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Methodology for the Detection of Residential Vulnerable Areas – the Case of Barcelona

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Abstract. In a context of a shifting environmental, economic and social paradigm, European cities face a situation that is at the same time challenge and opportunity: the need for urban rehabilitation of the vulnerable degraded socio residential fabric. Public administrations in big cities and metropolitan areas are confronted with both the undercurrent need of actualization of the built stock and the rise of urban residential vulnerability. The city of Barcelona, as many others, is the result of multiple phenomena with high urban and social consequences. The socio spatial integration of immigrant population, the touristic rise and gentrification processes are current situations simultaneously taking place in the city. In parallel, a framework of economic crisis in which public investments in urban and social matters decrease, provides a temporal juncture that results into an increase of social polarization and socio economic inequality that becomes evident and expressed in the territory. This research focuses in the case of Barcelona, and presents a methodology based on a system of indicators elaborated through the exploitation of statistical data complemented with very specific data supplied by the Barcelona City Council. The accurate knowledge of socio demographic, socioeconomic and residential and urban characteristics is crucial in order to define the very complex urban dynamics that describe in the city neighbourhoods and areas. Residential vulnerability is defined as an assembly of objective conditions that relate to residential space and indicate situations of social discrimination and structural disadvantage of the population, related to a specific time and context. Thus, it is relevant to analyse the concentration of certain indicators of vulnerability in specific places or neighbourhoods, to contrast its effect on the socio-residential situation and its temporal evolution in order to identify tendencies. The present study contributes to the identification of data sources and a system to calculate the purposed indicators, the elaboration of a GIS analysis in order to determine the characterization of neighbourhoods and census sections according to each indicator, and the identification of areas with a higher degree of problematic based on synthetic analysis. A very relevant knowledge basis that can be used by public policy makers in order to establish measures that define vulnerable areas where to carry out actions that foster urban equality.



1. Introduction

The analysis of vulnerability is closely linked with other issues that refer to social structure such as social inequality, poverty or social exclusion. This concept has been object of thought and definition by many authors within the scope of Social Sciences, specially Geography and Sociology. Some references such as Chicago School [1][2][3] have provided diverse contributions to the definition and discussion of the term vulnerability. From a transversal point of view, United Nations refer to vulnerability as "(...) a state of high exposition to certain risks and uncertainties, combined with a decreasing capacity to be protected or defended from the risks and face their negative consequences. Vulnerability exists in all levels and dimensions of society. It is an integral part of the human condition and, thus, it can affect both individuals and the society as a whole". [4]

In the Spanish State, authors like Alguacil, Camacho and Hernández define urban vulnerability like "the potential of the population from a certain urban space to be affected by adverse circumstances. A concept that refers not only to the existence of a critic situation that has nowadays been proved but also to the existence of certain risk conditions, fragility and disadvantage facts that could motivate the development of further critic situations of consolidated inequality" [5]. Indeed, urban vulnerability is based on the combination between social, professional and residential exclusion. The coexistence of these aspects usually results into a process of spatial segregation and social concentration in neighbourhoods that turn very disadvantaged in urban and social terms [6]. As concluded by many authors, vulnerability refers, in one hand, to the increase of risks affecting groups of people, society or states. On the other hand, it refers to the debilitation of mechanisms to face risks. Previous studies on urban vulnerability in the Spanish State have aimed to detect the most disadvantaged neighbourhoods, providing a theoretic reference and methodological proposal that includes a process of operation of the concept in analytic procedures and measurable indicators, and, in addition, the establishment of an analytic mechanism to measure vulnerability in different territorial areas that can be diagnosed. [7] [8] [10] [11].

The present study is based on the following dimensions of urban vulnerability:

Axis 1. Socio economic vulnerability, characterized by unemployment (especially high rates), precarious job market (instability and low income) and the low educational level of working classes (specially related with high school dropout rates).

Axis 2. Socio demographic vulnerability, characterized by a demographic aging that relates to situations of dependence, sanitary problems, deterioration of dwellings, lack of income or low income and increase of unipersonal housing. Besides these facts, a major complexity of the housing structure is linked with the consolidation of types of family with high social vulnerability. Mostly, it is the case of stranger immigration arrived from non-developed countries.

Axis 3. Residential and socio urban vulnerability, that refers to the importance of the spatial support for the satisfactory development of daily life: the need of quality housing and quality of the neighbouring residential urban environment. The degradation of both turn into a risk of vulnerability among the resident population. Substandard housing and those housing environments that do not accomplish the basic habitability requirements because of their bad conservation state, insufficient surface or lack of basic installation, are high expressions of residential vulnerability.

2. Objectives

The object of the present research is to develop a method in order to define and discuss on the socio spatial dimension of vulnerability, and on those aspects that must be addressed when purposing public proactive polices for the improvement and urban rehabilitation of neighbourhoods within the Neighbourhood Plan of the city.

The objectives of this study are:

- Compilation of the adequate information, and treatment with a contrasted geospatial method in order to identify relevant indicators of residential vulnerability according to their importance and significance within the available data.

- Elaboration of a system to describe socio spatial characteristics of residential neighbourhoods, as a base of a GIS analysis with the aim to determine most vulnerable areas.

3. Methodology

The present research provides a system of geospatial information that contains socio demographic, socio economic issues, together with urban and residential spatial characteristics. A compilation of sufficient indicators in order to establish a measure of relative differentiation of the rate of residential vulnerability between several neighbourhoods, in order to foster measures to further resolve inequality.

This methodology is based on a very large information basis at municipal level, providing the possibility to develop a study at a micro-urban scope, such as census unit, neighbourhood and urban lot among others. A large database has provided enough information for the elaboration of 146 indicators in total. A first exploration provided the selection of significant indicators, reducing them the analysed issues to 37 quantitative indicators of different topics at neighbourhood, census unit and plot scales. They were adjusted to those concepts that are considered relevant in order to measure situations of vulnerability among the three axes that articulate the present research as explained previously:

1. **Socio economic problematic:** Indicators that enable to identify population fragility because of a scarce economic capacity, educational level, unemployment or other social deficiencies, lack of services or impossibility to access them.

2. **Demographic problematic:** Indicators that enable to describe structural situations of the socio residential space that refer to the population profile: aging and superannuation of residents, variation in terms of loss or immediate growth of population, proportions of stranger non-European population, dependence rates. In general, data that is compiled from the municipality: register, Social Services, economic municipal support, etc.

3. **Urban regression processes:** Systematization of indicators that enable to identify the level of urbanization insufficiencies, situation or degradation of dwellings, lack of public services and green areas, etc. Data compiled from the municipal Cadastral database, Census 2011, Urban Council department, etc. Based on the availability of data and Cadastral database such as effective antiquity (age of building reform), some indicators regarding building characteristics were elaborated. The aim of this process is to provide, by means of several sources of information (building permits of antiquity and rehabilitation, certificates of habitability, building technical reports, energy certificates, etc.), an actualized view on the current state of buildings and dwellings regarding habitability conditions.

Each obtained indicator has been treated on different scales (neighbourhood and census unit) according to the concentration of the most unfavourable extreme that is established with the percentage quartile that contains 25% of the units. This procedure provides the identification of most extreme vulnerability situations. Based on this group of extreme units, a scale between 1 and 10 was elaborated with the aim to emphasize on the level and rate of fragility and in order to differentiate the most extreme border among all cases. A measure that establishes an ordinal system for each entity (neighbourhood or census unit) referred to each indicator, in a way that positions each case among the rate of most extreme unfavourable situation. The development of a scale that contributes to identify most vulnerable areas according to all indicators in an organized manner. A methodology that is usually applied in multicriterial valuation studies that are applied to processes of territorial planning [12].

The following procedure consisted on the elaboration of a matrix of relative weights for each indicator according to criteria proved in previous studies and contrasted in the present study. This methodology enables to take into account the fact that certain indicators have higher influence on the studied three axes of vulnerability. Socio economic indicators, Urban Indicators and Socio urban Indicators are identified as those that have the highest relevance in the identification of vulnerability situations because they directly point at situations of deficiency of either economic resources or physical dwelling or environment deterioration. The research is based on a weighting that allocates a significance of 2/5 to Axis 1, 1/5 to Axis 2 and 2/5 to Axis 3, as shown in Figure 1.

AXIS	COMPONENT	INDICATOR	WEIGHT	
Economic, social or environmental problematic			Indicator	Axis
Socio economic Indicators	Residential exclusion	Grants for rental accommodation	6	28
		Eviction	8	
		Punctual municipal grants	5	
	Economic deficiencies	Seniority pension or invalidity	2	
		per capita Family income	3	
	Risk potentiality	Unemployed population	3	
		Non-qualified workers	1	
Demographic problematic				
Socio spatial Indicators	Mobility	Population from non-european nationalities	2	16
		High rates of intern migration	2	
		Low rates of intern migration	0	
	Dependence	Child population index	1	
		Ageing index	3	
		Superannuation index	2	
		Mortality due to respiratory illnesses	1	
	Residential density	Number of residents per dwelling	1	
		Dwelling surface per resident	2	
		Population density	1	
	Housing/dwelling density	1		
Urban regression processes				
Urban Indicators	Physical	Dwelling average surface	1	21
		Ageing of buildings	2	
		Average category of residential uses	1	
	Building at risk	State of buildings: state of ruin, bad or deficient	4	
		Building typology	1	
	Accessibility	Buildings of more than 4 floors with no lift	3	
	Rehabilitation activity	Buildings > 40 years old with no rehabilitation licence	1	
		Licences of interior conservation	2	
		Licences of facade conservation	2	
	Energi eficiencia	Buildings > 40 years old with no building permits	3	
	Energy Efficiency Qualification F or G	1		
Socio urban Indicators	Tenancy	Social subsidized housing applicants	2	11
		Private housing with mortgage payment	1	
		Rental housing	1	
		Cadastral value	2	
		Property structure (vertical or horizontal)	1	
		Type of property	1	
	Urban activity	Empty locals in the ground floor	2	
		Commercial locals in the ground floor	1	

Figure 1. Indicators analysed in order to determine vulnerability

Finally, the results of each indicator and its values were represented in maps, with a special emphasis on those ranges of higher vulnerability based on the quartile that shows the 25% in situations of most extreme vulnerability. In order to reduce the extension of neighbourhoods the map shows only in a red coloured range of three tones in order to distinguish the three most extreme levels of vulnerability: the most exceptional and extreme (5%) in dark maroon; the very pronounced (between 5-10%) in bright red; and the very high (between 10-25%) in pale red or rose.

4. Results

In order to attend situations of urban vulnerability it is fundamental to consider simultaneously the socio demographic, socio economic, and residential and urban dimensions that affect neighbourhood's urban improvement or regression processes. The results derived from the application of the previously exposed methodology to the Barcelona case are presented in this section according to this order.

4.1. Socio economic Indicators

The concept of this axis refers to the capacity of households to afford satisfactorily a certain emotional and material welfare. The reference authors express this idea in terms of economic limitations of residents, usually identified by unemployment or precarious jobs and work conditions, as well as educational level of the population.

The description of components that configure this axis focuses on those indicators that express a higher risk of residential exclusion, measured by a high presence of municipal grants for rented accommodations, maintenance of housing, high rates of eviction, high unemployment rates and low qualified professional profiles. The obtained results are shown in Figure 2.

4.2. Socio spatial Indicators

Components that articulate this axis express a synthesis of the changing processes of residential mobility, dependence rates and residential density. The description provides the profile of neighbourhoods with a higher presence of migrant population that currently present a low dynamic of population income, a fact that determines a lower growth and development than the average of the city. In parallel, spaces with a higher presence of dependent population, specially ageing, and more affected with respiratory illnesses as an indicator of residential sanitation and habitability. Finally, areas where there is a higher residential density (dwellings are occupied by more people) and lower residential surfaces per resident in the city are often linked with complex family structures with higher fragility. The obtained results are shown in Figure 3.

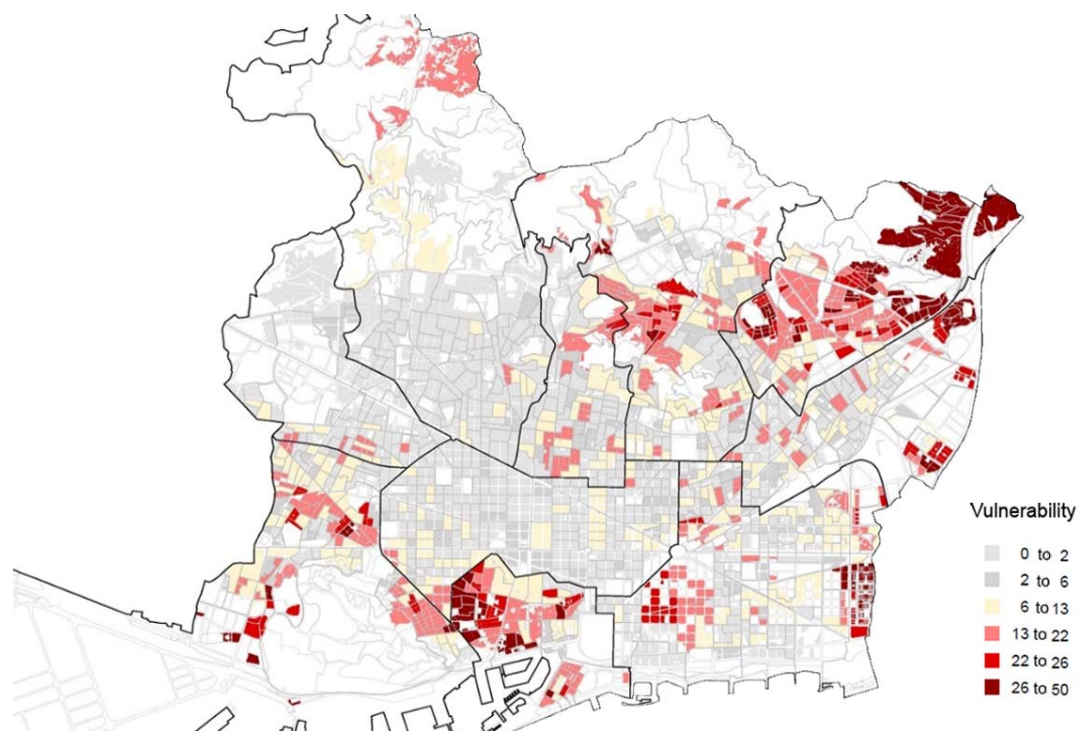


Figure 2. Socio economic Indicators

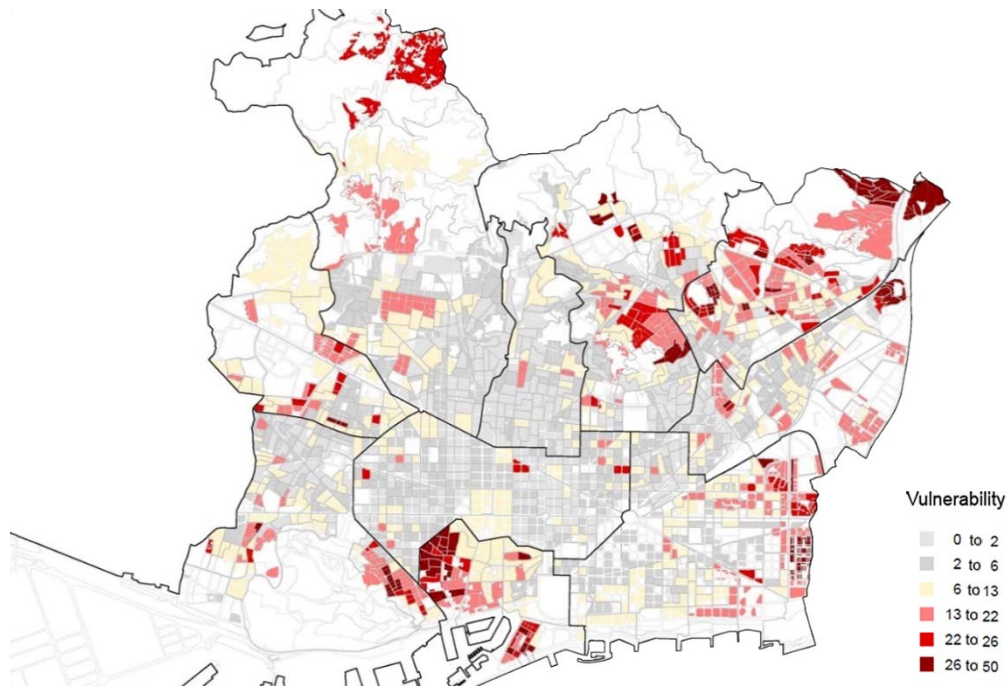


Figure 3. Socio spatial Indicators

4.3. Urban and Socio urban Indicators

A first urban component refers to the description of the residential tissue, the physical state of buildings and dwellings, according to dimension and constructive quality. The deficient state of conservation of buildings, lack of accessibility (lifts) or absence of rehabilitation activity for ageing constructions is considered. The obtained results are shown in Figure 4.

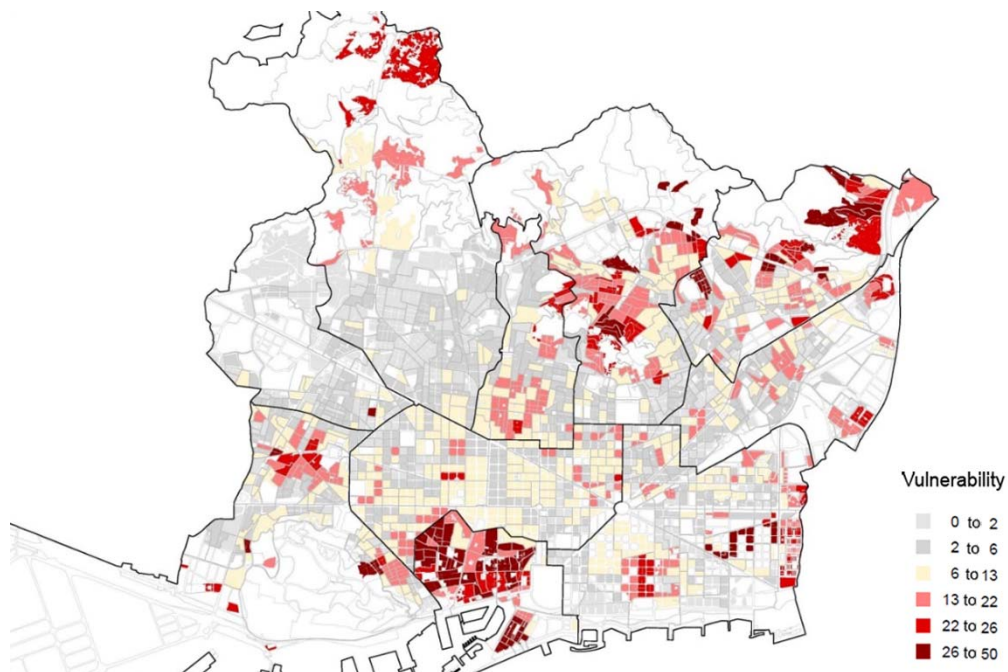


Figure 4. Urban Indicators

A second consideration takes into account socio urban aspects, referring more explicitly to issues that are essential in order to modify the physical state of dwellings, such as juridical, property and valuation aspects. At this level, the tenancy regime, demand of social subsidized housing and level of value, together with the dynamics of ground floor activity, identify areas of socio urban vulnerability. The obtained results are shown on Figure 5.

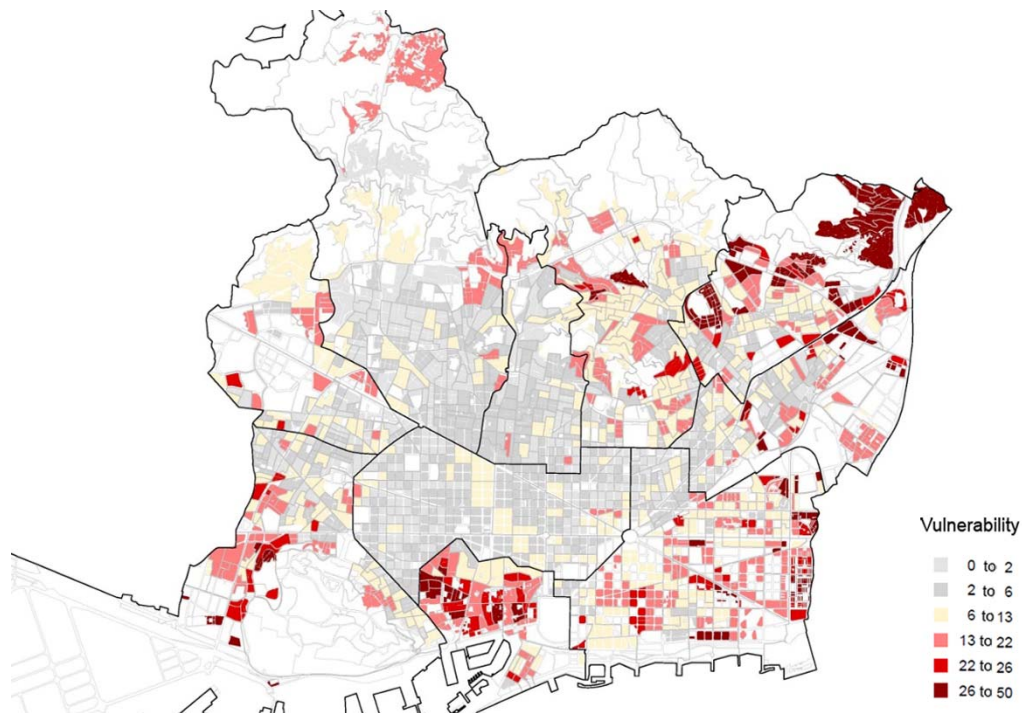


Figure 5. Socio urban Indicators

5. Conclusions

The elaboration of a methodology proposal for the operation of the concept in an analytic dimension by means of measurable indicators, as well as the systematization of the analysis of each indicator, provide a measure of vulnerability.

The final result of the study is materialized in a multivariable matrix that is structured according to three axes: Socio economic, Socio spatial, and Urban and Socio urban. All of them contribute to the identification of areas with a higher level of residential vulnerability. This approach is based on objective conditions, obtained from the study data sources and treated by an analysis methodology that contributes to generate a compared measure of the current state of neighbourhoods in order to provide a base to foster future intervention policies by means of the city Neighbourhood Plan or other rehabilitation policies.

A first geographical territorial analysis of data brings a disaggregated vision of the difference between aspects that characterize the neighbourhoods according to socio residential space, with emphasis on those aspects that proof to be more significant. The essential characteristics of the city of Barcelona are shown simultaneously with the vulnerability situations, that appear to be located in very specific areas where a further qualitative study will be able to corroborate the real state of buildings, dwellings and residents on site. This continuation of the study will enable to test the situation and its social and economic context, as a previous step before the implementation of a Rehabilitation Plan that can attend specifically the needs of resident population in each neighbourhood.

Areas that present the highest levels of vulnerability have been distinguished, according to those that contain the quartile of the highest 25% of vulnerability. A mapping of three colours distinguish the three highest levels: extreme, pronounced and high. Areas that present values under these three groups

correspond to those that are adjusted closely to the average and the third quartile, identified with moderated vulnerability, and distinguished from those that appear under the average of the city with a rate of low vulnerability or even imperceptible vulnerability in the range of the first quartile.

The analysis of areas with the highest level of vulnerability contributes to delimitate the areas that deserve highest attention when implementing a Rehabilitation Plan:

In general terms, the city presents a low level of vulnerability. Districts of l'Eixample or Les Corts almost have no zone with moderate or low level of vulnerability. The Sants-Montjuïc district presents some vulnerability areas located in Poble Sec and Hortafrancs. While the district of Sarrià-Sant Gervasi shows a very low level of vulnerability in its central area, there is sectors of higher risk in Vallvidrera and Les Planes. Gracia district also offers a good state in its whole.

The highest vulnerability level is confirmed in the district of Ciutat Vella (city center) and particularly in Raval and Gòtic sud. Simultaneously, it is noticed at the north east border of the city: Ciutat Meridiana, Torre Baró, Vallbona, Trinitat Vella, Can Peguera, La Clota, some areas in Trinitat Nova, Roquetes and Carmel. A similar situation is observed in the neighbourhoods of Besòs-Maresme and Bon Pastor, les Marines and some areas of the Sants-Montjuïc district. In the northern border, the area of Les Planes Vallvidrera is identified and necessary to define in a more detailed scale.

Sant Andreu district presents, in its central extension, a moderated and low vulnerability, while the northern and eastern, Besòs, Bon Pastor i Baró de Viver, are identified as zones of extreme fragility.

Sant Martí district is characterized by its current transformation, and will have to be further analysed in the future in order to describe its evolution. The areas of Besòs contain its most vulnerable areas, whereas the central zones and areas of transformation show more moderate situations.

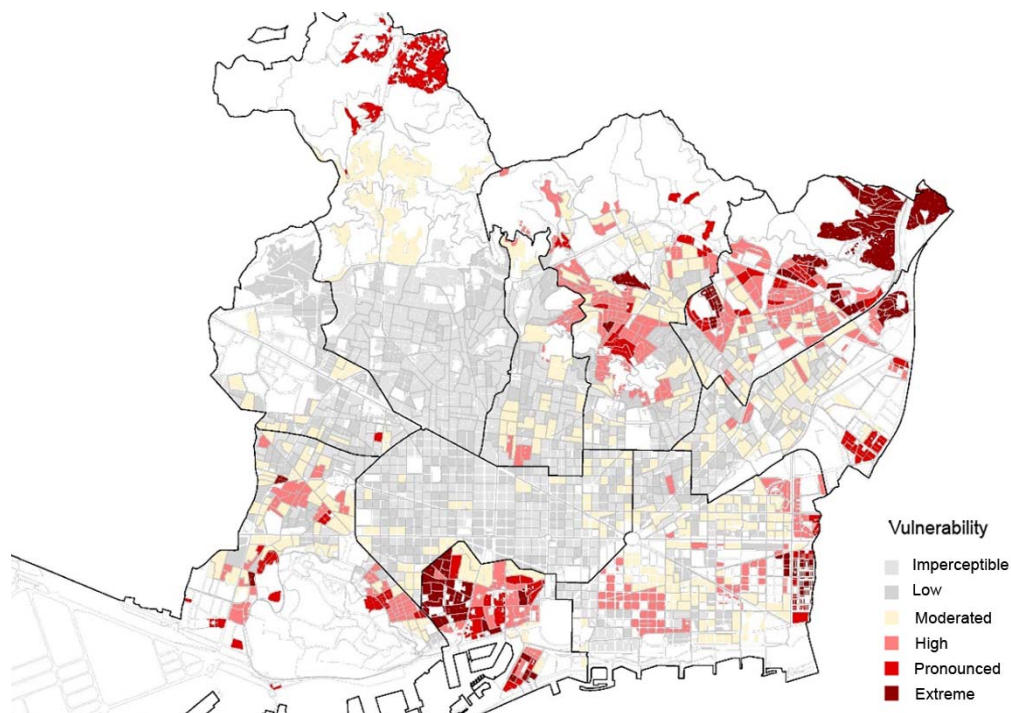


Figure 6. Global Vulnerability

Finally, districts of Horta-Guinardó and Nou Barris concentrate a very important part of the most disfavoured areas. It is important to note that those neighbourhoods faced most of the post-war migration processes, hosting population that was located in peripheral housing estates at the north east of Barcelona between the years 1950-1975. Indeed, Nou Barris was conformed initially with strong intern deficiencies such as the location of new neighbourhoods with no accessibility and no connection with the rest of the city. These initial material and urban weaknesses reinforced residents' movements of support and mutual

help, social bonds, associative fabric and combative action that demanded and called for the improvement of the quality of life by the initial years of democracy that resulted into urbanization, improvement and dignifying of many marginal spaces. Currently, the residents' organization and initiative to face difficulties remains and has resulted into the good implementation of integration actions towards newcomers. Nevertheless, the results of the present study proof the existence of a situation of extreme vulnerability that affect many neighbourhoods both referring to socio economic and socio urban and urban aspects based on the state of buildings and dwellings. A fact that calls for the need to continue implementing actions aiming to improve these areas.

In order to conclude the present study, it is necessary to underline that the results of this research show a characterization of the socio residential space of the city of Barcelona according to its situations of vulnerability. These situations are located in specific areas in which a future qualitative analysis on site is planned. A testing on site that is considered to be fundamental in order to confirm the results of the present data analysis and to validate the results for the totality of the city.

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