

# city as organism

new visions for urban life

22nd ISUF International Conference | 22-26 september 2015 Rome Italy

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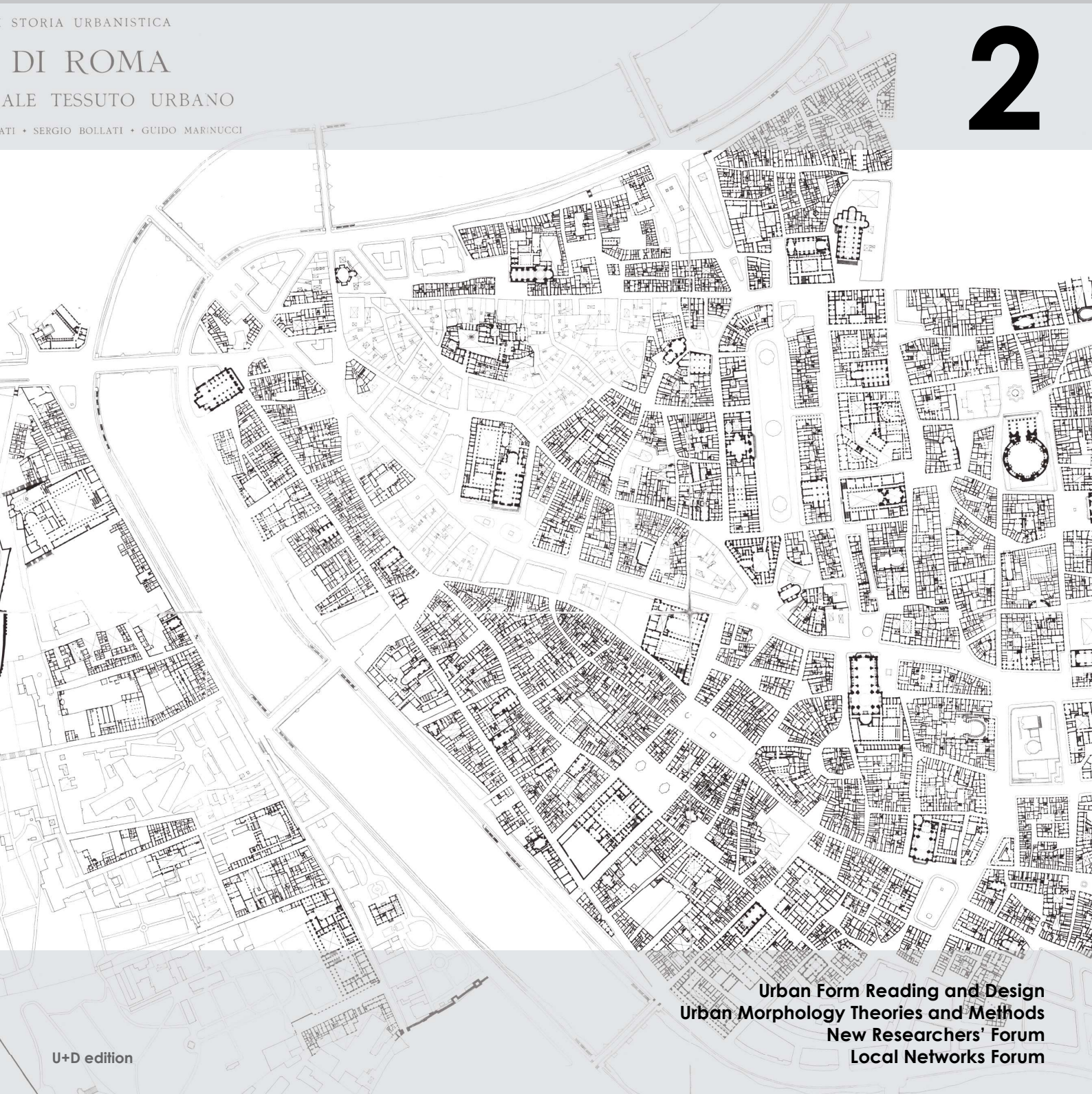
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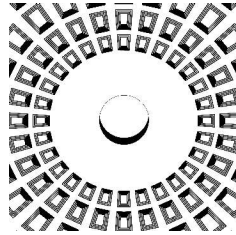
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Urban Form Reading and Design  
Urban Morphology Theories and Methods  
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## Urban morphology of Murcia (Spain) in the twentieth century. Compactness and density of urban fabrics

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### Abstract

Expansion of cities during twentieth century, and especially in its second half, has raised, almost since its construction, a controversy about its consequences on the lives of their inhabitants. New urban fabrics appeared in this period as a response to the big population growth. Describing cities morphology, compactness and density have become two of the most functional values, as Berghauser and Pont have shown in the last years (2009). These two parameters are able to classify the urban fabric forms, allowing the comparison of their influence in issues as: quality of life, mobility, energy and material consumption, etc. Since Muratori's studies of Venice (1960), development of Geographic Information Systems (GIS) and the open access policies to public data enable a systematic management of huge amounts of information required for these studies. In this paper, public information from Spanish Cadastre is used to classify different fabrics. Methodology is based on combining compactness and density at building level and at urban fabric scale and it is applied to the case of the periphery of Murcia city, in southern Spain, in the last century. Results show the evolution of fabric morphology along the century and its contrast with contemporary urban design theories.

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## Introduction

The periphery of cities emerged throughout the twentieth century, and, especially in the second half, has risen, almost since its construction, a controversy about the convenience of their forms and their consequences on the lives of their inhabitants. During this period, new urban morphologies appeared as responses to the new situation of rapid population growth at the cities. The impoverishment of activities and uses in these new suburbs causes an intense discussion that ends up with a demonization of the new neighbourhoods.

However, that process has not had the same severity in all places and it can be guessed that some combinations of social, economic and spatial variables are more beneficial to the quality of urban life than others. Out of these mentioned variables, is logical to think that the built environment has an influence on the activities that people perform in it.

Years after the construction of these new morphologies, it is necessary to analyze the variety of urban forms used in the suburbs of Spanish cities, understanding the causes that originated them. That will help cities and their professionals to face the upcoming challenge of recovering those neighbourhoods with negative social, physical or economic trends.

This paper presents a methodology which allows a morphological classification of the suburbs of the twentieth century Spanish intermediate cities. A main advantage of this method is that it can perform an analysis of a wide area in a systematic way, allowing comparison of results. The recent availability of open public databases and the possibilities of geographic information systems (GIS) are crucial to this research.

## Need of Interactive spaces for shaping the social behavior

The transformation of cities during twentieth century with an unprecedented population growth of urban environments caused the development of the study of urban morphology in the second half of that century. Those studies generated common tools to describe the new neighbourhoods and also to understand the forms of old historic places that had become desirables to preserve on that time.

The studies about the description of urban form can be divided into two groups, in relation to the objectives of this research. The first group, by the different schools of typomorphology, creates an entire set of concepts and definitions related to urban form. A second group is composed by several attempts to find measurable parameters to define and classify urban form.

The typomorphology schools identified the elements that compose the urban fabric. The variations of these elements explain the existence of different urban forms. Moudon (1994) distinguished three schools located in Italy (with Muratori and Caniggia among others), England (Conzen and the Urban Morphology Research Group at the University of Birmingham) and France (in the School of Versailles around Henri Lefebvre, Jean Castex, Philippe Panerai and Charles Depaule) with different backgrounds and objectives in their researches, creating a very useful body of definitions to describe the urban form since 1950.

These studies shared the interpretation of the city as an organism formed by interrelated elements that create components of larger scales. On this organisms, each of the elements is essential and irreplaceable (Muratori, 1960). This multiscale reading of urban form assigns to the built-plot the role of base element of the urban fabric. The building and its different relationship with non-built space, either the plot (private) or the street (public), is the key of many studies, being able to explain also the form of larger compounds.

This organism is built along the time, so it is also argued that the present form is historically determined (Conzen, 1960, Muratori, 1960, Caniggia, 1979). In the sequential process of building the city, each period has its own urban forms. Therefore, in the morphological reading, the continuities and crises that perpetuate or modify the shape of the city become basic, creating a typological process where some forms follow others.

From this interpretation of the city as a work of art created by the people of a place through a time, the French school of morphology highlighted that urban space is a result of a social construction. A society, with its characteristics and relationships among its members, establishes a series of space needs to perform its ways of life, its social practice (Lefeb-

vre, 1968). This cause-effect relationship happens in both ways, because urban space also presents restrictions to the ways of living of the society (Panerai, 1980).

Few years later, the research of qualities of urban form from the geometric and mathematical analysis began. However, it was not until more recent years, with the widespread use of computers, that the pursuit of measurable parameters bloomed explaining the urban spatial properties. Berghauser and Pont (2009) claim that this type of quantitative analysis expands the possibilities of typomorphology to explain urban forms.

Density was one of the parameters commonly used as a reference in urban form. It is defined as a relation where the denominator is always the ground area and the numerator relates mainly to number of houses, population or built area. It is interesting to understand the variety of density definitions collected by Boyko and Cooper (2011) that explain the different between them according to the purpose they are used for: number of rooms, living space, occupation, type of building, roads, etc.

In respect of city form, it stands out the studies of the spatial qualities of urban fabric according to their density. In them, even since functionalism (Gropius, 1930), it is appointed the insufficiency of density as unique value to define urban form (Martin & March, 1972). Berghauser and Pont's thesis, *Space, density and urban form* (2009), shows that combining building intensity (FSI – floor space index) and building coverage (GSI – ground space index) more accurate descriptions of urban form can be made. From the same two variables, gross floor area and footprint area, building height (L - Levels) and the spaciousness (OSR – open space ratio) are also obtained.

With the aim to reflect these four density index simultaneously, Berghauser and Haupt develop a diagram called "spacemate". In this diagram, the FSI value lies in the Y axis as an indicator of the intensity of use of the area and the GSI value on the axis X reflecting the compactness. Derived indexes of OSR and L, linearly related to the above mentioned, can also be represented in the diagram. Any urban fabric with a known pair of these indicators can be placed in the 'spacemate' obtaining the other two.

The diagram also displays the relationships among the four indicators, especially between the primary and the secondary ones. In addition, as the indexes refer to the unit of area, the possible distortion caused by different area sizes is removed and the diagram can be used to find similarities among different fragments.

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### **Methodology for a typomorphological classification**

The methodology for obtaining a typomorphological classification of the recent periphery of the city of Murcia use parameters of density and compactness as indicators of the spatial quality of the urban environment. Through the parameterization of urban fabrics, it is possible to compare their morphologies with quantifiable and objective variables derived from the spatial configuration.

To obtain these parameters, it is necessary to calculate the gross floor area and the footprint area of constructions at different scales of analysis. The approach in different scales, as Muratori indicated (1960), allow the understanding of the urban organism as a whole. Moreover, it helps to the correct delimitation of areas to be analyzed at each level. The different levels are: the whole urban area of the city, the periphery emerged throughout the twentieth century and the urban fabric scale of the neighbourhood as the smallest fragment.

For each of these scales, there is a first phase of delimitation of the study area and a second phase of characterization with quantifiable parameters. From these results, a set of indexes of compactness and density (GSI, FSI, OSR and L) that characterize each area of study will be obtained. Finally, the method concludes with the classification in types thanks to a combination of those values in different scales.

To carry out this work, in which one part is based on comparative research, the existence of a homogeneous data sources is required for the different case studies. In this paper, we have used the products available at the online office of the Spanish Cadastre (<https://www.sedecatastro.gob.es/>) accessible through digital certificate, according to public data policy followed by the Spanish government.

**Figure 1.** Murcia (left) and its twentieth century periphery (dark grey in right figure)



#### *Delimiting study areas*

The delimitation of the study area in each level requires setting up certain standards which define its conditions, discarding parts and cases that are not specific to this research. Obtaining these standards has been made from the study of several cities of similar size, avoiding the influence of local features. Therefore, it is possible to extend the method to other cities with similar characteristics, allowing the contrast of results.

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On the largest scale, a framework of 15x15km is set as study area. The urban core of Spanish intermediate cities between 200.000 and 600.000 inhabitants fits into this frame, avoiding distortions in cases of very large municipality boundaries.

At the level of the recent twentieth century periphery, the study area is those census tracts that meet two conditions: that the FSI density value is greater than 0,35m<sup>2</sup> / m<sup>2</sup>, and that the percentage of plots built before 1900 is lower 2.5% (figure 1). With the first condition, the low density areas, outside the scope of this research, are excluded. And with the second one, the areas belonging to the urban cores and pre-twentieth century settlements are discarded.

It is necessary to discuss the benefits and drawbacks of the division of the territory into census tracts, conducted by the National Statistics Institute (INE). On one hand, this division makes possible the use, in later stages, of the statistics variables contained in the Census of Population and Housing. However, the boundaries of these sections are not drawn according to morphological criteria which create some distortions.

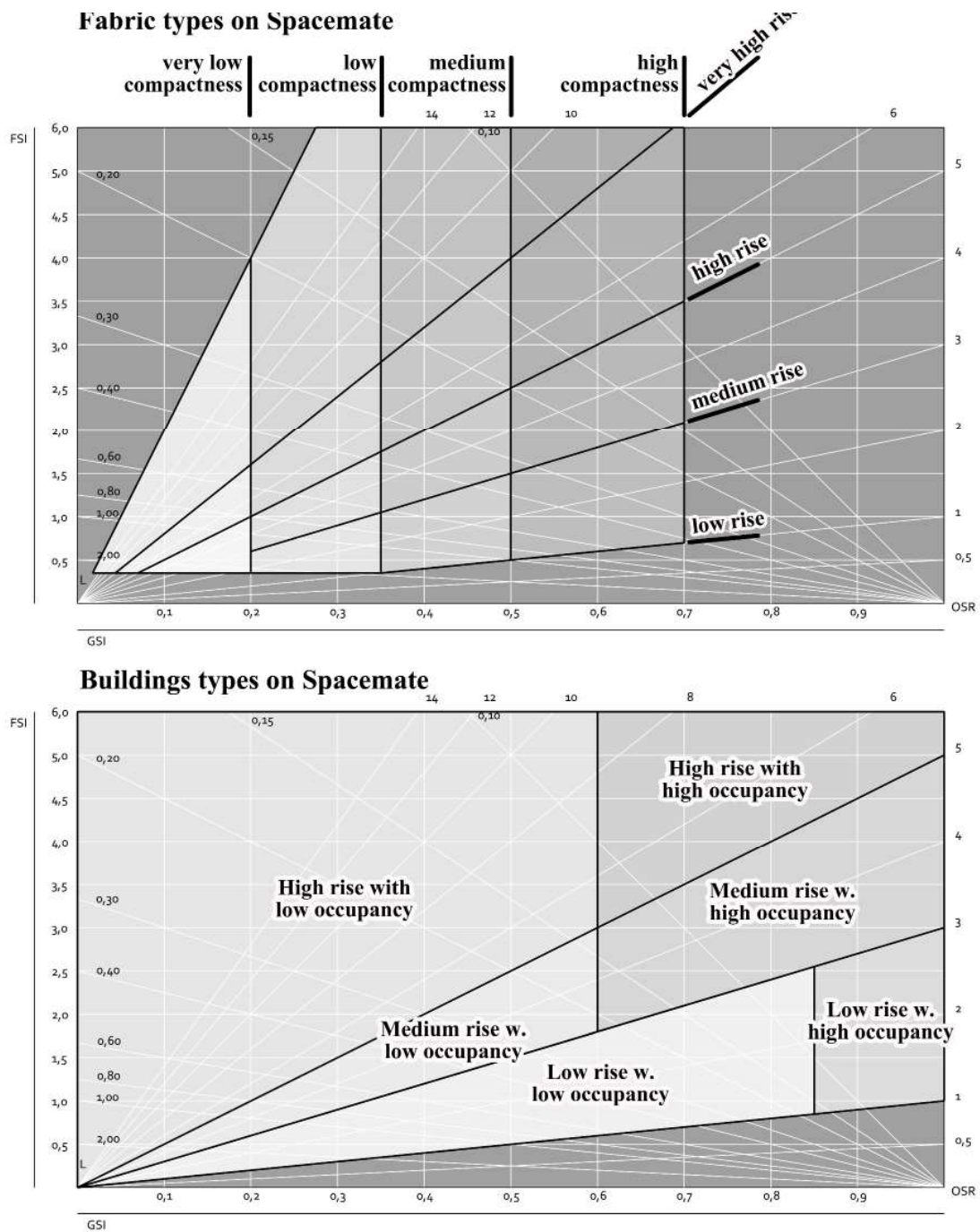
In the last scale, at the neighbourhood level, it proceeds to dismiss the census tracts whose main use is not residential or whose development is not complete. The need for accuracy of the boundaries on this level is greater, so the limits have been redrawn to homogenizing criteria. However, to preserve the possibility of using the census data, all the buildings must remain into the new limits.

#### *Types of fabric and 'spacemate'*

Values of density and compactness of neighbourhoods cluster some of them with similar formal characteristics in zones of the diagram 'spacemate'. If this property of 'spacemate' has been sufficiently proved (Van Nes et al, 2012; Kickert et al, 2014; Steadman, 2014), there are some conditions that hinder reading in the diagram:

- (a) Different types of urban fabric can overlap in the 'spacemate', since there are values of density and compactness common to different types.
- (b) Urban fabric types occupy zones of different sizes in the 'spacemate', since values of density and compactness of each type may be more or less variable according to internal rules that characterize each type.

**Figure 2.** Fabric types (above) and building types (below) on 'Spacemate'



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Exploring at the distribution of different types in the 'spacemate', some points can be highlighted:

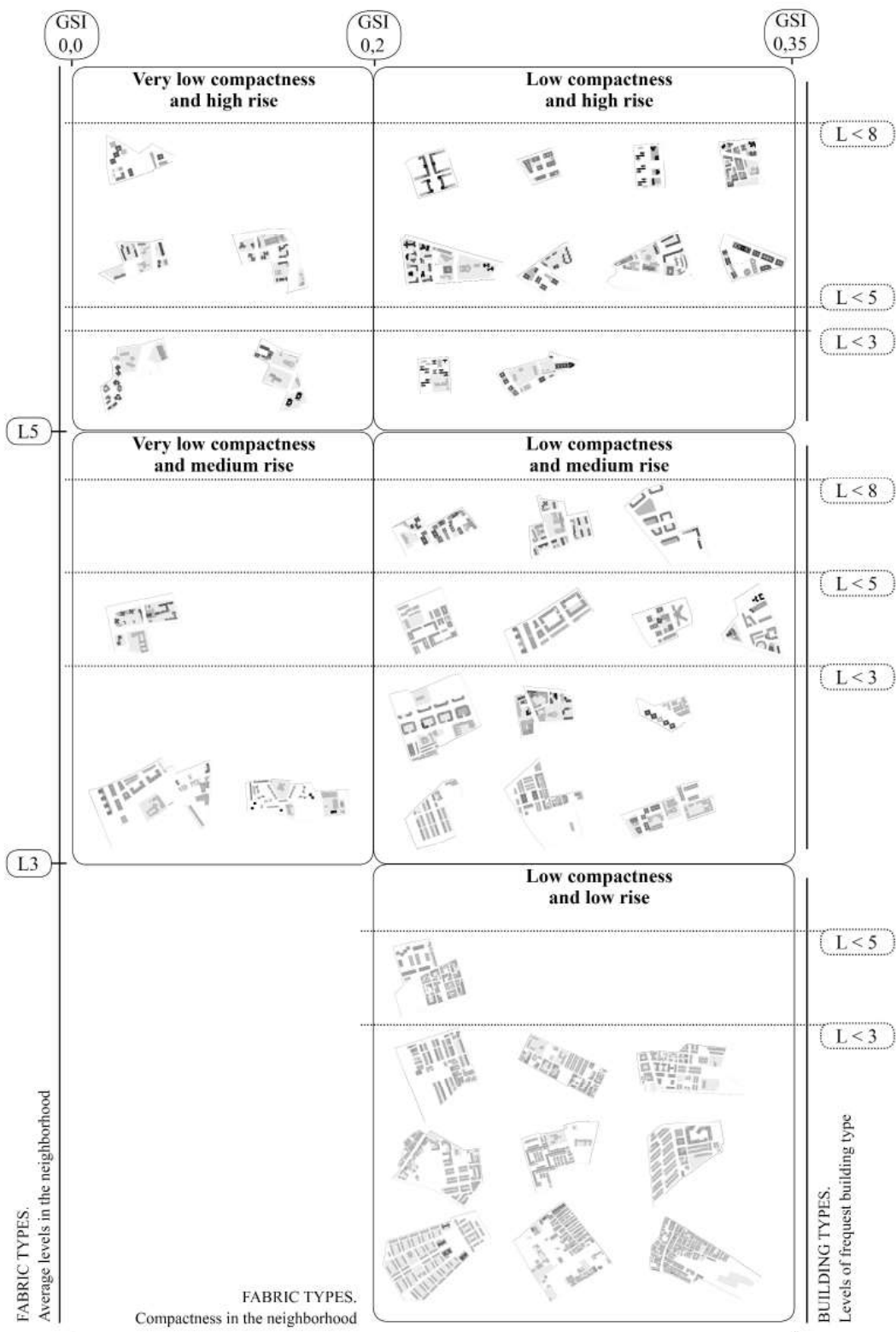
(1) There are values of density that have never been reached on the suburbs of the Spanish intermediate cities. The compactness has not been less than 10% and not more than 70%. The average number of floors is only occasionally over 8 and the density has rarely been greater than 4m<sup>2</sup>/m<sup>2</sup>.

(2) Within these limits, there are fewer cases and fewer types in outlying zones, while the central zone is more populated and with more types overlapping.

From these observations, it can be concluded that the classification of the urban fabric

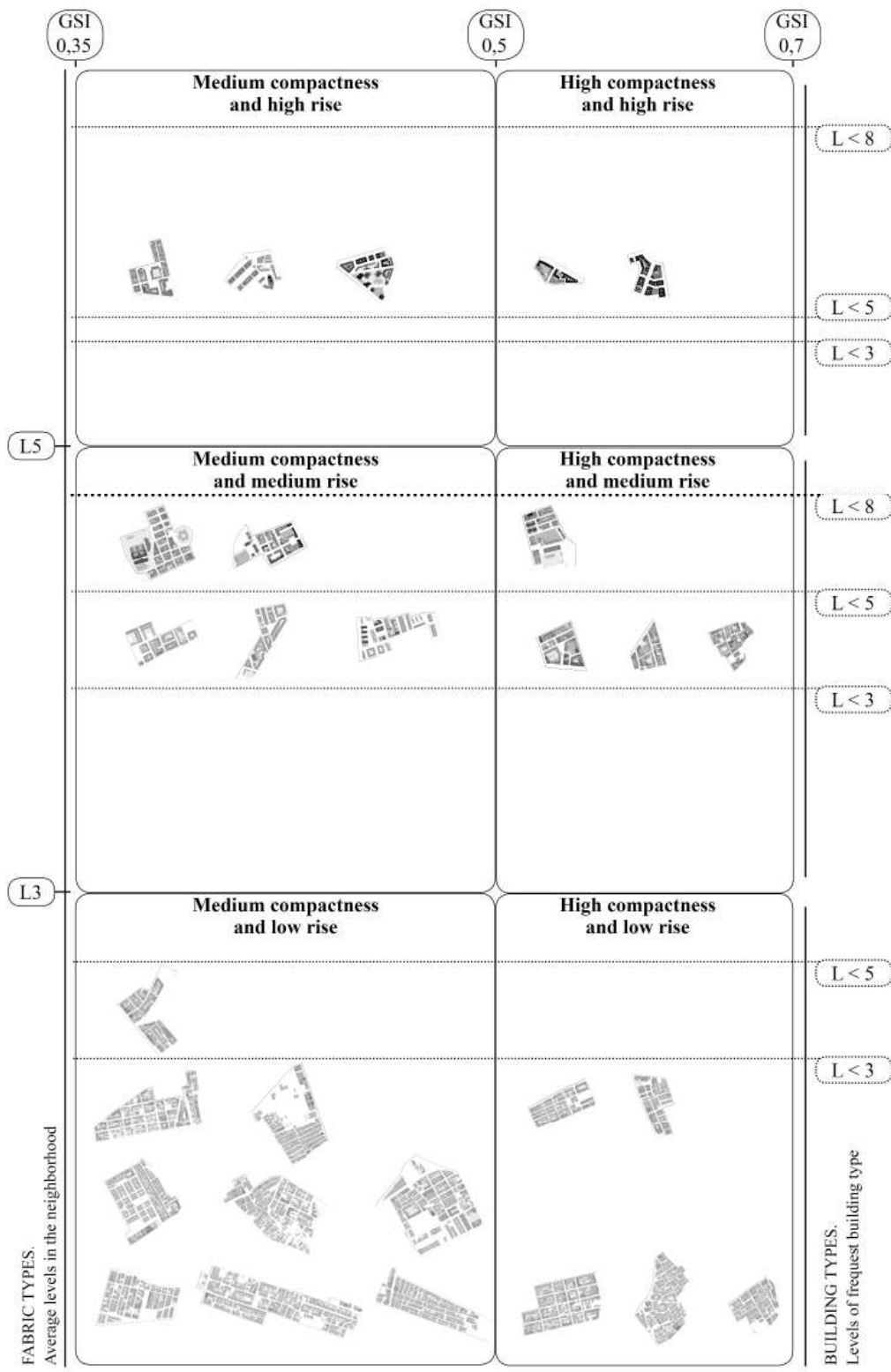


**Figure 3.** Typomorphological classification of Murcia (Spain). Very low and low compact fabrics types



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**Figure 4.** Typomorphological classification of Murcia (Spain). Medium and high compact fabrics types



with the only values of compactness and density does not offer sufficiently accurate and unambiguous types.

#### *Combination of fabric and building types for a typology of recent suburbs*

Due to the impossibility of distinguishing the forms of urban fabrics only with their values of compactness and density, it has been necessary to deepen the definition of types. Typomorphology schools has highlighted the preponderant role of the building type, or more specifically the 'built plot', in the definition of urban form. Different studies found the 'built plot' as the base element, that with its own aggregation rules creates fabrics with different spatial properties to satisfy the needs that the society required.

This relationship between component (building) and compound (fabric) is tested and operated in this research according to the density values. It stands to reason that the value of compactness of a tissue depends partially on the footprint of the buildings and also on the amount of existing streets and public spaces. Similarly, the density value of a neighbourhood depends both on their building types and on the restrictions they impose on the dimensions of public space.

According to this hypothesis, the morphological types are defined as a combination of compactness and density values of the urban fabric and of the buildings that compose it. The method has been conducted firstly by defining a typology of fabrics and a typology of buildings. Later, both types were combined into a typology of neighbourhood's forms.

These two typologies are defined on the 'spacemate' according to the values of FSI and GSI values of the neighbourhoods (census tracts in this case) and the plots. For the definition of types, it is necessary to adopt a series of criteria which have been taken mainly based on the characteristics of the object of study, as it was necessary in the definition of study areas in each scale. Tests conducted to date in other kind of urban areas, confirm the need to adapt this criteria to the study object in order to obtain an appropriate classification.

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The fabric types (figure 2) are defined by limits of compactness (GSI) and average level values (L). Using "L" instead of FSI value makes the abstract types much more recognizable and close to the standards used in the profession types. Thus, the urban fabric types were defined by compactness: very low (under 0.2), low (0.2-0.35), medium (0.35-0.5) and high (0.5 to 0.7). Regarding levels, the types are; low rise (1-3 floors), medium rise (3-5 floors) high rise (5-8 floors) and very high rise (more than 8 floors).

Building types were defined similarly (figure 2) trying to keep the relationship between fabric and buildings. Thus, the types are separated by L ranges: low rise (1-3 floors), medium rise (3-5 floors) and high rise (more as 5 floors) types. On the types, the GSI of the plot has different limits depending on the height of the building: set at 0.85 the separation between low and high occupancy for plots with less than 3 floors and at 0.6 for those with more floors.

If difficulties of 'spacemate' for the definition of fabric types have been already discussed, inaccuracies would be even greater trying to define types of buildings. However, to make a classification of neighbourhoods, the combined use of both typologies has provided satisfactory results without more complex calculations.

The typomorphological classification of neighbourhoods uses percentages of each type of building as a complement to the urban fabric type. In this process, various levels of specificity may be achieved depending on study requirements.

In this case, for each type of urban fabric, various subtypes can be defined depending on the type of building existing in the area. To avoid an excessively large typology, some simplifications were made:

- (1) Information of the most frequent, in percentages, building types is preserved in levels (L) and compactness (GSI).
- (2) For the second most frequent building type, only information of L is kept.
- (3) For the third most frequent, the only saved information is that one about if the levels are higher or lower than 5 floors.

Therefore, there are 16 types of urban fabric types and 41 possible combinations of building types, up to total of 656 possible types of fragments. However, since the types of fabrics can be composed only of some combinations of buildings types, the final number of neighbourhood types is reduced to 54 in the case of Murcia.

The final number of 54 possible morphotypes could be still interpreted as excessive for many purposes. But in this paper, it is useful to display a sequenced typomorphological classification in which it is possible to see the transition from one type to another (figures 3 and 4).

## Conclusions

According to this methodology, the frame of 15 by 15 km studied in Murcia has 29.5 km<sup>2</sup> built in a footprint area of 12.6 km<sup>2</sup>, with an average height of 2.3. The periphery, defined according to the above criteria, has an area of 15.8 km<sup>2</sup> in which there are 13.7 km<sup>2</sup> built in a footprint of 4.5 km<sup>2</sup>. Density of the periphery is 0,87 m<sup>2</sup>/m<sup>2</sup>, similar to the one in Malaga and lower than other analyzed cities like Palma de Mallorca, Cordoba or Valladolid in which the density is around 1m<sup>2</sup> / m<sup>2</sup>. Compactness of this area is 0.28, close to other studied cities of similar size.

The most common types of tissue on the periphery of Murcia are of low compactness (GSI between 0.2 and 0.35). Almost 50% of the 131 neighborhoods defined have these features. Within this group, 16% have an average of less than 3 floors, 19.1% between 3 and 5, and 14.5% between 5 and 8.

Into this type are included: open-block neighborhoods with more than 3 floors, traditional suburbs of detached houses with large open spaces and new fabrics of low density detached house.

There is also a strong presence, 14.5%, of medium compactness neighborhoods (GSI between 0.35 and 0.5) with low rise (L smaller than 3). This type corresponds to traditional dense urban fabrics of detached houses, mainly located in a bunch of urban settlements placed around the main core of Murcia.

As indicated above, the urban fabric types located on the edges of the 'spacemate' are far less frequent. So, there is only a neighborhood with an average of more than 8 floors, there are less than 10% of very low compactness neighborhoods (GSI less than 0.2) and there are less than a 7% of them with compact fabrics (GSI greater than 0.35) and high rise profiles (floors averages above 5).

Figures 3 and 4 show, firstly, how the values of compactness and density in the fabrics, combined with the percentages of existing building types allow to better distinguish different urban forms in areas of the 'spacemate' where overlap several types. Furthermore, the ordered classification according to these parameters, reveals the transition from one type to another. Thanks to that, it can be appreciating how building types change in each of the urban fabrics.

This classification observes the principles of organicity described by typomorphology schools and it makes possible to assign values of density and compactness to the various organisms, the urban fabrics, taking in account how their elements are and how they are grouped.

It has been left out of this paper, for reasons of space, the methodology used to establish the period of the twentieth century in which it was built each of the neighborhoods in order to observe the evolution of the urban fabric types used in Murcia.

The potential of the methodology lies in the opened possibility to comparative studies of different urban areas.

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