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Rural Districts between Urbanization and Land Abandonment: Undermining Long-Term Changes in Mediterranean Landscapes

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Abstract: The present study investigates changes in the rural landscapes of a Mediterranean country (Greece) over a long time period (1970–2015) encompassing economic expansions and recessions. Using a spatial distribution of 5 basic agricultural land-use classes (arable land, garden crop, vineyards, tree crop and fallow land) derived from official statistics at 6 years (1970, 1979, 1988, 1997, 2006, 2015), a quantitative analysis based on correlation and multivariate techniques was carried out to identify recent changes in the Greek agricultural landscape at prefectural level during different economic waves. Empirical results evidenced both intuitive and counter-intuitive landscape transformations, including: (i) a progressive, spatially-homogeneous reduction of cropland; (ii) a (more or less) rapid decrease in the surface of high-input crops, including arable land, horticulture and vineyards; (iii) a parallel increase in the surface of tree crops, especially olive; (iv) a spatially-heterogeneous decrease of fallow land concentrated in metropolitan and tourism districts, especially in the last decade; and, finally, (v) increasingly diversified landscapes in rural, accessible areas close to the sea coast. Based on a correlation analysis with background socioeconomic indicators, our findings reflect the multiple impacts of urbanization and land abandonment on the composition and diversity of rural landscapes. Changes in agricultural land-use were moulded by multiple drivers depending on latent transformations in rural systems and inherent conflicts with expanding urban regions. Together with market conditions and the Common Agricultural Policy subsidy regime, social contexts and the economic cycle are important when identifying long-term changes in agricultural landscapes, especially in transitional socio-ecological systems.

Keywords: land-use changes; fallow land; indicators; multivariate analysis; Greece

1. Introduction

Especially in peri-urban areas, land-use changes were promoted by multiple factors revealing controversial aspects at the base of socioeconomic processes [1–4] and leading to new hybrid landscapes, altering the traditional relationship between urban and rural areas [5]. After World War

II, a period of intense urbanization began in Europe, with low-quality land, for example, abandoned fields, pastures, sparse cropland and bare land surrounding large cities, converted to urban use [6–9]. In more recent decades, urbanization has involved an increasing amount of high-quality rural land, with dispersed urbanization having major implications for peri-urban landscape structure, quality and diversity [10–15].

Driving forces of landscape transformation were deeply investigated in earlier contributions [16–20]. Changing rural land-use, traditional cropping systems and long-established agronomic practices towards intensive and specialized food productions and high-density livestock along the urban-rural gradient has demonstrated to determine a process of "landscape homologation," owing to the simultaneous action of ecological and socioeconomic factors [21–27]. In both developed and emerging countries, rural landscapes are increasingly experiencing standardized development models leading to more fragmented and economically-fragile landscape structures, poor ecological quality, increased habitat fragmentation and soil degradation [28–32], mixing together relict semi-natural areas and scattered low-density settlements in a confused and indistinct matrix [12,13,33–35].

Understanding long-term, latent relationships among land-use, socioeconomic constraints and environmental factors is indispensable to clarify the inherent complexity of landscape transformations although, often due to low quality or partial lack of digital data, the influencing drivers remain frequently unknown [36–38]. Preventing landscape changes toward urbanization under specific socioeconomic dynamics, requires monitoring tools and planning solutions for sustainable development of peri-urban areas [39–41]. Developing conceptual and explanatory frameworks founded on empirical case studies is necessary to inform a sustainable land management strategy [42–44]. Investigation of landscape transformations in rural areas may also benefit from a comprehensive analysis of agronomic practices and use of cultivated land in terms of intensification or extensification of cropping systems [45,46]. In this regard, fallow land expansion or contraction over time represent an interesting proxy of rural landscape transformation [47–51]. Fallow land dynamics may reflect (i) seasonal movements of livestock and mixed farming, (ii) real-estate speculation and (iii) land abandonment [34,37,52–54].

Fallow land is one of the agricultural soil covers featured by fluctuating and dynamic developments due to exogenous and contextual influences if compared with other uses (e.g., forests) which maintain a more stable and less complex development [55]. Spatio-temporal variability in the surface area of fallow land may indicate the multifaceted impact of environmental agricultural and socioeconomic factors [37]. By comparing metropolitan and rural districts, the present work hypothesized that fluctuations in fallow land surface area are associated with economic cycles, urban-rural relationships, different models of rural development, types and density of cultivation, cropping systems (extensive or intensive, with varying degree of mechanization), production inputs and the related agricultural income [56]. The 2007 crisis in Mediterranean countries and especially in Greece, has determined socioeconomic conditions leading to a progressive re-colonization of rural land after decades of abandonment or sub-optimal use for cropping. In addition, thanks to sustainable development issues [57], relevance has been given to the matter of circular economy, outlining the role of fallow land as a stock of land for intensification (or extensification) of cropping systems at landscape scale [31,58–60].

Based on these premises, the present study investigates agricultural land-use changes in Greece during a long-time span (1970–2015), using spatial analysis, non-parametric correlation and multivariate statistical techniques. The main purpose is to identify (and discuss the role of) multiple drivers of latent modifications in socioeconomic local systems, based on inherent conflicts with expanding urban regions. The approach proposed in this study was aimed at verifying if landscape composition, structure and diversity significantly changed along the urban gradient during the investigated time period. Intuitive and counter-intuitive transformations in the agricultural landscape of Greece included: (i) a spatially-homogeneous and continuous decrease of cropland; (ii) decreasing surface areas (e.g., arable land, horticulture and vineyards); (iii) a parallel growth of tree crops, especially olive; (iv) a spatially-heterogeneous decrease of fallow land concentrated in metropolitan and tourism districts, especially in the last decade of economic crisis; and (v) an

increasingly diversified landscape in accessible areas with intermediate population density and close to the sea coast. The novelty of the proposed approach lies in a comprehensive analysis of different landscape processes in rural districts based on an exploratory framework investigating the intimate relationships with the economic cycle over a sufficiently long time period to encompass sequential expansion and recession waves.

2. Materials and Methods

2.1. Study Area

The study area focuses on Greece (301,330 km^2), a European country with a divided urban system centred on Athens, the capital city and Salonika [61]. Major urban centres include Patras in the Peloponnese and Iraklion in Crete [62]. Approximately 80% of Greek land is composed of mountains and upland. The larger lowlands are placed in the prefectures of Thessaly and Central Macedonia, which are key areas devoted to large-scale, high-input agriculture. Greece constitutes the most southern continental part of the Balkan peninsula embraced by the Peloponnese peninsula, the Aegean and Ionian Seas, separated by the Corinth Channel. The country includes more than 1500 islands in the Aegean and Ionian Seas. The most important islands are Crete, the Cyclades and the Ionian Islands [63].

Following Eurostat census, Greek arable land consisted mainly of cereals (29%), where fallow lands are only 4.3%. The latter recorded significant increases (over than 60%) in the last decade (2000–2010), even if the overall agricultural landscape of Greece has extensively modified over time [54]. This framework also brings out regional disparities in both socioeconomic and environmental domains, characterizing a thoughtful difficulty to face a truly shared sustainable development [64,65]. Innovation in cultivation and mechanization systems have advanced significantly the agricultural sector since the 1970s [66]. However, several factors (e.g., limited job opportunities in rural areas determining massive emigration towards urban centres) limited the progress of Greek rural society [24]. Furthermore, a limited specialization in high-input agriculture reveals important endogenous and exogenous driving forces, for example, poorly accessible areas (e.g., islands) and climatic impacts (e.g., droughts) [24,52,63,67]. In some Greek zones, a gradual decline of practices that combined diverse rural land-uses (e.g., fallow land), were used as olives and grazelands for the growing livestock, decreasing land-use diversity [54]. The simplification of local multifunctional land-use systems to intensive livestock grazing changed ecosystem equilibrium towards environmental, soil, vegetation and biodiversity degradation processes [68–73]. In fact, Greece is one of the European countries suffering from soil erosion and desertification, loss of organic matter, salinization and soil compaction [74–76], with about 20% of its land surface exposed to erosion risk [77,78].

Agriculture plays an important factor role in the local economy in the Peloponnese peninsula, while industry has developed in the northern region, such as Central Macedonia [79] and close to the metropolitan area of Athens. Whereas on the eastern plain, Thessaly is known for intensive agriculture and manufacturing (although slightly declining since the 1980). As one of the Mediterranean Islands, Crete has established an economy based mainly on agriculture and tourism [62,80].

2.2. Statistical Data and Indicators

In the present study, prefectures were defined as the elementary spatial unit since administrative boundaries have been largely used in both quantitative exercises and qualitative case studies dealing with urban geography and landscape analysis [34,43]. Based on the spatial distribution of 5 basic agricultural land-use classes (arable land, garden crop, vineyards, tree crop and fallow land) at 6 years (1970, 1979, 1988, 1997, 2006 and 2015), a quantitative analysis based on correlation and multivariate techniques was proposed to recognize recent agricultural changes in the Greek landscape. From this set of variables, derived from Agriculture statistics of Greece at prefectural level, useful indicators were provided to understand changes in the Greek agricultural landscape [64]. The spatial distribution of percent share of land by each land-use class and year was mapped by ArcGIS software (ESRI Inc.,

Redwoods, CA, USA) using prefectural boundaries as spatial unit. To assess rural changes, fallow farmland has been already used as indicator of rural development in earlier works [81–83]. The term 'fallow' defines agronomic practices aimed at securing sustainability of cropping systems leaving land uncultivated for one (or more) annual cycle(s). Fallow systems are traditional management practices aimed at re-establishing soil fertility, protecting rural areas from aridity, low soil fertility and productivity, reducing risk of erosion [81,84]. Establishing provisional patches, fallow land compensates habitat loss and mitigates persistent effects of agricultural intensification [85]. Fallow lands are traditionally involved in agronomic schemes based on the principle of crop rotation [84], getting nutrient for the forthcoming cropping season [86].

2.3. Data Analysis

A summary analysis of agricultural land-use change in Greece was developed using a Principal Component Analysis (PCA). The latter was performed on the data matrix composed by 51 prefectures and the percent land surface classified at 5 basic agricultural land-use classes in the investigated years. As the PCA was based on the correlation matrix, the number of significant factors was chosen by retaining the components with eigenvalue >1. Based on the scores of the most important factors, prefectures were mapped into different groups. Entities (agricultural land-use classes and provinces) placed close each other in the factorial plane indicate spatial convergence [33,87].

Focusing on agricultural land-use change and relative landscape diversification during the investigated time period, pair-wise relationships between contextual variables and agricultural land-use in Greece were explored using non-parametric Spearman rank correlation analysis testing for significant correlations at $p < 0.05$ after Bonferroni's correction for multiple comparisons. The contextual variables include (i) per-capita income; (ii) population density; (iii) distance from Athens; (iv) distance from Salonika; (v) distance from the sea coast; and (vi) a dummy indicating tourism districts. Percent share of garden crop in total agricultural area and two additional dummies (presence of international airport and public university) were not correlated with any other variable and were not considered further.

A Spearman rank correlation was also applied between Pielou J evenness index of landscape diversification and the abovementioned contextual variables during the studied period (1970–2015), illustrating agricultural landscape diversification in Greece [88]. Pielou's index defines the evenness degree of landscape diversification, indirectly assessing stability (or change) of agricultural systems during a long-time span (1970–2015). The absolute value of a diversity index increases both when the number of classes increases and when evenness increases. For a given number of classes, the value of a diversity index is maximized when all classes are equally abundant. Being derived from the Shannon index, Pielou's index was applied to the composition of the landscape found in each prefecture according to the following formula:

$$J = H'/H_{max}$$

where H_{max} is the natural logarithm of the number of considered classes ($n = 7$). Although Shannon index ranges from 0 (the lowest diversity) to infinity (the highest diversity), Pielou's J index ranges between 0 (the lowest evenness) and 1 (the highest evenness).

3. Results

3.1. Agricultural Land-Use Changes in GREECE (1970–2015)

The predominant agricultural land-use class in Greece can be associated with crops on arable land, recording the highest scores (>50%) in the whole study period, 1970–2015 (Table 1). However, the analysis of percent share of land by land-use class pointed out relevant changes for the Greek agriculture, especially for arable land. Even though the latter cover the largest agricultural area in Greece, arable land declined continuously from 1979 (61.9%) to 2015 (52.9%). Vineyards also decreased moderately over time (from 5.4% in 1979 to 2.9% in 2015). Gardens have undergone a moderate

increase over time, however, in the last year of survey (2015) their percent share of land decreased slightly. Areas under trees (e.g., compact plantations, including olive trees) were the only land-use class increasing continuously over time (from 16.6% in 1979 to 31.0% in 2015).

Table 1. Agricultural changes in Greece, 1970–2015 (percent share of land by land-use class).

Year	Crops on Arable Land	Garden Area	Vines (Grapes and Raisins)	Areas under Trees (Compact Plantations)	Fallow Land
1970	61.9	2.6	5.4	16.6	13.4
1979	60.0	2.8	4.8	19.6	12.8
1988	59.0	2.8	4.1	22.3	11.8
1997	57.6	3.1	3.4	24.4	11.5
2006	55.3	3.0	3.4	26.9	11.4
2015	52.9	2.1	2.9	31.0	11.2

Spatial dynamics occurred in the last 45 years in Greece were finally investigated considering the percent share of fallow land in total agricultural land (Figure 1). The highest percentages (>20%) are evident in cropping systems featuring intensive agriculture and crop rotation. Since 1979, especially in Attica and Peloponnese, fallow land was concentrated in relatively few prefectures. In the central-northern region, fallow land showed a more homogeneous distribution, associated to the most intensive cultivation models (e.g., garden crops) and viticulture. However, an increased incidence of fallow land has occurred in recent years in this area, especially around Salonika. In the southern part of Greece, fallow land has also experienced an intense decline since 1988, leading to a sharp reduction in its area in the following years and thus reaching values less than 10%. For example, landscape modifications in Cyclades indicated a progressive abandonment of marginal agricultural systems and a rather similar trend was observed in Corinth area.

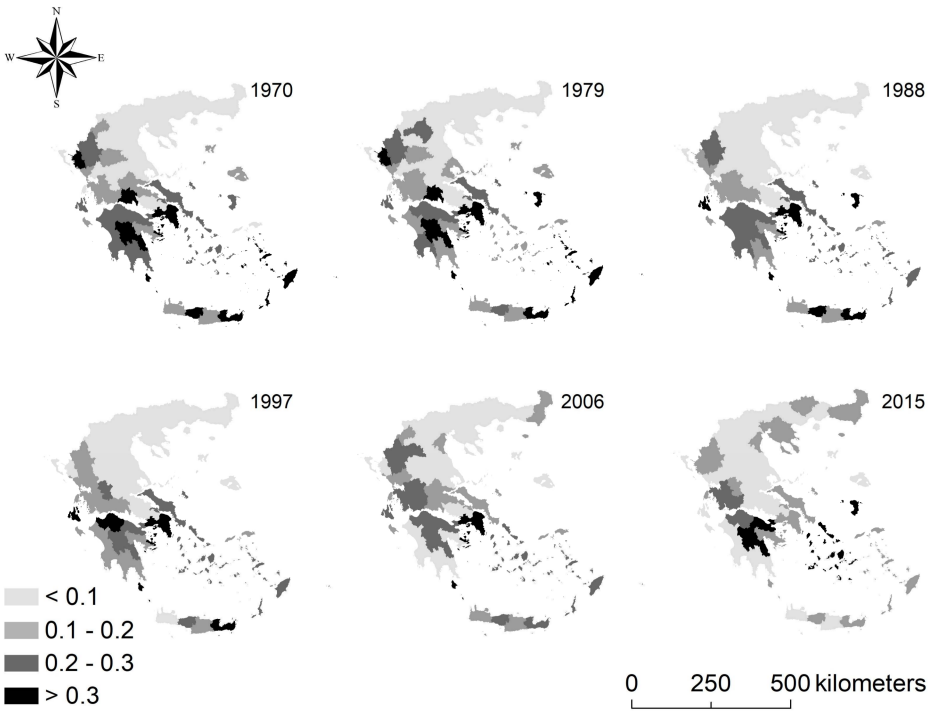

Figure 1. Percent share of fallow land in total agricultural land in Greece, 1970–2015.

3.2. Landscape Evaluation Using Principal Component Analysis

The PCA extracted three factors cumulating 85% of total variance (Table 2). The most important factor (explaining 47.2% of total variance) defined the Greek prefectures which base their economic production on tree crops and vineyards from 1979 to 1997, opposed to districts specialized in arable crops. PC1 was positively associated to fallow land until 1997, as well as to largely extensive cultivation systems. Fallow land was typically associated to a landscape with extensively managed cropping systems and heterogeneous structure.

Table 2. Loadings (>|0.6|) of Principal Component Analysis investigating agricultural land-use in Greece.

Variable	PC1	PC2	PC3	Variable	PC1	PC2	PC3
Ara70	−0.98			Tre70	0.80		
Ara79	−0.98			Tre79	0.84		
Ara88	−0.99			Tre88	0.85		
Ara97	−0.99			Tre97	0.86		
Ara06	−0.98			Tre06	0.85		
Ara15	−0.95			Tre15	0.85		
Cro70		0.95		Vin70			
Cro79		0.95		Vin79	0.67		0.63
Cro88		0.96		Vin88	0.68		0.64
Cro97		0.95		Vin97	0.63		0.69
Cro06		0.96		Vin06			0.71
Cro15		0.85		Vin15			0.71
Fal70	0.64						
Fal79	0.66						
Fal88	0.72						
Fal97	0.68						
Fal06		0.62					
Fal15		0.61					
Expl. Var. %	*47.2*	*24.1*	*13.4*				

PC2 (explaining 24.1% of total variance) revealed local districts specialized in agricultural productions. Fallow areas were positively associated with this axis in recent years (2006–2015), indicating consolidation of extensive cropping systems. Fallow land resulted to be relatively more common where there is more land available for agriculture; in prefectures with a more intensive cultivation system, the proportion of fallow land in total land area was significantly smaller. Component 3 (explaining 13.4% of total variance) identified areas specialized on vine production, possibly correlated with specific external factors.

Scores of principal components on agricultural land-use change in Greece were illustrated in Figure 2. The first quadrant identifies agricultural areas designed for viticulture and olive trees (e.g., Kerkyra and Zakynthos). In these areas, rural landscapes were relatively fragmented, diversified and heterogeneous, with a moderately low proportion of fallow land. Prefectures classified in the fourth quadrant showed a large extension of fallow land, possibly associated with traditional pastoral uses of land. A restricted agricultural specialization in these areas may derive from other factors, such as poor accessibility, climate aridity or even urbanization.

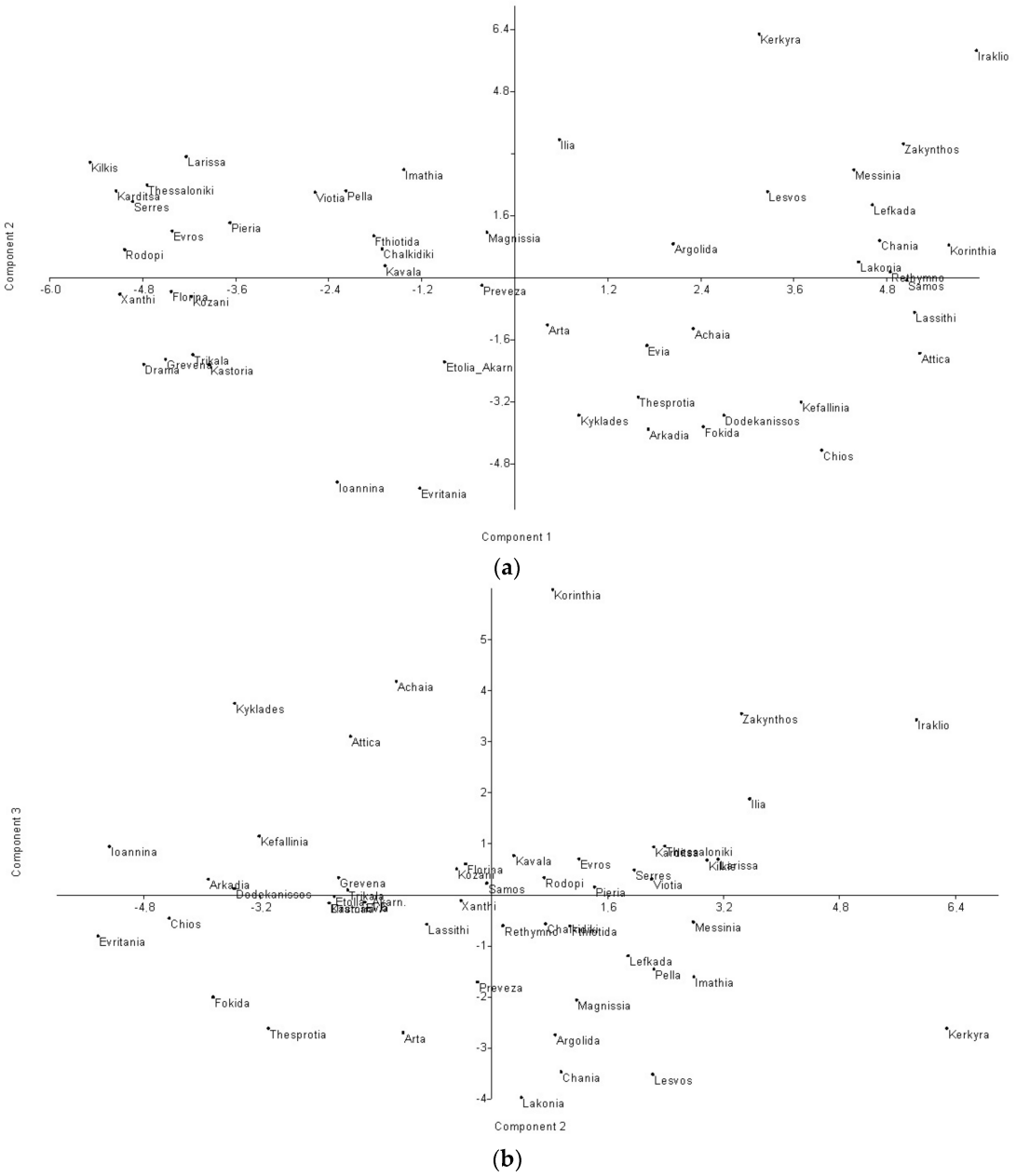

Figure 2. Scores of principal components illustrating changes in agricultural land-use in Greece (**a**) PC1 vs. PC2, (**b**) PC2 vs. PC3.

The socioeconomic contexts on the left side of Figure 2 highlighted prefectures with both annual and tree crops, distinguishing the most intensive systems (second quadrant) as in northeast Greece (e.g., Larisa and Salonika), from less intensive ones (third quadrant) recognizing more disadvantaged and less accessible socioeconomic contexts towards the Ionic Sea (e.g., Evritania and Ioannina). The latter areas are located far from the coast, revealing a widespread traditional agricultural system dominated by less intensive annual cultivation than other areas.

The scores of the first three principal components on agricultural land-use change in Greece were shown in Figure 3. Axis 1 outlines a latitudinal gradient, distinguishing northern and southern regions of Greece. In northern areas, agricultural land-uses were homogenously distributed, contrasting southern areas, hosting fragmented and heterogeneous landscapes possibly reflecting a greater diversification and biodiversity. In this regard, PC1 identified a territorial structure composed of

different degree of soil fertility and climatic conditions. Axis 2 divided Greece into eastern and western districts. Areas bordering the Aegean Sea displayed a marked agricultural specialization, opposed with the Ionian side, including areas less devoted to agriculture.

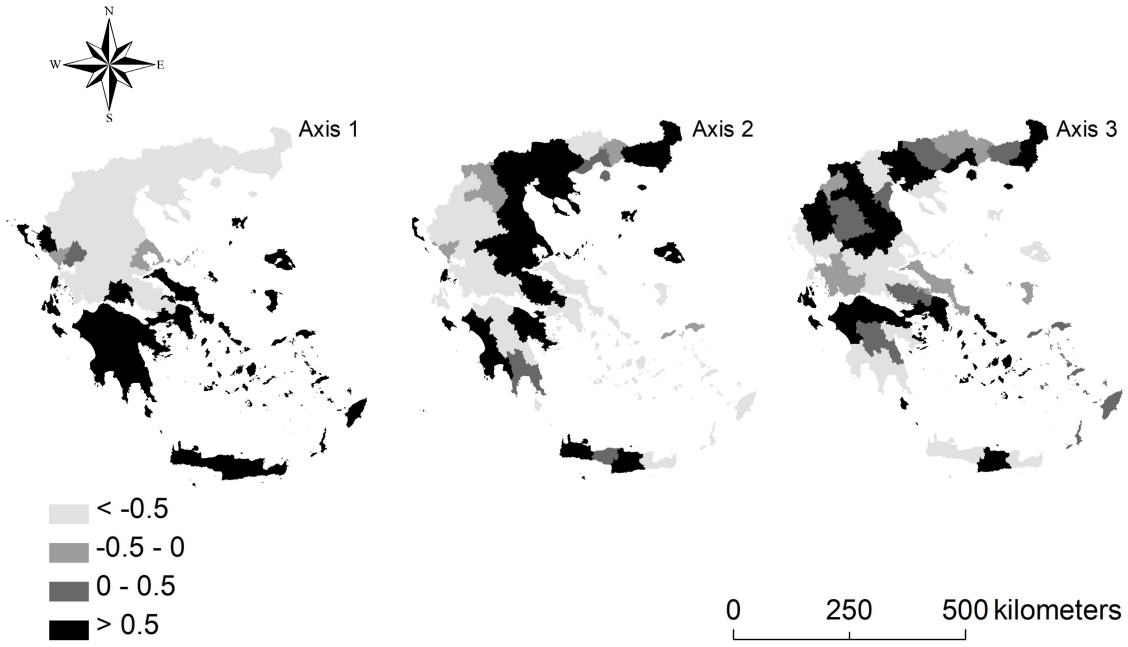

Figure 3. Scores of the selected components illustrating changes in agricultural land-use in Greece (Axis 1) PC1, (Axis 2) PC2, (Axis 3) PC3.

Axis 3 expressed a typical urban-rural gradient in Greece. Urban and compact areas diverged from rural prefectures since they are more accessible and connected by infrastructural networks. In this group, Athens and its region (Attica) emerged together with Crete, Macedonia and Salonika, followed by medium-density urban regions, for example, Larisa, Volos and Ioannina; finally, mixed urban-rural areas such as Achaia (Patras) can be identified.

3.3. Pair-Wise Spearman Rank Correlations

Pair-wise Spearman rank correlation analysis between contextual variables and agricultural land-use was applied to explore spatial changes in Greece during the investigated time period (Table 3), considering the following variables: (i) per-capita income; (ii) population density; (iii) distance from Athens; (iv) distance from Salonika; (v) distance from the sea coast; and (vi) tourism district.

Results of correlation analysis indicate that wealth regions are devoted to viticulture, resulting in high income in primary sector. Regions devoted to arable crops, often leading to more intensive agricultural systems, showed a coherent specialization in industrial productions and are located in the central and northern part of Greece. Compared with other non-urban districts, agricultural areas showed a relatively high population density, suggesting that rural areas in Greece are defined by settlement models with intermediate population density. This complex system declined progressively along the rural-urban gradient in the last decade. Agriculture became part of metropolitan contexts, mixing residential and productive settlements.

Table 3. Spearman rank correlation between background context variables and agricultural land-use in Greece, 1970–2015 *.

Variable	Per-Capita Income	Population Density	Distance from Athens	Distance from Salonika	Distance from the Sea Coast	Tourism District
Arable70	−0.54			−0.84	−0.54	−0.60
Arable79	−0.52			−0.80	−0.52	−0.59
Arable88	−0.48			−0.81	−0.54	−0.60
Arable97	−0.45			−0.79	−0.56	−0.57
Arable06				−0.79	−0.54	−0.58
Arable15				−0.79	−0.51	−0.57
Crops70		0.52				
Crops79		0.50				
Crops88		0.51				
Crops97		0.50				
Crops06		0.50				
Crops15						
Fallow70				0.74		
Fallow79				0.69		
Fallow88			−0.46	0.77		
Fallow97			−0.47	0.72	0.46	
Fallow06				0.53		
Fallow15						
Trees70				0.61	0.54	0.64
Trees79				0.64	0.53	0.60
Trees88				0.63	0.51	0.55
Trees97				0.62	0.51	0.53
Trees06				0.65	0.54	0.53
Trees15	0.58			0.54		
Vines70	0.62			0.60		0.44
Vines79	0.61			0.59		0.51
Vines88	0.61			0.59		0.49
Vines97	0.62			0.59		0.49
Vines06	0.63			0.56		0.49
Vines15				0.63	0.49	0.51

* Percent share of garden crop in total agricultural area and the two dummies "presence of an international airport" and "presence of a public university" were not correlated significantly with any other variable (significance tested at $p < 0.05$ after Bonferroni's correction for multiple comparisons).

Three distance variables were calculated to better understand the relationship between urban and rural contexts. The first variable corresponded to the distance from Athens, the capital of Greece. Fallow (and abandoned) areas concentrated in Attica and, less intensively, in other metropolitan regions of Greece. Distance from Salonika, the second city in Greece was less correlated with the spatial distribution of fallow land; in this case, topographical and territorial factors justified a greater rural specialization. In fact, the neighbouring region of Macedonia was characterized by a strong presence of arable land. Fallow land, tree crop and vineyards are less common in Salonika region. Distance from coastal areas influenced primarily the spatial distribution of tree crops and vineyards (especially in the most recent period). Arable lands were mainly located far from the sea coast. A similar spatial pattern was observed for crops associated to tourism districts (tree crops and vineyards).

3.4. Agricultural Land-Use, Fallow Land and Landscape Diversification

Pielou J evenness index of landscape diversification was correlated with the selected contextual variables in Greece (Table 4). Agricultural landscapes were different depending on the existing crop. Rural landscapes resulted to be less varied when dominated by arable land ($r_s = -0.91$ in 1979 and -0.67 in 2015). Landscapes dominated by vineyards, fallow land and tree crop systems were more diversified ($r_s > 0.5$). Heterogeneous landscapes in central and southern Greece were positively associated with per-capita income. The spatial distribution of Pielou J index was illustrated in Figure 4, confirming the findings presented above. The most heterogeneous areas coincide with

Peloponnese, Attica and Crete. Especially in Crete, cropping systems were increasingly associated with discontinuous urbanization linked to the tourism sector and thus leading to a moderate decline of traditional agricultural landscapes.

Table 4. Spearman rank correlation between Pielou J evenness index of landscape diversification and selected background variables in Greece, 1970–2015 *.

Variable	1970	1979	1988	1997	2006	2015
Arable land	−0.91	−0.87	−0.84	−0.82	−0.67	
Vineyards	0.69	0.68	0.68	0.72	0.63	0.49
Tree crop	0.74	0.70	0.68	0.67	0.51	
Fallow land	0.79	0.81	0.84	0.79	0.66	0.55
Income per-capita	0.56	0.58	0.53	0.53	0.48	
Distance from Athens	−0.40	−0.46	−0.49	−0.49	−0.46	−0.50
Distance from Salonika	0.82	0.77	0.74	0.74	0.61	
Distance from the sea coast	0.55	0.54	0.54	0.54	0.48	
Tourism district	0.53	0.48	0.45	0.45		

* Percent share of garden crop in total agricultural area, population density and the two dummies "presence of an international airport" and "presence of a public university" were not correlated significantly with Pielou evenness J index at every year of investigation (significance tested at $p < 0.05$ after Bonferroni's correction for multiple comparisons).

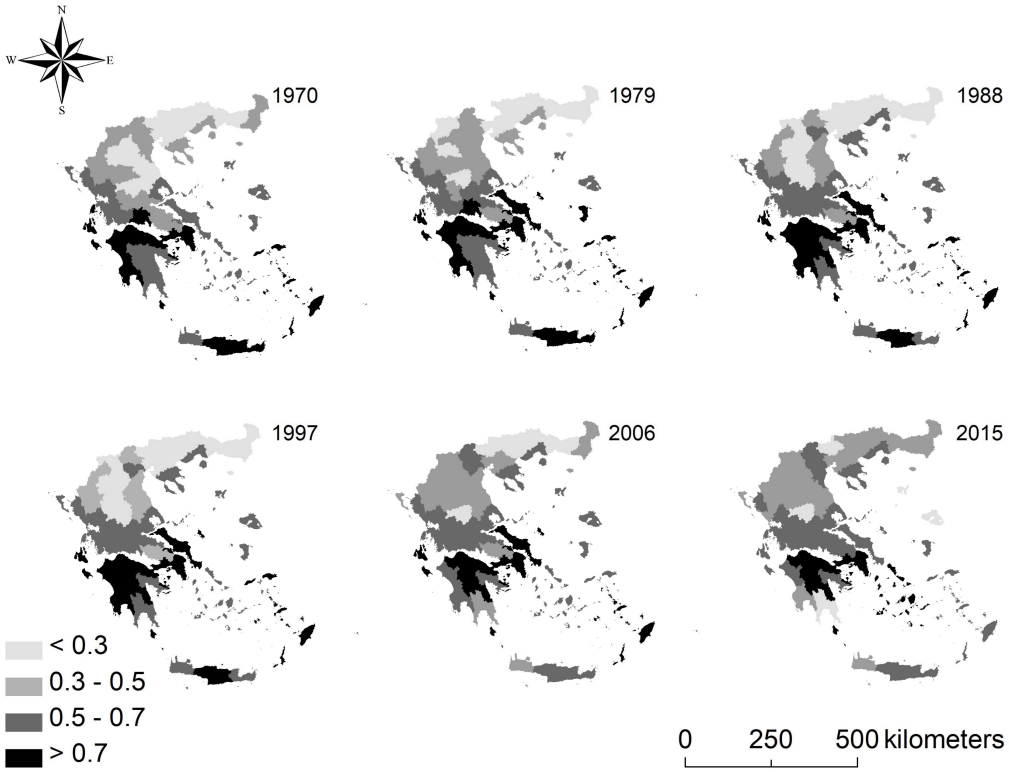

Figure 4. Spatial distribution of Pielou J evenness index illustrating agricultural landscape diversification in Greece, 1970–2015.

4. Discussion

Fallow land assumes the role of land stock for different functions: (i) crop rotation, seasonal use of land and mixed farming [54,67,84]; (ii) more intensive crops for high-value farming systems where fallow land can be considered as set-aside area [84,89]; (iii) pastoral purposes, fertilizing land and mitigate pervasive effects of agricultural intensification [85,86]; and (iv) abandonment of

agricultural land, under prospective urban and tourism use [80,90–92]. Fallow land can positively impact biodiversity and agro-ecosystem quality, allowing a multifunctional land-use and income diversification [81]. Empirical findings of this study outlined that, where fallow land is less common, there are more homogeneous and poorly connected agricultural systems. With more land available for production, fallow land allows intensification of cropping systems. Concentration of fallow land around Athens also reveals a progressive abandonment of agricultural land for speculative purposes. In this regard, fallow land was concentrated in cropping systems of central and southern Greece, especially Attica and Peloponnese, in the first two decades of observation. In the northern area, fallow land displays a more homogeneous distribution, associated to intensive cultivation models and viticulture, which is an important source of income for farmers [79,81]. In fact, Mediterranean olive plantations and vineyards were not abandoned since they guarantee economically-viable products [93]. For instance, an increased incidence of fallow land has occurred in recent years in the northern area, especially around Salonika. By contrast, fallow land experienced an intense decline in the southern part of Greece since 1988. Among the Greek islands [63,80], the Cyclades underwent intense abandonment of agricultural systems in 2015, thanks to tourism pressure, together with the Corinth area. In the latter circumstance, this phenomenon can be also associated with infrastructural development leading to construction of the high-speed railroad linking Athens to Patras [94]. In this regard, fallow land can also be defined as land reservoir awaiting both cultivation and speculation linked to urbanization and infrastructure development [90,91].

Our analysis revealed some inherent peculiarities of Greek rural areas. Despite a total reduction in agricultural land, there was a moderate growth of tree crops with mixed management (both intensive and extensive). For instance, Greece is one of the main producer of pistachios in Europe [95], mainly in marginal and remote areas [96], such as in Aegina island (Attica) [97]. In addition, an increasing wine specialization emerged in Greece due to the related exogenous factors (e.g., territorial, cultural and socioeconomic) enabling profitable income.

Our analysis finally indicates a substantial divergence in rural landscape composition before and after the most recent economic crisis. This can be justified by a progressive decline of CAP (Common Agricultural Policy) subsidies. From 1970 to 1997, the CAP-driven subsidy regime ensured stability of agricultural systems in Europe [24]. However, since the 1990s, the economic support of farm holders has substantially decreased, leading to important changes in the agricultural sector. Correspondingly, the Greek agricultural system has undergone effective structural and functional transformations in recent years, possibly reflected in structure and composition of rural landscapes [93]. In addition, agro-environmental EU regulations have allowed the awareness of more conservative agricultural models, possibly devoted to extensive cropping systems, for example, based on vineyards and olive groves. In the 2000s, the reduction of CAP subsidies led to a progressive restructuring of rural landscapes in Greece [98–100].

In addition to EU agricultural policy reform, the 2007 economic crisis has taken on a decisive and impacting role in Greek rural systems [64–91], accelerating land-use changes and transformations in primary productions. The wealthiest industrial regions in central and northern Greece were progressively shifting to viticulture, possibly resulting in a higher agricultural income. Landscape diversification has recently increased in northern Greece, being relatively stable in other areas such as Attica, Peloponnese and Crete [79]. For instance, peri-urban areas in Attica were increasingly composed of urban and rural elements preserving a large proportion of olive groves assuring a diversified landscape [14]. In other coastal regions, intensive cropping systems have sometimes stimulated urbanization processes, possibly leading to a less diversified landscape.

In summary, agricultural land-use transformations can be related to variability in fallow land use, reflecting joint action of multiple drivers: (i) geographical factors (elevation, latitude, accessibility, distance from the sea coast); (ii) incidence of CAP subsidies [92,101]; (iii) latent social transformations; (iv) evolution of the regional economic base, toward commerce, tourism and advanced services [64,79,80].

Evaluating the possible effects of different land-use alternatives on biodiversity is essential for guiding objective management choices [102–104]. The present study discovered landscape change paths in Greece and their possible impact on landscape diversity using spatial analysis and multivariate statistical models. Results pointed out the usefulness of comparative and multi-temporal approaches to landscape changes in complex regions [23,105–109].

Predicting the future of agricultural landscapes in Greece is relatively difficult due to the different driving forces involved [24]. Results of this study indicates that protection of a spatially-balanced landscape structure along the urban-rural gradient is a key target for strategies promoting environmental sustainability of Mediterranean regions. Future objectives of landscape conservation increasingly require appropriate strategies for sustainable development, containing urbanization-driven land speculation, soil sealing and land degradation [4,84,110].

5. Conclusions

A shift from a spatially-balanced, structurally-complex and functionally-diversified agricultural landscape to more homogeneous systems defines a typical process of simplification and homologation typical of contemporary rural regions and reflecting a progressive decline in land-use diversification. These processes may impact ecosystem functioning and increase ecological fragility of relict cropping systems [110]. Using multi-temporal land-use statistics and high-resolution diachronic maps, further studies are essential to investigate the role of structural and functional transformations in rural landscapes as a response to increasing anthropogenic pressure and climate change impacts along urban-rural gradients [31]. In this regard, analysing the changing spatial configuration of landscapes, may provide a knowledge base supporting a sustainable management of traditional cropping systems aimed at reducing land abandonment and soil misuse, mixing together operational indications from geographical, socioeconomic and ecological perspectives [111–115]. A comprehensive analysis of changes over time in landscape composition focusing on specific land-use classes, such as fallow land, may contribute significantly to new prospective visions for sustainable development of rapidly-evolving rural districts. In this regard, integrating agricultural statistics, land-use variables and landscape diversity indexes with socioeconomic indicators assessing local contexts definitely provides suitable tools for a comprehensive assessment of landscape transformations advancing appropriate measures for both economically-dynamic districts and remote, economically-disadvantaged areas.

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