The Use of GIS and Multicriteria Techniques for the Socio-Spatial Analysis of Urban Areas in Medium-Sized Spanish Cities

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Article

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Abstract: In recent decades, particularly intense changes have occurred in Spanish urban areas. This is the result of demographic and urbanizing transformations that have led to a change in the city model. The predominance of compact forms has been replaced by the growing prominence of urban sprawl. Structures are now more extensive, characterized, in turn, by fragmentation and notable consumption of land in the peripheries. In medium-sized cities, the municipalities bordering the central cities have concentrated the processes of suburbanization and periurbanization. This paper addresses the process of change for 34 cities and their urban areas located in inland Spain. A proposal is made for the delimitation and characterization of urban areas, taking the municipality as the unit of analysis. At the methodological level, six variables are used, analyzed by means of multicriteria statistical techniques combined with the use of GIS tools. An *Urban Transformation Index* (ITU) has been developed that synthesizes urbanizing, demographic and socioeconomic dynamics. In the territorial area, the 20-minute isochrone is used as a reference. In the temporal domain, the period of analysis addresses the events of the first two decades of the twenty-first century.

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1. Introduction. On the Dispersed Growth of Cities and the Delimitation of Urban Areas at Different Scales

In recent decades, we have found ourselves in an urban context marked by a slowdown in the demographic growth of cities, an increase and radicalization of environmental threats, growing competition between cities, awareness of social problems and increased urban sprawl [1]. Added to this are the effects of the recent crises, which are of a different nature (the financial crisis of 2008, the COVID-19 health crisis of 2020-21 and the energy crisis of 2022, linked to the invasion of Ukraine). The visible result is cities that are less dense, more dispersed, socially and territorially fragmented and more exclusive [2–4]. It is difficult to establish a closed, orderly and hierarchical reading of the explanatory factors. It is a territorial reconfiguration that affects the different scales of urban systems, doing so with an intensity of variable processes and with a gradation that is mainly a function of the proximity to the large metropolitan areas, the dynamics of the territories in which they are inserted, the presence of tourism activity and the type of urban and territorial policies deployed at the local/regional level [5,6].

The notions of density and urban fragmentation are subject to debate, but must be linked to the processes, dynamics and effects of urban sprawl. From the conceptual viewpoint, the initial references must be sought in rururbanization [7], which has subsequently resulted in processes of suburbanization, stagnation or loss of urban dynamics, the most recent stage of which is redevelopment, which is still geographically very selective [8]. However, there remains considerable conceptual confusion behind these ideas, marked by centrifugal movements of population migration

and activities from the city to the periphery in the functional realm of metropolitan regions. These processes of urban sprawl have been reproduced with unequal intensity and with different manifestations in diverse sociocultural contexts [9,10]. From the viewpoint of genesis, they have emerged essentially in the Anglo-Saxon sphere, with their maximum expansion in the United States at the beginning of the second half of the last century [11]. This favored the demographic and economic recovery of rural areas close to cities [12]. The explanatory factors are multicausal, with their more visible effects sometimes being a decrease in population, density and heterogeneity of the city that articulates the area, in favor of a greater intensity and complexity of the periphery [13]. This implies a change in the professional profile of residents and a change in the nature of economic activities in the peripheries [14,15]. This can be analyzed from different dimensions: residential density, constructive continuity, concentration, aggregation, centrality, nuclearity, mixed land uses and proximity between land uses [16]. As a result, mixed, dilated and transitory landscapes emerge, with the traditional conceptions of the rural and the urban being diluted and intermingled [17,18].

The reasons for the rapid development of these processes lie in structural factors. Its acceleration is linked to the effects of globalization and post-Fordism, which has left greater flexibility and new patterns of territorial location of residential and productive uses [19]. Connected to the above is the improvement of communications infrastructures [20]), as well as the progressive generalization of the information society [21]), and the forces of social change and lifestyles [22]. Furthermore, the most recent pattern of change comes hand in hand with the growing financialization of the economy in general and the housing market in particular [23].

In the Spanish urban system, these processes led to the substantial growth of important cities in the first decade of the 21st century. This has had significant impacts on the shaping of urban areas, being increasingly complex, multifunctional and with a variable territorial impact. This has also been replicated in inland medium-sized cities, which have not been untouched by these changes. In fact, in recent years, urban areas articulated by medium-sized cities have seen substantial growth in urbanized land, housing construction and population [24,25]. The visible result is the sociodemographic and urbanizing transformation of the central and urban municipalities and of those located in urban areas. However, the intensity and gradation of these processes has varied in the urban areas of the respective cities [2,3,26,27].

The reasons for the consolidation of this city model have been addressed from different approaches and by diverse authors. Particular attention has been paid to the territorial consequences of the process, especially in large urban spaces [20,28–34]. To a lesser extent and more recently, the change in intermediary cities has been analyzed, focusing on the events of the first decade of the twenty-first century [26,27,35,36]. However, the underlying complexity explains why there is still a certain lack of conceptual and methodological foundation when defining the scope, intensity, density and gradation of the extended city. These reasons determine that, in addition to studying the processes, it is important to focus interest on spatial scales (that of the city and its urban area). It is in the peripheries where much of the residential land, industrial and logistics estates, large shopping and leisure areas, or public facilities and infrastructures have been located. This has been done in specialized and territorially fragmented sectors, which increases the complexity of extended urban areas [36–38].

Methodologically, proposals have emerged from different disciplinary and institutional areas. Research works typically use statistical repertoires and the territorialization of data [39,40]), which are based on three types of indicators: 1.- indirect indicators, such as the existence of certain economic activities, the dynamics of population and housing growth, the typology of housing, etc., usually referring to the municipality due to the absence of sources on a lower scale in Spain [41,42]; 2.- morphological characteristics, based on the density of the built space, continuity of the urbanized area or the type of predominant land use, using remote observation techniques, such as Corine Land Cover or Siose, with certain problems to identify the processes of urban dispersion [6,26,43–47]; 3.- indicators of functional relationships between municipalities, based on commuter mobility between work or study and home [40,48–53]. In almost all cases, municipalities are used as administrative units of reference. The municipalities correspond to the NUTS-5 level (*Nomenclature of Territorial*

Units for Statistics), the lower unit for many of the statistics generated by the National Institute of Statistics (INE); urban planning regulations are, with exceptions, municipal in scope [54]; the municipal scale provides easily interpretable territorial units for regional planning and for the analysis of rural-urban relations [55].

From the institutional perspective, varying proposals stand out. In the case of Spain, the proposal of an atlas prepared by the Ministry of Transport, Mobility and Agenda (MITMA), available as the Digital Atlas of Urban Areas of Spain (mitma.gob.es), was first launched in 2000 and has been published successively until its latest version of 2022 (since 2007 in digital format). It is supported by consultations generated from the General Subdirectorate of Urban Planning to the municipalities to define their territorial scope. It is articulated on the basis of large urban areas, which have a central municipality of more than 50,000 inhabitants, which gives its name to the urban area. It also includes a varying number of municipalities in the surroundings of the central one with a population of more than 1,000 inhabitants. It draws on census sources of population and housing [56]. The criteria used for the delimitation were the dynamics of population and housing growth in the period 1960-1991. It does not consider, however, the modifications and transformations effected in the peripheries during the real estate boom, which were of great significance in the environment of medium-sized cities, which incorporated other nearby municipalities.

At European level, the institutional proposal is that of Urban Audit, which emerged at the end of the 1990s, sponsored by DG Regio and Eurostat (EU). Since 2010, it has included 39 indicators to delimit the areas. These are defined on the basis of functional relationships between municipalities (daily labor mobility), which help to delimit the Functional Urban Areas (FUA). The criteria for defining the center the FUA use central municipalities of more than fifty thousand inhabitants, to which are incorporated the adjacent ones in which at least 15% of the employed residents are working in the city [57]. Drawing on this definition, the proposal was prepared for the analysis of land use in European urban areas contained in the Urban Atlas of the European Copernicus Program (2006, 2012 and 2018 editions) [58]).

As can be seen, despite having the common objective of defining the scope of urban areas, all these institutional or academic initiatives are constructed on different methodologies, sources and variables. This means their results are equally disparate, with areas differing considerably in size. Those of the MITMA are much less extensive than those that appear in the Urban Audit proposal, which sometimes includes many municipalities and large spaces that maintain, both socioeconomically and functionally, features of rural spaces. In turn, the delimitation of the MITMA is much smaller and in many cases only includes the municipality of the central city or only those that are on its edges, sometimes ignoring recent change processes, which impedes a correct evaluation of the real scope of urban areas.

The uncritical taking of indicators that are assumed to be homogenized and equivalent throughout the territory to measure urban development can lead to interpretative errors and may give a biased image of some territorial dynamics [40,53]. This lack of consensus to fix the territorial scope of suburbanization, which was especially intense in the first decade of the 21st century, encourages participation in the debate, incorporating alternative and complementary indicators. A good example of this interest lies in the works that combine different types of indicators and methodologies (statistical and cartographic), integrating different variables, such as delimitation proposals based on demographic size, population density, evolution of the number of homes and mobility [39].

Under the framework of this state of the art, this work aims to focus on the processes of suburbanization of medium-sized cities in inland Spain to delimit their scope in the configuration of urban areas. It is intended to contribute to this debate and seeks to resolve some of the imbalances and deficiencies detected in the existing institutional proposals in the delimitation of urban areas. The fundamental reason is that these feature highly heterogeneous territorial scopes, which are especially critical when applying them to medium-sized cities. The hypothesis used is that the limit of urban areas for the inner average cities is marked by the 20-minute isochrone. This is a threshold that combines accessibility, urbanizing dynamics and socioeconomic transformations, the latter

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especially intense in the first decade of the 21st century. This idea contrasts with other criteria of functional delimitation, which more accurately reflect the reality of large urban areas, but which are questionable for their application to medium-sized cities.

A synthetic methodology is proposed, which uses multivariate analysis and GIS tools to define urban areas. The analysis criteria are based on the most recent demographic and urbanizing dynamics. It is approached from three different and complementary dimensions: the scope of suburbanization (definition of the urban area), the intensity (the unequal impact within the urban area) and the territorial gradation of the processes (differentiation of the most and least affected municipalities within the urban area). To resolve these issues, a synthetic indicator was generated from six variables grouped into three criteria.

2. Urban Footprint Measurement: Materials and Methods

In this proposal to delimit urban areas into medium-sized cities, a double methodology was used. A multivariate model, based on six variables developed at the municipal level, was run, while a GIS tool (QGIS) was used to territorialize the results and solve some parts of the analytical process. It was organized in several phases: selection of variables and development of indicators; delimitation of the space under analysis; design of a synthetic indicator; application of the indicator and classification of the behavior of the municipalities in each urban area.

The starting point of the process was the selection of variables and the development of indicators to measure the degree of integration of each of them in the different urban areas. Three main and complementary axes were chosen, one linked to urbanizing dynamics, another on demographic behaviors and a third on sociodemographic characteristics (Figure 1):

Axis 1.- This includes variables that synthesize the characteristics of the urbanizing dynamics and the process of transformation of the real estate stock. In this case, two indicators were used. One is the growth rate of urbanized land in the period 2000-2018: intensity of the urban footprint from the surface information and by categories provided by the geographic information layers of the Corine Land Cover (IGN) project. The second focuses on the rate of variation in the number of homes built in each municipality between 2001 and 2011: it was generated from the existing real estate stock in the Housing Censuses of 2001 and 2011 (INE).

Axis 2.- This centers on the behavioral features of demographic indicators. Two variables were used. The first is the population growth rate in the period 2001-2019, which were based on the data obtained from the 2001 Population Census and the 2019 Municipal Register of Inhabitants (INE). The second is the youth index in 2019, for which municipal data were obtained from the Digital Atlas of Urban Areas of the Ministry of Transport, Mobility and Urban Agenda [59].

Axis 3. This focuses on sociodemographic characteristics. In this case, we looked at the socio-productive structure (job activity profiles). There are two variables: one is the percentage of workers in the agricultural sector; the other is the percentage of workers in the service sector. In both cases, the data for the year 2019 were used, and were obtained from the Digital Atlas of Urban Areas of the Ministry of Transport, Mobility and Urban Agenda (MITMA).

To establish the potential catchment area, an urban area was defined with a central reference point. In this case, the geographical coordinates of the main building of the town hall of each of the 34 cities used as a sample were chosen. The spatial analysis tool Hqgis, integrated as a complement in the QGIS free software, was used to generate a buffer of 20 minutes of travel in a vehicle (20-minute isochrone). Based on this isochrone, a first territorial delimitation was made, including the municipalities whose center is integrated within that threshold. In a second step, two filters were applied to exclude municipalities that, being in the area of influence determined by the isochrone, presented territorial realities with sufficient personality to exclude them from urban areas. Those of 2,000 inhabitants or more that had not suffered urbanization dynamics related to their expansion and that were further away were excluded because they were considered central municipalities of rural districts other than the urban area under analysis. On the other hand, we also excluded those with more than 10,000 inhabitants were also excluded, as this renders them urban according to the Spanish classification of municipalities, which sometimes allows them to have their own urban area. Drawing

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on these starting criteria, the analysis was carried out for 736 municipalities located in the vicinity of 34 interior medium-sized cities.

The methodology was designed to respond to two complementary and sequenced objectives. The first aimed to delimit and characterize urban areas as sets. The second focused on the level of integration of the municipalities included within each of them. In the first, the value of each variable at the municipal level with the average value of its urban area was chosen as a criterion for characterizing behavior. To avoid the distortion that the values of the central city might generate over the whole area, these were removed from the indicator. The result obtained allowed us to differentiate the municipalities with behaviors higher than the average of the urban area. It also allowed the intensity of urbanization to be characterized and the level of integration with respect to the central city to be measured. It is understood, therefore, that features of the urban are found in those that present dynamics of urbanization and growth of housing, demographic growth and rising youth index, and percentage of workers in the service sector and higher levels of professional deagrarianization than the average of the urban area.

Once the potential area of the urban environment was defined, multi-criteria analysis was used. It was conducted with the six variables of the three analysis groups (dynamics of urbanization, demographic characteristics and socio-productive profile). Percentage values were used or values expressing a ratio of between 0 and 100, which avoids the model being affected by the various scale factors of these variables. The variables used individually illustrate, with substantial accuracy, the individualized behavior of the municipalities, differentiating the most and the least dynamic in each case and the level of integration and the position they occupy in their urban area. To test the results obtained with the static model, orthophotography and field work were used to check, adjust and correct the data. This final adjustment made it possible to eliminate or add municipalities according to the following criteria:

Elimination of municipalities: through the analysis of cartography and orthophotography, we exceptionally excluded some in which there was an evident territorial discontinuity with the central city, with little appreciable impact of the urban sprawl and which barely benefited from the growth of the city. These are areas where the impact of suburbanization is very small, but where the statistical model offers above-average results due to the low level of the starting point.

Incorporation of municipalities. In very specific cases, fieldwork and analysis of cartography and orthophotography recommended including municipalities with evident continuity in the existing urban area. In others, this was done in order to avoid the generation of discontinuities in the urban area (territorial islands). Finally, we added municipalities that, despite the statistical result not yielding indicators of urbanization or sufficient transformations, had large amenities or infrastructures of an eminently urban nature (shopping centers, industrial areas, airports, golf courses, etc.).

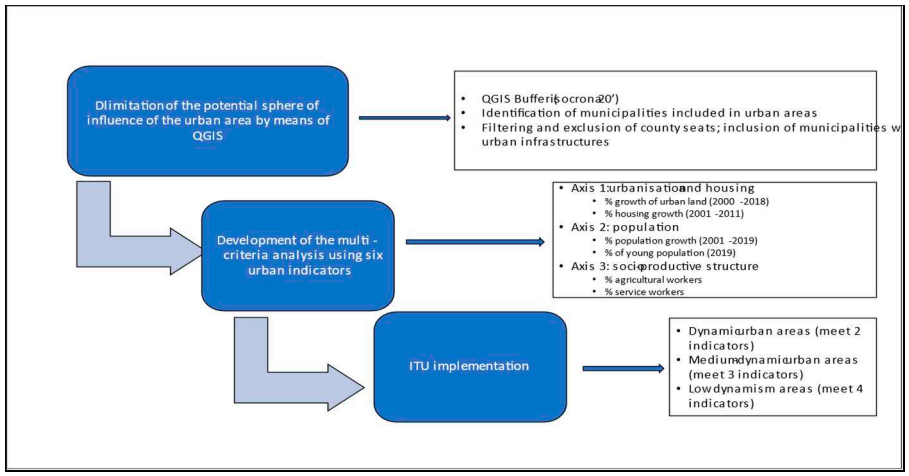

Figure 1. Methodology for the delimitation of urban areas in medium-sized Spanish cities. Own elaboration from: INE, Population and Housing Censuses 2001 and 2011 and Municipal Register of

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Inhabitants 2019; Transport, Mobility and Urban Agenda (MITMA), Digital Atlas of Urban Areas; IGN, Geographic information coverage Corine Land Cover Project, 2000-2018.

To classify the municipalities of each urban area (based on the integrated behavior of the six variables), the Urban Transformation Index (ITU) was generated. The ITU has the advantage of allowing a statistical grouping to be generated, which assigns a unique value and the position occupied by each municipality in the whole of each urban area. The result is an artificial numerical value per municipality, ranging from 0 to 100, and which integrates and unifies urban transformation from the aggregation and combination of the set of variables. This makes it possible to establish an orderly hierarchy of municipalities. The higher values indicate high urban dynamism in the municipality in question, while the low values suggest the opposite. The application of the ITU to all 34 cities results in three large groups of urban areas. The groupings were constructed through the use of standard deviations, which allowed us to identify the cut-off points or bands to create groups of urban areas with homogeneous features.

3. Results and Discussion: The Typologies of Urban Areas and Their Delimitation in Medium-Sized Spanish Cities

Table 1 shows the results of the initial multivariate analysis in which the results of the data can be checked in the three axes of analysis. For the first group of variables (population and housing), positive values can be found in all cases, although with considerable differences according to the cases. In the dimension referring to the growth of urbanized land four exceed 2% (León, Albacete, Santiago de Compostela and Vitoria). Ten other areas grew above 1%. With regard to real estate growth, considering the evolution of the construction of new homes from the data of the Censuses of 2001 and 2011, it can be seen there are two especially dynamic urban areas (Guadalajara and Segovia), with a growth of more than 100%. Ten others grew above 40%, while most of them did so with rates above 20% (24 out of 34).

Table 1. Variables selected in the methodological process and results of the application of the Urban Transformation Index (ITU) to the 34 urban areas articulated by medium-sized cities in Spain. Own preparation, using data from: INE, Population and Housing Censuses 2001 and 2011 and Municipal Register of Inhabitants 2019; Transport, Mobility and Urban Agenda (MITMA), Digital Atlas of Urban Areas; IGN, Geographic Information Coverage Corine Land Cover, 2000-2018.

Urban Areas	Axis 1: urbanization and housing		Axis 2: Population		Axis 3: structure Socio-productive		Urban Transformation Index (ITU)	
	Growth Urb. 2000-2018 %	Growth Housing 2001-2011 %	Population growth 2001-2019 %	Index Youth 2019 %	Agricultural workers2019 %	Service workers2019 %		
Guadalajara	**1.20**	**178.29**	**5.52**	**13.90**	**5.30**	**68.75**	**100.00**	**Group 1: Areas high Dynamism**
Pamplona	**1.30**	**85.97**	**3.30**	**15.60**	**2.30**	**63.90**	**87.42**	
Girona	**1.10**	**46.34**	**2.10**	**15.10**	**4.40**	**57.10**	**33.18**	
Toledo	**0.70**	**57.13**	**2.50**	**15.60**	**8.90**	**60.10**	**29.31**	
Segovia	**0.70**	**109.42**	**3.20**	**12.90**	**13.20**	**56.50**	**27.51**	
Vitoria	**4.10**	**32.29**	**1.60**	**12.20**	**14.60**	**59.20**	**26.71**	
Manresa	0.20	43.99	1.65	13.90	5.30	54.80	18.16	**Group 2: Areas medium dynamism**
Santiago de Compostela	2.90	25.46	0.20	12.60	12.40	60.30	18.03	
Albacete	2.40	27.75	0.60	15.20	24.10	53.30	16.91	
Salamanca	0.50	64.30	1.50	12.90	15.20	57.90	15.73	
Ciudad Real	0.80	37.10	0.50	14.20	15.95	60.05	14.26	
Badajoz	0.30	22.60	0.35	15.64	21.10	66.60	13.58	

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Elda	0.70	30.36	0.80	15.40	7.26	47.90	13.19	
Lion	2.10	30.26	0.20	10.60	15.50	62.10	12.04	
Lorca	0.20	33.20	1.60	17.10	35.30	49.30	11.42	
Talavera de la Reina	0.35	35.17	1.40	13.90	18.60	53.00	10.77	
Burgos	0.76	45.72	1.70	11.50	19.50	52.17	10.08	
Ponferrada	1.50	14.61	-0.50	11.50	7.50	57.70	9.40	
See also	1.00	34.62	-0.60	9.60	7.10	65.10	8.92	
Lérida	0.70	32.64	0.94	14.30	26.70	48.10	8.80	
Alcoy	0.25	17.61	0.02	13.80	7.60	53.20	8.44	
Merida	0.80	13.73	0.10	16.70	36.80	49.80	8.31	
Cáceres	0.60	13.26	-0.10	14.90	13.10	51.80	7.94	
Huesca	0.07	61.42	1.80	11.80	29.30	48.50	7.56	
Teruel	0.15	17.99	0.10	13.70	25.00	55.70	6.32	
Jaén	0.60	19.72	0.70	17.80	42.90	39.60	6.14	
Basin	**0.10**	**26.10**	**0.05**	**12.10**	**24.00**	**55.40**	**5.16**	**Group 3: Areas Low dynamism**
Logroño	**0.40**	**55.94**	**0.50**	**11.50**	**24.10**	**41.30**	**3.87**	
Linares	**0.90**	**12.91**	**-0.30**	**17.80**	**47.70**	**36.90**	**3.74**	
Logan	**0.40**	**15.43**	**-0.60**	**11.00**	**21.20**	**50.40**	**2.44**	
Zamora	**0.50**	**31.52**	**-0.30**	**10.60**	**29.50**	**44.00**	**1.87**	
Palencia	**0.30**	**18.01**	**-0.30**	**11.50**	**32.00**	**43.70**	**1.50**	
Avila	**0.07**	**19.38**	**-0.90**	**10.90**	**33.90**	**46.70**	**0.76**	
Soria	**0.20**	**30.72**	**-0.60**	**9.06**	**40.05**	**44.02**	**0.00**	
TOTAL	0.85	39.44	0.85	13.44	20.22	53.38	-	

Demographic transformations exhibit different results. The general trend is positive, but the rates have lower values. Only five urban areas registered a growth of more than 2% (Girona, Toledo, Segovia, Pamplona and Guadalajara). In another 22, the growth is less than 1%, and, in eight of them, the final balance is negative. With regard to youth rates, the results also show a greater dynamic in urban areas, although with considerable oscillations depending on the case. The highest rates are concentrated in the most rejuvenated areas, which exceed 15% (Girona, Albacete, Toledo, Pamplona, Badajoz, Linares, Mérida, Lorca, Jaén ...), while those with the oldest populations present ratios ranging between 9 and 10% (Soria, Ourense, Zamora, León, Ávila ...)

With regard to the socio-productive structure, there are also significant variations between the different urban areas, which, in this case, appear to be more calibrated than the previous results, thus defining to a large extent the degree of transformation of the new peripheries in each urban area. The percentage of agricultural workers, which can be understood as an indicator of the maintenance of traditional rural activities, ranges from figures below 5% to others exceeding 40%. The average of the 34 urban areas is 20% of active agricultural population, and 17 urban areas are above this reference value for the entire set, and only 9 are below 10%. The least agrarian are Pamplona, Gerona and Manresa. In the same sense, the percentage of the population employed in the tertiary sector identifies the group of workers involved in urban service activities. There are eight areas with percentages above 60% (Guadalajara, Badajoz, Orense, Pamplona, León, Ciudad Real, Santiago de Compostela or Toledo). Another 22 present tertiarization rates of above 50%, with only two having values below 40% (Linares and Jaén, with a strong agricultural profile) (Table 1).

However, the specific analysis of the separate variables allows neither for the identification of the dynamics nor of the growth rates and the delimitation of urban areas. The multivariate result provided by the synthetic indicator (ITU) and GIS analysis is required. The use of the ITU allows us to identify the behavior and the degree of compliance of the variables in the municipalities included in each urban area and establish typologies according to the three groups referred to (Table 1 and Figure 2).

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Group 1. *Very dynamic areas*. The degree of transformation and growth detected in all variables is high, which explains why most of the municipalities experienced a strong transformation in the municipalities around the central city. The generalized dynamics of the area are positive and, consequently, the number of positive indicators that each municipality must meet to be included in the urban area is lower. In this group, it is detected that a behavior above the average of the area in two of the six indicators coincides with a pattern of belonging to the urban area. This first group is formed by the five areas with the highest demographic dynamics, the highest surface growth rates of urban and real estate areas, and that present sociodemographic features that indicate urban patterns (high youth index, predominance of the service sector in employment and very low agrarian population index). This first group is composed of the urban areas of Guadalajara, Pamplona, Girona, Toledo, Segovia and Vitoria. In all of these, the set in the six variables is 0.5 times above the standard deviation of the total areas, and the ITI values present results that are above 25. Guadalajara is indisputably the urban area with the greatest urban transformation according to the ITU (the reference value is 100, the highest allowed by the index). Pamplona is close behind with a value of 87. The other areas included in this group show quite similar situations, although now located between the ranges of 25 and 30 of the ITU indicator. In the territorial sense, some are within the scope of influence of the polynuclear metropolitan area of Madrid, although outside this autonomous community (Segovia, Guadalajara and Toledo). The others are close to other metropolitan areas located at the head of the Spanish urban hierarchy (Gerona, Pamplona and Vitoria).

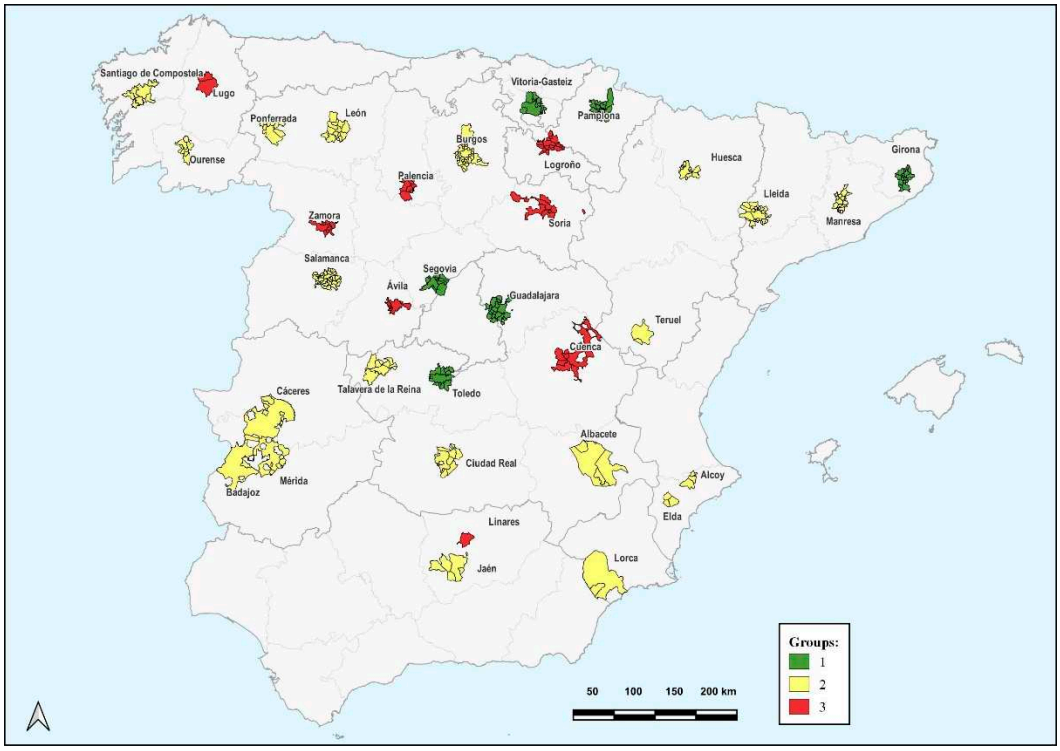

Figure 2. Urban Transformation Index (ITU). Ranking of the 34 urban areas articulated by medium-sized cities of inland Spain according to intensity of dynamics, transformations and urban characters. Source: Authors.

Group 2. *Areas of medium dynamism*. The transformation and growth of the variables is close to the average. This demonstrates that the municipalities of the urban area present behaviors comparable to those of the central city. The number of positive indicators that each municipality must meet to be included in the urban area is higher, due to lower dynamics of urban growth. In this group, it is detected that a behavior above the average of the area in three of the six indicators coincides with a pattern of belonging to the urban area. This second group refers to a set of urban areas with more moderate urban, real estate and demographic growth patterns, located around the average. It is the

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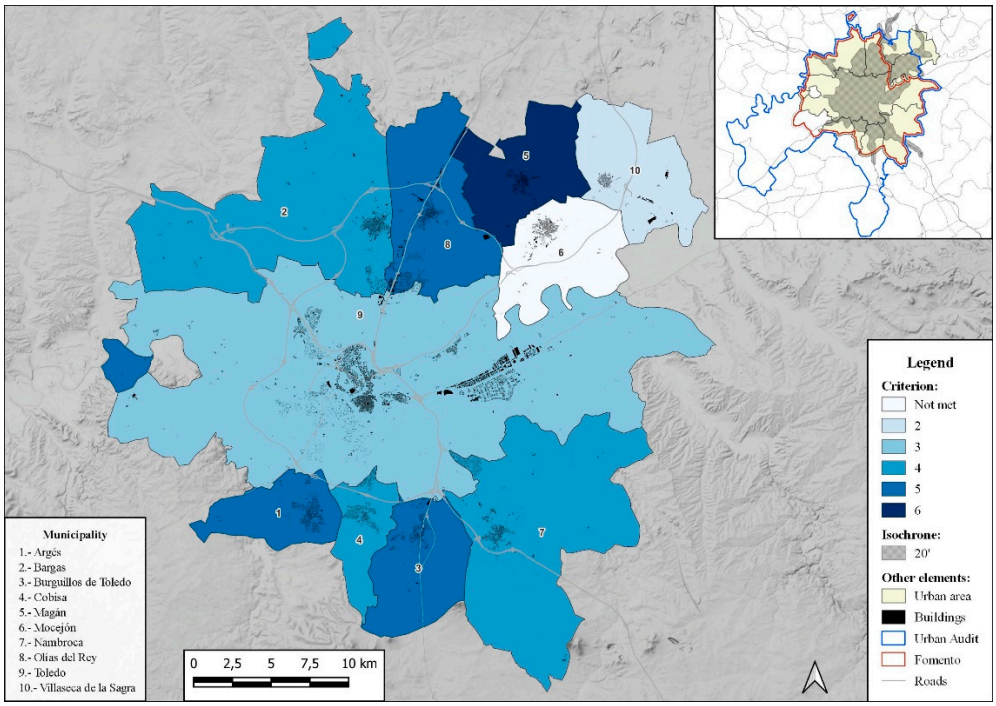
majority segment of 21 cities and their respective urban areas. The values of the index are in the range of 6 to 18, with the highest values found for Manresa, Santiago de Compostela and Albacete, while the lowest are in Jaén, Teruel and Huesca. Here appears a diverse set of realities of urban areas, widely distributed territorially (autonomous communities of Extremadura, Castilla-La Mancha, Castilla y León, Basque Country, Aragon, Catalonia, Murcia or Valencia) and relatively far from the big cities.

Group 3. *Areas that are not very dynamic.* In this group, the dynamics of transformation and growth of the variables are limited, such that many of the municipalities present behaviors below those of the central city and others are far from presenting urbanization processes. For this reason, the number of positive indicators that each of them must meet to be included in the urban area is even greater, since the trend of urban transformation is not clearly perceived or is non-existent. In this group, it is detected that a behavior above the average of the area in four of the six indicators coincides with a pattern of belonging to the urban area. The third group has UTI values at 0.5 times the standard deviation of the total. In this case, we have the least dynamic urban areas, consisting of eight (Cuenca, Logroño, Linares, Lugo, Zamora, Palencia, Ávila and Soria) with scores below 5 (only Cuenca slightly exceeds this threshold). In these cities, urbanization and housing dynamics are below average, with a very moderate or even negative demographic growth, and sociodemographic indicators continue to maintain characteristics typical of areas of medium or high rurality, which highlights the limited processes of suburbanization observed. Some of these are in mountain areas and four are in the region of Castilla y León. These are territories characterized by demographic sluggishness and the structural weakness of their economic models.

Along with the classification of urban areas, the ITU allows a categorization of the behavior of municipalities within each urban area to be established. This is done by using the fulfillment of criteria for each of them. For reasons of space, it is impossible to include the reality of all the cases. Six examples are presented, two corresponding to each of the three categories of urban areas (Figures 3, 4 and 5). They show the unequal degree of integration of each of the municipalities.



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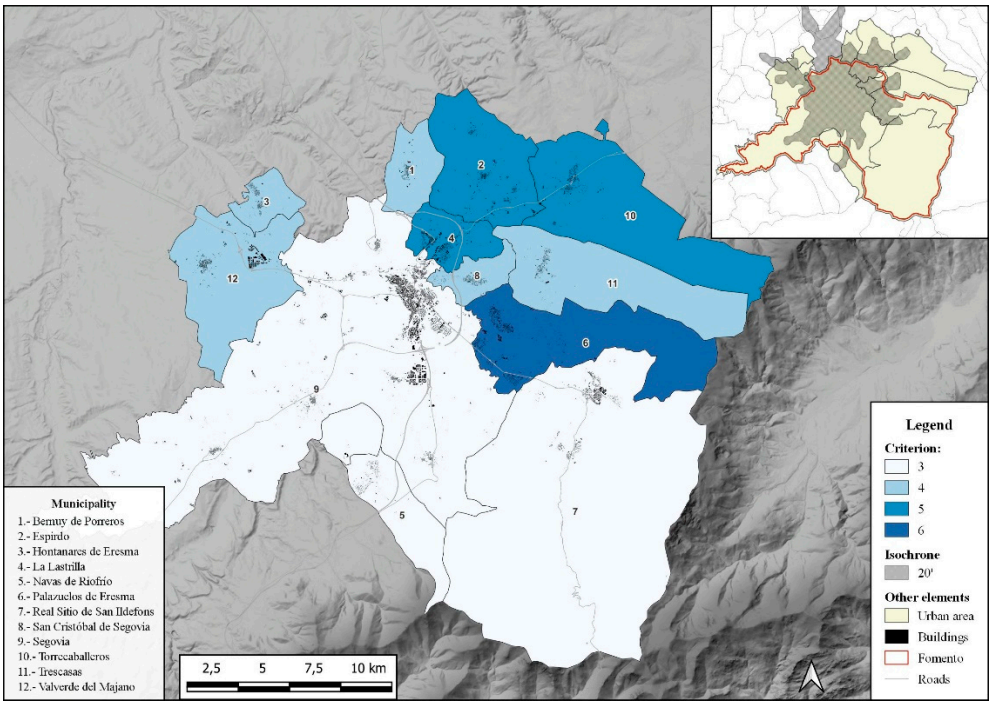
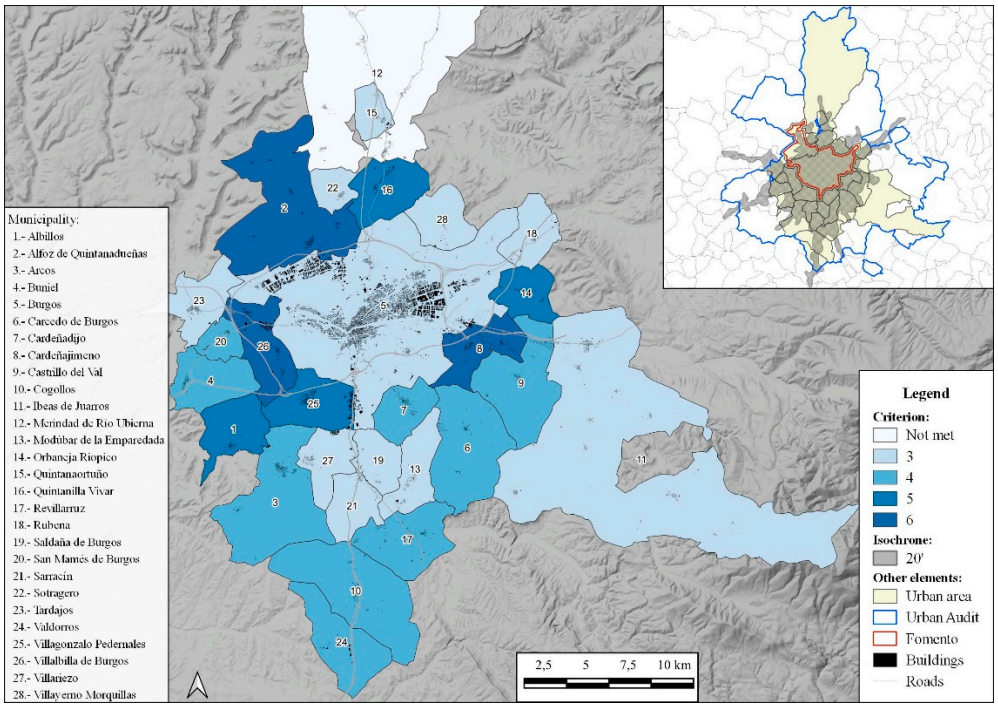


Figure 3. Delimitation of more dynamic urban areas (Group 1). Case examples of Toledo and Segovia. Source: Authors.



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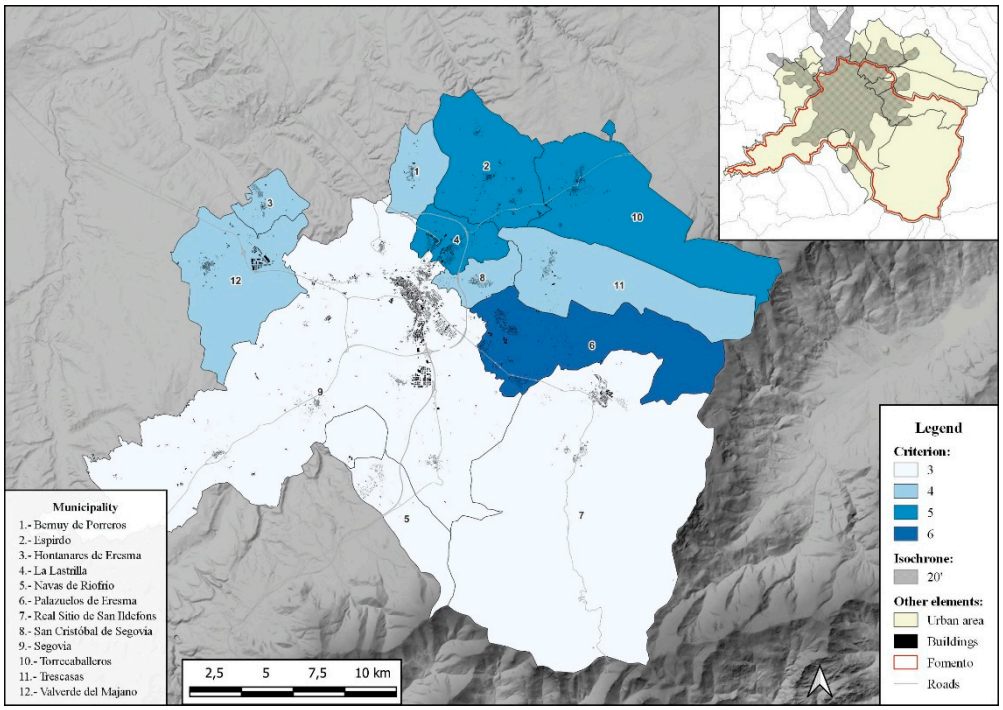
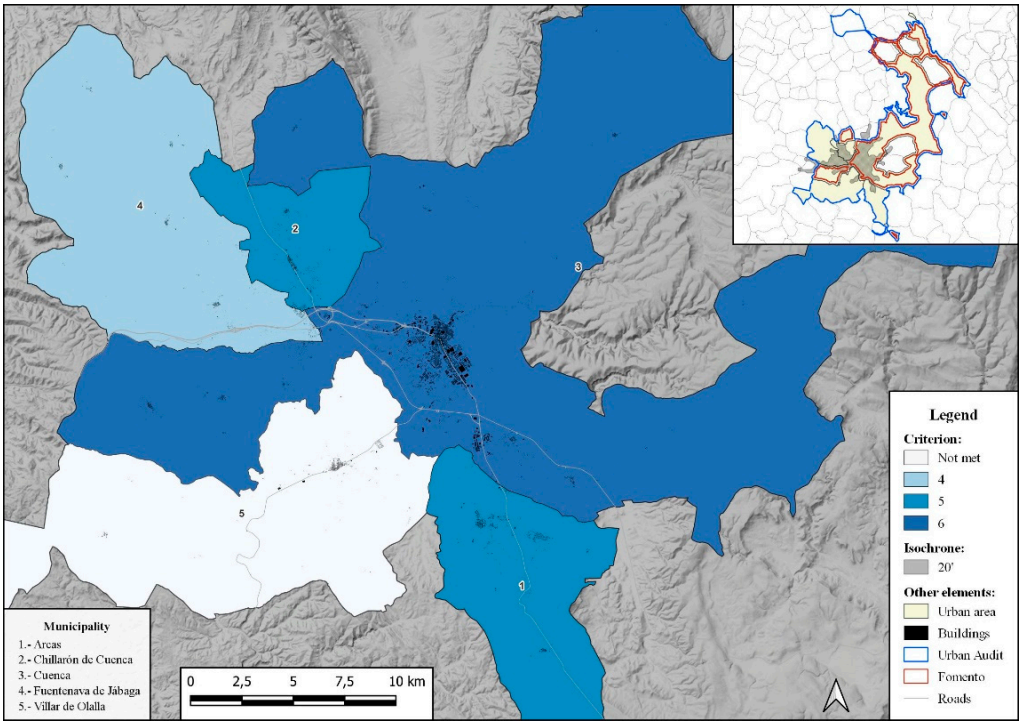


Figure 4. Delimitation of urban areas of medium dynamism (Group 2). Case examples of Burgos and Santiago de Compostela. Source: Authors.



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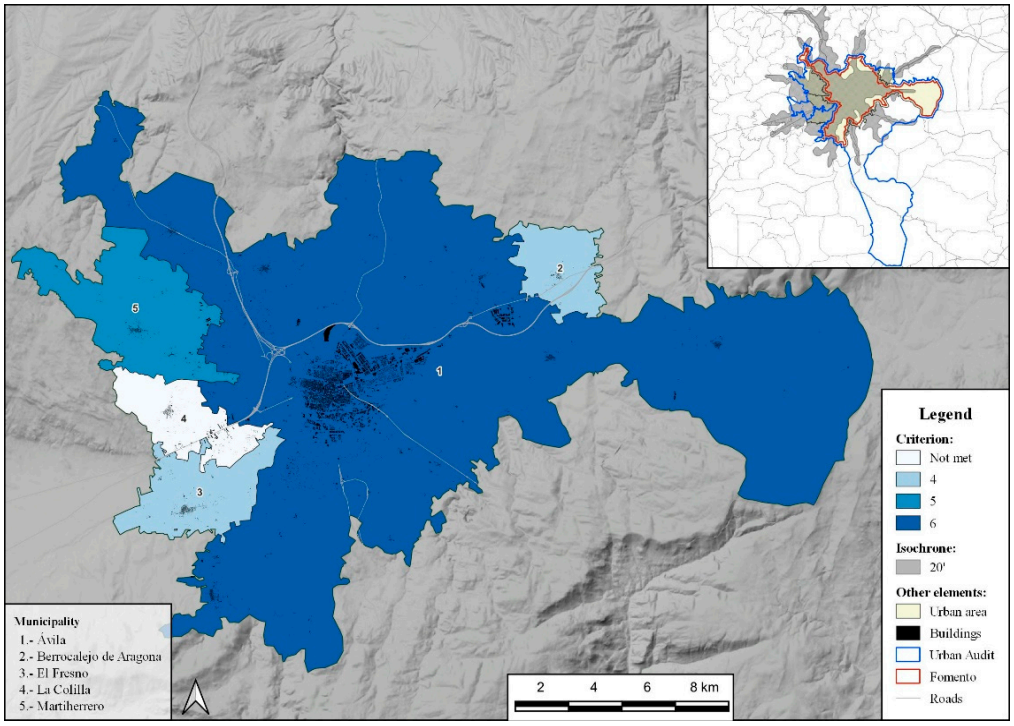

Figure 5. Delimitation of less dynamic urban areas (Group 3). Case examples of Cuenca and Ávila. Source: Authors.

4. Conclusions

The application of the ITU makes it possible to identify the limits, scope, intensity and gradation of the transformation process of each urban area. It does so by differentiating between the integrated behavior of the area and that specific to each municipality. The method draws on the logic of the behaviors of the variables in the different municipalities in relation to the central city they are ascribed to, which is used as a reference element. The use of multivariate methods complemented by GIS tools allows for the application of statistical procedures and the territorialization of results.

The selected case examples show that transformation processes are differ across urban areas, and, within them, between the municipalities they are comprised of. One of the conclusions that emerges from the analysis is that the urbanizing intensity is inversely proportional to the distance, although it is corrected by the main road axes. The municipalities closest to each central city tend to meet a greater number of criteria in the ITU. This situation also occurs for some municipalities that are more accessible or better connected, or with specific conditions of urbanization by virtue of strategic actions. Meanwhile, the greater the distance, the lower is the number of variables and the ratio. This reading can be clearly perceived in the urban areas of Burgos, Lleida, Salamanca, Santiago de Compostela and Guadalajara, where a gradation is observed in which intensity is lost as the limit of the 20-minute isochrone approaches. On the other hand, direct observation through orthophotogrpahy and fieldwork confirms that the 20-minue isochrone is a limit that expresses the impact of urbanizing processes on this scale of the urban system with great precision.

Moreover, there is a certain heterogeneity in the reality of the different urban areas, both in surface area and in number of municipalities. The 34 urban areas include 321 municipalities (an average of 9.5 municipalities per area), occupying 24,524.5 km² (an average of 149.4 Km²). Nonetheless, within the universe of study, there are very different situations, such as Burgos, with 28 municipalities or Salamanca with 24, while Linares has only 1, that of the capital, and Lorca or Badajoz with 2 (both are among the largest surface areas nationwide). The surface area also reflects highly differing realities, since Albacete has 2,059 km², while Linares has only 196.7 km². These mismatches in the surface area of the administrative reference units are partially corrected with the use of the 20-minute isochrone, which helps more precisely delimit the peri-urbanizing dynamics.

Another conclusion drawn from the application of the ITU lies in the comparison of results with other proposals for defining urban areas. Thus, the urban areas obtained clearly exceed those included in the proposal of the Ministry of Development (the Ministry includes 140 in the 34 urban areas, many of which are formed by a single municipality (Vitoria, Albacete, Lorca, Huesca, Teruel, Cuenca, Linares, Lugo, Ávila or Soria), while ITU doubles this, with 321, avoiding reductive readings in the territorial regard. Comparing the results with that of Urban Audit, we find less extensive scopes (Urban Audit includes 380 municipalities, compared to the 321 obtained with the ITU application); avoiding the inclusion of municipalities defined in this case by functional relationships measured through mobility and that have sometimes been unaffected by dynamics of urbanization and socio-professional change: Pamplona (23 in ITU versus 52 in UA), Vitoria (7 versus 19) or Burgos (28 versus 45).

Faced with these imbalances, the ITU methodology, which is based on six variables, allows us to obtain a delimitation more in line with the reality of the recent transformations produced in urban areas articulated by interior medium-sized cities. It clearly determines the existence of urban characteristics and notable dynamics of urbanization in the surrounding areas of these cities, which affect several of the neighboring municipalities. The method takes into account transformation from different perspectives. In a complementary way, it allows the dynamics to be categorized based on the combined use of population, housing, land and economic activity dynamics. It does not focus solely on the expansion of the urbanizing footprint or functional relationships.

Progress in the delimitation of urban areas seems necessary, in a context in which coordinated urban, housing and social policies of supramunicipal scope are required, which would allow them to address their problems more effectively. Urbanization processes, housing markets and social areas no longer respond to municipal boundaries. For the design of adequate policies and better management of the territory, studies and analyses are required at the relevant scale, in this case, that of the urban area (the expanded city in the territory). The complementary use of multivariate methods and GIS tools is an option that is effective in addressing the challenges of the dispersed city. Our results corroborate this, although a permanent methodological review is required. The proposal facilitates a delimitation instrument that is better suited to the results of recent urbanization in the environment of medium-sized cities.

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