

Land use change in Huerta de Valencia (2008-2013). Resilience and cultural landscapes

¹Timea Argyelan, ²Ignacio Díez Torrijos, ²María Vallés Planells, ²Francisco Galiana Galán

¹Department of Landscape Protection and Reclamation, Corvinus University of Budapest (Hungary)

²Department of Rural Engineering, Universitat Politècnica de València (Spain)

argyelan.timea@gmail.com, igdiector@agf.upv.es, convalpl@agf.upv.es, fgaliana@agf.upv.es

Abstract. The Huerta de Valencia is defined as the agricultural plane irrigated by Turia River that surrounds the city of Valencia, in the east coast of Spain. Its origins are dated in the 8th century with the arrival of the Muslim tribes in Spain and it is one of the last six “huerta” landscapes left in Europe. Traditionally, the Huerta has been in continuous evolution because of changes in agricultural management that answered to changes in the demands from society. But, since the second half of the twentieth century, landscape transformation has been faster and more extensive resulting in profound changes. This paper focuses on land use change in Huerta de Valencia with an emphasis on agricultural land abandonment. The objective is to assess spatial changes between 2008 and 2013 using aerial photograph interpretation and field survey. During this period, there has been a decrease in the pace of urban and infrastructure growth due to the economic crisis. However, land abandonment has become one of the most important factors for change in agricultural landscapes. The analysis of landscape evolution and historicity could give us some clues about the resilience and sustainability of certain cultural landscapes. This topic is relevant in certain landscapes such as la Huerta de Valencia.

Keywords: landscape evolution; land abandonment; landscape sustainability

1 Introduction

In the last decades, resilience theory has extended from the pure ecological domain - considering resilience as a property of ecological systems - to cultural landscapes (social-ecological systems) (Kirchhoff et al., 2012). The concept of resilience refers to the capacity of a system to experience shocks while retaining the same function, structure, and therefore identity or, in other words, the ability to deal with disturbances or change without altering the essential characteristics of this system (Walker et al., 2014). One of the defining features of resilience theory is that landscapes inevitably change, paying attention to the dynamics of change and how to adapt to change.

This work focuses on the case study of the Huerta de Valencia. This area can be considered a resilient landscape for the fact of being a 12-century-old traditional landscape. Huerta de Valencia is the result of a long lasting human interaction with the physical environment, whose origins as a huerta landscape are dated in the 8th century with the arrival of the Muslim tribes in Spain and the construction of the eight main Turia irrigation channels (Guinot, 2008). In fact, it is one of the most resilient landscapes of its type. In 1998, the Dobris Report (EEA, 1998) already showed that there were only six huerta landscapes left in Europe. Besides, despite cultural representations of the Huerta are usually associated to horticultural crops, different crops have been grown adapting to the population needs in each historical period (Díez and Sanchis, 2007). During the medieval age, lands were dominated by wheat and vineyard with olive and fruit trees on the edges and vegetables were in small plots while mulberry tree forest covered the Huerta by the sixteenth century. In the nineteenth century, horticultural crops became the dominant

vegetation; and it was not until the second half of the twentieth century when citric trees started to expand (Sanchis, 2013).

During the second half of the twentieth and beginning of the twenty-first century, the Huerta of Valencia, like other traditional European landscapes (Van Eetvelde and Antrop, 2004), experienced unprecedented fast and profound changes. On the one hand, urban areas replaced the agricultural landscape decreasing the area of Huerta, new infrastructures crossed over the Huerta landscape without considering the existing geographical patterns and new elements related to the urban and industrial activities coexisted with agriculture. On the other hand, the low profitability of farming activity was deriving in the abandonment of the farming activity and deterioration of cultural heritage.

At the present moment, due to the economic crisis, there has been a decrease in the pace of urban and infrastructure growth. Nevertheless, problems related to low profitability of agriculture persist and, hence, the threat of abandonment. In this way, Valencia Region is one of the Spanish Regions with the highest rate of abandonment. The goal of this work is to analyze land use change as one of the components of landscape evolution during the period of economic crisis between 2008 and 2013 in the Huerta of Valencia, which apparently should be more resilient than the average agricultural landscapes in Valencia Region.

2 Methods

The area of study is 11370 ha size and it is composed by the twenty-four landscape units delineated for Huerta de Valencia Action Plan (GVA, 2008). The starting point of the work was the land use map developed for this plan in 2008. In this map, land use corresponds to land cover. This means that it refers more to the natural or human-introduced elements that cover the surface than to the way people use a certain piece of land.

The identification of land use in 2013 was performed with the aid of ArcGIS software. For this task, the latest available aerial photograph, which corresponded to 2012 flight (Terrasit, 2014), was used. A new class “infrastructure” which was classified as “urban processed areas” in 2008 was included during this stage. These new infrastructures were mainly connected to CV-300 road in the north and the high-speed railway in the south (AVE). Finally, the field survey was developed during May 2014. It was conducted on a set of sample areas that were based on buffer areas of 500 meters around a set of randomly selected points that were spatially distributed among the 24 landscape units (Figure 1). As a whole, the sampled area was 1806 ha which involved 16 % of the area of study.

As mentioned above, one of the key issues in this study is the identification of abandonment. Abandoned agricultural land can be defined as land without agricultural use. However, sometimes the detection of abandonment is not straightforward. The edge between abandonment and agricultural use may be not sharp enough because abandonment may occur at different degrees of intensity. In this work, abandonment includes fields that have lost their characteristic regular pattern of cultivation because agricultural use has completely stopped or management intensity is very low.

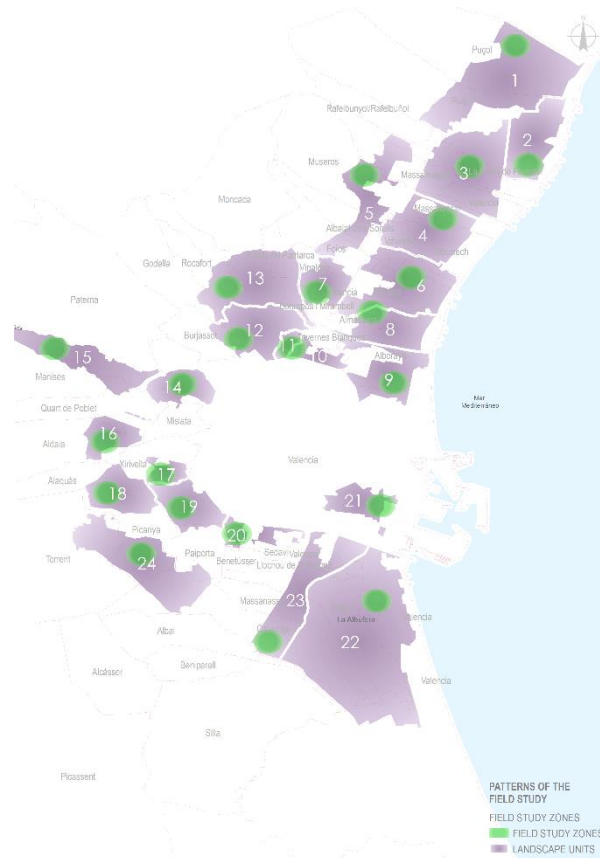


Fig. 1. Distribution of the sample areas in the area of study.

The map classifies land use in 17 types that can be grouped in two main groups: vegetated and non-vegetated surfaces. The vegetated surface applies to areas that have a vegetated cover of at least 4% for at least two months of the year; they are cultivated or contain natural vegetation. These covers consist of the life forms. The subclasses are the following:

- a) Rice fields: cultivated areas that are permanently under water and covered by productive rice vegetation (the exclusive distribution is only in the south of the study area).
- b) Citrical lands: permanent cover of a variety of citric fruit types but mostly by orange or mandarins.
- c) Irrigated arable lands: lands under annual crops, such as cereals, vegetables, potatoes, melons, and includes lands left temporary fallow and permanent crops, as orchards.
- d) Wetlands: areas that are saturated with water, either permanently or seasonally, typically on the east, south-east of the study area, where the vegetation is very characteristic and the soil condition is unique
- e) Palm fields: areas which are covered by different species of palms, mostly they are in bad condition scattered various areas in the study area
- f) Nurseries and greenhouses: include propagation and sale of plant, citrus and trees. Plants in nurseries, unlike in greenhouses, are grown in the open air.
- g) Abandoned fields/fields in bad condition: the exact meaning of that type of land cover is relative. However, in the case study, abandoned lands are defined the lands

which are suitable for agricultural production, but on which the land stopped being managed and used or management intensity is very low.

- h) Other fruit trees: this subclass contains new fruit production areas different from citrus, especially khaki fields. This class was added after the field survey. It corresponds to formerly abandoned areas or citric fields.

The artificial surfaces describe areas that have artificial cover because of human activities with less than 4% vegetative cover. The subclasses are the following:

- i) Asphalted field: areas which are completely artificially overlaid
- j) Containers: areas covered by containers which are related with marine transportation
- k) Industrial areas: all the zones which have been built-up by industrial parks and estates, they are mostly located on the edges of, or outside the main residential areas, mainly on the north part of the study area
- l) Installations: all the establishments which are relevant with electricity and maintenance, likewise military areas
- m) Landfill sites: sites for the disposal of waste materials by burial, found in mostly on the edges, and abandoned areas
- n) Urban processed areas: areas which are influenced by infrastructure, constructions or any type of sprawl that connected with urbanization.
- o) Infrastructure areas: motorways, or railways, including associated installations (stations, platforms, embankments).
- p) Storage fields: Artificially surfaced areas without vegetation, which also contains buildings and vegetation.

3 Results

The analysis of land use change in Huerta de Valencia as a whole shows three main dynamics during the period between 2008 and 2013 (Figures 2, 3 and Table 1). First, results show that there has been a decrease in the area covered by citrus from 32.2 % to 24.8%, which corresponds to a decline of 23% in citrus as compared to 2008. According to cross tabulation, 15 % of the area covered by citric fields in 2008 has become abandoned and 9% has been converted to irrigated arable land in 2013. Second, the percentage of abandonment or fields in bad condition has increased from 11.1 % to 15.6 %, which involves a rise of 40.8 % as compared to 2008. Cross tabulation shows that the surface increase of abandonment is mainly through citrus (31 %) and irrigated arable land (9.6 %). Finally, it is also remarkable the emergence of recently cultivated fields (4 % of the total area in 2013). According to the data derived from the fieldwork, most of these new cultivated areas would correspond to horticultural fields (97 %) and 3 % would correspond to other fruit trees, especially khaki fields. This fact would involve that the area of horticultural fields has not decreased but there has been a slight increase of 6.2 % in the area covered by irrigated arable land as compared to 2008 (Figure 4).

Concerning the analysis of change with regard to the land use values in 2008 (Figure 3), results also show a marked rise in palms (53.5 %), and asphalted fields (22.4 %). However, they are not considered significant since they occupy less than 1 % of the total area. There is also a drop in urban processed areas (13.8 %) which are mainly connected with the new high-speed railway (AVE) and CV-300 road. The artificial surface (containers, industry,

installation, urban processed areas, infrastructure, store and asphalted field and landfill) has not significantly increased. It has raised from 4.7 % to 5.4 % (Figure 5). This increase is mainly due to the new infrastructures and areas in urban process.

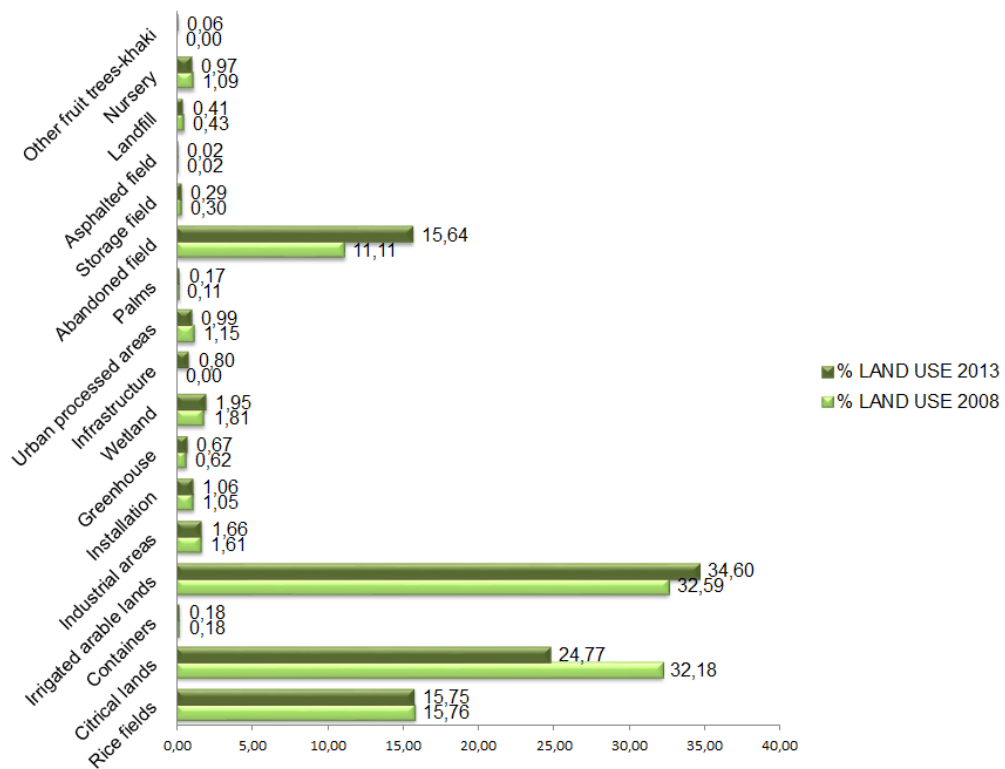


Fig.2. Percentage of area covered by the different land uses in 2008 and 2013.

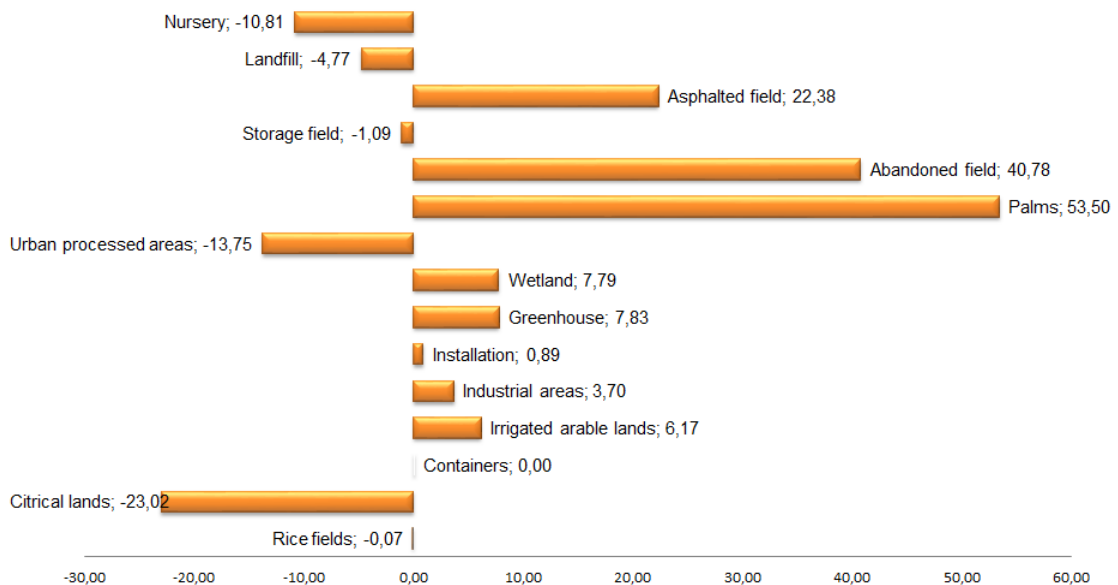


Fig.3. Percentage of land use change for the period 2008-2013 referred to 2008.

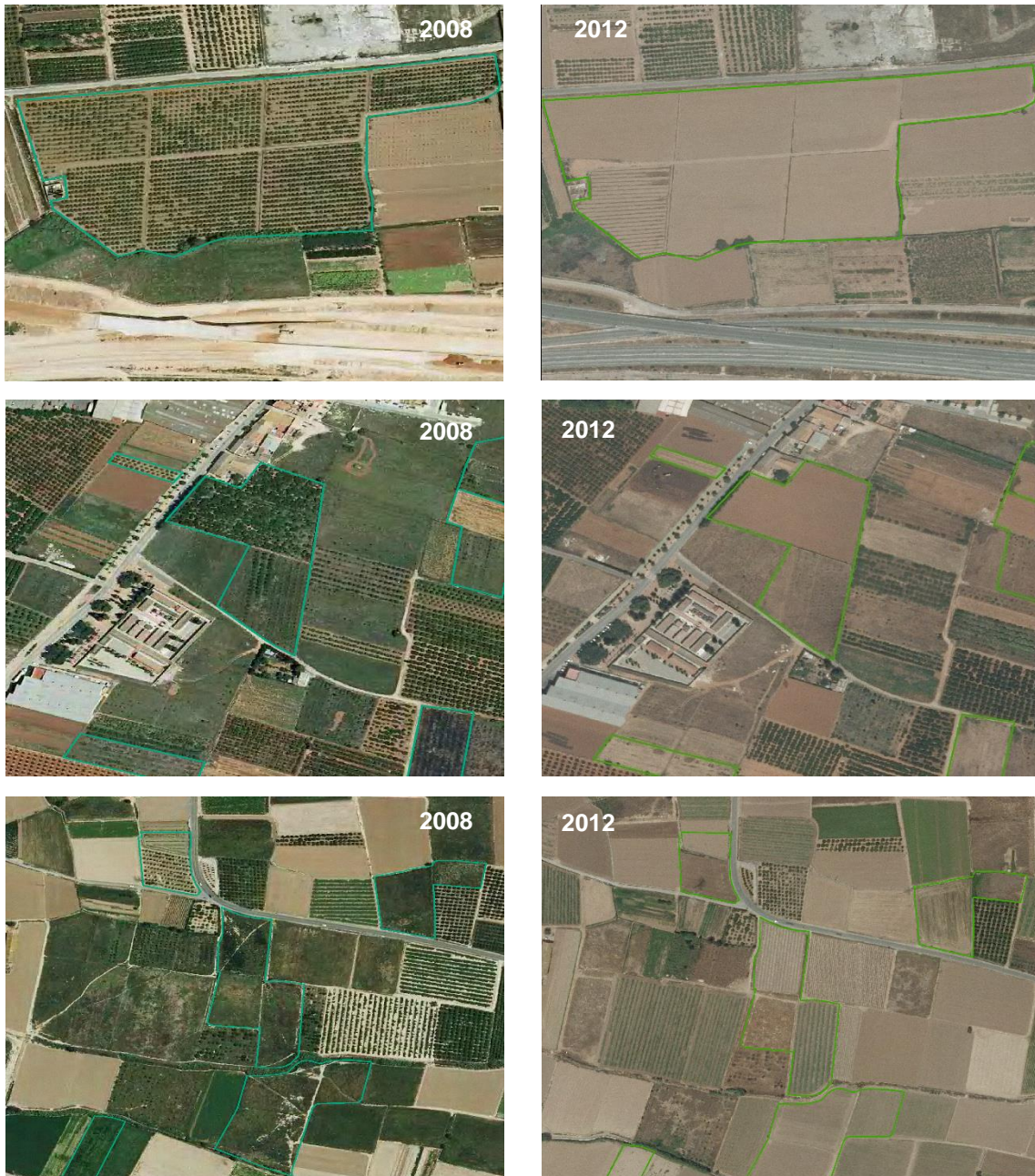


Fig. 4. Examples of new cultivated areas in Horta de Faitanar (19), Horta de Picanya (24) and Horta de Campanar (14)

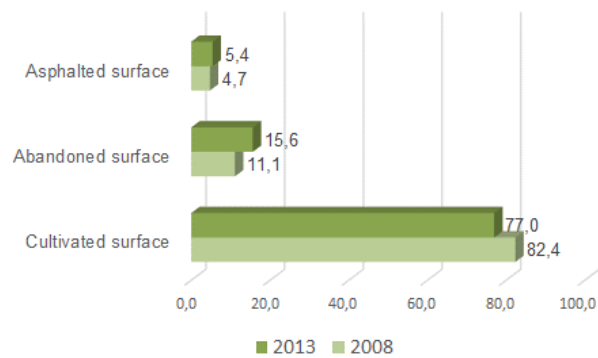


Fig.5. Distribution of the main types of surfaces in Huerta de Valencia

Table 1. Cross tabulation for land use change (ha) in Huerta de Valencia during the period between 2008 and 2013

		LAND USE 2008														
LAND USE 2013	Rice	Citrical	Containers	Horticultural	Industry	Installation	Greenhouse	Wetland	Urban process	Palms	Abandoned field	Storage field	Asphalted field	Landfill	Nursery	TOTAL 2013
Rice	1790,5										0,2					1790,8
Citrical		2760,4		34,3			0,2				22,7				0,2	2817,8
Containers			20,8													20,8
Horticultural	0,9	322,7		3457,6			0,3			1,0	146,2			0,4	5,6	3934,7
Industry		0,6		1,7	182,1						4,4			0,1	0,3	189,3
Installation				0,6		119,6			0,3		0,2					120,7
Greenhouse				8,7			67,3									75,9
Wetland				5,6				204,0		0,4	11,6	0,1				221,6
Urban process		5,6		5,6			0,1	1,6	60,5		34,1	0,3		0,4	4,0	112,3
Infrastructure		7,2		10,8	0,0				65,6		5,5			1,1	0,4	90,6
Palms		5,2		4,0						7,7	2,0				0,8	19,7
Abandoned field	0,6	550,0		171,2	0,4		2,5		3,7	3,7	1035,5	0,5		0,4	9,5	1778,1
Storage field		0,1		0,3							0,2	33,0				33,5
Asphalted field		0,4											2,0			2,4
Landfill														46,8		46,8
Nursery		3,8		3,5											103,1	110,4
Other fruit trees		4,0		2,2							0,4					6,7
TOTAL 2008	1792,1	3660,1	20,8	3706,0	182,6	119,6	70,4	205,6	130,3	12,8	1263,0	33,9	2,0	49,2	123,8	11372,2

When analyzing land use evolution unit by unit, results show different patterns of land use change (see Figures 6 and 7):

- Unit 22 (Horta de la Séquia de L'Or i Arrossars de L'Albufera). It is part of Albufera Natural Park and rice is the dominant land use. Abandonment is scarce.
- Units 6, 8, 9, 10, 11 and 12 (Horta de Meliana, Horta d'Almàssera i Alboraia, Horta d'Alboraia, Horta de San Miquel del Reis, Horta de Petra, Horta de Poble Nou). They are dominantly irrigated arable lands (this land use covers more than 70 % of the units) and with some scattered abandoned fields that involve less than 6 % of the units. New cultivated areas are not significant except for units 6 and 12 (Horta de Meliana, Horta de Poble Nou) which correspond to 3 % of the units.
- Units 7 and 13 (Horta de Vinalesa, Bonrepós i Mirambell, Horta de L'Arc de Moncada). Both units show a mosaic mainly composed by horticultural and mosaic fields with some recent khaki crops. With regard to the level of abandonment, there has been an increase from 6 % to 16 % in unit 13 as compared to unit 7, which has 5 % abandonment in 2013. New cultivated areas, including khaki, involve between 2 % and 4 % of the unit.

- d) Units 14, 20 and 21 (Horta de Campanar, Horta de Favara, Horta de Rovella i de Francs, Marjals i extremals). They are the most degraded units with predominance of irrigated arable land. Abandonment involves more than 20 %, but it has scarcely increased during this period. New cultivated areas, mainly horticultural fields, involve between 4 % and 8.5 % of these units.
- e) Units 18, 19 and 24 (Horta de Bennager, Horta de Faitanar, Horta de Picanya, Paiporta i El Safranar). In these units, citrics are dominant. The high-speed railway (AVE) fragmented them. In 2008, they showed high rates of abandonment (by 15-16 %) which have raised to more than 20 % in 2013. However, new cultivated areas, mainly horticultural, involve between 8 % and 13 %.
- f) Units 17 and 23 (Horta de Xirivella, Horta de Castellar-Oliveral). They show a mosaic of citrics and horticultural fields, where the latter are dominant. They have lower rates of abandonment than the other units do in Horta Sur (less than 20 %) and the rise in abandonment has been more moderate. New cultivated areas, including khaki in unit 17, correspond to 4-5% of the units
- g) Units 1, 3, 4, 5 (Puçol-El Puig, Horta de la Zona Central de la Reial Sequia de Moncada, Horta de Albuxeix i Massalfasar, Horta dels Alters de la Reial Sequia de Moncada). Citrics are dominant in these units. In 2008, they showed rates of abandonment between 9 % and 15 % and they have increased to rates between 17 % and 25 % in 2013. New cultivated areas range from 3 % to 6 % including khakis. Unit 2 (Horta dels extemals del Puig i La Pobla), with a different composition of land cover which includes the presence of old wetlands, shows similarities with the previous units in terms of rates of abandonment (25 %).
- h) Units 15, 16 (Horta del Riu Turia, Horta de Quart-Aldaia). They are the units with the highest rate of abandonment. It reaches 41 % in unit 16. New cultivated areas range from 4.5 % to 9 %.

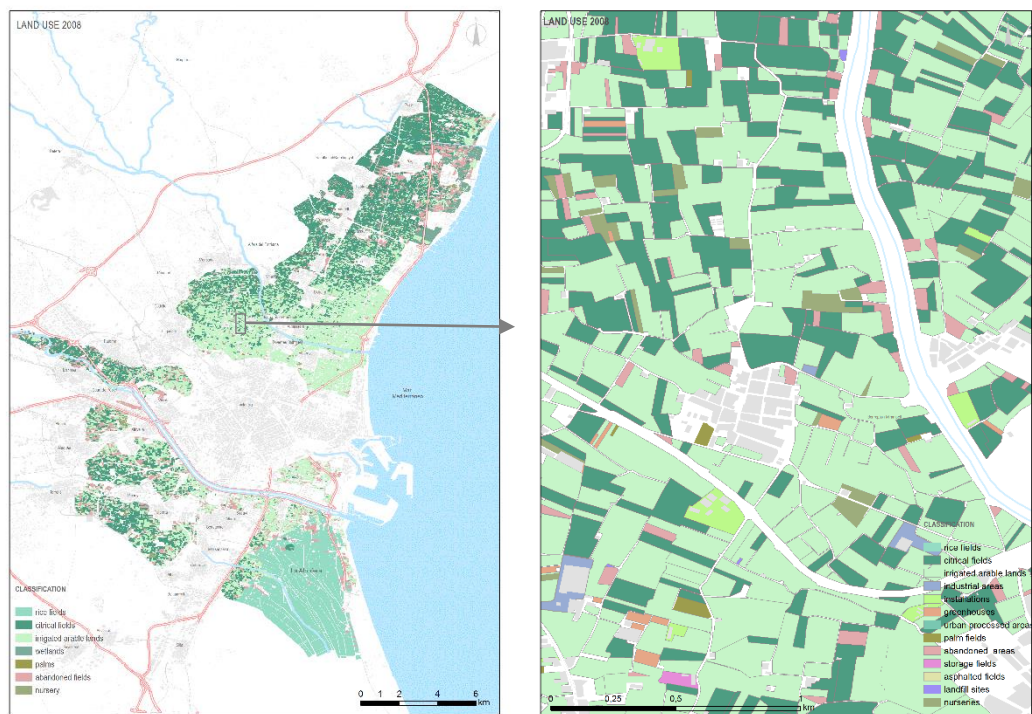


Fig. 6 a. Land use in Huerta de Valencia in 2008.

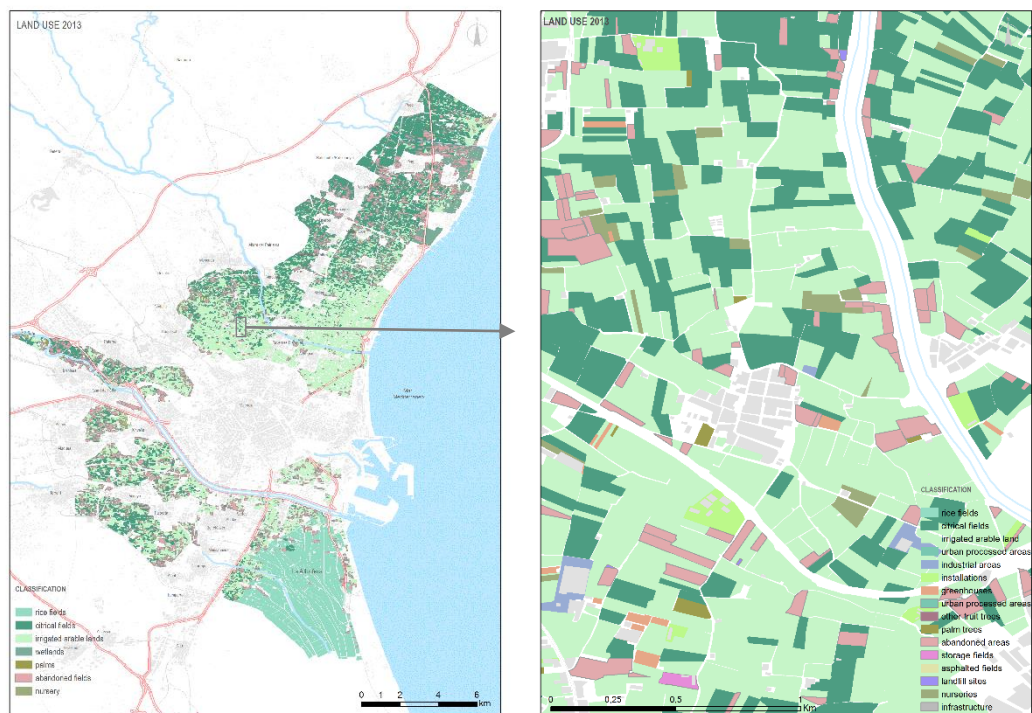


Fig. 6b. Land use in Huerta de Valencia in 2013.

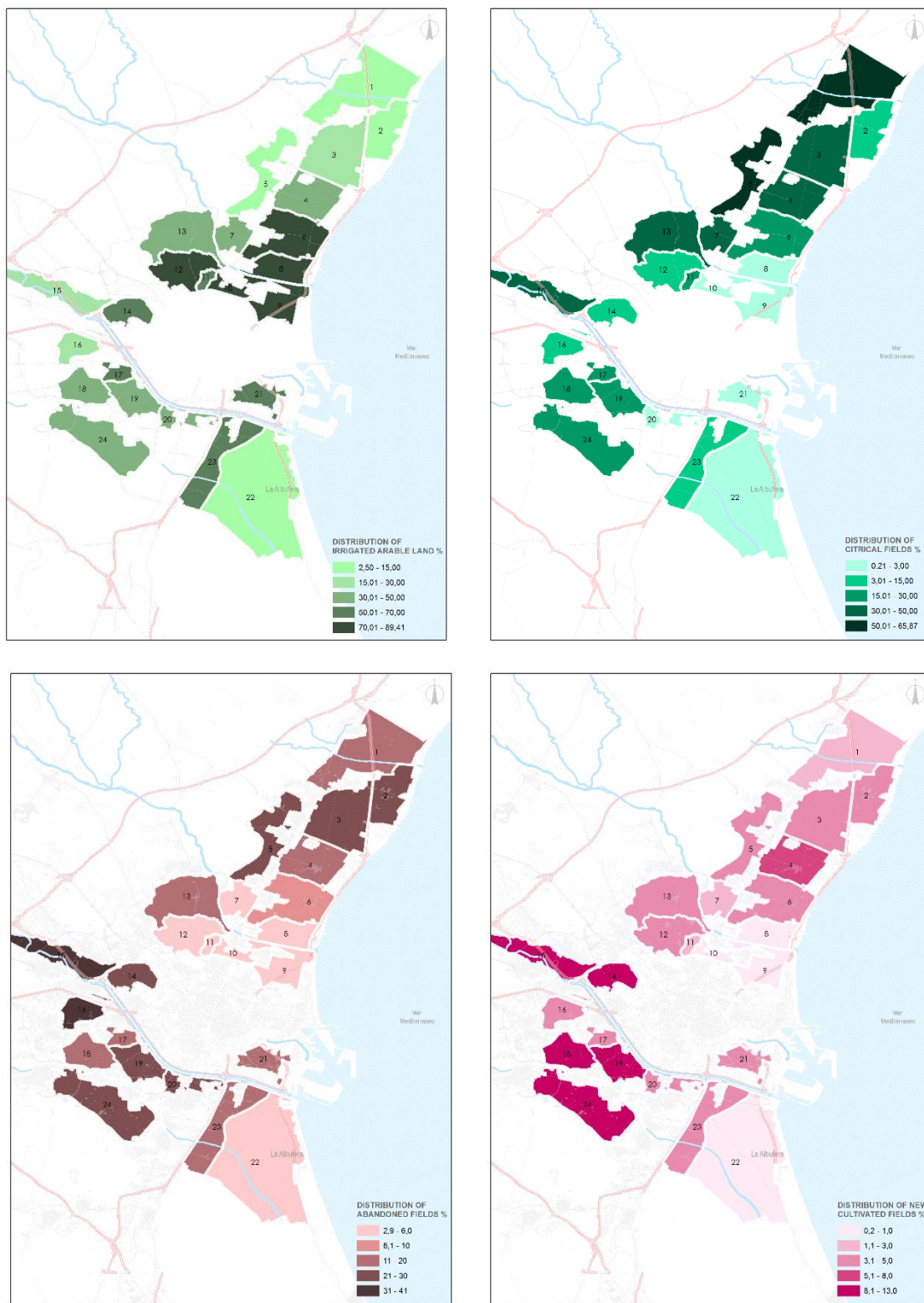


Fig. 7. Percentage of irrigated arable land, citrus, abandonment and new cultivated areas in 2013 within the different units that compose Huerta de Valencia.

4 Discussion

As expected, during the period between 2008 and 2013, there has been a decrease in the cultivated area (from 82 % to 77 % in the Huerta de Valencia). This loss corresponds to approximately 600 ha which means a drop of 6.5 % as compared to the area cultivated in 2008, which is similar to the average data in Valencia Region (6.3 %). This loss of cultivated area is mainly connected to the rise of abandonment since the artificial areas have not significantly increased during this period of economic crisis. While the area of abandoned fields has increased in 4.5 %, artificial areas have raised in 0.7 % (Figure 5).

Table 2. *Distribution of cultivated land (ha) in Valencia Region. Informes del sector agrario, Conselleria de Agricultura, Generalitat Valenciana.*

	2008	2009	2010	2011	2012
Cereals	45618	41273	41618	42767	42867
Legumes	1225	1266	1576	1909	1133
Tuber (human consumption)	2717	2224	2078	2079	2222
Industrial crops	1462	1539	1564	1345	1715
Flowers and ornamental	1550	1666	1757	1882	1830
Forage crops	2877	2380	2373	2509	2478
Vegetables	24398	20443	19114	19093	19430
Citrus fruits	182951	180150	179429	178429	173189
Non citrus fruits	140635	140318	136344	137153	136929
Vineyard	84911	80972	78785	73095	70627
Olive trees	95008	94296	93037	92152	92282
Other woody crops	21102	20906	20553	19716	19577
Nursery	3132	2718	3785	4542	4793
Total	607586	590151	582013	576671	569072

Another finding is the emergence of new cultivated areas. They correspond to approximately 450 ha, which were former citric or abandoned fields in 2008. According to the fieldwork, they are mainly new irrigated arable areas and a small proportion of khaki fields. Basing on this data, there has been an increase of the irrigated arable lands from 32.6 % to 34.6 %. From the observations and informal conversations with farmers during the fieldwork, we can say that many of these fields are quite recent. This finding is consistent, on the one hand, with the increase of 1.8 % in the area of vegetables reported by the Agricultural Regional Department during the period between 2011 and 2012 (Table 2). On the other hand, it could be related to the fact that the agricultural sector has increased in the number of employees between 2012 and 2013 in Horta Nord, especially when referring to self-employed workers (Pactem Nord, 2014).

When analyzing the different units, different patterns have been found. While the landscape unit located in Albufera Natural Park and the ones in Horta Nord with predominance of irrigated arable land show very low percentage of abandonment (less than 6 %), most of the other landscape units show high rates of abandonment (between 15 % and 25 %). These rates are even higher in certain areas like units 15 and 16 (Horta del Riu Turia, Horta de Quart-Aldaia) where the present rate of abandonment has got to 34.8 % and 41 % respectively). Besides, the rhythm of abandonment is especially worrying in

certain with a high value according to the Huerta Action Plan. This is the case of unit 13 (Horta de L'Arc de Moncada) with an increase in abandonment from 6 % to 16 %.

In general, landscape units with higher percentage of citrics are more abandoned. While the area covered by citrics has declined in 7.4%, the area of irrigated arable land has increased in 2 %. Citrics, which replaced an important part of the former irrigated land due to its high profitability and its attractive for part-time agriculture (Besó, 2013), are losing weight in the Huerta de Valencia. According to the present work, 15 % of the areas with citrics in 2008 are now abandoned and 9 % have been replaced by other crops, especially irrigated arable land. This trend may be explained by the fact that monoculture of citrics implies the decrease uncertain factors that promote resilience of socio-ecological systems. These are the decline in diversity and flexibility of landscape and the higher dependency on external inputs, for instance in terms of irrigation, as compared to irrigated arable land (Bergamini *et al.*, 2013).

Other features connected to resilience can be level of landscape protection (Bergamini *et al.*, 2013) and certificates of origin. In this way, unit 22 ((Horta de la Séquia de L'Or i Arrossars de L'Albufera) which is part of Albufera Natural, is one of the most stable units in the Huerta. Concerning certificates of origin, the existence of labels for certain products such as the rice and tiger nut (Arroz del Parque Natural de la Albufera and Chufa de la Huerta de Valencia) which are also linked to traditional local recipes may also explain that the maintenance of farming activity in those areas where these crops are traditionally grown.

Level of social memory and multifunctionality are also traits that can explain differences among the units in the Huerta. Previous work has shown differences in place attachment between people living in Horta Nord and Horta Sud. On the hand, in Horta Nord with higher physical and visual accessibility, the population identifies a high amount of references within the cultivated land. On the other hand, in Horta Sud, with higher levels of fragmentation, which causes the isolation of smaller cultivated patches, spatial references are scarce and the Huerta seems to have disappeared from people's environmental image. In this sense, public use is more frequent in Horta Nord than it is in Horta Sud (Díez, 2012).

Finally, increase in the level of innovation and public participation and involvement (The Resilience Alliance, 2009) which promote resilience of cultural landscapes have been documented in previous works (Giobellina, 2012; García, 2013; Ruiz, 2013). Changes in the production criteria especially referred to organic farming, emergence of alternative shorter commercialization channels and creation of community gardens are examples of the new micro processes that are taking part now in the Huerta. Further research should analyze the spatial distribution of these new processes and its effects on resilience.

4 Conclusions

This work provides an estimation of land use change in the area included in Huerta de Valencia Action Plan during the period between 2008 and 2013. According to the results, 13 % of the analyzed territory has changed. The main changes are the decrease in the area covered by citrical fields (7.4%), the increase of abandonment or areas in bad condition

(4.5%) and the rise of irrigated arable land (2%). The latter, being one of the most significant changes, is through the conversion of citrinal and abandoned fields.

As a whole, the loss of cultivated land in Huerta de Valencia is similar (6.5 %) to the average value for Valencia Region (6.3 %). However, results indicate that land use dynamics are not homogeneous within Huerta de Valencia. The increase of abandonment goes from 1% in the most stable units to 13 % in the most degraded ones. The work suggests a set of factors that may explain the diverse levels of landscape resilience within Huerta de Valencia such as type of crop, landscape diversity, level of landscape protection, connection with certificates of origin, level of social memory, multifunctionality, level of innovation and public involvement.

References

Bergamini, N., Blasiak, R., Eyzaguirre, P., Ichikawa, K., Mijatovic, D., Nakao, F., Subramanian, S.M. (2013): *Indicators of Resilience in Socio-ecological Production Landscapes (SEPLs)*, United Nations University Institute of Advanced Studies, Yokohama.

Besó Ros, A. (2013): La prolongació del verger. El paisatge dels horts de tarongers, in M.J. Picó Garcés, M. Ruiz Brox, Coord., *Veus per L'Horta*, Publicacions Universitat de València, pp. 46-47.

Díez Torrijos, I. (2012): La Huerta de Valencia, estructura y paisaje. *Palimpsesto 04. La permanencia del Cambio*. Barcelona, Càtedra Blanca, UPC.

Díez Torrijos, I.; Sanchis Ibor, C. (2007): Territorio e imagen. La percepción del paisaje de la Huerta de Valencia, *Saitabi*, 57: 63-77.

EEA. (1998): *The Environment in Europe. The Dobbris Report*, European Environment Agency and the Ministry of the Environment.

García Martínez, J.L. (2013): Horts de Lloguer, in M.J. Picó Garcés, M. Ruiz Brox, Coord., *Veus per L'Horta*, Publicacions Universitat de València, pp. 110-113.

Giobellina, B.L. (2012): Procesos emergentes: De la Huerta Andalusí a la Huerta agroecológica del siglo XXI, in J. Romero, M. Francés, Eds., *La Huerta de Valencia. Un paisaje cultural con futuro incierto*, pp. 173-196.

Guinot, E. (2008): *El paisaje de la Huerta de Valencia. Elementos de interpretación de su morfología de origen medieval*. Valencia, Colegio Territorial de Arquitectos de Valencia, Ajuntament de València i Publicacions de la Universitat de València.

GVA. (2009): Plan de la Huerta de Valencia. Un paisaje milenario, Conselleria de Medi Ambient, Aigua, Urbanisme i Habitatge, Valencia.

Kirchhoff, T., F. S. Brand, Hoheisel, D. (2012): Cultural landscapes as resilient social-ecological systems: transformation of a classical paradigm or a novel approach?, in T. Plieninger and C. Bieling, Ed. *Resilience and the cultural landscape: understanding and managing change in human-shaped environments*. Cambridge University Press, Cambridge, UK, pp. 49-64.

Pactem Nord (2014): Situación laboral y desempleo en el sector primario. Horta Nord. Informe Consorcio Pactem Nord. Consorcio socioeconómico.

Ruiz Brox, M. (2013): Horts Urbans, in M.J. Picó Garcés, M. Ruiz Brox, Coord., *Veus per L'Horta*, Publicacions de la Universitat de València, pp. 114-115.

Sanchis Ibor, C. (2013): La dinàmica històrica de l'Horta, in M.J. Picó Garcés, M. Ruiz Brox, Coord., *Veus per L'Horta*, Publicacions de la Universitat de València, pp. 21.

Terrasit, 2014. Ortofoto actual 2012. Terrasit. IDE de la Comunidad Valenciana <http://terramapas.icv.gva.es/ortoactualidad/>?

The Resilience Alliance. (2009): Resilience. <http://www.resalliance.org/576.php>

Van Eetvelde, V., Antrop, M. (2004): Analyzing structural and functional changes of traditional landscapes –two examples from Southern France. *Landscape and Urban Planning*, 67: 79-95.

Walker, B., Holling, C.S., Carpenter, S., Kinzig, A. (2004): Resilience, adaptability and transformability in social ecological systems, *Ecology and Society*, 9(2): 5.