

EAAE-ARCC
INTERNATIONAL
CONFERENCE

2nd VALENCIA
INTERNATIONAL
BIENNIAL OF
RESEARCH IN
ARCHITECTURE
11-14 NOV 2020



THE ARCHITECT AND THE CITY

VOLUME 1



UNIVERSITAT
POLITÀCNICA
DE VALÈNCIA



ESCOLA TÈCNICA
SUPERIOR
D'ARQUITECTURA

Publisher:

Editorial Universitat Politècnica de València, 2020
<http://www.lalibreria.upv.es>
ISBN 978-84-9048-842-3 (Set of two volumes)
978-84-9048-981-9 (Volume 1)
978-84-9048-982-6 (Volume 2)

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EAAE-ARCC International Conference & 2nd
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THE MEDITERRANEAN PERI-URBAN HISTORICAL *HUERTAS* (MURCIA-ALICANTE-VALENCIA-ZARAGOZA). TRANSVERSAL RESEARCH

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ABSTRACT

The Peri-urban Historical *Huertas* (PHH) have been a keystone of the landscape, economy and culture identity of some Mediterranean cities. The change in the economic model, especially the agricultural and urban ones, has subjected these gardens to urban pressures that have induced significant spatial alterations. However, the understanding of these is not simple due to the scarcity of PHH, the diversity of the changes and their variability over time, and the small scale at which the alterations operate over large territories. This paper includes the first steps in the consolidation of a research group focused on the better understanding of these changes, necessary to the conservation of their environmental, social and economic values. The text presents a classification of these alterations obtained through the transversal analysis of the orchards of Murcia, Alicante, Valencia and Zaragoza, distinguishing between those caused by replacement, dispersion, fragmentation and transformation. In addition, it collects observations on the study methodologies of each of these alterations adjusted to PHH characteristics.

KEYWORDS

Urban transformations; periurbanization; irrigated areas; methodologies.

INTRODUCTION

The Peri-urban Historical *Huertas* (PHH) are strategic in food production (Beltrán, 2012), provision of ecosystem services (Elmqvist, et al., 2015) and preservation of historical heritage, due to their complex traditional irrigation systems (Glick, 1970; Burriel, 1971; Courtot, 1986). In addition, its position in the edge of the urban areas makes this PPH especially vulnerable, undergoing processes of occupation and continuous transformations (Temes & Moya, 2016; Ros & García Martín, 2016; García-Mayor & Canales, 2018a). As Romero (2016) comments, the (un)protection of the large PHH and the absence of coordination initiatives at the metropolitan level synthesize very well the risk of lacking effective coherent management and management mechanisms in the second decade of the 21st century. Mediterranean PHH represent a type of landscape of great singularity for its typological singularity in Europe, as recognized by the Dobris Report of the European Environment Agency (1998), which only identifies six of such landscapes in Europe. As defined by UNESCO, the cultural landscape, denomination in which the landscapes of the garden are inscribed, are a complex reality, composed of natural and cultural components, tangible and intangible, whose combination configures the character that identifies them.

With the purpose of research about the changes and transformations that have been experiencing the PHH that still exist in Spain, we have set up a Researchers Network in the Mediterranean region committed to the analysis and study of these PPH, focused specifically in the understanding of the changes this landscapes have undergone from the perspective of environmental and social sustainability.

The spatial alterations of these PPH have been analysed in recent years from local perspectives, developing methodologies adjusted to the particularities of the predominant changes in each of them. This paper includes a classification of the types of alterations based on the comparative analysis between the different PHH and a summary of the analysis methods used for each of them.

1. SPATIAL TRANSFORMATIONS OF THE AGRICULTURAL LANDSCAPES

1.1. On the agricultural landscapes

The morphology and dimension of the PHH that have been studied are very different, and this is also recognized in the nature and intensity of changes that have characterized each of them. Firstly, the area that constitutes Valencia's historical orchards includes 40 municipalities and covers about 23,000 hectares, half of them, 11,393 hectares, are irrigated orchards classified as undeveloped area by the urban planning. Secondly, Segura's historical orchards constitutes an agricultural continuum and it includes both Vega Media and Murcia's areas. If we focus on Murcia's, the area of *huerta* includes 13 municipalities and covers 21,169 hectares, which is similar to the Valencia's one. If we focus on the Vega Media's historical orchard, it reaches 21 municipalities that are included and it covers 710, 398

hectares, with traditional irrigated orchard land covering 21,000 hectares out of the total administrative area. Finally, Zaragoza's historical orchards includes 20 municipalities and the relation between irrigated orchard land with respect to total area is remarkably different that the others. Indeed, it covers 38,060 hectares and irrigated orchard land covers 24,850 hectares.

Once the abovementioned description and contextualization of the different orchard's, it is important to clarify what kind of spatial transformations have been identified in those areas. To be specific, we have identified four different types of spatial transformation as a result of having applied a specific methodology, that will be explained later.

- Firstly, the replacement of the historical agricultural fabric by the expansion of urban areas. Some of the references that evaluate and quantify these changes are found in the study of Valencia's PHH (Temes & Moya, 2015; 2016), and their methodology reveals an example on how to describe these processes.

- Secondly, the dispersion of buildings over the initial agricultural plots involve a great intensity of transformation, especially in Segura's historical orchards. In this case of study Ros & García Martín (2016a; 2016b; 2017) have defined a preliminary methodology to quantify, classify and supervise this transformation process.

- Thirdly, the transformation of land use into the initial agricultural fabric, from the traditional orchards to new activities. The "micro" scale of this kind of transformations, performed over small plots, reveals a difficulty to apply usual research techniques, with land cover databases, and it requires a methodological revision, as it is described below.

- Fourthly and finally, the fragmentation of the historical agricultural fabric by the definition and construction of new infrastructures highlights an important

issue: the interaction between the urban development and the landscape conservation of these territories. The analysis of the invariant elements that define this agricultural landscape applied to Segura's historical orchards of Alicante (García-Mayor, 2017; García Mayor & Canales Martínez, 2015, 2018-a; 2018-b) establishes some key points to study the impact and role of these infrastructures over the PHH.

The following sections describe the main characteristics of the research methods of each of these spatial transformations. The analysis of the results is also explored.

1.2. Replacement

New urban development areas occupation processes over HHPM area correspond with urban growth analysis tools, at least initially. However, it reveals specific particularities. Indeed, urban growth is explained as a consequence of the extension of the urban built environment towards the orchard area. Its transformation has been represented as a vector dataset based on the 1:50,000 cartographies from the National Geographic Institute (NGI – IGN in Spanish), using urban blocks as minimal unit. This methodology and

the data source guarantee a homogeneous coverage for all the HHPM area. Moreover, the analysis is complemented, for each period, with the raster information provided by the aerial photo coverage (Figure 1).

The analysis of this replacement is studied in detail in Valencia's orchard from 1957 to 2015. Results reveal a great transformation. Data information treatment shows an increase of more than three times of the urban growth area, from 3,414 to 9,730 hectares. This magnitude reaches a high importance if we compare it with regard to the population growth, which increased from 781,113 inhabitants in 1957 to 1,547,479 in 2015, almost double.

The comparison of urban area in 1957 and 2015 (Figure 2) and its growths, reveal the change in the urban structure and the patterns of the agricultural lands replacement. In the first scenario, 1957, in addition to the historical core, it can be distinguished the first extensions of the city, the Grao and Poblados Marítimos areas next to the port and some linear growths along the main paths. The orchards area is occupied by several polarized settlements, linked to the agricultural economy.



Figure 1. Aerial photography as a reference, vector dataset 1: 50,000 cartography superposition. Source: the authors

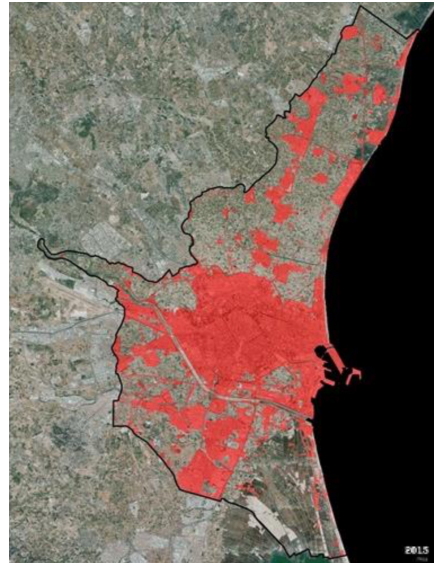
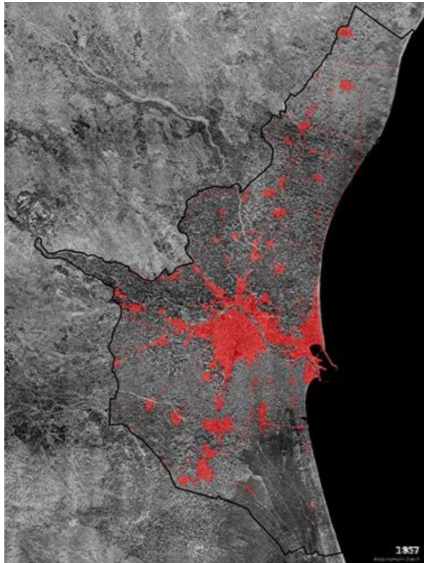


Figure 2. Comparison of the urban growth area transformation in Valencia. 1957-2015. Source: the authors.

In the second scenario, 2015, the shape has a completely different pattern, which is clearly characterized by the absorption of all the coastal settlements and the predominance of the urban growth extension. Only two orchard's specific locations last to be replaced: Horta de Campanar, to the northwest area, and Horta de Rovella I Francs, Marjals I Extremals, to the southeast area. Moreover, this transformation reveals multiple urban morphologies that define a new edge between the built environment (the city) and the orchard. Other municipalities located in this area have also assessed some important transformations. Indeed, some conurbations are identified as a new urban pattern, which has generated, therefore, not only the division and spatial discontinuity of the orchard, but also its functionality. As an example, a linear pattern of urban continuity can be identified in the north area of the orchard, linked to the roadway that connects Valencia to Barcelona. There is another important pattern of urban continuity in the south, covering Sedaví, Alfafar, Benetússer, Massanassa and Catarroja municipalities. This second area

is also characterized by the high use of the land by the industrial sector. This comparison exposes a clear interruption of the continuity that previously defined the agricultural use of the land and the built and non-built environment. This balance has been shattered and it affects mainly the southern area of the orchard. While north area still reveals some continuity of these areas, remaining orchard in the south is currently characterized by residual minor areas.

1.3. Dispersion

The construction of dispersed buildings on the original agricultural fabric requires analysis techniques that are no longer based on the urban block but on the plot and its constructions, usually isolated houses. In the case of various orchards in the Region of Murcia, the main source has been cadastral cartography, which also guarantees coverage of all cases, as well as the series of aerial photographs available that allows identifying the period of appearance of existing buildings nowadays.

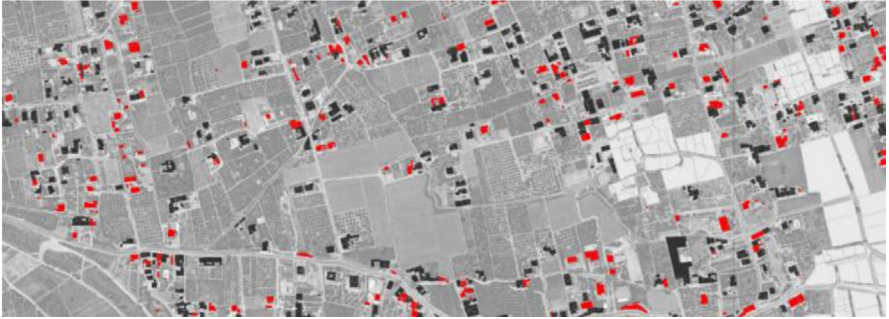


Figure 3. Differential study of the constructions in the West fragment of the Huerta de Murcia, due to the difference of orthophotos (2001-2015). Source: own elaboration by authors based on orthophotographies (SITMurcia) and cadastral cartography.

In the Huerta de Murcia, this method has allowed quantifying the growth of the total constructed area, which has gone from 929,207 m² from 1956 to 4,665,395 m², which is almost five times what was built in 1956. The rate of increase from one year to another, it suffered a gradual increase until 2007, when it fell sharply. The annual rate reached 1,231 houses per year during the period 2002-2007, decreasing to 69 units since 2007.

In addition, the identification of the period of appearance of the constructions has also allowed to identify the occupation patterns. In the period 1956-1981 the increase of houses into the PHH is very important, and it is mainly located in areas of homogeneous dispersion in the *Huerta Oeste* and *Huerta Sur*, as well as in a network of secondary roads, perpendicular to the main ones, in the *Huerta Este*. In the period 1981-2002 there are homes on the second line of main roads, on secondary roads and even on a third grade of paths. Wide areas of the *Huerta Sur* are also occupied by homogeneous dispersion. Finally, in the period 2002-2017 there is a very strong combination of all the patterns described above, in almost all of the Huerta sectors analysed.

The effects of the changes caused by this dispersion of housing have been evaluated in areas of smaller scale in the Vega Baja del Segura with two fundamental objectives:

first, correlate the phenomena detected at territorial scale with the dynamics of local scale through of cartographic analysis; and secondly, to parameterize the changes in the territory from the application of a 400x400 m grid as an optimized measure of the habitat in the huertas. This methodological proposal is an adaptation with the same approaches that are used in the parameterization of indicators for urban contexts (AEU, 2008) (Rueda, 2008) since the generic model is based on the parameterization of the complexity of the physical reality of a surface (García-Mayor, 2017).

In the Vega Baja, the detailed analysis of these patterns reflects that the land occupation remains stable until the 80s of the last century, having as main change the transformation of arable crops to arboreal up to 75% of the surface in some tiles studied. It will be during the last 30 years when there is a radical change of scenery: the traditional building, isolated and aligned only to one side of the path, is densified to form alignments on both sides of the road that represent a physical and visual barrier with the orchards adjacent. The typology of modest agricultural housing changes to a villa with urban standards, tripling the land occupation. Regarding the uses, the new constructions include, together with the residential, the activity of warehouses and commercial. To

adapt the road network to the needs and intensity of traffic, the irrigation pipes are piped and the asphalted surface is increased, which increases the unproductive land due to abandonment of agricultural activity, in addition to the area destined to infrastructure corridors and esplanades. Despite all these changes, it has been detected that the basic networks of water channels and roads together represent between 13% and 17.5% invariably over time in the metrics of the tiles under study.



Figure 4. Study of the evolution of the components of the orchard pattern in relation to the growth of a traditional settlement from the analysis of the flights. Source: own elaboration by authors based on the images of Ruiz de Alda flight (1929) and PNOA orthophotographies.

1.4. Transformation

The main methodological challenge is related to changes driven in the use of land affecting the agricultural plots. In this regard, different techniques are considered in order to conduct a coherent analytical approach between all four case studies, following the same criteria as previous sections. For this propose, the analysis is based on both the agricultural allotment as a minimum unit and a specific cluster of several agricultural plots, considering that they are applicable to all the cases.

In order to deal with the measurement of changes in the use of land among the PHH, the NGI provides a database on land occupation that has been the main source for identifying the land cover, namely the Spanish Information System on Land Occupation –SIOSE– (Instituto Geográfico Nacional n.d.). Specifically, the database used is referred to three specific reference years: 2005, 2011 and 2014. Initially, the real usefulness of the information gathered through these databases has been contrasted by defining the map keys shown in Figure 5: Map 1, level 1; Map 2, level 2 artificial and crops; Map 3: level 4 artificial unbundled data; and, Map 4: level 4 crops unbundled data.

These maps' analysis has permitted to detect the following issues and difficulties resulting from the use of the SIOSE data:

1. Considering all four PHH cases of study, it was detected that the representativeness of SIOSE database is not equally coherent mainly in relationship with "level 4 crops unbundled data; notwithstanding that in all the cases it is the same methodology applied for the identification of the use of land,
2. The land occupation by scattered houses produces distortions in the analysis results of the SIOSE among the cases of study. For instance, areas such as urban discontinuous or mix-urban lands with the greatest dispersion are identified as artificial land cover in some of the cases.
3. Moreover, it is highlighted that it doesn't exist a simple methodology for assessing changes in the land use using the ten-year temporal series of the SIOSE.

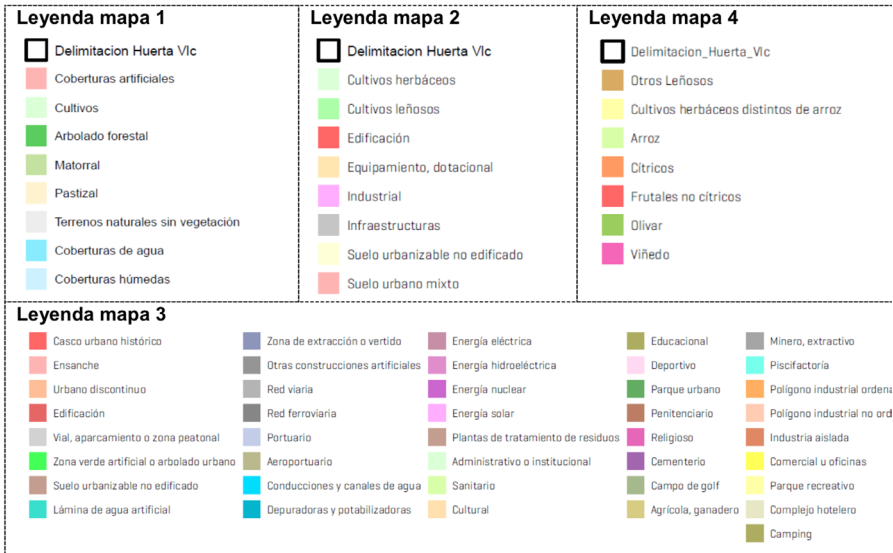


Figure 5. SIOSE 2011 – Key map levels used for the analysis of the Periurban Historical Huertas project.

In order to address the above difficulties, the following actions are proposed combining different databased that complement SIOSE information.

1. The development of a new classification which could be representative for the set of PHH taking advantage of use of land percentages from the SIOSE database.

2. Introducing complementary sources of information such as the Geographical Information System for Agricultural Plots –SIGPAC– (Ministerio de Agricultura 2015), which makes it possible to identify geographically the plots declared by farmers and stockbreeders under any aid scheme relating to the area cultivated or used by the livestock. In relation with SIGPAC database information, this system provides detailed information at the scale of the agricultural plot. Furthermore, intertwining SIGPAC and SIOSE provides accuracy and allows to make a double check of the land information.

1.5. Fragmentation

The landscape patterns and agricultural structures of the PHH are also affected by fragmentation, mainly due to the implementation of infrastructure routes: roads, trainlines, electricity grids, etc. The identification of these elements, which appear as clear cuts in the productive tissue, has been possible using the Spanish national-level topographic and cartographic bases (Instituto Geográfico Nacional 2015), combined with the graphic information from the aerial photography series which are accessible from the Spanish National Plan for Aerial Orthophotography –PNOA– (Instituto Geográfico Nacional 2016). It is important to highlight that the main methodological difficulty related to this issue has been to perform a correct interpretation of each element's role considering both, the effects on the landscape pattern tissue fragmentation, in contrast with the improvement of connectivity

derive from each infrastructural element scale and connection with other landscape elements. For providing a more thorough insight to the territorial analysis, the historical series of structuring landscape elements of the PHH selected are being considered in order to better understand these territorial areas as follows:

1. The specific landform: using the terrain model with the contour lines map in combination with the territorial shadow model.

2. The irrigation network system that involves irrigation and drainage canals. These follow a hierarchical canal distribution, first carrying the water from the river to the agricultural plots (river – major canals – minor canals), and the drainage of exceeding water (runoff waters and drainage canals). The water system has been fundamental to determine the final land organization and plot distribution, as well as the first stages of the scattered land occupation process.

3. The pathway network is also a hierarchical system which not only provides accessibility to the territory, but also permits the access to the water canal tracks for maintenance and for addressing the water distribution management.

4. The settlements original location in these territories followed a clearly searched for occupy slightly elevated topographical levels, trying to preserve as much fertile land as possible. Later, these settlement patterns resulted in the growth of villages and hamlets situated in relevant crossroads.

The accurate identification of all these elements is possible through the analysis of the Spanish National Geographic Institute documents MTN50 (Instituto Geográfico Nacional 2018), over the period from 1916 to 1950 in the case of the Huerta de Valencia. For the cases of the floodplains and Huertas del Segura there are aerial photographic materials available from 1927, which constitutes a fantastic graphic information for the study of the evolution of these territories.

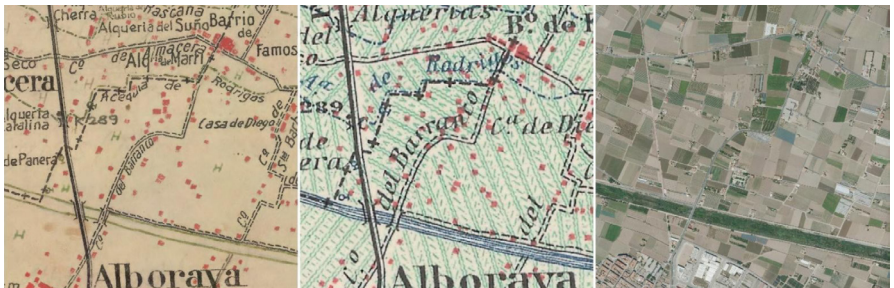


Figure 6. Representation of pathways, irrigation canals and riverbed over the historical cartographies

CONCLUSION

The best understanding and parameterization of the characteristics and changes of agricultural tissues seeks to allow a better strategy of integration and safeguarding of these spaces. The cross-sectional analysis of the different PHH is allowing to complete the local analyses, incorporating phenomena of alterations from a wider context. One of the first results is the conceptualization of the alterations in four main types: substitution, dispersion, transformation and fragmentation. Each of them present in all cases, but with different intensity. The variety of alterations, and their scale and intensity, shows the flexibility to the changes of these tissues, because many are derived from 'micro' transformations, at the level of small agricultural plots. This permissiveness causes a constant phenomenon of transformation (Calvo, 1982), which paradoxically implies a greater resilience of the territory, modifying its structure and appearing new elements proper of the urban or suburban areas (Antrop, 2004). The necessary adaptation of the methods of analysis of the spatial transformations to this type of tissues, adapting the techniques and resources, has been another of the most outstanding results in this phase of the investigation. In this sense, the search for sources that have a homogeneous coverage in the four PHH analysed has been especially relevant, assessing their representativeness for each of them, and the determination of the scale of the minimum unit of study in each alteration phenomenon (plot, block or area). In this comparative approach, methods have been experimented to solve the disparities in the cartographic databases of land uses of the different spaces, showing the lack of efficient criteria for the classification of this type of peri-urban agricultural spaces.

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