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Methodology for the Pre-diagnosis of Residential Buildings in Vulnerable Areas in the City of Barcelona

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Methodology for the Pre-diagnosis of Residential Buildings in Vulnerable Areas in the City of Barcelona

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Abstract. In a paradigm of raising urban economic and social inequality among south European cities, public administrations are confronted with the challenge to foster the improvement of the most deprived residential vulnerable areas. In the framework of the implementation of a building rehabilitation program on vulnerable residential neighbourhoods by the Barcelona City Council, the current research presents a technical and experimental approach on 16 of the most vulnerable areas. The aim of the study is to obtain a qualitative evaluation of the residential vulnerability as well as the identification of buildings with a most deprived physical state. The purposed methodology approaches a first pre-diagnosis of the building state and the detection of buildings that present a major need for rehabilitation actions, providing prioritization criteria. Rehabilitation is here considered from a wide and integral perspective, taking into account both socioeconomic aspects that describe the housing community and specific physic conditions of the built stock. Such methodology is complemented with the interchange of information with local actors, both from the social tissue and the neighbourhood local administration. The results of the present research provide the public administrations with the identification of data sources and a systematization of technical and social qualitative information onsite on a database, as well as the elaboration of a GIS analysis and cartography in a compendium of maps. The actualization and testing of quantitative information on specific areas provides the public administration with a set of very relevant tools in order to address specific and complex vulnerable areas and to efficiently invest public resources with the aim to improve both physical and social conditions of deprived neighbourhoods in long term.

1. Introduction

It is well known that maintaining, rehabilitating and updating the cities built stock allows to avoid urban and social degradation states. However, there are determined urban areas, such as vulnerable ones [1][2][3][4] in which these actions of rehabilitation and are often aborted as they require economic resources impossible to have on the part of their inhabitants. It is precisely in these cases where, often, rehabilitation plans are necessary for administrations [5], Barcelona is one of them.

The present article collects the results of the R & D project on "Pre-diagnosis of the state of the residential buildings in the most vulnerable areas of the city of Barcelona" carried out by the Polytechnic University of Catalonia (UPC) and funded by the public administration of Barcelona.

The study has its starting point in the "Study and detection in the city of Barcelona of areas of residential vulnerability" carried out previously by the UPC [6][7] that points and defines those areas within the city of Barcelona that present a higher degree of vulnerability [8].

The current study of Pre-diagnosis of the residential buildings [9] provides a first knowledge base on the state of the building stock in the most vulnerable areas that allows technicians and managers to carry out the necessary tasks within the Rehabilitation program from the city of Barcelona. The study performs a qualitative and technical approach on the field that allows a proven assessment of the level of vulnerability and identifies those buildings in the most unfavourable conditions.

This article provides both the methodology carried out and the results obtained from the study of the residential buildings in the vulnerable neighbourhoods of the city of Barcelona.

2. Objectives

The objectives are as follows:

- To contrast field areas selected from the " Study and detection in the city of Barcelona of areas of residential vulnerability" to detect and make a selection of those buildings that present a greater need for aid in rehabilitation, understood in a broad sense, which contemplates socioeconomic aspects of the community as well as the physical needs of the buildings.
- To establish priority levels in the need for rehabilitation of buildings within the areas of the study.
- To systematize the technical and qualitative aspects of the buildings, also regarding the inhabitants' habits, that can be susceptible to improve habitability, accessibility and energy conditions.
- To provide general knowledge of the state of the building in the areas of study in relation to habitability, accessibility and possible risks for people.
- To contrast the results of the prioritization with district technicians and social agents from the different districts, in order to reach a consensus on a list of buildings susceptible to being part of the Rehabilitation program.
- To elaborate a social map of each neighbourhood that allows to record information about the state of public space, social conflict, evolution of the neighbourhood, etc. and which also allows to put in context the state of each one of the buildings.
- To start the diagnosis of those buildings that may be included in the Rehabilitation program.

3. Methodology

The methodology presents the following phases:

A first stage of compilation of previous information and delimitation of areas of study. The vulnerability study [6][7] detected particularly vulnerable areas, of which the vulnerabilities 'high', 'pronounced' and 'extreme' were included in the study. After this selection, the selection was agreed with the Barcelona City Council. Also, those buildings that had recently undergone rehabilitation actions were discarded. A total of 3633 residential buildings were included in the study (see figure 1), table 1 shows the neighbourhoods studied by district.

Table 1. List of the areas and number of residential buildings included in the study

District	Neighbourhood	Number of studied buildings
1st district: Ciutat vella	Raval Sud	671
	Gòtic Sud	328
3rd district: Sants Montjuic	La Marina de Port	114
	La Marina del Prat Vermell	22
7th district: Horta Guinardó	Sant Genís dels Agudells	14
	La Teixonera	102

8th district: Nou Barris	Ciutat Meridiana	54
	Torre Baró	345
	Vallbona	94
	Trinitat Nova	109
	Roquetes	573
9th district: Sant Andreu	Bon Pastor	252
	Baró de Viver	22
	Trinitat Vella	345
10th district: Sant Martí	Besòs-Maresme	188
	La Verneda-La Pau	20

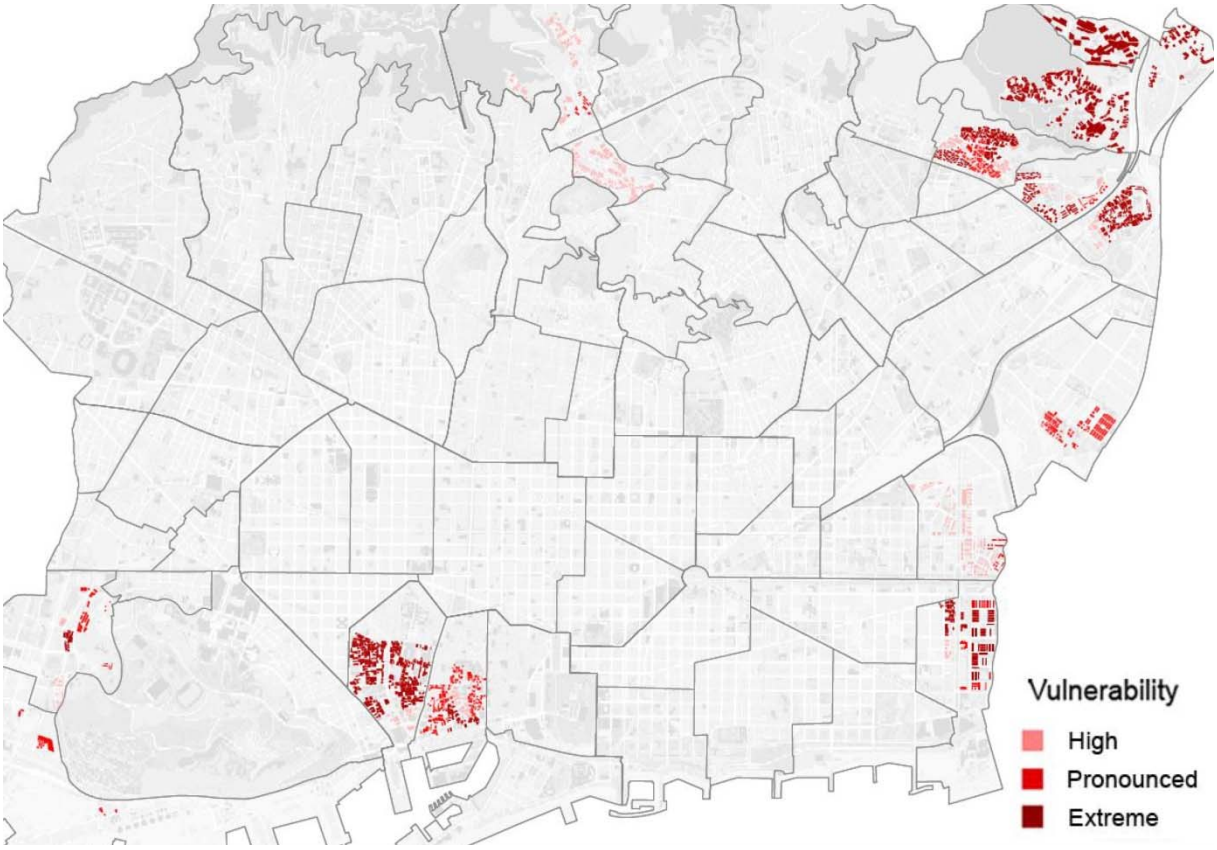


Figure 1: Location and vulnerability of the study areas

Next, a preliminary inspection of all buildings included in the study was carried out. This inspection was made from the outside of the buildings and focused on those points of the façades that could accumulate damage [10] and that could denote a poor state of the building. The indicators that are considered are the following: unstable façade elements, presence of security nets, windows without carpentry and/or glass or mortared windows, rusty metal elements, cracks in facade walls, facade buckling, dampness, cracks in the facing, degraded woodwork and lack of maintenance, stains and dirt. From here, a first pre-diagnosis of the totality of the buildings of the sample was elaborated. Five indexes according to the need of rehabilitation of the buildings were given to each. This first phase also included the collection of data on the context of the neighbourhood, its uses and activities [11].

After this first phase of pre-diagnosis, a validation phase was carried out with the technicians and neighbourhood entities to complete the social information collected and to contrast the prioritization of buildings previously carried out. The result of this phase is a consensual list of the buildings that have the greatest need for rehabilitation in the vulnerable areas that are part of the study.

The last phase of the study included a deeper diagnosis of 200 of the buildings that had obtained a worse score in the pre-diagnosis phase. These buildings underwent an inspection similar to the Technical Building Inspections (ITE) that are mandatory in Spain and which focus on the main aspects of safety, accessibility and energy performance of buildings [12] [13] [14]. Such data had to pave the way for further rehabilitations in those buildings.

4. Results

The results presented below mainly include the data obtained during the pre-diagnosis phase of the totality of the residential buildings studied.

As mentioned above, the rehabilitation need index responds exclusively to the state of conservation of the buildings based on their observation from the outside and distinguishes 5 levels: 1 urgent, 1,5 high, 2 necessary, 2,5 low, 3 very low. Buildings with urgent or high need for rehabilitation show structural damage and/or risk of detachment of parts of the facades while buildings with necessary need for rehabilitation present other non-risk evident damage. Buildings with low and very low need for rehabilitation should only be regularly maintained. Figure 2 shows different examples of buildings with their need for rehabilitation index as an example.

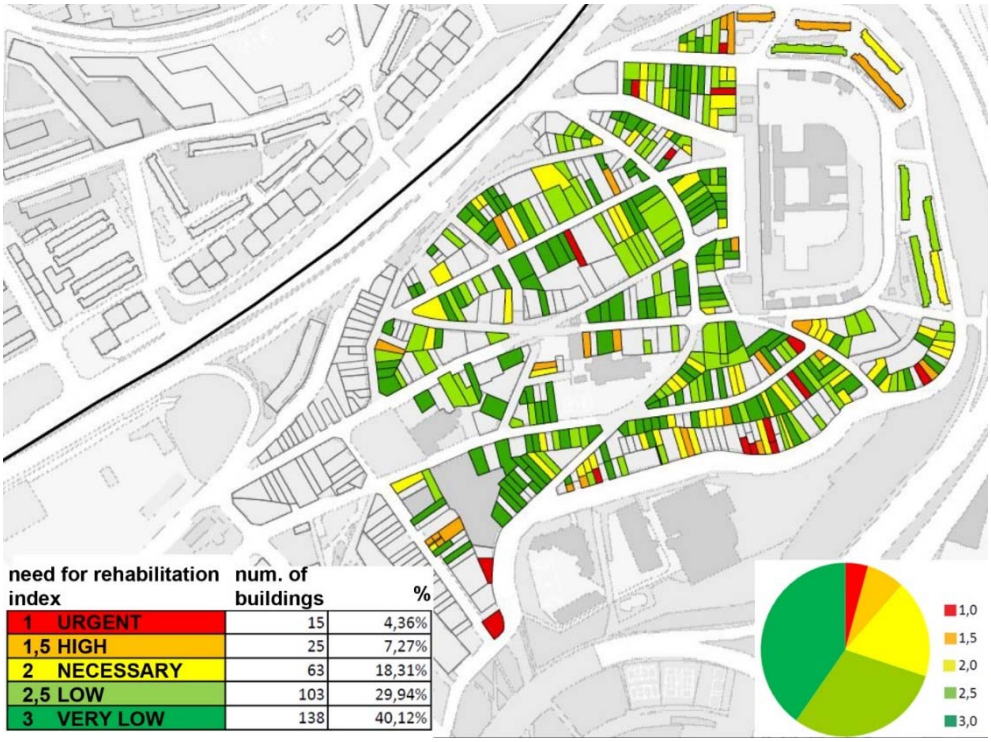
Figure 2: Examples of buildings with their need for rehabilitation index

All the results have been georeferenced in a GIS database in order to ease further analysis and dissemination. Maps of all the studied neighbourhoods have been made such as the one that is presented in figure 3 that contains the results of Trinitat Vella neighbourhood. Figure 3 also shows the percentages of each index, so it is possible to see that in that area buildings that present an actual risk and need for rehabilitation are around 12%.

This exterior inspection of the buildings also allows gathering information about the uses of the ground floors and the main uses of the public space (Figure 4). The streets with public uses on the ground floor tend to be perceived as more secure, as urban morphology clearly influences this perception.

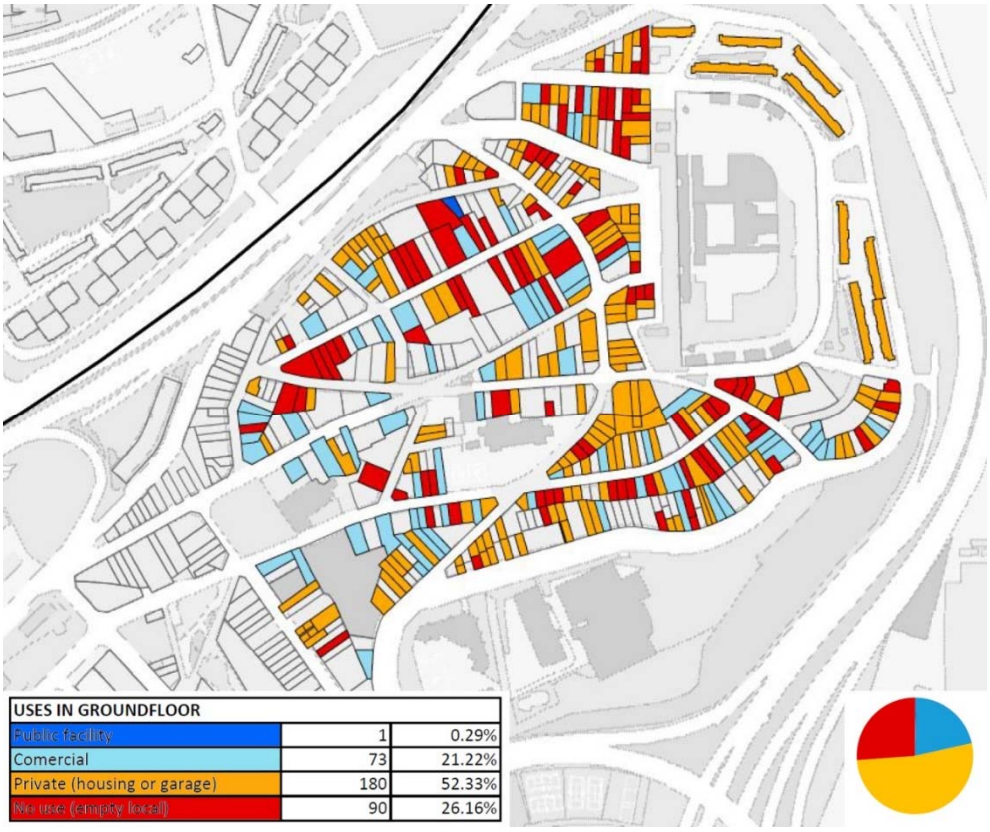
When comparing the results of pre-diagnosis of buildings in all neighbourhoods, it can be observed that in most cases the percentage of buildings that need to be rehabilitated is below 20% (dark and light red), except for two exceptions (see Figure 5). However, and in a generalized manner, there is a large number of buildings that need some type of rehabilitation (yellow).

The most frequently observed pathologies are the result of a prolonged lack of maintenance; there are many unstable elements on the façade with a risk of detachment, regardless of the building's typology. It can also be said that the neighborhoods closest to the coast have damage due to humidity. In the historic center, there are common damages in old buildings with load-bearing walls such as façade buckling and general damage in the façade elements.



need for rehabilitation index	num. of buildings	%
1 URGENT	15	4,36%
1,5 HIGH	25	7,27%
2 NECESSARY	63	18,31%
2,5 LOW	103	29,94%
3 VERY LOW	138	40,12%

Figure 3: Results in Trinitat Vella neighbourhood



USES IN GROUNDFLOOR		
Public facility	1	0.29%
Comercial	73	21.22%
Private (housing or garage)	180	52.33%
No use (empty local)	90	26.16%

Figure 4: Uses in ground floors in Trinitat Vella neighbourhood

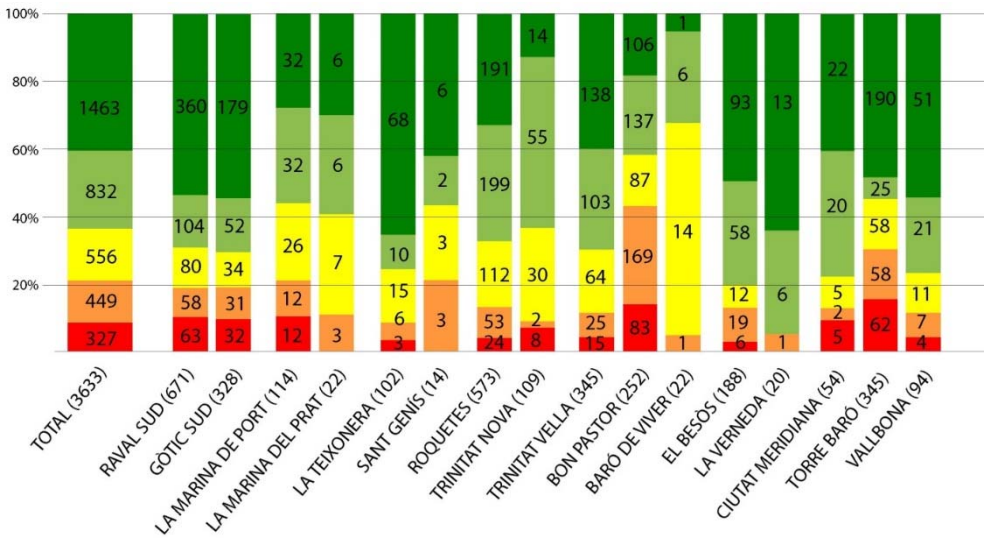


Figure 5: Comparison of the need for rehabilitation index between the different neighbourhoods studied which has a colour code: 1 urgent, 1,5 high, 2 necessary, 2,5 low, 3 very low The number of buildings is indicated in parentheses and inside the bars of the graph.

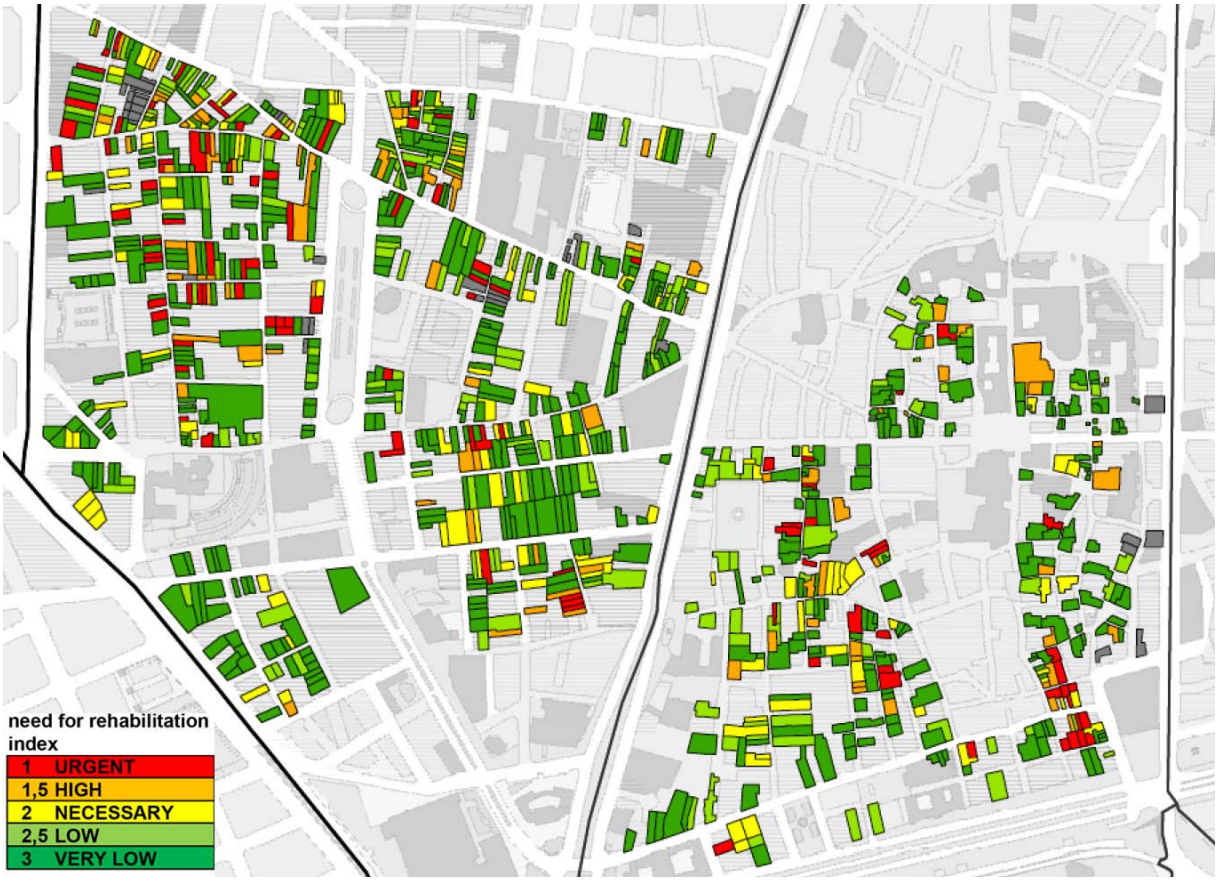


Figure 6: Raval Sud and Gotic Sud pre-diagnosis

When geo-referencing the pre-diagnosis and studying the generated maps, other factors can be observed that will influence the viability of future rehabilitations. Figure 6 shows the case of the two

districts studied in the historic centre of Barcelona, Raval Sud and Gòtic Sud. It is important to know if there are areas where buildings in need of rehabilitation are concentrated or, on the contrary, they present a scattered pattern. The aggregation not only has a clear influence on the perception of the area but can facilitate joint rehabilitation actions in several buildings that can contribute to lower costs (figure 7).

Figure 7: Different aggregation patterns, disaggregated on top, aggregated below.

5. Conclusions

Regarding the general need of rehabilitation of the studied residential buildings in the vulnerable areas about 20% of the cases fall within the two lower levels, therefore, it is very necessary or urgent to carry out rehabilitation interventions. About 20% of cases correspond to the intermediate range, where interventions are necessary but in a lesser extent and urgency. Little more than 60% of cases are considered in good condition, although of these a 25% show signs of deterioration, mainly due to lack of maintenance.

Regarding the physical pre-diagnosis of buildings, the neighbourhoods that have a greater need for rehabilitation in absolute numbers, and in order from major to minor, are El Bon Pastor, Raval Sud, Torre Baró, Roquetes, Trinitat Vella, the Gothic. Reaching the 252 buildings with a current need for rehabilitation in the case of Bon Pastor and 127 buildings in the Raval. Regarding the proportion of cases in very good condition according to an external inspection, the neighbourhoods with a higher proportion, higher than the average, are Raval Sud, Gòtic Sud, Besòs, Torre Baró and Vallbona. While Trinitat Nova, Bon Pastor, Roquetes and Marina de Port are well below.

According to the cartography of the physical evaluation, it is observed how there are some patterns of aggregation and location of the different levels of need for rehabilitation. It can be said that the lowest levels and therefore the most degraded buildings are usually located with a higher concentration by zones. In most cases, buildings in the worst condition are at least in aggregations of 2 or 3 buildings and are rarely isolated in a zone in good condition. This fact can facilitate the economic viability of rehabilitation if global actions are considered.

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References

[1] R. Castel. "Disaffiliation: Work and relational vulnerability" Esprit. París: Hébergeur.C. 1990.
[2] U. Beck. The society of risk. On the road to another modernity. París: Aubier París. 2001.
[3] A.K. Sen. Poverty and famines: An essay on entitlement and deprivation. Clarendon: Oxford. 1981.
[4] UN. "Report on the social situation of the world 2003. Social vulnerability: Sources and challenges." New York: United Nations Publications. 2003.
[5] P. Garcia-Almirall, B. Gutierrez-Valdivia. Políticas urbanas y de vivienda y desigualdad social. *ACE Architecture, City and Environment*, 9 (26), 2014. DOI: 10.5821/ace.9.26.3689
[6] C. Cornadó, P. García-Almirall, S. Vima, G. Vila Busqued, A. Uzqueda. "Methodology for the Detection of Residential Vulnerable Areas – the Case of Barcelona". *IOP Conf. Series: Materials Science and Engineering 245*. doi:10.1088/1757-899X/245/4/042062. 2017
[7] P. Garcia-Almirall, G. Vila, S. Vima, A. Uzqueda. "Estudi i detecció a la ciutat de Barcelona d'àmbits de vulnerabilitat residencial". Ajuntament de Barcelona, 2017.
[8] E. Ruiz, R. Aparicio, M.Serrano. Indicators for the determination of urban areas of special attention. Barcelona: Àrea Metropolitana de Barcelona. 2015.
[9] C. Cornadó, P. Garcia-Almirall. "Prediagnosi de l'edificació residencial en els àmbits de vulnerabilitat de la ciutat de Barcelona". Ajuntament de Barcelona, 2017.
[10] C. Díaz, C. Cornadó, L. Simancas. "A contribution to technical inspection processes in residential building diagnosis". 37th IAHS World Congress on Housing: design, technology, refurbishment and management of buildings. *Proceedings of the 37th IAHS World Congress on Housing: design, technology, refurbishment and management of buildings*. 2010
[11] B. Gutiérrez-Valdivia, A. Ciocoletto, P. Garcia-Almirall. "Migración, espacio público y convivencia en la región metropolitana de Barcelona". *ACE: Architecture, City and Environment*, 6 (17). 2011. DOI: 10.5821/ace.v6i17.2542.
[12] UNE 41805:2009-IN, Parts 1 to 14. *Diagnóstico de edificios*, 2009
[13] J. Monjo. Manual para la inspección técnica de edificios. Ed. Munilla-Leria, 2002.
[14] *ITE. Protocolo de Inspección Técnica de Edificios.* Colegio Oficial de Arquitectos de Sevilla, Fundación FIDAS, 2005.