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LAND USE CHANGES IN SPAIN. DRIVERS AND TRENDS IN AGRICULTURAL LAND USE

ZMENY V UŽÍVANÍ PÔDY V ŠPANIELSKU. STIMULY A TRENDY VO VYUŽÍVANÍ POĽNOHOSPODÁRSKEJ PÔDY

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I. Introduction

Land and soil are vital resources. However, the last decades have seen increasing pressures in land use and unsustainable trends. Land use change is both the result and a cause of diverse interactions between society and the environment(1) and is characterized by a high diversity of change trajectories depending on the local conditions, regional context and external influences. Understanding the spatial patterns of changes in the extent and intensity of land use, and how these relate to each other, is important for understanding land-use change trajectories(2).

Natural lands provide essential functions for human life: food security, water harvesting, clean air, other ecosystem services, territorial resilience. However, we face an increasing process of land artificialization in Europe. Land take for urban, infrastructure and industrial purposes exceeds 1.000 km^2 per year in the EU, with over half of this surface being defined as 'sealed', according to the *European Commission's 2011 Roadmap to a resource efficient Europe and The European environment – state and outlook 2015*(3).

Environmental concerns and land take and land degradation processes are being exacerbated by the occupation of new areas (e.g. for the construction of new transport infrastructure linking previously non-connected areas) and the substantial increase in emission levels, energy use and the consumption of natural resources such as water(4).

The European Environmental Agency identified social, economic, and policy and governance issues as the causes underlying these processes in Europe. Social factors include the demographic trends and the changes in lifestyle. While Europe's population growth is slow overall (and negative in some coun-

(1) Petit and Lambin (2002)
(2) Verburg et al. (2010)
(3) EEA (2015)
(4) OSE (2010)

Abstract (EN)

Land is an essential resource and plays a vital role in providing food and food security, water, ecosystem services and territorial resilience. However, the past few decades have generated enormous and increasingly unsustainable pressures on land use. The objective of this research is to analyse the main land use changes in Spain between 1987 and 2011 using data provided by the Corine Land Cover (CLC) project. The general trends in land use change at CLC level 1 in this period, and more specifically the changes occurring at CLC level 3 in land destined for agricultural use are analysed. The main reasons that explain these changes, including policy influences, are then identified. The results show that the area occupied by buildings and infrastructure has doubled, agricultural land has decreased and irrigated land has increased; forested areas have also increased, but their ecological quality has been degraded. These trends question the future sustainability of that land use in the analysed period.

Keywords (EN)

land use change, Spain, Corine Land Cover, sustainability

Abstrakt (SK)

Pôda patrí medzi základné prírodné zdroje a zohráva dôležitú úlohu pri zabezpečovaní potravín a potravinovej bezpečnosti, vody, ekosystémových služieb a územnej odolnosti.
V posledných desaťročiach je však na využívanie pôdy vyvíjaný enormný a čoraz viac neudržateľný tlak. Cieľom tohto výskumu je analyzovať hlavné zmeny využívania pôdy v Španielsku v rokoch 1987 až 2011 s použitím údajov poskytnutých projektom Corine Land Cover (CLC). Analyzované boli všeobecné trendy v zmene využívania pôdy na úrovni CLC 1 v tomto období, konkrétnejšie zmeny, ktoré sa vyskytujú na úrovni 3 CLC na pozemkoch určených na poľnohospodárske využitie. Následne boli identifikované hlavné dôvody vysvetľujúce tieto zmeny, vrátane politických vplyvov. Výsledky ukazujú, že plocha zastavaná budovami a infraštruktúrou sa zdvojnásobila, rozloha poľnohospodárskej pôdy klesla a rozloha zavlažovaných pôd sa zvýšila; rozloha zalesnených plôch sa tiež zvýšila, ale ich ekologická kvalita sa zhoršila. Tieto trendy spochybňujú budúcu udržateľnosť takéhoto využívania pôdy v analyzovanom období.

Kľúčové slová (SK)

zmena využívania pôdy, Španielsko, Corine Land Cover, udržateľnosť

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tries), internal migration, in particular, can lead to an increase in the demand for land use in some parts of Europe, and, at the same time, contribute to the decline of cities and villages elsewhere and the abandonment of farms in rural areas. Migration from outside Europe can also be a pressure for land use, in particular in urban areas. Nonetheless, land take is also seen in EU Member States with overall stable or declining populations, such as Portugal. Additionally, new trends in culture and lifestyle influence where people wish to live, the food they buy, etc. These issues are often addressed as consumption patterns[5].

Among the economic factors are mentioned the economic growth and affluence that stimulate commercial, industrial and service activities, which, in turn, can fuel demand for construction – and, in turn, land take. They also influence the demand for food and other land-based products, as well as for larger homes and second homes and, potentially, increases the use of private transport, which, in turn, can influence preferences for housing location. Additionally, global market trends link EU food production to global demand, and thus can influence agricultural practices and their impacts on land. The technological change can affect land-related developments in a range of sectors via, for example, changes in the costs of infrastructure and the methods used in agriculture.

Finally, policy and governance issues highly influenced land use changes. Some EU policies, such as the Cohesion Policy, the Environmental Policy, the Transport Policy, the Energy Policy and the Common Agricultural Policy (CAP) have had important impacts on land take and land degradation in Europe. Many of them have been negative, but potential positive impacts can also be identified. The impacts of EU policies need to be considered in terms of Europe's complex, multi-level governance system, from EU to national, regional and local levels. The specific contexts, including the policies and institutions within each Member State, play a key role in shaping the impacts of EU policies.

With an area of 506,023 km^2 and a coastline of 8,000 km, Spain is one of the largest countries in Europe and has experienced the greatest changes in land use in recent decades [6]. The objective of this study is to analyse the changes in land use in Spain between 1987 and 2011 using data provided by the Corine Land Cover (CLC) project, with a particular emphasis on changes in agricultural land that occupies approximately half of the country's surface. The different demographic, socioeconomic or political causes that explain these changes are analysed.

II. Methods

This research is based on the land use data provided by the CLC project managed by the European Environmental Agency. The CLC is the most spatially and temporally homogenous cartographic source that exists for land cover monitoring in Europe. It follows a hierarchical structure based on three homogeneous levels. At CLC level 1, five cover classes are defined. These classes expand to 15 at CLC level 2 and, finally, the inventory distinguishes 44 cover classes at CLC level 3 (see Appendix 1).

The CLC uses data at a resolution of 1:100,000, a Minimum Mapping Unit (MMU) of 25 hectares (ha) for areal phenomena and a minimum width of 100 m for linear phenomena. CLC also provides information on changes between land uses. In this case, the MMU for the resulting land use change layer is 5 hectares.

The advantages of using these data are that they use the same standards and land use criteria for all European countries with a common base year and that the system is interoperable and the same for all public administrations. Using these data allow for making comparisons at a spatial and temporal scale and providing open-source data.

Currently, the CLC project has published data for Europe in 1990, 2000, 2006 and 2012, which, in the case of Spain, correspond to the Landsat and Spot satellite image analysis for 1987, 2000, 2005 and 2011. The project management, data collection and data processing for Spain are performed according to the standards of the European Environment Agency by the National Geographic Institute (IGN).

In this study, an analysis is carried out of the changes occurring between the five uses of level 1 cover in Spain. Next, the changes in level 3 cover for agricultural land uses are studied in more depth. Finally, the possible causes, including the policy influence, that explain these changes are identified. The analysis was carried out with land cover data provided by the CLC project in Spain for satellite images corresponding to the mentioned years (1987, 2000, 2005 and 2011)[7].

III. Results

3.1 Land use changes at CLC Level 1

Table 1 shows the changes in land use that occurred in Spain in the analysed period using CLC level 1 data. Between 1987 and 2011, the most substantial changes occurred in the land dedicated to agriculture, with a reduction of approximately 1,650,000 ha, and in forest areas, where the surface has increased by almost 1,000,000 ha. However, in relative terms, the greatest variation has been the increase in artificial surfaces (urban settlements, infrastructure) that has almost doubled during this period.

The area dedicated to agricultural use in Spain occupies essentially half the national territory. Between 1987 and 2005, the amount of land dedicated to this use remained relatively stable at approximately 25 million hectares. However, the data collected in 2011 show that the area devoted to these agricultural uses has been significantly reduced, to 23.7 million ha.

Forest areas, although initially the second-most important land use, have become the most important. Forest surface increased between 2005 and 2011, in clear contrast with the trend from 1987 to 2005, and now occupy more than 25 million hectares.

Although artificial surface only represented 2.49% of the total national surface in 2011, this category has experienced

[5] EEA (2016)

[6] Ibid.

[7] IGN (2012)

Table 1: Land cover changes in Spain CLC Level 1 (1987–2011). Hectares

CLC Level 1	1987	2000	2005	2011	Changes 2011–1987
1. Artificial surfaces	669.888	895.981	1.017.360	1.260.414	590.526
2. Agricultural areas	25.411.955	25.387.248	25.364.294	23.762.385	-1.649.570
3. Forest and semi natural areas	24.192.357	23.953.657	23.852.221	25.179.341	986.984
4. Wetlands	110.259	111.083	111.082	100.660	-9.599
5. Water bodies	284.119	325.174	328.184	569.991	285.872

Source: IGN (2012)

Table 2: Land cover changes in agricultural lands in Spain CLC level 3 (1987–2011). Hectares

CLC Level 3	1987	2000	2005	2011	2011–1987
2.1.1 Non-irrigated arable land	10.374.685	9.918.940	9.756.262	10.013.557	-361.128
2.1.2 Permanently irrigated land	2.032.630	2.185.803	2.201.034	2.449.032	416.402
2.1.3 Rice fields	99.896	137.922	144.767	136.645	36.749
2.2.1 Vineyards	833.644	815.157	838.102	1.076.040	242.396
2.2.2 Fruit trees and berry plantations	796.200	869.320	891.096	1.147.440	351.240
2.2.3 Olive groves	1.728.146	1.806.683	1.865.182	2.273.136	544.990
2.3.1 Pastures	660.794	639.085	648.922	876.357	215.563
2.4.1 Annual crops associated with permanent crops	147.561	141.222	140.997	28.670	-118.891
2.4.2 Complex cultivation patterns	3.866.061	3.895.653	3.880.505	1.861.946	-2.004.115
2.4.3 Land principally occupied by agriculture, with significant areas of natural vegetation	2.481.812	2.503.725	2.499.950	1.424.654	-1.057.158
2.4.4 Agro-forestry areas	2.390.525	2.473.738	2.497.475	2.474.908	84.383
TOTAL	25.411.954	25.387.248	25.364.292	23.762.385	-1.649.569

Source: IGN (2012)

the most profound and transcendental changes given their irreversibility. The number of artificial hectares has almost doubled during these years, especially in the interior of the country and along the coastal strip. The extent of urban areas has almost doubled from 1987 and industrial areas and infrastructure have tripled, as have mining activities, dumps and construction sites. Artificial green areas have also increased significantly, quadrupling since 1987. Areas occupied by rail networks have also significantly increased.

Wetlands and water bodies represent approximately 1% of the surface in Spain and have also increased significantly during the period analysed, although it is necessary to distinguish between natural and artificial wetlands (reservoirs, salt marshes and artificial channels). In the analysed period, the natural areas have decreased and the artificial areas have increased.

3.2 Land use changes in agricultural lands (CLC Level 3)

Among the different agricultural land uses included in CLC level 3 (Table 2), the largest area corresponds to 'non-irrigated arable land'. This area has seen a net loss of 361,128 ha and is the use that has indicated the most marked decrease. It is worth noting that between 1987 and 2005, its size decreased by more than 600,000 ha but increased again in 2011. The initial loss of this land cover type was the result of the transformation of rainfed lands into irrigated lands, as well as new plantations of olive groves, fruit trees and vineyards. A portion of these lands was also transformed into artificial surfaces by the development of new construction and infrastructure. The subsequent gain in surface area has been made at the expense of the area dedicated to 'complex cultivation patterns' and 'land principally occupied by agriculture', as subsequently discussed.

Irrigated land has continued to increase, with 20% more area

dedicated to these types of crops in 2011. The number of hectares dedicated to rice cultivation has also increased, although this crop occupies a very small proportion of land in the national territory because of its special agronomic needs.

Permanent crops (vineyards, fruit trees and olive groves) have continued to increase in the period analysed. Fruit trees have experienced the largest increase in relative terms (44%). Vineyard area has increased by approximately 30%, although a slight decrease occurred between 1987 and 2000 because of European policies that encouraged the vines grubbing up. Land dedicated to olive groves have increased, gaining more than 540,000 hectares in these years or equivalent to a 31% increase in the area devoted to this crop.

The land surface dedicated to pastures and rangelands has also experienced an overall increase, although there was also a downward trend. Between 1987 and 2000, the land surface for pastures decreased but has since increased and experienced a net gain of more than 200,000 ha (32%).

The following land use categories have experienced surface area losses. The cover of annual crops associated with permanent crops has decreased cover by more than 80%, although they represent a very small portion of land use in Spain. These losses are much more significant for the complex cultivation pattern category, which has lost more than 2,000,000 hectares or almost 52% of its area. A very similar trend has occurred in the land category principally occupied by agriculture with significant natural vegetation areas—this surface area has decreased by more than 1,000,000 ha (42%).

Finally, agroforestry systems have maintained a relatively stable surface area, with a small net area gain (3%).

IV. Discussion

4.1 Reasons behind the land use changes at CLC Level 1

The main change in land use at the CLC level 1 has been due to the enormous urban sprawl. The rate of change was 1.9%, far exceeding the EU average rate, which was 0.68% for the 23 European countries covered by this project between 1987 and 2000, according to the CLC project data[8]. This fact implies not only a change in the use of land but also a profound degradation of soil and land.

The average annual rate of urban expansion in Spain was 2 hectares per hour between 1987 and 2000[9]. Since 2000, the trend has been even more dramatic, with a natural surface to artificial surface conversion rate of 3.37 hectares per hour between 2000 and 2005, almost doubling the number of urbanized hectares between 2005 and 2011[10]. Although the data do not reflect this increase because it is based on two fixed satellite images (2005 and 2011), this trend was much more intense in the early years of this period, before urban sprawl in Spain was halted by the 2007 financial crisis.

Between 1987 and 2005, the increase was the result of the conversion of agricultural and forestry surfaces into artificial surfaces. Approximately 62% of the new urbanized areas originated from agricultural areas and 25% from forest areas[11]. It is worth mentioning that these processes have not uniformly affected the Spanish territory but have been much more intense in the coastal areas (initially more intense in the Mediterranean, although in recent years, these processes have extended to the Atlantic and Cantabrian coasts), in regions of the interior near Madrid and around the medium- and large-sized cities.

Among the main causes of this significant increase are: i) the Spanish economic growth model from the late 1990s until the 2007 financial crisis that excessively concentrated growth in the construction sector; ii) European and national public policies that have fostered an economic growth dependent on high land-consuming sectors, such as construction, transport and tourism; iii) the transformation of the urban model, shifting from a vertical to a horizontal land use model and the consolidation of a new, dispersed city model[12] and iv) substantial investments in infrastructure, especially communication networks but also energy, ICT and water networks, driven by the significant investment of European Structural Funds[13].

The Spanish economy grew at rates higher than 3% between 1985 and 2007, being considered as a reference model for other countries at that time. An important part of this economic growth can be explained by the enormous importance of the construction and real estate sectors that allowed absorbing a large amount of low-skilled labour and that created significant employment and consumption opportunities. This situation generated an enormous housing bubble that caused the price of homes to increase throughout Spain by an average of 183% in nominal terms and by 117% in real terms. Not only did the price of homes increase significantly, but more than five million new homes were built during this period. The unsustainability of the model became evident in the wake of the financial crisis, which in less than two years generated more than 2,000,000 unemployed and put the sector in a deep recession[14].

The technological gap and the lack of a transport infrastructure in Spain meant that, since the beginning of the accession to the EU, investments in transport infrastructure were considered a strategic objective in all Strategic Reference Frameworks for Spain. The importance of such infrastructure to economic growth and competitiveness has meant that a large part of their cost has been co-financed by the Cohesion Policy and the European Regional Development Fund (ERDF)[15]. However, we must not forget the negative aspects of such infrastructure, such as spatial land fragmentation, environmental impacts or soil sealing and destruction of the bio-physical soil matrix.

The changes in agricultural land use are analysed in depth in the following section.

Transformations in the land surface and the state of the forest areas have enormous importance in both maintaining biodiversity and fighting climate change. This relevance is even

[8] EEA (2013)
[9] Moreira (2011)
[10] OSE (2010)
[11] Ibid.
[12] Guerrero et al. (2012)
[13] EEA (2016)
[14] Campos Echeverria (2008)
[15] EEA (2016)

stronger if we consider that Spain has the third-largest forested area in the EU, after Sweden and Finland[16].

As mentioned, in the analysed period, the forest area increased by almost one million hectares for several reasons. Much of the agricultural activity has been abandoned in recent decades, especially in low productivity and mountain areas given the lack of profitability and competitiveness of these farms and the lack of generational succession. In addition, in many areas, the extensive livestock activity that controlled the scrub in vast areas of the territory has also diminished or disappeared, which has facilitated forest recolonization, transforming formerly agricultural areas into forest areas.

Different policies have also had important repercussions for the increase in forest area, including reforestation policies. According to the *Third National Forest Inventory*, since the beginning of the major reforestation policies in 1940 and until 2008, more than five million hectares have been reforested in Spain, representing 17.9% of the Spanish forest area[17]. These policies were strengthened by the application of the CAP which promoted the conversion of agricultural land into forest land, from 1994-1999, although the new approaches and CAP reforms in the 2000-2006 implementation period reduced the importance of these policies.

Another policy with high impact on the forest area situation has been the conservation and environmental protection policy. In 1989, Spain passed the Law for the Conservation of Natural Spaces and Wild Flora and Fauna (Law 4/1989 of March 27). As a result, between 1987 and 1996, close to 600 protected natural areas were declared that covered approximately 2.7 million hectares and added to the 1.8 million hectares corresponding to the 77 spaces previously declared, placing 7.2% of the Spanish surface under some type of environmental protection[18].

This national policy was considerably reinforced by the implementation of the Habitats and Birds European Directives into Spanish legislation through Law 42/2007 on Natural Heritage and Biodiversity (which replaced the aforementioned Law 4/1989). This law also regulates Natura 2000 areas, the natural protected areas and the Areas Protected by International Conventions and Agencies. It is worth mentioning that Spain has 22,227,600 hectares recognized as Natura 2000 areas, representing approximately 18% of the European total and giving Spain the distinction of being the country with the most surface by far under this type of protection[19]. Some authors estimate that these policies have had an important impact on the maintenance and growth of forest areas[20].

However, other policies have had negative impacts, such as transport policies. The development of infrastructure has fragmented the forest territory, preventing continuous forested tracts that are the most important for the recovery of ecological processes because they allow connectivity between ecosystems.

In the analysis of changes in forest areas, it cannot be forgotten that there have been important trade-offs in these areas (losses - mainly fires, logging, urbanization - and regeneration - mainly over burn areas)[21], although this type of information is not reflected in the CLC. The incidence of forest fires has been very important in Spain during the period analysed. Between 1987 and 2011, 3.7 million hectares burned[22]. In addition to forest areas, there has been a significant regeneration of scrub in burned areas and abandoned agricultural areas that have led to an abundance of shrubland ecosystems[23]. Additionally, the growth of urban and industrial areas occurs at the expense of forest areas, and all of these factors cause a significant reduction in the ecological quality of forest areas.

Although the increase in forest area is positive, its continued growth is vulnerable to threats derived from abiotic factors, such as their geographical distribution or climate changes, which determine the potential distribution of forest species. Global warming is causing higher temperatures and droughts in Spain[24]. Additionally, most of the Spanish forests are located in mountainous areas or on generally poor soil. Both factors increase the vulnerability of the forest tracts.

Finally, with respect to wetlands and water bodies, the increase in the surface area has been the result of the creation of artificial water bodies, such as reservoirs for the urban water supply or irrigation. The occupied surface of rivers and natural channels has decreased. Coastal wetlands have also disappeared or been transformed into agricultural areas.

4.2 Reasons behind changes in agricultural land use (CLC Level 3)

In this section, the changes occurring in agricultural land use are analysed in greater depth. The 'non-irrigated arable land' use shows an uneven trend. Between 1987 and 2006, the area for such land use lost more than half a million hectares (negative net balance of 540,379 ha), experiencing one of the greatest decreases in agricultural land. However, 2011 data show a significant increase of 257,295 ha, which - although failing to match the 1987 figures - implies an important recovery of this land cover according to the CLC.

Cereal, oil seed and protein are the main crops grown on these types of land. Among the reasons for the losses mentioned are the low average Spanish yields of these crops compared with those in other European countries, where water is not a limitation. In addition, generational renewal in the agricultural sector is lacking because of emigration, few labour incentives offered by the sector to young people (for example, hard-working conditions, contingencies, low profitability, low social recognition) and the difficulties in being able to access holdings of minimum viable size given the high land price, the scarce and/or variable profitability of agricultural production or the variability in agricultural prices controlled by global markets. In addition, many rainfed lands, especially those close to cities and towns, have been urbanized because of ur-

[16] EUROSTAT (2012)
[17] MAPAMA (2009)
[18] MAPA (2005)
[19] EC (2018)
[20] Ruiz-Benito et al. (2010)
[21] OSE (2016)
[22] MAPAMA (2018b)
[23] OSE (2016)
[24] IPCC (2014)

ban sprawl, the advancement of secondary residences and the development of transport and communications infrastructure.

European policies have had an important influence on the changes presented. Direct aids from the CAP has partially slowed this trend, which has also been influenced by the fact that, in general, they are highly mechanized crops with few labour demands and little agronomic risk. The recovery of rainfed agricultural lands partly derives from the almost structural irrigation water shortage in Spain and the worldwide meteorological events that occurred in 2007–2008 that generated a food crisis triggered by a shortage of cereals and other commodities, thus raising their prices and making these crops more attractive to cultivate[25].

In contrast to the rainfed agriculture land is the increase in 'permanently irrigated land', which significantly expanded in 1987–2000 (net increase of 214,070 hectares) and then significantly slowed from 2000–2006 (with an increase of only 15,412 hectares). These lands increased again between 2006 and 2011 to 247,295 ha. These lands are mainly devoted to intensive horticultural crops that are in high demand in Europe and as such are highly productive and economically valuable.

The differences between periods have much to do with the changes of water policies, with a slowdown in the implementation of new irrigation areas, in contrast with the modernization and consolidation of those already existing occurred in the second period analysed. With respect to the increase in irrigated lands between 2005 and 2011, there has been an influence from the efforts made in the last decade for more efficient water use that enabled the same amount of water to irrigate more hectares, use groundwater through wells, reorganize and convert existing crops to those with higher productivity and profit and use desalination plants in production areas of intensive crops, such as those in the Spanish Mediterranean areas.

In any case, although these increases in the irrigated area have important benefits from an economic point of view, they must be approached with caution from the environmental point of view. The climate in Spain is characterized by recurrent droughts that require Special Drought Plans[26] and do not guarantee water availability to maintain this type of crops. This increase presents important environmental sustainability problems and raises the pressure to use water.

In Spain, other land covers that have experienced important increases are those related to permanent crops, such as olive groves, fruit trees and vineyards. Between 1987 and 2011, there was a continuous increase (44%) in 'fruit tree and berry plantation' areas. Although the use of 'fruit trees and berry plantations' includes high tree heterogeneity, for the Spanish case, a large part of the increase in area is explained by the increase in the number of citrus hectares. In 2011, this crop occupied 60.9% of the cultivated fruit tree area and its surface increased from 257,108 ha in 1987 to 317,605 ha in 2011. Spain is the main European country in the market for these products, accounting for 45% of all intra- and extra-community trade, being the main markets to which Spain exports Germany, France and Poland. The quality of the Spanish product and the growing European demand for these products explain the increase in surface area[27].

The olive is another crop whose surface cover has not stopped increasing since 1987. Spain is the leading country in the world for olive oil production. The growing demand for this oil derived from its nutritional and organoleptic properties. The special climatic and agrological needs that its cultivation requires make the Mediterranean basin the ideal place for its expansion (although in recent years, new production areas have appeared in South America, the United States and Australia).

Although oil prices show significant annual fluctuations and have almost failed to cover crop costs in some agricultural seasons, the olive is a crop with deep roots in the Spanish culture. In addition, the groves adapt to soils and climatic conditions in which other crops would not thrive. These conditions, together with the high prices that premium quality olive oil can obtain and the increasing entry into new markets and demand in international markets, lead to continued increases in the olive grove area in Spain.

The increases in olive groves and citrus areas have materialized in the creation of new farms with smaller footprints and varieties adapted to mechanization (thus substantially reducing unit costs), more business-oriented and making a more efficient use of irrigation, which seeks to respond to the growing demand for these products. This demand has generated a dichotomy between these 'modern' farms – generally located in areas of good fertility – and the 'more traditional' ones (which in the case of olive groves are usually located in mountain areas) with greater difficulties in competing for prices because of high structural costs.

The notable increase in the area dedicated to 'vineyards' in Spain demonstrates that, together with Italy and France, Spain is among the leading wine-producing countries[28]. The fluctuations in this area between 1987 and 2006 are largely related to the rigid regulations of the sector by the CAP Common Market Organisations, which in this period limited vineyard areas to farms that had certain rights. After Spain entered the EU, subsidized initiatives were established to grub up vineyards, which explains the net decrease in area between 1987 and 2000 (6,249 hectares), to which must be added the difficulties faced by many farms, such as the lack of generational renewal or the difficulties of the wine market that hindered its viability.

However, since 1996, such initiatives have been significantly curbed by a reduction in European subsidies. In 2000, Royal Decree 1472/2000 established that, to receive the premium for abandoning a vineyard, the area had to be within the area defined by the Abandonment Plans that were approved by the regional governments. But, none were approved in Spain.

The 2005 data show a change in the trend, with a moderate increase in surface area (22,945 hectares) that was significantly accentuated between 2005 and 2011 (237,938 hectares). These positive net balances are explained by the implementation of new vineyards, all in the context of transforming the Spanish wine sector through conversion and restructuring programmes to better adapt production to market needs (especially in Castilla-La Mancha region) and the emergence of new

[25] FAO (2009)
[26] MAPAMA (2018b)
[27] Aznar et al. (2015)
[28] OEMV (2018)

vineyards associated with high-quality wines[29]. The relevance of the sector in Spain and the profound modernization that the wine sector has undergone in recent decades, with a notable commitment to quality production and the international positioning of Spanish wines, explain this increase.

In analysing the evolution of the agricultural-forest transition zones, it is necessary to point out that the CLC data for these areas are not as accurate as for other types of land cover. The mapping accuracy of CLC (25 hectares) for the transition areas between agricultural and forestry uses, such as 'agroforestry areas' and 'land principally occupied by agriculture, with significant areas of natural vegetation', may not identify small, dispersed forest remnants or those in the growth or regeneration phase, which require a more precise working scale. Hence, the data analysis for these 'agricultural' expansion areas at the expense of 'forest' expansion can lead to conclusions that are less reliable than those of the other changes analysed.

With this exception, the importance of CAP aids directly linked to the presence of livestock can be noted through the increase in areas classified as 'agroforestry areas' (84,383 net hectares between 1987 and 2011). Agri-environmental policies and the greening proposed by the CAP have also contributed to increasing this type of land cover.

V. Conclusions

The analysis shown reflects the phenomenon that the trends in the changes in land use in the period analysed in Spain do not follow a clear direction to sustainable development. As mentioned, behind the changes are socioeconomic causes but also a notable influence of policies.

The main change has been the expansion of artificial areas at the expense of mainly agricultural land, sealing the soil and leading to irreversible changes. The enormous importance of the construction and tourism sectors in the country's economy and changes in lifestyles have led to an expansion of urban areas and high infrastructure development.

Changes in agricultural areas confirm that the number of hectares devoted to these uses has decreased, leading to a reduction in the capacity to produce food. In addition, there has been a notable increase in irrigated areas, which calls into question the viability of these approaches in a country with structural rainfall and water availability deficits and for which the predictions are that this phenomenon will increase with climate change.

Forest areas experienced an appreciable increase during the study period, which is undoubtedly an advance towards sustainability given the important work of these spaces in providing ecosystem services and fighting against climate change. However, we cannot fail to mention that the ecological quality of these areas has decreased as a result of the high incidence of forest fires, forest fragmentation, abandonment of agricultural land that has led to scrub and subsequent forest recolonization and the fact that many of these forest tracts are subject to abiotic stress.

To conclude this study on a positive note, some of these trends have changed since the last year analysed by the CLC. Therefore, it is expected that in the project's next set of data on Spain, the analysis outcomes will be more positive.

[29] Sánchez-Hernández et al. 2010

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