north and south of the previous ones, respectively.

And, as a "secondary network", four other cities with low indices (between 1 and 2) could be considered. They are small cities, but well located in the surroundings of the previous ones, especially Zafra, which is the central and traditional city of the entire southern third of the province of Badajoz.

They form a polycentric network (Figure 1), which structures an extensive central area of the region, with acceptable socioeconomic development and the highest population densities in the region, in some cases with more than 100 inhabitants/km^2 (regional average: 25).

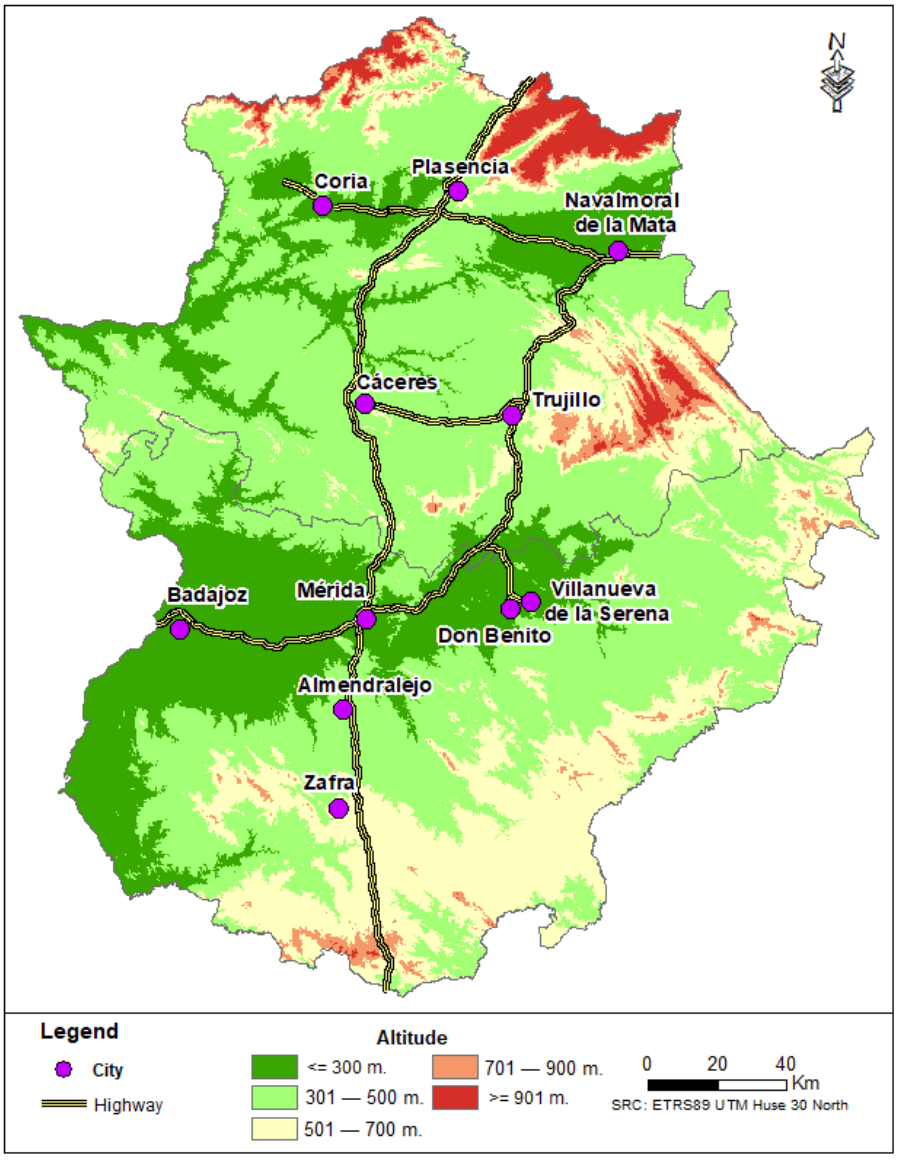

Figure 1. The urban system in Extremadura. Source: Prepared by the authors based on cartographic data from the National Geographic Institute (IGN).

With a traditional agricultural economy, all are in the two large sedimentary basins: the right bank of the Tagus, north of Cáceres, and Vegas del Guadiana-Tierra de Barros, in the north and center of Badajoz. Of these eleven cities, only Cáceres and Trujillo are located outside these basins, although they are very centrally located and well connected and integrated with the rest. The first, on the other hand, is the provincial capital; on the other hand, the second, quite close to the capital, has progressively lost its urban functions with the improvement of road infrastructure. This is what has also happened with other small traditional regional capitals in peripheral areas.

This urban complex is well connected by the national and regional highway system, although these cities do not act in a coordinated and complementary way as part of a network. On the contrary, they have traditionally behaved in a very isolated manner, in permanent competition, which implies the renunciation of the generation of economies of scale and a greater competitive capacity.

Among the motorways, the A-66 or Autovía de la Plata stands out, which crosses the entire nation and the region from north to south, parallel to the Portuguese border, between Gijón (to the north) and Algeciras (to the south). The other, the A-5, links the two capitals of the Iberian Peninsula, Madrid and Lisbon, with a NE-SW layout. They are complemented by the A-58, which leads out of the capital of Cáceres towards the A-5, in the direction of Madrid, a higher-ranking city over which it gravitates.

There are two other regional highways: the former A1, along the sedimentary basin and the irrigation lands on the right bank of the Tagus, which links the three cities north of Cáceres (Navalmoral, Plasencia and Coria), and the former A2, which leads to the Vegas Altas del Guadiana to the A-5, in the direction of Madrid, around which this area also gravitates.

3.2. Urban Accessibility, Territorial Development and Rural Resilience

Through this polycentric system of cities, there is a large central strip that is very accessible, less than 30 min away, but also large peripheral areas at distances of more than 45 min (Figure 2). In this sense, the easternmost area is very far from the urban system, coinciding also with mountain areas, as well as to the north and south, which gives them greater isolation. And, to the west, the border with Portugal extends—over 400 km—very hermetic and closed for centuries, which in the same way contributes to increasing isolation and repelling investments.

To the north, the Central System generates the isolation of its population centers, with the Sierra de Gata and Las Hurdes, in the westernmost area, which are more than 45 min away, especially the latter. In the eastern area, on the other hand, the municipalities of the Jerte Valley and La Vera are located almost in all cases within 30 min of both Plasencia and Navalmoral de la Mata and have better accessibility to these cities and to the external urban system of Talavera de la Reina-Madrid. A location map is included below, in which the place names referred to below have been collected to facilitate reading (Figure 3).

The Montes de Toledo extend along the entire easternmost peripheral strip of the region, stretching from Villuercas to the Montánchez and San Pedro Mountain ranges in the center of the region, which border the two provinces and the Tajo and Guadiana basins. Towards the south, this mountain system extends towards Siberia, with characteristics similar to mountainous areas. And below, the regions of La Serena and Campiña de Azuaga and Llerena extend on the southeastern border. It is a wide strip more than 45 min from the nearest cities and, in all cases, with mountainous and "riverside" characteristics due to the strong embedding of the river network.

This southern strip, which is largely inserted into the Sierra Morena Mountain system, continues to the southwest up to the border with Portugal. In this case, it is not the mountain but the "border effect" that is the most limiting factor. This border is only more permeable along the Badajoz–Olivenza axis, of about 25 km, as these two cities are located on the same line in the south–central part. But beyond this axis, further north, a wide strip

extends again in the regions of Valencia de Alcántara and Alcántara, which reach as far as the Sierra de Gata, in the Central System, in the northwest corner.

As will be seen below, these more remote areas are the most depopulated, with densities below 15 and even 10 inhabitants/km^2, a consequence of emigration and negative natural growth that have persisted to this day.

In some cases, these more remote areas do not have regional capitals (such as Sierra de Gata, Las Hurdes, Las Villuercas and Alcántara); in other cases, they are two-headed regions, with cities that compete and impede their own development. And they have lost these urban functions due to the inertia of depopulation or absorption by other nearby cities of higher rank, when mobility and accessibility have improved.

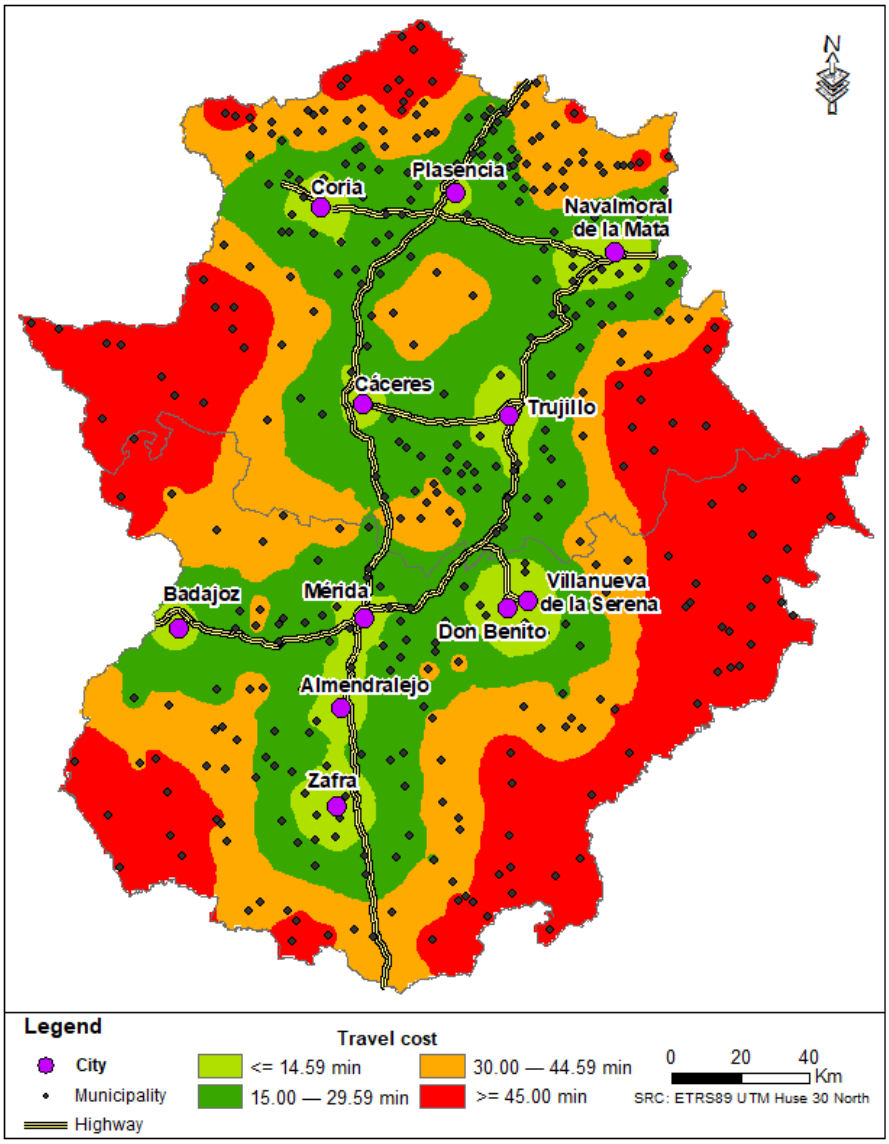

Figure 2. Isochrones and displacement ranges to the urban system. Source: Own elaboration based on IGN cartographic base.

In this sense, as Rieutort states [68], "les métropoles affirment leurs capacités motrices in raison notamment de leurs capacités relationnelles, they are also questionnées, voire remises en cause en observant l'accroissment des inégalités entre espaces centroux et périphéries/marges, les risks of fragmentation, the faible durability of processus en cours. Les "arrière-pays" rural ou les villes secondaires soint confrontés à des fragilités social économiques, aux enjeux des mobilités "contraintes" vers les centres, aux logiques prédatrices notamment sur le foncier, au manque ou à la dématérialisation des services;

"The ensemble pouvant faire emerger des sentiments de relégation". Further on, in reference to the most remote areas, he points out "risques de fragmentation socio-spatial ou de marginalization de ces derniers. . .".

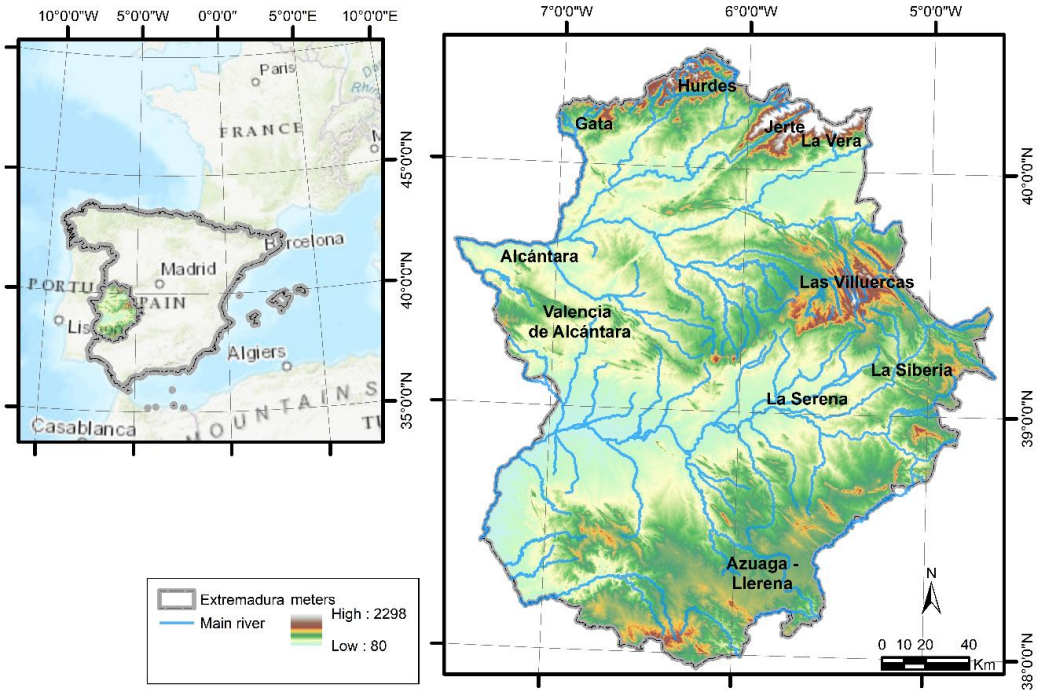

Figure 3. Location map of Extremadura.

For his part, Khün [70] states that "Cities and metropolitan areas not only concentrate people, but also goods, capital and services. They are also decision-making and innovation centers that, in the best of cases, slowly radiate outwards, and some rural areas do not even reach them or it is not possible due to the lack of qualifications, innovation and entrepreneurship. . . All these factors, taken together and, on many occasions, progressively, generate new marginalities and deepen existing ones, with the consequent difficulties for possible convergences".

Concrete results should confirm the spread of socioeconomic development from the urban network to its areas of influence, as well as the greater stabilization of the rural population. If this is the case, this positive impact should certainly decrease with distance. Since these are small "agro-cities", their influence should be limited, which is why the emphasis is placed on 30 min of travel and, at most, 45 min.

In relation to the population, as a faithful indicator, the basic demographic variables are indicated: the volume and evolution of the population since 1950 and the population density; the natural growth and migration balance, as a synthesis of demographic dynamics; and the dependency index, as an indicator of population structure (Table 4).

As can be seen in this table, the eleven main cities considered—the only ones with urban functions—do not reach 50% of the total population, compared to the 82% of the national average. More than half of the inhabitants continue to live in rural areas. Therefore, the process of urban concentration that has occurred in Europe or in developed countries has not occurred here. In Spain, it is the region that maintains the highest proportion of rural population (53%), three times the national average (around 16–17%). There is no doubt that the polycentric system of cities is contributing to this situation, although territorial imbalances are also reproduced at this regional scale. However, it must be considered that although a quarter of the population centers are still located beyond 45 min, only around 10% of the inhabitants live there.

Table 4. Demographic results by range of displacement and accessibility.

2022	Core Pop.	Total Pop.	Inhab/km^2	Population 2023–1950 *	Natural Growth **	Migration Balance **	Dependency Index
Cities	11	495,514					
%	2.8	47.0	123.6	84.3	−0.5	−1.8	51.9
<15 min	32	52,122					
%	8.3	4.9	53.4	−33.3	−5.8	−23	60.0
15:00–29:59	138	231,390					
%	35.7	22.0	26.8	−40.8	−6.1	−3.0	62.1
30:00–44:59	114	163,077					
%	29.5	15.5	23.4	−55.4	−8.2	−3.9	64.8
>45:00	91	111,822					
%	23.5	10.6	13.0	−64.9	−10.8	−6.8	69.8

Source: Prepared by the authors based on data from the National Institute of Statistics (INE). (*) Evolution of the population in the second half of the 20th century in percentages and (**) in thousands.

The most important thing is that almost 75% of the population lives within a 30 min commute and 90% within a 45 min commute, which facilitates the exchange of people and goods in both directions, as well as income and expenses, generating a series of very close synergies. It is the consequence of a polycentric system of cities well distributed throughout the territory in such a way that people who live in these rural centers have their main activity and income in the city, but also spend their money there, contributing to the joint development and maintenance of the rural environment for the use and enjoyment of all urban citizens.

Cities have gained 85% of their population since 1950, but all rural areas have lost inhabitants, although progressively, depending on the distance or accessibility to the cities, such that these losses range between 33% for the closest and 65% for the most peripheral. As Oliveira [19] indicates, "population rural regions grow more, ceteris paribus, the more connected they are (the smaller the distance) to the closest urban or intermediate region; and there is positive growth spillovers from urban to rural regions in terms of population. These effects are decreasing with distance".

This is not in line with the European Commission's [32] statement: "Half of all villages and more than 40% of towns in the EU have already lost population in the period 2011–2021. These were mainly villages and towns located more than 30 minutes' drive from a city, while villages and towns located close to cities experienced, on average, an increase in population".

These losses are reflected in both demographic dynamics and population structure. As regards demographic dynamics, all nuclei show negative natural growth rates, including cities, which suggests—if they become consolidated—a new demographic cycle or transition, characterized by persistent negative natural growth, which may be quite probable due to the increasing aging expected until at least mid-2040. Undoubtedly, these rates are also closely related to urban accessibility, such that they range between −5.8 and −10.8 per thousand inhabitants between the nearest and furthest nuclei, respectively, with a progressive gradation based on this distance.

Something similar happens with migration balances, which also show negative rates in the last five years and even in the last decade, including cities after the 2008 crisis. Only in the last two years have cities recovered their traditional positive balances, with immigration predominating, although very moderately. On the other hand, the rest of the rural centers continue to register negative rates, which range between −2.3 and −6.8 per thousand, depending on accessibility. It should be noted that the most peripheral centers have suffered persistent negative balances since the 1960s, so the losses have been very high, both due to emigration and its repercussions for natural growth, which has also been negative since those years of the last century.

As regards the structure of the population, the overall dependency index is presented, which considers the number of inactive people for every 100 active people. In this case, a

very similar gradation is repeated based on distance, such that the values fluctuate between 52% in cities and 70% in the most peripheral centers. We should speak of a very aging population, especially in the rural centers, which reaches almost a third of the total, while the young group does not reach 10%.

If the population and its demographic dynamics correspond to the degree of territorial development, the socioeconomic data should also show a similar gradation based on urban accessibility.

In Table 5, a series of data and indicators have been introduced for the characterization of cities and their rural environments to analyze the foreseeable degradation of values, direct or inverse, based on accessibility, as has already been observed in the previous table on the population.

In the southern half of Spain are located the two Autonomous Communities—Andalusia and Extremadura—with the lowest incomes in the country, especially in the more peripheral rural areas, in the mountains or on the border. But not even the cities reach the national average income per household. They are a network of small "agro-cities", with limited effects on their rural environment, but which, given their distribution and territorial proximity, encompass and spread their development to a wide central area in a homogeneous manner, with the highest population densities in the entire region.

There is a progressive decline in incomes towards the more peripheral rural areas, from EUR 28,500 to 20,500, a difference of almost 30%. And as regards socioeconomic level in general, the differences are close to 65%. The influence of urban accessibility on the levels of territorial development and its progressive deterioration is therefore evident, as is the case with the structure of these incomes. In this case, in cities, wages contribute 60% of total household income. This contribution from wages falls by almost twenty percentage points towards the most distant centers. In the latter, contributions from other passive income (pensions, unemployment benefits, other public aid, CAP aid, etc.) are almost 60%. In all cases, retirement pensions contribute just over half of this passive income, which is related to the greater aging of the centers with less urban accessibility and greater isolation.

Market share is another global economic indicator, which shows the consumption capacity of each municipality according to its population and purchasing power and is expressed per 10,000. In this case, the results really show the real differences between cities and the rest of the rural centers. The figures range between 405 for cities and 12 to 16 in the rest of the centers, also with a relative gradation based on urban accessibility, although interrupted by the centers closest to the cities, due to the fact that they are very few and have a small population.

The Social Welfare Index of the Extremadura Institute of Statistics [65] is a synthetic indicator that considers economic levels, but also others such as education, health, employment, services offered, natural environment and even accessibility to the nearest commercial centers. It is a complex indicator, which is expressed with reference to the regional average (equal to 100). Although with smaller differences, it corroborates the previous assessments, with a regressive and graduated oscillation of 109 to 96 between the cities and the most inaccessible centers.

All these indicators are largely the result of the economic structure, which appears to be quite diffuse and, with respect to some variables, confusing. The problem lies in the fact that each person is registered, according to the Population Census, in his or her usual place of residence, with his or her work dedication, even if the workplace is in another nucleus, in the case of cities. It will be seen, for example, how the dominant economy in all rural nuclei, without exception, is the service sector, even though in the smallest and peripheral nuclei there is little more than the agricultural sector and a group of isolated self-employed persons, with family businesses, for the most daily tasks. Thus, Collantes [69] expresses that "a deceptively diversified image of the economy of rural areas is created".

Table 5. Socioeconomic results by ranges of displacement and accessibility 2021–2022.

2021–2022 (*)	Home Rent	Salary %	Pension %	Market Share	Ind. Wellness	% Entrepreneurial Activity	Empr. Agrar.	Empr. Industry	Empr. Services
Cities	28,496	59.2	21.2	405.6	108.9	43.5	10.1	15.8	74.1
<15 min	22,797	51.1	26.6	15.3	104.2	4.8	29.2	22.1	48.7
15:00–29:59	21,636	45.3	28.2	16.2	101.8	22.8	33.2	19.7	47.1
30:00–44:59	20,735	43.3	30.0	14.6	99.1	17.1	32.3	21.4	46.3
>45:00	20,472	41.7	32.6	12.7	95.8	11.8	36.4	20.0	43.6

2021–2022 (*)	Work Agrarian	Work Industry	Work Construct.	Work Services	National Road **	Reg. Carret. **	Slope >20%	S. Terc+ Aluv%	Irrigation%	Olive Grove%	Herbac. %
Cities	9.1	8.7	6.2	75.8	34.7	19.6	6.2	55.1	47.5	23.1	60.2
<15 min	26.4	10.8	8.2	54.3	2.5	1,2	9.8	35.8	36.5	34.3	50.1
15:00–29:59	30.0	7.9	7.8	50.4	2.4	23	15.3	30.5	29.8	40.5	46.5
30:00–44:59	36.5	7.4	7.5	48.6	2.1	4.8	35.6	11.3	12.9	54.0	26.8
>45:00	38.7	6.1	6.9	47.9	1.5	5.4	44.7	7.8	3.7	59.4	33.9

(*) Source: Own elaboration based on data from the Statistical Institute of Extremadura (2024). (**) Km of road per 100 km^2 of surface area.

To analyze the economic structure, both the companies and the jobs generated by each sector of activity will be considered.

Cities account for only 43.6% of companies, so there has not been a process of concentration of business activity as significant as that which has occurred in other areas of the EU or in the country itself. This is due to other factors, such as the high weight of agricultural activity and entrepreneurs, the relocation of industry and construction, and the small size of cities. The centers closest to cities, which are very few and are practically integrated into them, are those with the lowest business weight, but from there on the values degrade between 23 and 12%.

The cities have a sectoral structure very similar to the national average, but their agricultural sector is three times larger than the national average and their industrial sector is much less developed. It is logical that these cities continue to maintain a certain agricultural business sector (10.1%), since they are in the most productive sedimentary basins. On the other hand, their industrial sector is limited to an agro-industry linked to these resources and a construction subsector in crisis. In addition, this industry is very delocalized and distributed throughout the territory based on agricultural and livestock resources. In fact, the cities are the group with the lowest percentage of industrial companies (15.8) compared to the rest of the rural groups (between 20 and 22%). It is, therefore, a very diffuse and extended sector, which is distributed throughout the regional territory, being the only sector that does not present a gradation of values based on accessibility.

The same occurs in relation to the employment generated by the three sectors of activity, with a clear predominance of the service sector in all cases, which ranges between 76% of the cities and 48% of the most distant centers, with a clear gradation of values based on accessibility to the urban system. In the agricultural and industrial sectors, which are more physically demanding and have lower salaries, the cities are those with the lowest values, progressively degrading from the closest rural centers to the most distant ones in a very regular manner. The one with the greatest oscillation is the agricultural sector, which is stratified between 9.1% of the cities and 38.7% of the most distant centers. The industrial and construction sectors show this same degradation, but with closer values, between 6 and 10%.

As for the agricultural sector, even the closest rural centers already account for 30% of employment in this sector, reaching almost 40% in the most distant ones. In any case, the services sector is predominant, which in these same ranges of municipalities oscillates between 47 and 43%, although these are jobs in the cities.

The transport system therefore plays an essential role in rural mobility, urban accessibility and the reciprocal flows and exchanges of people and goods.

The transport system is not very operational, the infrastructure and the frequencies and schedules, which are not adapted to the work demands, neither through road transport nor through railways, being very deficient, which forces people to travel by their own means. Camarero and Oliva [71] point out that "... As we can see, the rural inhabitant's participation in the activity is carried out through great daily mobility. The personal car has become the main resource to live in sparsely populated areas and remote rurality". And later, they add that "The circle of accessibility reduces the residential attractiveness and economic potential". In this sense, it has already been mentioned that all cities are well connected within the highway system, in such a way that this urban system has almost 35 km of highway and almost 20 km of regional roads for every 100 km^2 of municipal extension. However, motorways are becoming increasingly inaccessible to rural areas, especially those on the outskirts, ranging from 2.5 to 1.5 km between the nearest and furthest centers to the cities. However, as this network deteriorates with distance, the regional road network is expanding at a more local level, from 1.2 to 5.4 km/100 km^2 in the most distant areas. This network is essential to facilitate mobility to urban centers and cities in their respective areas of influence. It is insufficient, in any case, but it is in acceptable condition, which undoubtedly reduces travel times and encourages travel. As the Committee of the Regions points out [72], the objective must be that mobility-related

problems in disadvantaged regions are better recognized and addressed across the range of EU policies and programs, thus increasing access to mobility and reducing the risk of depopulation.

Finally, a series of very basic natural and agricultural indicators are added, but they are essential to understand the economic situation that has just been discussed. In addition, they also show a progressive deterioration with distance because of the fact that in a traditional agrarian economy, the most productive areas were those that were most occupied and with the highest population densities, which has increased with recent developments.

The cities are in sedimentary basins, flat areas with deep, fertile soils. The municipal boundaries of the cities have only a little more than 6% with slopes greater than 20%, compared to almost 45% for the more distant centers. As has been mentioned, the mountains and the Riberos areas cause greater isolation, together with the greater distance from the cities. But, above all, they make productive investments difficult in these isolated areas, just as has historically occurred with the unstable border areas.

As regards soils, 55% of the municipal areas of the cities are made up of tertiary and alluvial soils, so that 47.5% of their areas is devoted to more intensive and diversified irrigated crops (rice, corn, fruit trees, tomatoes, etc.). Based on this, an important agro-industry has emerged and developed. These characteristics also deteriorate with distance from the cities, such that in the most remote nuclei of the urban system this type of more productive soil is progressively reduced to 7.8% and irrigated land to 3.7%, with more extensive agriculture developing, frequently on small, terraced plots. In the irrigated areas of the main cities, herbaceous crops predominate (60%), which are progressively reduced towards the most distant centers (25–30%), while olive groves do so in the opposite direction, since it is the dominant crop in these peripheral rural areas (almost 60% compared to 23% in urban areas).

These natural characteristics, which have fostered agricultural and agro-industrial development in the most productive areas, may be the basis of the organization and territorial development in the region due to their having concentrated the population and fostered urban development since the mid-twentieth century. This urban development has been strengthened by administrative decentralization after the Dictatorship and by a second decentralization carried out later by the regional government, which has strengthened this inherited urban system.

3.3. The Expansion of the Polycentric Urban System as a Proposal for a More Balanced Territorial Development and the Resilience of the Rural Population

The alternative is to extend the polycentric urban system to these more peripheral areas, for which an attempt has been made to rescue and renovate the small centers that have traditionally served as more local (regional) capitals. Five centers have been selected, generally between 5000 and 10,000 inhabitants, to enhance their functionality with essential services, which should generate other synergies in the other sectors of activity and greater well-being and quality of life for the population residing in these more remote areas.

Undoubtedly, the improvement of the transport system would be necessary, since, as the European Commission [32] indicates, "Mobility is important for both economic activity and social life. . . and allows for reducing regional disparities in terms of connectivity".

However, what improves urban accessibility cannot have negative effects on small rural towns and, in general, on rural areas themselves. Therefore, in addition to the necessary improvement of transport and accessibility to the main cities, it is also necessary to promote these small "countryside" towns or agro-cities, at least with basic local services, which can also induce new and more diversified jobs and income outside a declining agricultural sector. In other words, the improvement of the transport system should not generate new or deeper rural peripheries, especially in the most remote areas.

The proposal therefore proposes a third decentralization process with the aim of strengthening and recovering the urban functions that have been lost in some traditional regional centers in these more peripheral areas.

According to ESPON [21], "Polycentric territorial structures induce more balanced growth. If polycentricity is measured by combining population size and economic growth distribution among the cities in each region or country, then more polycentric structures provide for a better distributed growth in the long run".

With this approach, a future scenario has been simulated for the region of Extremadura, in the sense of expanding the territorial extension of this existing polycentric system. Even without giving up on improving the transport system, which is expensive, the promotion of five small cities in the most distant and isolated areas is proposed. We believe that this is an affordable and feasible measure in the medium term, with a viable investment. The proposal and the territorial effects of these five new centers can be seen in Figure 4.

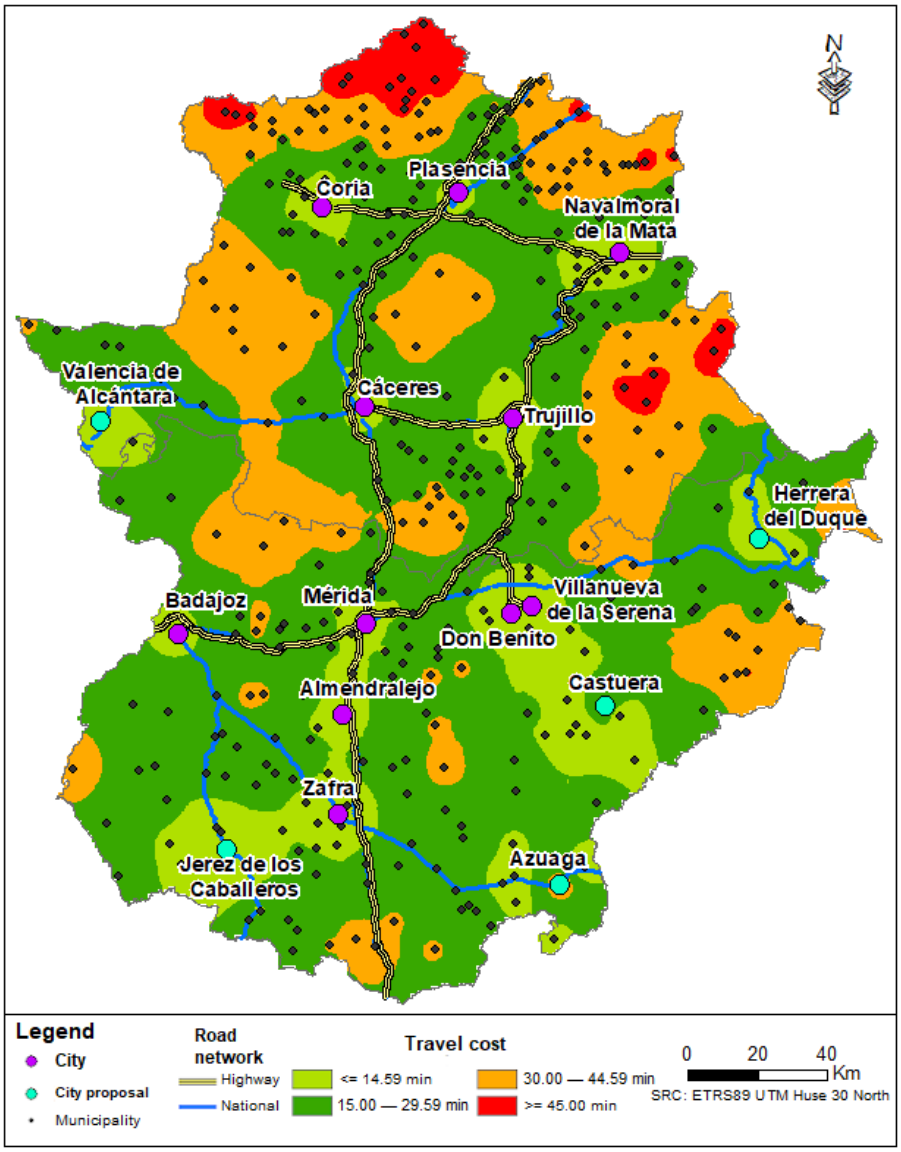

Figure 4. Proposal for expansion of the polycentric system of cities. Source: Prepared by the authors based on IGN cartographic data.

It is necessary to highlight the importance that these small towns or population centers can have in these remote and isolated rural areas. As stated by the Commission of the European Communities [73], "in rural areas further away from cities of any size, small and medium-sized towns often play a more important role than might be deduced from their size... it is key to avoiding rural exodus and ensuring that these areas remain attractive for living".

However, in some mountain areas, it is not even feasible to find a core with minimal accessibility due to the communication difficulties inherent in the topography; in fact, they have always been headless.

This is the case in the northern strip, occupied by the Central System, and the north-eastern strip, occupied by the Montes de Toledo, in its Villuercas sector. The first is the most mountainous and peripheral, with the regions of Sierra de Gata (on the border with Portugal) and Macizo de Hurdes, which is why they have traditionally gravitated towards external urban centers. Something similar occurs in the northeast, with the mountainous massif of Villuercas, where it is also not possible to determine a population center with a minimum centrality and accessibility. For these areas, it would be necessary to design other alternatives, such as a budgetary increase in their respective rural development programs, which are achieving important challenges but limited by scarce economic resources.

As a continuation of this last mountain range, there is the Siberia region, where the population of Herrera del Duque, with almost 3500 inhabitants, could carry out this work in one of the most distant and marginal areas. Continuing along this same eastern strip towards the south, there is La Serena, where Castuera is the most central nucleus and the traditional capital, with more than 5500 inhabitants. In the southern third of the province, there is only one urban nucleus, Zafra, very central, although small and with significant distances on its sides, so the impulse of Azuaga is proposed in the southeast, with more than 7500 inhabitants and, in the southwest, in the city of Jerez de los Caballeros, with more than 9000 inhabitants—both have been historical functional centers.

This last city can extend its influence to the Portuguese border, so that the entire southern half of the city would be fairly integrated into the urban system, since the Badajoz–Olivenza axis extends above Jerez. Further north of this axis, the central area of this border is another of the most backward and depopulated areas due to its urban inaccessibility. In this area, Valencia de Alcántara has been selected, with around 5500 inhabitants and also a traditional regional center.

The areas more than 45 min away practically disappear, only the entire Las Hurdes region would remain, with its five municipal areas, and another three in Sierra de Gata, as well as some other isolated municipalities in the center of Villuercas.

As you can see on this map, most of the region would be within a 30 min drive.

Table 6 shows the data corresponding to the number of municipalities and their total population, considering the 11 previous cities, plus the 5 new nuclei proposed as regional capitals in remote areas.

Table 6. Effects of the proposed expansion of the polycentric urban system.

Municipality	Nuclei (11 c) *	Nuclei (16 c) *	Pop. (11 c.)	Pop. (16 c.)
Cities	11	16	495,514	522,551
%	2.8	4.1	47.0	49.7
<15 min	32	56	52,122	106,991
%	8.3	14.4	4.9	10.1
15:00–29:59	138	182	231,390	279,990
%	35.8	46.8	22.0	26.6
30:00–44:59	114	106	163,077	122,315
%	29.5	27.2	15.5	11.6
>45:00	91	29	111,822	20,676
%	23.5	7.4	10.6	1.9

Source: Prepared by the authors based on INE data. (*) With 11 and 16 cities.

Despite adding the inhabitants of the five new selected centers, the cities still do not reach 50% of the population. With the new proposal, they do not experience significant variations in these two variables, but they do experience their impact on the whole polycentric system and, above all, in their effects on the urban accessibility of the most peripheral and remote rural centers.

Within a half-hour's journey, the number of population centers would increase from 47% to 65%, which would mean greater permeability for more than 18% of all municipalities. And the number of municipalities located more than half an hour away would decrease from 53% to 34.5%.

Considering the population living there, 86.4% would be within a 30 min commute compared to the current 73.9%. And within the 45 min isochrone, 98.1% of the regional population would be located.

In this last, more remote range, with almost a quarter of the municipalities currently, there would be just over 7%, from 91 to 29 rural centers, and their population would go from 10.6% to just 1.9%. They are very small and peripheral centers, due to their distance from the cities, their location in mountain areas and their depopulation. In this sense, the centers closest to the cities have an average of 1910 inhabitants, which are progressively reduced until the most distant, with an average of 713 inhabitants.

In any case, these apparently good results would not be efficient if a complementary urban network articulation is not contemplated, with the aim of promoting competitive economies of scale. To this end, as Rieutort [68] indicates, cooperation and reciprocity are essential, as are permanent egalitarian relations and reciprocal obligations, which must be translated into "solidarity between spaces" and "social and territorial cohesion".

4. Discussion

This article proposes three fundamental objectives: to define the structure of cities, their rank, hierarchy and territorial distribution, in order to confirm that there is a polycentric system; secondly, that there is a deterioration in socioeconomic development and demographic dynamics with distance and inaccessibility to this system; and thirdly, that this system contributes to the spread of development and to the resilience of the population in rural areas.

To this end, two hypotheses have been put forward: that there is a polycentric system of cities in the region, which spread development and keep the population in the rural environment; and, secondly, that it is a system of small cities, well distributed, but with limited functional areas due to their small size.

The development of the study allows us to confirm both the objectives and the hypotheses. It can be deduced that the region has a polycentric system of cities, well distributed throughout the territory, but they are small agro-cities, basically service-based. They clearly contribute to the spread of development and the stabilization of the population in the rural environment, but they present an intense degradation of all the variables in relation to the distance and their areas of influence are limited. Therefore, they leave a wide peripheral strip in the region that is very disadvantaged, both from the natural and economic points of view, which has led to a very intense depopulation, with losses of 60 and even 80% of the population they had in the middle of the last century, and they continue to suffer losses to this day. All these areas are located more than 45 min from the city system. In contrast, there is another large central zone with an acceptable degree of development, although below the national average, with population densities and demographic dynamics in line with the country's trends.

These statements fit with most of the European reports reviewed and organizations such as the OECD and the UN which focus their analyses on urban–rural connections and the need to reduce travel times to increase the territorial cohesion of all their Member States [3,4,24–26]. All these organizations agree on promoting a polycentric urban system of cities that are well distributed throughout a territory and which decentralize development and cooperate with each other to address territorial imbalances and the provision of

services and social and labor opportunities. This cooperation must generate sustainable, innovative and competitive economies of scale, in line with some authors of the studies consulted [74–76].

According to the methodology applied in this work, the polycentric model of Extremadura is, to a large extent, the reason why more than half of the population still remains in their rural environments, three times the Spanish average. Among the explanations of this figure is the fact that rural areas less than 45 min from these cities have at least half of their active population in the service sector (percentages that no small municipality could offer with its endogenous activity alone). Variables such as average household income, market share or the well-being index also corroborate the benefits of this polycentric model (with progressively lower values as distance and inaccessibility increase).

The results obtained validate the methodology applied to identify areas of urban influence and possibilities for socioeconomic development and/or territorial cohesion (identifying reference values or minimum standards of key variables, highly influenced by distance). In addition, this methodology is replicable and scalable to any other territory with similar economic and sociodemographic characteristics [77–80].

Among the nuances of the current polycentric model, the enormous dependence on administrations to develop an efficient and effective model stands out. The disconnection between administrations at regional and local levels when it comes to supporting and managing multiannual measures in different areas to establish populations in less favored areas of Europe helps to ensure that the current model is far from sustainable and offers more encouraging results.

Similarly, as suggested by authors such as Pérez-Morote et al. [81], identifying areas far from cities as vulnerable to depopulation does not mean that they are amenable to a single explanation and solution. For corrective measures to be effective, they must diversify activities; be endogenous, this being agreed upon by the affected population; and have good vertical and horizontal governance, according to authors such as López-Carlassare and Palma-García or Del Espino [82,83]. Employment opportunities and access to quality collective services are essential, as are access to affordable housing and proximity to family and friends, among many other factors, up to social and psychological causes, which are some of the most noted among emigrants according to the scientific literature consulted [84,85]. The population's requirement for all these needs, to some extent, is what allows the application of methodologies such as the one presented in this work, close to proposals such as the 100/30/30 Plan collected by Jurado-Almonte and Pazos-García [86].

To correct these imbalances and promote greater territorial balance, perhaps the most important EU policy is Economic, Social and Territorial Cohesion. Local measures cannot be used for large areas. Although endogenous development is proposed, it cannot be too local. Urban and rural development programs must be integrated, but in the EU they are separate, which probably makes greater integration and territorial development unviable. Cities must offer essential facilities and services and must contribute to diversifying activities, employment and income outside an agricultural sector in permanent decline, not only for their citizens, but also for those in their rural surroundings. The EU Rural Development Programmes have these among their objectives, but they work with limited resources and have a limited impact, with the Programmes that are developed in the surroundings of cities being those that obtain the best results, perhaps not so much for their activities as for those of the city itself. For this reason, the expansion of the city system is proposed, with the promotion of five traditional county seats in these peripheral areas. In recent decades, they have lost all their urban functions and are dragged down by the negative economic and demographic dynamics of their surroundings, as well as by the attraction of other nearby capitals, which absorb their functions, or by others of greater rank and offer.

According to several authors, it would also be advisable to diversify transport infrastructures, opting for quality public transport (with more adapted timetables) and mixed-use railways (transport of passengers and goods) that connect with the major European and trans-European axes [87,88]. A complementary network of urban articulation should be foreseen to promote competitive economies of scale and interconnection with the network of cities, which should be addressed by the administrations. To this end, urban–rural relations, cooperation and reciprocity, equal relations and obligations, and solidarity are essential for greater integration and better social and territorial cohesion. All this would reduce existing territorial inequalities and improve the economy of the affected rural environments.

The lack of coordination and governance between the different political and administrative levels and the low quality and competence of the institutions must be addressed as soon as possible, as the EU itself recognizes in its most recent reports on territorial cohesion.

5. Conclusions

Territorial, socioeconomic and social imbalances are long-standing concerns in Europe. In fact, cohesion arose with the Founding Treaty of the European Union in Rome (1957), with the intention of correcting these economic and social imbalances, which undoubtedly have a territorial projection. They are the result of the centralization of development and population in the main cities to the detriment of the most isolated and remote rural areas, which are gradually being relegated and depopulated.

Despite the concern and significant investments by the EU since then, these imbalances have continued to increase, with a central area that concentrates activities, employment, innovation, income and services, compared to an increasingly isolated and depopulated periphery, at European, national and regional levels. This is a constant in the Economic, Social and Territorial Cohesion Reports, in which the EU recognizes these problems and tries to provide some solutions.

The Council of Europe, through the European Conference of Ministers responsible for Regional Planning (CEMAT), already denounced these imbalances on the European continent at its first meeting in 1970.

The OECD also recognizes this, as is the case in the Urban Agendas (2016–2019) of the EU, the UN and Spain. All these institutions propose the same strategy, the development of a polycentric urban system of small and medium-sized cities, well distributed throughout the territory, cooperating in a network to generate sustainable, innovative and competitive economies of scale, as well as to offer facilities and services to the rural environment of their respective functional areas. In short, this polycentric urban system must now contribute to the decentralization of this development, accumulated in recent decades, towards its functional areas, enabling the stability and resilience of the rural population.

Specifically, Extremadura (southwest Spain) has a polycentric urban system, which has managed to decentralize development and services and largely stabilize the population in most of its territory. Currently, more than half of its population lives in rural areas, three times the national average.

Eleven cities have been classified, typified and ranked, most of which could be designated as small "country" cities, which are ordered practically according to their inhabitants, even though the volume of population has not been considered in the multivariate analysis. The highest ranked are the two provincial capitals (Badajoz and Cáceres), which bring together all the traditionally more specialized services. Added to these is the regional capital (Mérida), more administrative and recent, which occupies a central location and very good communication, but is limited by the other two higher-ranking cities and by others better located in its surroundings. Among them, to the east, two cities stand out, Don Benito and Villanueva de la Serena—in the process of integration due to their proximity—with an extensive area of influence in the northeastern corner of the province of Badajoz. These five cities make up the basic network, very central in the regional system.

Next, there is the complementary network, with an extension of the previous one to the north and south, with the cities of Plasencia and Almendralejo, respectively.

And finally, there is a secondary network of smaller towns, which extend the previous network towards the south and, above all, towards the east and west, although there are still extensive peripheral and remote areas, in the mountains, on steep riverbanks or on the border. Hence the importance of this secondary network, more for the provision of basic services (education and health) than for the diversification of activities and employment outside the agricultural sector.

They are all well connected by the motorway network. The autonomous road infrastructure is also well developed and in good condition. However, cities not only do not cooperate in the network, they compete, reducing the possibilities of development as well as their influence in their functional areas.

According to the four territorial ranges based on accessibility, depopulation is the most noticeable and immediate effect of the lack of development. In fact, all demographic variables, without exception, show values that progressively deteriorate up to 45 min, a distance from which they are already unified throughout the territory with very negative values—proof that urban influence no longer reaches beyond this distance.

Something similar happens with the main socioeconomic variables, whose most notable characteristic is the service sector, not only in cities but also in all ranges of municipalities, ranging from 76% of workers in cities to 48% in the most distant rural areas. In all cases, it is the sector that employs a greater percentage of the population. There is no doubt that a good part of this population, registered in rural areas, works in the cities in the service sector.

It should be noted that among the overall number of entrepreneurs and self-employed workers, those working in the agricultural sector increase with distance, ranging from 10% in cities to more than 36% in the most distant centers. It should also be noted that these peripheral centers also have quite a few single-family and single-person businesses for carrying out the most everyday tasks.

The industry, which is limited almost exclusively to agro-industry and construction, has little weight and is highly delocalized and distributed throughout the territory—a consequence of the delocalization towards these closer centers, which offer cheaper land and, possibly, lower tax pressure.

Because of this economic structure, the rest of the variables also show a progressive deterioration towards the most remote areas. This is the case for household income and its composition, market share and the welfare index.

But the physical variables also show the same tendency to deteriorate in their values from the cities to the most remote areas. Slopes, soils and irrigation fluctuate between 45–50% and 5–10%. The same occurs with other variables, such as olive and herbaceous crops. All these variables show the same progressive deterioration as the demographic and economic data, although in this case it is more likely that it is the cause than the consequence of the urban system.

The influence of the urban system on its rural surroundings is therefore evident and could extend to a 30 min or even a 45 min journey, although in a rather degraded form. It is a group of small towns, with an influence more oriented towards the provision of services, which is progressively degraded by distance and inaccessibility. In any case, this polycentric system can maintain, despite the losses of past decades, half of its population in rural areas. Although there are no abandoned municipalities, those that are located on the most peripheral fringe have suffered permanent emigration until today and are very old, with population densities below 10 inhabitants/km^2.

Therefore, in addition to the necessary improvement of road infrastructure, especially railways, a modernization of public transport systems is being considered. However, the prospects are not good regarding road and railway infrastructure, which is very expensive in areas with low population densities and areas with steep slopes and altitudes on the outskirts. The conditions necessary for the profitability of the public transport system

and road concessions are also not met due to the availability of private transport and low occupancy rates, which entails higher costs and concessions and routes with longer journey times.

In any case, any improvement in transport must facilitate territorial permeability, mobility, accessibility to the city system, and adaptation to work and commercial hours. It must also allow for a greater extension of functional areas and urban–rural interrelations. But it should not mean, as has occurred in recent decades, that improved accessibility through transport generates negative effects in the most peripheral areas by causing the loss of urban functions in the small towns and regional centers of these more remote areas, which, on the other hand, are not reached or are reached in a very attenuated manner by the decentralization of development from the main cities.

In short, it can be said that the objectives and hypotheses set out have been confirmed in a very reliable way. There is a polycentric urban system to which most of the population can travel in a maximum time of 30 to 45 min. Although there is an extensive peripheral strip practically all around the region, only 10% of the population is located at distances greater than 45 min. This small percentage of the population is due to emigration and a negative and persistent natural growth from the middle of the 20th century to the present day. In any case, it is necessary to maintain a minimum population in these areas for the use of resources, environmental protection, and, in mountain areas or riverbanks, the strong tourist attraction and the adaptation and care of infrastructure and heritage.

It is clear that in such vast areas, with small centers and low population densities, problems cannot be tackled with specific, isolated and very local actions for each municipality, nor with very generic measures for all equally. On the other hand, it would be necessary to mention the lack of coordination and governance between the different political–administrative levels (five from the EU to local government) and the lack of quality and competence in the institutions—aspects that have been highlighted in the last two EU Reports on Economic, Social and Territorial Cohesion.

Finally, the territorial expansion of this polycentric urban system is proposed with the recovery and promotion of the traditional regional capitals in these more remote areas, which have progressively lost their urban functions in recent decades. The aim is to expand territorial development from the urban network to this remote periphery, increasing the population's resilience, as has occurred in the rest of the region as far as the impact of urban polycentrism currently reaches. With this, practically the entire population would be under the influence of this polycentric system.

The trends and recommendations in territorial policy of the Council of Europe, the EU, the OECD and, more recently, the UN insist that the decentralization of development and the correction of territorial socioeconomic imbalances is only possible through polycentric urban systems and greater urban–rural integration. Extremadura has been a permanent reference and model for all these organizations.

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Appendix A. List of Variables Used in the Principal Component Analysis

Table A1. Municipalities.

Physical Variables	**Companies**	Industrial index
Total area	Agrarian	Market share
Altitudes < 300 m	Industrial	Socioeconomic level index
Altitudes > 700 m	Construction	Well-being index
Slopes >20%	Services	**Population**
Precipitation 500–600 cc.	Wholesale trade	Population 2023
Precipitation > 800 cc	Retail	Inhabitants/km^2
Humid brown lands	Hospitality	Population 1950–2023
Alluvial soils	Transportation	Birth rate 2016–2020
Tertiary soils	Social services	Mortality rate 2016–2020
Land Uses	Business activities/1000 inhabit.	Natural growth 2016–2020
Dry land	**Workers**	Immigration balance 2016–2020
Irrigation	Agrarian	Population > 65 years
Herbaceous	Industrial	Population < 15 years
Woody	Construction	Aging index
Cereals	Services	Youth index
Foragers	Total workers	Senile dependency index
Vegetables	**Socioeconomic Indices**	Youth dependency index
Industrial crops	Net income per capita	Total dependency index
Legumes	Net household income	Middle Ages
Fruit trees	Wages	**Roads**
Olive grove	Pensions	National/100 km^2
Vineyard	Unemployment	Regional/100 km^2
Cattle raising	Other benefits	Total motor vehicles
Bovine	Other income	Vehicles/1000 inhabitants
Ovine	Business activities index	Accessibility index
Goat	Productivity index	
Porcine		

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