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Is land abandonment remarkable in the so-called Empty Spain?

¿Es notable el abandono de tierras en la llamada España Vaciada?

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Keywords
Demographic dynamics, depopulation, land-use change, rural policy.

Abstract

Since the turn of the 21st century, the rural populations of many municipalities in Spain have considerably decreased. This demographic phenomenon, known as the Empty Spain, is widely considered as a driver of land abandonment. The main goal of this study was therefore to spatially analyze this phenomenon, by comparing current data on variables such as total population, land use/cover, number of livestock animals, and number of wildfires to data obtained two decades ago, to verify whether land abandonment (the cessation of agricultural activities in a certain land) is remarkable (easily detectable in a national-scale map) in these territories. The Empty Spain phenomenon affects 5,084 out of the 8,043 national municipalities, which encompass 320,000 km2, or more than 60% of the Spanish territory. In the depopulated areas, over 37,000 km2 of traditional agroforestry lands have undergone land-use transformation. Of these lands, 24,000 km2 have changed to grasslands, heathlands, or forests, 8,500 km2 have been converted to intensive agricultural lands (including vineyards, olive groves, and other fruit tree plantations), and an additional 3,000 km2 have been converted to intensive pastures (livestock husbandry intensification). Overall, the data shows that the abandonment of extensive traditional farming systems, and at the same time, the expansion of intensive agricultural land-uses are two coexisting processes that have taken place across the Empty Spain. In ecological terms, these trends of land-use change may cause landscape simplification, with the consequent risks of land degradation and environmental deterioration.

Palabras clave
Cambios de usos del suelo, despoblación, dinámicas demográficas, políticas rurales

Resumen

Desde el inicio del siglo XXI, la población rural de muchos municipios de España ha disminuido considerablemente. Este fenómeno demográfico, conocido como la España vaciada, se considera ampliamente como un motor de abandono de tierras. El objetivo principal de este estudio fue, por tanto, analizar espacialmente este fenómeno, comparando los datos actuales sobre variables como la población total, el uso/cubierta del suelo, el número de animales de ganadería y el número de incendios forestales con los datos obtenidos hace dos décadas, para comprobar si el abandono de tierras (el cese de las actividades agrícolas en un determinado terreno) es notable (fácilmente detectable en un mapa a escala nacional) en estos territorios. El fenómeno de la España vaciada afecta a 5.084 de los 8.043 municipios nacionales, que abarcan 320.000 km2, es decir, más del 60% del territorio español. En las zonas despobladas, más de 37.000 km2 de tierras agroforestales tradicionales han sufrido una transformación del uso del suelo. De estas tierras, 24.000 km2 se han convertido en pastizales, brezales o bosques, 8.500 km2 se han convertido en tierras agrícolas intensivas (incluyendo viñedos, olivares y otras plantaciones de árboles frutales) y otros 3.000 km2 se han convertido en pastos intensivos (intensificación de la ganadería). En general, los datos muestran que el abandono de los sistemas agrícolas tradicionales extensivos y, al mismo tiempo, la expansión de los usos agrícolas intensivos de la tierra son dos procesos coexistentes que han tenido lugar en toda la España vaciada. En términos ecológicos, estas tendencias de cambio de uso del suelo pueden provocar una simplificación del paisaje, con los consiguientes riesgos de degradación del suelo y deterioro medioambiental.

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Introduction

Over modern times, the population of Spain has increased substantially until reaching more than 47 million inhabitants, as recorded in the official count of 2021. However, this growth trend obscures a widespread phenomenon of rural outmigration, which mostly occurred during the 1960s and 1970s (García Coll & Stillwell, 1999). Since the turn of the 21st century, the economics of Spain has experienced two quite contrasting decades: the so-called building boom of the early 2000s, and a deep economic crisis and slight recovery during the late 2000s and early 2010s (Parreño-Castellano et al., 2021). Under this socio-economic context, extensive rural areas of Spain have lost their population by outmigration and urbanization. In addition, aging rural populations and the lack of generational replacement are predominant across the country. This phenomenon has been coined "the Empty Spain" (Langreo Navarro & García Azcárate, 2019; Llorent-Bedmar et al., 2021).

Usually, the decrease in rural population is considered to be a (primary or secondary) driver of land abandonment, as local populations move to urban areas and neglect agricultural activities (Lasanta et al., 2017; Schuh et al., 2020; Weissteiner et al., 2011). Often, the abandoned croplands and pasturelands face tree and shrub encroachment through processes of ecological succession (MacDonald et al., 2000). Progressive regeneration of native vegetation consequently increases the spatial connectivity among patches of vegetation, thus elevating wildfire risk (Herrando et al., 2016; Mantero et al., 2020). In addition, land abandonment leads to a certain landscape simplification, as mosaics of traditional land-uses progressively disappear (Marini et al., 2009; Vrdoljak & Samways, 2014).

Rural depopulation and land abandonment are two topics that have been widely studied in Spain, but so far, mostly by demographers (Collantes et al., 2014), ecologists (Martínez-Valderrama et al., 2020), and other scholars (van Leeuwen et al., 2019). Overall, many experts consider depopulation as one of the main drivers of land abandonment. For instance, Perpiña Castillo et al. (2020) identified four sets of drivers: (i) factors reducing land profitability; (ii) socioeconomic contexts including farm size, age of farmers, etc.; (iii) regional contexts that determine the connectivity between farms and markets; and (iv) mismanagement of soil and water resources.

Nowadays, the declining population in rural areas across Spain has become a national concern, and policymakers have expressed interests in sustaining rural territories, using certain administrative tools (Orcao & Cornago, 2007). Recently, the Spanish government has established the Ministry of Ecological Transition and the Demographic Challenge (MITECO), which is responsible for sustainable socio-ecological development of the rural areas. To address the challenge of declining rural populations, the Spanish Ministry of Territorial Policy and Public Function published a national strategy, based on 150 measures organized in three strategic lines of action: depopulation, ageing, and floating population (Ministerio de Política Territorial y Función Pública, 2017). To cope with a similar population decline across rural Europe, the European Union (EU) has established policy responses aimed at mobilizing resources, promoting social innovation, generating greening economy, etc. (Copus et al., 2020; Raugze et al., 2017). In fact, the risk of land abandonment has already been assessed by some scholars (Perpiña Castillo et al., 2020), mainly for mountainous areas (Dax et al., 2021). Several studies that focused on land abandonment in Spain were conducted at a regional scale (Corbelle-Rico & Crecente-Maseda, 2014; González Díaz et al., 2019).

Therefore, the main objective of this study was to determine whether the so-called Empty Spain has indeed faced land abandonment. We defined abandoned lands as lands (mostly agroforestry) that have changed to grasslands, heathlands, and forests as a consequence of the cessation of agricultural activities. Additional objectives were to assess differences (and similarities) among the major land-uses, and to analyze variables affecting these processes, such as depopulated areas, major land-uses, number of wildfires, and number of livestock animals. The study's major hypothesis was that throughout Empty Spain, land abandonment is not remarkable (where remarkable was considered as an extent that can be easily detected in a national-scale map, i.e., >5% of the land surface of the analyzed territory). We also hypothesized that the cover of both forest and seminatural areas has decreased, as well as the number of wildfires.

Material and methods

Sources of data and information

Our research was conducted at two spatial scales: municipal and provincial. First, we gathered data on population for 8,043 municipalities (the entirety of Spain, except for the Canary Islands) for the period of 2000 through 2020. This data was sourced from the Official Census (Instituto Nacional de Estadística: INE). Then, we used the Corine Land Cover (CLC) inventory for 2000–2018 to assess relevant changes in land-use. At the next stage, we obtained information about the number of wildfires that

occurred in the 50 provinces of Spain between 2001–2019 from the former Ministry of Agriculture, Fisheries and Environment (MAPAMA). Also, we collected information on the number of livestock animals per province in 1999 and 2018. These two years correspond to the information provided by the Official Livestock Census.

Then, we ran a correlational analysis at the provincial scale for the following variables: (1) depopulated area (km^2) in 2018 compared to that in 2000; (2) the change in surface area (km^2) of artificial land cover (including urban, industrial, commercial, transportation infrastructures, mines, landfills, construction sites, and non-agricultural vegetated areas) between 2000 and 2018; (3) the area of agricultural lands (km^2) in CLC 2000 and CLC 2018; (4) the area of forest and semi-natural lands (km^2) in CLC 2000 and CLC 2018; (5) the area of wetlands (km^2) in CLC 2000 and CLC2018; (6) the area of waterbodies (km^2) in CLC 2000 and CLC2018; (7) number of wildfires per year (2001–2019); and (8) total animal units (cattle equivalent) in 1999 and 2018.

Delimitation of Empty Spain

We used the ESRI ArcMap 10.5 software for the study. We downloaded a shapefile that includes all the municipalities of Spain (except the Canary Islands), provided by the IGN (Instituto Geográfico Nacional) for free. In this shapefile, we used official population data (provided by the INE) to produce two fields with the total population of each municipality in 2000 and 2020. Then, for each municipality, we subtracted the values recorded for 2000 from those recorded for 2020. In a new field of the attribute table, we assigned Y for negative values (depopulation) and N for positive ones (population increase). At the next stage, we created a new shapefile of depopulated municipalities, named Empty Spain. This allowed us to identify the geographical extent of Empty Spain, as well as various properties of each municipality, such as size, number of inhabitants, spatial distribution, etc.

Land-use change

We analyzed land-use change between 2000 and 2018 using data provided by the CLC in a raster format. For this analysis, we clipped TIF images with the boundaries of our shapefile named Empty Spain. We considered 44 different types of land use/cover (Level 3 of the CLC dataset), and grouped these types into four land-use/cover classes, including: traditional agroforestry lands, agricultural fields, intensive pastures, and forests (including seminatural areas) (Table 1). Finally, we performed a correlational analysis at the provincial scale and calculated the cover of the Level 1 CLC classes (1-artificial surfaces, 2-agricultural areas, 3-forest and seminatural areas, 4-wetlands, and 5-waterbodies) for the 50 provinces.

Table 1
Equivalence between classes considered for analyzing abandonment and CLC codes (Kosztra et al., 2017).

Land use/ cover	Major land-use 1	Major land-use 2	CLC – Level 3
Agroforestry lands	Agriculture Semi-natural	Heterogeneous Vegetation associations	242, 243, 244 313, 323, 324, 333
Agricultural fields	Agriculture	Arable land Permanent crops	211, 212 221, 222, 223
Intensive pastures	Agriculture	Pastures	231
Forest and seminatural	Forest	Forest Grasslands Heathlands	311, 312 321 322

Data analysis

In our study, we considered the municipal and provincial working scales. The in-formation at the municipal scale served to assess the geographical extent of Empty Spain, and the changes in land-use. We used basic parameters for this scale, including mean values, median, percentiles, range, standard deviation, etc. At the provincial scale, we gathered data of eight variables (as detailed in Subsection 2.1), which were tested for a normal distribution, and then pairs of variables were Pearson-correlated. The total livestock population was converted into cattle-equivalent animal units (AU): one cattle as 1.00 AU, 1 sheep/goat as 0.12 AU, and 1 pig as 0.37 AU. We used the MO Excel and Statistica software packages for computation, analysis, and graph production.

Results

Empty Spain

Figure 1 shows the geographical extent of Empty Spain. The total land area of municipalities that have lost population between 2000 and 2020 exceeds 320,000 km^2, i.e., more than 60% of the total area of Spain, affecting 5,084 municipalities (out of 8,043) of peninsular Spain and the Balearic Islands. The depopulation has mostly affected small rural municipalities (90% percentile: 2,302 inhabitants) although cities such as Seville (ca. 700,000 inhabitants) have also been affected. The areas that have not lost population include the Madrid metropolitan area, the Mediterranean

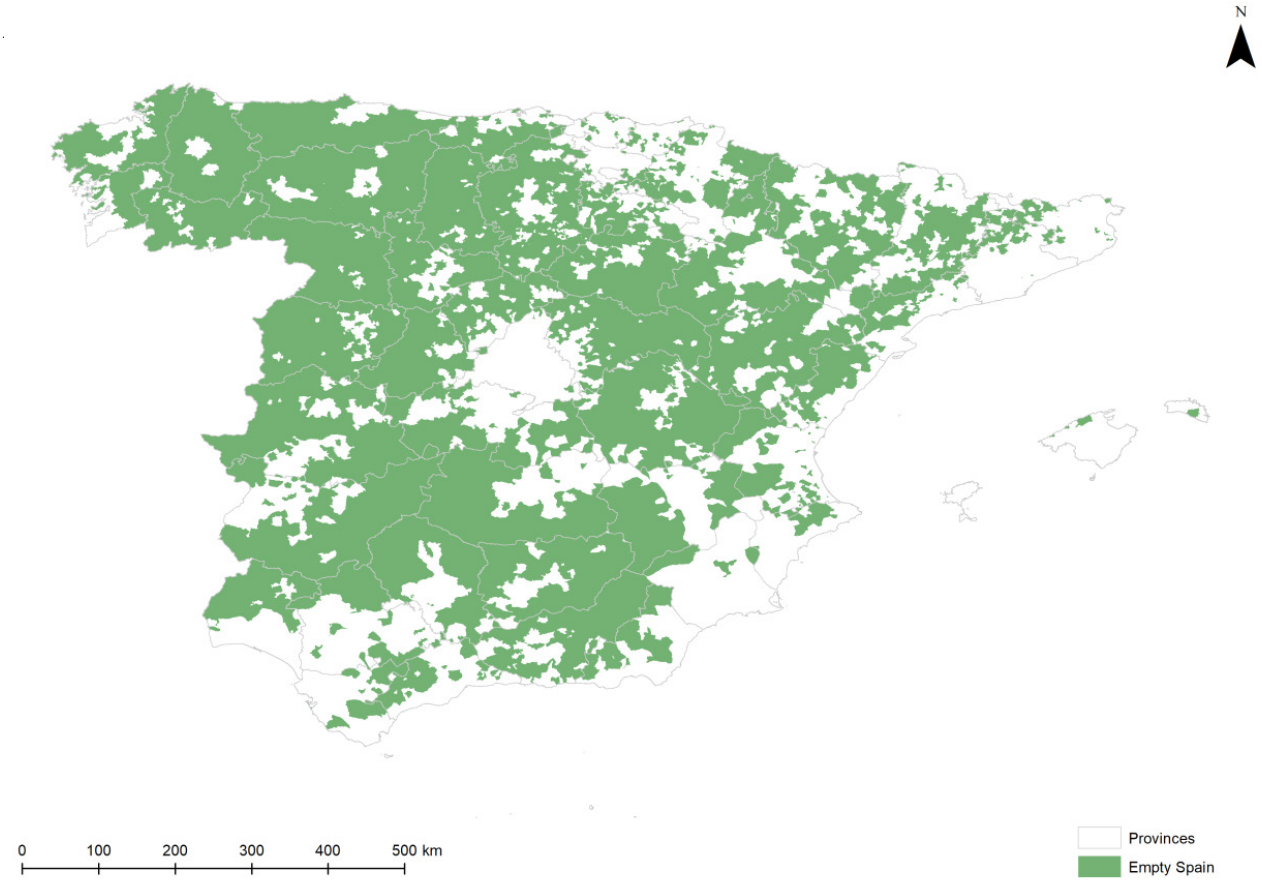

Figure 1. Geographical extent of Empty Spain.

coast, the Basque Country, agricultural belts (Guadalquivir and Ebro depressions, La Mancha vineyards, etc.), and some inner hotspots centred by important provincial cities, in which civil services (bureaucracy, hospitals, universities, finances, commercial centers, etc.) are located. It is particularly remarkable that the population of some corridors that connect municipalities has not decreased: the Mediterranean corridor, the municipalities through which strategic motorways pass, etc. In the Cantabrian Sea, this corridor stretches between the French border and the eastern half of Asturias.

Land abandonment

Table 2 shows the main land use changes that Empty Spain has experienced between 2000 and 2018. About 37,000 km^2 of traditional agroforestry lands have been transformed and have faced either abandonment or intensification. Of these lands, above 24,000 km^2 of agroforestry systems have been abandoned, i.e., converted to grasslands, heathlands, or forests, while the rest have changed to intensive croplands (above 8,000 km^2) or pasturelands (ca. 3,000 km^2). The remaining ~1,000 km^2 of land has changed to artificial areas or other land-uses not considered in this analysis (other CLC Level 3 codes).

We assigned traditional agroforestry, agricultural fields, and intensive pastures as 'anthropogenic lands', and grasslands, heathlands, and forests as 'natural lands'. Subtracting the sum for 'anthropogenic lands' in 2000 from that in 2018 revealed a negative value (-25,541 km^2), while subtracting the sum for 'natural lands' in 2000 from that in 2018 revealed a similar but positive value (+24,536 km^2). Therefore, between 2000 and 2018, out of a total of ~ 320,000 km^2 across Empty Spain, ~8% of land has actually been abandoned, i.e., transformed from 'anthropogenic lands' to 'natural lands'.

Figure 2 shows the geographical distribution of the different land-use classes of Empty Spain utilized for this analysis at the municipal scale. Most of the geographical areas where traditional agroforestry lands have been modified to grasslands, heathlands, and forests (land abandonment) are in the north-western part of the country (Galicia region) and in municipalities of the Iberian System (central-eastern

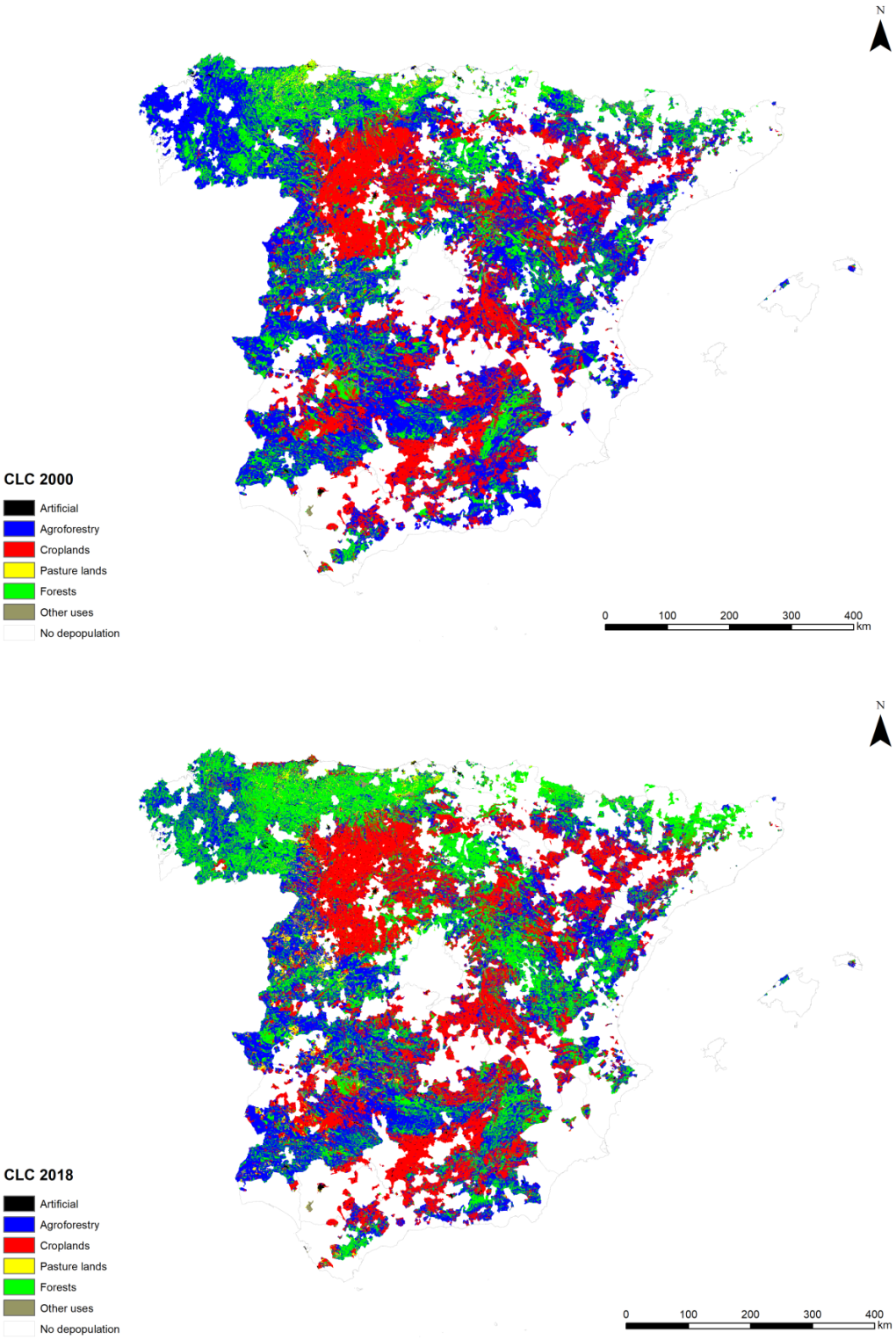

Figure 2. The main land uses of Empty Spain in 2000 (top) and 2018 (bottom).

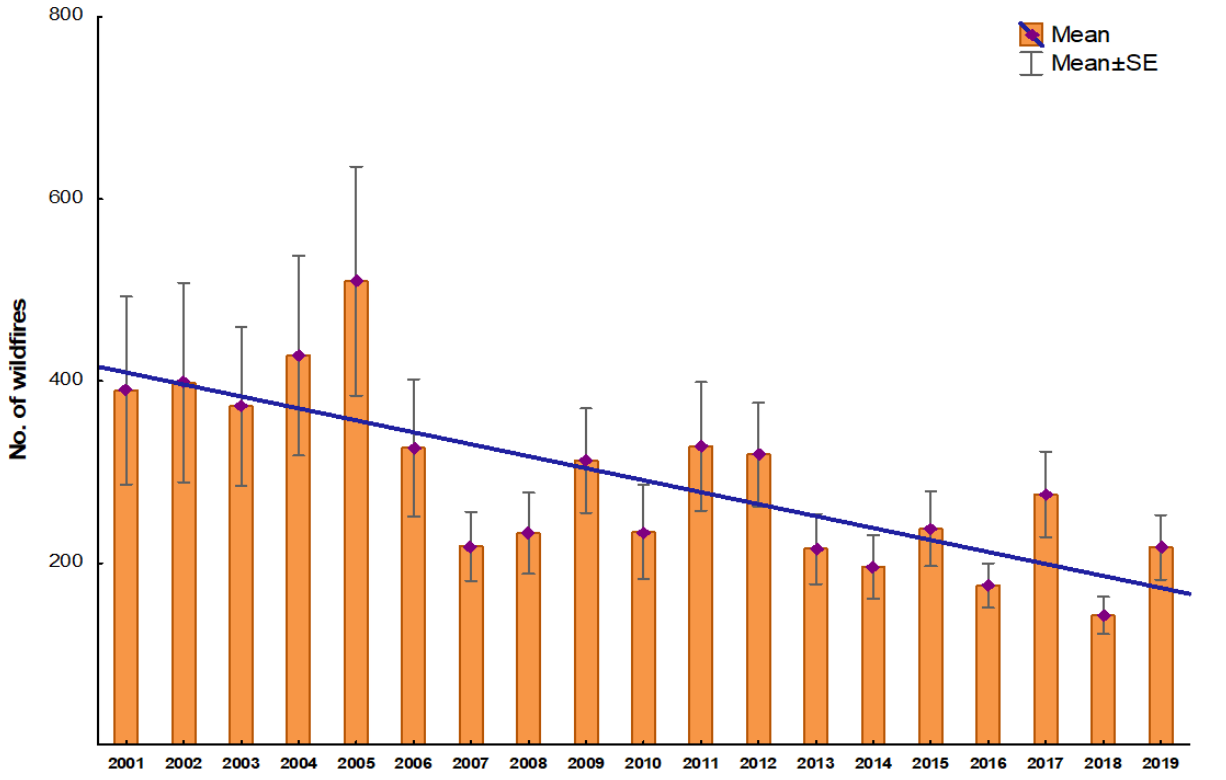

Figure 3. Mean yearly number of wildfires per province from 2001 to 2019. The blue line represents the regression fit of the mean values (y= 422.5857 – 13.1319x).

Table 2
Main land use changes in Empty Spain. Canary Islands are not included.

Land use/cover	CLC 2000 (km²)	CLC 2018 (km²)	Difference (km²)
Traditional agroforestry	138,261	101,248	-37,013
Agricultural fields	92,212	100,654	+8,442
Intensive pastures	3,573	6,603	+3,030
Total 'anthropogenic lands'	234,046	208,505	-25,541
Grasslands	19,279	24,338	+5,059
Heathlands	7,776	15,982	+8,206
Forests	52,061	63,152	+11,091
Total 'natural lands'	79,116	103,472	+24,536
Other land uses/covers	5,911	7,096	+1,185
TOTAL	319,073	319,073	0

Spain). Changes in croplands and pastures are evident in the central-western part of the country (Extremadura, Castilla-La Mancha, etc.). Regarding artificial surfaces and other land-uses not considered in this analysis, overall changes in areal cover have not been remarkable.

Wildfires

Figure 3 shows the number of wildfires across Spain (50 provinces) per year between 2001 and 2019 (available data). Despite the substantial increase in cover of forest (+11,091 km²) and heathlands (+8,206 km²; Table 2), the number of wildfires decreased substantially over this period. From a spatial point of view, the provinces of Ourense (Galicia, NW Spain) and Asturias (northern Spain) each had the greatest annual number of wildfires – nine times throughout the studied period – and A Coruña (also in Galicia) had the most wildfires during one year. The maximum number of wildfires per province ranged between 638 in 2018 and 4292 in 2005 (with very high wildfire occurrence between 2001 and 2005).

Livestock husbandry

Figure 4 shows the mean number of animal units per province for the years 1999 and 2018. While the average

Table 2
Correlation coefficients of the analyzed variables for 2018. *, **, *** for significant effects at p<0.05, 0.01 and 0.001, respectively.

	Depopulation	Artificial	Croplands	Forest and seminatural	Wetlands	Water-bodies	Wildfires	Livestock
Depopulation	1.000							
Artificial	-0.347*	1.000						
Croplands	0.766***	-0.029	1.000					
Forest and seminatural	0.738***	-0.174	0.383**	1.000				
Wetlands	-0.120	0.153	0.188	-0.127	1.000			
Water bodies	0.573***	0.015	0.705***	0.258	0.235	1.000		
Wildfires	0.136	-0.035	-0.158	0.202	-0.111	-0.024	1.000	
Livestock	-0.086	0.366**	0.021	0.059	-0.065	-0.004	-0.023	1.000

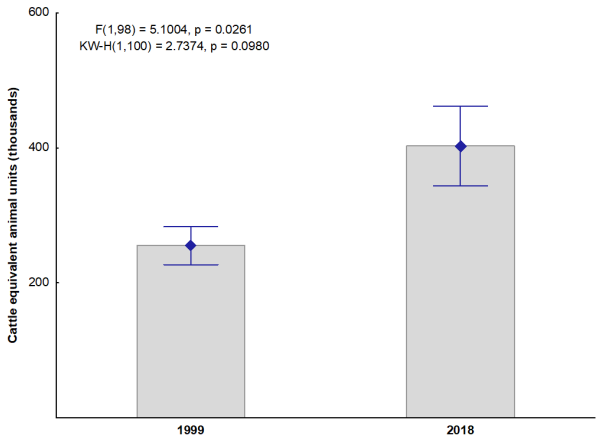

Figure 4. Mean (and standard error) values of livestock census in 1999 and 2018.

number of animals has almost doubled, we found high variability among different provinces. For instance, Navarra and Barcelona experienced an increase of more than 1 million AU, and the province of Cáceres faced an increase of ca. 0.7 million AU (presumably extensive ranching). Meanwhile, Lleida and Badajoz have faced a decrease of 0.8 and 0.5 million AU, respectively, during this period. Currently, four out of fifty provinces exceed 1 million AU (Navarra, Barcelona, Cáceres and Salamanca) and nine others (Madrid among them) have more than 0.5 million AU.

Correlational analysis

Table 3 shows the correlation coefficients between pairs of the analyzed variables for 2018 using data from the 50 provinces of Spain. The land surface covered by municipalities that have lost population showed significant and strong positive correlations with areal cover of agricultural lands, forests (including heathlands and natural grasslands), and waterbodies, and a negative correlation with artificial land areas. The positive correlation between croplands and forests/seminatural areas is particularly remarkable.

Discussion

The phenomenon called Empty Spain, i.e., geographical areas that have lost population between 2000 and 2020, covers a land surface of more than 60% of Spain, the second largest country in the European Union (EU), after France. In terms of land area, it encompasses more than 320,000 km^2. Depopulation has mostly affected rural municipalities with a total population below 2,300 inhabitants. Yet, some remarkable cases of depopulation have occurred in cities. For instance, the cities Cádiz, Valladolid, Ferrol, León, Salamanca, Santander, Granada, and Seville have all faced a population decrease of 9,000–24,000 inhabitants between 2000 and 2020. This trend can be related to the relatively high cost of housing in some of these cities, which prompts many people to move to nearby, cheaper municipalities (suburbanization processes) (Tajani et al., 2019).

One way or another, across the Empty Spain, the overall net abandonment of ca. 25,000 km^2 of rural lands, encompassing ~ 8% of the total area of Spain, contradicts our study's primary hypothesis. Yet, land abandonment and land intensification are two processes that have coexisted throughout the studied period. In Empty Spain, around 37,000 km^2 of traditional agroforestry lands have been abandoned (ca. 2/3 of this area) or converted to intensified systems (ca. 1/3 of this area), such as irrigated olive and vineyard plantations, fodder pastures to feed intensive

livestock animals, etc. This land-use change has taken place in many municipalities.

Our findings fully agree with the predictions made by Perpiña Castillo et al. (2020). Nonetheless, it is irrelevant to establish cause-effect relationships between depopulation and land abandonment since the latter is driven by a combination of many factors (Ustaoglu & Collier, 2018). This perhaps explains why agricultural intensification (with the resulted in increased profitability) coexists with land abandonment (that was mainly detected in areas defined with natural constraints such as remoteness and mountainous topography) (Dax et al., 2021). The concurrent contradictory processes of intensification/extensification have been observed even at the farm scale of the traditional agroforestry (dehesa) systems (Herguido Sevillano et al., 2017).

The increase in land covered by forest and seminatural areas since the turn of the 21st century (which contradicts the study hypothesis) did not correspond with the decrease in number of wildfires (which fits the study hypothesis). This challenges the common conception that depopulation triggers a cycle that is followed by land abandonment and consequently, by an increase in wildfires (Mantero et al., 2020). Yet, we acknowledge that this trend may be a consequence of increasingly efficient official policies for fire prevention (Vélez, 2010).

One way or another, the increase in forest cover in many parts of Spain is mostly attributed to natural tree regeneration. However, Moreno-Fernández et al. (2020) showed that natural regeneration is lower in the southern part of the country, because of the drier and warmer climate. Also, reforestation is significant in parts of Spain with a high agrarian tradition (Herguido Sevillano et al., 2017). Nevertheless, the most wildfires per year have been observed in 3 provinces out of 50 throughout the 19 years of data collection. Interestingly, these three provinces are Ourense (9 years), Asturias (9 years) and A Coruña (1 year) located in the north and north-western Spain, i.e., in the regions in which Perpiña Castillo et al. (2020) foresaw the maximum risk of land abandonment by 2030. Over the period we studied, Ourense (7,273 km^2) and Asturias (10,604 km^2) have faced over 500 km^2 and 300 km^2 of agricultural land abandonment, respectively.

The recent expansion of intensive vineyards, olive groves, and other fruit tree plantations, such as pistachio, almonds, chestnuts, cherries, plums, oranges, etc. (Morgado et al., 2020; Pulido et al., 2019) is the most plausible reason that explains the substantial increase in agricultural lands in spite of the decreasing rural populations. This kind of agriculture produces comparatively high-profit crops, but is not labor intensive, as most tasks are mechanized (Galván et al., 2021). The substantial increase in fodder pastures between 2000 and 2018 can be attributed to the increase of landless livestock-intensive farms in some regions, which rely on off-farm produced feed (Eldesouky et al., 2018). Yet, the dehesa systems still survive due to EU subsidies (Escribano et al., 2018), agrotourism (Sánchez-Martín et al., 2019), and in some cases, due to the production of gourmet products (e.g., ham, beef ribeye, lamb chops, etc.) (Díaz-Caro et al., 2019).

The top ten provinces with the highest number of livestock include both high density (Barcelona and Madrid) and low density ones (Cáceres and Salamanca). A possible explanation could be the location of intensive farms near large urban centers that act as distributors for the entire country (Jarosz, 2008), alongside with the increase in animal stocking rates in the dehesa systems (Gaspar et al., 2007).

The positive correlation between croplands and forest/seminatural areas may be attributed to the simultaneous trends of land abandonment and agricultural intensification. The increase in highly intensive agricultural systems seems to contradict the agri-environmental schemes (AES) promoted by the EU in the new Common Agricultural Policy (CAP), which is aimed at increasing biodiversity and improving the provision of ecosystem services (Reed et al., 2014). At the same time, land abandonment can be considered as a first step in allowing tree regeneration (Chauchard et al., 2007), increasing carbon sequestration (Novara et al., 2017), and promoting eco-tourism (Ioppolo et al., 2013). Therefore, land abandonment, and its perception by the CAP, should be viewed as a two-sided coin in the context of climate change and global markets (Lasanta et al., 2017). The CAP promotes strategies such as agroforestry, and at the same time, encourages farm intensification (Escribano et al., 2016).

In ecological terms, land-use change from traditional farming systems, such as agroforestry, into intensive croplands and pasturelands causes landscape simplification, consequently decreasing environmental quality. Over time, this transformation in land-use can accelerate processes of land degradation and environmental deterioration (Riechers et al., 2020). The EU is mindful about the possible consequences of large-scale land abandonment (e.g., the Empty Spain), such as the progressive loss of agriculture-related values and cultural heritage (Tarolli et al., 2019). In fact, various mitigation measures are now

being promoted, such as improving farming conditions, supporting areas with natural constraints, encouraging forestry conservation schemes, and investing in rural services and infrastructures (Lasanta et al., 2017). Unfortunately, the success of these measures cannot be assessed yet.

Further research is still needed in order to overcome the limitations of this study. Specifically: (a) a more refined delimitation of the Empty Spain according to population dynamics over a longer time span; and (b) the use of higher-complexity analyses, aimed at finding conclusive relationships between population decline and land abandonment, as well as assessing the effect of other variables, including factors that were not considered in this study.

Conclusions

The phenomenon known as the Empty Spain reflects a serious demographic challenge, which also affects land-use and management. Overall, data shows that between 2000 and 2018, extensive lands were abandoned across Spain, particularly in the north and north-western parts of the country (Asturias and Galicia regions), where natural constraints are quite common. Over this period, the rural areas in Spain experienced landscape simplification, because traditional agroforestry systems have been widely abandoned. Meanwhile, extensive lands were converted into intensified systems (olives, vineyards, etc.) near agricultural belts such as Guadiana valley and La Mancha region. The agricultural intensification is also demonstrated by the increase in livestock, both in intensive (Navarra and Barcelona provinces) and extensive farming systems (province of Cáceres). Although extensive lands have been abandoned, the number of wildfires has decreased over this period. Overall, the trends of land abandonment and landscape simplification are expected to reduce environmental quality across the rural areas of Spain.

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