

Case Report

# Industrial Sprawl and Residential Housing: Exploring the Interplay between Local Development and Land-Use Change in the Valencian Community, Spain

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**Abstract:** Urbanization in Mediterranean Europe has occurred in recent decades with expansion of residential, commercial and industrial settlements into rural landscapes outside the traditional metropolitan boundaries. Industrial expansion in peri-urban contexts was particularly intense in Southern Europe. Based on these premises, this work investigates residential and industrial settlement dynamics in the Valencian Community, Spain, between 2005 and 2015, with the aim to clarify the role of industrial expansion in total urban growth in a paradigmatic Mediterranean region. Since the early 1990s, the Valencian industrial sector developed in correspondence with already established industrial nodes, altering the surrounding rural landscape. Six variables (urban hierarchy, discontinuous settlements, pristine land under urban expansion, isolated industrial settlements, within- and out-of-plan industrial areas) were considered with the aim at exploring land-use change. Empirical results indicate a role of industrial development in pushing urban sprawl in coastal Valencia. A reflection on the distinctive evolution of residential and industrial settlements is essential for designing new planning measures for sustainable land management and containment of urban sprawl in Southern Europe. A comparative analysis of different alternatives of urban development based on quantitative assessment of land-use change provides guidelines for local development and ecological sustainability.

**Keywords:** residential development; industrial development; land-use changes; Southern Europe

## 1. Introduction

Land-use has transformed substantially in recent decades since agricultural and forest areas have been replaced by urban settlements designated for both residence and industrial/commercial activities [1,2]. Such transformations were associated with distinctive socioeconomic contexts [3–11] and a progressive trend toward decentralization of population and industries [3,12,13]. In Europe, the recent expansion of industrial settlements was the result of multiple factors, including economic and financial globalization, national and local policies, societal changes, and new lifestyles [10,14]. Moreover, urbanization processes—especially those involving industrial settlements—have occurred in recent decades outside the traditional urban centers, settling new economic poles along peri-urban landscapes [4,7,15–18]. Along with residential sprawl [6,8,9,19,20], some metropolitan areas in Europe have witnessed a huge expansion of industrial settlements, increasing their degree of innovation

and urban competitiveness [4,21–23]. However, new industrial settlements have been concentrated along the major roads of metropolitan regions, optimizing logistics, attractiveness and commercial relations with global markets [4,24,25]. The increasingly dispersed location pattern of economic activities—especially industry—in peri-urban regions have received particular attention in social sciences recently [26,27]. Positive externalities of proximity have been documented [28]. The notion of ‘Industrial Districts’ [29] or ‘Industrial Clusters’ [30] have been analyzed in the content and nature of these externalities. Firms participating in territorial-based networks have developed a set of relationships in the form of “untraded interdependencies”, which benefit their innovation and competitive capabilities in different aspects [31].

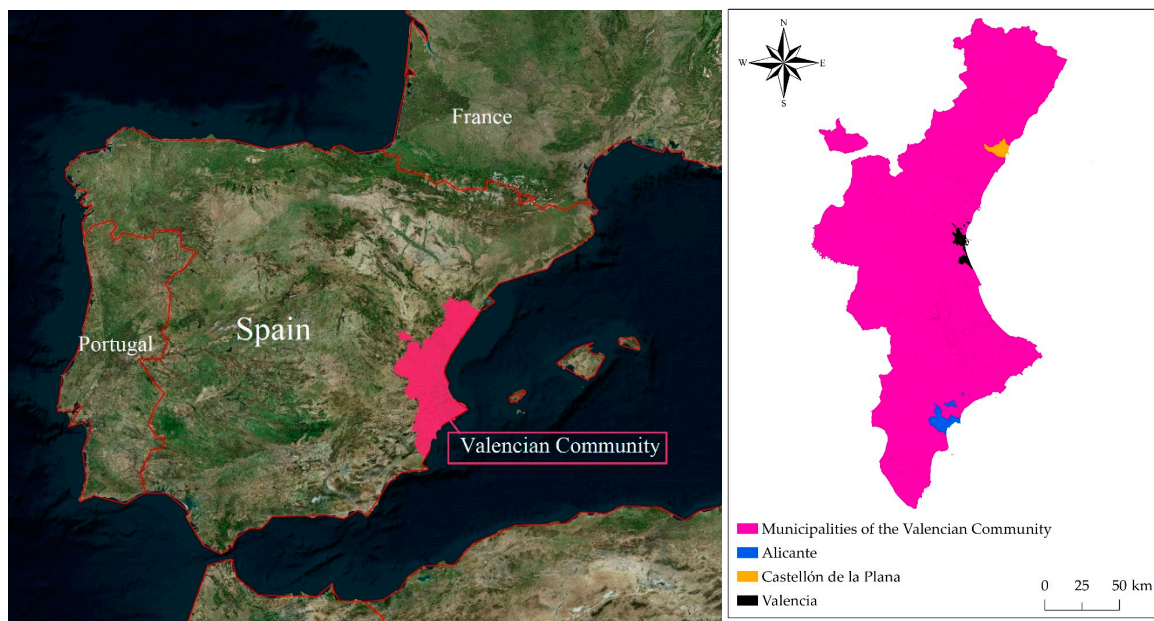
At the same time, the expansion of residential settlements in peri-urban Europe has also been investigated [4,8]. For instance, Southern European cities have extended into rural areas forming suburbs and residential sub-centers with medium-dense settlements mixed up with scattered and fragmented commercial areas [32–35]. In these contexts, spatially unbalanced settlements have expanded into rural areas through low-density suburbs and isolated residential settlements [36]. The legacy of the past development was replicated in the spatial configuration of several metropolitan regions in Southern Europe [10]. Weak planning regulations, ‘informal’ building activities and high costs of housing in central cities have played a major role in residential sprawl [33,37]. At the same time, processes underlying industrial sprawl in such contexts were only occasionally investigated and need a more comprehensive understanding to clarify the latent mechanisms underlying urban dispersion in the Mediterranean basin. The purpose of the present work is to investigate industrial and residential expansion of a Southern European city (Valencia, Spain). A mixed residential/industrial expansion was particularly evident in Valencia since the 1980s [38–42]. More recently, large industrial poles were established in peri-urban districts involving different economic sectors; for example, the car manufacturer in the Southern Valencia and ceramics in the province of Castellón [43]. The current industrial outline also changed the traditional landscape in Valencia, converting rural areas towards residential and industrial land-use [42].

Based on these premises, the present study assumes that spatial transformations in the Valencian Community have been strongly associated with economic specialization and social contexts [43,44]. In these regards it was demonstrated how urban expansion in the Southern Europe has frequently stimulated transformations towards (i) industrialization, (ii) economic specialization and (iii) innovation spillovers [31]. Such phenomena led to accelerated growth of residential and industrial settlements, giving job opportunities to people living in neighboring districts [4]. Exploring residential and industrial evolution in the last decade in relation with other land-use may suggest improved regional planning and sustainable management of peri-urban land. By reflecting on the recent residential and industrial evolution in a Spanish region, a comparative assessment of the interplay between local development and land-use changes may inform policies for urban containment under conditions of accelerated industrial development.

## 2. Material and Methods

### 2.1. Case Study

With an area extending 23,255 km<sup>2</sup> and hosting nearly five million inhabitants, the Valencian Community is one of the most dynamic regions of Spain [45], located in the eastern area of the Iberian Peninsula (Figure 1). Valencia, the capital city of the Valencian Community, is the third largest city in the country, with a metropolitan area populated by 1.5 million inhabitants. Besides Valencia, Castellon de la Plana and Alicante are the other two head towns of the region [38,46,47].



**Figure 1.** Territorial framework of the study area in Southwestern Mediterranean Europe. Source: Own elaboration.

Being a typically Mediterranean region, Valencian Community has become a major tourist destination in recent decades [39,42], promoting its touristic image, especially the Costa Blanca destination in Alicante [39]. Its strategic position in the Mediterranean basin, mild climate and territorial diversity contribute to make the Valencian Community very attractive in every aspect and season [45], revealing its cultural and natural heritage, a diversified economic system, extended farmlands and highly qualified services in the tourism sector [42].

The Valencian Community has exhibited a particularly intense urban growth in recent years (48). In this region, suburbanization has affected not only major cities but also medium-sized towns, peri-urban areas and intermediate rural districts [48]. According to data derived from the Corine Land Cover European project, sealed soil area increased by 52.1% between the 1990s and the 2000s, a value above the national average. About 41.4% of this development came from urban areas, particularly those characterized by dispersed and low-density patterns. Consequently, discontinuous urban fabric grew by 48% and sparse urban structures by 103%, while compact urban fabric rose by 8.5% (following the statistics disseminated by Observatory of Sustainability in Spain in 2006).

In recent decades, the Valencian Community had experienced a rapid urban and economic growth centered on “commercial” attractiveness, with implications on landscape quality [45]. While residential settlements have spread along the seacoast, reflecting the expansion of second home housing markets [49–52], industrial activities have been more concentrated along the main road axes [53]. Recent urban developments have defined a new metropolitan corridor where the main urban centers provide a sparse countryside of houses, industrial parks and highways expanding into agricultural lands [42]. Such kind of outline designs a distinctive Spanish style of urban sprawl [3,54,55]. Counteracting a potential loss of landscape, the Valencian Community was the first Spanish region to be fully adherent with the objectives of the European Landscape Convention through the design and implementation of a set of policies and plans for the protection and enhancement of its landscapes [45].

The agreement of Spain’s democratic Constitution in 1978 instigated a process of political decentralization, basically changing legal bases and political drives overdue land-use planning [40,49]. Authority concerning the urban and regional planning was relocated from the Spanish capital city, Madrid, to the regions, like the Valencian Community. Therefore, regional governments endorse their regional economic development since decentralization transformed also the social background for planning and economic expansion [40]. Regional administrations were shaped and cities, as

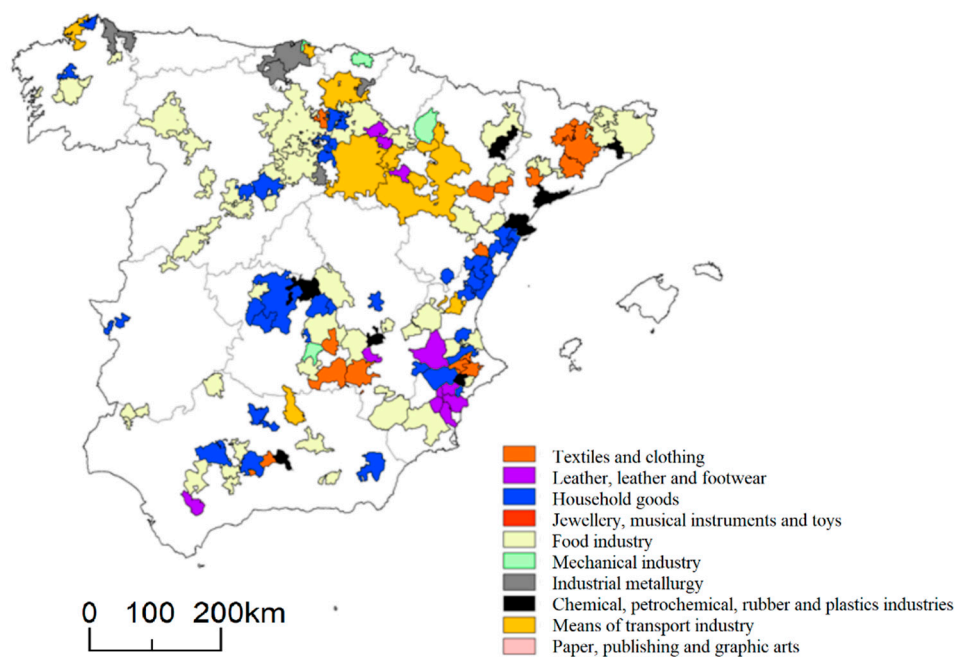
Valencia, turned out to be the regional capitals, occupied with new institutional and representational devices. The 1978 Constitution deputized select jurisdictional authority over urban planning to new regional administrations, like the Generalitat Valenciana; meanwhile, municipalities engaged important planning autonomy and regional government to have a certain planning role of territorial planning at the supra-municipal scale [40]. Though the scale of territorial planning is distinct and greater to that of traditional urban planning, both territorial and urban planning are essentially connected with a common devotion on land-use [40].

With the 1990–1992 Act during a social-democratic government, a modest effort to limit landownership rights gave more importance to public goals in the planning system [56]. In fact, the 1994 ‘urbanizing agents’ law has led to increased investment and urbanization in the context of public spatial planning throughout the Valencian Community. This event has directed real land-use changes in the planning practice of local authorities, industry development and land markets [57,58]. As a result of land speculation often derived from urban dispersion, landowners have built up a wealth of second homes and villas in peri-urban areas and near the seacoast. The 1994 law was applied to provide luxury infrastructure to these semi-consolidated and often underserved areas. The owners could build more and escape from the new infrastructure, though they were forced to pay for these benefits and to give up a significant part of their land [59]. However, such urbanization has transformed the landscape, as owners build second homes and villas with high land consumption [56–60].

However, the recent housing construction of second homes along the seacoast and dispersive urbanization happened thanks to direct involvement of the local and regional government [61,62]. In fact, Spanish municipalities have suffered from a shortage of financial resources due to the regional decentralization. As a result, local administrations have detected sprawl urbanization to raise their resources through land supervision and new housing taxes. They are consequently better fortified to face inhabitants’ demands and opportunities for the enhancement of services. The transaction fees connected to urbanization and land liberalization, together with local fiscal competences over housing construction, have offered both municipal and regional administrations with the resources needed to renovate cities [61,62]. Though, the restrictions of what modernization incomes have occasionally been blurred, to the extent that the housing boom became in some cases unreasonable, like in Southeastern Spain [8,20,37].

## 2.2. *The Industrial Context*

The Valencian Community has been the most investigated among the industrial districts of Spain (Figure 2), thanks to the role of industry in regional economy since the early 1980s [44,63,64]. The first industrial district of the region was in a municipal cluster specialized in the ceramic production in the province of Castellón, being likely the most studied local system in Spain [46,47,63–66].



**Figure 2.** A general map identifying and classifying industrial districts in Spain (2011). Source: Own elaboration from [44].

The historical expansion of Valencia's metropolitan area reflected the structural transformations arising from the industrialization process of the 1960s. In the 1970s, population and economic growth associated with industrialization were concentrated in the central municipality and in specific municipalities southwest of Valencia. In the 1980s, development took place mainly northwest of Valencia, as a result of industrial, residential and tertiary sector growth promoted by improvements in transport and communication infrastructures. Residential and economic decentralization started in the 1990s, giving rise to marked differences in land-use structures between the central municipality, where the tertiary sector was mainly located, and the metropolitan ring, where industry still prevails [67]. A small portion of the regional population (17%) settled in a low-density intermediate region in-between seacoast and mountains, concentrated along the main roads, where a predominance of medium-sized towns, industrial settlements and rain-fed agriculture dominate the landscape [60]. In this context, industrialization stimulated residential expansion.

Despite the 2007 recession, industrial specialization in Valencia was preserved in recent times, thanks to ceramic production [46]. However, industry in the last decade has lost importance in the Valencian economy. According to the data collected in the Spanish Regional Accounts, the manufacturing industry contributed 19.5% of regional Gross Value Added (GVA) in 2000, falling to 12.3% in 2009. The industrial decline was particularly intense in this period: Valencian industry accounted for 11.5% of Spanish industrial GVA in 2000 and only for 9.0% in 2009. In a decade, the productive structure of the Valencian Community has reduced its industrial specialization: the location quotient of the manufacturing industry decreased from 1.19 in 2000 to 1.09 in 2009. In 2011, the industrial GVA grew in a context of recession, with a share in the regional value added up to 13.3% [48]. Valencian industry has been negatively influenced by the 2008 crisis, to the extent that some of the traditional sectors are on the edge of extinction, especially furniture and glass manufacturing sectors. Other sectors seriously affected by global recession are the textile industry, clothing and toys. Conversely, the manufacture of ceramic products and the manufacture of rubber and plastics have better endured the recent crisis [48]. For instance, the existence of sub-networks of different relations within the ceramic district of Castellón gave a substantial resilience to the crisis, having promoted a spatial differentiation into a core network and a peripheral network with distinctive products and management, particularly in terms of share capital and innovation [46,47,65,66]. The

ceramic industry emerged with a greater number of related firms in a bounded geographical area [27]. In Valencia, it is considered an example of ‘growth poles’ [68,69]. The ceramic cluster has maintained a dynamic trajectory and demonstrated a great adaptation to the crisis [45]. Even the textile industry is an important industrial district located in the province of both Alicante and Valencia, increasing considerably in recent years [44,70].

### 2.3. Indicators

Land-use data used in this study has been derived from the database of the Statistical and Cartographic institute of the Valencian Community (Table 1). Land-use maps were elaborated through photointerpretation on a set of ortho-photo-images at two distinctive years, 2005 and 2015. Land-use maps indicate that the landscape of Valencian Community is composed by more than 160,000 polygons of different land-use classes. For each polygon, the centroid was calculated as the most representative location. Polygon centroids are used widely in geographical studies [71,72] since they allow characterization of the spatial distribution of land-use in a definite region [73]. Each centroid was used to calculate the distance from the neighboring centroids [72]. Polygons were also profiled according to (i) the surface area, (ii) the perimeter and (iii) the mean elevation (using a Digital Terrain Model provided by the same data source); (iv) the ratio among surface area and perimeter of each land-use polygon; and (v) the name of the respective municipality.

**Table 1.** List of indicators used in this study.

Acronym	Description	Unit
Cooc	Geographic coordinate x of each centroid	
Cooy	Geographic coordinate y of each centroid	
Cpm	Municipal code	
Mun	Municipal name	
S_mun	Municipal area	Ha
Dtm	Elevation	m
Area	Patch area	Ha
Per	Patch perimeter	m
Area_p	Patch area to perimeter ratio	ha/m
D_sea	Distance from the sea	m
D_road	Distance (minimum) from the road network	m
D_va	Distance from downtown Valencia	m
D_al	Distance from downtown Alicante	m
D_ca	Distance from downtown Castellon	m
A_va	Distance from Valencia airport	m
A_al	Distance from Alicante airport	m
A_ca	Distance from Castellon Airport	m
D_nat	Distance from natural areas	m
D_rail	Distance from railway	m
Cos	Coastal municipality	Dummy (0: no; 1: yes)
Urb	Urban center	
Disc	Discontinuous urban areas	
Exp	Area with compact urban expansion	Dummy (0: no; 1: yes)
I_iso	Isolated industrial area	
I_pla	Planned industrial settlement	
I_npla	Out-of-plan industrial area	

For each land-use polygon, a spatial analysis was carried out to calculate other indicators assessing the linear distance from attractors such as (i) the seacoast, (ii) the neighboring major road, (iii) each of the three main cities in the region (Valencia, Castellon de la Plana and Alicante), (iv) each of the three main airports of the region, (v) the closest boundary of the neighboring statutory natural area and (vi) railway. The category “natural areas” included forests (e.g., deciduous forests and conifers), marshes, shrub, rocky outcrops, water system, as well as marine cliffs. Area designation followed the regional

plan of protection of natural areas (Pla d'Ordenació de Recursos Naturals, PORN). Dummies were used to identify polygons belonging to (i) coastal municipalities, (ii) urban centers, (iii) discontinuous settlements, (iv) areas under urban expansion, (v) isolated industrial areas, (vi) planned industrial areas and, finally, (vii) out-of-plan industrial areas. Spatial analysis was carried out using Geographic Information Systems. Kernel density allowed us to calculate a magnitude per unit area from point features to fit a smoothly tapered surface to each point creating an output raster dataset with 1 km grid resolution. Descriptive statistics (average, minimum and maximum value, standard deviation and variance) were also calculated for each relevant variable.

#### 2.4. Cluster Analysis

Clustering allowed identification of different types of land-use and their changes over time. Given a set of weighted features, a Cluster and Outlier Analysis (Anselin Local Moran's I index) was run with the aim at identifying statistically significant spatial clusters and outliers. For each land-use class reported above, spatial analysis also explored how each cluster had transformed over time considering the relative surface area as a basic attribute.

### 3. Results

The analysis of polygon centroids falling in residential areas (urban center, discontinuous settlement and urban expansion) and industrial areas (industrial isolated, ordered industrial estate and unordered industrial estate) is illustrated in Table 2 separately for 2005 and 2015. The surface area for each land-use ('sup\_area'), the amount of industrial parcels ('n\_parc'), the average patch area ('aver\_parc') and the related standard deviation ('dev.stand\_parc') were calculated. Change over time in the surface area ('Var\_sup\_1505') and the absolute number of parcels ('Var\_n\_1505') was also calculated. Suburban areas, including discontinuous settlements and residential areas have strongly expanded between 2005 and 2015 (34%) although with a moderate fragmentation (12%). Isolated and out-of-plan industrial fabric decreased by 22% and 15%, respectively. Planned industrial areas have grown moderately (5%), similarly to settlements dispersed along the major economic poles and roads (12%).

**Table 2.** Indicators and descriptive statistics.

	2005				2015				Change (%)	
	sup_area (km <sup>2</sup> )	n_parc	aver_parc (ha)	cv_parc	sup_area	n_parc	aver_parc	cv_parc	Var_sup_1505	Var_n_1505
Urban center	79,754,314	732	108,954	4.1	80,440,345	742	107,829	4.1	1	2
Discontinuous areas	992,621,479	4291	231,326	7.6	1,223,159,368	4369	277,235	11.5	23	3
Urban expansion	241,406,968	2353	102,508	1.8	268,825,338	2535	104,764	2.4	11	9
Industrial isolated	77,794,708	976	79,708	8.1	60,698,912	965	62,383	7.2	-22	0
Planned Ind. Areas	175,128,636	691	253,442	3.4	183,157,805	770	236,944	1.9	5	12
Out-of-plan Ind. Areas	51,773,908	366	141,459	5.5	43,939,408	348	124,123	6.4	-15	-3
Total landscape	57,216,872,486	157,687	362,066	8.2	57,162,714,346	159,867	359,353	9.4	0	1

Comparing residential and industrial land-use maps dated 2005 and 2015, both urban types expanded significantly over time (Figure 3). Metropolitan expansion was particularly evident in the case of dispersed urban settlements and planned industrial fabric.

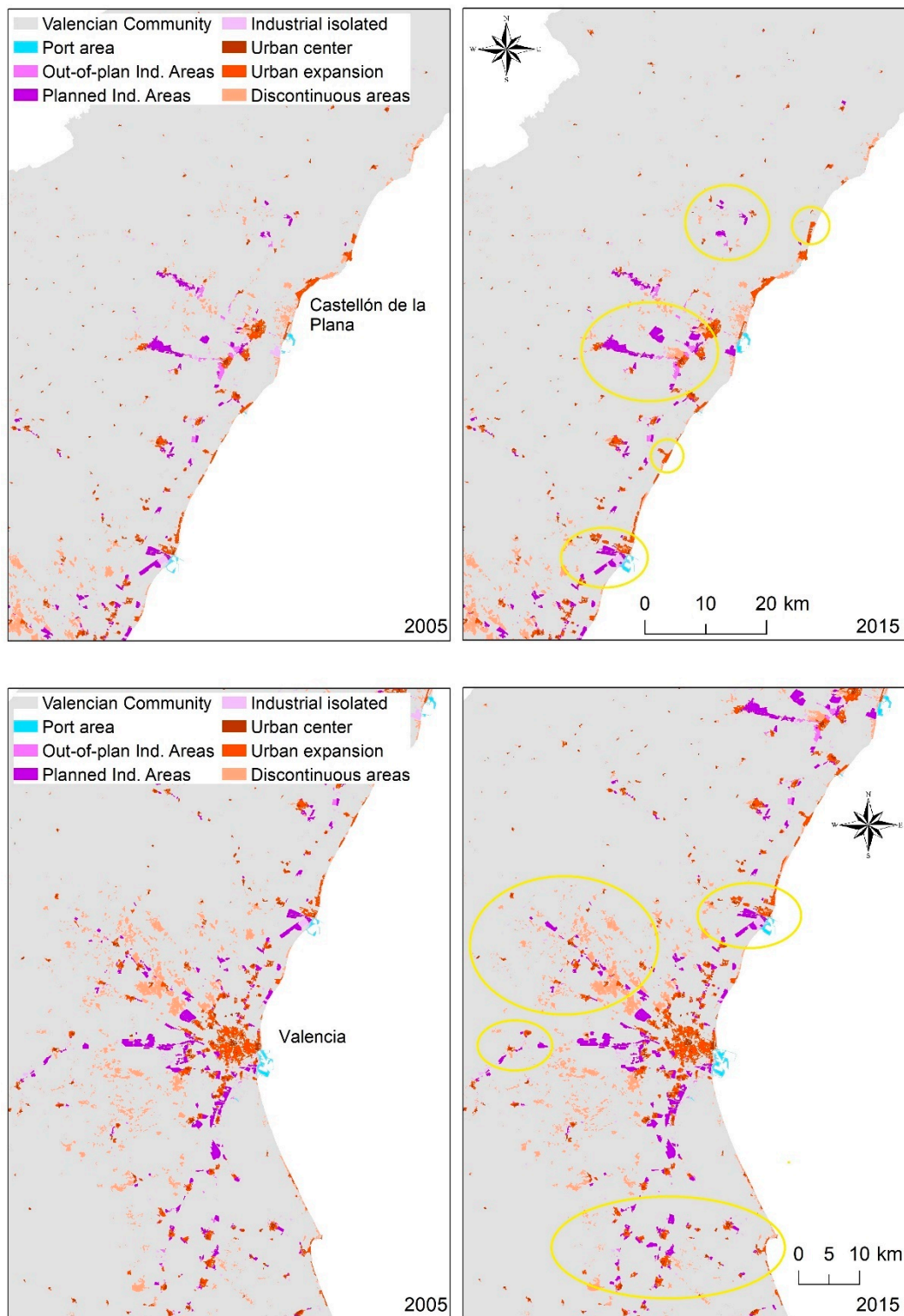
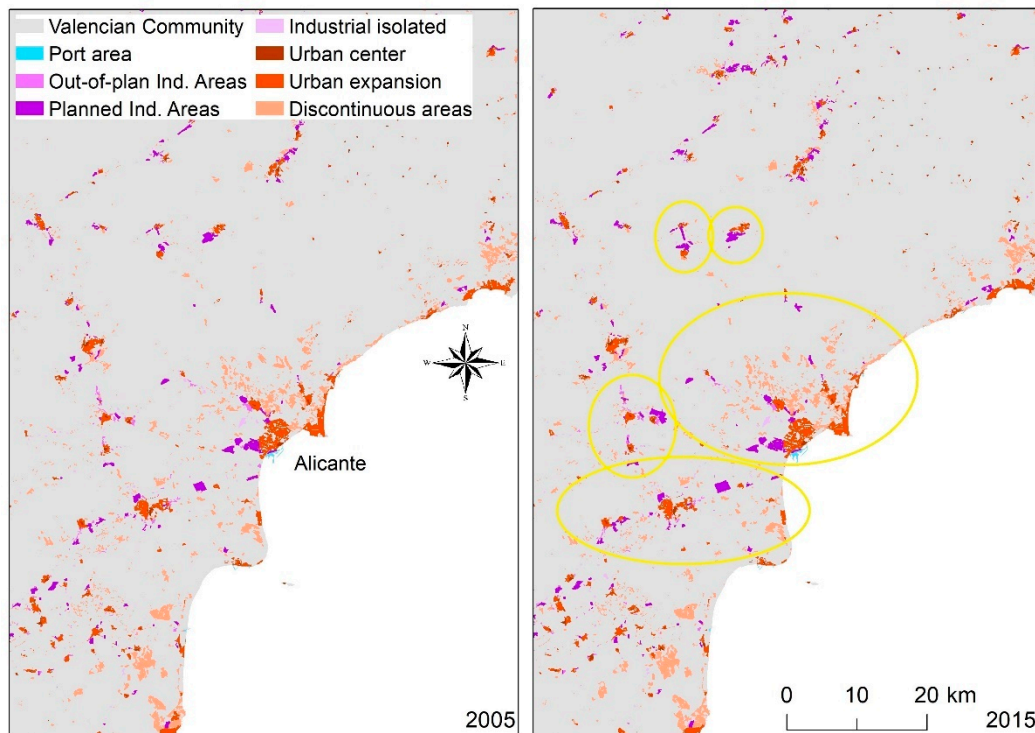


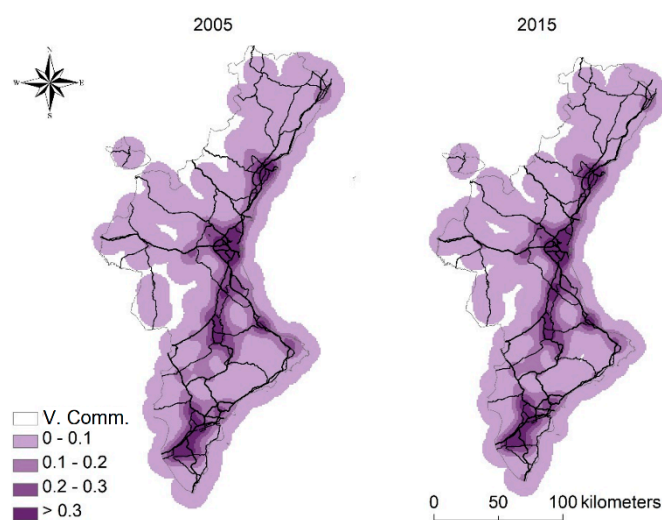
Figure 3. Cont.





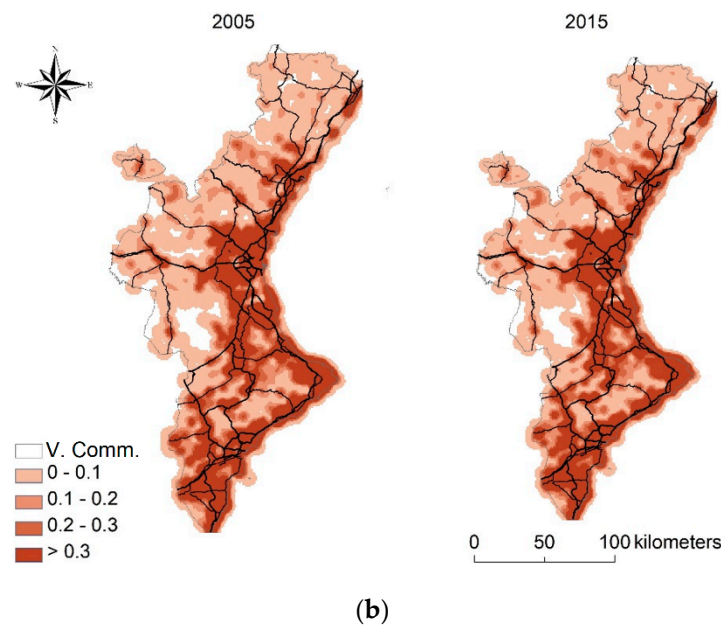
**Figure 3.** Spatial distribution of urban and industrial land-use in 2005 and 2015. From Castellón de la Plana (upper figures), Valencia (second row of figures) to Alicante (figures in bottom).

Kernel analysis outlined different trends for industrial and residential land-use between 2005 and 2015 (Figure 4). First, industrial districts developed mainly along the motorways and main roads (Figure 4a). They seem to become more compact over time, particularly in the metropolitan area near Valencia. Industrial intensification took place near the major production centers and in correspondence with large urban centers. Unlike industrial settlements, residential development outlined a different trend where the highest density has concentrated over time along the coastal rim and, more slightly, along the main roads (Figure 4b).



(a)

**Figure 4.** Cont.



**Figure 4.** Kernel analysis of (a) industrial and (b) residential land-use polygon centroids in 2005 and 2015, based on main roads.

Descriptive statistics (average, minimum and maximum value, standard deviation) were calculated for the distance between residential and industrial centroids from natural (protected) areas (Table 3). The lowest value was recorded for both discontinuous settlements and expanding urban areas, indicating a preference of sprawled settlements for locations close to natural amenities. The average distance from dispersed settlements decreased over time (from 765 m in 2005 to 718 m in 2015), indicating a subtle expansion of settlements towards natural areas. The greatest distance to natural locations was recorded for industrial areas, both informal and planned. Especially for unplanned sites, this distance decreased slightly from 1120 m (2005) to 1012 m (2015). This evidence indicates that industrial areas were settled relatively far from natural areas. At the same time, industrial areas were located far from residential areas. A specific pattern is evident for 2015, where isolated, planned and informal industrial estates were far from natural areas, 7.6, 22.3 and 2.8 km, respectively.

**Table 3.** Distance (m) among residential and industrial sites from natural areas.

Land-Use Type	Average	Min	Max	Deviation Standard
2005				
Urban center	797	0	7303	859
Discontinuous areas	943	0	6641	869
Urban expansion	766	0	6440	847
Industrial isolated	1007	8	7936	874
Ordered industrial estate	1022	0	5758	970
Unordered industrial estate	1120	3	8628	1080
2015				
Urban center	800	0.0	7303	866
Discontinuous areas	929	0.0	6641	816
Urban expansion	718	0.0	5908	769
Industrial isolated	1006	8	5435	798
Ordered industrial estate	1041	22	5758	954
Unordered industrial estate	1012	3	5270	843

Analysis of spatial clusters identifies both residential and industrial settlements, classified into 4 sub-categories: (i) high–high cluster (red), when larger areas of a specific land-use are concentrated in areas similar in size and type of land-use; (ii) high–low outlier (orange), when larger areas of a given

land-use type are concentrated around smaller areas of the same land-use; (iii) low–high outlier (dark blue), when smaller areas of a given land-use are concentrated in larger areas of the same land-use; (iv) low–low cluster (light blue), when smaller areas of a given land-use are concentrated in areas similar in size and type of land-use (Figure 5).

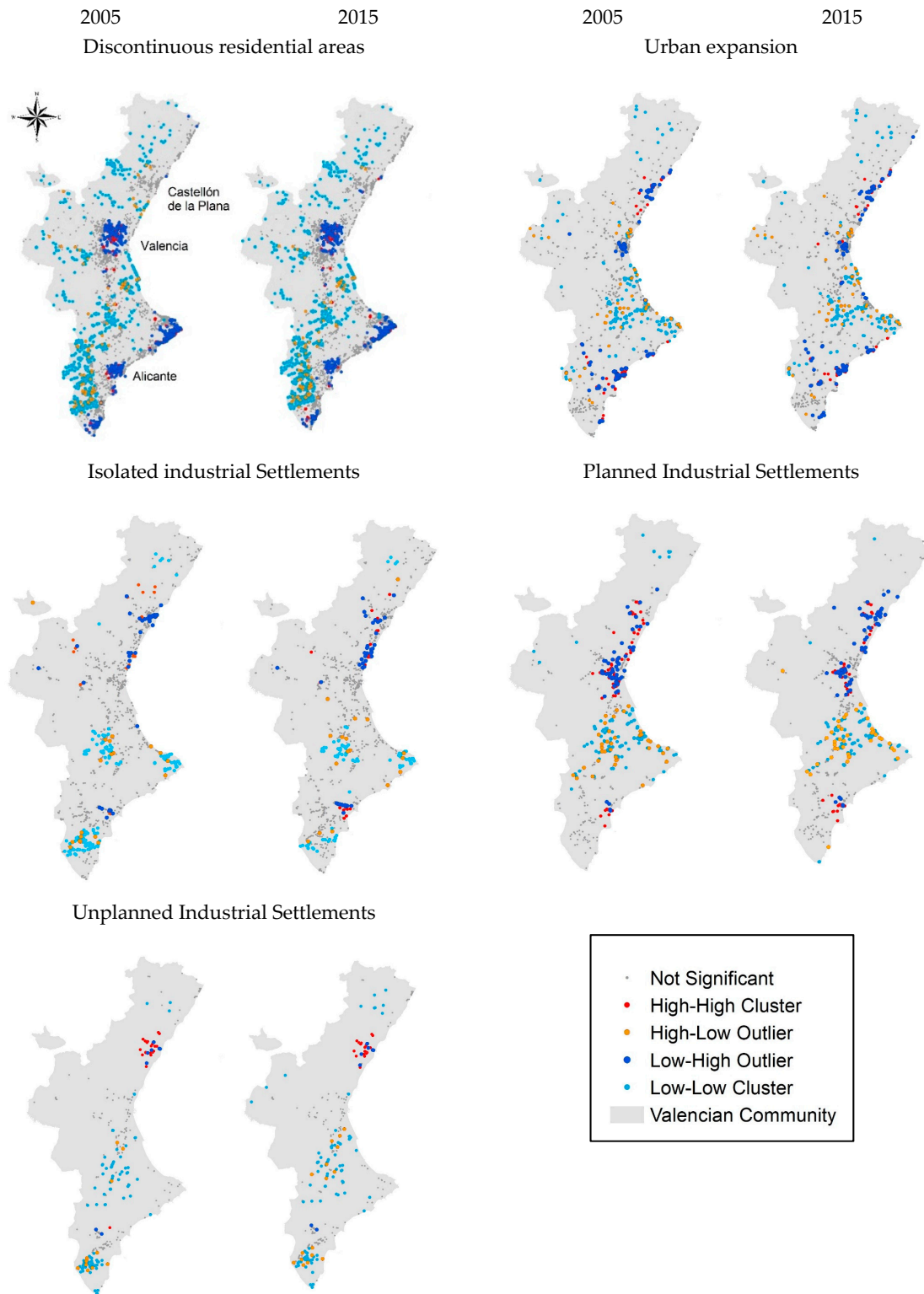


Figure 5. Results from a Moran's spatial clustering by land-use type, 2005 and 2015.

A greater dynamism was observed for the industrial settlements in the Valencian Community. In the area around Castellon, isolated industrial settlements expanded over time were classified as a low–high cluster. This outcome exhibited that small (isolated) industrial settlements tend to group over space following typical trends of larger industrial contexts. A similar trend also occurs in the area near Alicante. A divergent trend was instead recorded with low–low clusters, which seem to shrink over time, a pattern typical of the three light blue clusters identified in the southern area near Alicante. A strong dynamism is also evident for planned industrial areas. Particularly, fragmentation of industrial land was observed in the area of Castellon where the largest outlier in 2005 has turned into two distinct spatial outliers in 2015.

At the same time, high–high clusters emerged in the area of Alicante. Greater clusters and outliers have emerged for unplanned industrial estates. This trend was found in almost all areas, strengthening over time and concentrating in the spatial districts already evident for 2005. Concerning residential areas, several clusters define small plots of discontinuous land-use near larger residential areas (dark blue). This kind of cluster emerges in the cities of Valencia and Alicante, but also along the southern coastal area (Costa Blanca), between Denia and Benidorm. Moreover, this cluster does not vary significantly over time. Smaller and more isolated discontinuous residential areas are concentrated in the internal municipalities of the Valencian Community south of Valencia (light blue). Expanding areas strengthen clusters of this land-use class. In fact, the most evident clusters are located along the seacoast, particularly low–low clusters (light blue) between Valencia and Alicante.

#### 4. Discussion

A half-century ago Valencia was a traditional Spanish provincial city entrenched economically and culturally in the surrounding croplands [42]. Nowadays the city has transformed rapidly [45], influencing the entire Valencian Community, promising a destination for tourists, and attracting trade and foreign investments [60,74]. In addition to the city of Valencia, the other two major cities, Alicante and Castellon de la Plana, have also expanded their metropolitan boundaries. For instance, while the economy of Alicante is based on a growing tourism sector, Castellon de la Plana has seen the birth of new and consolidated industrial districts in recent times [38,44,46,47,70].

The results of this study have outlined that residential development followed a different trend from industrial development in the Valencian Community. The highest residential density was concentrated along the seacoast, being spatially associated with the road system and decreasing along the urban–rural gradient. In contrast with the spatial pattern observed for residential settlements, industrial districts have developed especially along the major roads and railways. In fact, industrial areas have concentrated in the metropolitan area of Valencia, avoiding both mountainous and coastal locations. Moreover, the highest industrial density seems to overlap with the intermediate area designated by regional planning in Valencia [60]. A greater industrial intensification took place close to (i) the major production centers and (ii) the largest urban centers [75–77].

Descriptive statistics revealed a different relationship of residential and industrial development with natural areas. Discontinuous settlements and new compact urban areas designated for residential purposes were the results of suburbanization. These settlements were frequently located near the city and, in many cases, have replaced agricultural, forest and (protected) natural areas [6,78]. Conversely, industrial settlements resulted more distantly from natural areas. Their distance increased for both isolated and ordered industrial areas over time, decreasing for unplanned areas. The resulting outcome is a possible sign that, due to their potential risk for human health and environmental quality, industrial areas were preferentially located further away from natural areas. Reflecting on where locating residential or productive settlements is essential in prevention of potential risks to population and human activities in a given district [79]. Mediterranean contexts are sensitive to extreme episodes which affect economic activities and the inhabitants living in dispersed villages [78,80–83]. The presence of an industrial pole in areas classified at risk can cause socioeconomic damages and environmental disturbance [84,85].

Empirical results provide a better knowledge of a complex process of urban sprawl fueled by industrial development. Policymakers and decision-planners should consider specific requirements and threshold for implementing measures of sustainable land management [60,86]. Containment of urban sprawl is particularly required in risky areas dominated by industrial settlements. Land conversion to urban use should be allowed only in specific areas, considering criteria for sustainability and resilience, and taking example from earlier studies that demonstrate how sprawl affects land quality at the local scale [60]. In contrast with classical patterns of residential sprawl, industrial expansion has followed a precise spatial location depending on the road system, alternative to both coastal and internal natural locations. Analysis of land-use changes over time also demonstrated that residential development in the study area was limited and spatially coherent while an accelerated expansion of industrial settlements was noted together with strong location heterogeneity. More specifically, the Alicante context exposed similar production units forming an industrial cluster dominated by small enterprises. In Valencia, larger industrial areas were surrounded by smaller (satellite) areas. For planned industrial areas, a more evident spatial fragmentation was observed during the study period in Castellon where a large industrial district in 2005 was divided into two distinct outliers in 2015.

The spatial distribution of clusters and outliers has finally emerged for unplanned industrial settlements. This trend occurred in almost all districts and consolidated over time. Being the most studied economic district in Spain [46,47,61–65], the industrial context of Castellón emerged with Moran's clustering. In this area, isolated industrial settlements expanded rapidly over time, ensuing a low–high clustering. These results indicate that small (isolated) industrial contexts tend to cluster after a sufficiently long time period, following consolidated trends typical of larger industrial settlements. A similar trend also occurs in the area surrounding Alicante. A divergent trend was recorded with low–low clusters, which seemed to decrease over time, in the three light blue clusters identified in the southern area near Alicante. The lack of up to date information limits the analysis of land-use change to the most recent time period. Several empirical studies are based on statistical data including censuses carried out every 10 years in Spain [44]. The approach proposed here and based on land-use analysis allows an enriched location analysis of industrial settlements. Our results emphasize the role of sprawl monitoring, distinguishing different components of urban expansion, namely residential and industrial growth. Integrating statistical sources such as national censuses, with land-use maps and other continuously updated databases would allow a more precise assessment of land-use dynamics vis à vis local development in a given region [44,87].

The analysis of residential and industrial areas has proved to be convenient for reading the internal structure of the Valencia community and its recent land-use development defined by different economic functions. Empirical results of this study finally outline an increase in the geographical polarization of industrial settlements at the local scale. The growing spatial inequality fueled by recession has been reflected in the emerging configuration of Valencian Community [67,88]. The city of Valencia and the entire Valencian Community will endure to be a characteristic case study of Mediterranean urban transformations [42], shaping complex landscapes intrinsically defined by a mix of residential, industrial, agricultural and natural land-use [82,86,89]. The residential and industrial development has resulted in the loss of soils and open areas that will contribute to land degradation, as agriculture and forest land is transformed into sealed land that results in low infiltration rates and high runoff, the emission of CO<sub>2</sub> and the lack of vegetation. Therefore, there is a need to fight against the loss of services, goods and resources that soils offer to humankind. Future policies should promote the Sustainable Development Goals of the United Nations [90] and aim to achieve the Land Degradation Neutrality Challenge [91].

## 5. Conclusions

The Valencian Community has witnessed a transformation of its traditional land-use towards low-density residential settlements, often linked to the presence of second homes built up thanks to the influence of tourism as in Alicante, and industrial contexts, as a result of the consolidation of

specialized industrial poles (e.g., ceramics) in Castellón de la Plana. Through a comparative analysis of urban development alternatives, a quantitative assessment of land-use changes provides appropriate guidelines corresponding to local development, smart growth, and ecological sustainability. Reflection on the distinctive evolution of residential and industrial settlements in coastal Spain is indispensable to design new planning measures for sustainable land management and containment of urban sprawl.

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