
Assessing Land-Use Changes in European Territories: A Retrospective Study from 1990 to 2012

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Abstract

The need to understand what land use is has motivated the development of programmes that aims to identify it and quantify it—CORINE Land Cover (CLC) in 1985. From this official and open geodatabase—through the using of geographic information system (GIS) tools—the amount of area established for each land use has been identified in all the 28 member states of the EU. This mostly corresponds to agricultural and forestry uses. Between 1990 and 2012, it was possible to determine countries with variable land use models such as Finland, Latvia, Portugal and Spain—the rest of the states presenting stable land use models. Additionally, some countries are characterized by the predominance of one or two land uses. Contextually, the proposal aims to develop a retrospective study regarding the land-use changes in the EU territories from 1990 to 2012, through the available tools such as CLC.

Keywords: land uses, CORINE Land Cover (CLC), European territories, geographic information system (GIS) tools, planning

1. Introduction

The increasing need for comprehensive and reliable information about land cover, land uses and their dynamics and patterns has catalysed the development of several sets of global land cover data, derived from Earth observation by satellites [1]. Such development was motivated

by different initiatives and programmes national and international. In fact, the variety of mapping standards reflects the wide scope of interests and programmes [2].

Precisely, the land use coverage maps are data extremely useful, as evidenced by its widespread use and interdisciplinarity that they provide. These maps enable us to obtain information on the occupation of the land—biophysics coverage on the surface of the Earth [3]. For this reason, their use is essential for the study and modelling of territorial dynamics [4].

Among the available products Global Land Cover (GLC2000) should be highlighted; it had a global coverage by the year 2000 [5]. Europe stresses on Pan-European Land Use and Land Cover Monitoring (PELCOM), created from images of the year 1996, with a resolution of 1 km [4]. However, in Europe, at national and regional levels, it has included Coordination of Information on the Environment (CORINE) maps [4].

In this regard, in Europe, a special effort to monitor the change of land cover in a standardized manner has been carried out. The so-called inventory of CORINE Land Cover (CLC or 'Corine') has been created from satellite images. This common database used by a large number of organizations in Europe and co-funded by the European Commission and the member states has been processed by the European Environment Agency (EEA) considering the different land use covers—through the guidelines of the System of Environmental and Economic Accounts (SEEA) for 'land and ecosystem'. Thus, the database is now the core element for integration of the information system of the EEA [6]. In fact, the CORINE project containing the use coverage of European Union (EU) is seen as a relevant complement for the knowledge regarding major changes in land cover [7].

Although traditionally the CLC has been generated from the photo interpretation of satellite images, nevertheless, in some countries, such as Germany, Austria, Finland, Ireland, Iceland, Norway, United Kingdom, Sweden and Switzerland (mainly since 2006), the map is obtained from generalization techniques of national maps with greater detail [8]. In other cases—Slovakia, Hungary and Poland—CLC is used to obtain further details, scale 1:50000 maps, with a minimum map unit (MMU) from 4 and a legend adapted to the specific geographic features of the territory [8]. The same techniques have been used to obtain land use data prior to 1990 CLC [7].

Therefore, there are different ways of producing CLC. Still, countries like Germany or Ireland have changed its methodology in the production of CORINE land use maps—as for the photo interpretation for the general use. A similar scenario occurred in the Netherlands, once the government decided to produce the CLC independently [8, 9].

However, from CORINE, land use maps remain a tool of major relevance that enables one to analyse soil applications—regardless of the problems arising at the administrative and technical level. According to the directive INSPIRE 2007-2-EC [10], CLC is one of the most outstanding harmonized European data sets and CLC even has achieved a semantic and technical standardization, considering that the CLC is a set of reference data in common use for European scale assessments since it uses a generic land cover class definition throughout Europe [11, 12].

Indeed, other sources of information, so far, have only compatibility and comparability enclosed between different maps sources of land cover and its legends' theme—since they exist as independent datasets [1]. Usually, the heterogeneity in land cover maps result from different methods and underlying patterns—several layouts, syntactic issues, schematic heterogeneity and semantic aspects [13]. Different mapping methodologies are difficult to separate land use changes, once those changes are the results of a different used approach in creating the map [1].

Nevertheless, land use data sets are crucial in exploring socio-economic, political, cultural and environmental factors that influence land use decisions [14–16].

In this regard, the changing landscape of European territories is the subject of several studies and researches—pointing to significant change [17–19]. However, despite the pace of change of land uses in the European panorama, there is only a limited research that analyses the patterns of change in the use of the land on a pan-European level. Most of the existing research related to land-use change patterns have consisted of case studies from specific regions or local areas [20–24].

The harmonized CLC data have been used for the analysis of multiple disciplines, such as environmental [11] in social and economic analyses [25], transportation management [26] and demographic studies [27].

On the one hand, local case studies provide evidence on change catalysts in land use in a more detailed local context. Still, they are often verified in particular contexts, actors, processes, resolutions or scales [28]. Also, European land use change studies can lead to a more global view, whereas the analysis of the land use changes and the associated factors can be generalized and even their methodology can be transferred between different scenarios [29].

The European landscape has a wide variety of regional features and a well-defined dynamic structure—where agriculture is one of the most dominant land uses [30]. The agricultural land use covers more than 35% of the European territories—almost ten times more than the urban land use [31, 32]. Nevertheless, this is not the only type of soil that is changing in Europe.

The overall objective of the present study is to perform a retrospective analysis of the European land use changes. Contextually, it will determine the extension that EU state members dedicated to land uses, according to CLC. So, specific objectives can be summarized: (a) identify countries, where there is land use which is widespread and dominant over the remaining land uses and (b) if the surface extension dedicated to land uses has been constant or variable between 1990, 2000, 2006 and 2012.

2. Material and methods

To carry out the study, firstly, data have been collected such as official information that is detailed with sufficient precision and accuracy to characterize each of the countries part of the EU, according to their land use in 2018. It was decided to analyse the EU for its economic relevance and also according to the significant expansion of territory on a global scale.

Regarding information sources, the EEA provides the CLC, through the Copernicus Global Land Service¹. This inventory was initiated in 1985 although the first ‘visible’ results date from 1990, and updates have occurred in 2000, 2006 and 2012 (**Table 1**) [9]. Another two main goals, of the CLC programme, are: (a) providing quantitative coverage of the soil—consistent and comparable data across Europe for stakeholders in European environmental policy and (2) developing a digital land cover database covering the EU Member States and other European and North African sovereign states [1].

	CLC1990	CLC2000	CLC2006	CLC2012
Satellite data	Landsat-5 MSS/TM	Landsat-7 ETM	SPOT-4/5 and IRS P6 LISS III	IRS P6 LISS III and rapid eye
	Single date	Single date	Dual date	Dual date
Time consistency	1986–1998	2000 +/- 1 year	2006 +/- 1 year	2011–2012
Geometric accuracy, satellite data	≤ 50 m	≤ 25 m	≤ 25 m	≤ 25 m
Min. mapping unit/width	25 ha/ 100 m	25 ha/100 m	25 ha/100 m	25 ha/100 m
Geometric accuracy, CLC	100 m	Better than 100 m	Better than 100 m	Better than 100 m
Thematic accuracy, CLC	≥ 85% (Probably not achieved)	≥ 85% (Achieved)	≥ 85% (Not checked)	≥ 85%
Change mapping (CLCC)	Not implemented	Boundary displacement min. 100 m; Change area for existing polygons ≥5 ha; for isolated changes ≥25 ha	Boundary displacement min.100 m; All changes ≥5 ha are to be mapped	Boundary displacement min.100 m; All changes ≥5 ha are to be mapped
Thematic accuracy, CLCC	—	Not checked	≥ 85% (Achieved)	≥ 85%
Production time	10 years	4 years	3 years	2 years
Documentation	Incomplete metadata	Standard metadata	Standard metadata	Standard metadata
Access to the data (CLC, CLCC)	Unclear dissemination policy	Dissemination policy agreed from the start	Free access for all users	Free access for all users
Number of countries involved	26 (27 with late implementation)	30 (35 with late implementation)	38	39

Table 1. Evolution of Land Cover CORINE [33].

¹The CORINE programme was established in 1985 by the European Commission at: <http://land.copernicus.eu/global>.

Additionally, it has a spatial resolution of 100 m to linear phenomena. Also, different land uses have been classified using three levels of details—from the first with a higher degree of aggregation, the third party with the greatest degree of detail and therefore more disaggregated. The third comprises a total of 44 classes allowing one to characterize the land uses of each country (**Table 2**).

Regarding the CLC spatial coverage, additionally to the 28 EU member states, it also covers Albania, Bosnia and Herzegovina, Iceland, Kosovo, Liechtenstein, Macedonia, Monte Negro, Norway, Serbia, Switzerland and Turkey. Nevertheless, for this large set of countries, information only has been available in CLC 2000, 2006 and 2012 updates—and in the 1990 version countries not belonging to the EU was not included.

Then, GIS tools (ArcGIS) along with management tools (Microsoft Access) have been used. Considering that CLC updates generate a map of land use changes, only changes larger than 5 hectares, the first map corresponds to the changes between 1990 and 2000. With the first map, and combining with other intersections features, it has been possible to generate two new maps: (a) reference data and (b) a review of the previous map. According to [33]: *‘the study of the territorial changes should be studied from the change maps and not from the intersection of the CORINE maps for the years of reference, given that the cross-tabulation of various maps can produce technical changes not real, arising from variations in production methodology’*.

Regarding the methodological framework, the objective was to obtain the representative land use through polygons and their corresponding alphanumeric information for Europe in 1990, 2000, 2006, and 2012.

The graphical information layer consists of polygonal graphics entities, each of 44 kinds of reported soil applications. Also, the alphanumeric information contains information fields associating an identifier - a code for the use of the soil for level 3 (**Table 2**); the area of the polygon is measured in hectares as well as the length of the surface of each of the polygons is also calculated.

Considering the aim of the study, it has been necessary to count the number of hectares of land use classified by CLC for each of the countries—aiming to achieve that this was also represented by polygonal entities of each of the EU countries and administrative boundaries. This layer of information has a scale of 1: 1,000,000 being the graphic equivalent to 200 m, and the coordinate reference system is European Terrestrial Reference System 1989 (ETRS89), the same used for CLC for flooring applications. The origin is the centre of the mass of the Earth, including oceans and atmosphere. In addition, the z-axis is parallel to the direction of the pole Conventional International Origin (CIO). The x-axis intersects the Greenwich Meridian origin, and the origin plane is perpendicular to the z-axis.

Using GIS tools, a file representing the administrative boundaries of each of the 28 EU Member States has been generated throughout territorial polygons that have been processed.

After, have been overlapping polygons previously obtained for CLC land uses representing all polygons with EU land uses. This new layer inherits the thematic attributes of the layer on the CLC land uses.

LEVEL 1	Nomenclature definition	LEVEL 2	Nomenclature definition	LEVEL 3	Nomenclature definition
1	Artificial surfaces	11	Urban fabric	111	Continuous urban fabric: most of the land is covered by buildings, roads and artificially surfaced area cover almost all the ground. Non-linear areas of vegetation and bare soil are exceptional.
				112	Discontinuous urban fabric: most of the land is covered by structures, buildings, roads and artificially surfaced areas associated with vegetated areas and bare soil, which occupy discontinuous but significant surfaces
				121	Industrial or commercial units: artificially surfaced areas (with concrete, asphalt, tarmacadam, or stabilized, e.g. beaten earth) devoid of vegetation, occupy most of the area in question, which also contains buildings and/or vegetated areas.
				122	Road and rail networks associated land: motorways, railways, including associated installations (stations, platforms, embankments). Minimum width to include: 1 m.
		12	Industrial, commercial and transport units	123	Port areas: infrastructure of port areas, including quays, dockyards and marinas.
				124	Airports: airport installations like runways, buildings and associated land.
				131	Mineral extraction sites: areas with open-pit extraction of industrial minerals (sandpits, quarries) or other minerals (opencast mines). Includes flooded gravel pits, except for river-bed extraction.
				132	Dump sites: landfill or mine dump sites, industrial or public.
				133	Construction sites: spaces under construction development, soil or bedrock excavations, earthworks.
		13	Mine, dump and construction sites	141	Green urban areas: areas with vegetation within urban fabric. Includes parks and cemeteries with vegetation.
				142	Spot and leisure facilities: camping grounds, sports grounds, leisure parks, golf courses, racecourses, etc. Includes formal parks not surrounded by urban zones.
		14	Artificial, non-agricultural vegetated areas		

LEVEL 1	Nomenclature definition	LEVEL 2	Nomenclature definition	LEVEL 3	Nomenclature definition
2	Agricultural areas	21	Arable land	211	Non-irrigated arable land: cereals, legumes, fodder crops, root crops and fallow land. Includes flower and tree (nurseries) cultivation and vegetables, whether open field, under plastic or glass (includes market gardening). Includes aromatic, medicinal and culinary plants. Excludes permanent pastures.
				212	Permanently irrigated land: crops irrigated permanently and periodically, using a permanent infrastructure (irrigation channels, drainage network). Most of these crops could not be cultivated without an artificial water supply. Does not include sporadically irrigated land.
				213	Rice fields: land developed for rice cultivation. Flat surfaces with irrigation channels. Surfaces regularly flooded.
		22	Permanent crops	221	Vineyards: areas planted with vines.
				222	Fruit trees and berry plantations: parcels planted with fruit trees or shrubs: single or mixed fruit species, fruit trees associated with permanently grassed surfaces. Includes chestnut and walnut groves.
				223	Olive groves: areas planted with olive trees, including mixed occurrence of olive trees and vines on the same parcel.
		23	Pastures	231	Pastures: dense, predominantly graminoid grass cover, of floral composition, not under a rotation system. Mainly used for grazing, but the fodder may be harvested mechanically. Includes areas with hedges (bocage).
				241	Annual crops associated with permanent crops: non-permanent crops (arable lands or pasture) associated with permanent crops on the same parcel.
		24	Heterogeneous agricultural areas	242	Complex cultivation: juxtaposition of small parcels of diverse annual crops, pasture and/or permanent crops.
				243	Land principally occupied by agriculture: areas principally occupied by agriculture, interspersed with significant natural areas.
				244	Agro-forestry areas: annual crops or grazing land under the wooded cover of forestry species.

LEVEL 1	Nomenclature definition	LEVEL 2	Nomenclature definition	LEVEL 3	Nomenclature definition
3	Forest and semi-natural areas	31	Forests	311	Broad-leaved forest: vegetation formation composed principally of trees, including shrub and bush understories, where broadleaved species predominate.
				312	Coniferous forest: vegetation formation composed principally of trees, including shrub and bush understories, where coniferous species predominate.
				313	Mixed forest: vegetation formation composed principally of trees, including shrub and bush understories, where broadleaved and coniferous species co-dominate.
		32	Scrub and/or herbaceous vegetation associations	321	Natural grassland: low productivity grassland. Often situated in areas of rough uneven ground. Frequently includes rocky areas, briars, and heathland.
				322	Moors and heathland: vegetation with low and closed cover, dominated by bushes, shrubs and herbaceous plants (heath, briars, broom, gorse, laburnum, etc.).
				323	<i>Sclerophyllous</i> vegetation: bushy sclerophyllous vegetation. Includes maquis and garrigue. Maquis: a dense vegetation association composed of numerous shrubs associated with siliceous soils in the Mediterranean environment. Garrigue: discontinuous bushy associations of Mediterranean calcareous plateaus. Generally composed of kermes oak, arbutus, lavender, thyme, cistus, etc. May include a few isolated trees.
				324	Transitional woodland-shrub: bushy or herbaceous vegetation with scattered trees. Can represent either woodland degradation or forest regeneration/colonization.
		33	Open spaces with little or no vegetation	331	Beaches, dunes, and sand plains: beaches, dunes and expanses of sand or pebbles in coastal or continental, including beds of stream channels with torrential regime.
				332	Bare rock: scree, cliffs, rocks and outcrops.
				333	Sparsely vegetated areas: includes steppes, tundra and badlands. Scattered high-altitude vegetation.
				334	Burnt areas: areas affected by recent fires, still mainly black.
				335	Glaciers and perpetual snow: land covered by glaciers or permanent snowfields.

LEVEL 1	Nomenclature definition	LEVEL 2	Nomenclature definition	LEVEL 3	Nomenclature definition
4	Wetlands	41	Inland wetlands	411	Inland marshes: low-lying land usually flooded in winter, and more or less saturated by water all year round.
				412	Peat bogs: peatland consisting mainly of decomposed moss and vegetable matter. May or may not be exploited.
		42	Maritime wetlands	421	Salt marshes: vegetated low-lying areas, above the high-tide line, susceptible to flooding by sea water. Often in the process of filling in, gradually being colonized by halophilic plants.
				422	Salines: salt-pans, active or in process of. Sections of salt marsh exploited for the production of salt by evaporation. They are clearly distinguishable from the rest of the marsh by their segmentation and embankment systems.
				423	Intertidal flats: generally unvegetated expanses of mud, sand or rock lying between high and low water-marks. On contour on maps.
5	Water bodies	51	Inland waters	511	Water courses: natural or artificial water-courses serving as water drainage channels. Includes canals. Minimum width to include: 100 m.
				512	Water bodies: natural or artificial stretches of water.
		52	Marine waters	521	Coastal lagoons: unvegetated stretches of salt or brackish waters separated from the sea by a tongue of land or other similar topography. These water bodies can be connected with the sea at limited points, either permanently or for parts of the year only.
				522	Estuaries: the mouth of a river within which the tide ebbs and flows.
				523	Sea and ocean: zone seaward of the lowest tide limit.

Table 2. CLC nomenclature [33].

To avoid the appearance of *slivers*, in the layers overlapping, that is, a country's boundary, CLC flooring applications, a margin of tolerance (distance) between two lines was set in order that two similar lines are considered as a single. In the present chapter, more graphic tolerances correspond to 200 meters of the layer corresponding to countries' boundaries.

Once geo-database was obtained for EU territories, and considering the CLC land uses for the years 1990, 2000, 2006, and 2012, the overlay process was performed four times for each of the

countries. Taking into account that four countries in the EU 28 Members had no registered CLC land uses for the year 1990, 432 geodatabases were obtained in total.

Subsequently, all these geo-database alphanumeric information were analysed by country and by year basis, using the Microsoft Access database. For each of these geo-databases there was a table of alphanumeric information, applying a query that is based on the Standard Query Language (SQL). In this regard, the surface of EU Member States has been summarized through CLC land use (**Table 2**). Relating the number of hectares of each country allocated to particular land use (**Table 2**), it was possible to characterize the EU countries according to land uses and determine what changed according to hectares' numbers dedicated to different land uses in the years 1990, 2000, 2006 and 2012. Also, this synthetic methodology has been based on actual and open-access EU data—possible to replicate in future years/periods.

3. Results and discussion

The results come from the analysis of the land uses for each of the European countries in the years 1990, 2000, 2006 and 2012. The results will be exposed through the graphs, tables and thematic cartography. This typology of results allows to extract the most relevant information and to characterize each of the European countries on the basis of the 44 uses of the soil determined by CLC—through an easy read.

According to the latitude, EU Member States have been classified into three groups: (i) further to the North—'North EU group countries'; (ii) further to the South—'South EU group countries'; (iii) countries that occupy an intermediate position—'Central EU group countries' (**Figure 1**). Also, the obtained surfaces can be observed in **Table 3**.

Initially, the 'North EU group countries' have been analysed—Estonia, Finland, Latvia, Lithuania and Sweden (**Table 4** and **Figure 2**).

Estonia seems to be a country dominated by two land uses—mixed forest (313) and coniferous forest (312), corresponding to the forest and semi-natural areas. The following higher percentage of land use corresponds to non-irrigated arable land (211). Therefore, if there was a greater exploitation of agricultural resources, there would be an increase in food production. In fact, the abovementioned land uses present an expansion; however, it does not differ significantly, considering the extension of the rest of the land uses—which are from 5–10%, corresponding to transitional woodland-shrub, broad-leaved forest, pastures and land occupied by agriculture (324, 311, 231, 243).

Finland is a predominantly forest country, characterized by two major land uses: coniferous forest (312) and mixed forests (313). Surprisingly, between 2000 and 2006, the extension occupied by those land uses was approximately similar; nevertheless, in 2012, coniferous forest cover increased. Therefore, it seems that the use of the coniferous forest land has increased in detriment of the mixed forest. The third land use with major relevance in Finland is transitional woodland shrub (324). However, this land use has decreased in 2012, until reaching an area similar to water bodies' land use (512).

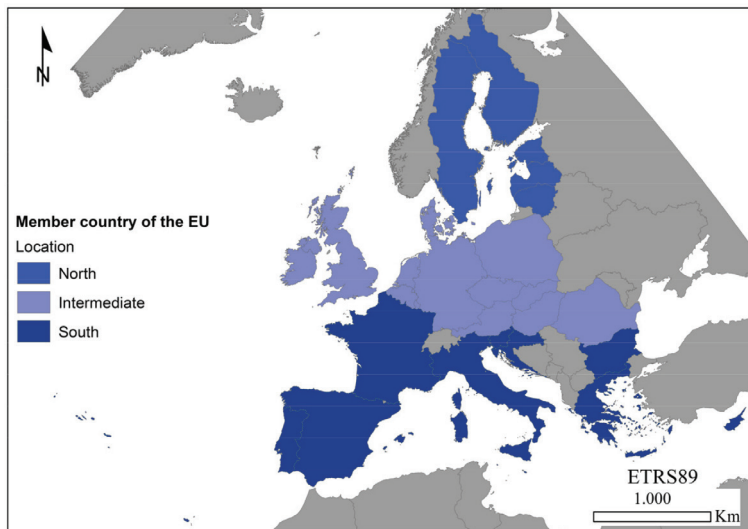


Figure 1. EU Member States (authors).

Latvia does not seem to highlight by a specific land use as all the land uses in 2012 comprised 0–16%. The major land uses are vineyards (211), mixed forests (313), transitional woodland shrub (324), coniferous forests (312) and pastures (231).

Countryt	Area (hectares)	Country	Area (hectares)
Austria	8,728,000	Italy	31,300,000
Belgium	3,086,000	Latvia	6,914,000
Bulgaria	12,620,000	Lithuania	6,950,000
Croatia	5,977,000	Luxembourg	2,631,000
Cyprus	1,215,000	Malta	33,180
Czech Republic	8,228,000	Netherlands	3,766,000
Denmark	4,379,000	Poland	33,010,000
Estonia	4,834,000	Portugal	9,267,000
Finland	35,320,000	Romania	26,690,000
France	55,190,000	Slovakia	5,240,000
Germany	36,540,000	Slovenia	2,119,000
Greece	14,970,000	Spain	50,660,000
Hungary	9,969,000	Sweden	46,000,000
Ireland	7,013,000	United Kingdom	24,490,000

Table 3. Surface of EU Member States (authors).

	Estonia				Finland				Latvia				Lithuania				Sweden			
	1990	2000	2006	2012	2000	2006	2012	2012	1990	2000	2006	2012	1990	2000	2006	2012	2000	2006	2012	2012
LEVEL 3																				
111	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
112	1.08	1.12	1.25	1.27	1.05	1.07	0.96	0.96	0.80	0.82	1.17	1.20	2.26	2.26	2.29	2.33	0.89	0.90	0.91	0.91
121	0.41	0.40	0.37	0.39	0.15	0.15	0.19	0.19	0.23	0.26	0.36	0.37	0.58	0.57	0.51	0.51	0.14	0.15	0.15	0.15
122	0.07	0.07	0.05	0.05	0.01	0.01	0.00	0.00	0.03	0.02	0.03	0.03	0.09	0.09	0.08	0.08	0.05	0.06	0.06	0.06
123	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.03	0.03	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01
124	0.05	0.05	0.05	0.05	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.05	0.05	0.05	0.03	0.03	0.03	0.03
131	0.15	0.13	0.13	0.17	0.06	0.06	0.07	0.07	0.05	0.05	0.06	0.07	0.09	0.09	0.07	0.06	0.02	0.03	0.03	0.03
132	0.08	0.08	0.08	0.07	0.01	0.01	0.02	0.02	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.01	0.02	0.02	0.02	0.02
133	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.04	0.03	0.04	0.02	0.00	0.01	0.00	0.00
141	0.05	0.05	0.05	0.05	0.02	0.02	0.02	0.02	0.13	0.10	0.10	0.10	0.12	0.12	0.12	0.12	0.07	0.07	0.07	0.07
142	0.03	0.03	0.04	0.05	0.04	0.05	0.04	0.04	0.01	0.01	0.14	0.14	0.04	0.04	0.04	0.05	0.10	0.12	0.12	0.12
211	14.59	14.62	15.15	15.11	4.76	5.09	4.58	4.58	14.07	15.41	16.34	16.68	33.63	34.17	32.79	32.86	6.67	6.66	6.65	6.65
212	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
213	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
221	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.26	0.26	0.26
222	0.04	0.04	0.03	0.03	0.00	0.00	0.00	0.00	0.06	0.05	0.06	0.06	0.15	0.14	0.13	0.11	1.25	1.24	1.24	1.24
223	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
231	6.14	5.68	6.78	6.71	0.01	0.01	0.01	0.01	14.43	13.21	11.91	11.48	7.55	6.54	6.18	5.93	4.42	4.45	4.46	4.46
241	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	47.95	46.37	49.74	49.74
242	3.53	3.91	3.27	3.24	0.00	0.00	0.00	0.00	8.54	8.40	8.19	8.21	12.27	12.72	13.48	13.45	3.63	3.68	4.52	4.52
243	8.20	8.20	6.56	6.58	3.93	3.65	3.96	3.96	6.76	6.75	5.21	5.22	8.08	7.91	7.85	7.79	0.43	0.43	0.43	0.43
244	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.13	6.14	6.14	6.14

	Estonia				Finland				Latvia				Lithuania				Sweden			
	9.56	9.57	8.22	8.40	2.20	2.23	2.03	8.94	8.71	8.38	7.96	6.45	6.47	6.65	6.65	9.82	11.25	7.01		
311	18.55	18.09	17.99	18.00	29.51	28.47	41.70	15.26	14.61	14.15	12.98	11.58	11.20	11.06	11.00	0.83	0.84	0.84		
312	18.80	18.43	19.23	20.04	26.19	27.39	17.87	19.59	18.52	17.64	16.33	11.55	11.23	11.44	11.42	1.52	1.52	1.52		
313	0.82	0.80	0.71	0.71	0.01	0.01	0.05	0.10	0.08	0.12	0.13	0.01	0.02	0.02	0.02	0.06	0.06	0.06		
321	0.31	0.31	0.20	0.20	1.24	1.23	2.07	0.00	0.00	0.00	0.00	0.05	0.05	0.05	0.05	0.13	0.14	0.14		
322	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.29	6.32	6.32		
323	7.93	8.85	9.98	9.03	14.14	13.91	9.61	6.48	8.46	11.27	14.19	2.51	3.40	4.20	4.53	0.27	0.27	0.27		
324	0.10	0.07	0.07	0.07	0.00	0.00	0.00	0.06	0.06	0.03	0.03	0.04	0.03	0.02	0.02	8.06	8.06	8.06		
331	0.00	0.00	0.00	0.00	0.01	0.01	0.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
332	0.05	0.02	0.01	0.01	0.32	0.32	0.13	0.01	0.01	0.06	0.06	0.01	0.01	0.01	0.01	0.00	0.00	0.00		
333	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
334	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
335	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.57	0.57	0.57		
411	1.59	1.60	1.71	1.71	0.08	0.08	0.10	0.38	0.36	0.30	0.30	0.28	0.28	0.30	0.30	0.03	0.00	0.00		
412	2.69	2.71	2.90	2.90	6.58	6.52	6.30	2.02	2.08	2.26	2.27	0.60	0.60	0.62	0.62	0.01	0.01	0.01		
421	0.01	0.01	0.01	0.01	0.02	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
422	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
423	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
511	0.07	0.07	0.07	0.07	0.20	0.21	0.18	0.23	0.23	0.25	0.25	0.28	0.27	0.28	0.28	0.00	0.00	0.00		
512	4.53	4.53	4.55	4.55	9.14	9.14	9.28	1.62	1.61	1.74	1.75	1.63	1.64	1.65	1.66	0.01	0.01	0.01		
521	0.03	0.03	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.02	0.02	0.02	0.02	0.02		
522	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.30	0.30		
523	0.48	0.48	0.49	0.49	0.28	0.28	0.32	0.11	0.11	0.12	0.12	0.03	0.03	0.03	0.03	0.00	0.00	0.00		

Table 4. Percentage of land use from 1990 to 2012 for Estonia, Finland, Latvia, Lithuania and Sweden (authors).

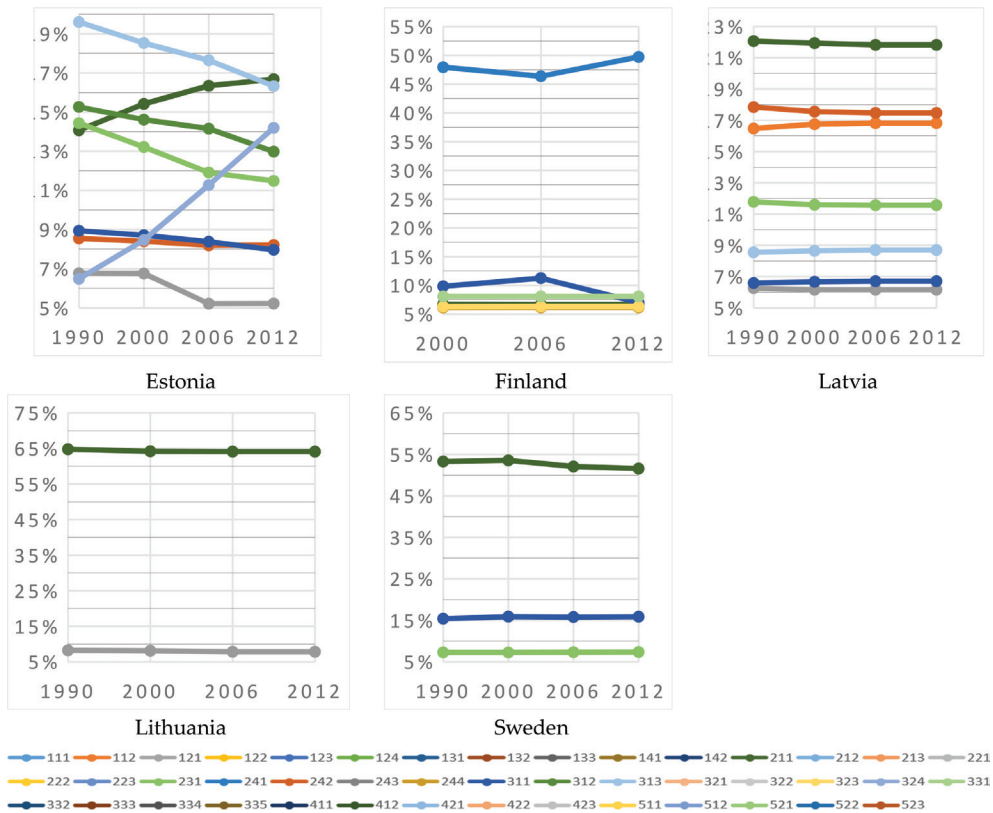


Figure 2. Trend of land uses higher than 5% for the North EU group countries (authors).

Lithuania stands out as an eminent agricultural country — once approximately one-third of the land comprised vineyards (211). Additionally, the area designated for vineyards tends to be fairly constant. Even this percentage is far superior to the second major land use, corresponding to complex cultivation (242). The following land uses with the highest percentage correspond to the forest and semi-natural areas, mixed forests (313) and coniferous forests (312).

Sweden stands out as a prominent agricultural country with approximately half of the territory earmarked for annual crops associated with permanent crops (241). Additionally, this trend over the analysed period seems to increase. Thus, it is possible that such values will increase even further in future. However, the second major land use in Sweden should also be considered, corresponding to forestry use, which is broad-leaved forest (331) (Tables 5–7 and Figure 3).

Through the analysis of the developed graphics for the Central EU countries, it is possible to verify that the trend of variation of the land uses in countries such as Austria, Belgium, Czech Republic, Denmark, Germany, Hungary, Ireland, Netherland, Poland, Romania and Slovakia is low or very low. So, constant and stable land use models predominate in this area.

[illegible]

	Austria					Belgium					Czech Republic					Denmark					Germany				
	4.10	4.89	5.26	5.25	6.59	6.67	6.70	6.70	6.70	3.17	3.52	3.53	3.60	1.63	1.62	1.68	1.68	1.68	1.68	6.69	6.70	6.74	9.72		
311	25.52	26.25	26.87	26.69	4.60	4.63	4.48	4.48	4.48	21.01	21.59	21.86	21.73	4.61	4.16	3.93	3.93	3.93	3.93	15.83	15.73	15.70	16.56		
312	15.19	13.39	12.12	12.11	8.55	8.64	8.70	8.70	8.70	7.41	7.77	7.82	8.03	3.16	3.04	3.16	3.16	3.16	3.16	6.57	6.61	6.69	4.07		
313	6.48	7.14	7.22	7.26	0.03	0.03	0.03	0.03	0.03	0.51	0.35	0.33	0.32	0.55	0.54	0.51	0.51	0.51	0.55	0.49	0.47	0.42			
321	3.26	2.92	2.63	2.63	0.57	0.55	0.52	0.52	0.52	0.03	0.02	0.02	0.02	1.11	1.14	1.16	1.16	1.16	0.16	0.16	0.15	0.27			
322	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			
323	0.09	0.09	0.25	0.40	0.74	0.54	0.60	0.60	0.60	3.14	2.30	2.02	1.93	1.07	1.92	2.07	2.07	2.07	0.40	0.59	0.59	0.63			
324	0.00	0.00	0.00	0.00	0.04	0.04	0.04	0.04	0.04	0.00	0.00	0.00	0.00	0.18	0.19	0.22	0.22	0.22	0.03	0.02	0.02	0.03			
331	3.33	2.90	3.00	3.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.05	0.05	0.03			
332	3.40	3.59	3.62	3.62	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.13	0.09	0.03			
333	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			
334	0.65	0.52	0.43	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			
335	0.26	0.25	0.24	0.24	0.14	0.09	0.10	0.10	0.10	0.07	0.08	0.08	0.08	0.68	0.68	0.66	0.66	0.66	0.14	0.14	0.14	0.10			
411	0.04	0.03	0.02	0.02	0.16	0.16	0.16	0.16	0.16	0.05	0.05	0.06	0.06	0.59	0.57	0.56	0.56	0.56	0.25	0.25	0.25	0.21			
412	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.02	0.00	0.00	0.00	0.00	0.45	0.49	0.53	0.53	0.53	0.03	0.04	0.04	0.05			
421	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			
422	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.07	0.08	0.08	0.08	0.08	0.05	0.05	0.05	0.04			
423	0.27	0.27	0.27	0.27	0.16	0.19	0.19	0.19	0.19	0.06	0.06	0.06	0.06	0.00	0.00	0.00	0.00	0.00	0.21	0.21	0.21	0.21			
511	0.54	0.56	0.57	0.57	0.30	0.33	0.34	0.34	0.34	0.62	0.65	0.66	0.67	0.83	0.85	0.88	0.88	0.88	0.83	0.88	0.93	0.91			
512	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.20	0.22	0.22	0.22	0.03	0.03	0.03	0.04			
521	0.00	0.00	0.00	0.00	0.13	0.13	0.14	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.05	0.05	0.07			
522	0.00	0.00	0.00	0.00	0.02	0.02	0.02	0.02	0.02	0.00	0.00	0.00	0.00	1.37	1.36	1.34	1.34	1.34	0.04	0.04	0.04	0.04			
523																									

Table 5. Percentage of land use from 1990 to 2012 for Austria, Belgium, Czech Republic, Denmark and Germany (authors).

[illegible]

	Hungary					Ireland					Luxembourg					The Netherlands					Poland				
	15.41	15.90	15.81	15.88	0.43	0.41	0.41	0.41	0.41	0.41	24.56	24.29	24.39	24.46	1.33	1.55	1.62	1.62	1.62	1.62	4.71	4.82	4.90	4.92	
311	15.41	15.90	15.81	15.88	0.43	0.41	0.41	0.41	0.41	0.41	24.56	24.29	24.39	24.46	1.33	1.55	1.62	1.62	1.62	1.62	4.71	4.82	4.90	4.92	
312	1.04	1.08	1.02	0.98	3.55	3.34	3.93	3.93	3.92	3.92	4.87	4.57	4.54	4.50	4.35	4.32	4.29	4.25	4.25	4.25	17.77	17.86	17.94	18.04	
313	1.62	1.68	1.66	1.63	0.33	0.41	0.99	0.99	0.99	0.99	6.20	5.95	6.83	6.81	2.50	2.52	2.52	2.53	2.53	2.53	7.09	7.39	7.79	7.89	
321	2.42	2.45	2.45	2.45	1.31	1.25	0.61	0.62	0.62	0.62	0.07	0.07	0.00	0.00	0.68	0.84	1.11	1.25	1.25	1.25	0.14	0.12	0.11	0.11	
322	0.00	0.00	0.00	0.00	0.82	0.77	1.31	1.31	1.31	1.31	0.00	0.00	0.00	0.00	1.00	1.01	1.07	1.13	1.13	1.13	0.01	0.01	0.01	0.01	
323	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
324	2.61	2.61	3.60	4.12	3.05	5.20	4.00	4.00	4.13	0.19	0.95	0.20	0.20	0.02	0.04	0.04	0.04	0.04	0.04	0.04	0.59	0.96	1.81	1.70	
331	0.00	0.00	0.00	0.00	0.13	0.09	0.11	0.11	0.11	0.00	0.00	0.00	0.00	0.00	0.37	0.32	0.28	0.28	0.28	0.02	0.01	0.01	0.01	0.01	
332	0.00	0.00	0.00	0.00	0.24	0.20	0.22	0.22	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	
333	0.03	0.03	0.03	0.03	0.28	0.29	0.76	0.76	0.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.03	0.03	0.03	0.03	
334	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	
335	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
411	0.98	0.82	0.83	0.83	0.26	0.23	0.27	0.27	0.27	0.00	0.00	0.00	0.01	0.01	0.79	0.90	0.90	0.97	0.97	0.34	0.31	0.32	0.32	0.32	
412	0.13	0.10	0.10	0.10	17.60	15.84	14.60	14.56	14.56	0.00	0.00	0.00	0.00	0.00	0.20	0.21	0.21	0.22	0.22	0.03	0.03	0.03	0.03	0.03	
421	0.00	0.00	0.00	0.00	0.03	0.04	0.05	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.21	0.22	0.22	0.22	0.22	0.00	0.00	0.00	0.00	0.00	
422	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
423	0.00	0.00	0.00	0.00	0.22	0.26	0.23	0.23	0.23	0.00	0.00	0.00	0.00	0.00	0.26	0.21	0.21	0.21	0.21	0.00	0.00	0.00	0.00	0.00	
511	0.51	0.50	0.50	0.50	0.13	0.11	0.10	0.10	0.10	0.09	0.09	0.09	0.08	0.07	1.24	1.24	1.24	1.24	1.24	0.24	0.24	0.24	0.24	0.24	
512	1.32	1.37	1.39	1.40	1.75	1.68	1.61	1.61	1.61	0.23	0.23	0.23	0.22	0.22	7.07	7.16	7.20	7.23	7.23	1.18	1.22	1.25	1.26	1.26	
521	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	
522	0.00	0.00	0.00	0.00	0.08	0.08	0.10	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.03	0.03	0.03	0.00	0.00	0.00	0.00	0.00	
523	0.00	0.00	0.00	0.00	0.72	0.65	0.64	0.64	0.64	0.00	0.00	0.00	0.00	0.00	0.17	0.17	0.17	0.18	0.18	0.03	0.03	0.03	0.03	0.03	

Table 6. Percentage of land use from 1990 to 2012 for Hungary, Ireland, Luxembourg, the Netherlands and Poland (authors).

CODE	Romania				Slovakia				United Kingdom		
	1990	2000	2006	2012	1990	2000	2006	2012	2000	2006	2012
111	0.05	0.05	0.04	0.04	0.02	0.02	0.02	0.02	0.12	0.13	0.13
112	5.39	5.40	4.59	4.59	4.54	4.43	4.68	4.72	4.95	5.28	5.31
121	0.57	0.58	0.43	0.43	0.56	0.56	0.61	0.63	0.57	0.79	0.82
122	0.03	0.03	0.02	0.02	0.03	0.05	0.05	0.09	0.03	0.05	0.05
123	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.04	0.05	0.05
124	0.01	0.01	0.02	0.02	0.05	0.05	0.04	0.04	0.18	0.20	0.20
131	0.09	0.10	0.11	0.11	0.07	0.06	0.07	0.08	0.22	0.28	0.29
132	0.03	0.03	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03
133	0.01	0.01	0.01	0.01	0.10	0.01	0.03	0.04	0.02	0.03	0.03
141	0.03	0.03	0.02	0.02	0.02	0.03	0.03	0.03	0.24	0.27	0.27
142	0.03	0.03	0.02	0.02	0.20	0.17	0.20	0.22	0.93	1.13	1.13
211	34.04	34.19	36.48	36.48	34.12	34.27	32.98	32.88	24.79	27.18	27.16
212	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
213	0.15	0.03	0.13	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00
221	1.78	1.72	1.32	1.32	0.57	0.49	0.47	0.46	0.00	0.00	0.00
222	1.60	1.56	1.52	1.52	0.27	0.23	0.25	0.24	0.07	0.04	0.04
223	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
231	10.63	10.59	10.39	10.39	6.51	5.58	5.31	5.27	27.34	28.43	28.40
241	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
242	3.50	3.55	3.32	3.32	0.50	1.24	1.25	1.25	3.79	0.13	0.13
243	4.96	4.98	4.00	4.00	8.17	6.60	7.32	7.31	2.24	0.44	0.44
244	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
311	20.20	20.40	20.65	20.65	21.26	21.97	22.14	22.10	2.70	2.15	2.16
312	4.85	4.72	5.41	5.41	10.97	10.81	10.52	9.81	5.17	5.45	5.13
313	4.19	4.21	4.22	4.22	7.26	8.09	8.80	8.92	0.21	1.11	1.10
321	1.46	1.46	2.48	2.48	0.66	0.59	0.57	0.57	7.96	5.78	5.79
322	0.31	0.31	0.31	0.31	0.28	0.29	0.31	0.31	11.83	7.37	7.38
323	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
324	2.64	2.55	1.36	1.36	2.99	3.50	3.36	4.02	0.78	1.08	1.34
331	0.10	0.10	0.05	0.05	0.00	0.00	0.00	0.00	0.08	0.14	0.14
332	0.03	0.03	0.03	0.03	0.13	0.12	0.12	0.12	0.25	0.08	0.08
333	0.08	0.08	0.02	0.02	0.12	0.11	0.10	0.10	1.39	1.05	1.05

	Romania				Slovakia				United Kingdom		
334	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
335	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
411	1.60	1.60	1.29	1.29	0.12	0.06	0.08	0.08	0.07	0.06	0.06
412	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.09	9.31	9.31
421	0.00	0.00	0.03	0.03	0.00	0.00	0.00	0.00	0.13	0.15	0.15
422	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
423	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.25	0.25
511	0.68	0.68	0.74	0.74	0.15	0.21	0.22	0.22	0.02	0.02	0.02
512	0.67	0.67	0.66	0.66	0.31	0.43	0.44	0.44	0.89	0.91	0.91
521	0.28	0.28	0.28	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00
522	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.09	0.09
523	0.02	0.02	0.02	0.02	0.00	0.00	0.00	0.00	0.56	0.54	0.54

Table 7. Percentage of land use from 1990 to 2012 for Romania, Slovakia and the United Kingdom (authors).

Focusing on Austria, the country shows that the land use for the coniferous forest (312) predominates above others. In fact, it occupies more than one-quarter of the Austrian territory—so, the country is considered forest. The following major land uses correspond to non-irrigated arable land and mixed forests (211 and 313).

The most representative land use in Belgium corresponds to non-irrigated arable land (211). The second most widespread use corresponds to complex cultivation (242). However, it practically occupies the same extension to discontinuous urban fabric (111), equivalent to most of the land covered by structures, buildings, roads and artificially surfaced areas associated with vegetated areas and bare soil, occupying discontinuous but significant surfaces. Therefore, even though it can be said that this country is eminent in agriculture, there is also the development of associated structures indicating the degree of development of the country. Also, this model seems consolidated and not variable in future years—once the lines that describe land uses are mostly horizontal and parallel.

Although the area destined to non-irrigated arable land (211) has been descending in Czech Republic, its extension is far above other land uses, occupying more than one-third of the country. The second relevant land use corresponds to the coniferous forest (312) occupying almost one-fifth of Czech Republic surface. It also should be highlighted that the third major land use corresponding to pastures (231) has increased significantly in 2000.

Denmark presents a surface of approximately 65% occupied by non-irrigated arable land (211). The country's agricultural character seems such that it will not change in the next few years—once the line that determines the percentage of land use (211) remains horizontal.

Germany and Hungary have repeated the model of land uses with a high predominance of non-irrigated arable land (211). Non-irrigated arable land in Germany occupies approximately

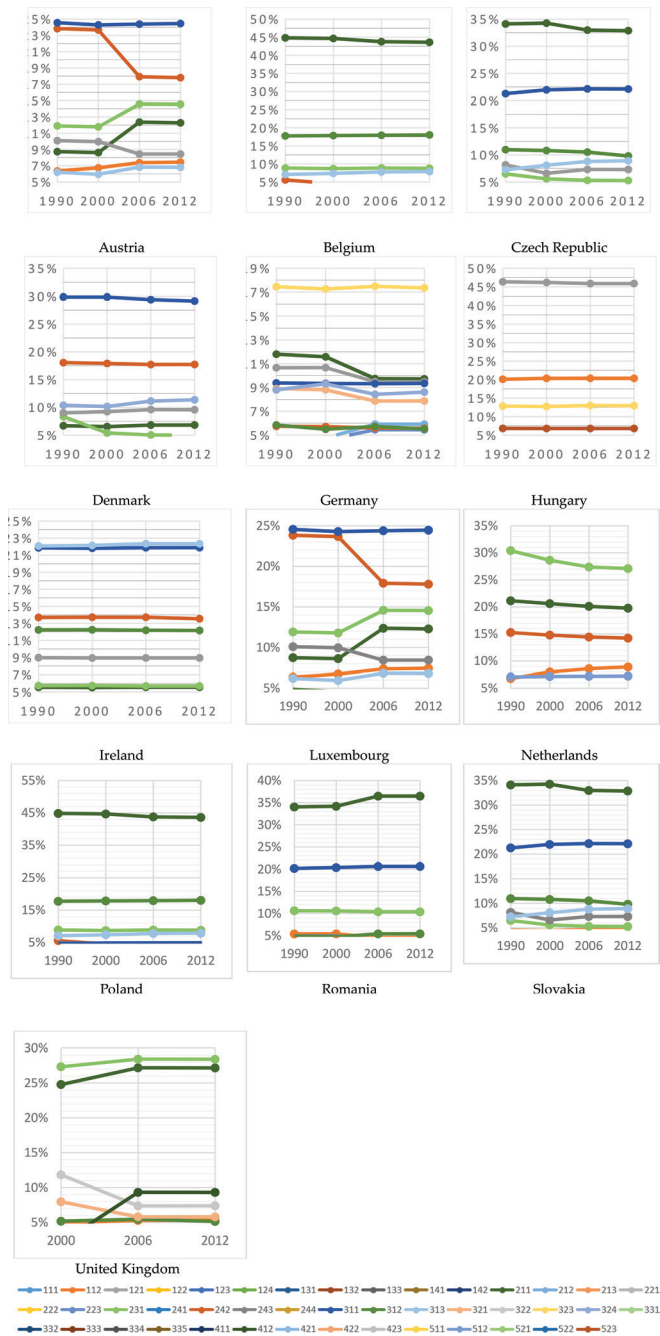


Figure 3. Trend of land uses higher than 5% for the Central EU group countries (authors).

52% of the territory and in Hungary approximately 40% of the territory. In Germany, land use stands out for coniferous forests (312) and pastures (231), which increased substantially between 2006 and 2012. In 2012, some land uses clearly increase as is the case of broad-leaved forests (311), discontinuous urban fabric (112) and others; on the contrary, mixed forests (313) descend, some of them suddenly becoming almost non-existent complex cultivation (242), and land principally is occupied by agriculture, with significant areas of natural vegetation (243). Conversely, in Hungary, the model is very steady and is similar to what occurs in Denmark due to the great dominance of single land use—non-irrigated arable land (211).

Regarding Ireland a clear dominance of single land use is also possible to verify—pastures (231), occupying more than half of the territory surface. In fact, this land use is much higher than the second most relevant land use in Ireland, peat bogs (412).

Luxembourg is a clear example of a country where the opposite happens, noting a very variable land use model. Though there is a clear dominant land use, broad-leaved forests (311), such use occupies about one-quarter of the country area. The second most relevant use is complex cultivation (242), which has greatly declined since 2000. There are also other two significant land use: pastures (231) and non-irrigated arable land (211). Therefore, it seems that the agricultural production model is changing and as a result, the model of land use is changing as a whole.

The Netherlands like Ireland has pastures (231) as the dominant land use, occupying approximately 27% of the territory. However, its dominance is not as clear as in other cases such as Ireland—once the second major land use corresponding to non-irrigated arable land (211)—and occupies approximately 20%, and the third land use complex cultivation (242) reaches approximately 15% of territorial occupation. However, these three dominant land uses imply that this country is predominantly agricultural.

Poland, Romania and Slovakia are other three examples of dominant land use and also the remaining uses slightly vary. In these three countries, the dominant land use clearly corresponds to non-irrigated arable land (211). This scenario is more visible in Poland where the land use is above 40%, which is also clearly the dominant land use scenario in Romania and Slovakia, both above 30%. Therefore, these countries are characterized by agricultural land uses.

In the Polish case, the second major land use corresponds to coniferous forests (312). In Romania and Slovakia, the second most relevant land use corresponds to broad-leaved forests (311).

Interestingly, a country where there is not only one clearly dominant land use but two is the United Kingdom. Although something similar happened in Finland, none of the two dominant land uses—pastures (231) and non-irrigated arable land (211)—has descended to please each other throughout the analysed years. Possibly, this effect would occur if natural resources are explored, that is, pastures in the non-irrigated arable land. However, the tendency notes great stability and uniformity. So, it is possible to say that the land use model varied between 2000 and 2006 and has been more stable in the 2006–2012 period. In fact, between 2000 and 2006, a tremendous increase of peat bogs (412) has occurred; as well as the significant decline

in moors and heathland (322), complex cultivation (242) and natural grasslands (321) (**Tables 8 and 9** and **Figure 4**).

Curiously, all South European countries with an exception for Portugal have shown a well-defined land use model in which there is one or two dominant land uses that determine the country's land use pattern.

In the Bulgarian case, the land use is denominated by non-irrigated arable land (211) and occupies approximately one-third of the country's territory— which is clearly superior to the second major land use in Bulgaria, broad-leaved forests (311). Thus, a consistent land use model is identified in the Bulgarian territory and is possible that it will remain in the coming years.

A similar scenario occurs in Croatia, where there is clearly a dominant land use, the broad-leaved forest (311), prevailing over others and occupying approximately 30% of the country. There is also a second land use with relevance, corresponding to complex cultivation (242)— occupying approximately 17%. The situation is similar to Bulgaria but with some disparities in the period from 1990 to 2000 where a significant variability in these land uses is observed; the situation has stabilized from 2000 and in fact is similar to what occurred in the United Kingdom.

Once, in the case of Cyprus, there was a dominance of non-irrigated land (211), which occupied about one-quarter of the country. However, different from what occurs in Bulgaria and Croatia, there is also a single secondary major land use, but Cyprus presents two land uses side by side that virtually occupies the same surface extension: *sclerophyllous* vegetation (323) and coniferous forests (312).

The same that has been seen in Cyprus is verified in France, where the dominant land use is above the 25%, the non-irrigated arable land (211). Additionally, two land uses exist with major relevance: broad-leaved forests (311) and pastures (231). The rest of the uses are in percentages lower than 11% while remaining stable over the analysed years.

A considerable amount of land uses have been developed in Greece. Here, it should be highlighted that the predominant land use is *sclerophyllous* vegetation (323), occupying below 18% of the territory. Thus, Greece presents a great diversity of land uses. Also, it's possible to notice that the land uses whose percentage of extension is between 3% and 12% have suffered the vast majority of variability between the years 2000 and 2006. Such changes contrast with the constancy shown in 1990 and then in 2012. Land use, where a decrease has been identified between 2000 and 2006, corresponds to arable land (211)—land mostly occupied by agriculture, with significant areas of natural vegetation (243)—transitional Woodland shrub (324) and natural grassland (321). On the contrary, land uses that have increased are permanently irrigated land (212), olive groves (223) and mixed forests (313).

Once again, in Italy, a predominant land use is also found—arable soil land (211), occupying more than one-quarter of the Italian territory. A second predominant land use—but in much lower amount, occupying approximately 18%—is the former broad-leaved forest (311) and finally, the rest of the soils due to the supremacy of the first use of the soil is virtually stagnant.

	Bulgaria					Croatia				Cyprus				France				Greece				
	21.00	21.07	20.73	20.70	29.87	29.87	29.87	29.40	29.15	0.08	0.07	0.07	16.18	16.04	16.97	17.07	9.38	9.34	9.32	9.35		
311																						
312	4.89	4.86	4.90	4.87	1.75	1.79	1.75	1.72	1.72	16.49	16.42	16.38	6.76	6.48	6.21	5.96	5.84	5.49	5.73	5.52		
313	5.49	5.53	5.86	5.84	4.77	4.72	4.77	4.77	4.75	0.04	0.04	0.04	3.43	3.55	3.51	3.52	3.10	3.08	4.20	4.10		
321	3.59	3.54	3.65	3.65	1.33	4.38	4.39	4.40	3.18	2.80	2.80	2.80	2.46	2.27	2.23	2.23	8.90	8.81	7.87	7.87		
322	0.29	0.29	0.24	0.24	0.12	0.07	0.05	0.05	0.00	0.00	0.00	0.00	0.82	0.70	0.73	0.73	0.40	0.41	0.38	0.38		
323	0.00	0.01	0.01	0.01	2.29	2.41	1.85	1.80	1.80	17.01	16.62	16.44	0.87	1.04	1.04	1.05	17.45	17.26	17.48	17.35		
324	6.69	6.68	6.53	6.62	10.36	10.16	11.13	11.36	11.36	3.20	4.33	4.33	1.95	2.23	2.39	2.52	8.80	9.31	8.42	8.61		
331	0.02	0.02	0.02	0.02	0.01	0.00	0.00	0.00	0.00	0.55	0.49	0.49	0.06	0.06	0.06	0.06	0.21	0.22	0.20	0.20		
332	0.10	0.10	0.11	0.11	0.21	0.19	0.06	0.06	0.06	0.24	0.12	0.12	0.12	0.78	0.75	0.75	0.12	0.11	0.21	0.22		
333	0.38	0.38	0.35	0.35	1.07	1.01	0.84	0.85	1.30	1.33	1.30	0.76	0.78	0.78	0.78	0.78	1.38	1.39	1.67	1.80		
334	0.02	0.01	0.00	0.00	0.03	0.06	0.00	0.04	1.22	0.02	0.22	0.05	0.05	0.02	0.02	0.00	0.05	0.06	0.07	0.14		
335	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.07	0.05	0.05	0.00	0.00	0.00	0.00		
411	0.08	0.09	0.08	0.08	0.31	0.33	0.33	0.34	0.06	0.05	0.05	0.05	0.13	0.14	0.34	0.34	0.18	0.18	0.17	0.17		
412	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00		
421	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.21	0.21	0.21	0.11	0.13	0.13	0.13	0.22	0.22	0.21	0.21		
422	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.05	0.02	0.02	0.02	0.04	0.04	0.03	0.03		
423	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.07	0.06	0.06	0.00	0.00	0.00	0.00		
511	0.27	0.27	0.31	0.31	0.43	0.44	0.44	0.44	0.00	0.00	0.00	0.00	0.21	0.21	0.22	0.22	0.17	0.17	0.17	0.17		
512	0.57	0.57	0.59	0.59	0.53	0.53	0.53	0.52	0.17	0.22	0.22	0.23	0.36	0.39	0.38	0.39	0.65	0.65	0.69	0.73		
521	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.13	0.12	0.12	0.07	0.07	0.08	0.08		
522	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.08	0.08	0.00	0.00	0.01	0.01		
523	0.04	0.04	0.04	0.04	0.91	0.91	0.91	0.91	0.91	1.50	1.49	1.49	0.06	0.06	0.13	0.13	1.46	1.47	1.46	1.46		

Table 8. Percentage of land use in 1990, 2000, 2006, and 2012 for Bulgaria, Croatia, Cyprus, France and Greece (authors).

CODE	Italy			Malta			Portugal			Slovenia			Spain			
	1990	2000	2006	2012	1990	2000	2006	2012	1990	2000	2006	2012	1990	2000	2006	2012
111	0.48	0.47	0.46	0.46	1.20	1.20	1.20	1.20	0.13	0.13	0.13	0.13	0.01	0.01	0.01	0.01
112	2.89	3.07	3.31	3.34	20.10	20.34	20.36	20.36	1.43	2.34	2.65	2.67	2.05	2.05	2.07	2.07
121	0.64	0.75	0.89	0.94	2.12	2.35	2.35	2.35	0.17	0.33	0.40	0.43	0.32	0.33	0.33	0.33
122	0.04	0.04	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.02	0.08	0.11	0.06	0.09	0.09	0.29
123	0.03	0.03	0.03	0.03	0.63	0.67	0.67	0.67	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.01
124	0.07	0.07	0.07	0.08	1.19	1.19	1.19	1.19	0.05	0.06	0.06	0.06	0.03	0.03	0.03	0.04
131	0.14	0.16	0.16	0.17	1.10	1.04	1.04	1.04	0.07	0.14	0.16	0.16	0.06	0.06	0.06	0.09
132	0.01	0.01	0.01	0.01	0.05	0.11	0.13	0.20	0.00	0.01	0.01	0.02	0.02	0.02	0.02	0.01
133	0.02	0.02	0.02	0.01	0.04	0.00	0.00	0.00	0.02	0.06	0.07	0.05	0.03	0.01	0.03	0.03
141	0.03	0.03	0.04	0.04	0.58	0.58	0.58	0.58	0.02	0.02	0.03	0.03	0.01	0.02	0.02	0.01
142	0.05	0.07	0.08	0.09	0.69	0.69	0.69	0.69	0.05	0.10	0.13	0.15	0.06	0.06	0.08	0.07
211	26.74	26.88	26.82	26.78	0.48	0.39	0.39	0.39	12.73	11.16	9.80	9.36	5.54	5.51	5.55	5.55
212	0.14	0.14	0.14	0.14	0.00	0.00	0.00	0.00	1.04	1.10	0.87	0.88	0.01	0.00	0.00	0.00
213	0.92	0.95	0.98	0.98	0.00	0.00	0.00	0.00	4.86	4.41	3.57	3.57	0.00	0.00	0.00	0.00
221	1.77	1.75	1.91	1.91	0.18	0.18	0.18	0.18	7.11	6.81	6.96	6.96	0.77	0.76	0.76	0.76
222	1.32	1.33	1.40	1.39	0.00	0.00	0.00	0.00	8.40	8.19	8.91	8.90	0.18	0.18	0.18	0.17
223	4.17	4.02	4.00	3.99	0.00	0.00	0.00	0.00	6.19	6.85	6.85	6.82	0.00	0.00	0.00	0.00
231	1.51	1.42	1.42	1.42	0.00	0.00	0.00	0.00	12.89	12.62	10.87	11.56	5.73	5.74	5.69	5.69
241	1.30	1.26	0.68	0.68	0.00	0.00	0.00	0.00	8.57	7.84	5.61	5.37	0.00	0.00	0.00	0.00
242	7.30	7.17	7.27	7.23	3.26	3.26	3.26	3.26	6.09	6.06	5.59	5.60	13.70	13.72	13.72	13.54
243	6.59	6.79	7.03	7.02	46.35	46.18	45.88	45.88	2.39	2.19	1.32	1.32	8.98	8.94	8.95	8.95
244	0.62	0.58	0.57	0.57	0.00	0.00	0.00	0.00	4.29	3.41	3.95	3.98	0.00	0.00	0.00	0.00

	Italy				Malta				Portugal				Slovenia				Spain				
311	18.16	18.20	18.42	18.41	0.00	0.00	0.00	0.00	0.00	9.21	11.24	16.63	16.29	21.86	21.82	21.88	21.88	8.77	8.82	9.16	4.03
312	4.38	4.27	4.30	4.28	0.21	0.21	0.21	0.21	0.21	0.48	0.26	0.04	0.04	12.24	12.25	12.19	12.16	0.41	0.41	0.47	0.56
313	3.42	3.63	3.66	3.65	0.45	0.45	0.45	0.45	0.45	0.89	1.14	0.95	0.95	22.08	22.14	22.35	22.34	1.82	1.82	1.83	1.47
321	4.81	4.88	4.58	4.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.03	1.02	1.02	1.02	0.00	0.00	0.00	0.00
322	0.91	0.48	0.50	0.50	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.02	1.12	1.12	1.12	1.12	0.11	0.11	0.11	0.09
323	3.14	3.28	3.31	3.31	12.85	12.75	13.01	12.94	0.06	0.06	0.06	0.06	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
324	3.35	3.55	3.45	3.46	0.00	0.00	0.00	0.00	0.00	0.23	0.23	0.21	0.21	2.11	2.15	1.90	1.90	0.09	0.09	0.10	0.09
331	0.27	0.25	0.25	0.25	0.00	0.00	0.00	0.00	0.00	0.32	0.39	0.66	0.68	0.03	0.03	0.03	0.03	0.40	0.48	0.49	0.51
332	1.58	1.47	1.43	1.43	0.00	0.00	0.00	0.00	0.00	0.60	0.59	0.46	0.50	0.84	0.84	0.83	0.83	0.20	0.26	0.28	0.27
333	1.60	1.38	1.19	1.19	1.63	1.52	1.52	1.52	1.52	2.25	2.43	2.30	2.32	0.53	0.52	0.52	0.52	1.65	1.63	1.64	2.12
334	0.01	0.03	0.01	0.03	0.00	0.00	0.00	0.00	0.00	3.02	2.85	3.07	3.48	0.02	0.00	0.00	0.00	3.41	3.54	3.65	4.47
335	0.18	0.15	0.14	0.14	0.00	0.00	0.00	0.00	0.00	1.20	1.07	1.50	1.48	0.00	0.00	0.00	0.00	1.30	1.28	1.27	1.72
411	0.05	0.05	0.06	0.06	0.00	0.00	0.00	0.00	0.00	2.48	2.45	2.38	2.38	0.13	0.12	0.12	0.12	10.85	10.54	10.25	9.80
412	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.11	0.10	0.10	0.00	0.00	0.00	0.00	0.09	0.09	0.09	0.07
421	0.08	0.07	0.08	0.08	0.00	0.00	0.00	0.00	0.00	0.49	0.32	0.40	0.21	0.00	0.01	0.01	0.01	0.16	0.15	0.11	0.05
422	0.03	0.03	0.03	0.03	0.08	0.08	0.08	0.08	0.08	0.20	0.19	0.18	0.18	0.02	0.02	0.02	0.02	0.06	0.06	0.06	0.07
423	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.07	0.07	0.07	0.00	0.00	0.00	0.00	0.04	0.04	0.04	0.04
511	0.16	0.16	0.15	0.15	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.03	0.03	0.26	0.25	0.25	0.25	0.01	0.01	0.01	0.00
512	0.56	0.56	0.57	0.58	0.00	0.00	0.00	0.00	0.00	0.09	0.09	0.09	0.09	0.14	0.13	0.14	0.14	0.02	0.02	0.04	0.02
521	0.15	0.15	0.15	0.15	0.00	0.00	0.00	0.00	0.00	0.09	0.09	0.09	0.09	0.00	0.00	0.00	0.00	0.02	0.02	0.03	0.02
522	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.31	0.31	0.31	0.31	0.00	0.00	0.00	0.00	0.18	0.18	0.51	0.48
523	0.41	0.41	0.41	0.41	6.81	6.79	6.79	6.79	6.79	1.34	2.21	2.45	2.38	0.02	0.02	0.02	0.02	4.01	4.43	4.31	4.81

Table 9. Percentage of land use in 1990, 2000, 2006, and 2012 Italy, Malta, Portugal, Slovenia and Spain (authors).

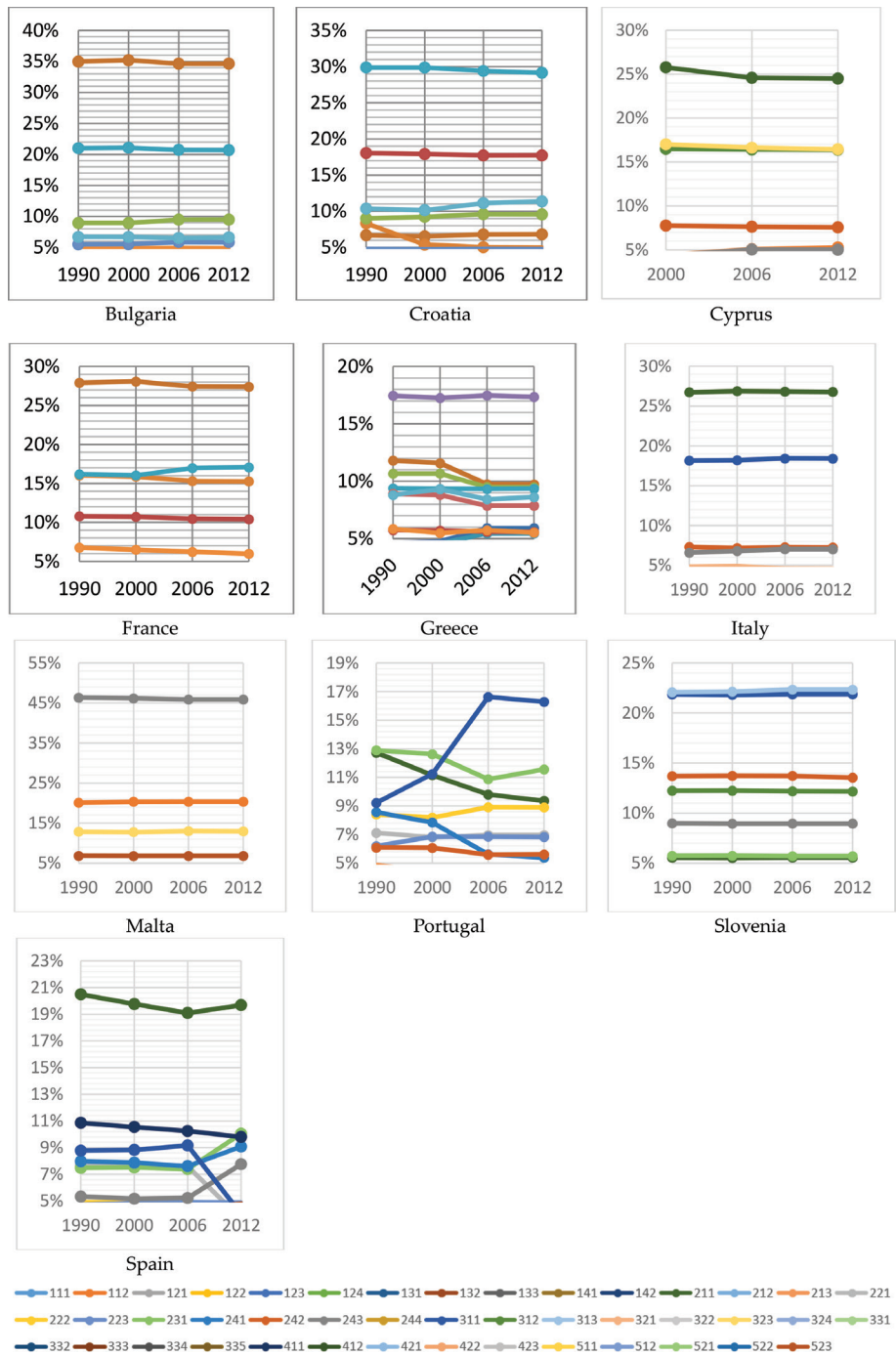


Figure 4. Trend of the land uses of percentage higher than 5% for the South EU group countries (authors).

Also, a low variability pattern of land use is seen in Malta. Nevertheless, the most relevant land use is occupied by agriculture, with significant areas of natural vegetation (243)—representing approximately half of the extension of the country. Additionally, the second major land use is the discontinuous urban fabric (112).

A pattern of land use that breaks with the shown tendency of conservative models over the analysed years is found in the Portuguese case. In Portugal, the extension of the different uses of the soil has varied considerably. The increase in the broad-leaved forest (311) from 9.21% in 1990 to 16.29% in 2012 should be highlighted. It is also noteworthy that the land use pastures (231) and non-irrigated arable land (211) have both decreased. In fact, this last one (non-irrigated arable land) presents similar values to vineyards (221) in 2012. However, if there is variability in the extent of the land uses, what occurred in other countries like Austria, Luxembourg or the United Kingdom should be taken into account, between 2006 and 2012, which seems to play a critical role in the decrease of data variability.

Slovenia is another example of highly stable and consolidated land use patterns, once all tendency lines are horizontal. In this case, two land uses co-exist, mixed forests (313) and broad-leaved forests (311), both over 20%. The combination of these two land uses—40% of the territory—establishes a forest character for Slovenia. As an example, the fourth important use of the land corresponds to the coniferous forest (312) and the third to the complex cultivation (242).

In context, Spain does not escape from the predominance of a single land use pattern, the non-irrigated arable land (211), which occupies approximately one-fifth of the Spanish mainland. Additionally, the remaining land use covers an area below 11%. Regarding the surface extension variability for each land use, although there was a trend of low variability between 1990 and 2006, between 2006 and 2012, this trend broke with high variability. In this sense, increases in the land use include pastures (231), annual crops associated with permanent crops (241), land principally occupied by agriculture with significant areas of natural vegetation (243) and burnt areas (334) and in a lower level of increase comes the land use agro-forestry areas (244), permanently irrigated land (212), glaciers and perpetual snow (335), discontinuous urban fabric (112); in terms of decreasing more dramatically, the land uses include broad-leaved forests (311), vineyards (221), fruit and three berry plantations (222) and less-pronounced inland marshes (411). Therefore, it seems that this model in the future can present great variability and probably will need time to be able to stabilize.

After the analysis of the EU territories, the major land uses are represented on a map (**Figure 5**). The map enables us to verify that most of the land use corresponds to agricultural and forestry, the two being the most predominant agricultural uses. Even within agricultural use, it is possible to notice that the majority corresponds to non-irrigated land (211). Therefore, it can be argued that EU territories are characterized by agricultural and forest uses—mostly intended for agricultural-use non-irrigated land.

Also, in countries located in the North of Europe, their land uses are both agricultural and forestry. In Central EU territories, under the use of agricultural land, the non-irrigated land is the predominant one (211). This is similar to what happens in the EU South territories. However, in this area, the predominance of agricultural use is not so dominant, alternating in some countries the majority use to forestry use.

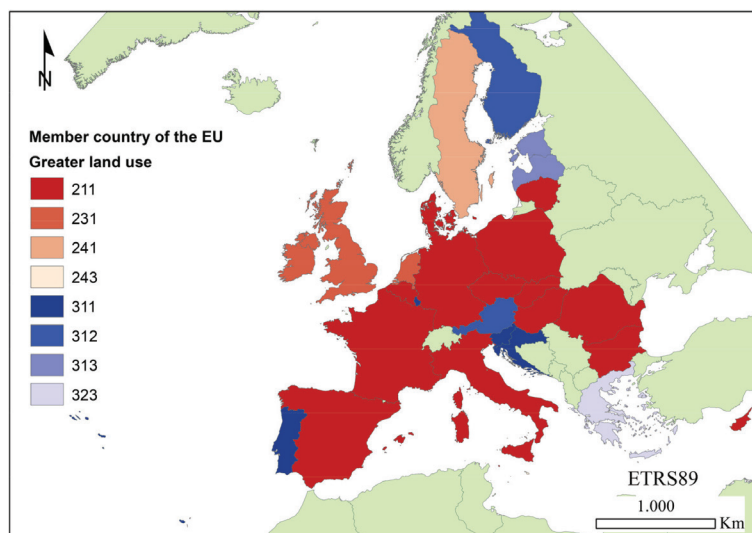


Figure 5. Major land uses in EU territories (authors).

4. Final remarks

The synthetic methodology analysis shown to characterize each of the EU Member States according to the area dedicated to different land uses—defining land use patterns, models and dynamics. Also, this typology of study is possible to replicate using the official and open-access tools mentioned above. In fact, through CLC and its available data, the analysis can be expanded for 2012 and onwards.

In this regard, the performed analyses provide valuable results and knowledge for the decision-makers, in territorial governance and land use planning, which can influence directly and indirectly the socio-economic aspects, such as the environmental paradigm.

Precisely, different trends regarding the presence of certain typologies of land uses in the EU territories between the periods of 1990, 2000, 2006 and 2012 determine that the majority use in Europe is the agrarian use, followed by the forest, in which the majority is the non-irrigated land. Also, it is possible to verify the high variability in land use pattern of some countries—as the case of Finland, Latvia, Portugal and Spain. The rest of the countries present are deeply consolidated models determined by the scarce variation trend of land use.

It is also possible to verify as the land use in some countries is not very varied, since one or more land uses very prominently predominate over others. This is the case of countries like Finland, Lithuania, Sweden, Austria, Czech Republic, Denmark, Germany, Hungary, Ireland, Netherlands, Poland, Romania, Slovakia, Bulgaria, Croatia, Cyprus, France, Greece, Italy, Malta, Slovenia and Spain. Therefore, in these countries it is not easy to observe quick changes on the land use model and pattern. As a result, if for some reason in some of the abovementioned countries it is deemed appropriate to change the land use, it is necessary to change major land uses, to achieve higher variability.

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