UR-Hesp: A Methodological Approach for a Diagnosis on the Quality of Open Spaces in Mass Housing Estates

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Abstract:

In light of the symptoms of obsolescence shown by housing estates built in the 1960-70s, numerous approaches have contributed to the debate on this urban form characteristic of functionalist urbanism. The study of open spaces—an aspect that, to a large extent, is responsible for the quality of housing estates—is still an ongoing research approach. However, fifty years after their construction, it is possible to see how its initial homogeneity has led to very different situations that are difficult to categorise. Only by addressing the specific urban processes that each housing estate has undergone will it be possible to promote conservation and regeneration strategies that are suitable for each case.

This paper aims to develop a methodology that will help to offer a diagnosis of the urban quality of housing estates. The approach is based on urban morphology from a diachronic perspective, since the transformation processes are assessed from the initial situation to the present one. Through the basic elements that define the urban form the proposed methodology works with nine 'physical' variables. The specific analysis provided by the methodology helps in the definition of regeneration strategies for open spaces. The methodology was tested for three case studies in Spanish cities.

Key-words: urban obsolescence, urban regeneration, urban morphology, Madrid, Barcelona, Zaragoza

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Highlights:

- The methodology is useful in refining the diagnosis of quality of open spaces in housing estates.
- Based on urban morphology, the focus is on the physical dimension of open spaces.
- The analysis is multi-scale and diachronic.
- The application to three case studies identifies shared and specific physical processes.
- The specific diagnosis is applicable to several urban regeneration strategies.

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Towards the systematisation of the study of open spaces in housing estates

In response to the systemic problems of physical, social and economic obsolescence that some mass housing estates built during the 1960s and 1970s show (García Vázquez et al. 2016; Monclús et al. 2016), their urban regeneration has recently received institutional support (EU Ministers for Urban Development 2010; United Nations 2015). This fact has stimulated recent international debate in different approaches to these types of mass housing estates——constructed during the urban boom after the Second World War (Wassenberg 2012). Cultural approaches particularly stand out, more specifically, ones that have acknowledged the important historical meaning and heritage of the estates (Pendlebury et al. 2009; Urban 2012). Others, of a socio-economic nature, have covered the problems of security and concentration of vulnerable populations (van Soomeren et al. 2016; Hernández Aja et al. 2018; Hess et al. 2018), as well as residents' satisfaction and their importance in regeneration processes (Turkington et al. 2004; Wassenberg 2013). There is also the building perspective that has focused on the lack of design and construction quality (Monteys Roig et al. 2010; García Vázquez 2015), and lately an environmental approach has been included among the challenges that the estates must address (Ruiz Palomeque et al. 2006; De Luxán et al. 2006; Monzón et al. 2017).

Among all these problems, this paper focuses on the urban dimension and on open spaces, in particular, which is a less common focus of studies thus far. Previous authors have contemplated urban problems in general terms (Moya González 1983; Hall 1997; Turkington et al. 2004; García Vázquez et al. 2016). The most outstanding issues in studies thus far are physical isolation, monofunctional use and ambiguity in urban density/intensity. When considering the layout of open spaces, it is common to find issues relating to, firstly, difficulties in organising semi-public and collective spaces, secondly, to the alienating character of the physical environments and, thirdly, to the absence of a relationship between buildings and streets. And, moreover, with respect to the conservation of open space, the lack of both urbanisation and/or maintenance are recurrent problems studied. However, looking beyond the problems examined in these studies, mass housing actually estates offer major improvement opportunities for two reasons: firstly, because they are planned growth projects and, secondly, because their layout——with a greater proportion of open spaces——facilitates physical transformation, particularly when compared to other types of urban fabrics (Sotoca 2012).

Functionalist urbanism is based on the assumption of the positive role of open green spaces. However, this optimistic approach is questionable. Actually, the open-space layout has considerable responsibility in creating the urban quality of housing estates (Monclús et al. 2017). Despite the elusiveness of the term 'quality', Carmona (2019) found some characteristics that enhance open spaces——evolutionary, diverse, free, delineated, engaging, meaningful, social, balanced, comfortable and robust. These principles are based on the idea urban design plays a key role in order to promote more compact, vital, safe and inclusive cities, as far as the quality of physical design can stimulate these conditions——without being a guarantee for success. The key role of urban design and its positive influence on the promotion of quality public spaces is in line with the international urban agenda (EU Ministers for Urban Development 2007, 4; UN-Habitat 2015a). This idea, discussed by other authors (Urban Task Force 1999, 49; Wassenberg 2013, 134; García-Pérez 2017), is the result of an approach based on the potential users of open spaces (Rapoport 1977; Gehl 2010).

Moreover, after approximately 50 years since the construction of most housing estates, several authors state that not all of them have evolved in the same way (Wassenberg 2013; Hess et al. 2018). Among the many factors——social, economic and geographic——that cause this divergence, it is useful to delve into the physical dimension of urban quality of open spaces of housing estates (Díez Medina 2016). Moving away from such generalist approaches, knowledge based on the specificity of each case could

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help to better diagnose problems, because not all housing estates have the same issues, or experience these at the same time.

The 'specificity systematisation' of housing estates (Rowlands et al. 2009; Díez Medina et al. 2017), considered from the morphological dimension, is a relevant task that takes into account the transformation processes they have undergone since their construction. The objective of including the morphological perspective is to provide the debate on housing estates with more details about the principal elements of urban forms——streets, plots and buildings, necessarily adapted to the particular characteristics of the 'open city' (Oliveira 2016; Kropf 2017)——and about the main processes shaping their transformation over time. The use of a diachronic perspective makes it possible not only to explain their initial homogeneity——a consequence of the general application of the principles of functionalist urbanism and of the dominant development and construction methods of the period——but also to assess their varying evolution. Moreover, this specificity together with a diachronic approach could help to understand these different time trajectories and to determine which transformation might be most successful in a particular case, if changes have not yet been implemented.

In order to meet the challenges presented by open spaces in mass housing estates, current methods of urban analysis are only partly effective. Many such methods focus on partial results (Hillier 2007); they are not adapted to the singular characteristics of mass housing estates (Berghauser Pont et al. 2010), neither do they consider a diachronic perspective (Rueda 2012a). To tackle this issue, this paper proposes a hybrid methodology called UR-Hesp[1]: that of using existing methodologies yet adapting them specifically to mass housing estates. This methodology seeks to diagnose open space in terms of identifying both their weak points, which make them vulnerable, as well as the strengths that make them resilient.

After presenting the methodology, this is then applied to three case studies in Spanish cities. This will make possible, firstly, to discover the resilience and obsolescence characteristics of housing estates; secondly, to facilitate decision making during the process of defining urban regeneration strategies for open spaces, thus contributing to their improvement and adaptation to current needs through an operating diagnosis; and, finally, to provide a comparative view of housing estates by establishing shared and specific urban processes.

The UR-Hesp methodological approach

The objective of UR-Hesp methodology is to work with the smallest set of variables to describe the 'physical' characteristics of open spaces.

Firstly, these variables are organised around the basic morphological elements mentioned above——roads, plots and buildings. Each of the three following subsections will address each of these elements separately. Despite their methodological nature, they include a number of inputs from the international debate.

Secondly, the selected variables describe open spaces from a broad perspective. Quantitative and qualitative approaches are combined, including direct relationship variables (local choice of the road network, functional mix, types of in-between spaces, porosity and scale) and indirect relationship variables (integration, permeability, density and diversity). Quality is also evaluated with the use of maps and diagrams, aiming to understand not only 'how much' quality and 'when', but also 'how' and 'where' (Dovey et al. 2017).

Thirdly, the methodology evaluates the urban transformation processes considering a timeframe that runs from the initial design of the housing estates to their current situation.

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Fourthly, the methodology is adapted to the Spanish context (Cortés Alcalá 2004), in particular, to Spanish datasets.

Finally, the methodology takes on its greatest significance when all physical variables are interpreted as a whole. The simultaneous reading of each of the variables allows generating a global knowledge of the obsolete——understood as a mismatch between supply and demand (Lichfield 1989, 25)——or resilient——when the physical characteristics are adaptable to past, present and future demands——physical characteristics that specifically define the open spaces of the housing estates.

Roads, streets and paths

Integration, permeability and local choice of open spaces in housing estates are the variables studied in relation to roads, streets and paths. These are understood in a broad sense, as spaces for social relationships, recreation and mobility, both vehicular and pedestrian, beyond the orthodox concept of the traditional city.

Integration

The definition of housing estates recognises their peripheral nature and their condition as islands as intrinsic original qualities (Wassenberg 2013). The consequence of this initial situation——caused by both economic (reducing the cost of land by locating projects in vacant areas) and ideological reasons (housing estates were intentionally built with an autonomous character)——was a significant isolation whose effects have been studied from several perspectives. These include approaches based on architectural determinism (Hillier et al. 1984; Hanson 2000; Hillier 2007), social exclusion (Vaughan 2007), or those that consider socio-economic aspects related to the real estate market (van Kempen 1994; Krantz et al. 1999), among others. These studies concluded that the less peripheral a housing estate, the higher its quality. Moreover, the urban processes that they have undergone since their construction have changed the position of several housing estates, which, in many cases, now occupy better relative metropolitan areas (Sotoca 2012; Wassenberg 2013; Guerra Mirón 2015).

This situation justifies the relevance of studying the evolution of the integration of housing estates at a metropolitan scale, using the physical approach to the concept that the Space Syntax theory and methodology offers (Hillier 2007). This theory evaluates the degree of spatial integration of an urban fabric through the study of the configuration of its roads and streets. The research is based on the development of a model for each city analysed[2] at two different points in time: the construction period and the present. The technique used to obtain the model is 'cartographic redrawing' (Pinho et al. 2009) applied to road-centre line maps (RCL). Data are obtained from the open database of *OpenStreetMap* (Geofabrik GmbH et al. 2016) by applying the techniques described by Kolovou et al. (2017).

The scores of mass housing estates at metropolitan scale are calculated first, considering the global spatial integration level of the roads and streets of each housing estate, according to a scale of five categories, one for each quintile distribution from 'very high' to 'very low', defined differently for each time and context. Then, the quality of integration is classified as 'good' (very high and high), 'standard' (average) or 'poor' (low and very low values).

Permeability

The weak relationship between housing estates and nearby urban fabrics led to problems of physical isolation in many of them. Several authors identify this situation as one of the causes of their rapid obsolescence (Sotoca 2012; Wassenberg 2013). However, the lack of permeability has been reduced in many cases due both to urban processes outside the housing estates themselves——the growth of nearby urban fabrics——and to internal processes——transformation and improvement actions around the edges of housing estates. Permeable housing estates show a lower number of urban barriers,

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thus generating a spatial format that, from the physical dimension, improves accessibility for resources and people (Lynch 1985; Rueda 2012a; García Vázquez et al. 2016), social inclusion (Hillier 2007; Vaughan 2007) and resilience (Ferrer i Aixalá 1996). From this perspective, the fewer urban barriers, the greater the quality score of a housing estate. Therefore, it is necessary to discover the variations produced in the degree of permeability——defined as the capacity for interaction and connectivity between a housing estate and its nearest urban fabric.

In this study, the variation in permeability is obtained by analysing the evolution of the urban fabric through the configuration of the edges of roads and streets on the perimeter of the housing estates following the *Space Syntax* theory and methodology. Therefore, two-time points are considered——the initial and the current one——regarding the spatial structure model defined in the previous section. In this case, permeability is the result of combining a quantitative approach (by obtaining the number of connections between the housing estate and the rest of the urban fabric on the perimeter (Rueda 2012a)) and a qualitative approach (by weighting the result by its global average integration (Hillier 2007)).

The result is presented on a scale of five categories, from 'very high' to 'very low', as in the case of integration. The analysis is conducted in a contextual and dynamic manner, that is, by considering the aforementioned relative values for each city and situation (initial and current). In this specific case, the values are organised from those with a connection every 100 metres, with a 'very high' integration value, to those that have a 'very low' value (according to the previous sub-section). Then quality is classified as 'good' (very high and high), 'standard' (average) or 'poor' (low and very low permeability).

Local choice

By declaring 'the death of the street', functionalist urbanism radically changed creation and transformation processes of urban spaces. The new configuration backed a strong road hierarchy that separated the traditional functions associated with streets——transport, parking, commercial activity, recreation and access (Rodríguez-Tarduchy et al. 2011, 135). This model of a differentiated hierarchical structure has been widely debated due to its influence on urban complexity (Alexander 1968), or on the social structures of housing estates (Hanson 2000). The theories and strategies based on the differentiation between vehicular and pedestrian traffic have also had a great impact (Buchanan 1963). However, although on many housing estates there is a clear hierarchy in their road networks for vehicles, their internal spatial structures are not so hierarchically organised, since they have created spatial grids——not very distant from the logic of the traditional city. In any case, the processes they have undergone with regard to this variable are a response, firstly, to the change in the relationship between pedestrian and vehicular spaces, which consequently has brought the transformation of the original superblocks (Pérez-Igualada 2017); secondly, to the establishment and urbanisation of large urban voids, which permitted greater connectivity; and, finally, to transformation actions of the inner structure of the housing estates themselves carried out during urban regeneration and/or renewal initiatives. Therefore, the study of the internal road network is based on recent research projects that do not consider hierarchy as a problem *per se*, but how it fits into the final resulting configuration (Marshall 2005, 186). This configuration can influence the co-presence of agents in the open space (Marcus 2010, 33), and can stimulate more social encounters between users (Carmona 2019, 56).

The quality of the local road network can be assessed thanks to the development of spatial models of roads and streets at two different time points, as in the above cases. On this occasion, using the Space Syntax[3] methodology, the study focuses on their capacity to generate local betweenness centralities——that is, the capacity of the road network to be chosen as the origin and destination in local pedestrian movements. The result is presented on a time, context and dynamic scale. Again, five categories for each time and context situation, from 'very high' to 'very low', are assessed following the

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criterion of quintiles distribution. Then quality is classified as 'good' (very high and high), 'standard' (average) or 'poor' (low and very low local choice).

Plots

This section studies open spaces through the configuration, location, use and ownership of plots. Delving into these issues makes it possible to define the general planning of housing estates through a study of their uses, the typology of their open spaces and their plot structure.

Functional mix

The separation of functions supported by the Athens Charter promoted the appearance of what some authors called dormitory towns, where the first symptoms of urban obsolescence were detected (Blos 2000; Dekker et al. 2004; López de Lucio 2013; Lepratto 2015). Despite the initial situation, both the 1956 Land Act, by introducing the idea of standards for facilities and services (Linares 1991)——which in many cases ended up being built years later——and the interventions related to facilities and services carried out from the 1980s onwards (Sotoca 2012; Martínez Gutiérrez 2017) caused what is now a heterogeneous result. In this respect, the advantages of a functional mix for public spaces have been amply studied (Lynch 1985; Montgomery 1998; Jacobs 2011; Mashhoodi et al. 2011). For these authors, the higher functional mix is a driver of agents and activities that help to promote the vitality of an open space.

The importance of this criterion lies in knowing land uses both quantitatively and qualitatively. The process consists of assessing land use diversity——by applying the Simpson index to areas built for residential, public and tertiary use——and the location of the non-residential uses——through the definition of mutually exclusive categories. Type and location provide complementary information about 'where' and 'what' is this functional mix (Dovey et al. 2017).

The results show the evolution between the initial and the current situation of both the functional mix (the degree of variation runs from 'very high'——less than 0,6——to 'very low'——more than 0,9 (Rueda 2012a, 521)) and of their type and locations (facilities and services inside or outside the housing estate and tertiary activities in specific areas or ground-floor commercial premises). Then, quality is assessed as 'good' (very high and high) 'standard' (average) and 'poor' (low and very low functional mix), considering as type and location as supplementary information.

Typology of in-between spaces

In-between spaces, understood as the open spaces between towers and slabs resulting from the disappearance of the traditional concept of streets and squares, is a characteristic feature of functionalist urbanism (Rodríguez-Tarduchy et al. 2011). These new ideas introduced changes not only in the amount of open spaces but also in their structure. This new configuration has been debated by several authors because it generates 'empty spaces' (Krantz et al. 1999; López de Lucio 2013; Sendra 2013; Wassenberg 2013; Lepratto 2015) or hinders their management and maintenance (Moya González 1983; Rubio del Val et al. 2010). However, the urban processes of housing estates have produced a variety of results. In contrast to some spaces that have consolidated their public nature, a second group has undergone privatisation processes (Castrillo Romón et al. 2016). Other less fortunate spaces have been abandoned——known as 'brown spaces' (waste ground)——and a fourth group includes spaces that, due to the parking deficit, have ended up becoming residual spaces——also known as 'grey spaces'——(Ezquiaga en Monclús et al. 2015).

The classification of open spaces is carried out, firstly, quantitatively, by using the 'corrected spaciousness' variable, which compares the open space area for public use with the floor area ratio. This offers a view of not only the amount of space but also of its adequacy to the total built area (Berghauser

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Pont et al. 2010). The empirical studies about urban fabrics carried out by Rueda (2012a) propose correct adequacy in the values included between 0.06 and 0.3 spaciousness[4]. The results are presented in five categories that range from 'very high' (under 0.3) to 'very low' adequacy (over 0,9). Secondly, the enclosure of open spaces can influence their use, sense of ownership and management as Alexander (1980, 470), argues and as Minoura (2016, chap. 3) demonstrates empirically. To determine this, the structure of in-between spaces is analysed through the exclusive definition of three archetypes of residential open spaces ('closed or semi-closed', 'inter-block', and 'indeterminate' spaces, from the highest to the lowest levels of enclosure). 'Good' quality levels are achieved if both, very high or high levels of corrected spaciousness and enclosure open spaces take place simultaneously. Housing estates reach 'standard' quality if at least their corrected spaciousness and archetype score average levels. All other possibilities achieve 'poor' quality values.

Plot structures

The growth model of functionalist urbanism did not consider plots as the main elements for the composition, formation and transformation of cities; this produced a simplification of the urban fabric (Rodríguez-Tarduchy et al. 2011, 134). However, plot structures still exist in housing estates, at least in the Spanish context, for administrative purposes, as testimony to the structure of land ownership. As Kropf (2018) argues, this structure is, sometimes, intangible, which causes, in most cases, great spatial ambiguity between use and ownership. This lack of legibility is precisely one of the weak points that can have an influence on the obsolescence of in-between spaces, especially when considering their management and maintenance (Panerai et al. 2002). In this sense, in contrast to some consolidated in-between spaces for public use, others have undergone a process of privatisation (Castrillo Romón et al. 2016), and a third group is composed of those that have been abandoned. Therefore, recognising the plot structure implies accepting the processes——past and future——that are generated when exploring the ownership of in-between spaces.

Plot studies are conducted using land registry records (Dirección General del Catastro 2016). This allows for a classification of both the various possible owners and the various existing plot situations by using four exclusive definitions. The owner is classified as follows: public, private or unknown. The plot situations are: the in-between space as the non-existence of a plot, the in-between space as a unique jointly owned plot, the in-between space as a multiple jointly owned plot with a clear structure and the in-between space as multiple jointly owned plot without a clear structure. If both clear physical structure and clear ownership concur, 'good' quality is achieved. The quality is 'standard' if only clear structure takes place; all other possibilities are rated as 'poor' quality.

Buildings

Finally, in-between spaces can be described through their relationships with buildings, which are responsible for configuring and defining their form. This section covers the study of building variables, both direct——scale, proportion and physical design of the urban edge——and indirect——building density and diversity.

Density

For some authors, housing estates are low-density developments (Berghauser Pont et al. 2010; Rueda 2012a; Sotoca 2012), while others consider that their high densities distinguish them (Turkington et al. 2004; García Vázquez et al. 2016). In this regard, it is important to refine the calculation of actual densities, taking into account certain degree of diversity in the studied housing estates. In any case, all authors agree that housing estates represent a more open and fragmented form compared to traditional cities, and this is precisely one of the factors that cause obsolescence.

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Regarding open spaces, the advantages that compact urban forms provide have been the subject of intense debate (Whyte 1980; Gehl et al. 2006; Jacobs 2011). Nowadays, the development of dense and compact cities is unavoidable to promote more intense and vibrant urban fabrics (Rueda 2012b; UN-Habitat 2015b). However, the problems that may arise in these settings must be taken into account——risk of overcrowding and overloading the urban environment ——(Leal et al. 2012). In this regard, initiatives on housing estates offer a significant opportunity to promote greater urban concentration and compactness. The first step means overcoming the ambiguous view regarding building density of housing estates, which is the result of a concept that is limited to the canonical ratio of building structures to an area unit (Ezquiaga 2015). In response to this situation, several research studies have proposed a re-definition of the term density that will lead towards more qualitative dimensions (Berghauser Pont et al. 2010; MIT 2011; Fernández Per et al. 2015).

In this study, the starting point for the classification of density is the research of Berghauser Pont, which defines four physical study variables (floor area ratio, coverage, medium height and spaciousness[5]) represented as a whole in a graph named '*spacemate*'. The results, which record the transformation process, classify housing estates by types of physical density depending on the relative position they occupy on the graph. Housing estates with similar spatial characteristics are grouped together based on: coverage (from 'very low', under 15%, to 'very high', over 50%, according to Ferrer (1996)); floor area ratio (from 'low', under 1, to 'high', over 2, considering Lozano (2013)); and, finally, medium height (from 'low', under 3, to 'extreme', over 7, according to García Martín (2017)). Considering the user intensity approach (Berghauser Pont et al. 2010, 167), a 'good' quality is achieved when physical density is intense (high FAR), and compact (high coverage), without reaching extreme values (Fernández Per et al. 2015). 'Standard' scores are given if at least FAR or coverage does not get rated with low values. 'Poor' is given to all remaining cases.

Building diversity

The construction of housing estates was generally characterised by the creation of a homogeneous physical format with low diversity, both in the building types and in their implemented urban solutions. This situation, due not only to the prevalence of economic criteria but also to the application of ideological principles, in many cases generated spatial structures that were described as monolithic (Ferrer i Aixalá 1996). However, specific attention to each housing estate reveals, on one hand, that not all designs were so homogeneous and, on the other, that 50 years after their construction, their initial situation has varied, which has diversified the results even more.

In contrast to the homogeneity of the initial ideal, diversity is currently considered to be a positive characteristic, capable of generating more inclusive spaces by giving users a chance to choose that did not exist before (Carmona 2019, 51). Although diversity can be understood from numerous approaches——social, economic, etc.——the starting point for this research is the physical dimension (Talen 2008, 115; Marcus 2010; Lees 2010; Jacobs 2011; Oliveira 2016). As a complement to other research focused on the type of obsolescence of housing designs (Monteys et al. 2001; Montaner et al. 2010; García Vázquez 2015), this research is based on their urban dimension. Urban diversity studies the richness and the abundance of building types in housing estates due to their ability to generate physical formats that facilitate both greater spatial diversity in the configuration of types of in-between spaces——by having more mechanisms to avoid repetition and monolithism——and greater socio-economic diversity.

Diversity is classified here according to the Simpson index, which is widely used in the analysis of biodiversity[6]. This index can encapsulate, in just one variable, the richness and abundance of building types. The characterisation is again carried out at two-time points——initial and current——defining, for each case, both the characteristic building types and their abundance on the housing estate. First, the values are presented, for each time point, on a scale of five categories, from 0 to 1, from the most

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'diverse' (values between 0 and 0.2) to the most 'homogeneous' (values between 0.8 and 1). Then quality is assessed as 'good' (very high and high) 'standard' (average) and 'poor' (low and very low building diversity).

Eye-level design

The final variable in this methodological proposal considers the physical configuration of the urban space at 'eye-level'; that is, it is the study of the physical configuration of the meeting between the ground level and the building, which, to a large extent, is responsible for the quality of the in-between space (Gehl et al. 2006). The new configuration proposed by functionalist urbanism was very often designed based on the urban scale and on the project 'from above' (aerial views or using models), forgetting the importance of the lower scale. However, in the 1980s, there was a review of modernity in favour of the humanisation of public spaces (Whyte 1980; Gehl 2006). Following these theories, recent research stresses the importance of the detailed systematisation of the configuration of the floor plan as a mechanism to improve in-between spaces (Castrillo Romón et al. 2016).

In this regard, there are two questions worth analysing: adequacy to the human scale and the porosity of the built edge. Firstly, adequacy to the human scale makes it possible to discover the extent of the relationship between the design of in-between spaces and size, the senses and human mobility, which guarantee the generation of more vibrant, high-quality and exciting cities (Gehl 2014). Secondly, the configuration of the edge is decisive in the vitality of the city due to its ability to stimulate people who go through and remain in the in-between spaces, boosting interchanges between them (Gehl et al. 2006).

The characterisation of 'eye-level' design is based on the detailed study of typical spaces inside housing estates. This study focuses, firstly, on the human dimension of each space, considering, on one hand, the height/width ratio ('horizontal'——if they have a substantially wide proportion——; 'balanced'——based on a 1:1 ratio——; and 'vertical'——if they have a substantially narrow proportion) (Oliveira 2013) and, on the other, the distance, defined by J. Gehl (2014) as 'close' (if it does not exceed 25 metros), 'medium' (up to 100 metres) and 'distant' (over 100 metres). Secondly, it focuses on the porosity of the built edge; the results are classified depending on the size of the edge per area unit and on the quality of the edge itself, from 'active' (over 15 doors every 100 metros) to 'inactive' (from 0 to 2 doors every 100 metres) (Gehl et al. 2006). 'Good' quality of 'eye-level' design is achieved when balanced height/width ratio, close distance and more than 20% of active façades concur. 'Standard' quality is achieved if at least one partial variable is 'good' (scale and distance or porosity of the built edge), whereas the other possibilities are rated as 'poor' quality.

Interpretation

Table 1 summarises the quality approach for each variable, its description, the theoretical and methodological references, as well as the evaluation method. Once the analysis has been carried out on an individual basis, the interpretation phase begins in which the physical variables described are comprehensively studied. It is precisely the accumulation of individualised knowledge for each variable that makes it possible to establish an integrated physical diagnosis of open spaces. Thus, it is possible to recognise the obsolete or resilient physical characteristics of each case study and also to obtain some ideas that would allow future improvement in urban regeneration strategies.

Methodological application to three Spanish housing estates

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This section presents the application of UR-Hesp methodology to three housing estates in three Spanish cities, allowing an evaluation of both the scope and the limitations of the methodology and also addressing the debate on urban quality. It is structured as follows: i) a justification of the case studies chosen; ii) a critical view of each housing estate; and finally, iii) a comparison among different housing estates.

Selection of case studies

The selection of the case studies was based on the following considerations:

- Time criteria: the selected housing estates were built in the post-war period, between 1960 and 1975——the boom years for European cities, where housing estates fulfilled the ideas of seriation and standardisation (Monclús et al. 2018).
- Geographical criteria: the study includes Madrid, Barcelona and Zaragoza because they have populations of over 500,000 inhabitants and are representative examples of the period of the emergence of housing estates.
- Size criteria: the chosen cases are developments of over 1,000 dwellings, which are representative of the mass construction of housing.
- Representativeness factor: as the specialised literature shows, the chosen examples, although not included in catalogues of modern heritage (AA.VV. 2009), are paradigmatic of the housing estate construction episode (Ferrer i Aixalá 1996; Monclús et al. 2012; López de Lucio et al. 2016).
- Diversity factor: the examples, despite their similarities, have varying both starting points and trajectories, which help in verifying the need for specific approaches.

The case studies chosen were Saconia in Madrid, Ciutat Meridiana in Barcelona and Balsas de Ebro Viejo in Zaragoza (Fig. 1 and Table 2). This sample encompasses both private (Saconia and Ciutat Meridiana) and public estates (Balsas de Ebro Viejo). Moreover, the socioeconomic profile of each of these estates is different. Saconia and Balsas have a more affluent socioeconomic profile, with middle-income residents, whereas Ciutat Meridiana has a concentration of lower-income residents. Moreover, the latter has intermediate levels of vulnerability owing to a concentration of population with below average education levels (Hernández Aja et al. 2018). Considering the representativeness factor, Saconia is an example of organic rationalism, highly regarded at the time of its construction (Fullaondo 1969; Hernández Aja 2003). Ciutat Meridiana is an example of private speculation in the development of housing estates (Castro 2017). Finally, Balsas is an example of a public development for workers from a closed industrial area (Marco Fraile et al. 2009).

Saconia. Madrid

Saconia is a private development designed in 1964 and built between 1967 and 1985. The architects evaded the rigidity of the most orthodox design of housing estates, without renouncing the necessary economy of means (Perpiñá et al. 1969). As such, the solutions used were based on a flexible typology, carefully modulated and adaptable to the topography. The typologies were organised around neighbourhood units, leaving a central open space to place facilities with the aim of building recognisable communities (Díez Medina et al. 2018). Since its construction, far from showing urban vulnerability signals (Hernández Aja et al. 2018), Saconia has undergone a positive socioeconomic trajectory (Table 2). From a physical perspective, however, Saconia presents some problems and threats——also detected after applying this methodology——which the City Council has recently decided to deal with (Ayuntamiento de Madrid 2016).

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Considering the analysis carried out, the level of integration has increased slightly, although it has always taken place at a steady rate at 'standard' levels of quality. The enormous growth of the North of Madrid explains the increase in integration, although its position——near the city centre but isolated to the West——polarises the extent of this process (Fig. 2). Regarding permeability analysis, whereas initially at very low levels ('poor' quality), Saconia now reaches high levels. This increase in quality towards 'good' values is due to the modification of the autonomous character with the creation of new inter-district connections, allowing better accesses with the surrounding urban fabric (Fig. 3). Considering local choice, the road network has offered low values since its origin. Although the design solution is a clear model of hexagonal superblocks adapted to the topography around a structuring axis, similar to a grid model; internal pedestrian routes lack a clear design, creating a confusing system that lowers its score to 'poor' quality (Fig. 3).

Saconia had very low levels of functional mix, essentially comprising educational facilities within superblocks in alignment with the neighbourhood unit idea. 20 years later a community centre was constructed, providing facilities and tertiary activities at the back of the housing estate. Although new non-residential buildings have tended to improve this situation, levels of functional mix remain low and therefore their quality in this field is 'poor' (Fig. 4). Considering the in-between spaces, a quantitative approach shows a high adequacy between open areas and built-up areas, whereas the configuration seeks to establish semi-closed spaces. Both factors allow Saconia to achieve 'good' quality values, without changes since it was built. Criticism of the most canonical construction of housing estates implemented by the architects allows a clearer articulation of public and semi-public spaces (Fig. 4). Moreover, the plot solution adopted since Saconia was built——an open space as a unique plot with an unknown owner——has generated conflict between residents and the City Council regarding its management. Although the open space is designed as a single plot, the lack of definition of the property produces 'standard' quality levels (Fig. 4,6).

Density quality is also 'standard', without significant changes during the period under consideration. Moreover, the average level of coverage and floor area ratio reveals options for compaction and intensification, while taking into account that the height index is high. Considering the building diversity, the special emphasis placed by the architects on developing flexible buildings has allowed high diversity values since its construction to be achieved, without noteworthy transformations to date. Their solutions, based on the application of a modular criterion to both construction and urbanisation using flexible building solutions adapted to the spatial needs, explain the 'good' quality of the results (Fig. 4). The last variable, 'eye-level' design, reports more heterogeneous results. Whereas close distances show care was taken on the human mobility factor, the height/width ratio shows high vertical proportions and a narrow space sensation. The urban boundary analysis reflects only 11% of active façades, located mainly inside the semi-closed space. The topographical adaptation of buildings to the ground does not often favour a close encounter between buildings and open space. For all these reasons, the 'eye-level' design quality is 'poor' (Fig. 5).

As a result, Saconia offers greater resilience since its construction in factors such as the configuration of the in-between space and building diversity. The urban processes experienced in the housing estate have promoted an increase in spatial permeability. However, some other factors have shown signs of obsolescence right from the beginning (local choice, plot structure or 'eye-level' design), or the improvements produced have been insufficient (functional mix). Also, some other factors can still be improved (integration, density). Consequently, urban regeneration strategies could focus on improving its levels of functional mix, as well as enhancing building edges. It is not easy to modify internal spatial structure. In fact, while also addressing 'eye-level' design issues, in addition, it would be possible to promote a series of micro-strategies to create a clearer and connected pedestrian route system. Meanwhile, changes in the plot structure would benefit from clearer management.

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Ciutat Meridiana. Barcelona

Ciutat Meridiana was designed in 1963 and built between 1964-1967 on uneven land, initially allocated to be used for a cemetery. However, the land was rezoned as residential owing to emergency housing requirements (Ferrer i Aixalá 1996). After several planning proposals, the architects chose a high-rise solution that allowed the private developer to achieve a specific floor area ratio for profitability reasons, while facilitating building on uneven land. Since its origins, Ciutat Meridiana has undergone several socioeconomic problems (Table 2), and today it is one of the most vulnerable areas of Barcelona (Hernández Aja et al. 2018). In fact, it is experiencing an intense process of population renewal, in which new immigrant population are occupying the vacant housing. These difficulties have led to the development of numerous plans and programmes for urban regeneration.

A high level of integration of Ciutat Meridiana has been reported since its construction, by occupying a key metropolitan position over several large infrastructures working as a gateway to and from the city ('good' quality, Fig. 2). However, spatial permeability has been very low from the beginning, with only one connection to a motorway and only a few other links to other urban areas. The topography, with a steep incline, has made it difficult to correct this 'poor' quality. Despite occasional improvements, the effects of the same on the whole has been limited (Fig. 3). Considering road networks, local choice levels are low in both time scenarios considered. This network, without clear axes and with a high number of 'cul-de-sac' streets, shows a lack of clarity and leads to 'poor' quality results (Fig. 4). Despite the improvements in terms of universal accessibility that have been implemented——the quantitative analysis shows a slight quantitative increase (4%)——the levels are still low today.

Bearing in mind the functional mix, the original design comprises both ground floor for tertiary purposes and a civic area surrounded by commercial space. However, the initial low level has improved to average through the construction of new facilities and services since the 1970s (Fig. 4). This fact has stimulated an increase in quality from 'poor' to 'standard' values. There are two typologies of in-between spaces: on the one hand, canonical inter-block space of 'slabs' typology, and, on the other, indeterminate space in the case of the tower blocks. Although the inter-block design provides more quality with respect to its capacity to define spaces, the low quality indeterminate space negatively counteracts this. Quantitatively, the corrected open space ratio shows low adequacy, revealing a disproportion between the floor area and the open space. Both factors determine the rating of 'poor' quality to the present day, without significant changes in the lack of strategies to transform the configuration of spaces. (Fig. 6). The plot structure——illegible multiple plots on real estate——does not show a clear relationship between the physical boundaries and the property divisions ('poor' quality). This situation——without change during the period under review——makes it difficult to have a clear idea of who maintains the open space (Fig. 4, 6).

Ciutat Meridiana is an example of low compactness and intensity. The minimum levels of coverage and floor area ratio determine the development of the housing estate in height ('poor' initial quality). The consolidation of vacant plots as open spaces during the development of urban regeneration programmes has reduced the levels of compactness and intensity further still, consolidating the 'poor' quality over time (Fig. 4, 6). The building diversity level is medium, without variations since its construction ('standard' quality). The solution adopted is based on square towers of nine floors with simple slabs of seven floors, in combination with other minority typologies, such as high-rise towers and H-shaped staggered slabs (Fig. 4). The eye-level design shows that great care was taken with the original design for both the human scale and the boundaries between open space and buildings, thus achieving 'good' quality levels. The human scale is adequate, with a height/width ratio close to 1 (balanced) and a close distance between urban slabs. Moreover, the attraction capacity of the boundary is high, with up to 42% of active façades. Likewise, the layout of this boundary is quite homogeneous with respect to the open space, reducing the concentration of inactive corners (Fig. 5).

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The resilience factors of Ciutat Meridiana which have been present since its construction are both the integration provided by its metropolitan position and the focus on 'eye level' design in the analysed urban fragment. Among the initial obsolescence factors we find low permeability, the local choice of the road network, the functional mix level, the typology of in-between spaces, the plot structure, density and building diversity. Although some interventions have dealt with these challenges, their scope has been limited (permeability and road system), or there is still room for improvement (functional mix). Some interventions—without doubting their need—have even affected other factors such as density levels. To improve its urban quality, urban regeneration strategies could take advantage of the low coverage and floor area ratio in order to promote a new plot structure, in which physical and property layout could be clearer. Moreover, to the extent that these operations could promote greater mix of functions and building diversity, a higher quality of open space could also be obtained. Measures to promote greater spatial permeability would also be desirable, considering the particular topography of this housing estate. Furthermore, a new spatial permeability could allow an improvement of local choice levels, reducing the 'cul-de-sac' streets, and promoting clear axes.

Balsas de Ebro Viejo. Zaragoza

Balsas de Ebro Viejo was designed in 1964 and built between 1964 and 1975. Balsas is a public development (Obra Sindical del Hogar) to house workers from nearby industrial areas (Adiego 1984). The architects chose an orthodox superblock solution with a central core of facilities, surrounded by residential typologies in towers and slabs, in line with hygienist criteria. Balsas has begun a process of population renewal, with a slight increase in the immigrant population, although no signs of vulnerability have been identified (Hernández Aja et al. 2018). As such, urban regeneration processes could be crucial in the short and medium term.

The exceptional location of Balsas, close to the historical centre, influenced the high levels of integration since its construction achieving 'good' quality values. Moreover, the transformation that the left riverbank of the city has undergone in recent years has reinforced its integration to very high levels (Fig. 2). The relationship between the housing estate and the surrounding area was originally autonomous (average permeability levels, developing 'standard' quality). However, its support on inter-district axes has led to an increase in permeability over time, thanks also to the transformation of industrial land towards other residential areas ——with different morphological characteristics——(Fig. 3). At present, the complex reaches very high levels of permeability, raising its urban quality to 'good' levels. In regard to road networks, it achieves 'good' quality levels through providing medium values of local choice since its construction. The two inter-district roads upon which this network is supported, have helped develop this area as a local centre in itself. Additionally, the qualitative nature of these inter-district roads means that they are not perceived as urban barriers.

Considering functional mix, there has been considerable improvement (from low to medium levels, now achieving 'standard' values of quality), as the result of the construction of a central core of facilities and services 22 years after the estate was first built. The initial low quality was a result of a scheme of tertiary activities in commercial areas, both on the ground floors of some buildings and in exempt buildings (Fig. 4). Moreover, since significant configuration changes during this period, the typology of in-between spaces defines more enclosed spaces. Bearing in mind the quantitative analysis, the corrected open space ratio has increased from medium to high levels thanks to a slight densification process. At this point, this factor contributes to an increase in quality from 'standard' to 'good' (Fig. 4, 6). Despite these more enclosed open spaces, the plot structure is based on a system of multiple plots with illegible physical boundaries, with an unclear relationship between the physical and property limits (Fig. 4, 6). This situation gives rise to a low quality of the plot structure, which has not yet been corrected since construction.

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The average values of physical density allow achieving 'standard' quality levels since the estate was built. Moreover, the construction of facilities has produced a slight densification process, with further future filling up opportunities (Fig. 6). The building diversity is, since its origins medium ('standard' quality), based on a Z-shape with and parallel slabs and towers. Densification strategies could take advantage of this value, seeking to increase building typologies, therefore improving their diversity (Fig. 4). From an eye-level design perspective, the analysis of the configuration of the boundary between buildings and open space shows only 2% of façades are active, caused by a predominant residential use on the ground floor. Moreover, considering location, the best boundaries are arranged with a view over a parking space. However, the design is suitable to human scale owing to the balanced height/width ratio and close distances (Fig. 5). When both factors are considered together the final quality at 'eye-level' design is 'standard'.

Specifically, Balsas de Ebro Viejo has offered greater resilience at integration level since its construction. In addition, the urban transformation of the area has allowed processes of urban insertion. The slight densification process it has undergone has promoted better levels of functional mix; and an increase in quality of typology of in-between spaces, by promoting a more intense relationship between the open and the built surface areas. However, to improve the other quality factors, physical urban regeneration could ensure greater quality of the necessary open spaces, in particular with respect to its boundary conditions. This would enhance the relationship between buildings and open spaces and tackle the lack of clarity between usage limits and plot structure limits. Moreover, these improvements would help to achieve higher levels of functional mix and building diversity, using densification strategies. This would also increase the quality of open spaces.

A comparative view of the three selected case studies

This section presents the capacity of UR-Hesp methodology to establish comparative views of different case studies. Comparisons help to identify common starting points, to discuss the different trajectories and to also detect common processes (Fig. 6, Tab. 3).

With respect to the 'streets', the typical autonomous character of mass housing estates is more evident by the lack of permeability identified in Saconia and Ciutat Meridiana——although this is not the case for Balsas. In terms of street integration levels, these range from medium to high levels, with little change evident between the three estates. An original lack of permeability has been corrected in different trajectories. Although some housing estates have increased the level of permeability considerably (Saconia, Balsas), other estates nowadays present several spatial connectivity problems (Ciutat Meridiana). An increase in spatial permeability was the first common process detected, showing how far the evolution processes of a city on a global scale are important in the connectivity of a housing estate on a local level. The road networks do not achieve more than medium values of local choice levels, confirming, on the one hand, the general low capacity of this structure for giving preference to local displacements. On the other, some differences could be appreciated between cases. For instance, Balsas de Ebro Viejo has more optimal conditions for the generation of local centralities than the other case studies.

Taking into account 'plots', there is one initial factor characteristic in all cases: a low level of functional mix. However, there is also a common process in all three cases to promote the implementation (or completion) of new public and tertiary uses, thus increasing diversity. Despite this similarity, the results obtained at each housing estate are varied. The possible solutions are as diverse as the locations themselves. The plot structure of open spaces has hardly undergone changes in the chosen mass housing estates. However, the different types of plot structure in each case study show a medium/low quality——owing to the lack of clarity between the physical spatial structures and the properties——; they all have different options for improvement, particularly when taking into account legislative

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restrictions. The type and quantity of in-between spaces are also specific to each housing estate, with little variation. On the one hand, different typologies reveal more concern with semi-closed space (Saconia, Balsas), and others are characterised by canonical inter-block or indeterminate spaces (Ciutat Meridiana).

With respect to the 'buildings', density values tend to be homogenous during the period under analysis, but there are significant differences between the chosen case studies. It is important to recognise this characteristic as one of the critical points because the shape of the density could have an important impact on decision-making based on objective data with respect to potential intensification improvements. For instance, whereas Balsas or Ciutat Meridiana could take advantage of this kind of strategy, Saconia could not, because of its more compact urban form. Building diversity is also a variable that has not experienced major changes. The results vary depending on the greater or lesser importance this was given during the initial design phase, particularly so in Saconia. Here, the eye-level design analysis discloses an unequal concern for the human scale and the porosity of building boundaries. Again, this is one of the most heterogeneous factors, in which specific analyses would be particularly important.

It seems clear that, given the diversity of the initial characteristics of the housing estates, now, some fifty years after their construction, the diverse trajectories these housing estates have undergone mean a deeper study of each case study is necessary. The results support this idea. In fact, some common starting points have evolved towards different quality positions. Quality has improved because of internal changes in the housing estates (building diversity, functional mix or road networks), or because of external factors related to the city (integration or permeability). Moreover, the design phase seems to play a key role in some quality variables (density, plot structure, eye-level design or typology of open spaces).

Conclusions

This paper presents a methodological proposal from the perspective of urban morphology. The aim is to explore how and where urban quality can be recognized in open spaces on housing estates in order to find suitable ways of intervention in regeneration projects. UR-Hesp methodology is based on nine physical variables grouped by the basic elements that define urban form. It combines quantitative and qualitative approaches and deals with multi-scalar and diachronic characteristics. The methodology was tested in three Spanish case studies. The diverse characteristics of this sample are sufficiently balanced to allow the extrapolation of this methodology to other case studies.

UR-Hesp methodology could be an effective support for urban regeneration project strategies in modernist housing estates, mainly for three reasons:

Firstly, it could be a useful tool to help identify specific quality indicators in mass housing estates. Trying to go beyond the generalist nature of criticism (mainly reporting the bad conditions of many housing estates), it is important to consider that not all estates have the same problems. Furthermore, these problems do not have either the same intensity nor do they appear at the same time. The diagnosis of quality is based on identifying some specific signs or indicators of 'good' or 'poor' urban quality. Considered all together, these indicators provide important clues about the weaknesses and strengths in the urban design of open spaces.

Secondly, more than a mandatory approach, the methodology contributes to generating more specific knowledge on resilience and obsolescence factors and could help to better identify the particular aspects that urban regeneration strategies and processes should deal with. UR-Hesp methodology facilitates a

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more specific and accurate diagnosis and could assist in more objective approaches during stakeholders' decision-making processes.

Thirdly, the use of a diachronic perspective shows how important it is to bear transformation processes in mind, in order to achieve a better understanding of quality from the initial design to the current situation. To consider how the estates have evolved during the years adds useful information to the complex task of understanding their different trajectories and the state they are in at the present. Moreover, this diachronic approach is useful to identify common processes, whether of degradation or improvement. Although housing estates have specific characteristics——depending on their context, design and socioeconomic features——, processes tend to be similar and quite comparable.

However, UR-Hesp methodology is not exempt from limitations. On the one hand, we must admit that the application of this methodology implies reducing the complexity of reality to a simplified analytical model——an otherwise common practise in most urban analyses—. What UR-Hesp does allow, in contrast to generalist critique, is surveying the specific nature of housing estates (with respect to their urban forms resulting from functionalist urbanism) in each specific case study. Besides that, this approach based on quality assessment could help to build better physical environments. Nevertheless, it must be pointed out that improvements in physical aspects are not a guarantee of success, although they could promote changes in other dimensions. Hence, this approach cannot be the only valid perspective. The systemic nature of obsolescence requires a study of such morphological dimensions, bearing in mind other analyses, in order to understand obsolescence and resilience as complex processes also related to social, economic and environmental aspects.

This paper has identified potential future research topics. Firstly, this methodology could be extended to a wider sample of housing estates in order to gain deeper knowledge on obsolescence and resilience patterns and to better identify diverse trajectories. In this respect, our research group is currently working on a sample of 30 such case studies. Secondly, beyond the specificities of the Spanish context, the methodology could be adapted to encompass other specific contexts and datasets. Taking into account previous literature could help to achieve this future goal (Rowlands et al. 2009; Hess et al. 2018). Finally, the results could be cross-referenced with data from other studies, such as ones on social vulnerability, economic analysis or environmental studies. Open space is not the only aspect to be taken into account when considering urban quality on housing estates, but it is an important element that needs to be improved during integrated urban regeneration strategies and processes.

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[1] 'UR-Hesp' is acronym for Urban Regeneration of Housing Estates in Spain. For further information, see acknowledgments.

[2] This study considers the definition of the functional area made by the European Union as the physical limit of each city.

[3] For the local calculation this study considers a radius of 800 metres, which is the distance that a person can walk in ten minutes.

[4] The authors present the variable as 'corrected compactness', inversely proportional to the corrected spaciousness (Rueda 2012a, 465).

[5] Although spaciousness is considered originally as a four physical indicator of *Spacemate*, this study takes spaciousness into account as quantitative indicator in the 'typology of in-between spaces' section.

[6] This variable takes as a reference the study on urban diversity carried out by Salvador Rueda (2012a). Compared to the use of the Shanon index proposed by his methodology, this study considers the Simpson index to be more relevant for the representation of abundance and richness based on the first empirical results obtained.

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Tables caption

Table 1. Summary table of the UR-Hesp methodology. (G: Good, S: Standard, P: Poor).

Table 2. Summary of the main characteristic of the case studies

Table 3. Results obtained by applying UR-Hesp methodology to three selected case studies.

Figures caption

Figure 1. Case studies: original design, historical and current aerial views
Source: *Legado Histórico COAM*, *Registro de planeamiento urbanístico del Departament de Territori i Sostenibilitat de la Generalitat de Catalunya* and *Archivo Urbanismo del Ayuntamiento de Zaragoza* (original design), *Instituto Geográfico Nacional* (historical and current aerial views).

Figure 2. Case studies: city scale. This figure shows the integration variable.

Figure 3. Case studies: district scale. This figure shows permeability and local choice of road network variables.

Figure 4. Case studies: housing estate scale. This figure shows functional mix, typology of in-between spaces, plot structure and building diversity variables.

Figure 5. Case studies: urban fragment scale. This figure shows the eye-level design variable.

Figure 6. Comparative diagnosis matrix of the selected case studies.

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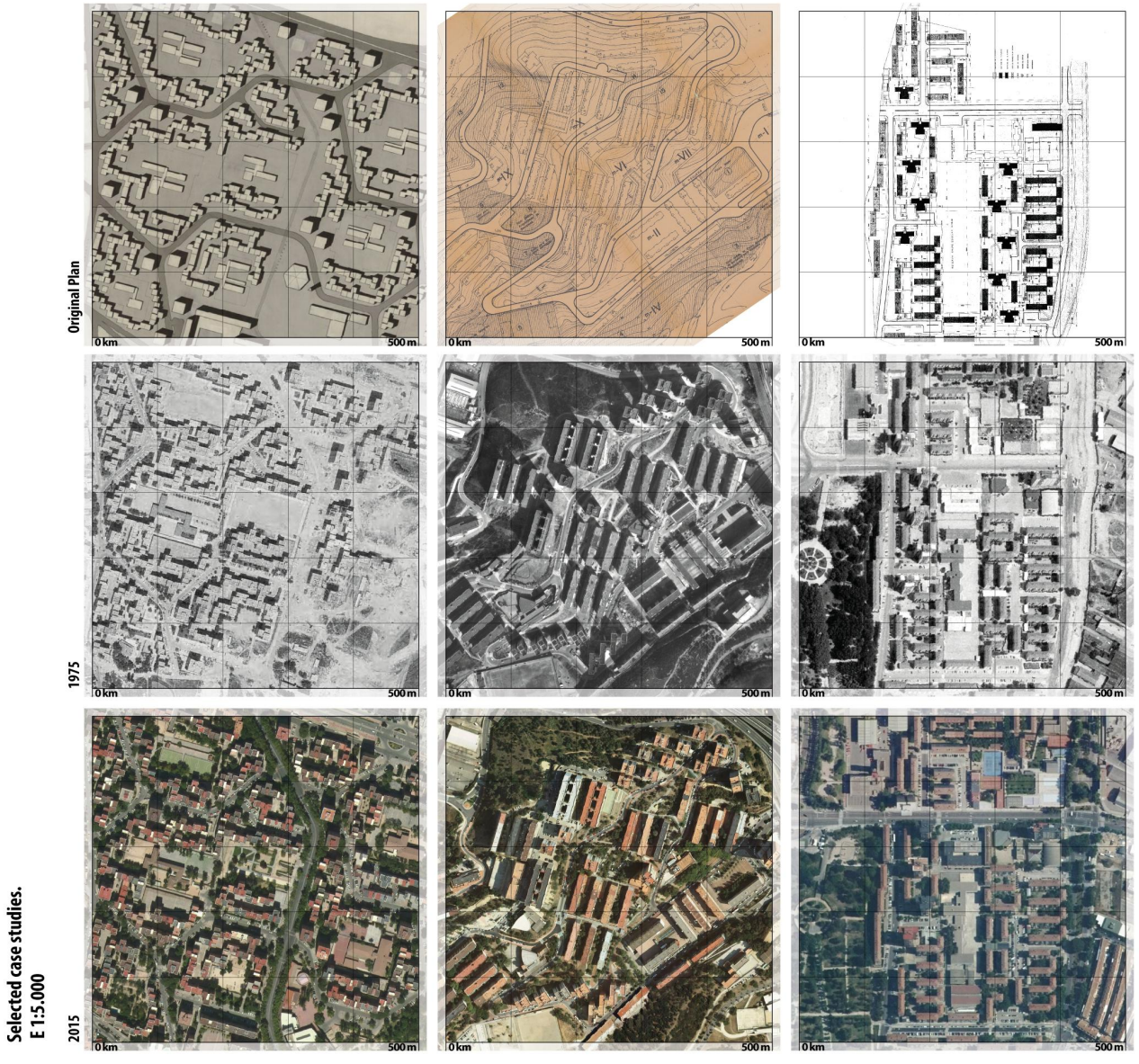

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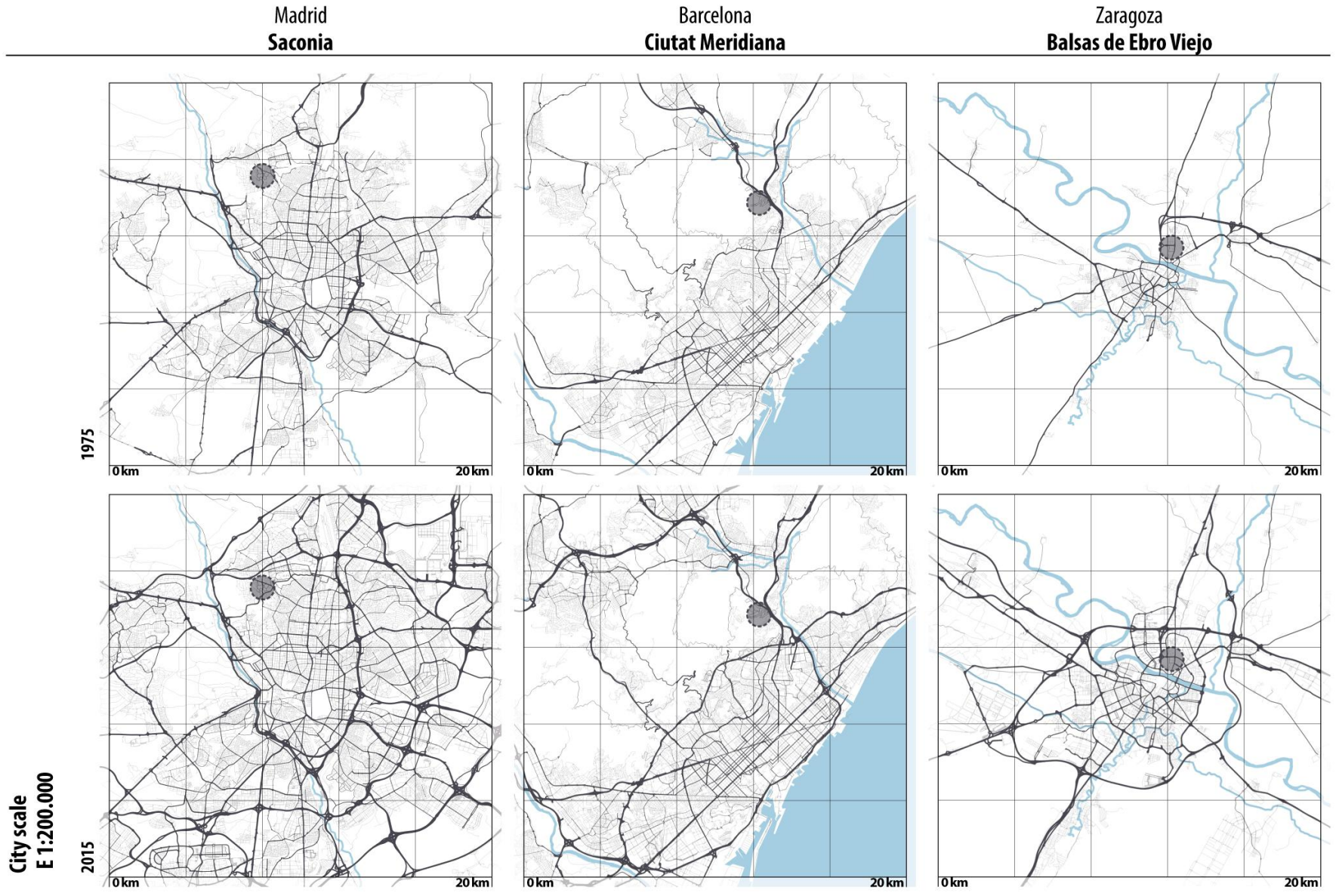

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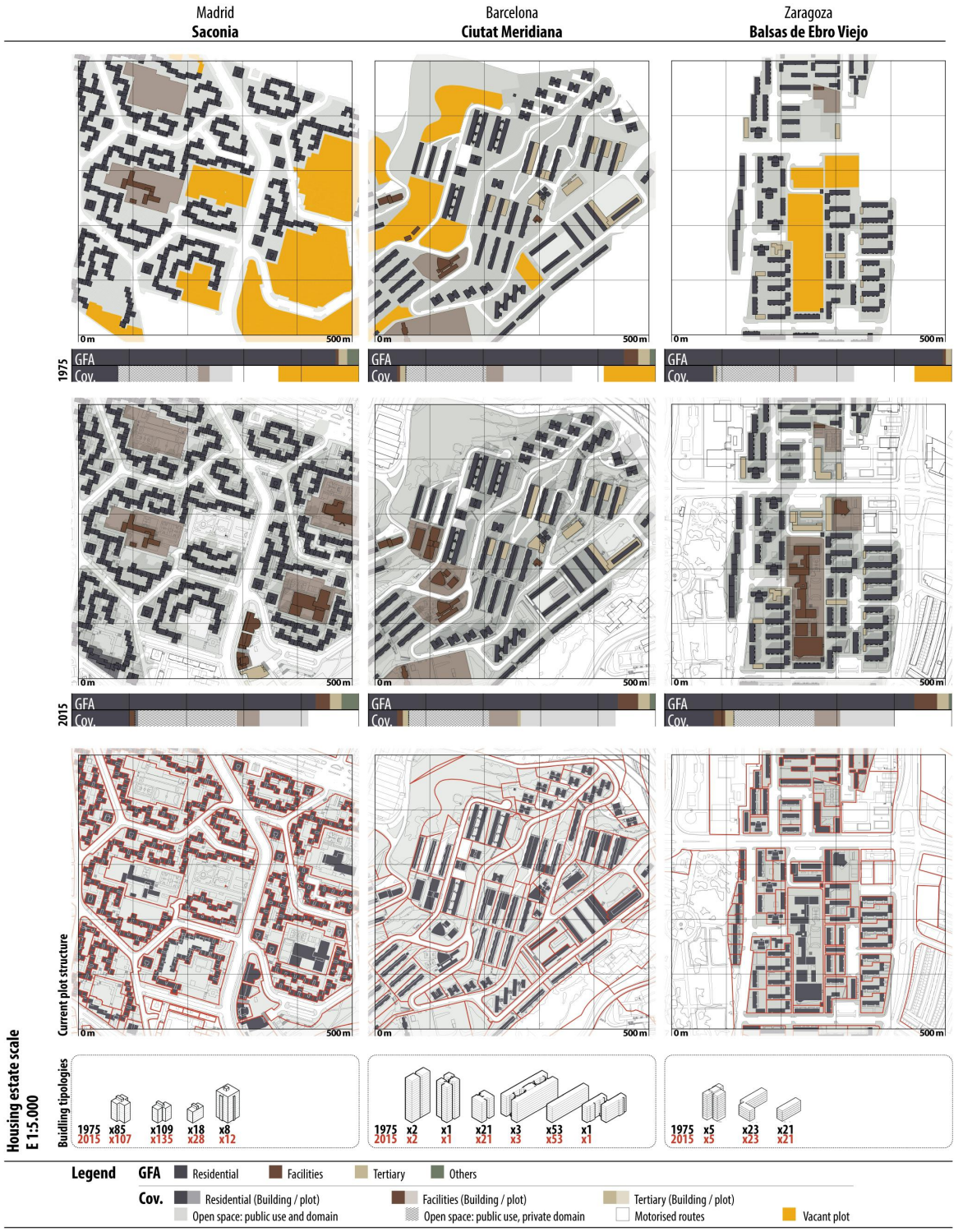

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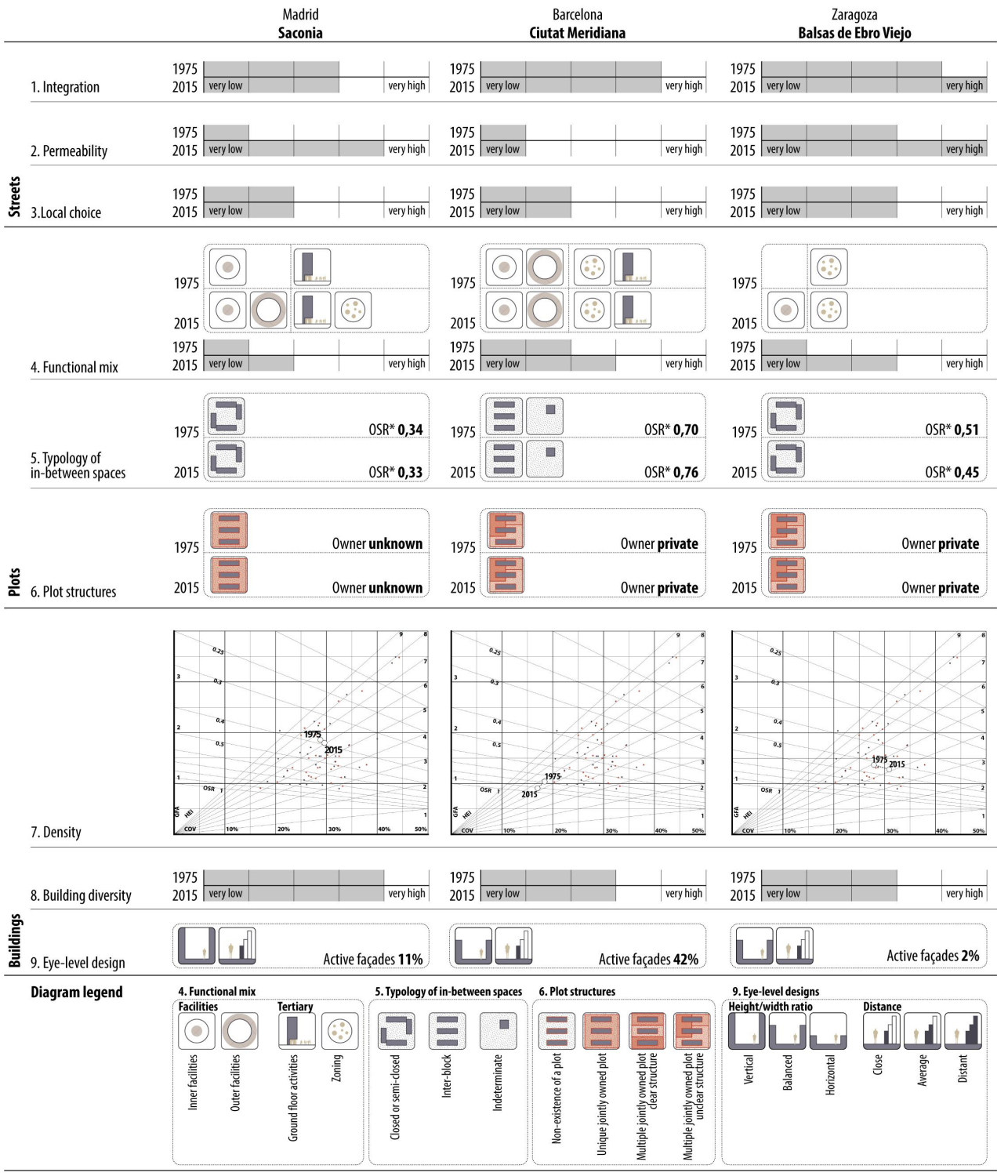

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			Methodological description	Quality approach	Processes	Reasons	Physical variability	References	Methodological reference	Specific study variables	Quality evaluation		Scale
Streets	Connection with the urban fabric	**Integration**	Studies the evolution of the position that a housing estate occupies in relation to the urban fabric on a metropolitan scale, analysing the configuration of roads and streets	Peripheral location cause connectivity problems, social exclusion or is related to the real estate market. From these approaches, the less peripheral a housing estate is, the more quality it has	Improvement of integration vs. consolidation of global isolation	External: growth of the city	High	(1–7)	(4, 8)	Global integration	G: very high (Q_5) and high (Q_4) values S: average (Q_3) values P: low (Q_2) and very low (Q_1) values		City scale (Fig. 2)
		Permeability	Analyses the degree of connectivity with the nearby urban fabric, studying the configuration of road edges	Permeable housing estates show a lower number of urban barriers, thus generating a spatial format that, from the physical dimension, improves accessibility for resources and people, supporting social inclusion	Improvement of permeability to the nearby urban fabric vs. consolidation of isolation	External: growth of the city Internal: urban renewal	High	(4–7, 9–12)	(4, 8, 11)	No. of links/perimeter * global integration	G: very high (Q_5) and high (Q_4) values S: average (Q_3) values P: low (Q_2) and very low (Q_1) values		District scale (Fig. 3)
	General housing estate structure	**Local choice**	Defines the type of spatial structure (road and pedestrian network) and its configuration within the local network	The spatial structure of streets influences the movement of pedestrian. More co-presence could influence more social encounters at local scale	Transformation of the nature of the road (pedestrian vs. vehicular), changing the structure of superblocks	Urban regeneration and/or changes due to vehicular pressure	Average	(4, 10, 13–16)	(4, 14)	Local choice (800 m radius)	G: very high (Q_5) and high (Q_4) values S: average (Q_3) values P: low (Q_2) and very low (Q_1) values		
Plots	General housing estate structure	**Functional mix**	Quantitatively and qualitatively describes use patterns through the study of residential and non-residential plots	Higher functional diversity is a driver of agents and activities that help to engage vitality on open space	Provision or abandonment of facilities, unplanned transformation for the addition of new uses	Consolidation of the housing estate over time/public facilities or urban renewal works	Average	(9, 17–23)	(11)	Simpson index of functional mix	G: very high (<0.6) and high (> 0.6) values S: average (>0.7) values P: low (>0.8) and very low (>0.9) values		Housing estate scale (Fig. 4)
		Typology of in-between spaces	Quantitatively analyses the area devoted to in-between spaces and classifies it through exclusive types	Balanced amount of open space could intensify the co-presence of people. Considering not only the amount of space, but also its configuration, more delimitated open space has more quality	Consolidation, privatisation or abandonment of in-between spaces	Vehicular pressure, maintenance and management problems	Average	(2, 7, 22–28)	(10, 26, 28)	Corrected spaciousness (OSR*)	G: very high (>0.06 and <0.3) and high (>0.3) values S: average (>0.5) values P: low (>0.7) and very low (>0.9) values	G: both good variables S: no poor variables P: others	
										Archetype of in-between space	G: semi-closed S: inter-block P: indeterminate		
		Plot structures	Classifies the plot solution used, observing how its physical shape influences the 'use' and 'management' of a space	Clear physical boundaries and clear property help to maintain open space, that influence the comfort level of potential users	Privatisation of spaces	Maintenance and management problems	Average	(25, 29–31)	(10, 31)	Plot types Ownership	G: Clear both structure (no plot, single plot and legible multiple plot) and property (public or private) S: Clear physical structure		

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		Methodological description	Quality approach	Processes	Reasons	Physical variability	References	Methodological reference	Specific study variables	Quality evaluation		Scale
										P: No clear physical structure (illegible multiple plot) and property (unknown)		
Building	**Density**	Quantitively classifies the physical density of the urban form through the definition of the floor area ratio (FAR), compactness (COV) and average height (HEI)	More intense and compact physical densities bring richer social opportunities	Densification	Consolidation of the housing estate over time/urban renewal	Average	(11, 20, 26, 32–36)	(26)	Floor area ratio (FAR), coverage (COV), and height index (HEI)	G: High FAR (>2) and COV (>0.35), if not extreme values are reached (HEI >7) S: At least average FAR and COV, if not extreme values are reached P: others		
	Building diversity	Classifies the homogeneity of the chosen building types and their repetition as the basic format for spatial and social diversity	Higher housing types diversity could promote more social mix between residents, avoiding 'one-fits-all' design	Introduction of new types	Consolidation of the housing estate over time/urban renewal	Average	(11, 20, 37, 38)	(11)	Simpson index of building diversity	G: high (>0.2) and very high (<0.2) values S: average (>0.4) values P: low (>0.6) and very low (>0.8) values		
Detailed housing estate structure	**'Eye-level' designs**	Identifies the physical characteristics in the meeting between a building and an open space	Adequacy to human scale –human dimension and human mobility– enhance the comfort of users and attractive built edge stimulate the presence of people			Low	(25, 32, 39–44)	(32, 45)	Scale and distances	G: Balanced height/width ratio and close distance S: Balanced height/width ratio or close distance P: others	G: both good variables S: one good variable P: others	Urban fragment scale (Fig. 5)
									Porosity of the urban edge	G: more than >20% of active façades (>15 doors / 100 meters) S: more than >10% of active façades P: others		

(G: Good, S: Standard, P: Poor).

Table 1. Summary table of the UR-Hesp methodology.

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Table 2.
Summary of the main characteristic of the case studies

	Colonia Saconia – City of Poets	Ciutat Meridiana	Balsas de Ebro Viejo	Source
City	Madrid	Barcelona	Zaragoza	(Ferrer i Aixalá, 1996; López de Lucio, Ardura Urquiaga, Bataller Enguix, & Tejera Parra, 2016; Monclús, Labarta, Díez Medina, Agustín, & Bergera Serrano, 2012)
Year of the design	1964	1963	1964	
Year of construction	1967/85	1964	1964/75	
Architects	A. Perpiñá Sebriá, L. Iglesias Martí, C. de Miguel González y I. Briones	M. Torres, E. Hernández, J. Puigdengoles, S. Maña (Masterplan) F. Bendala, S. Maña (Urbaization)	A.Allanegui, F. García Marco, J. Guindeo, J.L. de la Figuera y L. Monclús	
Promotion	Private	Private	Public	
Original socioeconomic profile	Middle class	Working class	Working class	
Relative household income (respect the average of the functional area, in 2015)	92%	53%	91%	(Instituto Nacional de Estadística, 2013)
Urban vulnerability	No	Yes	No	(Hernández Aja et al., 2018)

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Table 3.
Results obtained by applying UR-Hesp methodology to three selected case studies.

			Saconia (Madrid)		Ciutat Meridiana (Barcelona)		Balsas de Ebro Viejo (Zaragoza)	
			Partial result	Final result	Partial result	Final result	Partial result	Final result
Integration	1975		Average, Q3	S	High, Q4	G	High, Q4	G
	2015		Average, Q3	S	High, Q4	G	Very high, Q5	G
Permeability	1975		Very low, Q1	P	Very low, Q1	P	Average, Q3	S
	2015		High, Q4	G	Very low, Q1	P	Very high, Q5	G
Local choice	1975		Low, Q2	P	Low, Q2	P	Average, Q3	S
	2015		Low, Q2	P	Low, Q2	P	Average, Q3	S
Functional mix	1975		Very low, 0.92	P	Low, 0.83	P	Very low, 0.94	P
	2015		Low, 0.84	P	Average, 0.79	S	Average, 0.78	S
Typology of in-between space	1975	OSR*	High, 0.34	G	Low, 0.70	P	Average, 0.51	S
		Archetype	Semi-closed		Inter-block and indeterminate		Semi-closed	
	2015	OSR*	High, 0.33	G	Low, 0.76	P	High, 0.45	G
		Archetype	Semi-closed		Inter-block and indeterminate		Semi-closed	
Plot structures	1975		Clear physical structure but not clear property	S	Not clear physical structure	P	Not clear physical structure	P
	2015		Clear physical structure but not clear property	S	Not clear physical structure	P	Not clear physical structure	P
Density	1975	FAR	Average, 1.86	S	Average, 1.04	P	Average, 1.37	S
		COV	Average, 29%		Average, 18%		Average, 28%	
		HEI	High, 6.46		High, 5.62		Average, 4.91	
	2015	FAR	Average, 1.80	S	Low, 0.91	P	Average, 1.28	S
		COV	Average, 30%		Low, 17%		Average, 31%	
		HEI	High, 6.10		High, 5.37		Average, 4.15	
Building diversity	1975		High, 0.40	G	Average, 0.50	S	Average, 0.41	S
	2015		High, 0.38	G	Average, 0.50	S	Average, 0.41	S
'Eye-level' design	2015	Scale and distances	Vertical and close	P	Balanced and close	G	Balanced and close	S
		Boundaries	11% active		42% active		2% active	

P: Poor quality, S: Standard quality and G: Good quality

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