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2ND INTERNATIONAL
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CONFERENCE

**REGIONAL
DEVELOPMENT,
SPATIAL
PLANNING AND
STRATEGIC
GOVERNANCE**

Conference Proceedings

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**2nd INTERNATIONAL SCIENTIFIC
CONFERENCE**

**REGIONAL DEVELOPMENT,
SPATIAL PLANNING AND
STRATEGIC GOVERNANCE -
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Institute of Architecture and Urban & Spatial Planning of Serbia (IAUS)
Belgrade, 11000 Bulevar kralja Aleksandra 73/II
Fax: (381 11) 3370-203, tel. (381 11) 3370-091
E-mail: iaus@EUnet.rs, www.iaus.ac.rs

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SESSION B

**SUSTAINABLE REGIONAL AND SPATIAL
DEVELOPMENT AND STRATEGIC
MANAGEMENT**

A METHODOLOGY TO STUDY THE RELATIONSHIP BETWEEN URBAN ACTIVITIES AND MORPHOLOGY IN THE CASE OF A TWENTIETH CENTURY SUBURB IN MADRID (SPAIN)

Fernando M. García Martín¹

¹ Department of Architecture and Building Technology, Technical University of Cartagena, Spain
e-mail: fernando.garcia@upct.es

1 INTRODUCTION

The periphery emerged in our cities throughout the twentieth century, and especially in the second half, has raised, almost since its construction, a controversy about the convenience of their forms and their consequences on the lives of its inhabitants.

The discussion about the impoverishment of the activities in the cities, especially in the suburbs is present for years. But if that process had not the same intensity in every place, it can be guessed that some combinations of social, economic and spatial variables are more beneficial to the quality of urban life than others.

This paper presents a methodology used to study the relationship of the urban form with the human activities performed on a Madrid district built along this period. Years after the construction of these new morphologies, this type of empirical study is necessary to face not only the grow of the cities in the future, but also the upcoming challenge of recovering those neighbourhoods with negative social, physical or economic trends.

2 THEORY

The new urban morphologies appeared during twentieth century caused the progress in the study of urban morphology in the second half of this century. New definitions were created to describe the new neighbourhoods and the old historic centres which preservation had become a preoccupation on that time.

At the same time, a multitude of studies were trying to understand the new ways of habitation but the transformation of cities and their forms were faster than researches. Nowadays, under a situation of population stabilization in developed countries, the empirical review of ways of life in different urban morphological types remains at an early stage.

2.1 The description of the urban form.

Three different schools of typomorphology started the study of urban form with a entire set of concepts and definitions of elements. The change of this element cause, as a result, the existence of different urban forms.

Moudon (1994) named the schools located in Italy (with Muratori, Caniggia and others), England (Conzen and Urban Morphology Research Group of the University of Birmingham) and France (at the School of Versailles around Henri Lefebvre, Jean Castex, Philippe Panerai y Charles Depaule), with different origins, since 1950, and objectives. These schools studied the morphology of urban environment according to the type of buildings and associated open spaces that make up the city.

Concepts like type, scale, adaptability, morphogenesis or social action of the urban form appeared in the works of these groups as Luque (1993) or Moudon (1994) explained.

2.1.1. *Parameterization of urban form. Density and compactness.*

Other researchers seek for quantifiable parameters that dictate the spatial properties of urban areas. They pretend, as Berghäuser (2009) claims, expand the possibilities of typomorphology to explain urban forms.

Density is commonly used as a parameter of the urban form. It is defined as the ratio between a numerator that could relate to housing, inhabitants or built surface and a denominator that is always the ground surface. Boyko & Cooper (2011) showed the variety of measures of density

However, density is insufficient to define the urban form as Gropius (1930) or Martin and March (1975) indicated. Berghäuser and Haupt, in their thesis *Space, density and urban form* (2009) show that combining density and occupation (percentage of ground area occupied respect to total available) can make accurate descriptions of urban form.

2.1.2. *Evolution and changes in the urban form.*

The tipomorphology basics has allowed subsequent studies to analyze and compare changes in different urban morphologies. A primary objective of this works was to determine what Marat-Mendes and Scoffham (1998) defined as the sustainable urban form: “the one that has the capacity of surviving the processes of change, and at the same time provides environmental quality which responds to the variety of settlement patterns and contexts over different periods of time”.

Studies from Scoffham (1985), Moudon (1986), Siksna (1996), Whitehand (2001) and Marat-Mendes (2003) are performed with this intention, quantifying the changes in the built environment and open spaces of the city. By focusing on the physical, the results are far from the objectives in this study, but the methods used have been a support for the design of this research.

2.2 The study of the relationship between inhabitants' activities and urban form.

Although this issue is apparently essential, for more than forty years different voices are pointing to the lack of work on it and its translation to the professionals of planning. In 1968, Mario Gaviria question in his work on the Great San Blas, Madrid, if "architects are little empirical", he argued that methods used in the urban planning and architecture are more intuitive than scientific and that the disappearance of planners after the building finishing is, in large part, responsible for this lack of scientific knowledge. More recently, Arnis Siksna in his work on the effects of size and shape of the blocks in American and Australian city centres (1997) explains that "although some aspects have been studied, there is very little consolidated knowledge."

Furthermore, the analysis of existing studies has also located terms in which that moves the debate on this issue at present. The need to consider the morphological factor in the discussion on the sustainability of cities has led some authors to try to define sustainable urban form. Mike Jenks, Elizabeth Burton and Katie Williams, among others, have carry out this question around the study of convenience of compact city models over dispersed city in two publications: 'Achieving Sustainable Urban Form' (2000) and 'The compact city: a sustainable urban form?' (2010). A proactive approach is offered by Kevin Thwaites, Sergio Porta, Ombretta Romice and Mark Greaves in 'Urban sustainability through environmental design. Approaches to time-people-place responsive urban spaces. (2007). And Y.R. Jabareen in 'Sustainable Urban Forms: Their typologies, Models, and Concepts' (2006) gives an overview of various models of sustainable urban form.

It is common to find studies on the influence of urban form on mobility (Simmonds and Coombe, 2000), energy consumption (Owens, 1986), consumption of environmental resources (Newton, Ambrose and Tucker, 2000) or inhabitants health. Of these, the closest to the objectives of this research are those that focus on social equity (Burton, 2000).

Nevertheless, some voices defend differing positions than assumed by most models. So, against the common view of compact city as more convenient in the aspects listed above, some authors like Breheny (1997) is opposed to the processes of densification of cities.

2.2.1. Indicators of the quality of the urban environment. The diversity and intensity of human activities.

It is also necessary to establish criteria to evaluate human activities in urban settings. Diversity and intensity of activities are two factors commonly accepted as indicators of the health of population uses. However, the rationalist vanguards of the first half of the twentieth century, in his conception of the city, tried to simplify and separate the activities that take place in it. The cities were designed by generating areas in which they were only one of the uses listed in the Athens Charter (1933), written during the CIAM IV held that year.

Since the crisis of reductionist concepts, diversity has been increasing its importance on the success of urban life. A series of classics papers since 60s created the theoretical body of another kind of cities. Alexander (1965) tried to organize schemes suitable for reflecting a structure of complex and diverse cities with semi-lattice relationships. Jacobs (1961), from a less structural approach, also claims the value of diversity in urban life. William H. Whyte (1980) analyzes the social life of small urban spaces, in order to find the characteristics that give them greater intensity and wealth of activities. The last of the classic works cited were compiled by Gehl (1971), which also explores the social activities in urban areas, establishing a classification and providing a few tips to increase the intensity and diversity.

In the second half of last century arrived concepts applied by ecologist in natural ecosystems (Pickett et al, 2008) to the vocabulary of urban planners. In this context, diversity is for Rueda (2002) an indicator of information exchange potential. If a person is viewed as an information-carrier, people diversity is necessary for exchange. Similarly, the diversity of economic activities generate creativity, since it implies the presence of various information-carriers in the same space, enhancing the chances of encounters with complementary.

Increasing the diversity of an environment is for Rueda, a way to create stability of the system in the future. As Holling (1973) defined, the 'resilience' of the systems is their ability to absorb changes in external or internal variables to the system and still persist. Diversity and resilience of urban systems are directly related. Diversity creates a complex and diverse network of relationships among agents that allows to maintain the system operative with the disappearance of some of these relationships due to natural changes, abrupt or not. In urban areas this network of relationships results in stability, cohesion and social maturity.

Rueda also warns that the use of diversity as a single index of the organization of a system is rather poor and must incorporate two other issues: the persistence and spectrum. The first one is related to time, and the second with the space (Margalef, 1986).

2.2.2. Methodologies to study human activities.

A selection of works about urban activities which could support this research are exposed below. They are classified according to their methodology.

A first group is composed by works based on the direct data collection. Studies of this group are numerous and are characterized, due to limited resources, to be conducted on relatively small areas.

Within this group there is a first set in which the study is done for a period of time. Perhaps the most remarkable of these works were compiled by Jan Gehl (1971), Leslie Martin and Lionel March (1975) or William H. Whyte (1980).

In a second set are those where the data was obtained by surveys. The work of Moharnmad-reza Masnavi (2007) becomes relevant to this research because its study of indicators of the life quality in four districts of Glasgow and East Kilbride New Town according with their density and mix of uses.

The second group of studies are those performed on large areas using existing data sources as indicators of activities, to avoid costly data collection processes. The emergence of geographic information systems (GIS) and policies of open access to public data in recent years have helped to carry out this type of work. Research on vulnerable neighborhoods by the Observatory of Urban Vulnerability of the Department of Architecture, Housing and Land Development of the former Ministry of Housing of Spain is a excellent example of this group.

3 CONDITIONS TO COMPARE MORPHOLOGIES.

This research faces the problem to compare the evolution of human activities in the different urban morphologies. The existence of a wide range of variables that take part in the evolution of neighbourhoods makes complicate this study.

3.1 Methodological problems.

Some spatial conditions that could disturb the results of our study cases must be confronted:

- Location: Southeast of the central zone of Madrid, that composed of the historic center and the widening of the nineteenth century, is located the Puente de Vallecas district which is chosen as study area. The development of this district was almost entirely in the twentieth century. Despite being a short time period, the abruptness of the situations occurred in demography, economics, politics and urban design, have left their mark on the

district's urban form which fragments of different morphologies. The presence of this variety in a nearby area reduces the influence derived from the location.

-Size: Talking about urban form is often referred to the city as a whole, focusing on its infrastructure, its topographic conditions, etc. However, this study sought to focus on the smallest scales, those called 'neighbourhoods' in popular language. Each of these areas must simultaneously represent a homogeneous morphological type and have available statistical data.

In addition, some parameters must be selected to describe the urban form and compare the activities. Density and compactness as discussed by Berghauer and Haupt define the urban form in the scale established in this research.

Finally, there must be practical problems such the existence and availability of the necessary map data. To carry out this research, in which one part is of a comparative nature, requires the existence of homogeneous data sources for different case studies. Access to homogeneous maps to analyze and parameterize urban form is made possible by the open access to the virtual office of Spanish cadastre (<https://www.sedecatastro.gob.es/>). Use of historic aerial photos is also crucial to study the evolution of the chosen district.

3.2 Parameterization of the urban form.

3.2.1. Obtaining urban form parameters.

The use of cadastral mapping allows calculating efficiently and very close to reality the built and occupied area. From this values and the total area were calculated the indices and ratios that define the density and compactness of each fragment.

-Occupied area: This value is defined as the vertical projection of all the volumes of the building on the ground, the footprint. Spaces under porches and overhangs are considered as occupied.

-Built area: The calculation of this value is made possible because the cadastre maps files are for use with Geographic Information Systems (GIS) software. On these files, each object is associated with a data base where is including floors number. The built surface of each object is calculated as the result of its footprint by the number of floors. Their sum is the built surface in the area. For this calculation, following the usual indications, underground volumes and open areas were not counted.

-Total area: The district is divided in smaller division which can fit with homogenous urban forms. The divisions that the Instituto Nacional de Estadística (INE) made for elections and which is used also for the Population and Housing Census are adopted.

Thanks to this 'census tracts' statistical data of inhabitants activities could be related to the morphology of the city at the scale of this study.

The parameters that will describe the urban form of each fragment are calculated with these three surface values. Parameters for compactness (GSI), intensity (FSI), height (L) and unbuilt space pressure (OSR) defined by Berghäuser and Haupt (2009) are divided into basic and derived parameters.

Basic parameters are indexes that show the relationship of the built and occupied area with the total area.

-The ground space index (GSI) reflects the relationship between the built and unbuilt spaces, revealing the extension of land cover by building and the compactness of the urban fabric. It is calculated as the ratio between the occupied area and the total area of the fragment.

-The floor space index (FSI) shows the intensity of the floor area, regardless of its use. It is calculated as the ratio between the built surface and the total area of the fragment.

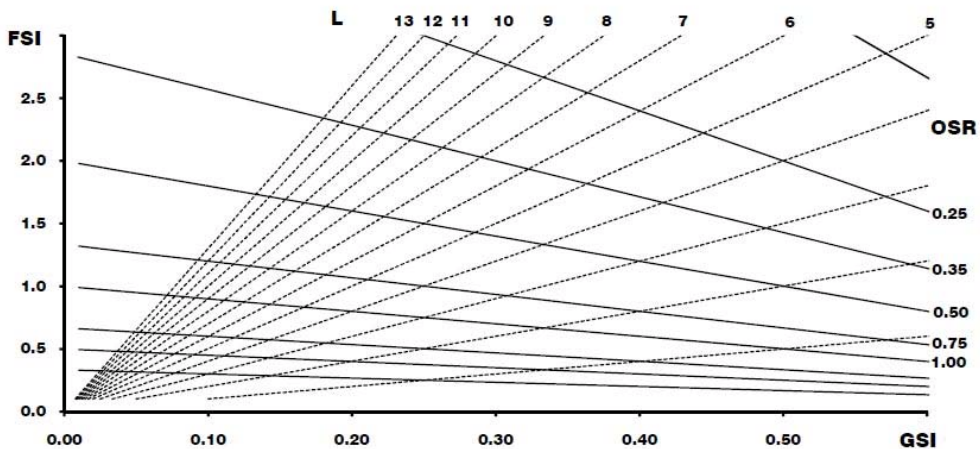


Figure 1. 'Spacemate' chart. (Berghauer, 2009)

The two derived parameters are linear functions of the two variables used.

-The open space ratio (OSR) relates the amount of unbuilt space by built area, showing the pressure on the free space in an area.

-Levels (L) relates directly to the building form. It is calculated as the built between the occupied surfaces.

In order to capture these four variables simultaneously, Bergahuser and Haupt developed a chart called "spacemate" in which the FSI value is placed on the Y-axis and the GSI value on the X-axis. The derived parameters, OSR and L, linearly related to the basics can be also reflected in the diagram. Any fragment which a pair of these parameters known can be located in the 'spacemate'.

3.2.2. From census tracts to fragments and sectors.

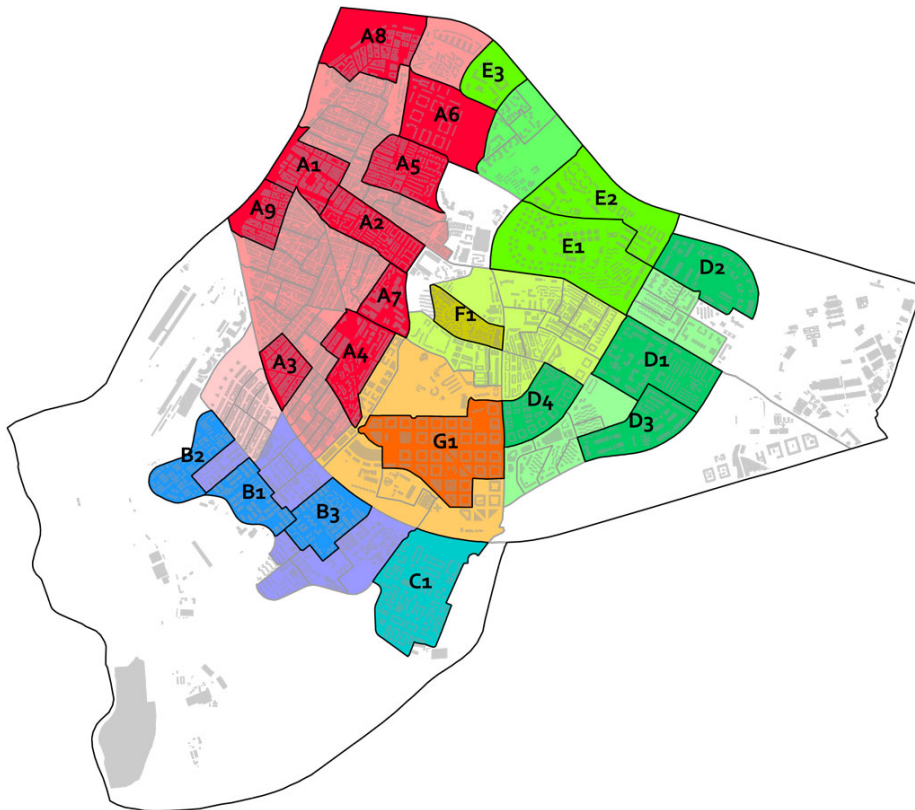


Figure 2. Fragments and sectors.

The use of all census tracts for analysis was discarded. Their large number, about 190, difficult to read and explain the results and, secondly, it was a lack of correspondence between these divisions and the reality of district morphology.

Table 1. Fragment form parameters.

Fragment	Area (m ²)	Built surf. (m ²)	Occupied surf. (m ²)	GSI	FSI	OSR	L
<i>A1</i>	124.195	200.143	67.533	0,54	1,61	0,28	2,96
<i>A2</i>	147.057	192.808	55.979	0,38	1,31	0,47	3,44
<i>A3</i>	85.046	150.443	49.666	0,58	1,76	0,23	3,02
<i>A4</i>	167.294	180.127	54.024	0,32	1,07	0,62	3,33
<i>A5</i>	156.769	257.083	66.804	0,42	1,63	0,34	3,84
<i>A6</i>	150.760	230.687	27.993	0,18	1,53	0,53	8,24
<i>A7</i>	91.402	145.682	32.872	0,35	1,59	0,40	4,43
<i>A8</i>	135.911	218.750	60.190	0,44	1,60	0,34	3,63
<i>A9</i>	83.153	114.585	45.754	0,55	1,37	0,32	2,50
<i>B1</i>	121.177	84.070	41.838	0,34	0,69	0,94	2,00
<i>B2</i>	129.795	131.822	33.384	0,25	1,01	0,73	3,94
<i>B3</i>	134.864	131.178	40.013	0,29	0,97	0,72	3,27
<i>C1</i>	275.759	262.034	71.885	0,26	0,95	0,77	3,64
<i>D1</i>	254.384	344.860	61.256	0,24	1,35	0,56	5,62
<i>D2</i>	202.166	331.715	39.296	0,19	1,64	0,49	8,44
<i>D3</i>	167.545	219.421	42.357	0,25	1,3	0,57	5,18
<i>D4</i>	146.053	181.045	42.109	0,28	1,23	0,57	4,29
<i>E1</i>	331.408	278.033	72.713	0,21	0,83	0,93	3,82
<i>E2</i>	215.017	199.004	43.291	0,20	0,92	0,86	4,59
<i>E3</i>	86.936	68.559	15.369	0,17	0,78	1,04	4,46
<i>F1</i>	87.735	84.836	25.564	0,29	0,96	0,73	3,31
<i>G1</i>	372.504	515.917	127.228	0,34	1,38	0,47	4,05

Instead of those land divisions, different 'fragments' were defined. Each of them was composed by one or more adjoining census tracts with homogeneous morphological parameters, usually developed under a single urban plan. The fragments selected have a dimension range from 8,5 to 17,5 hectares, which some exceptional case that reach 37,5 hectares.

Relating to the historical growth of Puente de Vallecas seven different 'sectors' were identified. Each of them represents a period of time in the development of the district. With a larger size than the 'fragments', 'sectors' allow to easily makes a historical lecture of the urban form and shows the evolution of the different parameters trough the time.

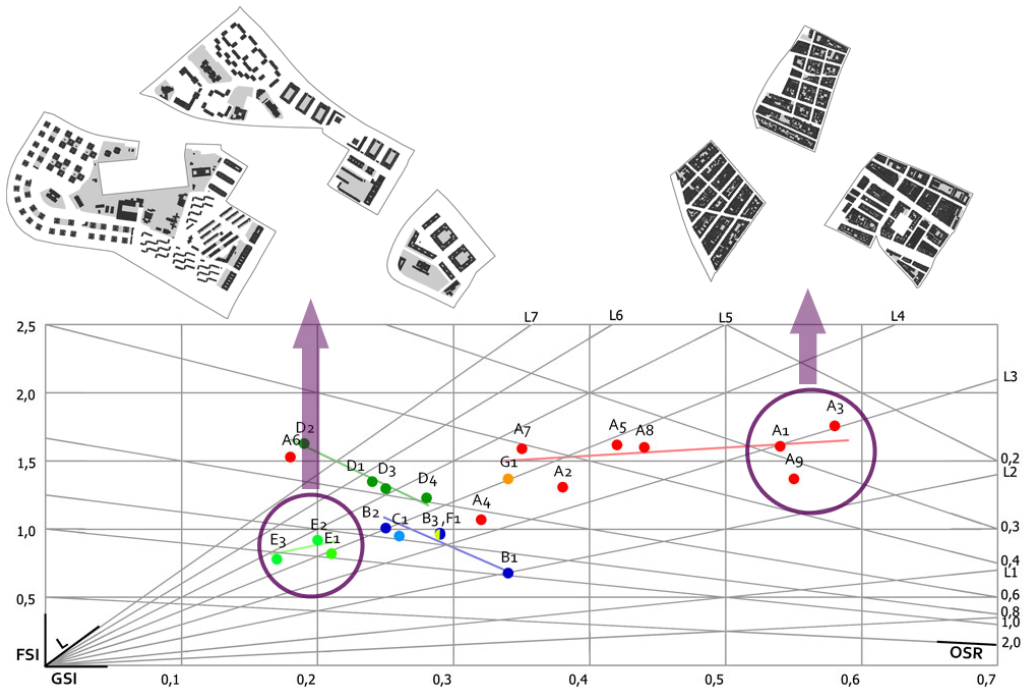


Figure 3. Fragments position in the 'spacemate' chart.

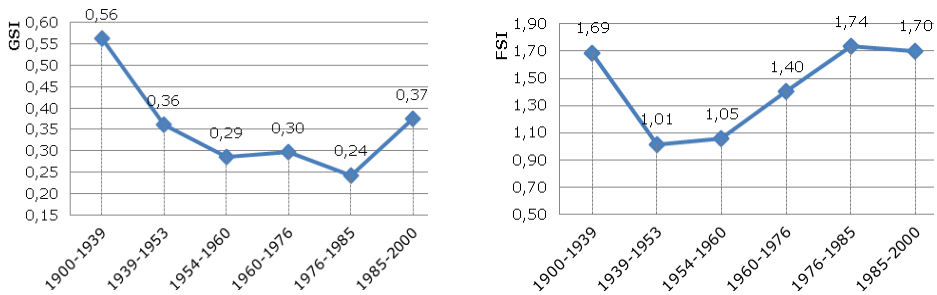


Figure 4. Evolution of GSI and FSI parameters in the district along development periods.

4 CONDITIONS TO COMPARE ACTIVITIES IN THE CITIES.

4.1 Methodological problems.

In this research were used existing data sources for the whole national territory. This kind of data was selected in order to have the possibility to extend the study in a larger area or to replicate it in other locations and contrast the results.

The statistical data sources used were the Annual Population Registers from 1986 to 2010 period, the Census of Population and Housing from 1991 and 2001.

As observation, the census tracts have been modified from 1991 to present, so it is necessary to review these changes.

4.2 Indicators of the human activities.

Six indicators were selected from the census and population register. These indicators try to be representative of the activities that people perform in the city both in the public realm as in the private.

Six values are divided in three pairs: one about population, one about housing and one about the commercial activity. In each pair, one indicator is a 'snapshot' that reflect the situation in a moment of time while the other is a 'dynamic' during the period from 1991 to 2001. The 'snapshots' reflects the diversity of activities on this area and the 'dynamics' the attraction to the inhabitants on that time.

Table 2. Activity indicators.

	<i>'Snapshot' indicator</i>	<i>'Dynamic indicator'</i>
Populations changes	Population density	Population growth <i>Padrón de población de 1986 a 2010</i>
Housing changes	Year arrived to dwelling	Empty dwelling growth <i>Censo de viviendas 1991 y 2001</i>
Commercial changes	Shops density.	Empty shops growth <i>Censo de locales 1990 y 2001</i>

Once calculated each indicators with the information of data sources, its value is added to the 'fragment' in the map of the district and the 'spacemate' chart.

5 ANALYSIS OF THE RELATIONSHIP BETWEEN URBAN ACTIVITIES AND MORPHOLOGY.

The last step of this methodology is to search for the relationship between indicators of activities and the morphology of the fragments. The spacemate chart is the tool which allows observing the value of the indicators related to urban form parameters.

As an example of the analysis that this methodology is able to perform, next is exposed the relationship between the empty dwelling growth indicator and the urban form of the selected fragments.

5.1 Empty dwellings and urban form, an analysis example.

Dwellings are the home for the private realm of activities, performed only with whom there is a degree of privacy, the components of the household. To evaluate the relationship that may exist between the urban morphology and the activities taking place in the private sphere one of the variables used is the growth of empty dwellings. This indicator has a dynamic character, showing the evolution over the 1991-2001 period. The morphologies more attractive to the people along this time will have better results than less attractive.

During the period 1991-2001, in which there was a decrease in the population of the district, the number of empty dwellings in fragments analyzed increased in 1439, from 8.5% of housing stock in 1991 to 10.4% in 2001. This tendency affect to almost all the fragments.

The fragments where the number of empty dwelling was reduced along this period share very concrete morphological parameters: from 22 to 46% of occupied surface and a range of 3.5 to 5-story height. These fragments (A5, A7, A8, B2, D4 and G1) represent the type of property more attractive to the population in this period.

In fragments D1 and D3, within same GSI range but level average over 5 floors the number of empty homes increased, but the percentages between 35 and 45% are lower than in the rest of the fragments. In the same GSI range but with less than 3.5 levels, are some of the fragments which higher increase of empty dwellings: 177% in A4, 202% in F1.

In the range over 45% of occupied area the fragments have the oldest urban layouts with small plots conforming long and narrow blocks. Cases A1 and A9 increased the empty houses over 120% but A3 remain stable. According to location of A1 and A9 is probably that ground price pressure in the closest point to Madrid downtown had influence on these results.

Below 22% of GSI, the unfavourable growth of the fragments (located on the edge with the highway on the north of the distrit) with between 120 and 200% more of empty housing indicates that these forms were unattractive during this period.

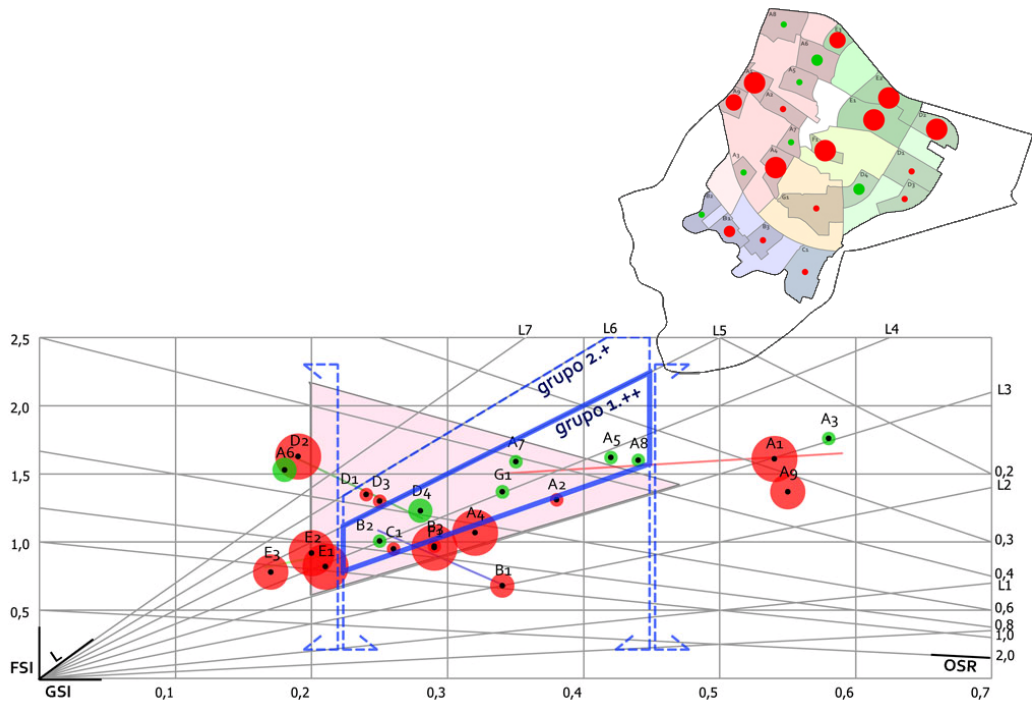


Figure 5. Map and 'spacemate' chart of empty dwelling growth from 1991 to 2001.

Table 3. Empty dwelling growth from 1991 to 2001.

ID	A1	A2	A3	A4	A5	A6	A7	A8	A9	B1	B2
VFD91	145	210	233	111	390	203	100	344	249	45	107
VFD9101	293	61	-1	197	-93	-160	-1	-138	300	37	-50
%VFD9101	202,1%	29,0%	-0,4%	177,5%	-23,8%	-78,8%	-1,0%	-40,1%	120,5%	82,2%	-46,7%
ID	B3	C1	D1	D2	D3	D4	E1	E2	E3	F1	G1
VFD91	66	99	203	79	99	256	84	120	14	48	0
VFD9101	22	45	69	136	46	-156	171	238	17	97	309
%VFD9101	33,3%	45,5%	34,0%	172,2%	46,5%	-60,9%	203,6%	198,3%	121,4%	202,1%	-

6 CONCLUSIONS

The method paved the way to a more empirical understanding of the influence of urban form in the lives of its inhabitants. Although several weaknesses have been detected in this first case study, it seems possible to improve the method to obtain more consistent results.

Exploring the way open with this research could give some successes on the quality of our urban environment. The knowledge of the activities performed in each form could help in the design of new urban growths and, moreover, in the rehabilitation of the twentieth century suburbs that must be faced in the upcoming years.

With data and maps sources used might be possible to extend the study to the whole national territory. But there are more specific researches which could bring more light to this theme: study of particular morphologies, cities or activities.

The methodology also allows following the evolution, with each new census, of activities and even creates a monitor system of the transformation of the city.

The following weaknesses are highlighted:

- The parameterization of the urban form according with the information contained in the cadastre cartography is not fully exploited yet. Future work could offer more information about the influence of spatial variables on daily life.
- The statistical data available at this level of detail (census tract) is limited and not specifically designed for the purpose of this research. However, the possibilities that this knowledge provide for the cities could encourage incorporating new specific data to census questionnaires.
- The evaluation of activity indicators with the 'spacemate', in spite of visually effective, is not enough rigorous. Nowadays research is been done about the convenience to use correlation analysis.

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SUMMARY

Previous works on the study of relationship between urban form and human activities were based on data collection by the own researchers. However, on this paper is exposed a methodology which is using existing statistical data that allow to expand the study. A new possibility is opened to analyze and compare the evolution of the urban activities, their intensity and diversity, not only for singular study cases where the researcher collect their own data, but for a whole range of cities.

Two key points make able the developing of this methodology: The parameterization of urban morphology with density and compactness values and the statistical data of Population and Housing Census available to the scale of census tracts.

Some results for the chosen study case, the district of Puente de Vallecas of Madrid, mainly built along the twentieth century, are exposed. For this case, the urban activities were evaluate through population and commercial indicators which show the appeal for the citizen and the diversity as a factor that helps the stability of the area for the future.

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