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Territorial Facts and Trends in the EU Rural Areas within 2015-2030

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2018

Joint Research Centre

EUR 29482 EN

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EU Science Hub
https://ec.europa.eu/jrc

JRC114016

EUR 29482 EN

PDF ISBN 978-92-79-98121-0 ISSN 1831-9424 doi:10.2760/525571

Luxembourg: Publications Office of the European Union, 2018

Cover page: Alt Wetterade farm, Helmstorf, Germany 2017, credit EC audio-visual services

How to cite this report: Perpiña Castillo C., Kavalov B., Ribeiro Barranco R., Diogo V., Jacobs-Crisioni C., Batista e Silva F., Baranzelli C., Lavalle C., Territorial Facts and Trends in the EU Rural Areas within 2015-2030, EUR 29482 EN, Publications Office of the European Union, Luxembourg, 2018, ISBN 978-92-79-98121-0, doi:10.2760/525571, JRC114016.

Acknowledgements

We would like to thank Mr. Jesus BARREIRO HURLE (Project Officer, JRC.D.04), who kindly contributed to this report.

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List of Used Abbreviations

CAP	Common Agricultural Policy of the European Union
CAPRI	Common Agricultural Policy Regionalised Impact Modelling System
CLC	Corine Land Cover
DG AGRI	Directorate-General for Agriculture and Rural Development
DG ECFIN	Directorate-General for Economic and Financial Affairs
EC	European Commission
EU-28	European Union (28 countries)
EU-15	Elder EU member states (accession before 2004)
EU-13	Newer EU member states (accession 2004, 2007 and 2013)
ENCR	(Dedicated) Energy Crops
FADN	Farm Accountancy Data Network
FSS	Farm Structure Survey
GDP	Gross Domestic Product
GVA	Gross Value Added
ha	Hectares
kha	Thousand hectares
ICS	Industry, Commerce and Services
LFA	Less-Favoured Areas
LUCAS	Land Use and Coverage Area frame Survey
LUISA	EC-JRC LUISA Territorial Modelling Platform
MS	Member State
NUTS	Nomenclature of Territorial Units for Statistics
OECD	Organisation for Economic Co-operation and Development
UAA	Utilised Agricultural Area

Glossary[1]

Abandoned agricultural land: Land that was previously used to produce economic output (agricultural production, houses for residential purposes, industrial production, etc.) and that is no longer used for that purpose. Thus, abandoned land can be reclaimed back to the original use or possibly converted to other uses, in case demand for such uses exists.

Agricultural land: Land that is used for the allocation of other arable land, permanent crops, pastures and energy crops. In this report, it is used "Agricultural land" and "Utilised Agricultural Are (UAA)" interchangeably.

Built-up: Aggregated land use class, including land used for residential and industry/commerce/services uses. Built-up land constitutes a subset of the total artificial areas, which include transport infrastructures as well.

Energy crops: Crops dedicated to production of energy. This category comprehends non-food, lignocellulosic crops, belonging to the second generation feedstock. Species included are both herbaceous and woody: miscanthus, switchgrass, reed canary, giant reed, cardoon, willow, poplar and eucalyptus.

Food and feed crops: Crops used for the production of food and feed, grouped in: arable lands, rice, livestock grazing systems, mixed crop-livestock systems, vineyards, fruit trees and olive trees. The specific agricultural commodities included in each of these groups are determined by the CAPRI model.

Industry/commerce/services land: Land that is used for industrial activities, commerce and services.

Land use/cover flow: Land use refers to the purpose that the land serves, such as recreation, wildlife habitat or agriculture, without the need to describe the surface cover present on the ground, i.e. the socio-economic use of land (agriculture, forestry, recreation or residential use). Land cover refers to the surface cover on the ground, be it vegetation (natural or planted), urban infrastructure, water, bare soil or other. Land use/cover flows refer to transfers (gains and losses) of land area between different use/cover types.

Land-use allocation: It is the spatial distribution of the land among different functions, assuming the land requirements dictated by macro drivers and modelled by specialised sector models. The spatial allocation mechanism is based on a binomial discrete choice method and it is governed by local biophysical suitability, socio-economic and neighbourhood factors, land-use transition rules and policy constraints/incentives.

Land demand: Also referred to as land claim and land requirement, it is the amount of land that, in a specific geographical context (national or sub-national) and in a given year of the simulation horizon, is demanded/claimed/required in order to satisfy the assumed economic and demographic projections.

Primary sector: Primary sector is defined using the statistical classification of economic activities with the branch NACE A – Agriculture, Forestry and Fishing.

Urban land: Land that is predominantly used for residential purposes, including areas hosting local services to the population, such as sport and leisure facilities, and green urban areas.

[1] All concepts and corresponding definitions are coherent with the LUISA territorial modelling platform configuration, as from Jacobs-Crisioni et al. (2017).

Extended Executive Summary

Diversity is a particular characteristic of EU rural areas in many aspects – geographical, landscape, socio-economic, demographic, cultural and environmental. These areas have been undergoing significant changes over the last decades due to various factors such as EU policies (especially the Common Agriculture Policy), overall demographic and migration trends, deployment of transport infrastructure, globalisation, intensification of agricultural production, abandonment of marginal lands, urban development, etc. Further changes can be expected in the future because of policy reforms, socio-economic developments and climate change.

The current analysis aims to highlight selected key territorial facts and trends in EU rural areas at pan-European, national (NUTS 0) and regional (NUTS 3) level within 2015-2030. These trends are related to the status and potential evolution of rural population, agricultural land and agricultural land abandonment, as well as to their macro-economic aggregation into agriculture-driven clusters. A snapshot of employment and gross value added in agriculture by 2015 is provided, too. The analysis is performed by applying the LUISA Territorial Modelling Platform of the European Commissions' Joint Research Centre and in particular - its latest Territorial Reference Scenario 2017. The LUISA Territorial Modelling Platform is aligned to the main modelling tools, used by the EU-EC services, as well as it duly takes into account the existing EU regulations. The LUISA reference projections are therefore coherent with the projections of the other mainstream EU/EC tools in support to policy-making. The goal of the LUISA scenarios is not to predict the future, but to anticipate the likely implications from certain policy actions, i.e. exploring relations "what… if", in the context of a broad set of inter-related factors and complex systems.

Rural Population

The better education and employment opportunities, access to services and quality of life and hence, the lower risk of poverty and social exclusion in urbanised areas contribute to the continuously declining share of EU rural population. This trend is underpinned by low birth rates, out-migration of younger qualified people and increasing life expectancy. Consequently, the age structure of rural population is getting more and more inclined towards elder people.

In 2015 rural areas covered 75% (3.3 million km^2) of the EU populated mainland, but hosted only about a quarter of EU's population. The share of rural population in the newer EU-13[2] was more than two times higher than in the elder EU-15[3] – 34% versus 15.5% respectively. Rural population accounted for a large (1/3 and more) portion of total population in twelve EU member states, mostly located in Eastern Europe[4] - Czech Republic, Croatia, France, Poland, Estonia, Lithuania, Austria, Denmark, Romania, Slovakia, Slovenia and Ireland. Ireland was, nonetheless, the EU champion and the only one with more than 50% share of rural inhabitants in total population. In contrast, rural population was particularly low (below 15%) in Belgium, Malta and the Netherlands.

Within 2015-2030 the EU total population is projected to increase by 2%, while the rural population is expected to rise by just 0.6% (2.8 million). The rural population growth will not be uniform across the EU. The largest expansion is projected for Cyprus, followed by Poland. At the other end, the deepest drop is likely to occur in the Baltic region (Lithuania and Latvia) and Bulgaria.

Along with national trends, the regional rural population tends to be generally higher in Eastern Europe (Romania, Hungary, Slovakia, Czech Republic and Poland) than in

[2] Accession 2004, 2007 and 2013
[3] Accession before 2004
[4] Listed in ascending order

Western Europe. Elevated levels of regional rural population are also observed in Ireland, France, Denmark, Spain and Italy. Within 2015-2030 significant (>10%) increases in rural population are likely in the South and Northeast of Spain; Southeast of Sweden, Finland Belgium and the United Kingdom; North of Italy and Poland, around most capitals (Bucharest, Budapest, Dublin, Madrid, Prague, Rome, Stockholm, Tallinn, Vienna, Warsaw, etc.), and in Cyprus. The growth around capitals will be most likely driven by the lower living cost next to major labour markets, i.e. the people in those areas will be commuting to the nearby cities. Conversely, deep (>10%) cuts in rural population are expected in the North of Portugal, East of Germany and Hungary, large areas in Sweden, Croatia, Greece and Romania, as well as in Lithuania, Latvia and Bulgaria.

Employment in primary sector

In 2015 primary sector (agriculture, forestry and fishing) was responsible for 4.4% of total employment in the EU. Agriculture accounted for the lion's share (93%) of primary sector employment. The employment in primary sector was four times higher in the newer EU-13 than in the elder EU-15 – 12% versus 3% respectively. Romania and Bulgaria had the highest shares of employment in primary sector – 27% and 19% respectively, followed by Greece and Poland with 12% each. The lowest rates were found in Luxembourg, the United Kingdom, Belgium and Germany – below 1.5%. Quantifying employment in agriculture is, however, challenging because it is characterised by seasonal peaks, family businesses and part-time work.

Eastern Europe – Lithuania, Poland, Romania, Bulgaria, Greece, Croatia – and Portugal were peculiar with regions, mostly less developed (lagging)[5] rural ones, where the employment share of primary sector exceeded 20%. Rural areas also provided the largest number of employees – about 4.8 million, equal to 11.5% share in primary sector employment. Towns & suburbs ranked second with 4% (close to the EU average), while cities had the lowest share of primary sector employment of less than 1%.

Gross Value Added (GVA) in primary sector

The EU primary sector provided just around 1.7% of EU's total GVA in 2015 and it has been continuously declining for years. This figure was lower compared to the one for employment, meaning that the EU primary sector was more important from the employment point of view rather than from the productivity point of view.

Similarly to the employment trends, the weight of rural economy was almost two times higher in the newer EU-13 member states than in the elder EU-15 – 8.1% versus 4.1% respectively. Compared with the four-times gap in employment between EU-13 and EU-15 (12% versus 3%), this means that the productivity of labour force in EU-13 was much lower than the one in EU-15.

Likewise employment, Romania had the highest importance of primary sector GVA in the EU – 5.7% in 2015, followed by Greece (4.8%) and Estonia (4.6%). Again similarly to the employment, Luxembourg, Germany, the United Kingdom and Belgium were at the bottom of the ranking with less than 1% share of primary sector GVA. The GVA share varied considerably by regional typologies – from 4.5% in predominantly rural regions, to around 2% in towns and suburbs and only 0.5% in cities.

At regional (NUTS 3) level, the activities of primary sector were concentrated in rural regions of Austria, Croatia, Estonia, Finland, France, Ireland, Poland, Portugal, Romania and Slovenia. The regions with particularly high (above 15%) share of GVA in primary sector were mostly located in Eastern and Southern Europe (Hungary, Romania, Bulgaria, Croatia and Greece). These regions were largely falling into the less developed (lagging) category of the EU Cohesion policy.

[5] As defined by the EU Cohesion policy

Agricultural land

In 2015 agricultural land is estimated to cover 42% of all EU land area. The arable land accounts for the largest share – 56%, followed by livestock grazing (25%), mixed crops (13.5%) and various permanent crops (5.5%). Within 2015-2030 the EU agricultural land is projected to shrink by 1.1%, chiefly driven by the decline in the two principal groups – arable land and livestock grazing – by 4.0% and 2.6% respectively. Mixed crops are expected to expand by 11%. In the group of permanent crops, olive trees are likely to grow at the expense of vineyards.

Drastic changes in agricultural land at national level are not forecast by 2030. The seven largest EU countries – France, Spain, Germany, Poland, Italy, Romania and the United Kingdom – account for about 70% of all Utilised Agricultural Area (UAA) both in 2015 and 2030. In relative terms, Denmark, Hungary and Ireland top the EU list with more than 60% of their surface being occupied by agricultural land both in 2015 and 2030.

The diversity of landscape and climatic conditions significantly affect the spatial patterns of agricultural production in the EU. Arable land dominates in the majority of countries, exceeding 70% in Cyprus, Hungary, Denmark and Slovakia. Within 2015-2030 it is expected to enlarge by more than 20% in Belgium, the Baltic States, Spain and Malta, while in Slovakia and Germany it will shrink. Livestock dominates in Luxembourg, the Netherlands, the United Kingdom and especially – in Ireland (>80%), but within 2015-2030 it will decline in all these countries, except for Luxembourg, as well as in Austria, Latvia, Estonia, Sweden and Finland. Gains in livestock are likely (besides Luxembourg) in Portugal, Czech Republic and Slovenia. Mixed crops are particularly important for Croatia, Greece, Portugal, Finland and Slovenia. Cutbacks are projected for Slovenia, Belgium, Spain and Latvia, while large growth is likely in Bulgaria, Denmark, France, Croatia, Ireland, Latvia and Sweden. Permanent crops are widely found in the Mediterranean countries. Vineyards will shrink the most, mainly in Cyprus and France, but Cyprus will see the largest relative growth in fruit trees in the EU.

Due to a set of landscape, climatic and socio-economic factors, large (more than 3 times) inter-regional variations in the share of agricultural land over total area are observed in Southern Europe – Italy, France, Spain, Portugal, Bulgaria, but also Austria and the United Kingdom. Central and Eastern Europe (the Baltic States, Poland, Czech Republic, Slovakia, Hungary, Romania) are peculiar with a more homogeneous and at the same time – elevated share of agricultural land.

Within 2015-2030 noticeable (>15%) expansions of agricultural land are projected for a number of regions in Southern and South-Eastern Europe – Portugal, Spain, France, Italy, Croatia in particular (owing to the access to the CAP instruments and measures), Greece and Romania. Growth of similar magnitude, owing to the Climate Change, is also expected for Scotland in the United Kingdom, Sweden, Finland, Estonia and Latvia.

Agricultural land abandonment

In the period 2015-2030 about 11% (more than 20 million ha) of agricultural land in the EU are under high potential risk of abandonment[6] due to factors, related to biophysical land suitability, farm structure and agricultural viability, population and regional specifics. The risk for around 800 thousand ha (0.4%), located in Southern and Eastern Romania, Southwestern France, Southern and central Spain, Portugal, Cyprus, Poland, Latvia and Estonia, is particularly severe.

Economic factor and market instruments (including the EU Common Agricultural Policy) could largely mitigate those potential risks in a number, mostly Eastern countries and regions – Estonia, Latvia, Romania, Cyprus. The incremental abandonment within 2015-

[6] Total cessation of agricultural activities without conversion into other useful areas i.e. forest or artificial.

2030 is nevertheless projected to reach 4.2 million ha net (about 280 thousand ha per year on average) of agricultural land, bringing the total abandoned land to 5.6 million ha by 2030[7], the equivalent of 3% of total agricultural land. This would be an alarming trend, considering that the decrease in agricultural land (Utilised Agricultural Area) over the same period of time is estimated to be three times smaller, around 1%.

Amongst EU Member States, Spain (in particular North / Northwest) and Poland (where the largest single loss at NUTS 3 level is projected for the Chelmsko-zamojski region – 85 thousand ha) are likely to face by far the greatest agricultural land abandonment in both absolute and relative terms. The two countries will account for 1/3 of EU total loss, while Spain is projected to be the only EU country to miss more than 1 million ha.

In absolute terms, France (South / Southeast), the United Kingdom, Germany (Western parts) and Italy (especially Sardinia) complement Spain and Poland in the group of the largest agricultural land abandonment in the EU, altogether responsible for more than 70% of losses. Owing to the large total agricultural land, the relative shrinkage will be less pronounced in Germany and especially – France, both countries standing below the 3% EU average. In relative terms, the Netherlands (notably South Limburg), Northern Portugal, Finland, Greece (particularly Korinthia region and Lefkada island) and especially Slovakia (4.6% loss) are expected to be above the 3% EU average.

Arable land is projected to account for the largest share of abandoned land, followed by pastures and permanent crops. This is proportional to the prevailing breakdown of agricultural land by types, where arable land is the largest group, while the permanent crops are the smallest one. Permanent crops will account for a significant, albeit not dominant share in abandonment in Southern Europe – Greece, Italy, Spain and Portugal.

The bulk of abandoned agricultural land (4.8 million ha gross) is likely to remain unused within 2015-2030 because of negligible re-cultivation of once-abandoned land. Less than 600 thousand ha are only projected to convert into forests and natural areas, while the conversion into build-up area will be minimal – just 18 thousand ha.

Agricultural clusters

Based on certain similarities in agricultural and rural parameters, five indicative clusters of EU member states are identified for 2015:

- Advanced countries with rather limited role of an although efficient agricultural sector in the overall economy, due to predominance of other sectors (Cluster 1: the United Kingdom, Germany, the Netherlands, Belgium, Italy, Malta and Cyprus)
- Advanced countries with higher importance of an efficient agricultural sector for the economy (Cluster 3: Ireland, France, Luxembourg, Denmark, Czech Republic and Lithuania)
- Countries with very limited agricultural potential due to natural limitations (Cluster 4: Slovenia, Austria, Estonia, Finland and Sweden)
- Southern and Eastern countries with less efficient agricultural sector (Cluster 2: Portugal, Spain, Croatia, Greece, Hungary, Slovakia, Poland and Latvia)
- South-eastern countries with large agricultural sector (Cluster 5: Bulgaria and Romania)

The spatial distribution of regional (NUTS 3[8]) clusters reveals a much more dispersed and diversified picture without clear geographical patterns. The very large majority of NUTS 3 falls within regional clusters, whose characteristics are somehow similar to the ones of national clusters 1, 3 and 4.

[7] Taking into account 1.4 million ha that were already abandoned by 2015.
[8] City regions are excluded, only rural regions and towns & suburbs are analysed (80% of all NUTS 3)

1 Introduction

Diversity is a particular characteristic of EU rural areas in many aspects – geographical, landscape, socio-economic, demographic, cultural and environmental. These areas have been undergoing significant changes over the last decades due to various factors such as EU policies (especially the Common Agriculture Policy), overall demographic and migration trends, deployment of transport infrastructure, globalisation, intensification of agricultural production, abandonment of marginal lands, urban development, etc. Further changes can be expected in the future because of policy reforms, socio-economic developments and climate change (Nadi et al., 2015; Eurostat, 2017b; EEA, 2000). Certainly, rural regions will keep playing an important role in the EU economy and society.

In the context of the above challenges, the current analysis aims to highlight selected key territorial facts and trends in EU rural areas at pan-European, national (NUTS 0) and regional (NUTS 3) level within 2015-2030. These trends are related to the status and potential evolution of rural population, employment and gross value added in agriculture, agricultural land and agricultural land abandonment, as well as to their macro-economic aggregation into agriculture-driven clusters. The multiple geographical layers of the analysis (EU, national, regional) are important because the trends at different levels may be quite diverse, indeed. Better understanding of past and prevailing developments at sub-national level helps defining more efficient and effective future strategies not only for the regions, but also for the EU Member States and for the EU as a whole, in the context of the EU Common Agriculture and Regional policies.

The analysis is performed by applying the LUISA Territorial Modelling Platform of the European Commissions' Joint Research Centre (JRC), https://ec.europa.eu/jrc/en/luisa and in particular - its latest Territorial Reference Scenario 2017[9]. The LUISA Territorial Modelling Platform is primarily used for the ex-ante evaluation of EU policies that have a direct or indirect territorial impact. It is configured to project a baseline (reference) scenario, assuming official socio-economic trends (from ECFIN, EUROSTAT, AGRI, etc.), business-as-usual processes and the effect of established EU policies with direct or indirect territorial effects. Variations to that reference scenario may be used to estimate impacts of specific policies or alternative macro-assumptions. The ultimate goal of LUISA scenarios is not to predict the future, but rather to anticipate the likely implications from certain policy actions, i.e. exploring relations "what… if", in the context of a broad set of inter-related factors and complex systems. LUISA is de-facto an integrative tool because it is coherent with the other key macro-economic and biophysical models, and thematic databases used in the EU policy-making.

The following analysis is based on publicly available and accessible data and information. Sometimes data and information is not available at sub-national level. In some cases data and information may be available somewhere, but not accessible for various reasons. In all those cases, sound regionalisation approaches have been applied, to overcome the respective bottlenecks.

The purpose of this report is to offer an easy-to-understand summary of few key rural and agricultural facts and trends, coming along a scientifically-sound, comprehensive and sophisticated analysis and assessment, to a wider spectrum of stakeholders. For the sake of simplicity and clarity, very detailed explanations about the background methodologies, approaches and iterations are not provided. Such information is largely available from related scientific publications or upon specific request.

[9] For more information about the Scenario please refer to Annex 10.1.

2 Rural population

2.1 Context

Population is a major driver of the demand for housing, services (e.g. hospitals, schools), infrastructure (e.g. utilities, transport), food, timber and energy, and this means a continued pressure on resources such as land or water. At the same, population is also an important determinant of economic activity and employment, as it quantifies the available human capital in a region. Population is generally increasing in the EU, but important differences among EU Member States and regions are observed. The combination of rural migration and urbanisation has been changing the regional patterns of population distribution, with the proportion of people living in urban areas steadily increasing in the last decades. Better (high-level) education, employment opportunities, access to services and quality of life are also contributing to the continuously declining share of EU rural population. As a result, the EU population growth between 2000 and 2008 has mainly taken place in urban regions (above 4%) whilst in rural areas it was much lower (below 1%). In the years of the financial and economic crisis – 2008 and 2009 – the predominantly rural regions experienced a rather negligible growth of 0.2% and 0.1% respectively, while urban regions performed much better.

By 2015, the population living in EU-28 reached almost 510 million inhabitants (Eurostat, 2017a), with upward trends since 1961[10]. Around 28% of that population lived in rural areas, more than 40% – in cities and the remaining about 32% – in towns and suburbs. During the period 2010-2015 the number of rural inhabitants increased by 1.7 percentage points – a fact that indicates changing patterns in search of more (affordable) space and nature. The share of rural population in the newer EU-13[11] was more than two times larger than in the elder EU-15 – almost 34% versus 15.5% respectively.

With regard to the age structure, about 16% of the EU rural population was younger than 15 years, the working-age population (between 15 and 64 years) accounted for nearly 65%, while elder people (65+ years) represented around 20% (European Commission, 2016a). The age structure of rural population is getting more and more inclined towards old people (65+ years) at the expense of working age population. This overall trend is underpinned by the low birth rates and increasing life expectancy. Such a situation leads to an extra pressure over the working age population, since it needs to finance the public and social services for the ageing population. Ageing and out-migration of younger qualified people due to fewer education opportunities, poorer job opportunities, lower access to public services, transport or infrastructures, as well as the higher risk of poverty and social exclusion are the key reasons for the decline in local rural populations (Eurostat, 2013; Eurostat, 2017a; Mathews, 2007).

2.2 Data and methods

The rural population indicator presents the people living in rural areas as a percentage of total population and the expected changes in rural population between 2015 and 2030 at national and regional level (NUTS 3) for the whole EU.

The demographic projections have been produced by Eurostat for all EU Member States and are available with regional, gender and age breakdowns (EUROPOP2013). The most detailed version at NUTS 3 level is implemented in the LUISA Territorial Reference Scenario 2017. These regional projections are then dynamically allocated at a finer resolution in a 100m^2 grid map for each time step throughout the simulation period (2015-2030).

The identification of rural areas is based on the degree of urbanization method (Dijkstra, L., Poelman H., 2014) explained in Annex 10.2 according to which three main classes are

[10] After a fall of 282 thousand inhabitants in 2011 that may be attributed to the revision of population statistics for Germany following the 2011 census.
[11] But rural population decreased by 3.8% in EU-13 within 2010-2015.

distinguished: cities, towns & suburbs and rural areas. The spatial procedure starts from a population grid where each pixel is classified according to three distinct classes (high-density clusters, urban clusters and rural grid cells) at LAU2 level. Based on this data, population is computed as follows:

- The population for each defined class (cities, towns & suburbs and rural areas) is computed from the projected maps of population, and then aggregated using NUTS 3 boundaries (v10, year 2013) to obtain the sum of the population in cities, towns & suburbs and rural areas;
- The share of rural population is computed by dividing total rural population into total population within each NUTS 3 region and country. The same procedure is applied for the other two population classes, too.

2.3 Results

Within 2015-2030 the EU population is expected to remain rather stable with a positive trend (+10 million, equal to a growth of about 2%) in all three urbanisation typologies. Rural areas covered 75% (3.3 million km^2) of the EU populated mainland, but hosted only 25%[12] of the population in 2015. The EU rural population alone is projected to increase by 2.8 million (equal to 0.6%) within 2015-2030.

Figure 1 presents the breakdown of EU population by EU Member States living in cities, towns & suburbs and rural areas in 2015, while Figure 2 displays the evolution of rural population vice-versa total population over the period 2015-2030. Figure 1 indicates that the population distribution amongst the three typologies is very diverse across the EU. Rural population accounts for at least 1/3 of total population in twelve EU member states[13]: Czech Republic, Croatia, France, Poland, Estonia, Lithuania, Austria, Denmark, Romania, Slovakia, Slovenia and Ireland, the last one being the EU champion and the only one with more than 50% share of total population as rural inhabitants. In contrast, rural population is particularly low (below 15%) in Belgium, Malta and the Netherlands.

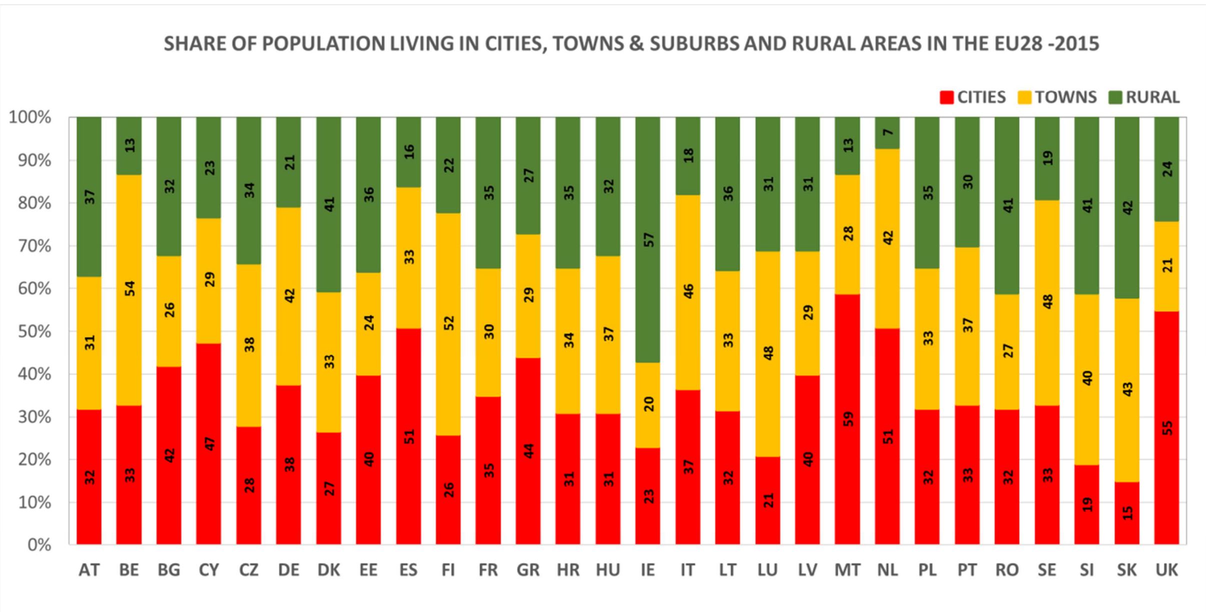


Figure 1: Breakdown of EU population by Member States living in cities, towns & suburbs and rural areas in 2015

[12] The Eurostat estimate is slightly higher, mostly because it also includes the outermost regions. Another reason for the slight difference is the modelling nature of the LUISA estimate.
[13] Listed in ascending order

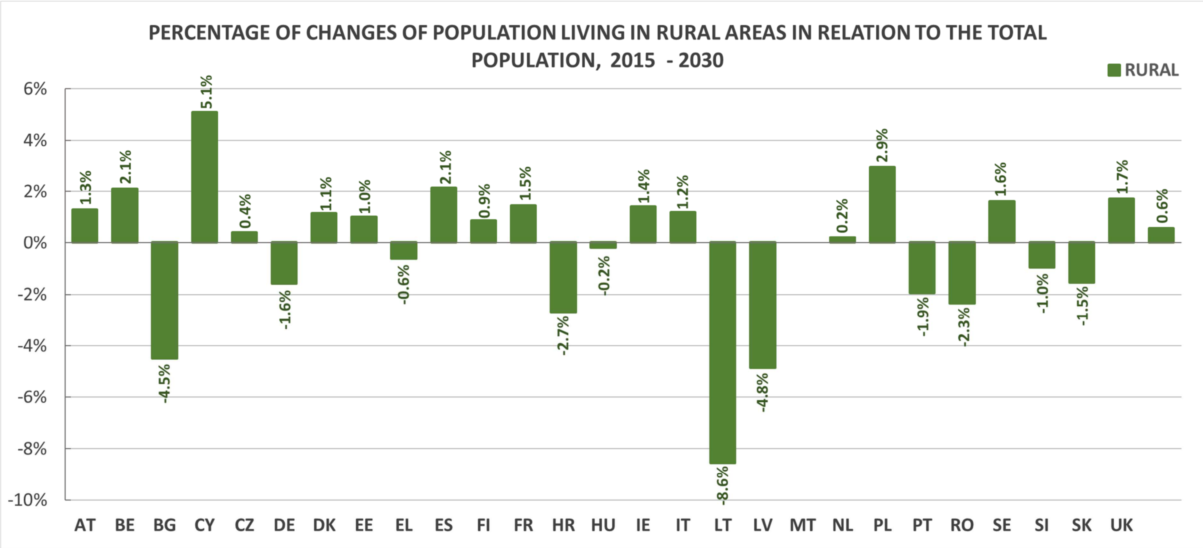


Figure 2: Projected evolution of rural population in EU Member States within 2015-2030, in percentage

As presented in Figure 2, the rural population in EU Member States is expected to follow diverse patterns within 2015-2030. The largest growth is projected for Cyprus and Poland, followed by Belgium and Spain. At the other end, the deepest drop is likely to occur in the Baltic region (Lithuania and Latvia) as well as in Bulgaria.

The average rural population at NUTS 3 level is approximately 100.000 inhabitants, with the majority of rural regions having a population of less than 300,000 inhabitants (Figure 3). Rural population tends to be generally higher in the East-European regions (in Romania, Hungary, Slovakia, Czech Republic and Poland) compared to those in Western Europe. The NUTS 3 region surrounding Prague (Czech Republic) is the only one in the EU that exceeds 600,000 inhabitants. Elevated levels of rural population are, nonetheless, observed also in Ireland, France and Denmark, as well as in Spain and Italy.

By 2030 important dynamics in rural population across NUTS 3 regions is expected – Figure 4. Significant increases in rural population (>10%) are likely in:

- Southern and North-eastern parts of Spain;
- South-eastern part of Sweden, Finland and Belgium;
- South-eastern part of the United Kingdom;
- Northern part of Italy and Poland;
- around most capital cities (Bucharest, Budapest, Dublin, Madrid, Prague, Rome, Stockholm, Tallinn, Vienna, Warsaw, etc.), as well as in Cyprus. The growth around capitals will be most likely driven by the lower living cost next to major labour markets, i.e. the people in those areas will be probably commuting to the nearby cities.

Conversely, deep (>10%) cuts in rural population are expected: in Northern Portugal, Eastern parts of Germany and Hungary, and large areas in Sweden, Croatia, Greece and Romania, as well as in the already identified Lithuania, Latvia and Bulgaria.

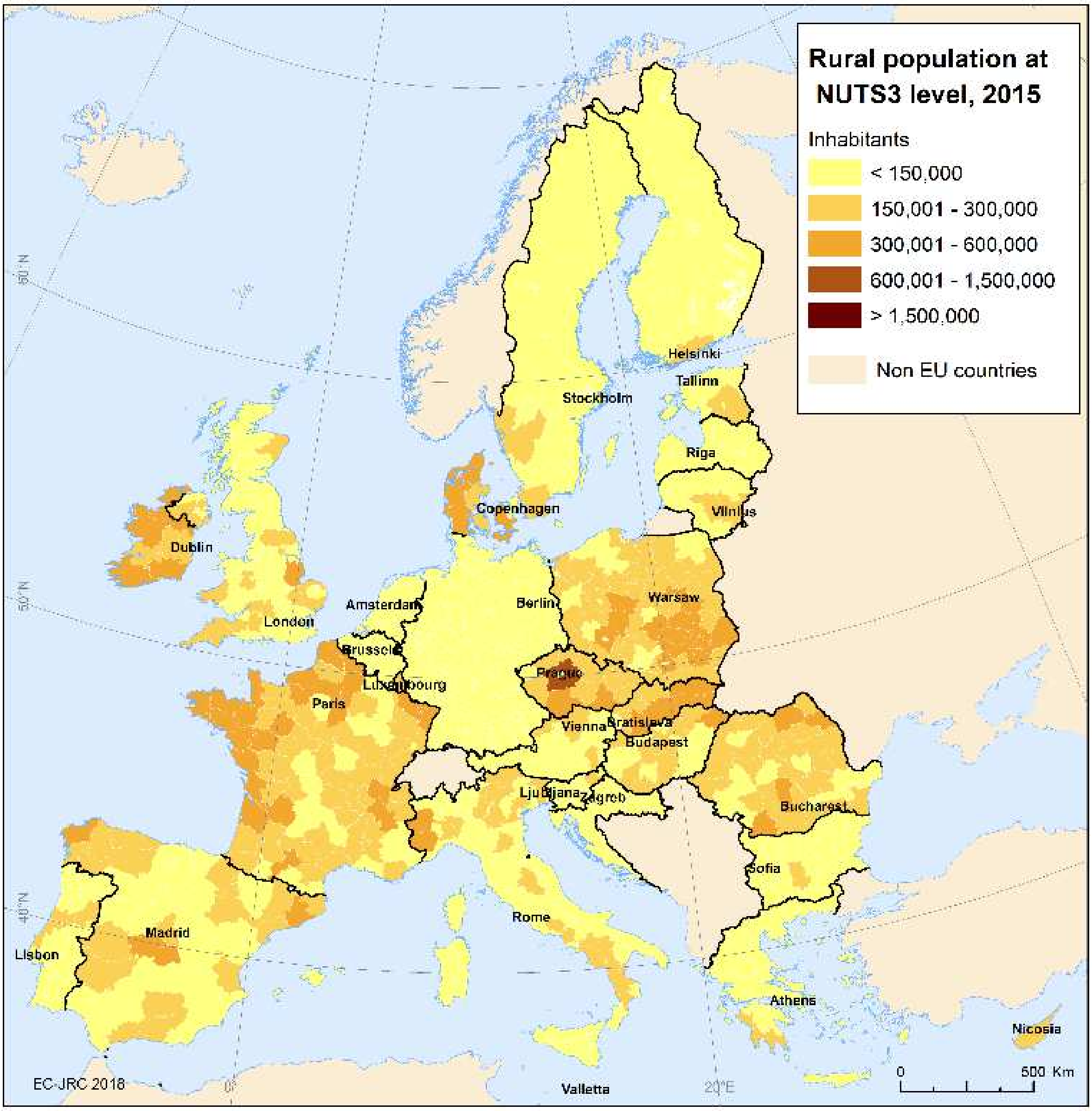


Figure 3: Population living in rural areas at NUTS3 level in 2015, number of inhabitants

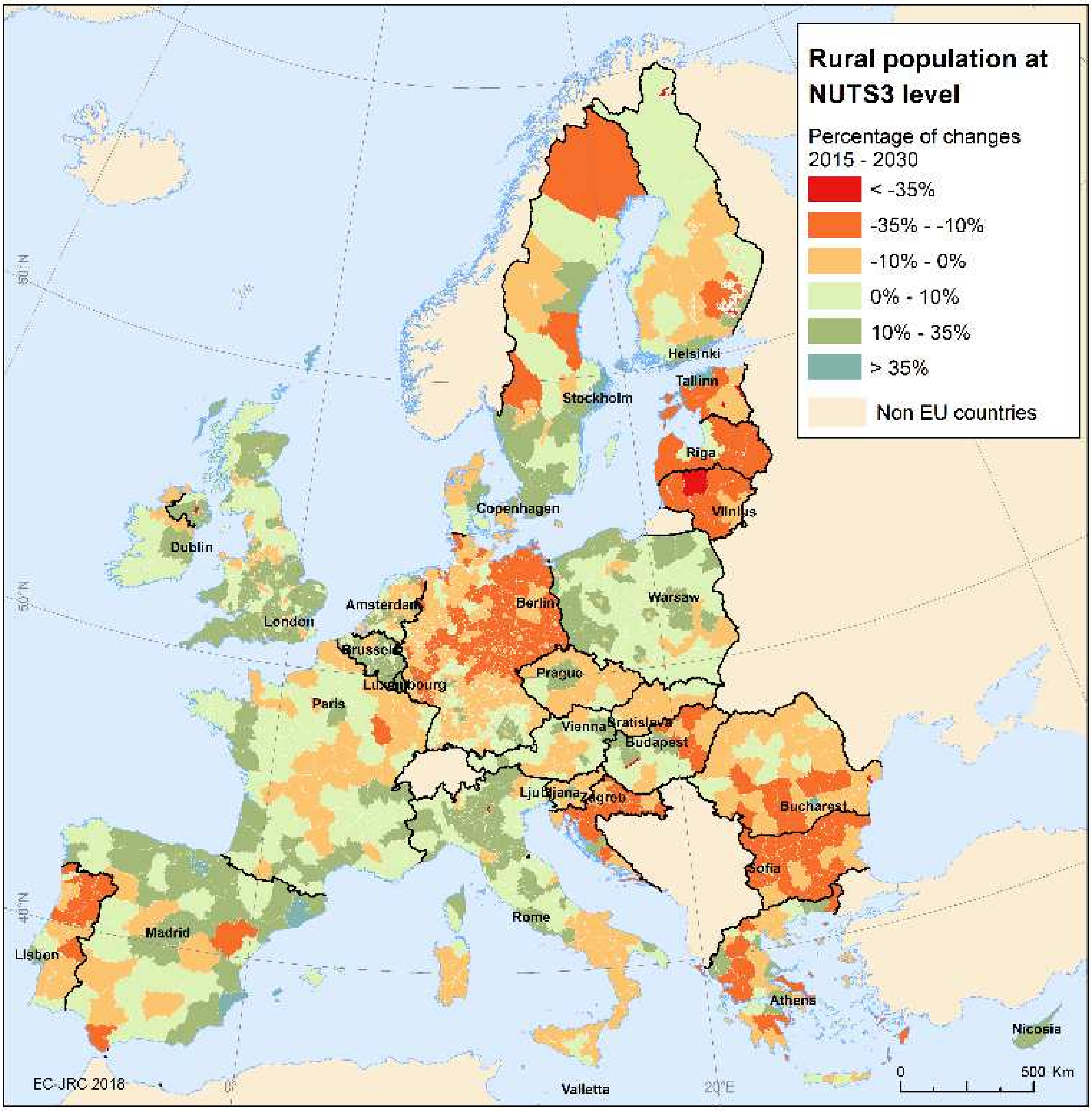


Figure 4: Change in population living in rural areas at NUTS3 level between 2015 and 2030, in percentage

3 Employment in primary sector

3.1 Context

Employment in primary sector (Agriculture, Forestry and Fishing), and particularly in agriculture, has special characteristics that make it challenging to measure. Agriculture is still dominated by family farms, where family members provide labour input. Many farmers and farm workers pursue agriculture as a part-time activity, having also other sources of income. Finally, agriculture is characterised by seasonal labour peaks, where large numbers of workers may be hired for relatively short periods (European Commission, 2013).

The number of employees in primary sector decreased between 2004 and 2011 in both absolute and relative terms – by 1.5 million persons i.e. almost one percentage points (European Commission, 2011). After 2008, the evolution of employment appeared to be a mix of trends from past years and the impact of the economic crisis. In some countries, the crisis seems to have contributed to a lessening of the job loss rate in primary sector (e.g. Latvia and Lithuania) or even to an increase in the number of people employed in this sector (Romania, Estonia, Hungary and Spain). By contrast, in Ireland, Belgium and Bulgaria the economic crisis may have accelerated the loss of jobs in primary sector.

3.2 Data and methods

Historical trends of employment in EU primary sector are used rather than LUISA projections. The reason of this methodological change is the lack of data on the economic evolution of regional agriculture. From the Scenar2030 publication (M'barek et al., 2017) projections for employment in the agri-food sector at EU and national level for the years 2016 and 2030 are reported[14]. As mentioned in Kitous et al. (2017) "the share of agriculture sector, within the whole economic structure, remains roughly stable in the OECD regions", in line with the reported growth figures found in the EU economic forecast[15] and the agricultural medium-term outlook[16]. Despite these limitations, the analysis includes the last observed year (2015) as a reference year, aiming at integrating employment into the regional assessment. The indicator, consequently, measures the share of employment in primary sector in relation to the total employment in a country / region. Primary sector is defined using the statistical classification of economic activities with the branch NACE A – Agriculture, Forestry and Fishing. The indicator presents information at national and regional level (NUTS 3) for all EU Member States, derived from the Cambridge econometrics database[17]. The number of employed persons in primary sector in relation to the total employment is used to compute the shares.

The identification of rural areas is based on the degree of urbanisation method (Dijkstra, L., Poelman H., 2014) as explained in Annex 10.2 "Degree of urbanisation" according to which three main classes are distinguished: cities, towns & suburbs and rural areas. The indicator, thus, combines information about employment per sector at national and regional (NUTS 3) levels and different regional typologies.

3.3 Results

By 2015, the share of primary sector in the EU overall employment was 4.4% (more than 9.5 million people) – Figure 5. Agriculture accounted for 93% of that employment[18]. The employment in primary sector was four times higher in the newer EU-13 than in the elder

[14] https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/scenar-2030-pathways-european-agriculture-and-food-sector-beyond-2020. This information is included in MAGNET model obtained for the DataM bioeconomy data.

[15] Economic performance and forecast (European Commission), accessible from: https://ec.europa.eu/info/business-economy-euro/economic-performance-and-forecasts/economic-forecasts_en

[16] https://ec.europa.eu/agriculture/markets-and-prices/medium-term-outlook_en

[17] Cambridge Econometrics' European Regional Database (ERD), Revision: 25/07/2017

[18] Shares derived from DataM bioeconomy data https://datam.jrc.ec.europa.eu/datam/mashup/BIOECONOMICS/index.html

EU-15 – 12% versus 3% respectively. Romania and Bulgaria had by far the highest shares – 27% and 19% respectively, followed at a large distance by Greece and Poland with around 12% each, and Portugal with 10%. At the other end were Belgium, Germany, Malta and the United Kingdom with less than 2% share, as well as Luxembourg with the absolute low EU-wide of less than 1%.

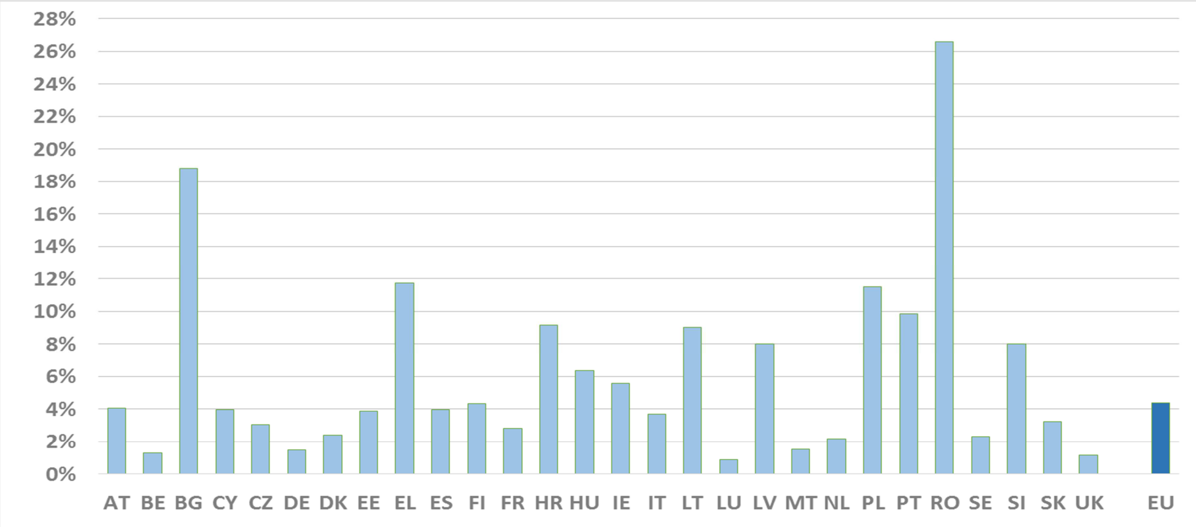


Figure 5: Shares of employment in primary sector in EU Member States in 2015, in percentage

By regional typologies, rural areas provided the largest number of employees – about 4.8 million, equal to 11.5% share in primary sector employment. With about 4% share, towns & suburbs ranked second and close to the EU average, while cities had the lowest (not surprisingly) share of primary sector employment of less than 1%. Eastern Europe – Lithuania, Poland, Romania, Bulgaria, Greece, Croatia – and Portugal were peculiar with regions, mostly rural ones, where the employment share of primary sector exceeded 20% – Figure 6. Town and suburban regions with such a high share were chiefly observed in South-eastern Europe – Romania, Bulgaria and Greece. On the contrary, along with the national figures and the breakdown by regional typologies, most NUTS 3 containing national capitals or other large cities, as well as vast areas in Western and Central Europe [Western Germany, Southern United Kingdom (England), Benelux, Northern France and French Riviera, Northern Italy, Czech Republic, etc.) had very low shares of primary sector employment of less than 2.5%. In all those regions, employment in secondary and tertiary sectors prevailed. The only two NUTS 3 containing cities, where primary sector accounted for more than 20% of total employment, were (again) located in South-eastern Europe – Bulgaria (Rouse, BG323) and Romania (Brăila, RO221).

The eligibility of EU regions (defined at NUTS 2) to benefit from the European Structural and Investment Funds (ESIF) depends upon their degree of economic development[19]. Less developed regions are eligible for the largest share of funds in order to kick-off growth and promote economic, social and territorial cohesion. Conversely, the most developed regions are eligible for the smallest share of funds. In this context, Figure 7 shows that the regions with the highest share of employment in primary sector in 2015 were largely falling into the less developed (lagging) category, except for the Mazowieckie region in Poland (PL12), where the national capital Warsaw was located. This was mainly due to the already revealed fact that in many Southern and Eastern

[19] As defined by the EU Cohesion policy: Type 1, or 'more developed' regions: NUTS 2 regions with GDP/capita above 90 % of the EU average; Type 2, or 'transition' regions: NUTS 2 regions with GPD/capita between 75 % to 90 % of the EU average; Type 3, or 'less developed' regions: NUTS 2 regions with GDP/capita below 75 % of the EU average;

countries (Portugal, Croatia, Greece, Bulgaria, Romania, etc.) agriculture still played an important role for the economy of many, especially rural regions. Those regions could therefore potentially benefit from the continuously improving coordination between agricultural and cohesion policies.

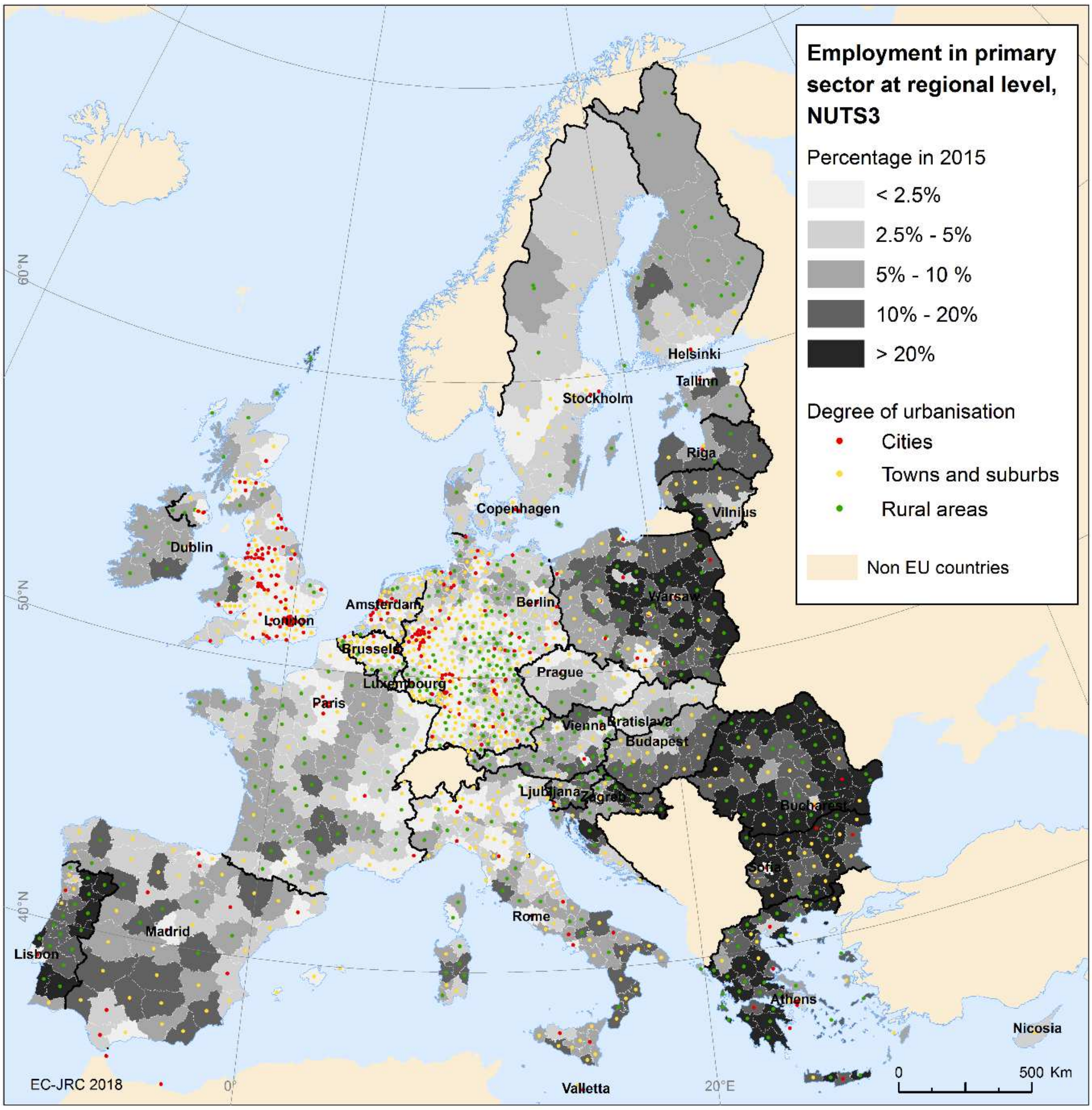


Figure 6: Share of employment in primary sector per degree of urbanization at NUTS 3 level in 2015, in percentage

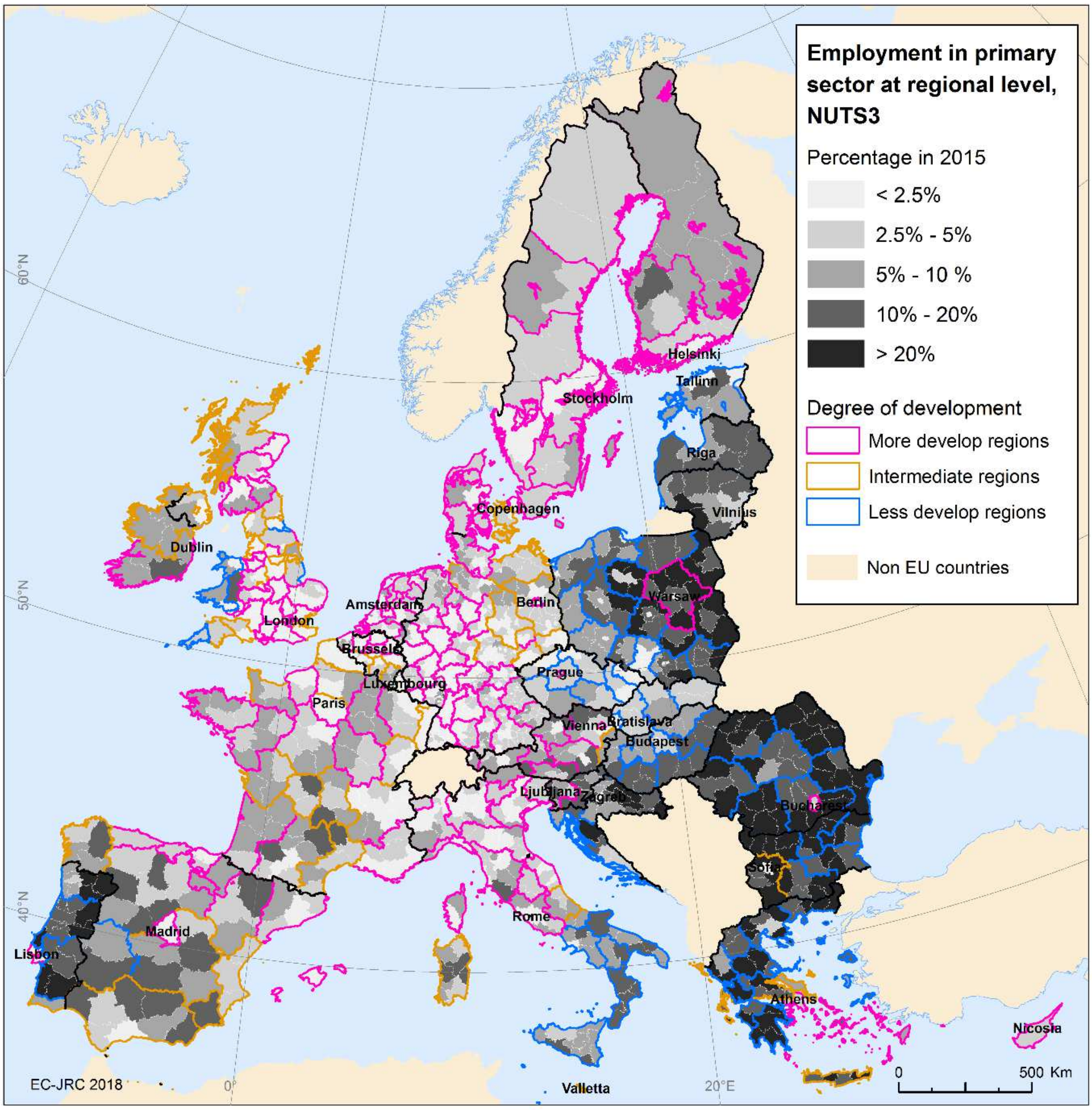


Figure 7: Share of employment in primary sector by degree of economic development in 2015 at NUTS 3 level

4 Gross Value Added in primary sector

4.1 Context

Gross value added (GVA) measures productivity by representing the value of goods and services produced in an area, industry or sector and thereby, contributing to the economy. In national accounts, GVA is the output of the country less the intermediate consumption. GVA is directly linked to the Gross Domestic Product (GDP), but accounts for taxes and subsidies (i.e. GVA + taxes – subsidies = GDP). GVA therefore appears more suitable to measure economic performance at regional level.

Primary, secondary and tertiary sector contribute in a different way to the EU's GVA. By far, tertiary sector (services) is the largest component of economic activity in the EU, accounting for almost 2/3 of the value added in 2010. In contrast, primary sector represented less than 5% of the value added in 2010 and it has been continuously declining in the last decades.

4.2 Data and methods

Similarly to the employment analysis (see Section 3.2), historical trends of GVA in EU primary sector are used rather than LUISA projections, due to the lack of data on the economic evolution of regional agriculture. The analysis includes the last observed year (2015) as a reference year, aiming at integrating GVA into the regional assessment. The indicator, consequently, measures the share of primary sector GVA into the total GVA by using the statistical classification of economic activities by branch of NACE A – Agriculture, Forestry and Fishing. The indicator presents information at national and regional level (NUTS 3) for all EU Member States, derived from the Cambridge econometrics database[20]. The GVA in primary sector (in million EUR) in relation to the total national GVA (in million EUR) is used to compute the shares.

The identification of rural areas is based on the degree of urbanisation method (Dijkstra, L., Poelman H., 2014) as explained in Annex 10.2 "Degree of urbanisation" according to which three main classes are distinguished: cities, towns & suburbs and rural areas. The indicator, thus, combines information about GVA in primary sector at national and regional (NUTS 3) levels and different regional typologies.

4.3 Results

The importance of primary sector for the EU economy has remained quite stable over the recent past (2007-2012), however in 2009 there was a drop in the GVA, both in absolute and relative terms, due to the economic crisis (European Union, 2014). Consequently, by 2015 primary sector accounted for just 1.7% of total GVA in the EU. This figure was much lower compared to the one for employment, meaning that the EU primary sector was far more important from the employment point of view (labour intensive), rather than from the productivity point of view. Similarly to the primary sector employment, the weight of rural economy differed considerably between the newer EU-13 and the elder EU-15. In 2015 the share of primary sector's GVA in EU-13 was approximately two times higher than in EU-15 – 8.1% versus 4.1% respectively. Compared with the four-times gap in employment between EU-13 and EU-15 (12% versus 3%), this means that the productivity of labour force in EU-13 was much lower than the one in EU-15.

Likewise employment, Romania was the EU leader in primary sector GVA with 5.7% – Figure 8. The second in the employment classification ranking – Bulgaria, came fourth in the GVA ranking with 4%, overpassed by Greece (third in employment) and Estonia with 4.8% and 4.6% respectively. At the bottom of the GVA ranking there was no significant difference with the employment one. Germany, the United Kingdom and Belgium again

[20] Cambridge Econometrics' European Regional Database (ERD), Revision: 25/07/2017

occupied the lowest placing with less than 1%, going down to the record low of 0.25% in Luxembourg[21].

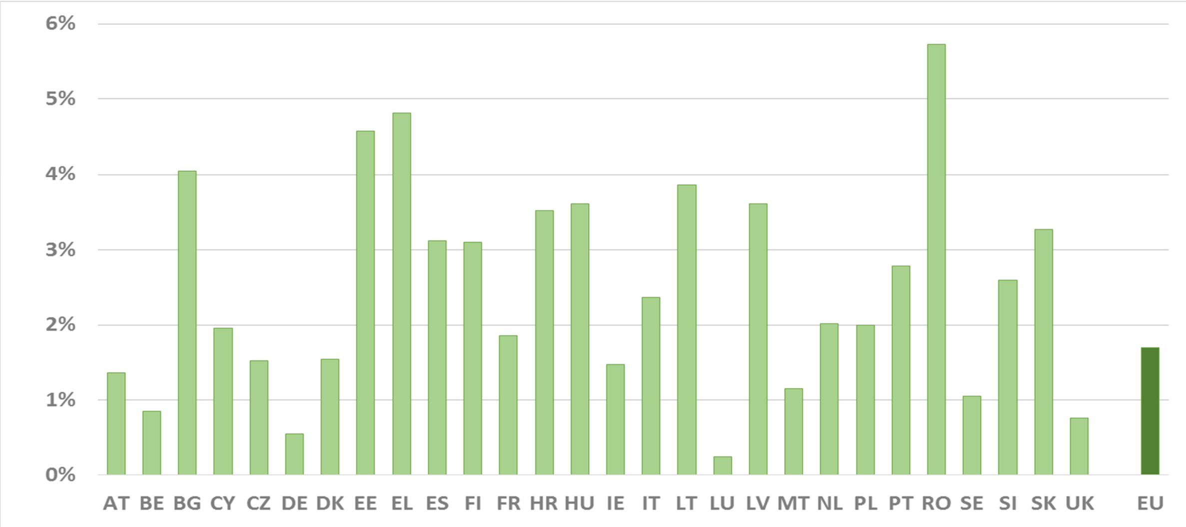


Figure 8: Share of GVA in primary sector at national level for 2015 and 2030, in percentage

The share of primary sector's GVA varied considerably by regional typologies. In predominantly rural regions, the primary sector's GVA contributed well above the EU average, accounting for roughly 4.5% in 2015. The GVA share was considerably lower in towns and suburbs (2%), though it was still above the EU average of 1.7%. The contribution of primary sector to the regional GVA in cities was negligible – 0.5%.

Significant further variations in GVA of primary sector were observed at regional (NUTS 3) level – Figure 9. The activities of primary sector were mainly concentrated in rural regions of Austria, Croatia, Estonia, Finland, France, Ireland, Poland, Portugal, Romania and Slovenia. In Belgium, Czech Republic, Germany, Denmark, Hungary, Italy and Sweden the GVA of primary sector came simultaneously from towns & suburbs and rural regions. The regions with the largest (above 15%) share of GVA in primary sector were mostly located in Eastern and Southern Europe (Hungary, Romania, Bulgaria, Croatia and Greece). The highest EU values (above 25%) were identified in Romania (Brăila and Ialomiţa) and Bulgaria (Silistra). At the other end, many regions in Italy (especially in the North), France, Belgium, the Netherlands, Germany and Poland had very low (below 2.5%) shares of GVA in primary sector. But in those countries there were still NUTS 3 with higher importance of this sector – above 5% and even above 10 %, particularly in traditional rural zones.

The regional heterogeneity is highlighted by the large differences amongst rural-urban typologies. For example, the average share of primary sector's GVA in Spanish rural regions was about 10% (the highest share was in the Cuenca region, ES423 – nearly 15%), but only around 2% in urban areas (the highest share was in the Valladolid region, ES418 – nearly 7%). In Bulgaria, the respective values were 12% in rural regions (the highest share – in Silistra region, BG325 – 26%), but only about 1% in urban areas (the highest share – in Rousse region, BG323 – 7%).

As regards to the eligibility of EU regions (at NUTS 2) to benefit from the European Structural and Investment Funds (ESIF), similarly to the employment situation from Figure 7, Figure 10 shows that the regions with the highest share of GVA in primary sector were largely classified as less developed / lagging. This was due (again) to the fact that in many Eastern and Southern countries (Slovakia, Hungary, Romania, Bulgaria,

[21] Only Malta moved slightly up in the GVA classification.

Greece, Croatia) agriculture still played an important role for the economy of many, especially rural regions.

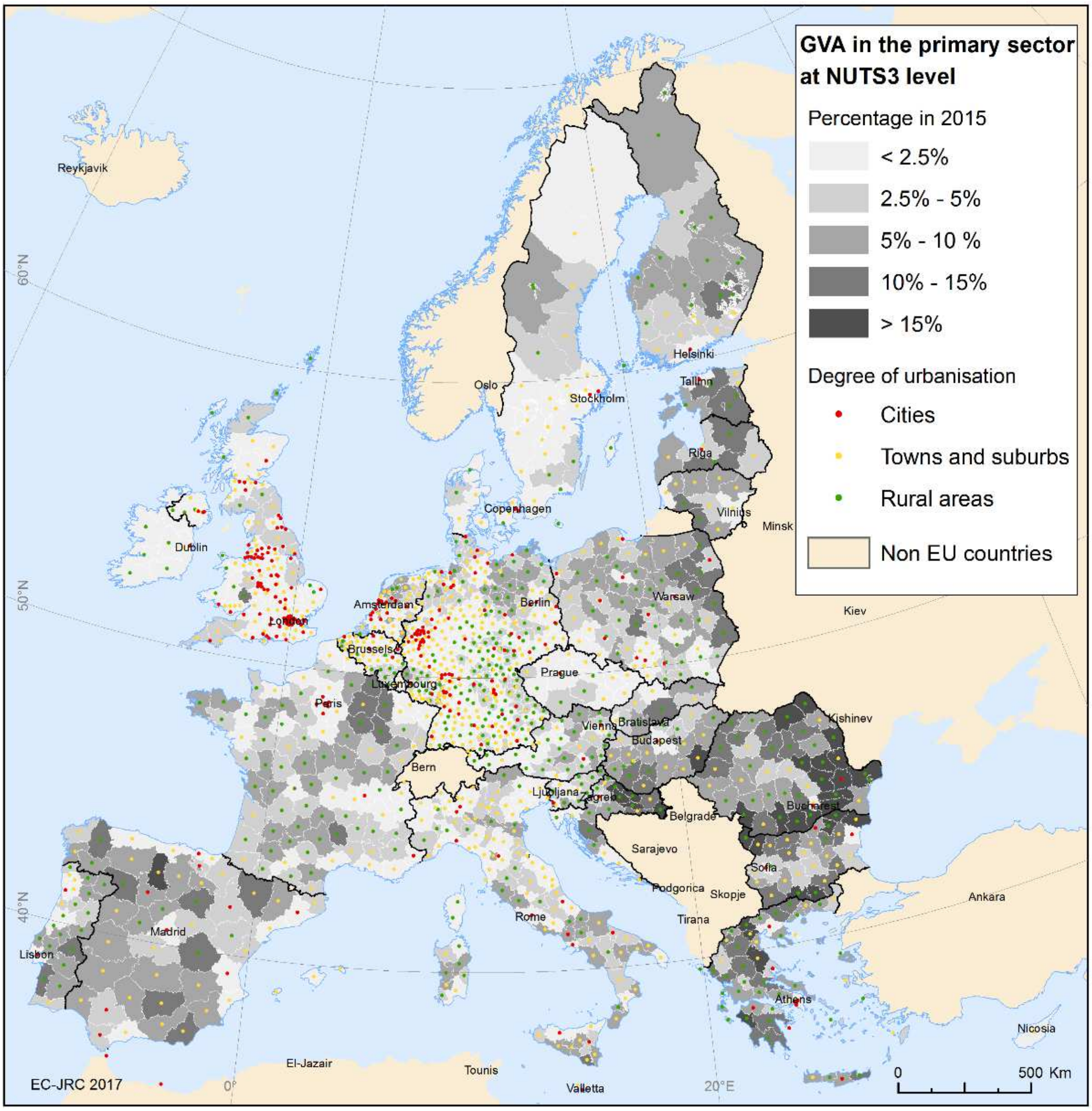


Figure 9: Share of GVA in primary sector per degree of urbanization at NUTS 3 level in 2015, in percentage

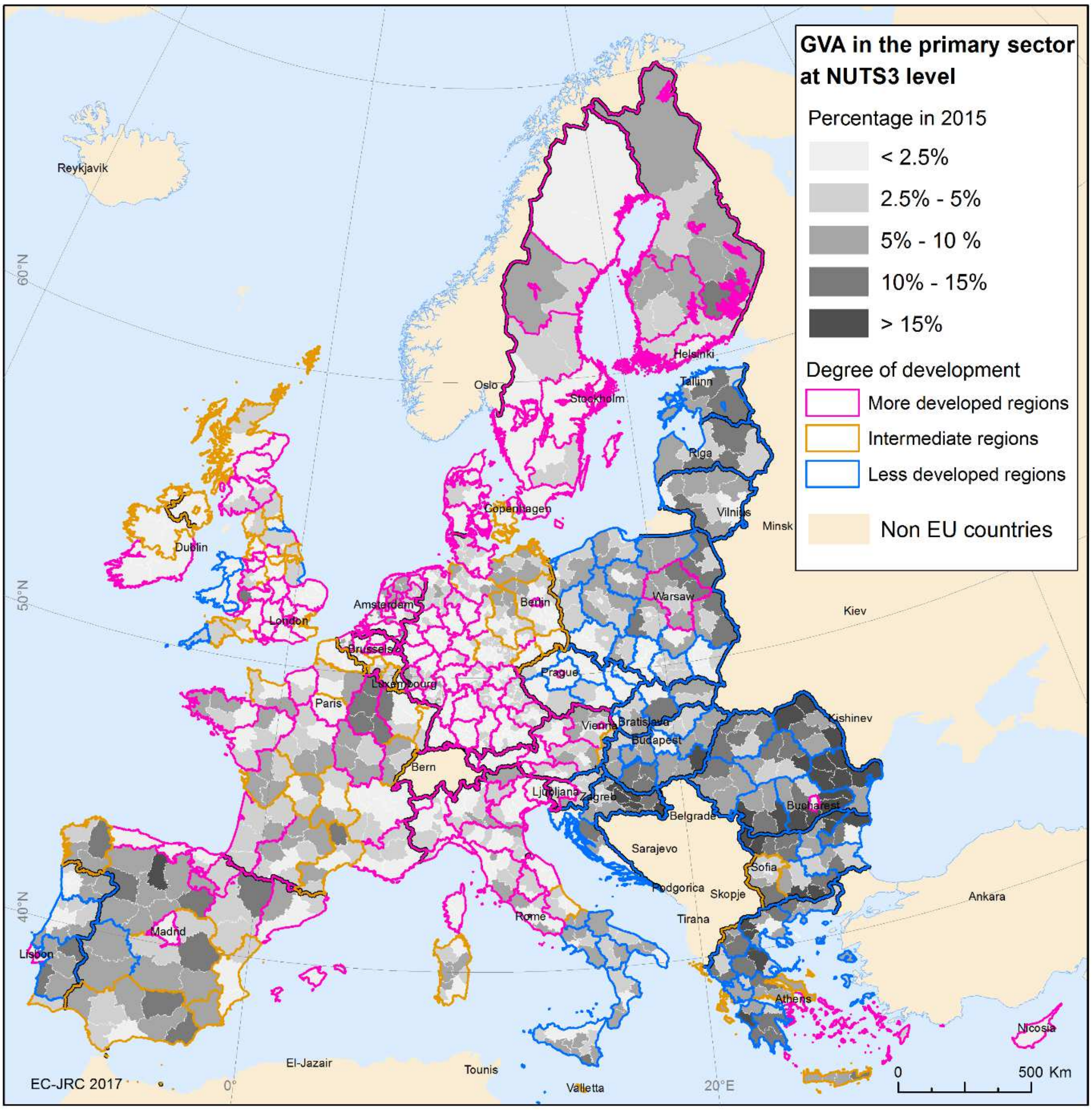


Figure 10: Share of GVA in primary sector by degree of economic development in 2015 at NUTS 3 level

5 Agricultural land

5.1 Context

Agricultural land covers almost 50% of the EU territory offering a high variety of economic activities and landscapes directly related to its physical, climate and soil characteristics. Of the whole Utilised Agricultural Area (UAA) in the EU by 2013, 60% was used for arable crops, one third – for permanent grassland and meadows, and 6% - for permanent crops. In absolute values, France had the largest agricultural area – 28 million ha, equal to 16% of the total UAA in the EU, followed by Spain (23 million ha, 13% of UAA). More than 70 % of the total agricultural land was located in the elder[22] EU-15 Member States (European Commission, 2016a).

The distribution of the main agricultural production systems highly varied amongst countries. While arable crops covered almost 50% of the UAA in Denmark, Poland, Czech Republic, Slovakia and Hungary, in Ireland, the United Kingdom, the Netherlands and Luxembourg more than 50% (topping 80% in Ireland) of the UAA was used for permanent grassland and meadows. Permanent crops were more prevalent in the Mediterranean countries – Cyprus, Greece, Italy, Spain and Portugal.

Concerning the agricultural market and acreages, within 2008-2013 the EU area decreased by 8% (427,000 ha) and yields went down by 1%. The EU area with cereals reached 57.8 million ha and produced 301.5 million tonnes in 2013. Common wheat accounted for 45% of all cereals, followed by grain maize (21%) and barley (20%). Oilseeds covered 11.5 million ha, and harvest reached 29.8 million tonnes in 2013. The largest contributor was rapeseed (20.5 million tonnes), followed by sunflower (8.2 million t). Olive oil production, taking place mainly in Spain, Italy and Greece, reached 1.5 million tonnes in 2013, which was however down by 38% from the previous campaign[23]. Rice area in the EU accounted for 467,000 ha in 2013, which was again down, but unlike olive oil – only slightly (2%) compared to the previous year, but yields were higher and the total EU rice production reached 1.89 million tonnes. Finally, the production of protein crops - 2.6 million tonnes in 2013 – remained considerably below the one in previous years (European Union, 2013).

5.2 Data and methods

The indicator for agricultural land provides the estimated share of land occupied by agriculture in 2015 and the expected evolution until 2030 at national and regional (NUTS 3) level for all EU Member States[24], assuming that the production of:

- food and feed takes place on land allocated to arable farming, pastoral/livestock grazing, mix-crop systems, permanent crops and rice production;
- energy from agricultural land correspond to the bioenergy crops i.e. non-food crops, mainly perennial grasses (miscanthus or switchgrass) and short rotation coppice (willow or poplar) [see Perpiña et al., 2015].

The regional land demand for agricultural activities is specified according to the CAPRI 2016 Baseline projections[25], thus being consistent with the EU Agricultural Outlook 2016-2026 (European Commission, 2016c). CAPRI is a partial equilibrium model that simulates market dynamics of agricultural commodities for impact assessment of the Common Agricultural Policy (Britz and Witzke, 2012). The EU supply and market models of CAPRI are calibrated to the European Commission's medium-term prospects for EU Agricultural

[22] Accession before 2004
[23] Anyhow, olive oil production is peculiar with large variations from year to year, due to a set of agronomic and market factors.
[24] As simulated in the Territorial Reference Scenario 2017 of the EC-JRC LUISA Territorial Modelling Platform (see Jacobs-Crisioni et al., 2017).
[25] 2016 CAPRI baseline was provided by the EC-JRC Directorate Sustainable Resource, Economics of Agriculture Unit (JRC.D.04).

markets and income (European Commission, 2015), considering the following targets: supply, demand, production, yields and prices. CAPRI is also part of the model suite used to derive the EU energy, transport and GHG trends published in the EU Reference scenario 2016 (European Commission, 2016b). Among other outputs, CAPRI produces projections at regional (NUTS 1 and NUTS 2) level for all Member States on yields, production and land area to be allocated for specific crops. Regarding policy assumptions, the CAPRI 2016 Baseline incorporates agricultural and trade policies approved up to 2015, including some measures of the latest CAP 2014-2020 reform.

The spatial patterns of agricultural activities are simulated as agricultural production systems, which are specified following an aggregation of the individual crop projections provided by CAPRI (Table 1). Furthermore, the agricultural land abandonment is also simulated by specific classes – arable land, permanent crops and pasture/livestock grazing lands.

Table 1: Classification of the agricultural production system (based on Eurostat nomenclature) and the correspondence with LUISA base map classes (based on Corine Land Cover 2012).

LUISA base map[26]	**LUISA model classes**	
	Model type classes	**Aggregated classes**
211 - Non-irrigated arable land 212 - Permanently irrigated land	Arable crop system	Arable farming systems
213 - Rice fields	Rice production	
231 – Pastures 244 - Agro-forestry	Livestock production	Livestock grazing systems
321 - Natural grassland	Extensive livestock grazing	
241 - Annual crops associated with permanent crops 242 - Complex cultivation patterns 243 - Land principally occupied with agriculture	Mixed crop-livestock systems	Mixed crop-livestock systems
221 – Vineyards	Vineyards	Permanent crop systems
222 - Fruit trees and berry plantations	Fruit production	
223 - Olive groves	Olive production	

5.3 Results

In 2015, the agricultural land area is estimated to reach 185.6 million ha, which would be equal to 42% of all EU land area. Arable land, with its 103.4 million ha, accounts for the largest share of UAA (56%), followed by livestock grazing with 47 million ha (25% of UAA) and mixed crops with 25 million ha (13.5% of UAA) and various permanent crops with 10.2 million ha (5.5% of UAA). By 2030, the largest increase of almost 11% is projected for mixed crops (Figure 11). The dynamics in permanent crops systems will be diverse – the areas with olive trees are expected to substantially expand, but largely at

[26] The LUISA base map 2012 (Jacobs-Crisioni et al., 2017) that is used in the allocation mechanism, is an enriched version of CLC 2012, but with a significantly higher spatial and thematic resolution mainly owing to the integration of relevant land use/cover information from multiple compatible geodata sources (Copernicus "High Resolution Layers", Urban Atlas, European Settlement maps, etc.). Since LUISA is dependent on the base map 2012 (refined-CLC2012) as starting point of the simulation, it is worth mentioning the exiting differences between CLC and other European data sources (LUCAS, Farm Structure Survey, etc.), not only due to the spatial interpretation, but also to the thematic classification (La Notte et al., 2017; Hiederer, R. 2016; Pointereau et al., 2008; European Environmental Agency, 2006).

the expense of cutbacks in the areas with vineyards. Within 2015-2030 the two principal groups – arable land and livestock grazing – will be on decline by 4.0% and 2.6% respectively, which trend largely defines the overall downward trend of agricultural land of 1.1% over the same period of time, reaching 183.6 million ha in 2030. Bioenergy crops[27] are likely to occupy a negligible area of 210 thousand ha, i.e. just 0.12% of the total agricultural land in 2030. The incremental abandoned agricultural land, which is not considered as a productive land, is expected to exceed 4 million ha within 2015-2030 (see the next chapter on Agricultural land abandonment for further information).

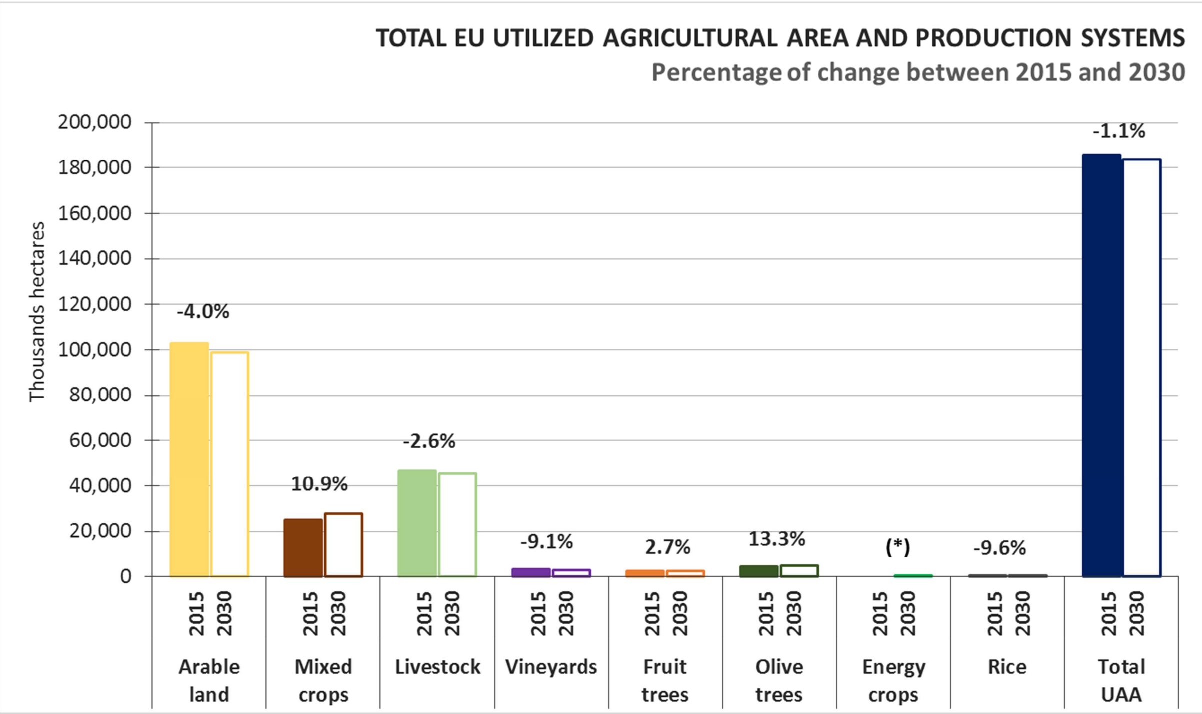


Figure 11: Agricultural land (thousand hectares) for production of food, feed and energy in the EU, changes between 2015 and 2030. The percentage values reflect the changes in land occupied by agricultural production systems and total UAA during the same simulation period. (*) – the land occupied by dedicated energy crops is considered (close to) null in 2015

Despite the relatively small changes that are projected for agricultural land within 2015-2030, important conversions among different types of agricultural production systems may also occur. The application of the land-use/cover flows[28] method allows unveiling those conversions. Figure 12 clearly reveals that the internal conversion of agricultural land (i.e. between various types) is expected to be by far the largest transformation, accounting for more than 7.7 million ha (4.2% of the UAA), of which more than 2.3 million ha would be arable land into mixed crops. The loss of agricultural land (converting into abandoned land) is estimated to more than 4.8 million ha (more than 2.5% of UAA), partially because of negligible re-cultivation of once-abandoned land (evaluated at just around 0.1%). The transformation of agricultural land into build-up or forest & natural areas would be less significant, accounting altogether for less than 1.5% of all agricultural land.

[27] There are projections for bioenergy production from 2025 onwards only and these also heavily depend on each single Member State's projections.

[28] The approach of land-use/cover flows is based on the methodology presented by the European Environmental Agency for 'Land Accounts for Europe' (EEA, 2006). It was adapted to the LUISA framework and land-use classification scheme (for detailed description of the method, see Barbosa et al., 2015).

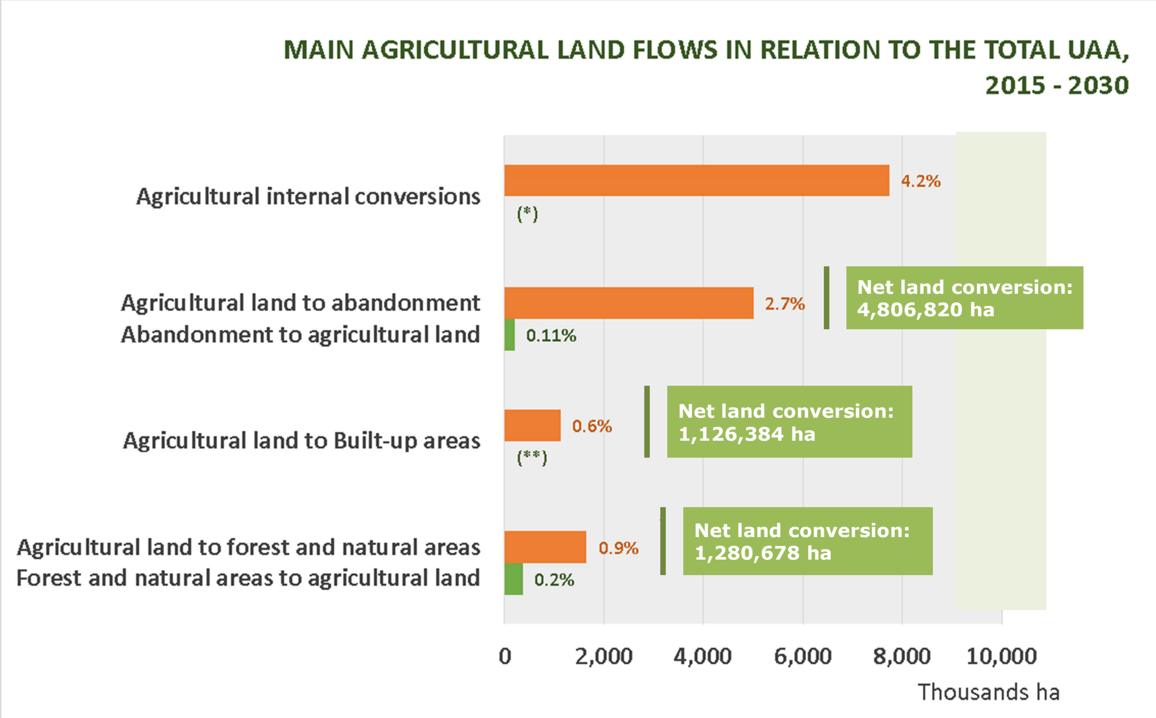
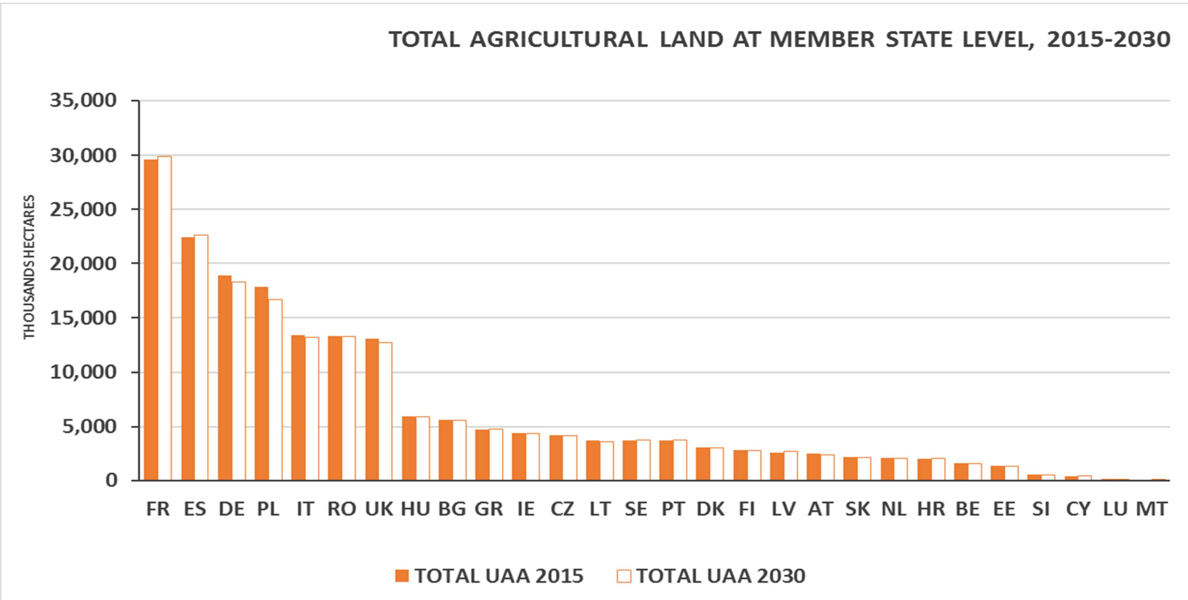


Figure 12: Main agricultural land-use/cover flows from agricultural to other land uses, including internal agricultural conversions. Net land conversions between flows are also included except the ones that either have the same amount of net land (*) or do not occur (**). The shares of flows are computed based to the total UAA in 2030.

Similarly to the overall EU picture, drastic changes in agricultural land are not forecast for EU Member States either (Figure 13). The seven largest EU countries – France, Spain, Germany, Poland, Italy, Romania and United Kingdom – account for about 70% of all UAA both in 2015 and 2030. Slight increases (<5%) are projected for France, Spain, Cyprus, Portugal, Greece, Malta, Croatia, and Latvia. In relative terms (agricultural land as share of total area), Denmark, Hungary and Ireland are the clear EU leaders, with more than 60% of their surface being occupied by agricultural land both in 2015 and 2030. Conversely, Sweden, Finland, Slovenia, Austria and Estonia are the group of countries with the least land devoted to food, feed and energy production in the EU.



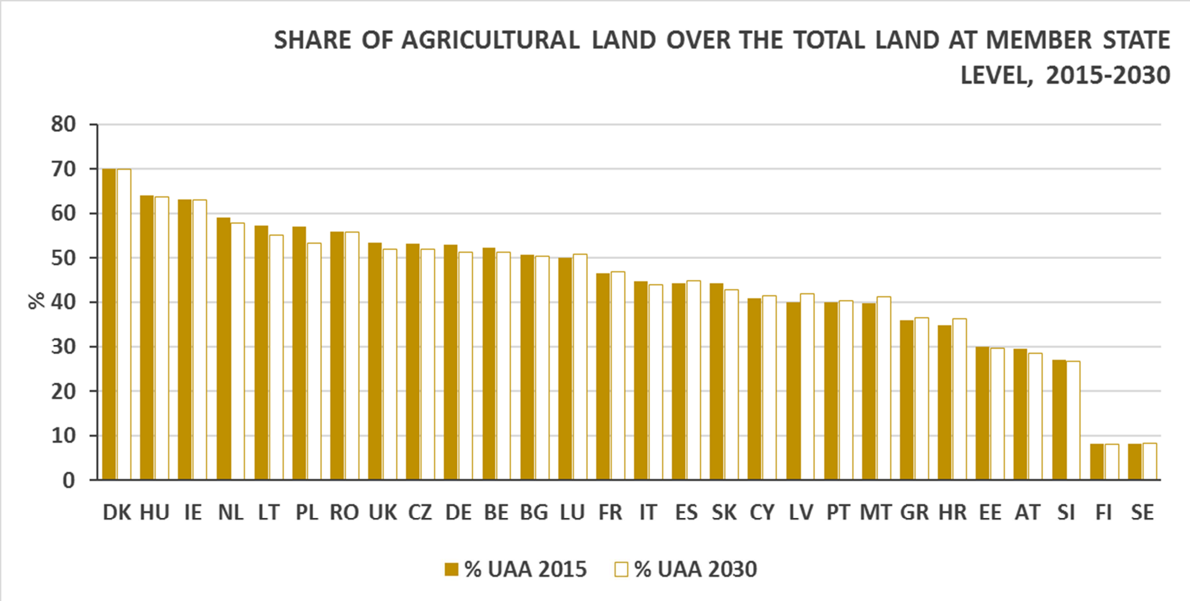


Figure 13: Absolute (top) and relative (bottom) agricultural land in 2015 and 2030 by EU Member State

The diversity of landscape and climatic conditions, and consequently, the spatial patterns of agricultural production vary considerably among EU Member States (Figure 14 and Figure 15). Arable crops, nevertheless, are the dominant agricultural land use in the majority of countries, exceeding 70% in Cyprus, Hungary, Denmark and Slovakia. Slovakia is, however, projected to be amongst the biggest relative losers of both arable and total agricultural land by 2030, together with Germany. Arable land is expected to enlarge more noticeably (by more than 20% within 2015-2030) in Belgium, the Baltic States, Spain and Malta (but from a very low basis for the last one). Livestock has more than 50% share of all agricultural land in Luxembourg (but similarly to Malta – negligible absolute figures EU-wide), the Netherlands, the United Kingdom and especially in Ireland (above 80%). Livestock is, nonetheless, expected to shrink in all those countries, except in Luxembourg. Other important (more than 20%) losers of livestock would be Austria, Latvia, Estonia, Sweden and Finland, while gains above 20% are likely (besides Luxembourg) in Portugal, Czech Republic and Slovenia. Mixed crops are particularly (above 30%) important for Croatia, Greece, Portugal, Finland and Slovenia. Cutbacks are projected for Slovenia, as well as for Belgium, Spain and Latvia, while large (above 40%) growth is likely in Bulgaria, Denmark, France, Croatia, Ireland, Latvia and Sweden. Permanent crops (vineyards, fruit trees, olive threes) are widely found in the Mediterranean countries, topping around 20% in Greece and Spain. As already indicated, vineyards are projected to shrink the most, often at the expense of olive threes, especially in Cyprus and France. Cyprus will, in exchange, see the largest single relative growth in fruit trees of more than 30% in the EU by 2030. The share of rice and energy crops in total agricultural land is negligible but noticeable growth in energy crops[29] cultivation is expected in the Netherlands, Finland and Romania.

[29] There is no energy crop production in Belgium, Cyprus, Germany, Greece, Croatia, Hungary, Italy, Lithuania, Latvia, Malta, Portugal, Sweden and Slovakia by 2030.

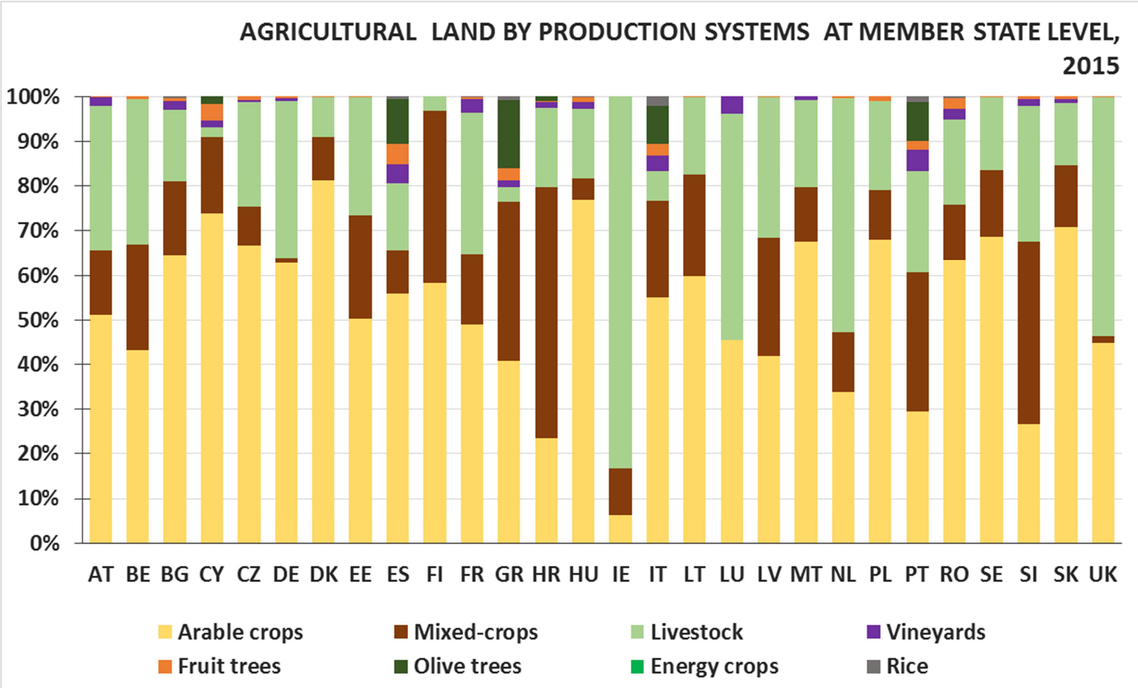


Figure 14: Breakdown of the agricultural production systems as percentage of total UAA at EU Member State level in 2015

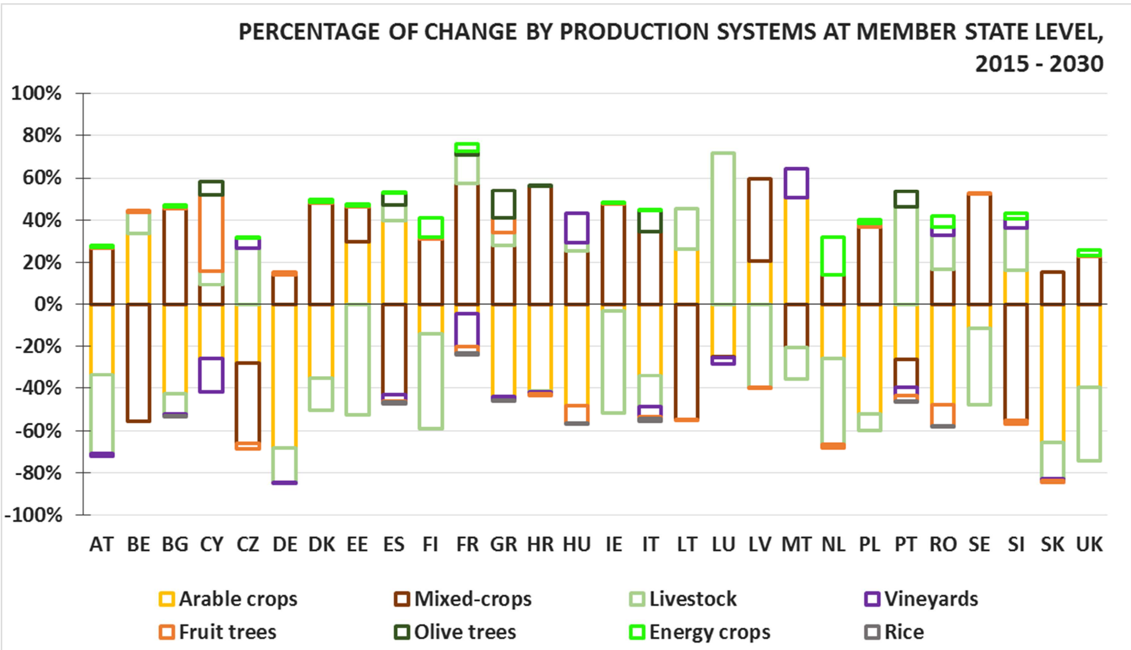


Figure 15: Percentage of change in the agricultural production systems at EU Member State level between 2015 and 2030

Figure 16 and Figure 17 provide an insight into the prevailing regional (NUTS 3) patterns and the likely future trends of agricultural land in the EU. The shares of agricultural land for the production of food, feed and energy over the total NUTS 3 surface vary considerably among and within Member States. Owing to a set of landscape, climatic and socio-economic factors, there are countries, mostly in Southern Europe e.g. Italy, France, Spain, Portugal, Bulgaria, but also Austria and the United Kingdom, with large (more than 3 times, i.e. from below 25% to above 75%) inter-regional variations in the share of agricultural land over total area. Other countries, predominantly in Central and Eastern

Europe – the Baltic States, Poland, Czech Republic, Slovakia, Hungary, Romania – are peculiar with a more homogeneous and at the same time – elevated share of agricultural land over total area. Romania, in particular, appears as the EU country with the widest area where more than 75% of total land is dedicated to agriculture. The significant inter-regional differences in Germany are mostly due to socio-economic factors – the big industrial centres and urban agglomerations leave little land to agriculture. The very low (below 5%) presence of agricultural land in the Central and Northern parts of Sweden and Finland is chiefly defined by the unfavourable climatic conditions for agriculture.

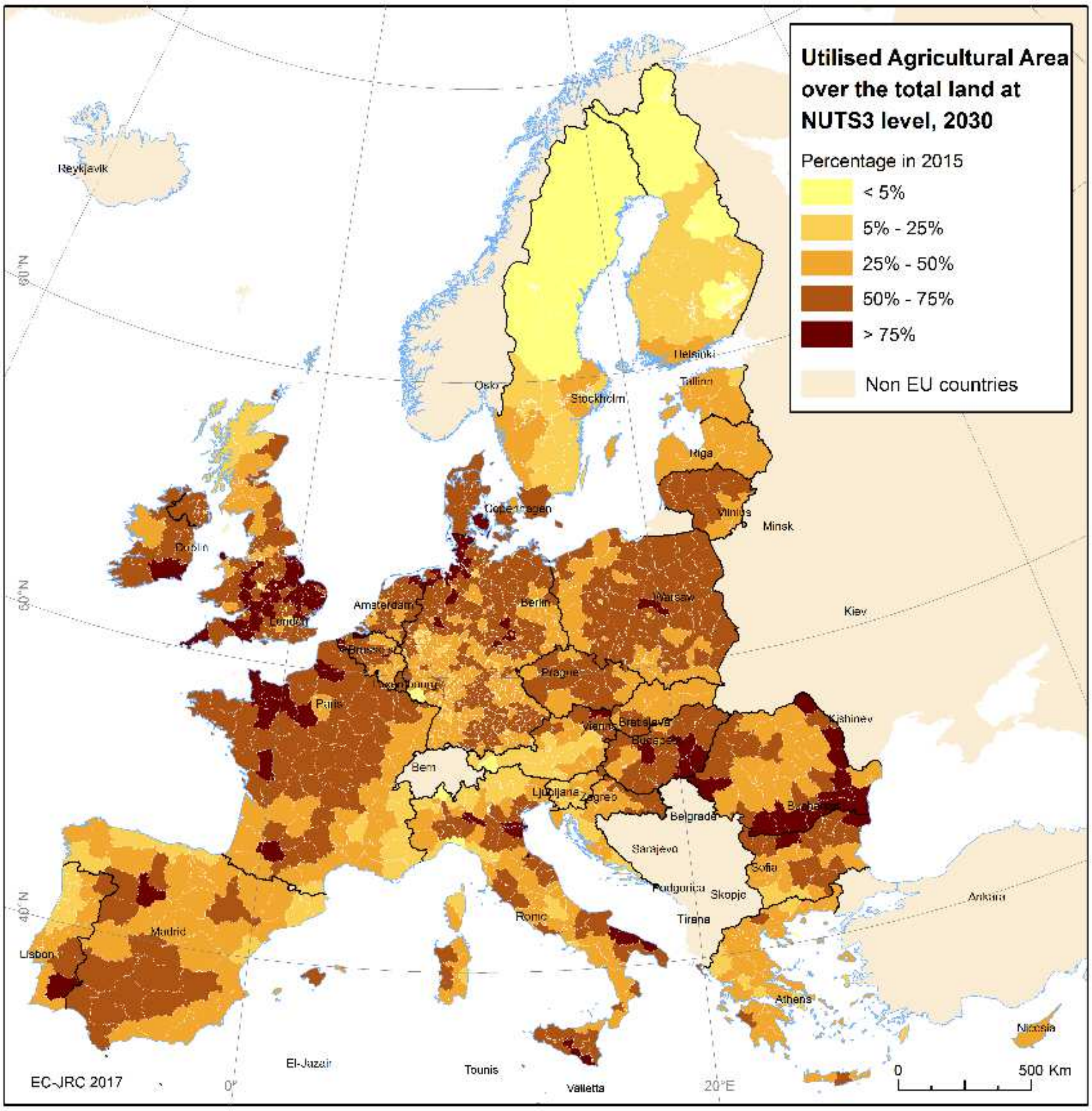


Figure 16: Share of agricultural land for the production of food, feed and energy land over the total land at NUTS3 level, 2015

Within 2015-2030 a noticeable (over 15%) expansion of agricultural land is projected for a number of regions in Southern and South-Eastern Europe – Portugal, Spain, France, Italy, Croatia in particular (owing to the access to the CAP measures), Greece, Romania, etc. Growth of similar magnitude (albeit, from a much lower basis), largely owing to the Climate Change, is also expected for the Northern strip of countries and regions that comprises Scotland in the United Kingdom, Sweden, Finland, Estonia and Latvia. Nonetheless, in line with the overall forecast trend of 1.1% shrinkage of EU agricultural land between 2015 and 2030, more than 75% of all NUTS 3 in the EU are likely to see a contraction of land for the production of food, feed and energy. The reduction would be widespread in the regions of Central Europe – Lithuania, Poland, Czech Republic, Slovakia and Slovenia. It is worth noting that some of the deepest cuts in agricultural area would occur in Portugal, Spain, France, Sweden and Finland, pointing out on significant intra-regional (sometimes even neighbour) disparities at national level.

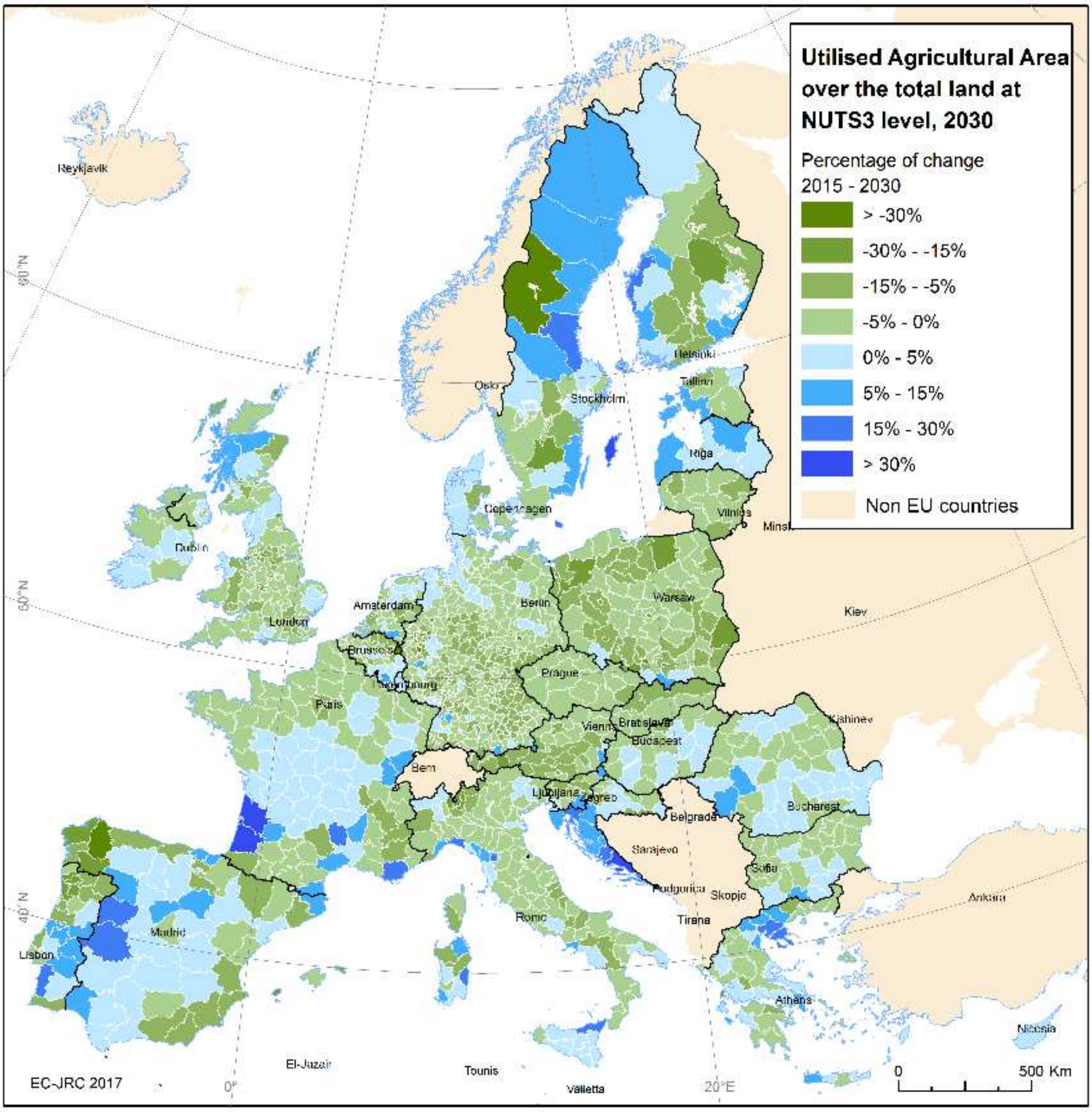


Figure 17: Percentage of changes of agricultural land for the production of food, feed and energy at NUTS3 level, between 2015 and 2030

6 Agricultural land abandonment

6.1 Context

In the majority of EU Member States, a considerable loss of UAA was recorded in the last decades not only due to urban expansion and afforestation, but also to farmland abandonment. As already indicated, between 2015 and 2030 this trend is expected to continue and the UAA is estimated to shrink by around 1%, mainly due to conversion into artificial areas, forest and natural vegetated areas.

Agricultural land abandonment became important already in the 1950s and it is still a topical issue. It can be defined in different ways[30] according to the approach. The most common definition refers to land that was previously used for crop or pasture/livestock grazing production, but does not have farming functions anymore (i.e. a total cessation of agricultural activities) and has not been converted into forest or artificial areas either. Many factors are involved in this complex and multi-dimensional phenomenon. Agricultural land abandonment can be triggered by primary drivers related to low productivity, remoteness or mountainous regions, or unfavourable soil or climate conditions for agriculture. Secondary drivers such as rural depopulation, detrimental regional socio-economic factors, policies or farm structure can further accentuate land abandonment (Van der Zanden et al., 2017).

Agricultural land abandonment has empirically shown to contribute to several positive and negative impacts, with trade-offs largely depending on the specific context (Van der Zanden et al., 2017; Hart et al., 2013). The diverse impacts of abandonment need to be addressed via a broader set of policy instruments to alleviate the negative effects or even – reverse the trends in the early stages of the process. In this context, for years the EU Common Agricultural Policy (CAP) has been providing financial support to farmers for the management of natural resources, biodiversity, sustainable farming, maintaining valuable landscape and helping rural areas to remain attractive, while responding to the public demand for sustainable agriculture in Europe (European Commission, 2009).

6.2 Data and methods

The following analysis provides an overview of agricultural land abandonment trends in the EU. In particular, the likely territorial patterns of land abandonment within the period 2015-2030 are analysed. The resulting outcome is an agricultural land abandonment indicator at national, regional (NUTS 3) and grid level for all EU Member States, which represents the share of abandoned agricultural land into the total agricultural land.

The modelling framework[31] (Annex 10.1) takes on board the main elements that drive an abandonment process:

- Non-market related: biophysical, agro-economic, demographic and geographic factors by regions. The integration of these endogenous components makes possible to build a European potential risk map of agricultural land abandonment at fine resolution (100 square metres pixel) throughout the simulation period (2015-2030).
- Market-related: Agricultural land demands projected up to 2030 from the 2016 CAPRI baseline projections[32] integrating the main policy, macro-economic and market assumptions. The measures of the latest 2014-2020 CAP reform are also covered.

The allocation of agricultural production systems is simulated according to the land claims specified at regional level by CAPRI. Along with the regional expectations of

[30] See, for instance, definition of abandoned agricultural land in Hart et al. (2013) referred to actual abandonment, semi-abandonment or hidden abandonment and transitional abandonment or Pointereau et al. (2008).

[31] In Jacobs-Crisioni et al. (2017) are described the technical improvements, scenario assumptions, data sets and models that are included in the LUISA Territorial Reference Scenario 2017.

[32] 2016 CAPRI baseline was provided by the EC-JRC Directorate Sustainable Resource, Economics of Agriculture Unit (JRC.D.04).

agricultural production systems, the LUISA Platform also endogenously simulates the areas of abandonment in accordance to the potential risk map while taking into account the market-related factors, the competition for land among agricultural activities and with other land uses (urban, industry, forest, etc.) at the same time. Consequently, the locations that are most likely to undergo abandonment processes of arable land, pastoral land and/or permanent cropland are identified. Throughout the simulation period (2015-2030) the abandoned agricultural land may either not change, or it may convert into other types of land use/cover in the subsequent time-step, depending on the land use/ cover utility optimisation, demography, accessibility, as well as other factors that are incorporated in the LUISA Platform.

The risk map of agricultural land abandonment is built by aggregating a set of factors (Table 2), and adapting several methods (Benayas et al., 2007; Pointereau et al., 2008; Confalonieri, et al., 2014; Terres et al., 2015; Lasanta et al., 2016), into three groups: 1) biophysical land suitability for general agricultural activities; 2) farm structure and agricultural viability, and 3) population and regional context.

Table 2: Main factors that drive agricultural land abandonment[33]

Biophysical land suitability	Farm structure and agricultural viability	Population and regional context
Length of growing period	Age of farmers	Low population density
Soil Organic matter	Farmer qualification	Remote areas
Soil texture	Farm size	
Root depth	Rent paid	
Soil pH	Rented UAA	
Salinity and sodic	Farm income	
Precipitation	Farm investment	
Soil drainage	Farm scheme (subsidies)	
Slope		

Each criterion corresponds to a spatial thematic layer or statistical information at NUTS 2/3 level from different European data sources (see Annex 10.3 – Table 5, Table 6 and Table 7). In the first group, soil, climate and terrain criteria[34] are used for classifying land according to its suitability for generic agricultural activity. Severe natural conditions are in line with the EU Regulation No 1305/2013 (European Union, 2013; Eliasson et al., 2010), Annex III "Biophysical criteria for delimitation of areas facing natural constraints", in order to be eligible for payments. In the second group, structural farm and agriculture information is used to reflect the stability, viability and performance for preventing farmland abandonment at regional (mostly NUTS 3) level. This information is mainly gathered from FADN[35] (Farm Accountancy Data Network) and EUROSTAT-FSS (Farm

[33] The rationale behind the selection of these driving factors and the cut-off values to be classified as severe natural conditions can be found in Eliasson et al., 2010; Confalonieri, et al., 2014; European Union, 2013.
[34] The spatial information related to these criteria are mainly gathered from IIASA (International Institute for Applied Systems Analysis), FAO (Food and Agricultural Organization of the United Nations), SINFO project (Soil Information System for the MARS Crop Yield Forecasting System), ESDB (European Soil Data base), EFSA (European Food Safety Authority, Spatial Data Version 1.1) and HWSD (Harmonized World Soil Database).
[35] The *Farm Accountancy Data Network* (FADN) is an instrument to evaluate the income of agricultural holdings and the impacts of the EU CAP. The concept of the FADN was launched in 1965, when Council Regulation 79/65 established the legal basis for the organization of the network. It consists of an annual survey carried out by the EU Member States. The services responsible in the EU for the operation of the FADN 3/94 collect every year accountancy data from a sample of the agricultural holdings in the EU. Derived from national surveys, the FADN is the only source of microeconomic data that is harmonized, i.e. the bookkeeping principles are the same in all countries.

Structure Survey)[36]. The last group of population and regional factors is particularly dependent on the dynamic character of the LUISA modelling method at grid level. Two main variables are used to identify places where agricultural abandonment is more likely to occur – very low population density areas and remote areas. Areas with population density below 50 inhabitants / km2 are considered as very low density areas (Terres et al., 2015). For each cell, the modelling mechanism counts the allocated residents within the surrounding kernel of (approximately) 1 km^2. Remote areas are identified those which are more than 60 minutes driving away from the closest city or town (Dijkstra L. and Poelman H., 2008) – Annex 10.5.

Plotting together the three maps (one for each of the above groups – Annex 10.4, Figure 30, Figure 31 and Figure 32) allows building a comprehensive potential risk map of agricultural land abandonment in the EU within 2015-2030[37]. The spatial aggregation is made by using a weighted linear addition (WLA). There biophysical factors have been assigned the highest weights following the assumption that abandonment could be initially triggered by primary drivers related to remote and mountain regions, as well as unfavourable soil and climate conditions for agriculture.

6.3 Results

6.3.1 European potential risk map of agricultural land abandonment

Figure 18 aggregates the potential risk of agricultural land abandonment in 2030, while Figure 19 displays it at grid level. The risk is estimated only for areas where the land use is agriculture, i.e. arable farming (including rice), livestock grazing, mixed crop-livestock and permanent crops.

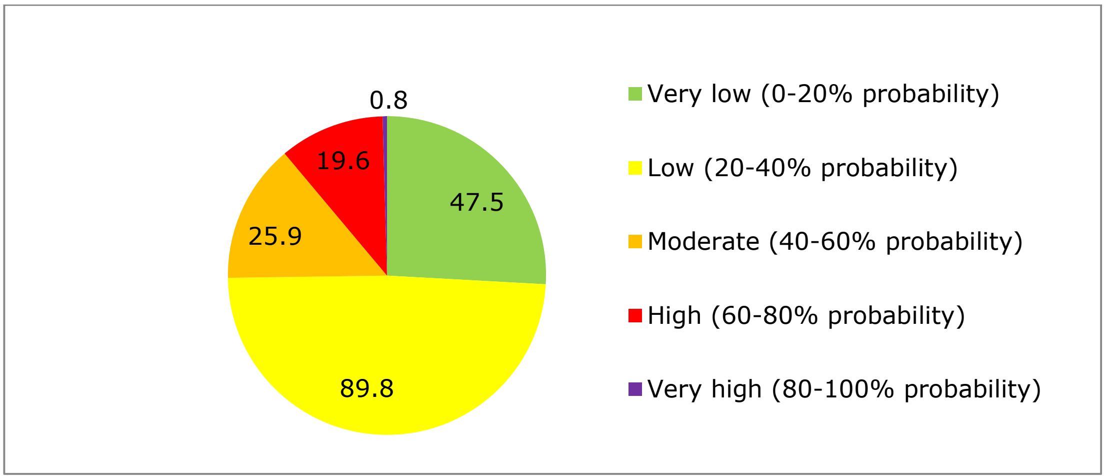


Figure 18: Potential risk of agricultural land abandonment in the EU in 2030, million ha

In 2030 the very large majority of EU agricultural land is projected to be under very low (around 1/4 of all) and low (about 1/2, being the largest category) risk of abandonment. From the remaining 1/4, more than half (14% of all) is estimated to be under moderate risk of abandonment. This, however, still leaves around 11% of EU's agricultural land under high (19.6 million ha, 10.7%) and very high (800,000 ha, 0.4%) potential risk of

[36] *Farm Structure Survey* (FSS) covers all agricultural holdings with an UAA of at least one hectare or using market production as a threshold. The main purpose of FSS is to obtain reliable data, at regular timing intervals (two / three years), on the structure of agricultural holdings in the EU, in particular about land use, livestock and labour force. It was conducted for the first time in 1966-67. Approximately every ten years the FSS is performed in the form of agricultural census at more detailed geographical levels. The EU Member States transmit individual (micro) data to Eurostat, where these are stored in the Eurofarm database. The legal basis for the FSS is regulation (EC) No1166/2008 of 19 November 2008.
[37] In five-year time-steps

abandonment respectively, primarily in Romania, Estonia, Latvia, Poland, Cyprus, Spain, Portugal, France, Ireland and Denmark. Altogether, those findings mean that although the potential risk of agricultural land abandonment is relatively modest at EU level, it may be quite severe in some EU Member States and in particular (as shown in Figure 19) in some of their regions, e.g. Southern and Eastern Romania, Southern and central Spain, Southwestern France, etc.

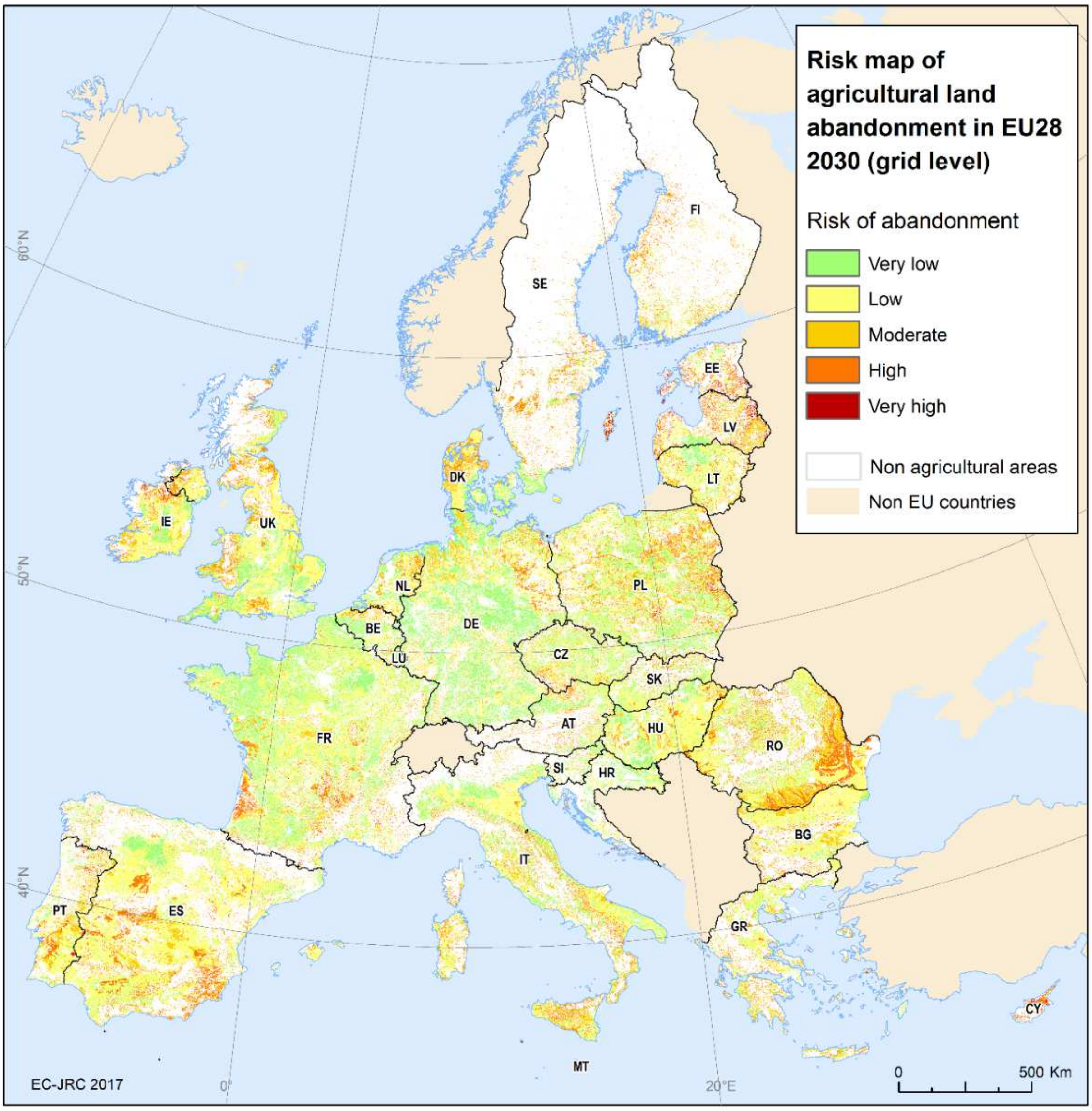


Figure 19: Estimated potential risk of agricultural land abandonment in 2030 at grid level (100-metres resolution) in the EU

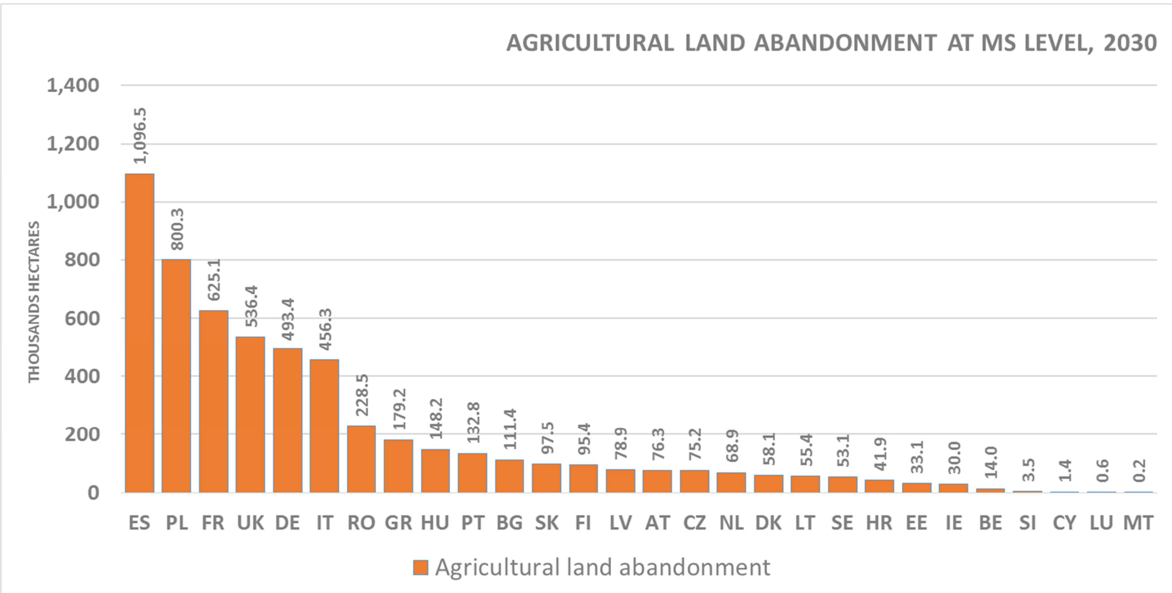
The land abandonment risk in various regions is driven by different factors. The biophysical component is the leading one in large parts of Austria, Poland, Greece, Spain, Estonia and Latvia, northern parts of Sweden, Finland, Italy, Ireland and the United Kingdom, as well as in the southern parts of France and Bulgaria. It is mainly due to mountain ranges, such as the Apennines, Pyrenees, Alps, Dolomites, Carpathians, French Central Massif, Iberian and Cantabrian mountains which provide unfavourable terrain and climate conditions. Considerable abandonment risk due to climate limitations is mostly found in the Mediterranean countries where soils suffer from drought (Greece, Italy, Spain), but also in the United Kingdom and Scandinavia (due to acidic and waterlogged soils). In the inner part of Spain, the middle and northern areas of Sweden, Finland and

Ireland, the northern and eastern parts of Romania, and partially in the Baltic States, Hungary and Cyprus, the elevated agricultural abandonment risk is mainly associated with remoteness and low population densities. Economic and structural farm factors are likely to be the primary cause for the increased agricultural abandonment risk in many regions of Spain; the north of France, Greece and Italy; the central and northern parts of Sweden and Finland; Eastern Bulgaria, as well as in the Baltic States and Hungary.

6.3.2 Projected agricultural land abandonment within 2015-2030

In the period 2015-2030 the incremental agricultural land abandonment in EU-28 is projected to reach around 4.2 million ha i.e. about 280 thousand ha per year on average. This will bring the total abandoned agricultural land to roughly 5.6 million ha[38], equal to approximately 3%[39] of the total agricultural land (183.6 million ha) in 2030. This would be an alarming trend, considering that the decrease of EU agricultural land over the same period of time is estimated to about 1% only, i.e. a difference by factor of three. Arable land is by far the dominant type of agricultural land in the EU and consequently, it will also account for the largest share of abandonment. More than 70% of the total EU abandonment in 2030 will be arable land (4 million ha), followed by pastoral land with more than 20% (1.2 million ha) and permanent crops with approximately 7% (400 thousand ha). Almost a quarter (≈1.38 million ha) of all agricultural abandonment in the EU will most likely occur in mountainous areas[40] where arable land would be again the most affected agriculture system (974 thousand ha, i.e. 70% of all mountainous abandonment) due to, among others, natural handicaps and challenging mechanisation.

Figure 20 presents the absolute (in thousand hectares) and relative (as share of total UAA) agricultural land abandonment between 2015 and 2030 per EU Member States, while Figure 21 shows a detailed map of the projected agricultural land abandonment (in black colour) in the EU over the same period of time. Figure 20 and Figure 21 reveal that Spain and Poland are likely to face both the greatest absolute and relative (about 1/3 of all EU) agricultural land abandonment, Spain being the only EU country under threat to lose more than 1 million ha (around 20% of all EU losses). Since the two countries were



38 Taking into account 1.4 million ha that were already abandoned by 2015.

39 This estimate is close to other similar projections, e.g. Lasanta et al. (2016), where the farmland abandonment under the most likely scenario ranges 3-4% by 2030. In a more extreme scenario, with lack of public support (e.g. CAP) for extensive farming and tough global competition among agricultural commodities, the rate of farmland abandonment may reach 7%.

40 Mountain areas have been spatially identified using the Less-Favoured Areas (LFA) classification map, corresponding to the class named "Totally mountain/hill areas" from the Spatial Dataset 2000-2006 based on GISCO Communes - Version 2.4.

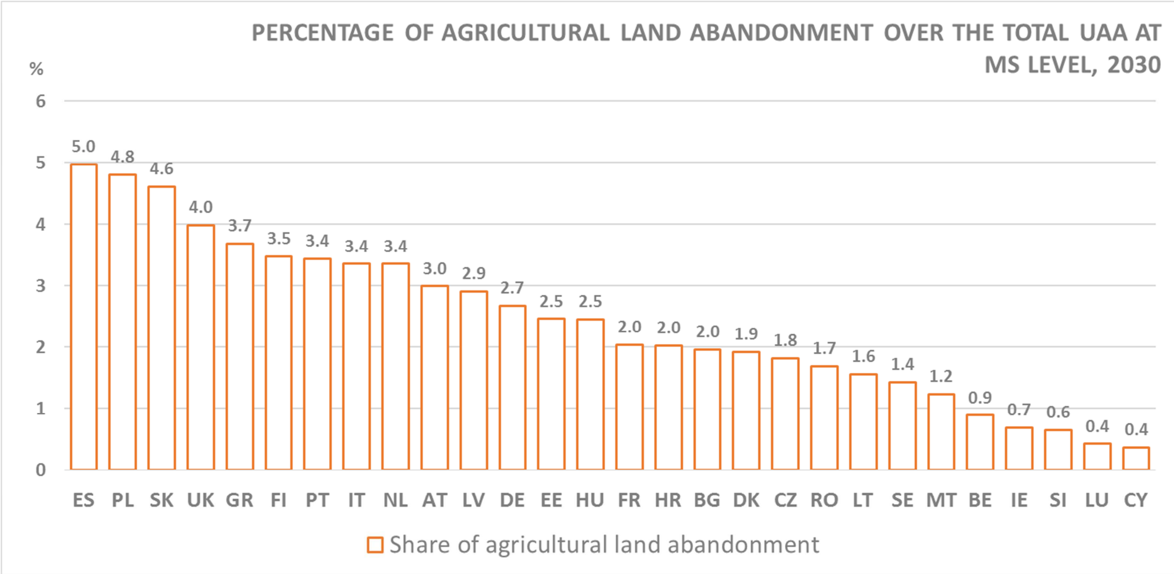


Figure 20: Absolute (top) and relative (bottom) agricultural land abandonment between 2015 and 2030 by EU Member States

also amongst the ones with the highest potential risk of land abandonment (Figure 19), this means that various economic and market instruments are likely to have little impact on the agricultural land abandonment. On the other hand, economic and market factors may largely mitigate the high potential risk in Estonia, Latvia, Romania and Cyprus. In terms of absolute figures, France, the United Kingdom, Germany and Italy complement Spain and Poland in the group of the largest agricultural land abandonment[41], altogether responsible for more than 70% of all EU losses. Owing to the vast total agricultural land, the relative shrinkage will be less pronounced in Germany and specifically in France, both countries being projected to rank below the average EU forecast of 3%. Conversely, due to relatively smaller total agricultural land, the Netherlands, Portugal, Finland, Greece and especially Slovakia (4.6% loss) are expected to be above the 3% EU average. With regard to the agricultural land abandonment at fine grid level (Figure 21) spatial patterns can be distinguished across Spain and Poland, Northern Portugal, South-eastern France, Southern Apennines, the Italian islands of Sardinia and Sicily, North-eastern Hungary, Central Romania, etc.

The diversity of landscapes and hence, the spatial patterns of agricultural production and land abandonment vary considerably among EU Member States (Figure 22). At least 80% of the expected abandonment will consist of arable land in Bulgaria, Cyprus, Denmark, Finland, Hungary, Lithuania and Slovakia. Over half of the abandonment is likely to be pastures in Ireland, the United Kingdom, the Netherlands and especially – Luxembourg, where the rate will exceed 90%. Permanent crops will account for a significant, albeit not dominant share in agricultural land abandonment in Southern Europe – Greece, Italy, Spain and Portugal.

Looking at regional level, Figure 23 presents the projected abandoned agricultural land as share of total agricultural land at NUTS 3 level in the EU within the period 2015-2030. It confirms that Spain is expected to face the biggest challenges in the EU, especially in its North / Northwest, where Lugo (ES112) will be affected the most, with almost 80 thousand ha of abandoned land. Other regions in Southern Europe, which are likely to see significant land abandonment, are identified in Northern Portugal[42], South-eastern

[41] The next one (seventh) in descending order, Romania, is to lose two times less land than the sixth, Italy.
[42] With the highest absolute loss of more than 27 thousand ha expected in Terras de Trás-os-Montes (PT11E).

Figure 21: Estimated agricultural land abandonment in 2030 at grid level (100^2 metres) resolution

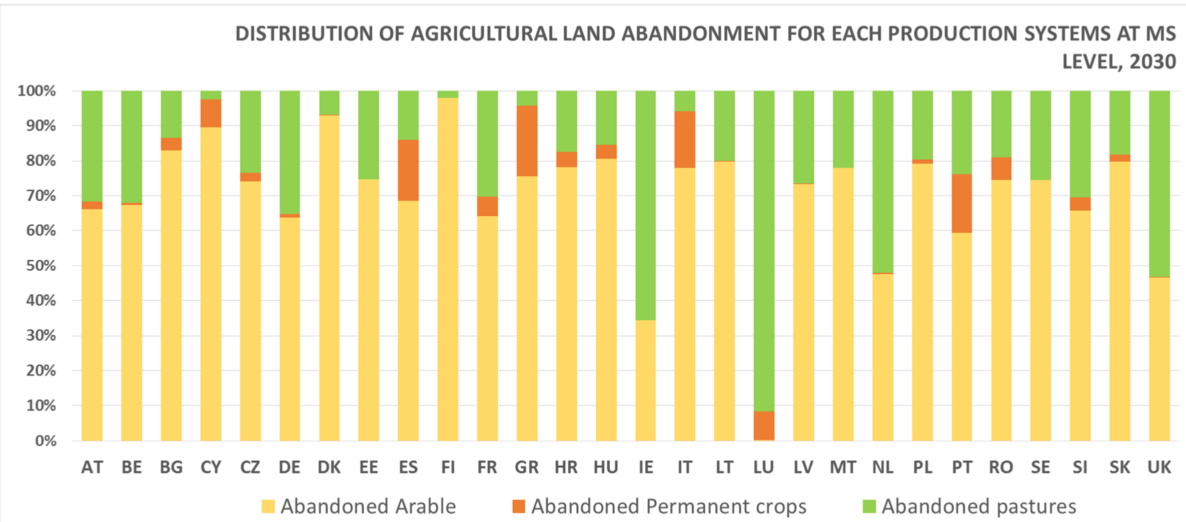


Figure 22: Breakdown of agricultural land abandonment per EU Member States within 2015-2030

France[43], Sardinia[44] in Italy, and Greece – Korinthia (EL652) on the Peloponnese peninsula and the island of Lefkada (EL624). In Central and Northern Europe, substantial agricultural land abandonment is projected for Northern Hungary (Nógrád County, HU313), South-eastern Poland, where the largest absolute EU-wide loss of more than 85 thousand ha at NUTS 3 is computed for the Chelmsko-zamojski region (PL312) in Lublin Voivodeship[45], few NUTS 3 in Western Germany, as well as in the central and far-North parts of the United Kingdom. Single regions in Western Austria (Insbruck, AT332) and Southern Netherlands (South Limburg, NL423) are also expected to undergo a significant (more than 30%) agricultural land abandonment, which trend is not likely to spread onto the surrounding regions.

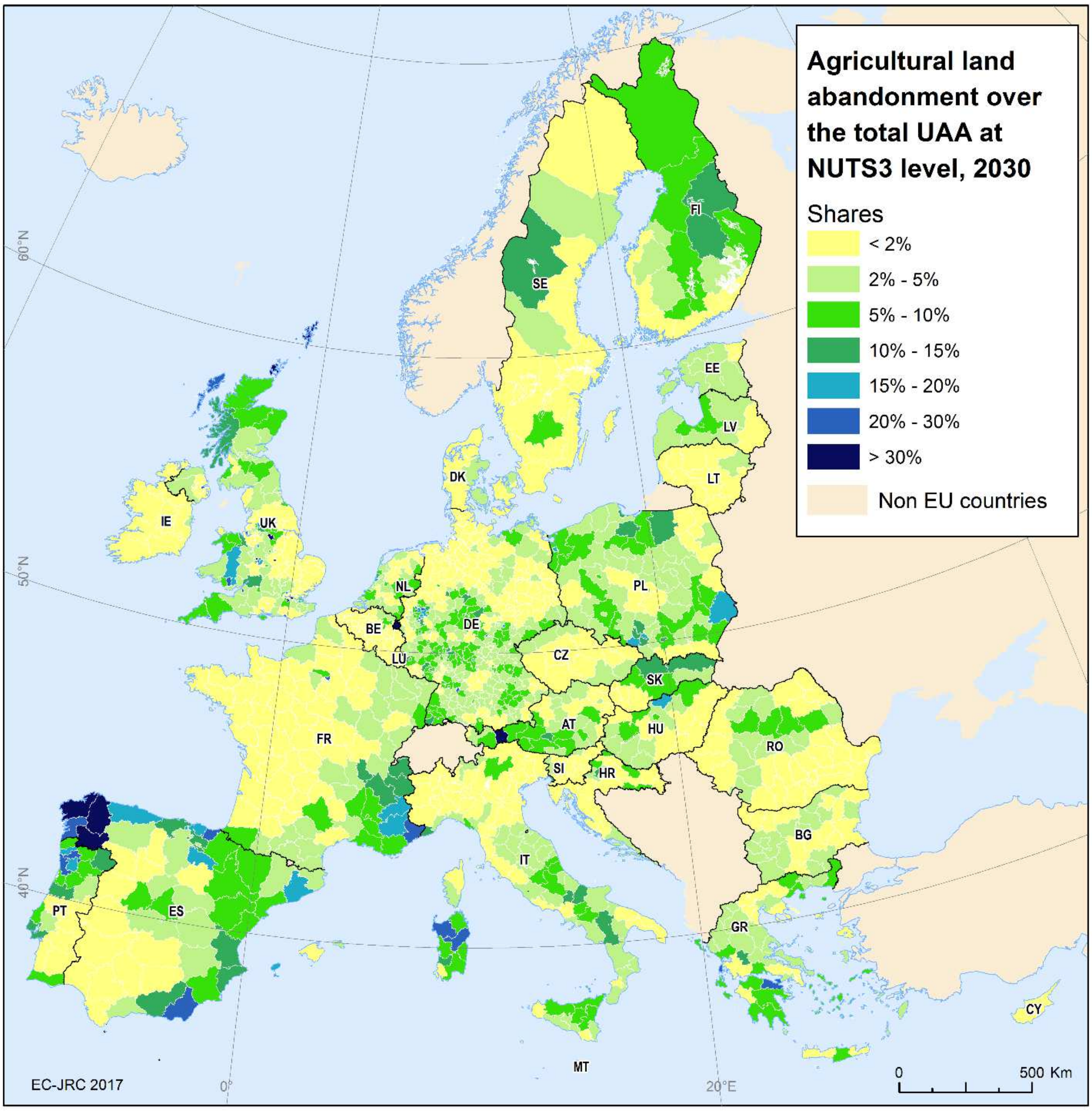


Figure 23: Shares of agricultural land abandonment with regard to the total agricultural land aggregated at NUTS 3 level in 2030

[43] The largest loss of about 33 thousand ha is, however, projected for Aveyron (FR622) in Southern France.
[44] Projected about 48 thousand ha for Sassari (ITG25) and 35 thousand ha – for Nuoro (ITG26)
[45] Another region where significant loss of almost 53 thousand ha is projected is the Olsztynski one (PL622) of the Warmian-Masurian Voivodeship in Southern Poland.

As examples for detailed assessment of agricultural land abandonment al local level, two zones – Murcia in Spain and Karditsa in Greece (Figure 24) – have been zoomed.

a)

b)

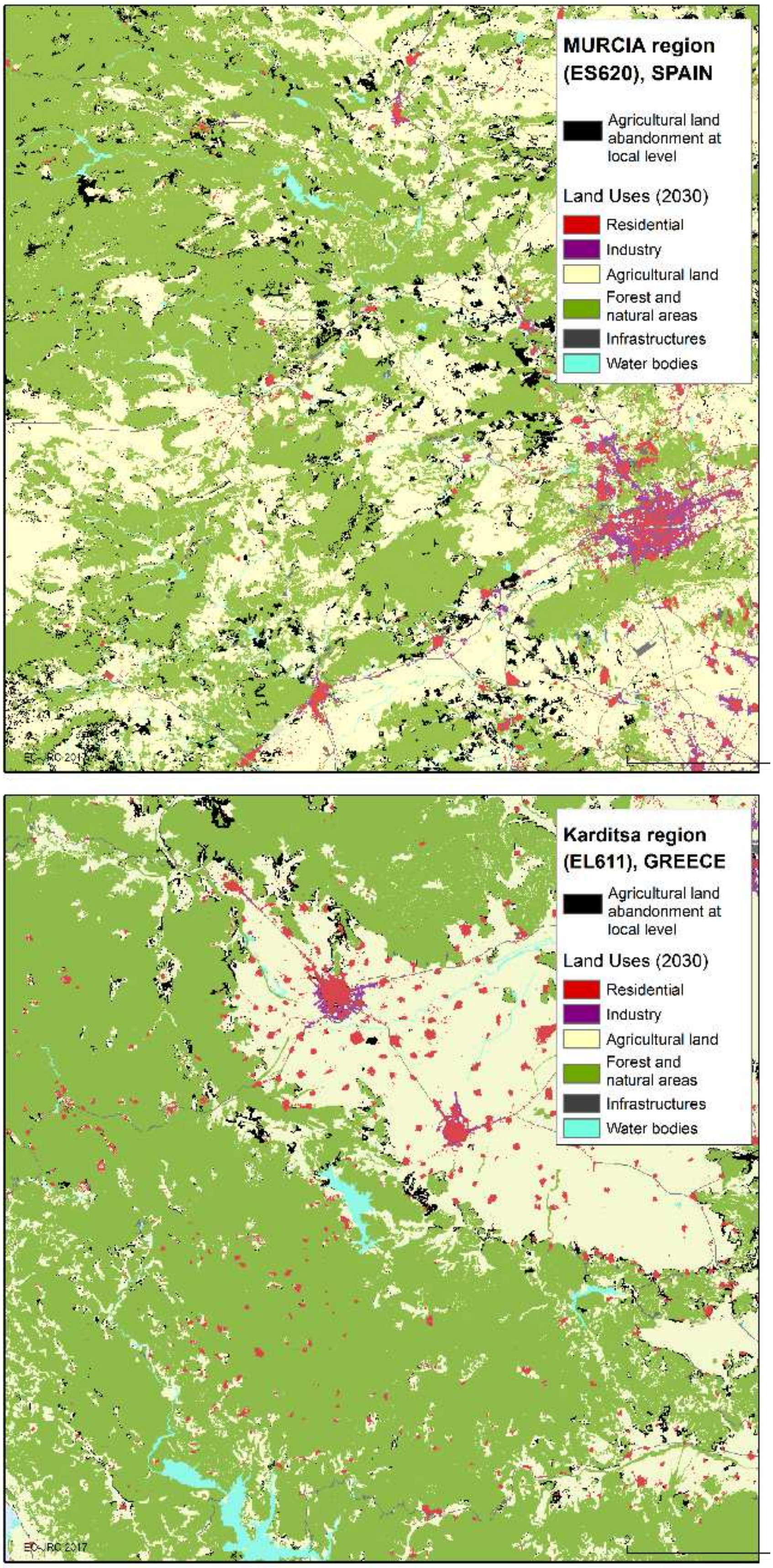


Figure 24: Land abandonment at local level in: a) Murcia region in Spain and d) Karditsa region in Greece. The black polygons represent abandonment overlapping other land uses.

Fruit trees dominate agricultural land in the North-western part of Murcia (Figure 24a). Permanent crops are, thereby, the most common agricultural land affected by abandonment. Arable land is, however, also abandoned close to the urban areas – the cities/towns of Cieza, Archena, Calasparra and Murcia. This phenomenon might be related to planned urbanisation processes on surrounding spare land. The western part falls into the "remote area" class. The mountain areas are also classified as being under elevated risk of abandonment due to natural constraints. Other factors that increase the land abandonment risk are the high salinity concentration in some areas and the low annual precipitation (dry areas).

In Karditsa region (Figure 24b), agricultural land abandonment is mainly composed of arable land and some patches of permanent crops (vineyards). These areas have moderate stability and viability for preventing farmland abandonment according to the economic and structural farm variables. Accessibility is also impeded because the region is partially remote and mountainous, surrounded by dense forests. Steep slopes (above 15%-30%), heavy clay texture and short cultivation period are other biophysical factors that boost the land abandonment risk.

6.3.3 Conversion dynamics of land abandonment

On the next step, the analysis of the likely evolution of agricultural land abandonment is further refined by looking at the conversion dynamics of abandonment (Figure 25) by applying the method of land-use/cover flows[46], which focuses on aggregated land conversions "from" or "to" abandoned agricultural land. Figure 25 clearly reveals that the conversion from agricultural land into abandoned land will be by far the most frequent transformation, reaching about 5 million ha or 2.7% of the total agricultural land. The opposite transformation, i.e. abandoned land converting into various types of agricultural land, will amount to 200 thousand ha (0.11% of abandoned land) only. This leaves a net conversion of about 4.8 million ha as loss of agriculture land. The transformation of abandoned land into forest and natural areas is projected to be much larger and hence, the net balance will be far better – almost 600 thousand ha, equal to more than 10% of recuperation. The creation of new built-up areas is likely to be much less important, recovering just 18 thousand ha (about 0.3%) of abandoned agricultural land in the EU between 2015 and 2030.

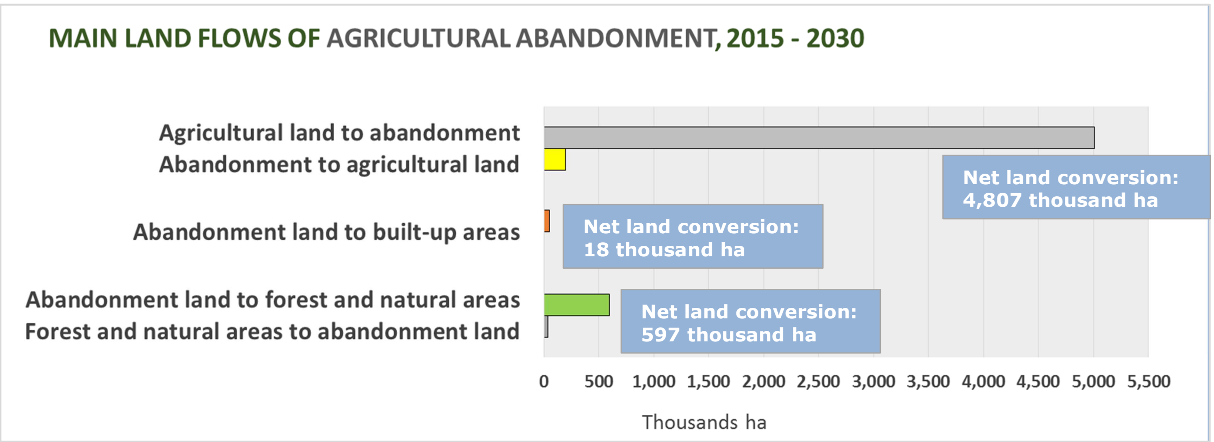


Figure 25: Conversion dynamics of agricultural land abandonment in the EU within 2015-2030

[46] The approach of land-use/cover flows is based on the methodology presented by the European Environmental Agency for 'Land Accounts for Europe' (EEA, 2006). It was adapted to the LUISA framework (for a detailed description of the method see Barbosa et al., 2015).

7 Agriculture-driven socio-economic and demographic clusters in the EU

In an attempt to integrate the already analysed topics (rural population, employment and GVA in primary sector, agricultural land and agricultural land abandonment) into a single analytical framework, this chapter proposes an agricultural and rural-related clustering at national and regional (NUTS 3) level in the EU by 2015. The aim is to sketch distinct socio-economic and demographic profiles, taking into account relevant territorial patterns and characteristics, with particular focus on the EU rural areas[47]. Specific statistical techniques (see Annex 10.6 for a more detailed description) are applied to offer comparability amongst countries and regions.

7.1 The national perspective

The EU Member States have similar, but also different socio-economic, demographic, landscape and climate characteristics, which characteristics drive the evolution of their agricultural sectors. Based on the similarities, five groups of countries (clusters) have been statistically identified according to the five rural indicators that have been already discussed in the previous chapters – Figure 26 and Table 3.

National Cluster 1: Low (actually – the lowest) rural population share and moderate (but well below the EU average) values for employment, GVA and agricultural land abandonment, as well as moderate (but above the EU average) agricultural land. This cluster includes the highly developed and industrialised Northern-Southern strip, consisting of the United Kingdom, Germany, the Netherlands, Belgium and Italy, as well as the Southern group of small countries, containing Malta and Cyprus. The relatively lower importance of primary sector is because other, secondary and/or tertiary sectors (industry, various services, tourism, etc.) dominate the national economic performance. Within the cluster, Italy is the only country where the employment and GVA shares of primary sector are close to the EU average. The comparatively elevated share of agricultural land (e.g. almost 60% in the Netherlands), coupled with relatively lower land abandonment and definitely low share of rural population (e.g. 7% in the Netherlands and 13% in Belgium) indicate good agricultural land management and high efficiency of primary sector. Within the cluster, land abandonment due to less suitable landscape and climatic factors, represents an issue in Italy (mostly around the Apennines) and in the United Kingdom (Northern parts), but still the values are close to the EU average.

National Cluster 2: Moderate (but above the EU average) share of rural population with high employment in agriculture and moderate (but well above the EU average) GVA, coupled with around the EU average agricultural land and high (actually – the highest) land abandonment. The countries in this cluster include the Mediterranean strip of Portugal, Spain, Croatia and Greece, as well as the Central European strip of Hungary, Slovakia, Poland and Latvia. The relative economic importance of primary sector in the national economic structure of Cluster 2 members is much higher than in Cluster 1. On the other hand, the efficiency of primary sector seems to be lower, which could be due to certain socio-economic specifics such as the still ongoing recovery from the 2008-2009 financial and economic crises. This lower efficiency, coupled with some landscape and climatic restrictions (e.g. droughts in Central and Southern Spain), delineates land abandonment as an essential challenge. Besides these overall trends, some important particularities of the countries in the cluster are observed. In Portugal, Greece and Poland the employment in agriculture is two times the EU average, while Croatia, Hungary and Latvia have rather elevated GVA contribution of primary sector.

National Cluster 3: Moderate (but well below the EU average) economic performance of primary sector in terms of employment and GVA, with moderate (but above the average)

[47] City regions are excluded, only rural regions and towns & suburbs are analysed (80% of all NUTS 3)

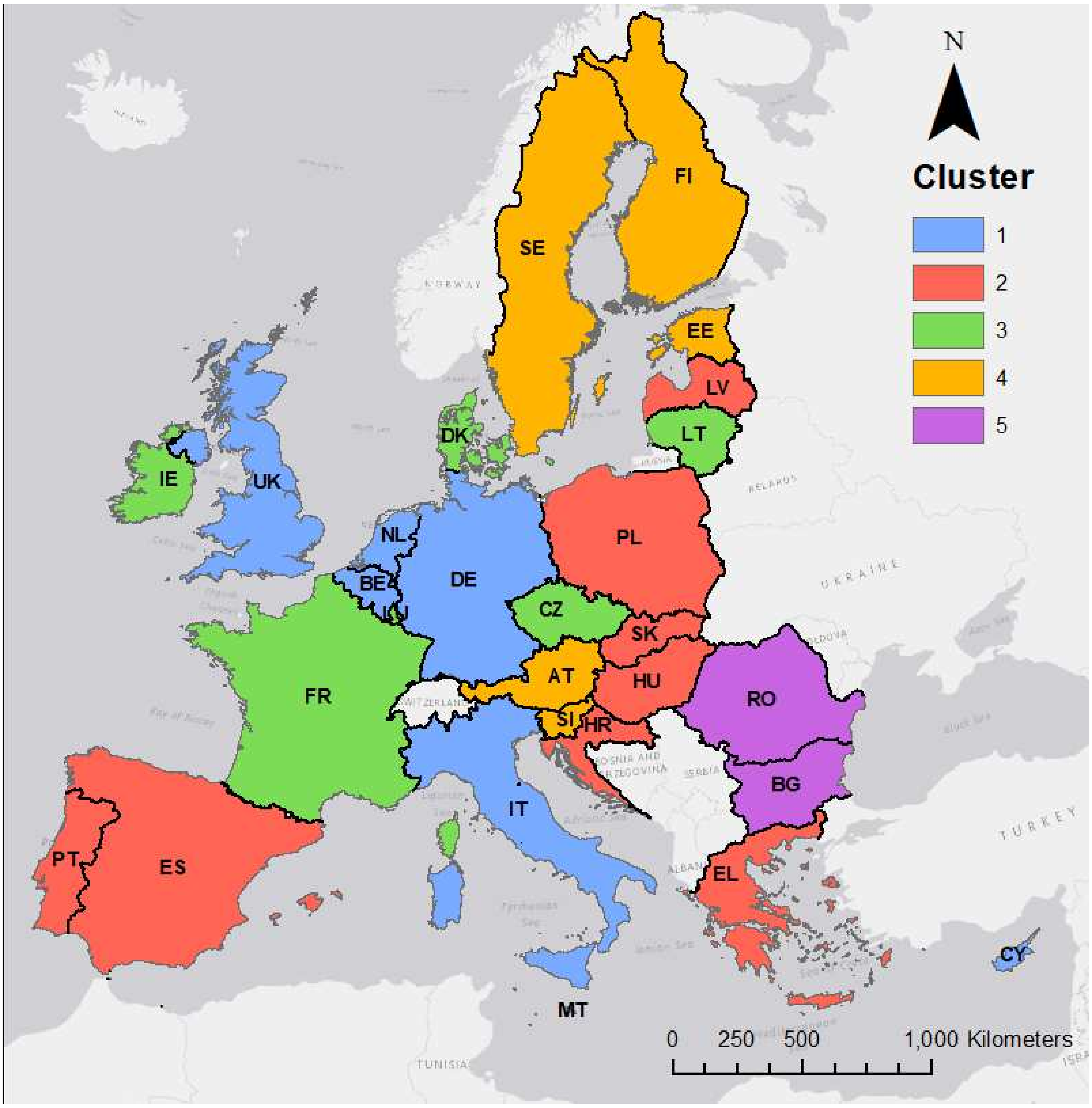


Figure 26: Agriculture-related clustering of EU Member States based on rural population, employment and GVA in primary sector, agricultural land and land abandonment in 2015

Table 3: Simplified characterisation of the EU agriculture-driven clusters at national (NUTS 0) level in 2015 based on the statistical aggregation of the five assessed indicators (Annex 10.6), as deviation from the respective median and average values

Situation 2015	Rural population	Employment in agriculture	GVA primary sector	Share of agricultural land	Agricultural land abandonment
Cluster 1	Low	Moderate	Moderate	Moderate	Moderate
Cluster 2	Moderate	High	Moderate	Moderate	High
Cluster 3	Moderate	Moderate	Moderate	High	Moderate
Cluster 4	High	Moderate	Moderate	Very Low	Moderate
Cluster 5	High	Very high	Very high	Moderate	Moderate

rural population, high (actually – the highest) share of agricultural land and moderate (but well below the EU average and actually – the lowest) land abandonment. Unlike the previous two clusters, the members of this group – Ireland, France, Luxembourg, Denmark, Czech Republic and Lithuania[48] – are scattered across the EU, i.e. no clear cross-border effects (strips) can be identified[49]. Cluster 3 resembles very much Cluster 1, especially with regard to economic performance (employment and GVA contribution) of primary sector and land abandonment. The main differences are the higher share of agricultural land[50] and the much larger rural population[51] in Cluster 3. These observations suggest that Cluster 3 is (similarly to Cluster 1) populated by highly developed countries, but with superior weight of agriculture owing to a set of inter-related socio-economic, landscape and climatic advantages. Thanks to those advantages, the land abandonment in Cluster 3 is slightly lower than the one in Cluster 1. As regards the performance of Cluster 3 versus Cluster 2, the share of rural population is the only indicator where the two clusters demonstrate similar behaviour.

National Cluster 4: High (actually – the highest) share of rural population, moderate (but below the EU average) employment in primary sector, very low (in fact – the lowest) share of agricultural land, and values of land abandonment and GVA of primary sector around the EU average. The very low share of agricultural land in the five countries from Cluster 4 is due to objective limitations – mountainous landscape (Austria and Slovenia) and/or cold climate (Estonia, Finland and Sweden). The moderate values of employment, GVA and land abandonment, standing virtually at the EU average, however indicate efficient and effective agriculture management practices, despite the generally adverse conditions. Those observations, combined with the high shares of rural population (41% in Slovenia, 37% in Austria, 36% in Estonia), imply that rural areas in those countries are well diversified towards other, non-agriculture related activities and sectors. Land abandonment exceeds the EU average in Finland due to unfavourable climatic conditions.

National Cluster 5: High share of rural population, very high (indeed – the highest) importance of primary sector in terms of employment and GVA, and moderate levels of agricultural land (but well above the EU average) and land abandonment (but below the EU average). This, in fact South-eastern cluster comprises just Bulgaria and Romania. The two countries are relatively less economically developed in the EU, but they are also traditional agricultural producers owing to favourable socio-economic, landscape and climatic conditions. Consequently, rural population accounts for almost 32% in Bulgaria and around 41% in Romania, while agriculture occupies more than 50% of total land in both countries. Land abandonment is lower in Romania than in Bulgaria. Juxtaposed to the other clusters, Cluster 5 resembles the most Cluster 3 in terms of rural population, agricultural land and land abandonment trends, while the main difference is in the much higher importance of primary sector in Cluster 5.

7.2 The regional perspective

Similarly to the statistical analysis of the agriculture-driven clusters at national (NUTS 0) level in the EU in 2015 (Figure 26 and Table 3), Figure 27 and Table 4 present the same type of analysis at regional (NUTS 3) level for 2015[52]. To alleviate comparisons between regional and national trends, the national map from Figure 26 is embedded (top left) in the regional map from Figure 27. The colour coding of regional clusters, corresponding to certain sets of characteristics, has been maintained as close as possible to the colour coding of national clusters, with the respective (as) similar (as possible) properties. As already indicated at the start of this chapter, the white NUTS 3 indicate highly urbanised (capital / city) regions where the current analysis is not relevant.

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[48] In the statistical analysis Lithuania comes very close to the borderline with Cluster 2, i.e. Lithuania has indeed quite some similarities with neighbour Poland and Latvia.
[49] The only cross-border link is between France and Luxembourg, but given the small size of the latter, any potential inter-relations would have rather limited impact over the performance of the whole cluster.
[50] Denmark and Ireland have the largest shares of agricultural land EU-wide - 70% and 63%, respectively.
[51] Exceeding 30% in all members of Cluster 3, peaking nearly 57% in Ireland
[52] Again, Annex 10.6 provides the precise statistical results (boxplots).

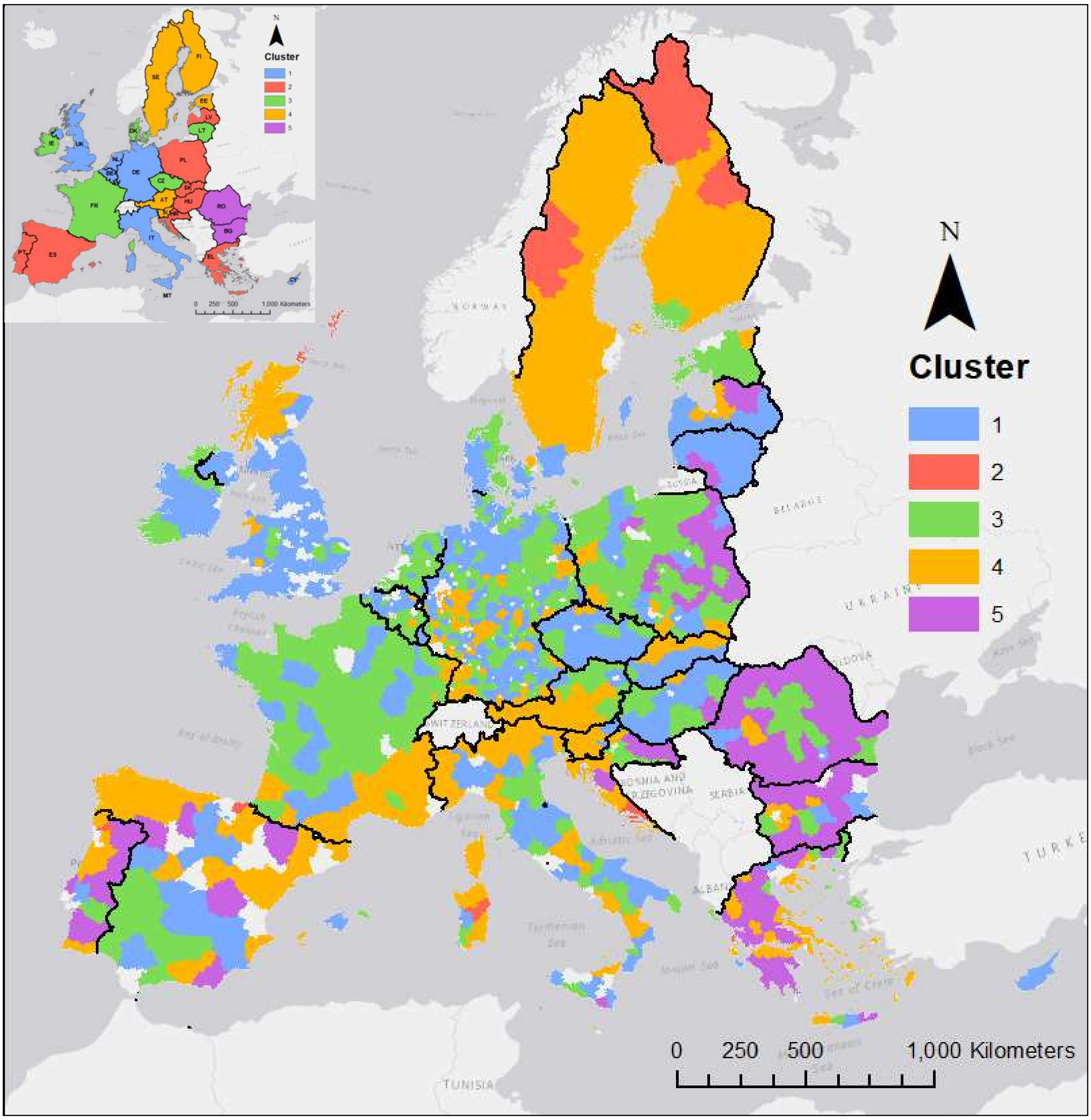

Figure 27: Agriculture-related clustering at regional (NUTS 3) level in the EU based on rural population, employment and GVA in primary sector, agricultural land and land abandonment in 2015, juxtaposed to the national (NUTS 0) level (top left)

Table 4: Simplified characterisation of the EU agriculture-driven clusters at regional (NUTS 3) level in 2015 based on the statistical aggregation of the five assessed indicators (Annex 10.6), as deviation from the respective median and average values

Situation 2015	Rural population	Employment in agriculture	GVA primary sector	Share of agricultural land	Agricultural land abandonment
Cluster 1	Moderate	Moderate	Moderate	Moderate	Moderate
Cluster 2	Moderate	Moderate	Moderate	Low	Very high
Cluster 3	High	Moderate	Moderate	Moderate	Moderate
Cluster 4	Moderate	Moderate	Moderate	Low	High
Cluster 5	Moderate	Very high	Very high	Moderate	Moderate

The comparison between the national and regional spatial distribution of clusters reveals significant differences and a much more dispersed and diversified picture without clear geographical patterns at regional level. The Mediterranean strip of countries – Portugal, Spain, Italy and Greece – has regions in all five clusters, while Bulgaria, Croatia, Germany, Hungary, Poland, Romania and the United Kingdom – in four. Large differences are observed even over relatively small and/or neighbour territories. For example, the islands of Sardinia, Sicily and Crete host four clusters simultaneously, while the three Balearic Islands are members of three different clusters.

Regional Cluster 1 has all five parameters within the Moderate range, nonetheless only agricultural land is above the EU average (and actually the highest amongst all clusters), while all other parameters are below the EU average, the rural population being the lowest amongst all clusters. Similarly to National Cluster 1, this cluster seems to mostly aggregate relatively advanced NUTS 3. Secondary and/or tertiary sectors may be more important for regional economy than primary sector, but agricultural practices are also well developed and efficient. The cluster is widely represented across the EU, especially in the United Kingdom, Central Ireland, Southern and Southwestern Denmark, Northern Germany, Lithuania, Southern Latvia, Czech Republic and Hungary, as well as (but to a lesser extent) in Spain, France, Northern Belgium, Southern Slovakia, etc. Two of the smallest EU member states – Luxembourg and Cyprus, are also in this cluster as whole countries. The cluster is not observed only in Finland, Estonia and Croatia.

Regional Cluster 2 appears to be the least performing amongst all clusters with regard to agriculture. The highest land abandonment, combined with the lowest agriculture land indicates serious challenges in regional primary sector, often due to landscape and/or climatic restrictions (e.g. in Northern United Kingdom, Sweden and Finland). The levels of employment and GVA around the EU average and the slightly higher than the EU average rural population suggest that regional economies are trying to adjust to the agronomic challenges by diversifying towards other activities, but still the land challenges persist. The good news is that this is the cluster with the lowest number of regions. Besides the three countries mentioned above, the Mediterranean strip of countries – Portugal, Spain, Italy, Croatia and Greece – and Germany have each one NUTS 3 in this cluster.

Identically to the national level analysis, **Regional Cluster 3** is quite similar to Regional Cluster 1, with the main distinction that rural population is the highest in the EU (in Cluster 1 it is the lowest). The employment and GVA in primary sector of Regional Cluster 3 is also somewhat higher than in Regional Cluster 1. Regional Cluster 3 therefore appears to aggregate relatively well developed NUTS 3 with higher weight of agriculture (owing to a set of inter-related socio-economic, landscape and climatic advantages) compared to the NUTS 3 in Regional Cluster 1, i.e. an overall picture that is similar to the comparison between National Cluster 3 and National Cluster 1. Likewise NUTS 3 from Regional Cluster 1, the NUTS 3 from Regional Cluster 3 are widely presented in the EU especially in Central and Northern France, the Netherlands, Eastern Germany, Northern and Western Poland, Estonia, but also in Southern and Southwestern Spain, Southern Belgium, Hungary, Central Romania, etc. Latvia, Lithuania, Sweden and Slovenia are the only larger[53] EU member states where Regional Cluster 3 is not observed.

Unlike National Cluster 4, which is well defined in geographical terms (in the Eastern Alps and Scandinavia), **Regional Cluster 4** is far more dispersed across the EU. It resembles to some extent Regional Cluster 2, but with better land parameters (especially for land abandonment), rural population below the EU average and one of the lowest levels of employment and GVA. Similarly to the analysis at national level, this cluster seems to be composed of NUTS 3 with rather limited potential for developing agriculture-related activities, such as vast North European areas in Finland and Sweden, Northern United Kingdom, Northern Estonia, as well as mountainous (mostly Alpine) zones in Austria, Slovenia, Italy, France and Germany. Many of the EU touristic hotspots also end up in this cluster – the North-western part of the Iberian peninsula (Portugal and Spain),

[53] As already stated, Luxembourg and Cyprus are part of Regional Cluster 1 as whole countries.

Algarve (Portugal), Granada (Spain), the whole Spanish-French-Italian Mediterranean strip (Riviera), the island of Corsica, the Gozo island of Malta, large coastal areas in Croatia, most Greek island, etc. Besides those areas, regions from Cluster 4 are also identified in Northern Slovakia, over the Czech-Polish, Polish-German and German-French borders, in Western Germany, etc.

The profile of **Regional Cluster 5** is basically analogous to the one of National Cluster 5, i.e. it comprises rural regions where agriculture is a traditional and key economic sector. Consequently, Romania and Bulgaria account for the largest areas in this cluster. Greece and Croatia complement the South-eastern contribution. Spain, Portugal and Poland also have quite a few NUTS 3 that are classified in Regional Cluster 5.

8 Concluding remarks and potential way forward

Over the last decades considerable efforts have been made to better analyse the EU rural areas due to their socio-economic importance. A substantial number of projects and studies (e.g. FARO-EEA, 2011; EURURALIS-Rienks, W.A., 2008; SEGIRA project, SERA project, EDORA - ESPON 2013 Programme; WWWforEurope-Camaioni et al., 2014) have been carried out on various aspects of rural world – changes and trends, rural typologies, driving forces, rural labour markets, environmental implications, policy interventions, CAP expenditure, etc. Apart from those studies, a vast scientific literature contributed to the enlarged knowledge of rural areas.

The work presented in this study represents a comprehensive analytical exercise on the socio-economic and demographic trends in EU rural regions. For the purpose of this analysis, a set of indicators has been shortlisted and consequently – developed to further extend the understanding of the situation by 2015 and the spatial trends within 2015-2030 in predominantly rural areas. These indicators were: rural population, employment and Gross Value Added in primary sector, agricultural land (and production systems) and agricultural land abandonment. Differences and disparities amongst regions (at NUTS 3 level) have been further highlighted and analysed.

The main tool that has been applied in the above assessment was the LUISA Territorial Modelling Platform (European Commissions – Joint Research Centre), and its latest 2017 Territorial Reference Scenario. LUISA is able to provide and explore scenarios of future territorial development in order to capture the direct and indirect impacts of EU policies in an integrated, spatially explicit manner. The assessment can, therefore, offer valuable qualitative and quantitative information, as well as provide useful insights about potential outcomes for rural areas across the EU.

Although dynamic spatial models (like LUISA) are helpful tools for supporting policy- and decision-making, they contain some objective limitations and uncertainties, such as: data availability and accessibility; thematic, spatial and temporal resolution; geographical coverage; sectorial distinction; preliminary assumptions; scientific methods; etc. Modelling dynamic indicators require, in particular, a set of spatially explicit and statistical data, whose availability and resolution are often quite limited and hence, insufficient for the specific goal of the assessment. Data harmonization is also an important pre-requisite to ensure consistency of model inputs and outputs. In this context, the NUTS 3 regional level has been identified as the minimum suitable scale to perform the current perspective territorial assessment. An important drawback has been identified in particular with regard to the employment and GVA data for primary sector. The absence of projections at regional level has resulted in necessary modifications in the applied method. Consequently, only a snapshot for 2015 could have been derived and no sound projections for the period 2015-2030 could have been developed. Additional efforts need to be invested to overcome these important limitations. Regionalisation strategies might be developed and implemented for downscaling employment and GVA from national macro-economic projections. The information on agricultural socio-economics and farm structures might also improve and refine in the future in terms of thematic, spatial and temporal coverage. A finer spatial resolution of input layers would enhance the final LUISA outcomes, too.

In terms of potential future work, the following topics could be considered:

- Integration of additional rural indicators such as: accessibility to transport and services, forest and natural vegetated areas, other economic sectors, etc.;
- Diversification of economic activities in rural areas;
- Rural-urban linkages, synergies and flows;
- Alternative scenarios to assess territorial impacts when/if no CAP mechanisms (Pillar I and Pillar II) are supporting the EU agriculture;
- Impact assessment of the so-addressed indicators in rural areas;

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10 Annexes

10.1 LUISA Territorial Modelling Platform – Reference Scenario 2017

LUISA is a pan-European modelling platform that provides alternative scenarios of territorial development in order to understand the impacts of EU policies in an integrated and spatially explicit framework. The current configuration, ***Territorial Reference Scenario 2017***, integrates the most recent and accuracy information, including past and future time series of socio-economic and environmental variables. It also intrinsically takes on boards existing European policies and legislation e.g. Common Agricultural Policy, Renewable energies, Trans-European Transport Network, EU Biodiversity strategies or protection of Nature2000 areas.

LUISA coherently links specialised macro-economic, demographic and geospatial models with other thematic spatial/statics databases in order to simulate the local allocation of land functions i.e. housing, manufacturing of goods and services, transport, food production or ecosystem services – Figure 28. Socio-economic, demographic and environmental direct and indirect impacts of EU policies are quantified, analysed and mapped at EU level throughout a simulation period. The model provides outcomes at local scale (100-metres resolution) or regional level with a temporal resolution of 5 years. Sectoral claims are allocated over the land according to their specific location, land suitability, restrictions of spatial policies, transition rules, etc. Claims are provided by a set of models that govern the starting stage of the projections and primarily based on DG ECFIN projections. Demographic projections rely on EUROPOP 2013 for the period 2015 – 2060 at national level. CAPRI model (Britz and Witzke, 2012) provides future agricultural land demands aiming at modelling changes in CAP policies (Common Agricultural Policy. Economic projections are derived from GEM-E3 and RHOMOLO model, while energy projections depend on JRC-EU-TIMES model.

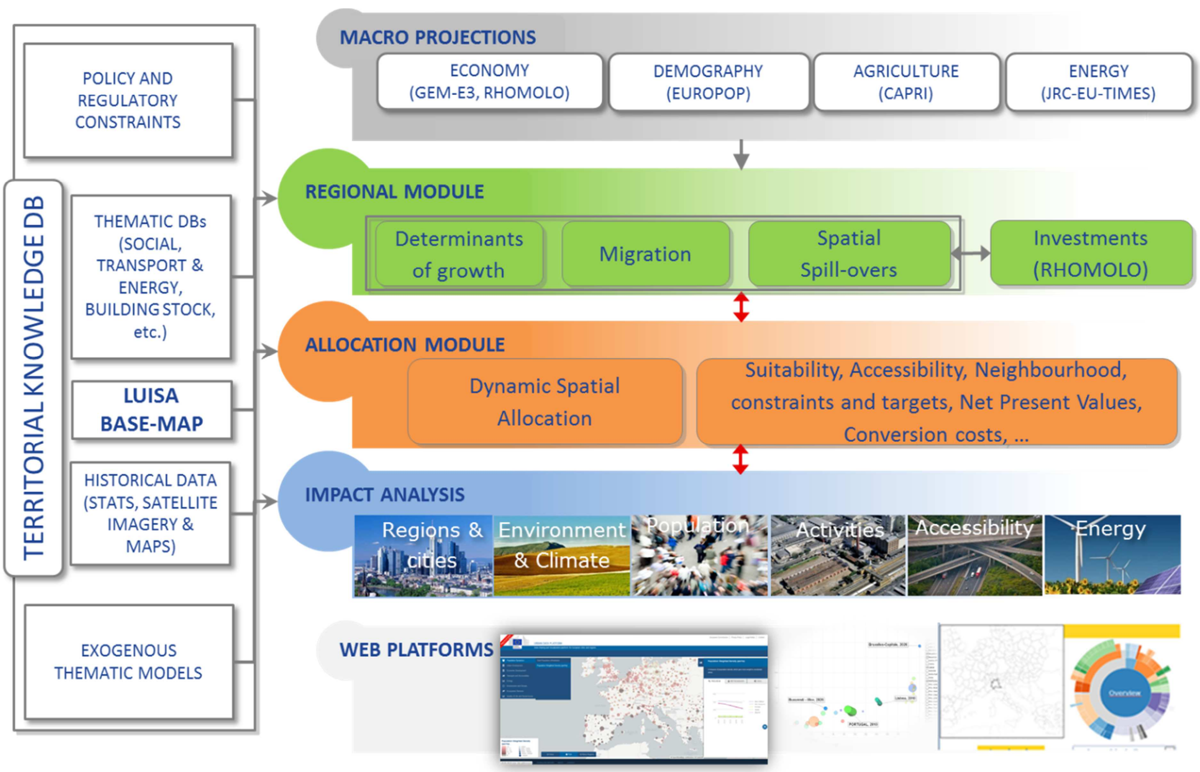


Figure 28: LUISA modelling framework. Main modular components and outputs

More information about LUISA application, key components, modular structure and methods can be found in Jacobs et al., (2017), Baranzelli et al., (2016) and Lavalle et al., (2017).

The complexity and diversity of rural areas leads to the need of integrating, in the same modelling framework, the maximum number of relevant sectors to provide a comprehensive analysis of territorial trends. The future of Europe's rural landscape depend on the combined effects of several and coincident (in time and space) developments like agriculture, urban and peri-urban developments, nature conservation, energy production, space for recreation or new infrastructures.

In this context, LUISA is able to transform independent macro-economic projection from different sectors into indicators as a key element to assess policy impacts. Indicators are used as main tools to represent specific (complex) topics in a simplified way but keeping the essence. The developed indicators in this study encompass the following thematic groups: demography, economic activity (mainly agriculture), accessibility and environmental aspects. A regional level of aggregation is used to represent and analyse the differences and disparities between regions, emphasizing on the situation of rural areas. From this analytical and quantitative assessment, a set of relevant questions can be answer:

— Is the rural population declining in a future scenario?
— Is the employment in primary sector at significantly higher risk in some rural regions compared to others?
— What is the contribution of the primary sector in rural regions?
— To what extent will the European territory be affected by agricultural land abandonment processes?
— Is agricultural land abandonment more pronounced in particular regions or areas? Consequently, are mountains and other remote areas more affected by abandonment processes?
— What are the main drivers of agricultural land abandonment within those affected regions?
— Which agriculture production systems (arable farming, livestock grazing or permanent crop) are more affected by land abandonment?
— Is the agricultural production increasing or decreasing across European regions? Which production systems are prevailing?

10.2 Degree of urbanization

The degree of urbanisation is a classification of different urbanisation typologies that has been used since 1991. The classification has evolved and continuously adjusted in terms of conceptual definition, methodologies, data availability, spatial, temporal and thematic resolution of data, etc. A new degree of urbanisation was defined in 2014[54] (Dijstkra and Poelman, 2014) where three types of urbanisation classes were identified based on a population grid of 1 km^2 according to a minimum population density threshold[55] (Eurostat, 2017a). This latest classification, based upon the 2011 population grid and the 2014 boundaries for local administrative units (LAUs), identifies cities (densely populated areas), towns and suburbs (intermediate density areas) and rural areas (thinly populated areas). Figure 29 presents the regional typology by degree of urbanisation aggregated at NUTS 3 level derived from the methodology developed in Dijstkra and Poelman (2014).

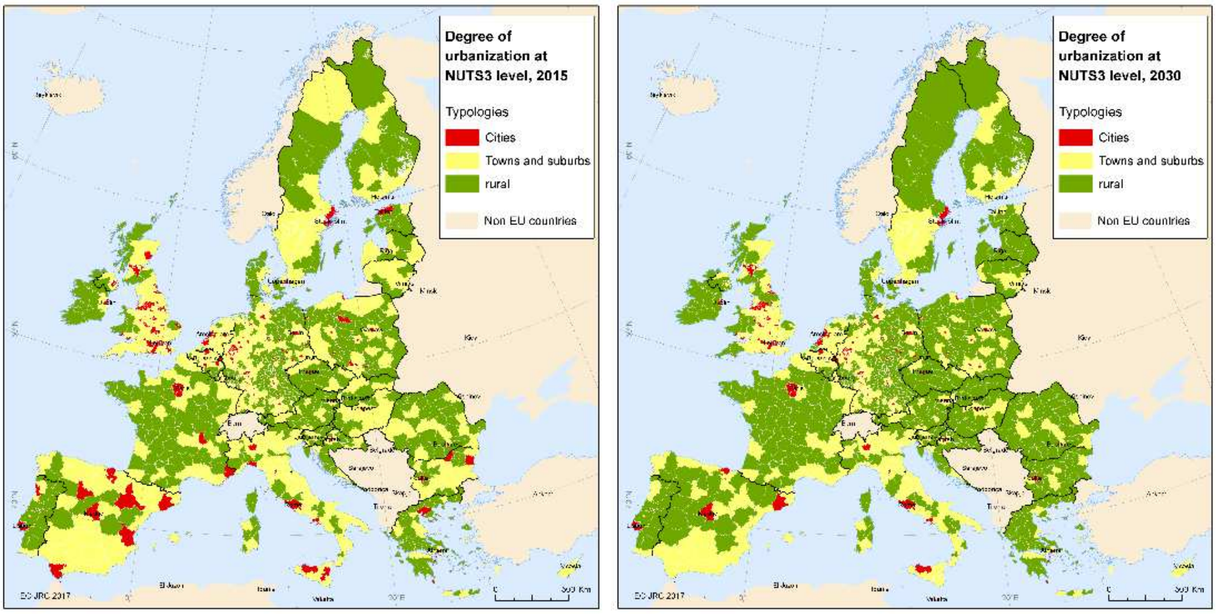


Figure 29: Spatial distribution of the three classes of urbanisation typologies (Cities, Towns & Suburbs and Rural regions) in 2015 (left) and in 2030 (right).

[54] In 2011, the European Commission Directorates-General for Regional and Urban Policy (DG REGIO) and Agriculture and Rural Development (DG AGRI), Eurostat and the Joint Research Centre (JRC), together with the OECD revised the degree of urbanisation classification based on a common methodological approach.

[55] *Cities* (densely populated areas), where at least 50 % of the population lives in urban centres; *Towns and suburbs* (intermediate density areas), where at least 50 % of the population lives in urban clusters and less than 50 % of the population lives in urban centres; *Rural areas* (thinly populated areas), where at least 50 % of the population lives in rural grid cells.

10.3 Data and information about the factors for agricultural land abandonment

Table 5: Selected biophysical criteria for identifying severe natural conditions for generic agricultural activities, their description and main reference

Biophysical land suitability factor	Description	Reference
Length of growing period	The number of days when the average daily temperature is above a certain temperature threshold. LGPt5 is selected, establishing 5°C as threshold. Spatial resolution: 8 km resolution.	IIASA/FAO[56] (2013)
Organic matter	Topsoil (0 – 30 cm) organic matter content. Spatial and temporal resolution: 1 km resolution; processed in 2012	Hiederer, R. (2012) based on ESDB and HWSD (IIASA/FAO/ISRIC/ISSCAS/JRC, 2012)
Soil drainage	It refers to the maintenance of the gaseous phase in soil pores by removal of water. Specifically, the oxygen availability to roots. This spatial layer is divided into seven classes, from excessively drained to very poorly drained soils. Imperfect, poor and very poorly drained soils are considered not favourable for crop growth. Spatial resolution: 1 km resolution.	SINFO project[57] (European Commission, 2013) which is based on ESDB[58]
Precipitation	The total mean annual precipitation is calculated as the sum of the mean monthly precipitation. The mean annual precipitation (in mm) was divided into seven classes with 200 mm intervals, from 0 to >1000 mm. Spatial resolution: 1 km resolution; processed in 2012.	EFSA[59] (European Commission, 2013); Hiederer, R. (2012)
Soil pH	Spatial layer of topsoil pH which represent the pH given for the dominant soil. Soil pH exceeding 9 or below 4 (extreme values) is considered not favourable for crop growth. Spatial resolution: 1 km resolution.	EFSA (European Commission, 2013) based on HWSD[60] (IIASA/FAO/ISRIC/ISSCAS/JRC, 2012).
Root depth	Determination of soil depth is important to ensure maximum root development due to the presence of specifics horizon that cannot be penetrated by the roots. This spatial layer is divided into eight classes from <10 to >120 cm. Spatial resolution: 1 km resolution.	SINFO project[61] (European Commission, 2013) which is based on ESDB[62]
Soil texture	Five classes were defined: coarse, medium, medium fine, fine and very fine. Soil texture with	SINFO project (European Commission, 2013) which is

56 IIASA (International Institute for Applied Systems Analysis) and FAO (Food and Agricultural Organization of the United Nations).

57 SINFO project (Soil Information System for the MARS Crop Yield Forecasting System).

58 ESDB (European Soil Data base).

59 EFSA (European Food Safety Authority, Spatial Data Version 1.1).

60 HWSD (Harmonized World Soil Database)

61 SINFO project (Soil Information System for the MARS Crop Yield Forecasting System).

62 ESDB (European Soil Data base).

	less than 18% clay, more than 65% sand, or which have stones, boulders or rock at the surface are considered not favourable for crop growth. Spatial resolution: 1 km resolution.	based on ESDB
Slope	Derived from the elevation was divided into six classes. Flat areas or with a slope <8% are the most appropriated for crop growth. Slopes in excess of 16% will provide difficulty for harvesting machinery. Spatial resolution: 100 m resolution, 2013.	Shuttle Radar Topographic Mission (NASA 2013)
Salinity	Medium or high salinity concentration areas are proposed as unfavourable agricultural conditions producing significant losses of production and serious damage to the crop. Spatial resolution: 1 km resolution.	SINFO project (European Commission, 2013) which is based on ESDB.
Sodicity	Soil sodicity is a land characteristic for which the proportion of absorbed sodium in the soil clay fraction is too high for plants to perform or survive. Spatial resolution: 1 km resolution.	SINFO project (European Commission, 2013) which is based on ESDB.

Table 6: Main farm structure and agricultural viability factors that drives agricultural land abandonment, their description and main reference

Economic viability of agricultural production	**Description**	**Reference**
Age of farmers	It is computed as a share by taking into account the number of farmers > 65 year old over the total number of farmers. It is assumed that abandonment is more likely to occur when the farmer is close to the retirement age. Spatial resolution: NUTS3 level	EUROSTAT – FSS (European Commission, 2017) Data: Holders above 65_ef_r_farm2007.xls
Farmer qualification	Three different levels of training of farm managers are specified: with only practical experience, basic and full agricultural training. It is computed as a share of farmers with practical experience with regard to the total number of trained farmers. Farmers with high qualification invest more in human capital, knowledge, etc., thus preventing farmland abandonment. Spatial resolution: NUTS0 level	EUROSTAT (European Commission, 2017). Data: Total_ef_mptrainman.xls Practicalexperience_ef_mptrainman.xls
Farm size	Share of farms (UAA) under 50% of the average size region (NUTS3). The rationale behind is that larger farms can share agricultural resources (machinery, inputs, buildings, etc.) and, thus, reducing production costs. In this way, large farms compared to small (fragmented) farms are usually more competitive and viable from an economic point of view. Spatial resolution: NUTS3 level	EUROSTAT – FSS (European Commission, 2017) Data: Size and type_ef_r_farm-3.xls

Rent paid	Rent paid (SE375)[63] for farm land and buildings and rental charges[64]. Rent paid is used as a proxy of the strength or weakness of the land market. It is assuming that high rental prices leads to high demand for agricultural land and therefore, a low risk of abandonment. Units: Euro Spatial resolution: *NUTS –samples*	FADN dataset and DG AGRI RICA (especial request)
Rented UAA	Utilised agricultural areas rented (SE025) by the holder under a tenancy agreement for a period of at least one year (remuneration in cash or in kind). It is expressed in hectares (10 000 m²)[5]. It is computed as a share of the rented UAA over the total UAA. The average is calculated for the years 2005-2010 for each holding in the database. Units: ha Spatial resolution: *NUTS –samples*	FADN dataset and DG AGRI RICA (especial request)
Farm income	Farm Net Value Added (SE425) expressed per agricultural work unit. Takes into account any differences in the labour force to be remunerated per holding[5]. This variable is used as a proxy of economic performance compared to the gross domestic product (GDP) per capita from the period 2005-2010. National GDP is a proxy of national income. Units: Euro Spatial resolution of GDP:NUTS0 Spatial resolution of Farm Net Value Added: *NUTS -samples*	FADN dataset and DG AGRI RICA (special request) EUROSTAT (European Commission, 2017). Data: nama_gdp_c.xls (Euros/ capita at market price)
Farm investment	Net investment (SE521) is defined as Gross investment – Depreciation[5]. This variable is normalized by the size of the farm (UAA)[65] at sample level. This can be interpreted as a proxy of improving (new machinery, new technics) and continuing farm activities, hence reducing the risk of abandonment. Units: Euro Spatial and temporal resolution: *NUTS -samples*	FADN dataset and DG AGRI RICA (especial request)
Farm scheme (subsidies)	Subsidies on current operations linked to production (not investments). Interest subsidies and payments for cessation of farming activities are therefore not included[5]. The indicator is computed by using the variable "Farm subsidies" (SE605) normalized by the UAA sample area. Units: Euro Spatial and temporal resolution: *NUTS-samples*	FADN dataset and DG AGRI RICA (especial request)

[63] Codes assigned by FADN for the selected variables
[64] Defined by FADN (European Commission, 2000)
[65] UAA not include areas used for mushrooms, land rented for less than one year, woodland and the other farm areas (roads, ponds, non-farmed areas, etc.). It is made up of land in owner occupation, rented land and land in sharecropping (remuneration linked to output from land made available). It includes agricultural land temporarily not under cultivation for agricultural reasons or as a result of being withdrawn from production as part of agricultural policy measures.

Table 7: Main demographic risk factors favouring farmland abandonment: low population density and remote areas

Demographic and regional context	Description	Reference
Low population density areas	Population density below 50 inhabitants / km^2 is considered low populated areas in our study, being much lower than the threshold used in other methods (150 inhabitants / km^2). Several dynamic tests were done to set up this cut-off value in order to better capture rural areas with very low population density. The modelling mechanism counts for each cell the allocated residents within a surrounding kernel with an area of (approximately) 1 km^2; then, It is possible to identify the cells with less than 50 inhabitants inside the surrounding kernel.	LUISA population density map based on EUROPOP2013 (NUTS3 level) Terres et al., 2015
Remoteness	Remote areas are represented as a dynamic map of travelling time to nearest town. Town access is defined as dynamic map of travelling time to the nearest town. Couple with access to the nearest town, this indicator also takes into account changes in travelling times between time steps. Thus, remote areas are identified as those that are further than 60 minutes away from towns.	Dijkstra L. and Poelman H., 2008 Terres et al., 2015

10.4 Biophysical, economic and farm factors for agricultural land abandonment

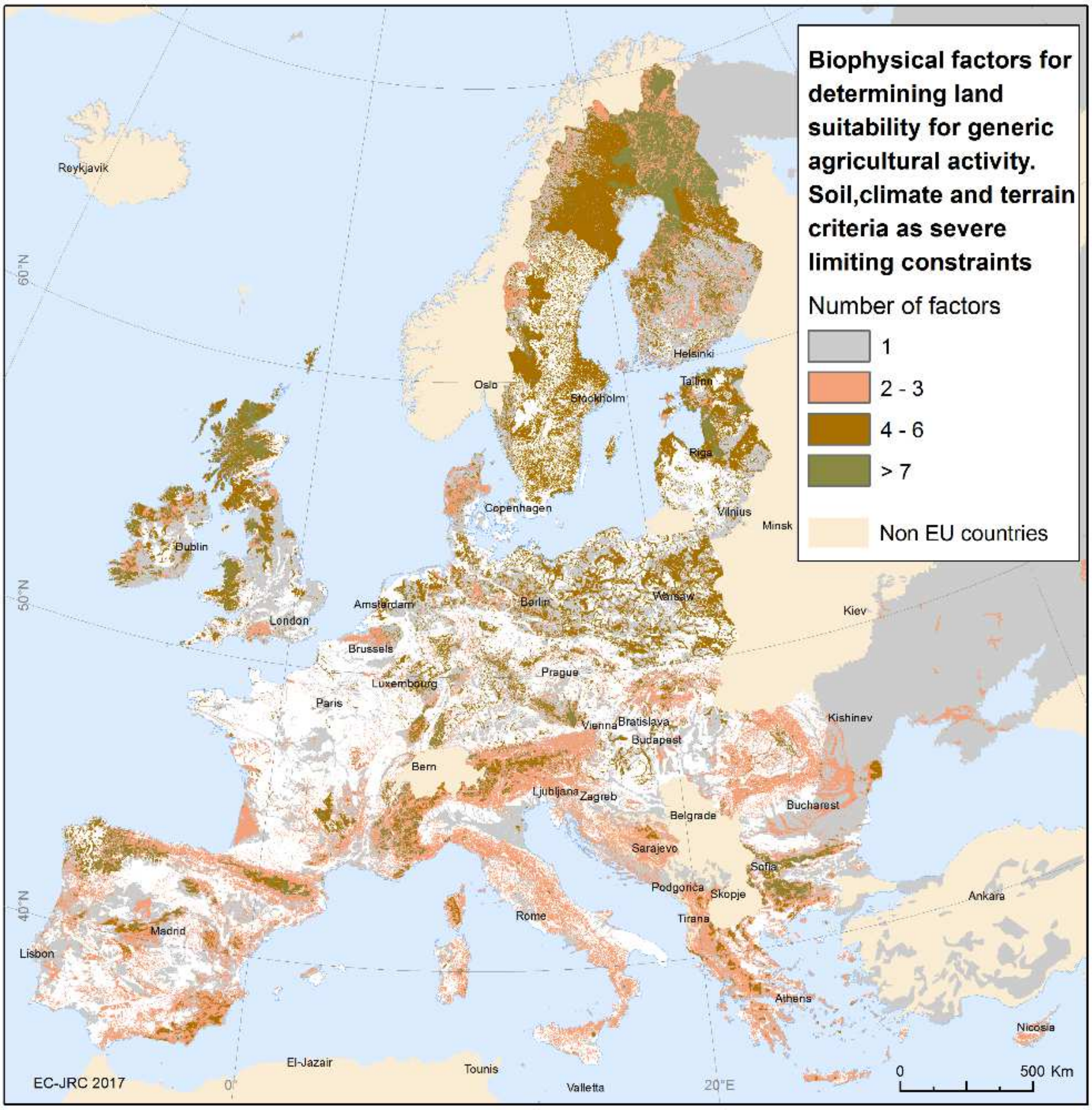


Figure 30: Number of biophysical factors spatially concurring for classifying land suitability for agricultural generic activities

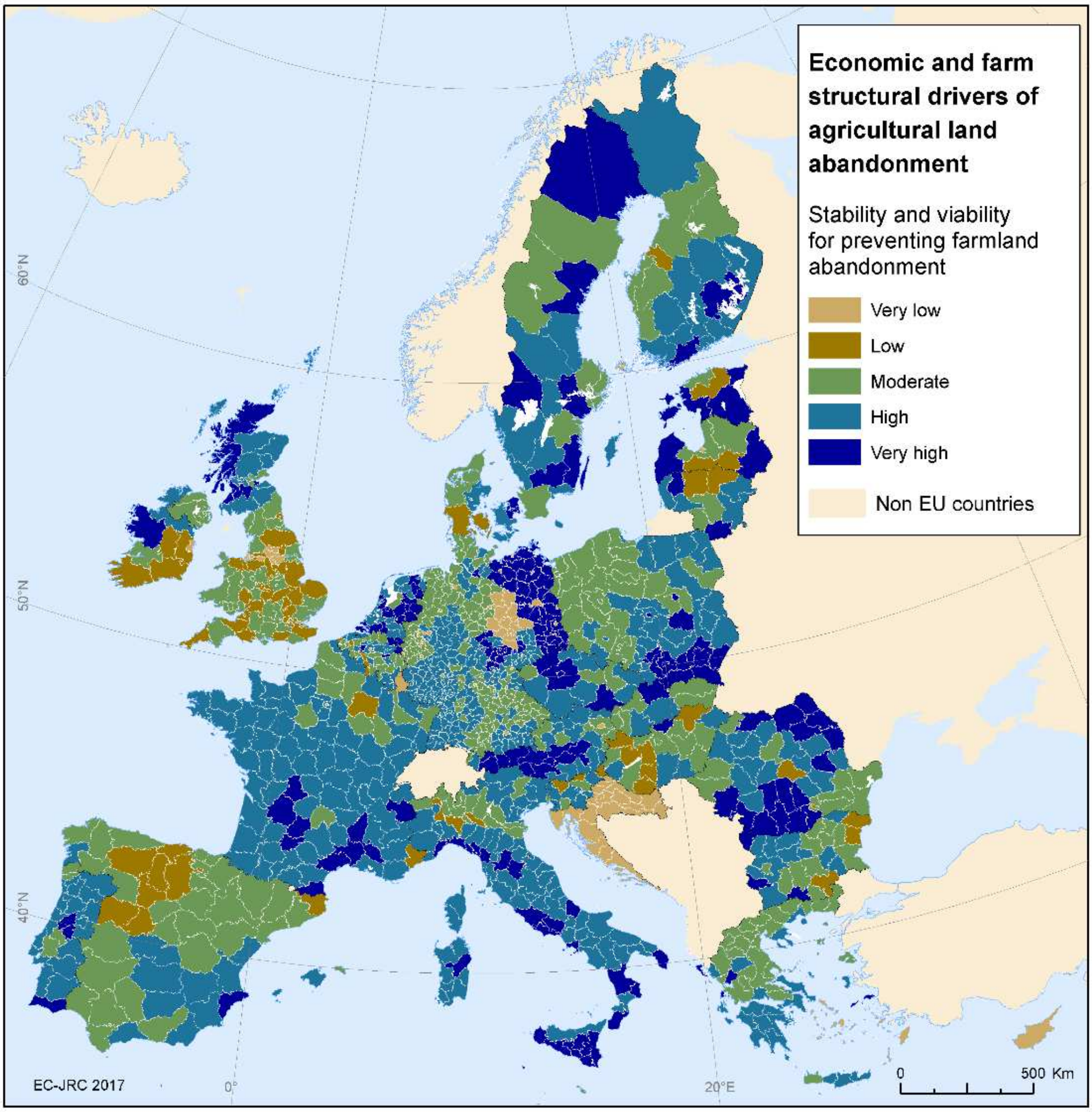
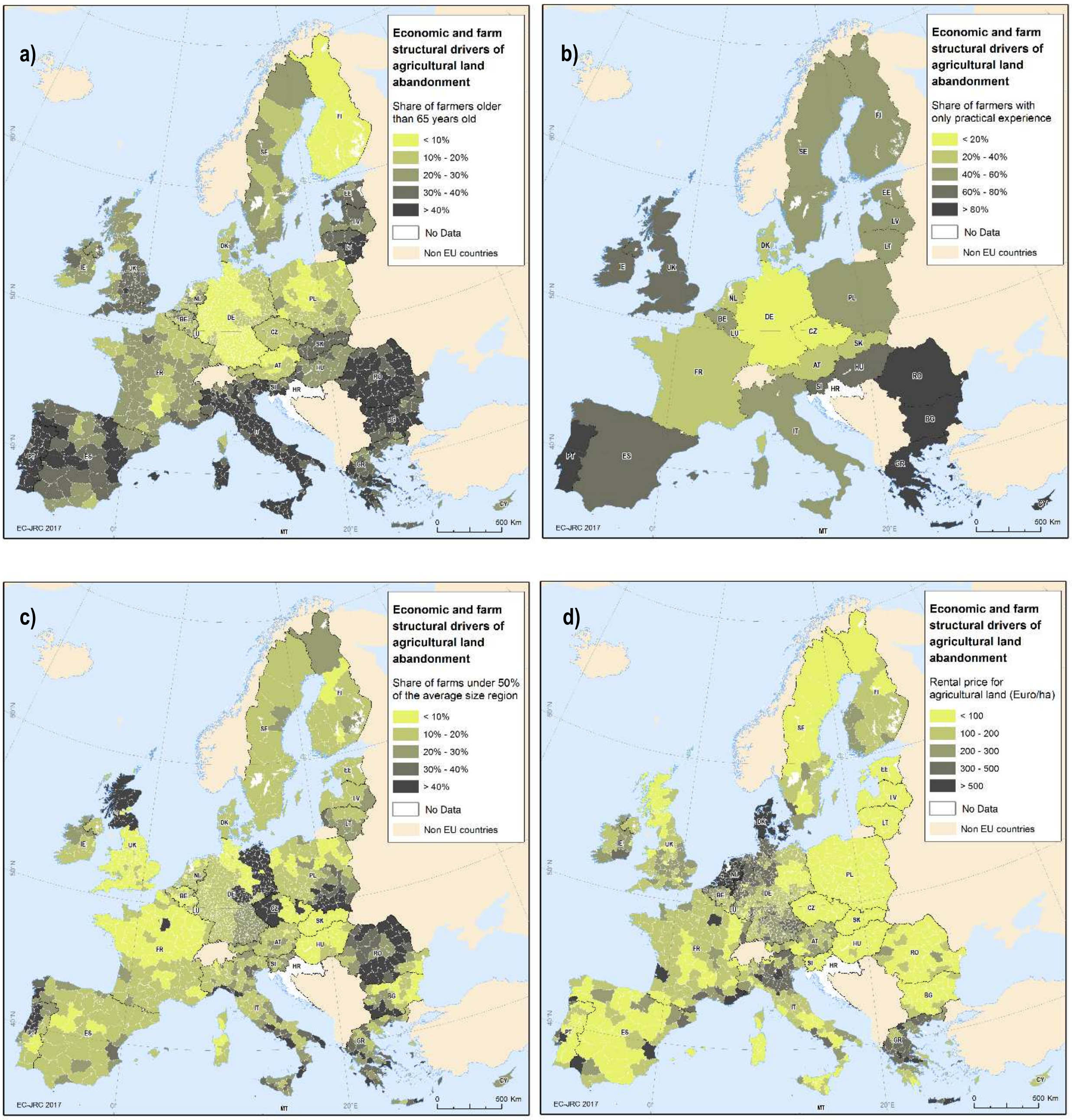


Figure 31: Map combining economic and farm structural drivers of agricultural land abandonment, period 2005-2010


a)
Economic and farm structural drivers of agricultural land abandonment
Share of farmers older than 65 years old
< 10%
10% - 20%
20% - 30%
30% - 40%
> 40%
No Data
Non EU countries
EC-JRC 2017
b)
Economic and farm structural drivers of agricultural land abandonment
Share of farmers with only practical experience
< 20%
20% - 40%
40% - 60%
60% - 80%
> 80%
No Data
Non EU countries
EC-JRC 2017
c)
Economic and farm structural drivers of agricultural land abandonment
Share of farms under 50% of the average size region
< 10%
10% - 20%
20% - 30%
30% - 40%
> 40%
No Data
Non EU countries
EC-JRC 2017
d)
Economic and farm structural drivers of agricultural land abandonment
Rental price for agricultural land (Euro/ha)
< 100
100 - 200
200 - 300
300 - 500
> 500
No Data
Non EU countries
EC-JRC 2017

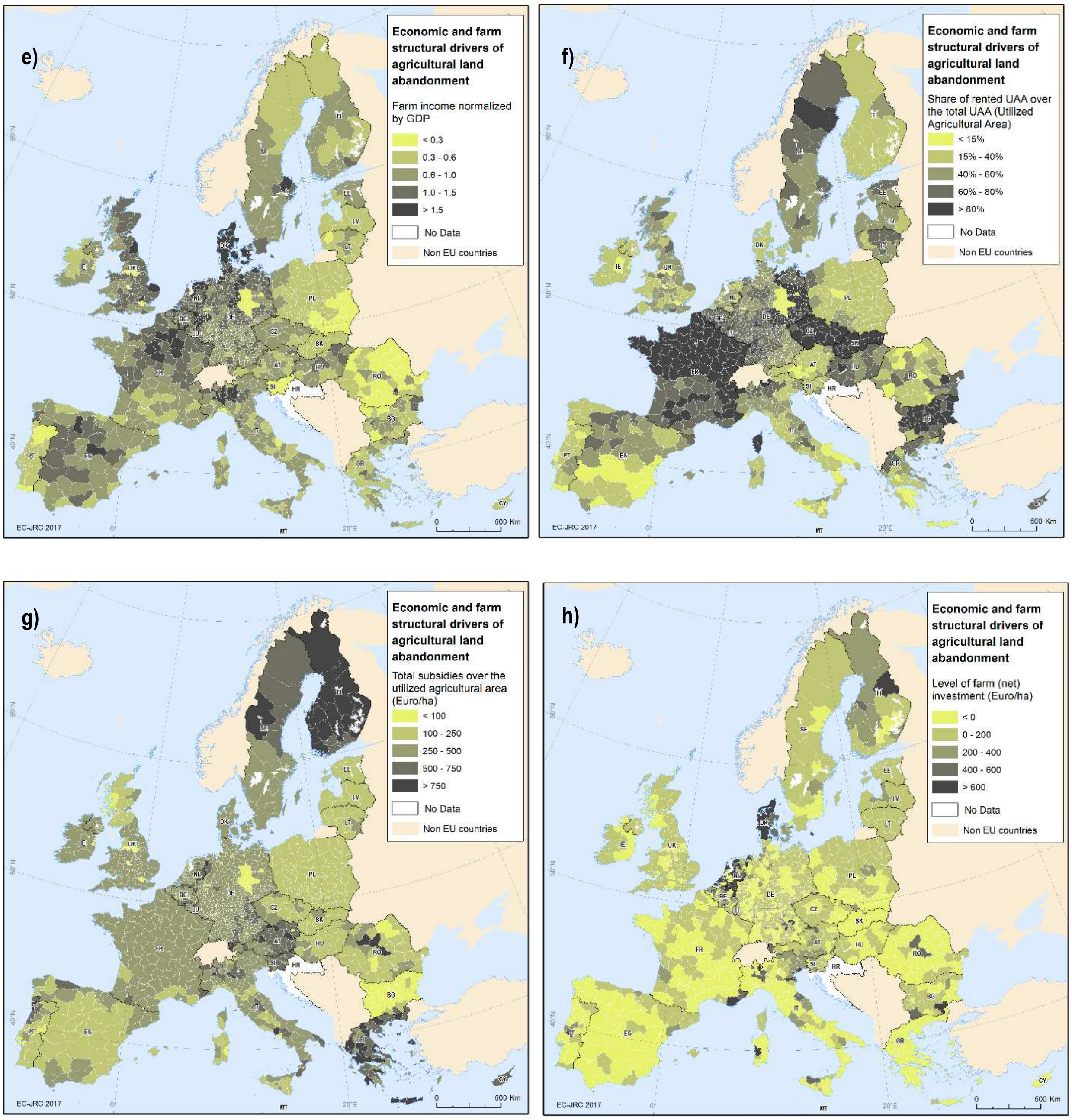


Figure 32: Economic and farm structure factors for stability and viability of farming activities and prevention of agricultural land abandonment: a) Share of old farmers (>65 years old), b) Share of farmer with practical experience only, c) Share of farms under 50% of the average size in the region, d) Rental price, e) Share of rented UAA, f) Farm income, g) Farm investment and h) Total subsidies

10.5 Remoteness

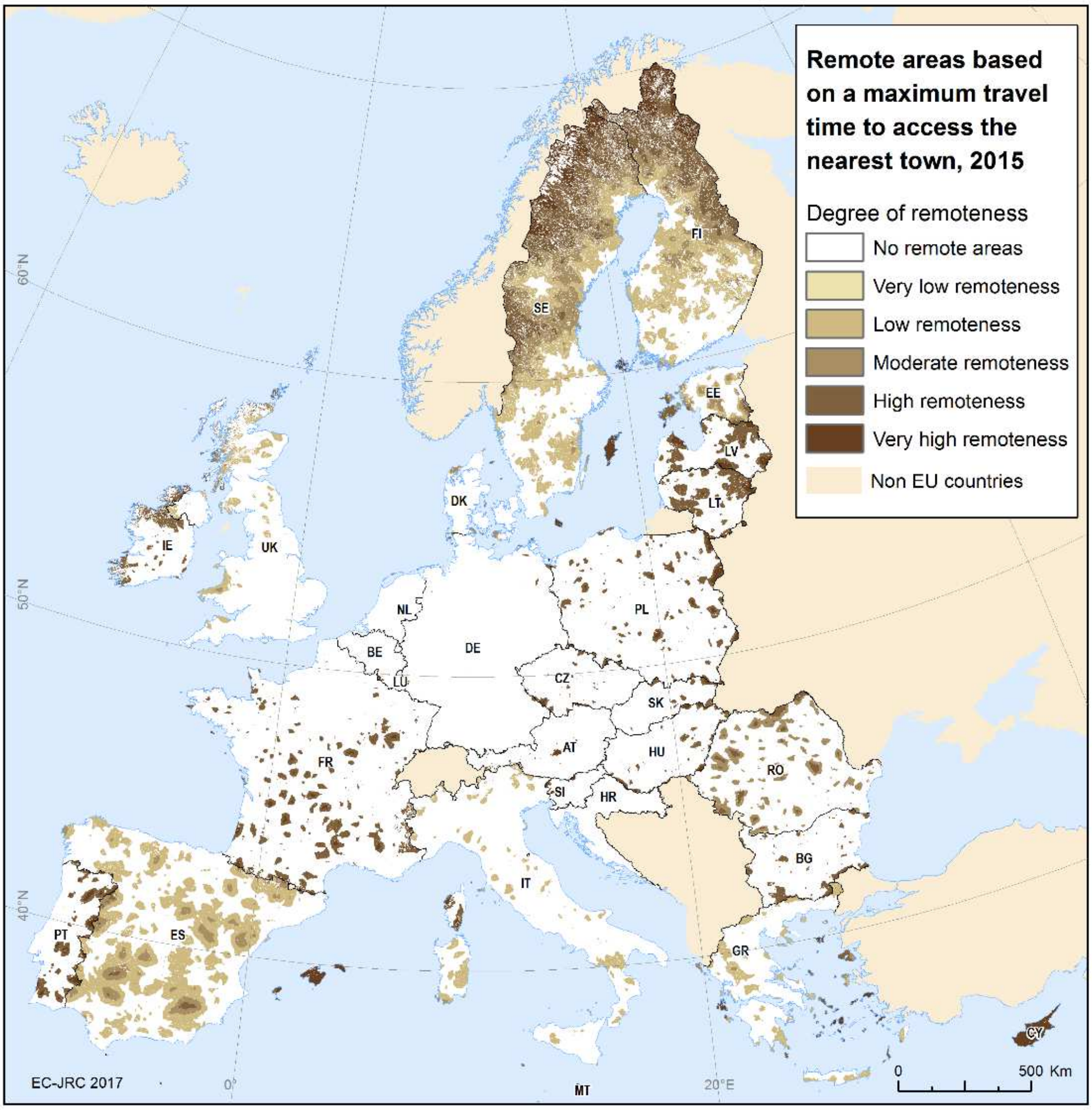


Figure 33: European map of remote areas computed at Member State level, 2015

10.6 Agriculture-driven cluster analysis for 2015

The spatial cluster analysis has been carried out by using "Grouping Analysis" with machine learning approach. Given the number of groups to create, the tool looks for a solution where all the features within each group are as similar as possible, and all the groups themselves are as different as possible. Feature similarity was based on the five indicators assessed in the report – rural population, employment and GVA in primary sector, agricultural land and land abandonment. Since no spatial constraint was specified, the Grouping Analysis tool used a K-means algorithm. K-means clustering is a simple unsupervised learning algorithm that is used to solve clustering problems. It follows a simple procedure of classifying a given data set into a number of clusters, defined by the letter "k," which is fixed beforehand. The clusters are then positioned as points and all observations or data points are associated with the nearest cluster, computed, adjusted and then the process starts over using the new adjustments until a desired result is reached (Lloyd, 1982). According to the algorithm, "k" points are placed into the object data space representing the initial group of centroids. Each object or data point is assigned into the closest "k". After all objects are assigned, the positions of the "k" centroids are recalculated. Steps 2 and 3 are repeated until the positions of the centroids no longer move.

The findings (boxplots) from the cluster are presented in Figure 34 and Figure 35 and show the basic statistics of the indicator's distribution once they were clustered.

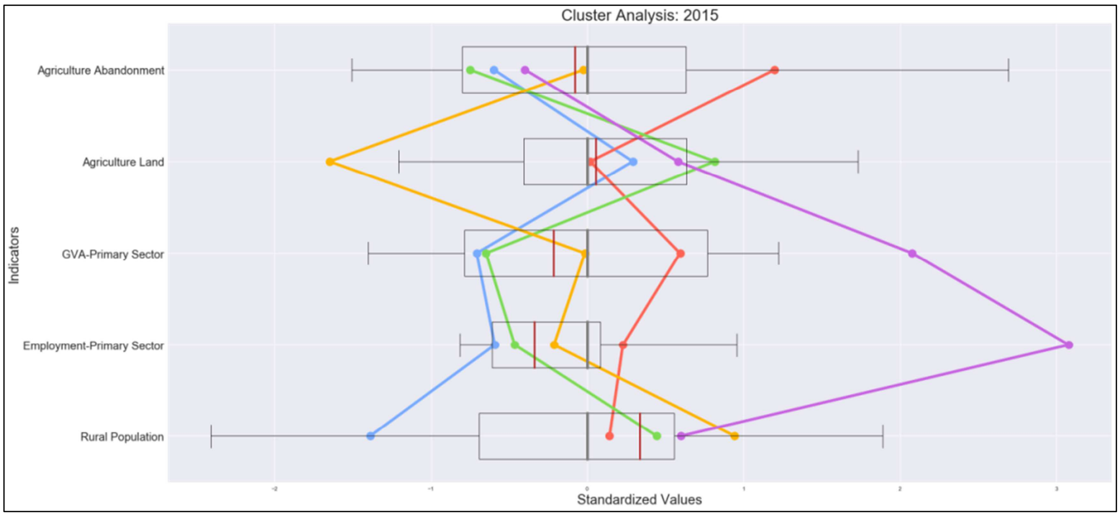


Figure 34: Statistical boxplots of agriculture-related spatial clusters at national (NUTS 0) level

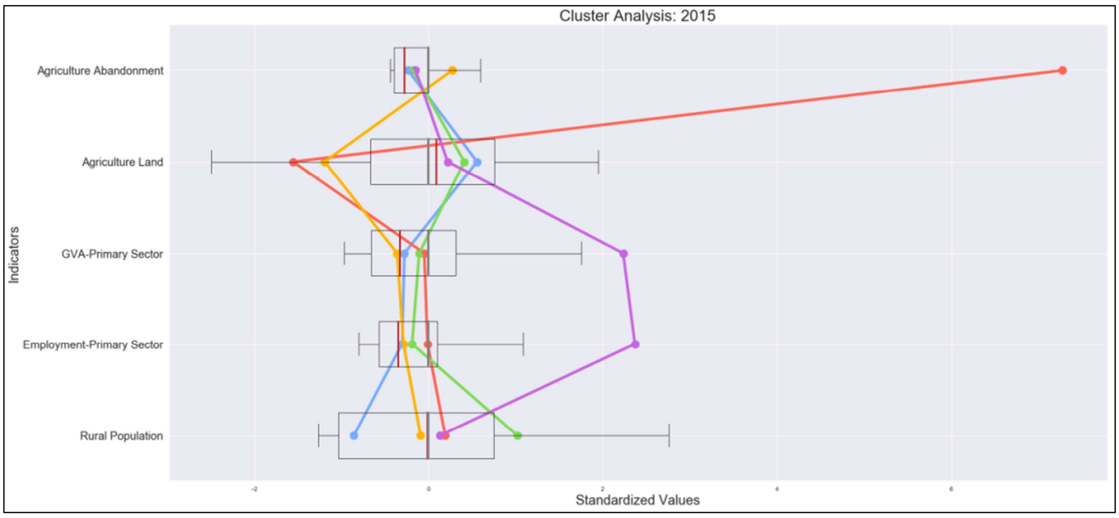


Figure 35: Statistical boxplots of agriculture-related spatial clusters at regional (NUTS 3) level

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doi:10.2760/525571

ISBN 978-92-79-98121-0