PAPER REF # 8223
Proceedings: Eighth International Space Syntax Symposium
Santiago, PUC, 2012

IMPROVING PEDESTRIAN ACCESSIBILITY TO PUBLIC SPACE THROUGH SPACE SYNTAX ANALYSIS

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KEYWORDS: *Pedestrian Accessibility, Public Space, Spatial Configuration, Environmental Quality*

THEME: Public Urban Space

Abstract

This paper is a part of a research project which has been designed for identifying the environmental quality in the pedestrian accessibility to different opportunities and services and understanding the determinant factors on it. The case of study is the city of Granada. Different types of factors like spatial configuration, attraction of opportunities or pedestrian comfort are jointly considered with the traditional accessibility measures. Frequently, accessibility is assessed only by considering a space-time dimension. That may result in an overestimation of the pedestrian accessibility measure with the consequent loss of quality in their streets. In this context, the present paper aims to show how traditional accessibility measures to public spaces (squares, gardens or parks) in terms of time, need to be complemented with other measures regarding spatial configuration.

This new approach provides useful information about the best routes or streets in the district or city to reach to public space from the point of view of quality in the accessibility. In this context the Space Syntax theory and other techniques developed at the Barlett School of the UCL present some measures that could aid to improve the environmental quality of the pedestrian accessibility to public spaces.

Our research analyzes different types of public space in Granada regarding their capacity to attract inhabitants. This capacity of attraction could be established depending on the extension, design and associated facilities that public spaces provide. Nevertheless, in this research only the extension has been considered so far. Based on this consideration, four levels of accessibility coverage have been established: neighbourhood parks, quarter parks, district parks and urban parks. Another aspect of our research is the influence of spatial configuration in the results of accessibility coverage of these spaces. Jointly with the public space coverage, global or local integration in the axial map could provide different weighting coefficients in accessibility analysis.

The main result of this study emphasizes the role of integration as a key factor in the pedestrian movement across the city. Traditional measures of time jointly with these measures of spatial configuration could aid to identify the streets with low accessibility levels. Then, strategies could be designed and developed to improve the environmental quality of the pedestrian accessibility to public spaces.

1. INTRODUCTION

The environmental quality in the accessibility to public space implies a different approach from traditional one that has been applied in accessibility studies. That because, the availability of a public space in terms of distance (nearby spaces) or the possibility of going to this space in a few minutes are not the only issues to consider. According to Lynch (1960) accessibility is a time issue but also depends on the "attractiveness" and the identity of the itineraries.

In this sense, the accessibility as it has been considered in this research, it is related to pedestrian. The pedestrian movement is the mobility model that has the capacity of maintaining the most direct relationship and interaction with the city, e.g. through the senses, in the interaction with other pedestrians, in the possibility of participating in the trading activity and cultural one along the streets (Venturi, 1998) and enjoying the natural, architectonic environment (Jacobs, 1996)

Thus, there is a necessity of considering the environmental quality when the pedestrian accessibility to public space is assessed. This gap between accessibility and environmental quality may be understood in the context of a low integration between urban planning and mobility planning (another big gap nowadays). Regarding that, mobility plans appears much later than urban plans instead of drawing an integration with joint strategies in future urban developments, where connected, integrated public spaces is a priority as a revitalizing action in the city (Gehl, 1936)

Public spaces have an important role regarding the environmental, economic, social context in the city as well as sources or providers of life quality and sustainability (Chiesura, 2004). Even from a wider point of view, the existence of cities is due to the synergistic effect that ecologic, economic, social factors create (Frick, 2007) thus in somehow, the city as a collective project exists because its public spaces exist as well.

From an economic point of view, public spaces generate positive externalities. Some authors, e.g. Correll, Lillydahl and Singell (1978); Luttik (2000); Kong et al (2007) highlight in their research how the areas near a public space with high quality or urban green space tend to get greater sale prices. These externalities are supposed to go down linked with lower levels of accessibility to the public spaces. Or the externalities may increase when the accessibility to these spaces is improved (e.g. by providing public transport or better itineraries to them; better quality itineraries)

Last point has to do with the social component of public spaces. Public spaces are spaces of socialization where the interpersonal relationships are generated. And these relationships and different kinds of them or their intensity may vary regarding place characteristics, time of use and frequency of social interactions (Gehl, 1956; Wiedenhoeft, 1979).

In this way, streets as connectors among public spaces (parks, gardens, etc) should be considered, analyzed, treated and designed as public spaces are. Because with a better urban design and environmental quality design, the streets may be enhanced as "great streets (Jacobs, 1996), facilitating the urban legibility and their own identity (Lynch, 1960) and so, improving an attractive image of the city.

The study area where the proposed method is going to be applied in this research about environmental quality of accessibility to public space is the city of Granada, which has been considered an ideal area due to its urban history and the presence of a wide variety in the typology of streets and public spaces.

Then, considering the previous starting points, the environmental quality of accessibility to public spaces should be analyzed through different factors of morphologic and functional dimension involved in pedestrian accessibility.

The assessment of the morphologic dimension will provide some important hints about its influence on pedestrian accessibility measures to public space. In order to analyze all these questions about spatial characteristics; integration and visibility, the spatial syntax of the study area in Granada is going to be assessed. Space Syntax was initially developed in 70's to give an answer to the urban renewal processes that took place in London and as a result of the observation of the space in the city as a place for physical, social activities. After that, the concept was published by Hillier and Hanson in 1984 in the context of the UCL (University college of London). However, we want to clarify that this research does not aim to test or validate the Space Syntax method itself but looking for a different application in the field of a new understanding of accessibility to public spaces considering the environmental quality during the access (through the itineraries).

2. CONCEPTS AND METHOD

This paper is developed on two key ideas: accessibility and spatial configuration. However, the application of these ideas or its measures it is going to link others concepts as integration or visual step depth.

*Accessibility***:** Accessibility refers to the ease to arrive to facilities, activities or goals, which could be appointed in general as opportunities. In addition accessibility could be defined as "the intensity of the possibility of interaction" (Hansen, 1959) and interchange (Engwicht, 1993). This research project is undertaken on the application of accessibility measures based on location and the following theoretical exposition is going to be focused on this kind of measures.

The potential accessibility measures are based on the prediction of travel distribution in which some weights in function of cost, time or distance to arrive to the opportunities are applied. In general both types of measures have advantages and disadvantages, but the potential accessibility measures have as an advantage; the facility to be understood and the capacity to be improved with additional factors. This work aims to develop a new measure of accessibility related to this type of accessibility measure.

Spatial configuration: The spatial configuration plays a primitive or principal role for the pedestrian mobility (Hillier et al, 1993). The spatial configuration affects to pedestrians when they have to take the decision about what route they select for their trips. So the spatial configuration could encourage or discourage the election of a route about which pedestrian can to arrive to the opportunities (Handy, 1197), even more if the streets have different design properties. This effect of spatial configuration on pedestrian mobility has created a new concept in planning studies, the concept of "the natural movement" (Hillier et al, 1993).

This natural movement is based on the distribution of configuration values in the axial map called integration (Hillier & Hanson, 1984). Under the theory of Space Syntax the proposed integration measures the degree in which a node is integrated or segregated respect of a part of total (local integration) or the whole (global integration). In the Space Syntax community which develop the theory and the practice of this measure, the integration is linked to the concept of accessibility in terms of spatial configuration.

The method that we present in this paper (figure 1) is based on the pedestrian network and the public space of the city of Granada. This method could be divided into two parts. The first one tries to show a traditional

analysis of pedestrian accessibility to public space based on the network analysis. The expected results of this analysis will show the service areas of the public spaces according to their properties.

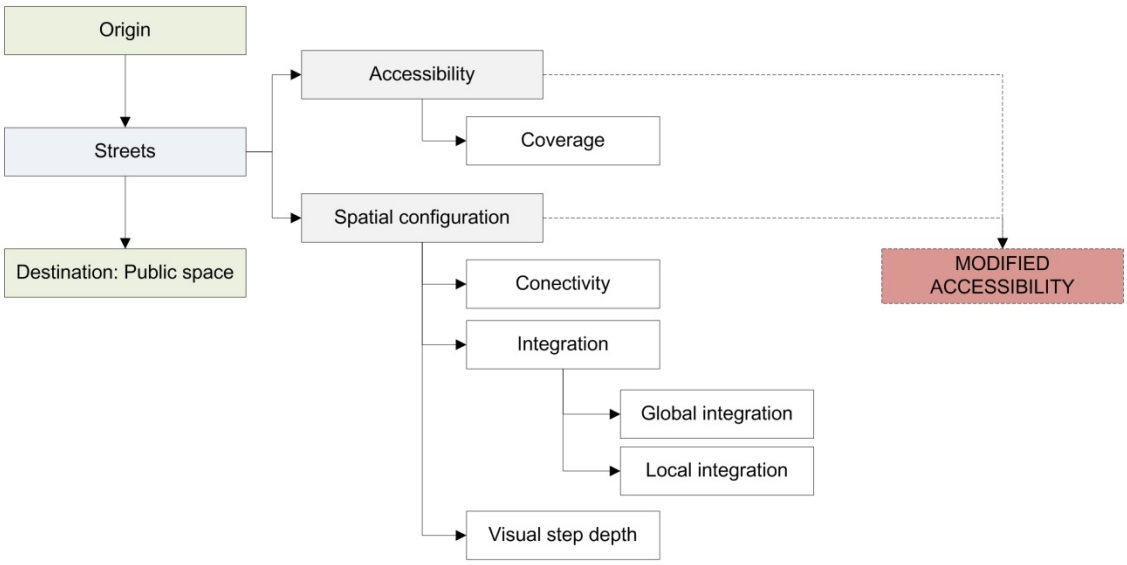

Figure 1: Method

These service areas of the public spaces define the accessibility coverages that public spaces could generate. However this kind of traditional measures based on space-time consider that all streets in the same level of space-time measurements constitute equal routes of accessibility to public space.

This uniformity of streets as preferential routes is not the most reliable approach when we are discussing about pedestrian. Streets have different inherent properties that distinguish them of whole and that make them preferential routes to access to public space.

The second part of the methodology consists in doing some analyses about the location of public space at different scales of the spatial structure of the city of Granada. These scales go from neighbourhood scale to a city scale.

To undertake spatial configuration analysis based on street network we use different measures of axial map provided by spatial configuration software developed by Alasdair Turned which is called DepthMap. Local and global integration or intelligibility are some of the most interesting measures that could be used to analyze spatial configuration in the city of Granada.

These measures of spatial configuration in the axial map are put in together with the diversity of public space and their capacity to offer accessibility. The necessity of creating modified accessibility measures tries to give an answer to the diversity of properties of streets that are at the same distance or time. Then some public spaces are selected to develop detailed analyses related to spatial configuration measures of the streets that delimitates those public spaces.

3. CASE OF STUDY

This research work is developed on the pedestrian network of the city of Granada (Andalusia) and its public spaces. The public spaces in this paper are defined as all open spaces represented in urban planning with an extension over 0.1 hectares and urban furniture for pedestrian rest. This definition of public spaces collect a diversity of spaces as squares, gardens, parks, boulevards or playgrounds.

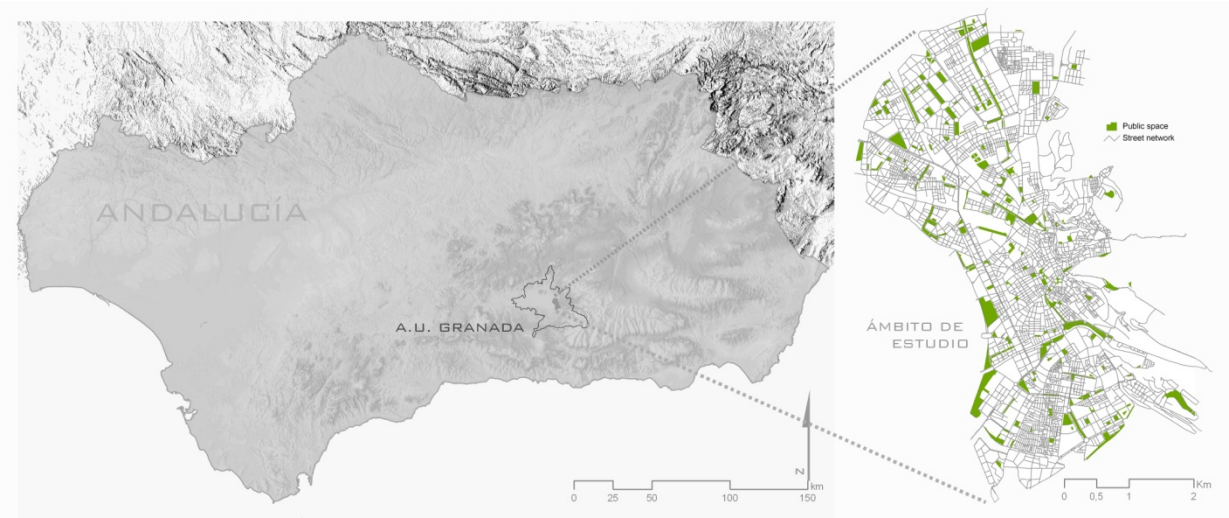

Figure 2. Case of study. Pedestrian network and public spaces of the city of Granada

4. ACCESSIBILITY

The public spaces of the research are selected based on the previous definitions of theoretic and spatial properties (Figure 2). Now these spaces need to be classified into different kinds of public spaces according to their characteristics. In addition a complete classification involves the consideration of a large number of variables.

However this research work does not consider all possible variables to classify the public spaces of Granada. The public spaces classification is only based on one variable so far; the extension. This ease classification allows testing and applying of tools to evaluate the environmental quality of accessibility to public space.

According to this last idea, the public spaces are classified based on the typology classification of public spaces proposed by Ballester-Olmos and Morata (2001) (Table 1).

Table 1. Summary of types of public spaces and open spaces in European countries

References	Type	Min. area	Max. distance
Ballester-Olmos & Morata. (2001)	Urban allotment	6 ha	1,000 m
	Neighbourhood square	0.5 ha	250 m
	Quarter park	1 ha	500 m
	District park	5 ha	1,000 m
	City park	10 ha	2,000 m
	Metropolitan park	> 10 ha	5,000 m

The classification of the public spaces of Granada gives as a result a total of three types of spaces. In ascending size order, these types are: neighbourhood squares (type I of public spaces), quarter parks (type II of public spaces) and the district parks (type III). This classification allows appreciating the lack of public spaces with higher scales than district scale, as urban scale.

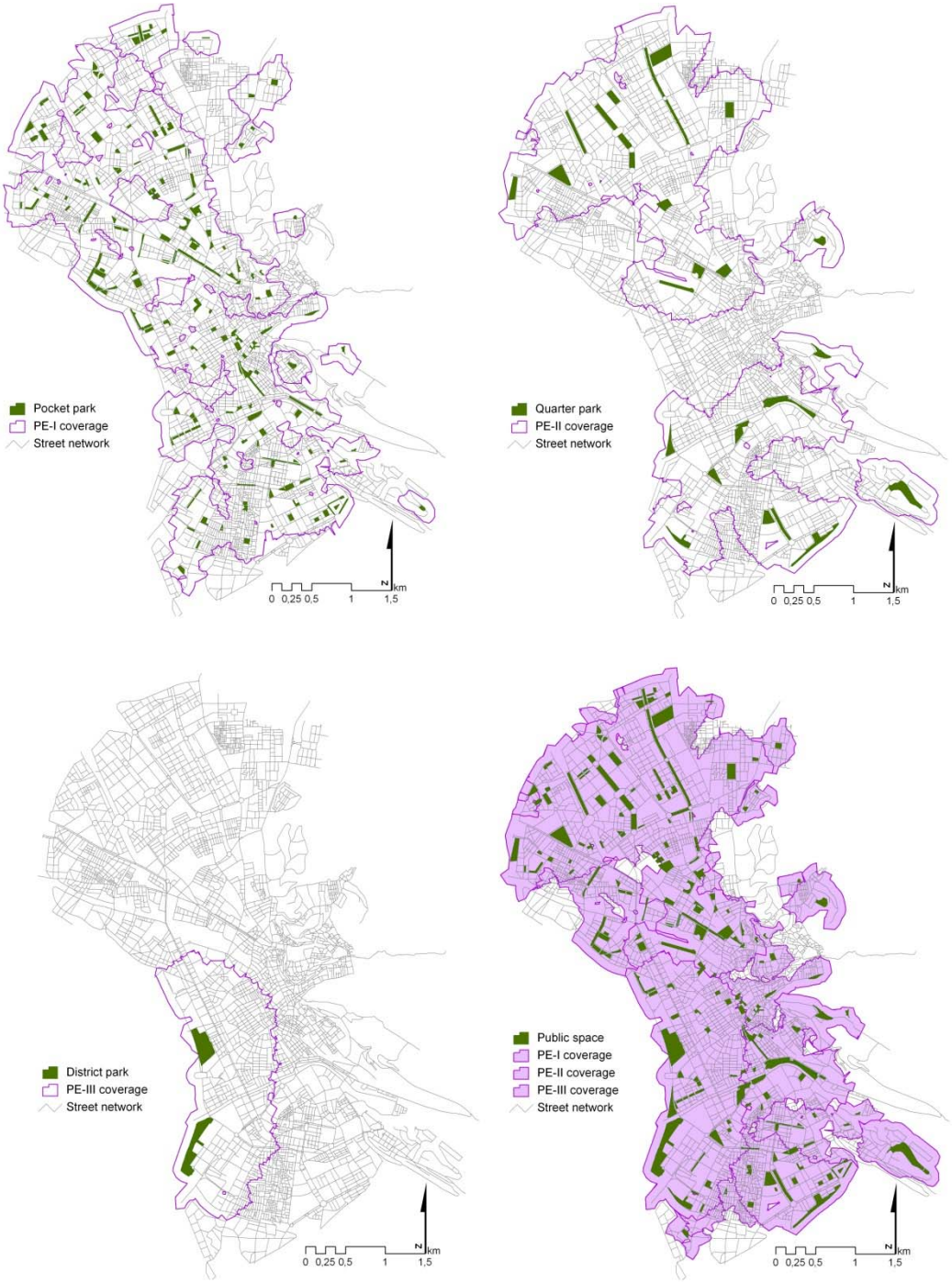

Figure 3: Accessibility coverage based on public space typology.

According to the maximum distance of service for each one of the types of public spaces established by Ballester-Olmos and Morata (2001) accessibility coverage maps could be represented (Figure 3). The first map of accessibility to public space (neighbourhood squares or public spaces type I) shows how almost the entire area of Granada is covered in terms of distance. However there is a lack of accessibility to quarter parks (public spaces of type II) in the historic centre of the city. This absence of accessibility to public spaces

of type II is caused by the morphogenesis process of the city. In addition the third map of accessibility to public spaces, district parks, makes evident that accessibility is restricted into a part of the city, leaving the rest of the city without access to these spaces.

Finally if the three maps of accessibility to public spaces are merged, the resulting accessibility map reveals that the entire urban area is covered by public space service area. In this way it could be argued that according to the coverage of public spaces and regulations about public space extension per habitant, the entire population of Granada have a relatively close public space, thus the possibility to access.

But looking at this map of synthesis of accessibility to public space some questions may be asked: Does public space coverage provide a reliable measure of accessibility? Concerning public spaces designed and planned in the city, are they located in the best places to be accessible by population? Are those public spaces related or connected in some way from the point of view of environmental quality?

These questions concerning spatial configuration should be managed and answered during the processes of spatial planning to develop a better urban planning with regard to public spaces and pedestrian accessibility. At the same time, urban planning dealing with public spaces and mobility planning dealing with accessibility should be managed in an integrated way.

5. SPATIAL CONFIGURATION

The pedestrian accessibility to public spaces is usually analyzed in terms of time or distance of trips along the pedestrian network. This network and its configuration is a key factor to collect the pedestrian flows at different scales in the city; neighbourhood, quarter, district or city.

Therefore, a planning process that analyzes these structural implications on the city could plan public spaces with better criteria. Criteria that make possible a location of public spaces, on one hand, with maximum coverage of accessibility and on the other hand, a location which is surrounded by pedestrian mobility routes in terms of spatial configuration. These criteria could provide more accessibility and a greater use of public spaces.

With the aim of observing the spatial configuration in a more detailed way, public spaces with typology III (public space of district level) have been selected. This selection has been made due to the higher extension they have in the city. That is going to allow us to take a vision from a global to a local scale in the measures of the spatial configuration. There are two public spaces included in typology III, with similar sizes and service areas, and which names are Garcia Lorca Park and Lagos Park.

5.1 Connectivity

The connectivity analysis of the city of Granada shows a gap in the results; some of them are concentrated in very high values and the rest of them in very low values of connectivity. The highest values of connectivity correspond to the axis of “Camino de Ronda” that gives form to the city and provides a large number of possible decisions about selection of routes in the pedestrian movement.

The gap in connectivity values with the highest value of Camino de Ronda axis does not allow to observe the differences in the rest of lowest values. To observe the differences between lowest values of connectivity, a reclassification of the symbology of values is needed, according to their distribution. In this way, the symbology by quartiles provides a good solution to observe the differences between values. Then the new map of connectivity shows some outstanding axes that are located in the middle of a quarter or linking two of them.

Regarding the public spaces selected it could be observed (figure 5) how García Lorca Park has axes with high connectivity values that surround it. But Lagos Park is surrounded by low connectivity axes. So the Garcia Lorca Park has a better connectivity than the Lagos Park and therefore it can offer more opportunities for decision from these axes with high connectivity.

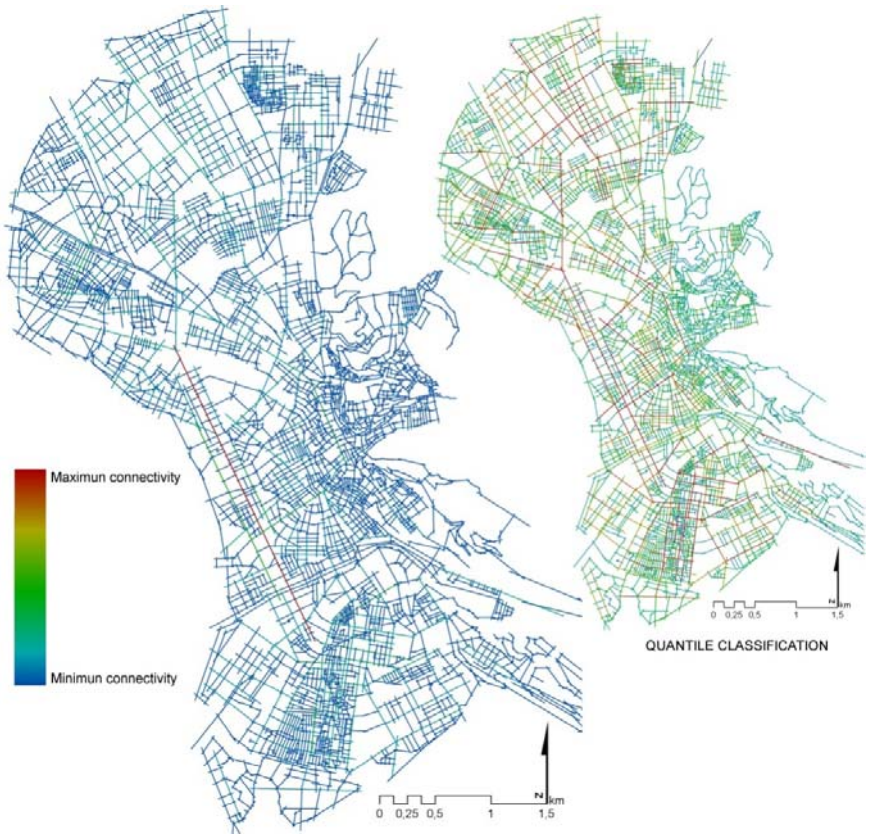

Figure 4. Axial connectivity of Granada

Figure 5. Axial connectivity into district parks coverage. On the left Garcia Lorca Park and on the right Lagos Park.

5.2 Integration

One of the most accepted measures related to accessibility in Space Syntax community is the measures of integration. In this way axes with highest integration values of spatial configuration will be most accessible.

Applying the global integration measures to the spatial configuration of Granada (Figure 6) we can observe that highest values of global integration are located in the city centre. In this way Avenida Camino de Ronda has the highest integration value. And the avenues or streets which intersect it have high values of global integration. These high values of global integration make that in these axes the pedestrian "natural movements" take place.

However the most segregated or less integrated axes are located on the East part of the city where there is an increment of slope. This slope caused that the morphogenetic process of this quarter drawn winding streets. Other axes with less global integration values are located in the quarter of "La Chana" (*a* in figure 6) and "Zaidín" (*b* in figure 6). In these cases the lowest values of global integration are justified by their morphogenetic processes in which these quarters grew as independents to Granada.

According to the local integration values of Granada, they show how the axis of Avenida Camino de Ronda has the highest value of local integration and some streets that intersect with it have high values of integration too. These values means that pedestrian "natural movement" move along these avenues in a local scale. In addition some outstanding axes (that are located in the middle of a quarter or linking two of them) have also high values of local integration.

This situation could be observed in detail in figure 7 where these two district parks are compared in terms of global and local integration values and location.

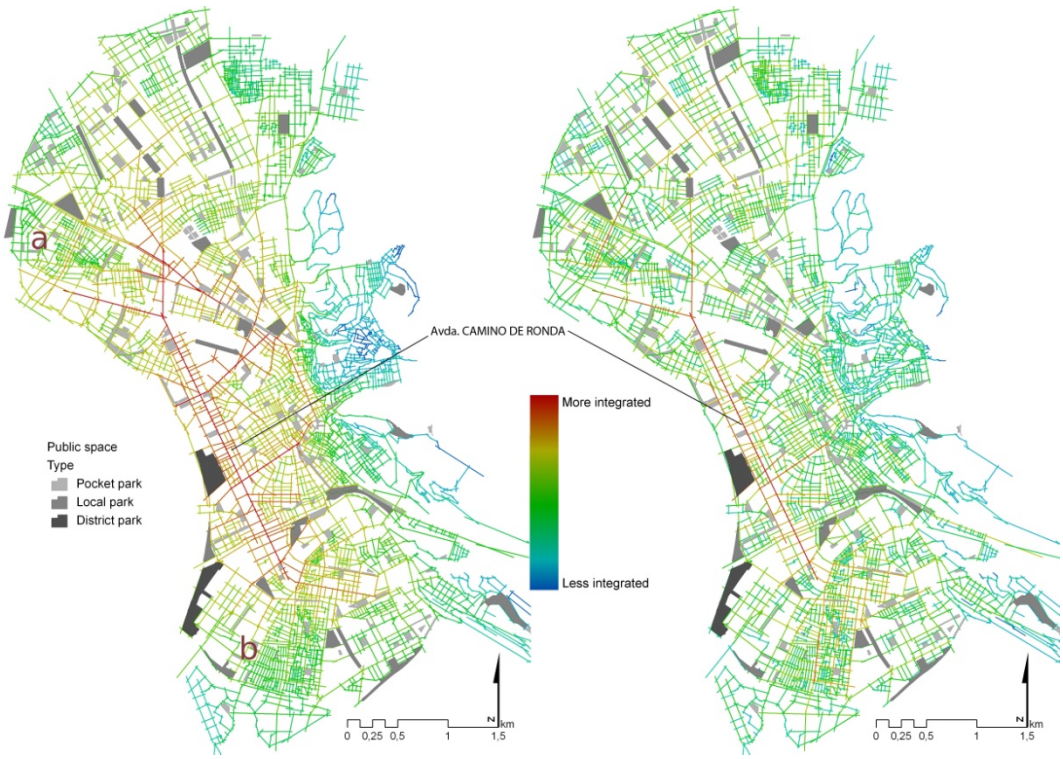

Figure 6: Global integration (HHRn) and local integration (HHR3)

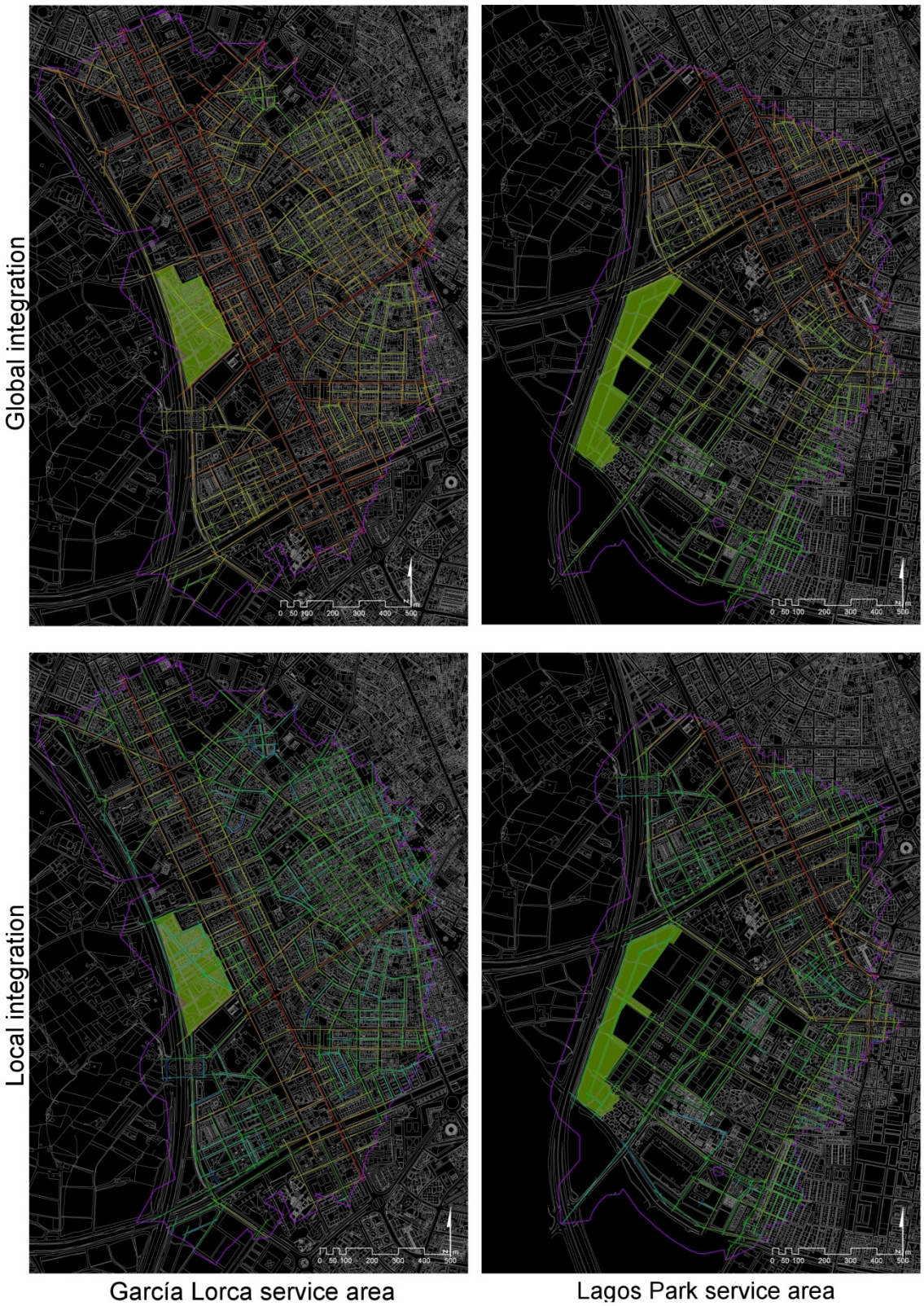

Figure 7: Global integration (HHRn) and local integration (HHR3) into district parks coverages.

Regarding global integration analysis, Garcia Lorca Park is surrounded by lines with high values of global integration, and then the park is well integrated in the whole city of Granada. So this park has a constant use by population even beyond its service area. Nevertheless Lagos Park is located between axes with low integration values (Table 3) and far from axis with high global integration values. Thus, this public space is segregated in the city and the pedestrian fluxes are moving across other axis.

Concerning local integration, the existing differences between the axes that surround both public spaces decrease. But again here as in the global integration, García Lorca Park is located in a better site that Lagos Park from the point of view of its local integration. This situation make that Garcia Lorca Park can be used in daily common trips in the district. But Lagos Park is not a key place for the pedestrian fluxes in this district, so its use is limited to those inhabitants who want to access to this specific park.

Table 3. Integration values of the axis of district parks

	García Lorca Park		Lagos Park	
	Global integration	Local integration	Global integration	Local integration
Maximum	1.08	3.66	1.02	3.08
Average	1.00	2.85	0.87	2.04
Minimum	0.91	1.88	0.77	1.30

5.2 Visual step depth

The visual step depth (as a quantification of the complexity of the detours to arrive to district parks) shows some differences between the district parks. The streets in the served area of stations García Lorca Park have lower values of visual step depht (86% ≤ 3 steps) than streets served by Lagos Park (98 % ≤ 3 steps)(Figure 9). Nevertheless these results can be understood by looking the service area of district parks.

Figure 8: Visual step depth into district parks coverages.

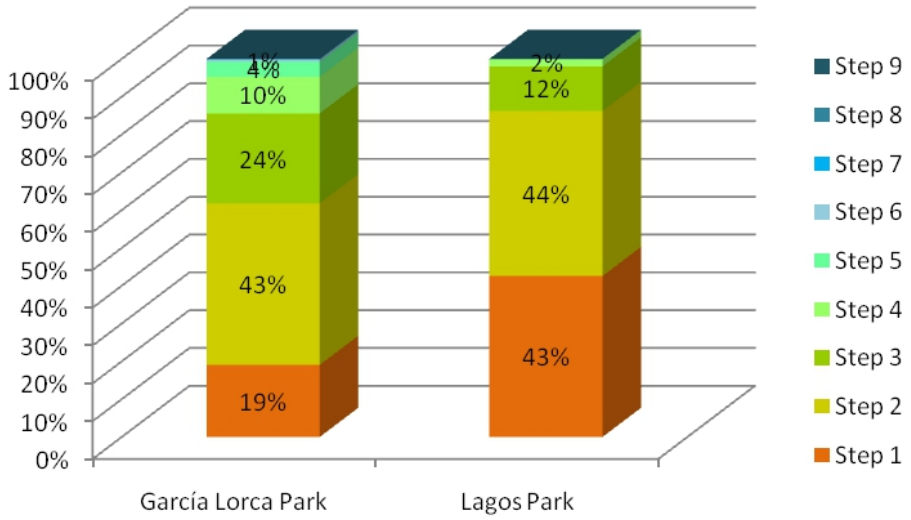

Figure 9: Chart of the visual step depth charts of the district parks.

The service area of García Lorca Park has higher number of streets than service area of Lagos Park where the blocks are bigger than the first ones. In addition the service area of Lagos Park has more extension of open space and there are a lot of pixels of step 1 and it increases its percent.

These results make that the visual step depth in this situation has not had enough utility to compare the service areas. But it can be useful to compare others service areas or to make some proposals for improving itineraries to these public spaces.

6. CONCLUSIONS AND FURTHER RESEARCH

The results of spatial configuration analysis in Granada show that there are great differences inside the service area of the district parks, providing a new point of view to the space-time measures. These differences make a public space more integrated or visible than others into a quarter, district or city.

Both studied public spaces have the same extension and provide similar service area. Nevertheless the García Lorca Park is more accessible than the Lagos Park in terms of spatial configuration. The García Lorca Park is surrounded by streets with better connectivity that increases the numbers of itineraries; streets with a higher level of global and local integration that collect the pedestrian fluxes at different scales in urban trips; and finally, streets with a large visibility of the park that enhance the origin-destination flows.

Then, the spatial configuration plays a crucial role in the environmental quality of pedestrian accessibility, determining the main pedestrian fluxes among different itineraries to reach public spaces with their respective conditions and characteristics. If the integration value of the itineraries and the visual step depth are known, this allows two main interventions:

- to locate public spaces in the most appropriate places in new urban developments, according with the typology regarding accessibility and;
- to design intervention strategies about those public spaces where the itineraries associated present low integration values. If these values are increased, the attraction to public spaces will be also increased.

The improvement on public space location or on their accessibility could result in a greater use of public space and thus, an increase of the possibilities of population to enjoy the benefits that public spaces provide.

The future line of progress of this paper is the integration of values about spatial configuration in accessibility measures, obtaining a modified or corrected accessibility. This first qualification of accessibility will be combined with other factors related with environmental quality of pedestrian accessibility and a final measure and representation of accessibility to public spaces will be obtained. This new understanding of accessibility will be more complete than traditional measures that only consider time and distance issues. But at the same time, it is expected to be a simple, efficient application method which will be use by planners.

7. ACKNOWLEDGEMENTS

This research has been done under the funding of the Regional Government of Andalusia and FEDER for the “Excellence Project” (P09-RNM-5394): “METHODOLOGICAL GUIDELINES FOR THE SUSTAINABLE METROPOLITAN INTEGRATION OF THE LIGHT RAIL SYSTEMS (INTEGRA-ME)”.

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