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Chapter 5

Implementation and perspectives of circular economy in rural Greece: the case of the Drama Regional Unit of Eastern Macedonia & Thrace Region

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5.1.1 Structure of the territory and rural area presentation

5.1.1.1 General presentation

Greece is located at the southern end of the Balkan Peninsula in southeastern Europe and the eastern Mediterranean Sea (Figure 5.1).

Figure 5.1 Location of Greece in Europe

It has land borders to the north, with Albania (212 km), the Republic of North Macedonia (234 km) and Bulgaria (472 km) and to the east with Turkey (192 km), totaling approximately 1110 km. Also, it is surrounded to the east by the Aegean Sea to the west by the Ionian Sea, and to the south by the Mediterranean Sea (Figure 5.2).

Figure 5.2 Bordering countries to Greece

Greece has the most extensive coastline of all the countries around the Mediterranean Sea with a length of 13780 km (Ministry for the Environment, Physical Planning and Public Works 2006) and one of the longest in the world, ranked in the 11th by length of coastline (CIA World Factbook: Coastline). This is due to the very big number of islands included in the country's territory. Greece has 6000 islands scattered in the Aegean and Ionian Seas only however 227 of them are inhabited (Hellenic Tourism Organization 2006).

Athens is the capital and the largest city of Greece. It is among the world's oldest cities dating back 3400 years and it is considered the cradle of western democracy. The population of the city area is 664046 persons (populationstat 2019) with an extremely high density of 17027 people per km^2. The population of the Athens urban area amounts to 3,152,887, ranking Athens as the 9th largest city in Europe. Athens is the political, financial and cultural centre of Greece. There are no cities in the country with more than a million people. There are 8 cities between 100000 and 1,000,000 people and 133 cities with 10,000 to 100,000 people.

The surface area of Greece is 132049 km^2 (Hellenic Statistical Authority 2019) of which 99% is land territory and 1% inland waters. The country ranks 15th in Europe and 97th in the world in order of the total surface area. The population of Greece according to the 2011 national census amounts to 10, 816,286 inhabitants of which 91.6% are Greeks, 1.8% have EU citizenship and 6.5% have citizenships from other countries.

The administrative division of Greece includes two levels, Regions and Municipalities. There are thirteen Regions (Figure 5.3), which correspond to the EU NUTS II-level divisions.

Furthermore, seven decentralized administrations were formed as part of the Ministry of the Interior to oversee the Regions, although these do not constitute entities of local government. The Regions are further subdivided into Regional Units (four to seven) and each Regional Unit is subdivided to a number of Municipalities. The Regional Units and the Municipalities of the country amount to 74 and 325 correspondingly.

5.1.1.2 Geography of Greece

Almost 80% of Greece's territory is a mountainous peninsular mainland entering the Mediterranean Sea, with another two smaller peninsulas, the Halkidiki and Peloponnese projecting from it. The largest mountain range, called the Pindos range, extends over the center of the country in a northwest-to-southeast direction reaching a maximum elevation at 2,637 m (Mount Smolikas). The Pindos range geologically forms an extension of the Dinaric Alps and it stretches also across the Peloponnese and underwater the Aegean Sea, forming many of the Aegean islands including Crete.

The Western and Central part of the country includes high and steep peaks intersected by many canyons and other karstic landscapes. The Meteora and the Vikos Gorges are located in this part of the country. The Vikos Gorge plunges vertically for more than 1,100m making it the world's deepest canyon in proportion to its width and the 3rd deepest after the Copper Canyon in Mexico and the Grand Canyon in the U.S.A.

The highest point in Greece is Mount Olympus, the mythical seat of Gods, rising to 2,917m above sea level and ranking as the 7th highest in Europe. The lowest point of the country is sea level. Another mountain range, the Rhodope range extends on the north east part of the country forming the border between Greece and Bulgaria. This area is covered by the most productive forests of the country. Plains exist in the Regions of Thessaly, Central Macedonia, Eastern Macedonia & Thrace, Western Greece and Crete (Figure 5.3).

Almost 20% of the country's territory consists of islands, which vary greatly in size and climate conditions. The largest island of Greece is Crete, with Evia being the second largest. Among the other large Greek islands are included Rhodes and Lesvos in the Aegean Sea and Korfu and Kefalonia in the Ionian Sea. Other smaller islands form groups, often called archipelagos, such as the Cyclades and Dodecanese in the south Aegean Sea.

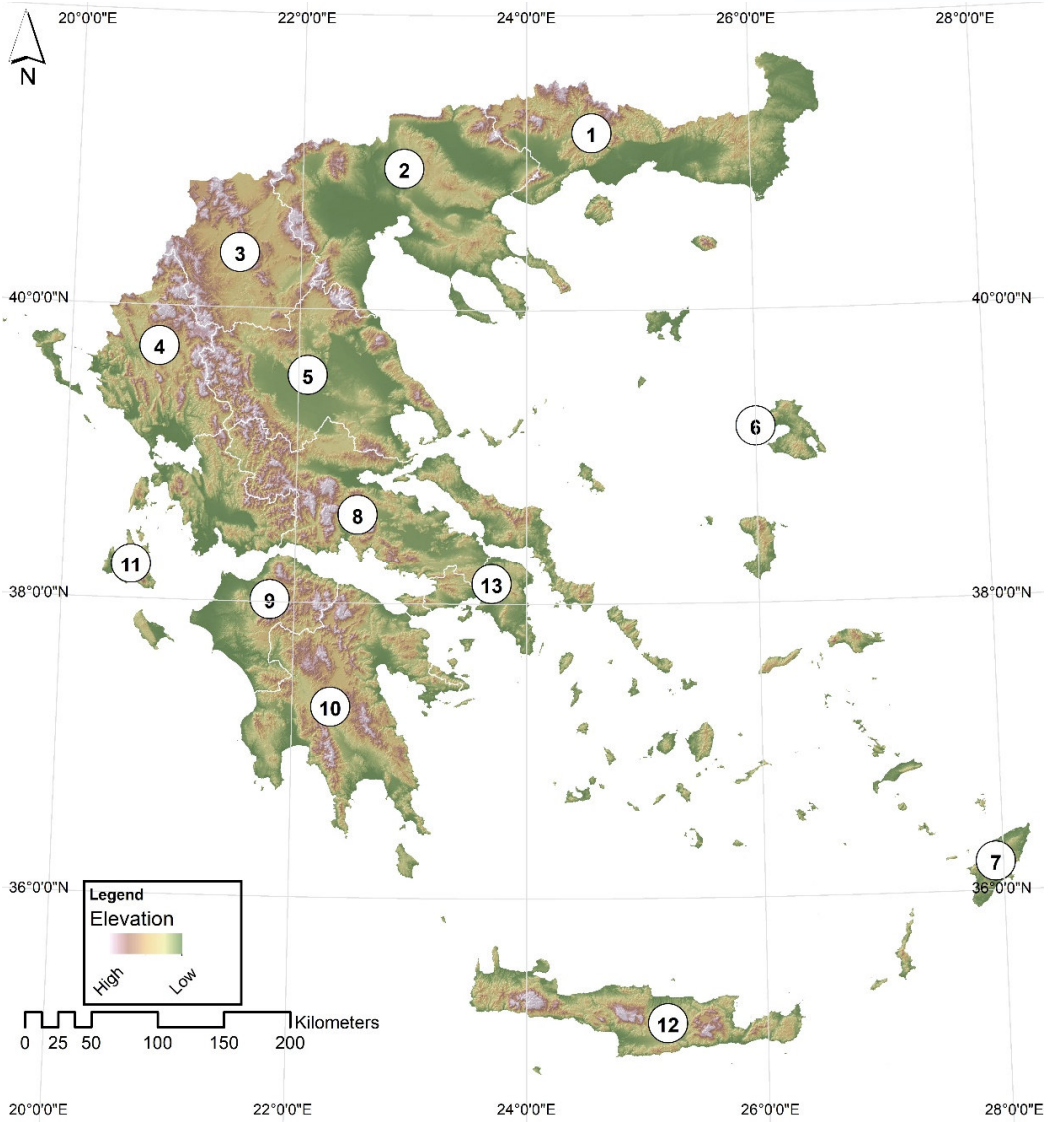

Figure 5.3 The Digital Elevation Model (DEM) and the thirteen administrative Regions of Greece

1: Region of Eastern Macedonia & Thrace, 2:, Region of Central Macedonia, 3: Region of Western Macedonia, 4: Region of Epirus, 5: Region of Thessaly, 6: Region of North Aegean, 7: Region of South Aegean, 8: Region of Central Greece, 9: Region of Western Greece, 10: Region of Peloponnese, 11: Region of Ionian Islands, 12: Region of Crete, 13: Region of Attica

Freshwater resources are abundant in Greece, although they are spatially and temporally unevenly distributed throughout the country, due to the climate diversity and the relief of the country. Mean annual precipitation ranges between 400mm in the east part of the country (Aegean Sea and Athens) to over 900mm in the Northwestern part and the Ionian Islands. Parts of the southern and central mainland, as well as the Aegean islands and Crete are in danger of desertification. Water demand and consumption is particularly increased during the summer dry period due to tourist arrivals and the increased needs for irrigation.

There are eight major river basins in the country: the Acheloos (Central Greece), Axios, Strimonas and Aliakmonas (Macedonia), Evros and Nestos (Thrace) and Arachthos and Kalamas (Epirus). Nine rivers, the Aliakmonas, Acheloos, Pinios, Evros, Nestos, Strimonas, Kalamas, Alfios and Arachthos flow over 100km within Greece, while four major rivers originate in neighbouring countries: Evros (Turkey), Nestos and Strimonas (Bulgaria) and Axios (North Macedonia).

Also, about 41 natural lakes, of which 19 with an area over 5 km^2, occupy over 600,000 ha or 0.5% of the country's total area. The largest lakes are Trichonida, Volvi and Vegoritida. Lake Prespa is on the borders with Albania and North Macedonia. There are about 400 wetlands of which 10 have been designated as Ramsar wetlands of international conservation importance. Finally, there are 14 artificial lakes, ten of which with an area over 5 km^2, which occupy another 26,000 ha (https://www.un.org/esa/agenda21/natlinfo/countr/greece/watergreece04f.pdf).
About 80% of the freshwater resources are in the form of surface water and the rest are groundwater. The total renewable water resources, that is the sum of renewable groundwater and renewable surface water resources (both internal and external) was estimated in 2017 to 68 billion m3/year and the renewable water per inhabitant to 6,129 m3/person/year (https://www.worldometers.info/water/greece-water/#water-use). On the other hand, in 2016, the total freshwater abstraction by public water supply per inhabitant was estimated to 172.9 m3, a much higher level than that of all the other European countries (https://ec.europa.eu/eurostat/statistics-explained/index.php/Water_statistics).

5.1.1.3 Rural area

5.1.1.3.1 Population

In terms of the degree of urbanization/rurality about 97% of the country's territory is classified as rural area. This classification is based on the new harmonized definition of urban and rural areas, which is using population grids and it has been developed by the European Commission in collaboration with OECD (Dijkstra and Poelman 2014). This new degree of urbanization uses a three-way classification of local units, LAU2s (municipalities): densely populated areas (cities or urban centres) where at least 50% of the population lives in high-density clusters; intermediate density area (towns and suburbs) where less than 50% of the population lives in rural grid cells and less than 50% in a high-density cluster and thinly populated areas (rural areas) where more than 50% of the population lives in rural grid cells.

Table 5.1 shows the country's detailed land distribution, while Figure 5.4 the spatial representation of the country's land distribution.

Table 5.1 Land distribution according to degree of urbanization/rurality in Greece, 2019

GRIDCODE	Area (ha)	km^2	Percentage (%)
Rural	12835700.0	128357.0	97.2
Towns and suburbs (Intermediate areas)	277850.0	2778.5	2.1
Cities (urban)	91347.6	913.5	0.7

TOTAL	13204897.6	132049.0	100.0

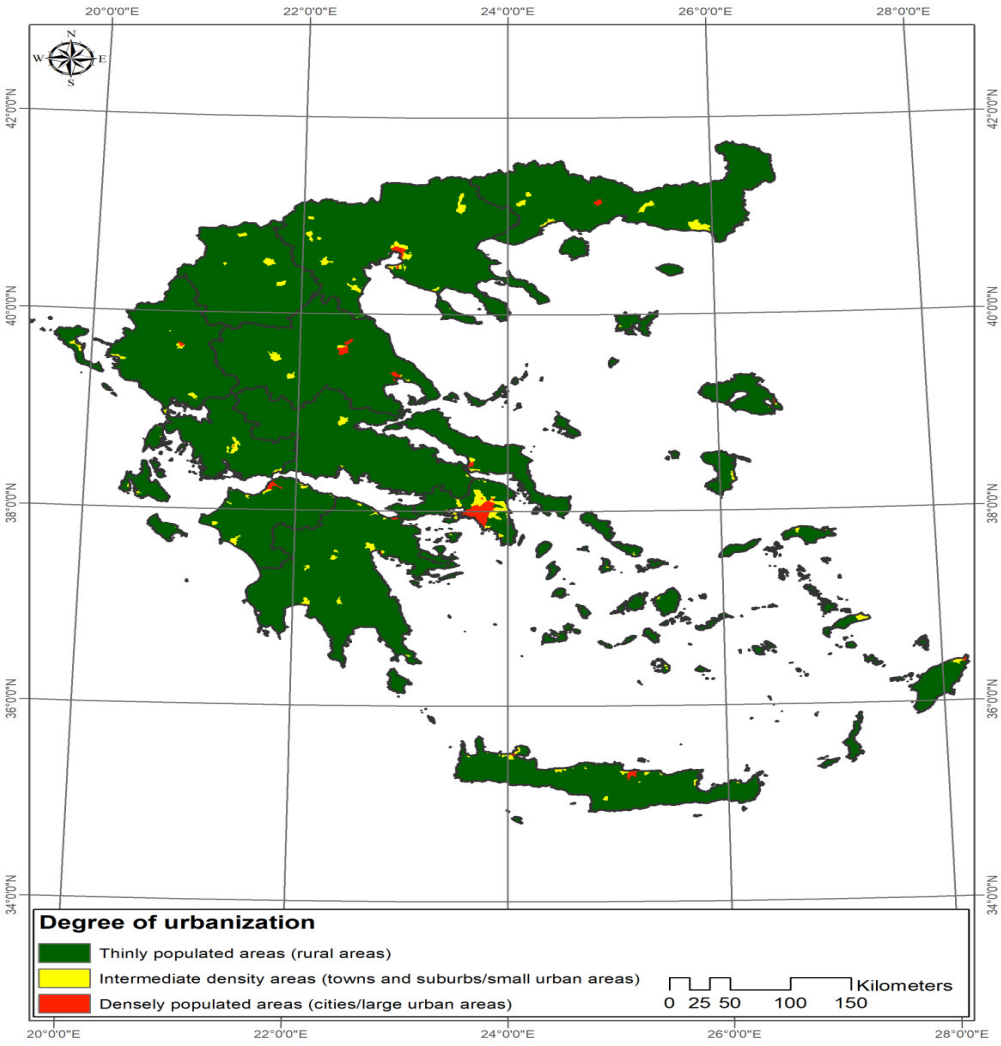

Figure 5.4 Spatial distribution of rural areas in Greece

Table 5.2 shows the country's detailed population distribution in terms of degree of urbanization/rurality. It appears from Table 5.2 that almost 1/3 of the country's population in 2019 (28.5%) lives in rural areas.

Table 5.2 Population distribution according to degree of urbanization/rurality in Greece, 2019

GRIDCODE	Population	km^2	Percentage (%)	Population density (persons/km^2)
Rural	3056510.7	128357.0	28.5	23.81
Towns and suburbs (Intermediate areas)	3464045.5	2778.5	32.3	1246.73

Cities (urban)	4204042.8	913.5	39.2	4602.13
TOTAL	10724599.0	132049,0	100.0	81.21

The rural population of the country showed a small declining trend between 2016 and 2019 (Figure 5.5), although in 2019 it appears stabilized. The observed population loss in the rural areas over the 2016-2019 period has favoured the town and suburb areas (intermediate density areas), where it seems that rural population has been moved to, as these areas presented an increasing population trend over the same period. During this period a small population decrease occurred also in the urban areas of the country.

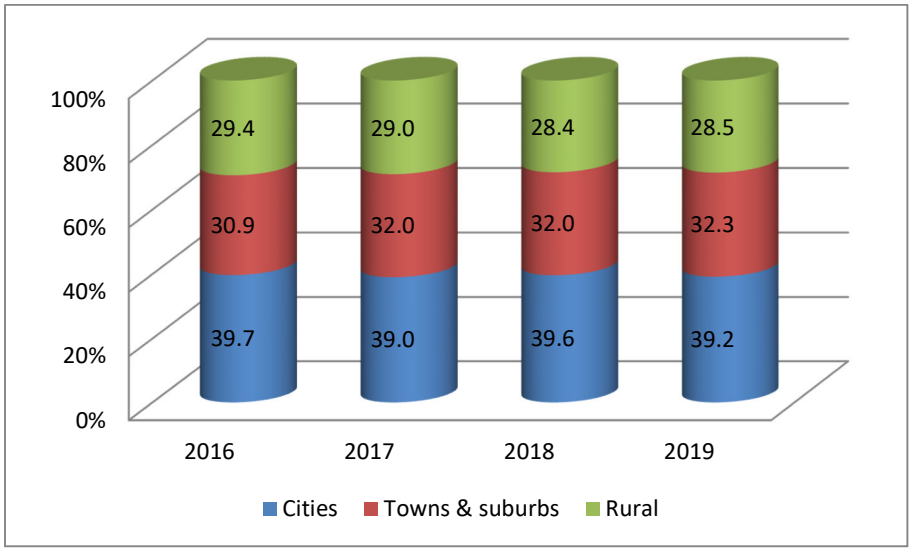

Figure 5.5 Percent population by degree of urbanization/rurality in Greece, 2016-2019

The gender distribution at it is depicted in Figure 5.6 is in favour of the male population. The ratio between the male and the female population was 54.8% and 45.2% respectively in 2019 following very small fluctuations over the 2016-2019 period. This is in contrast to the country overall gender distribution, which favours women as it is shown in Figure 5.7. The ratio between the male and the female population of the country as a whole in 2019 was 48.6% and 51.4% respectively, also showing very small fluctuations over the 2016-2019 period.

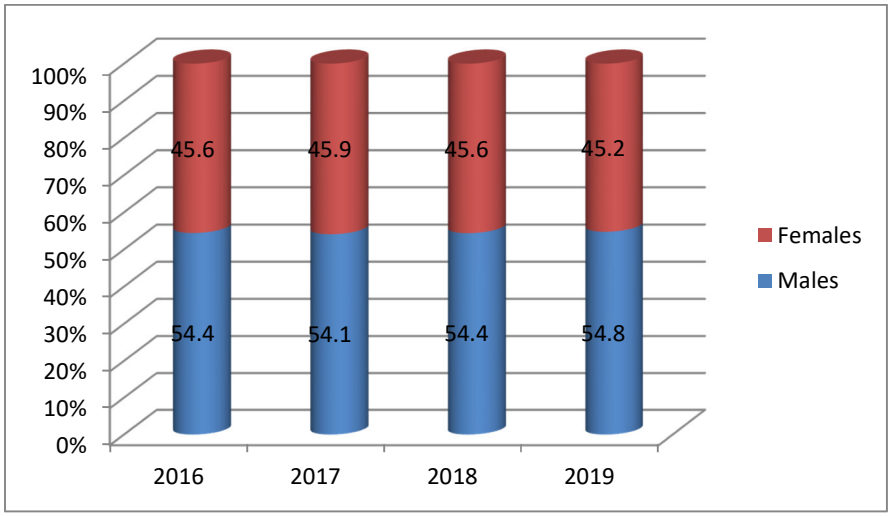

Figure 5.6 Percent distribution of rural population by gender in Greece, 2016-2019

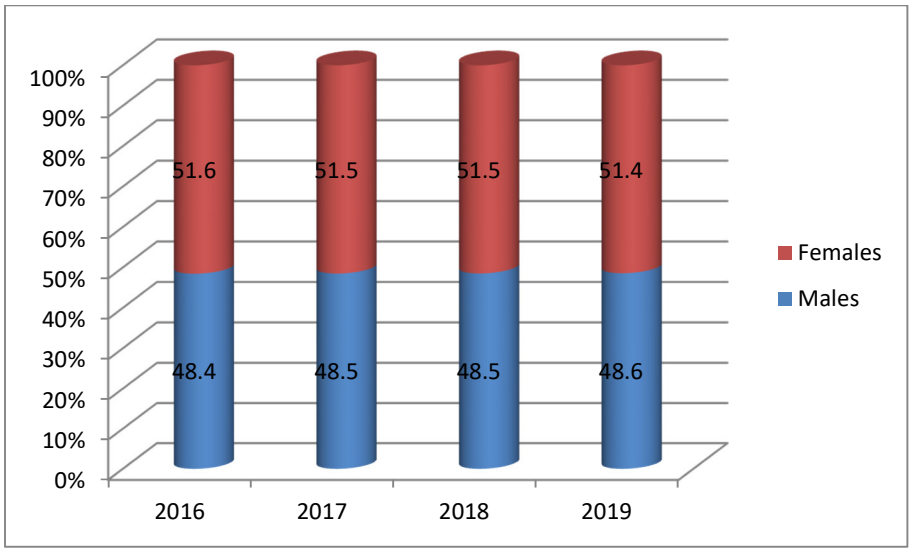

Figure 5.7 Percent distribution of total population by gender in Greece, 2016-2019

With regard to the labour force, 27.5% of the economically active population of the country, that is the population from 15 to 65 years of age, who were employed in 2019 lived in the rural areas, 33% in towns and suburbs and 39.5% in urban areas (Figure 5.8). This distribution pattern of the employed economically active population shows that opportunities need to be created to improve the employment conditions in the rural areas of the country.

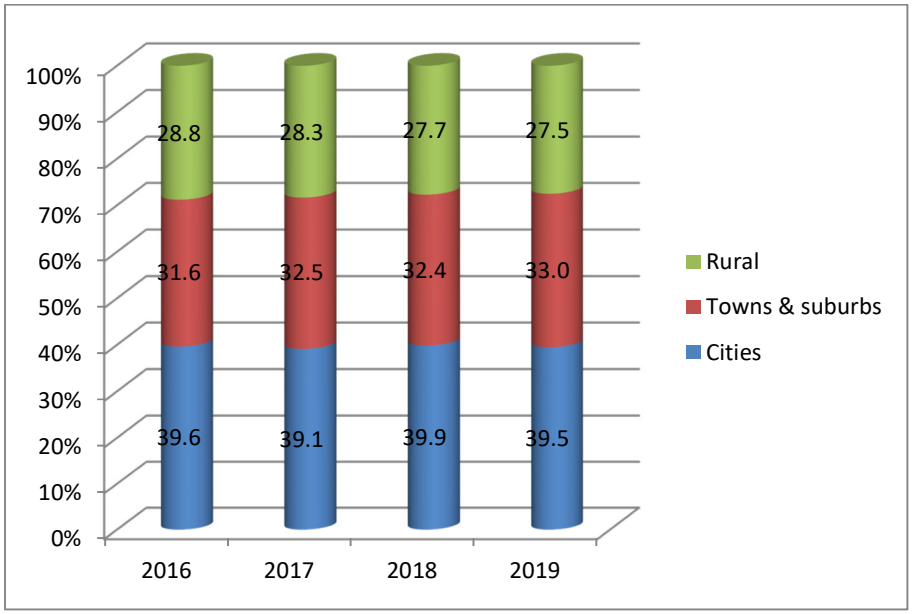

Figure 5.8 Percent total population by age, degree of urbanization /rurality and labour status in Greece, 2016-2019; Age 15-64 years, Employment status: Employed

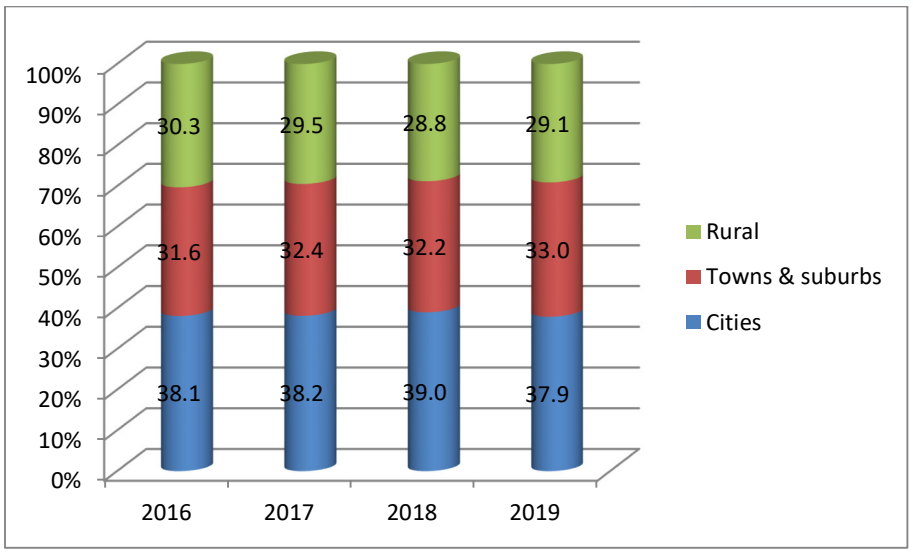

Figure 5.9 Percent male population by age, degree of urbanization/rurality and labour status in Greece, 2016-2019; Age 15-64 years, Employment status: Employed

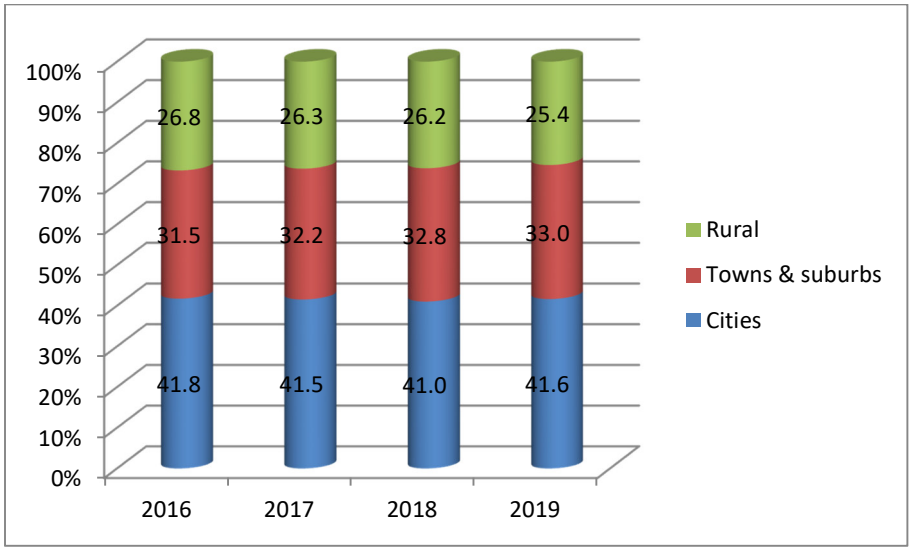

Figure 5.10 Percent female population by age, degree of urbanization/rurality and labour status in Greece, 2016-2019; Age 15-64 years, Employment status: Employed

About 29% of the employed economically active population in the rural areas in 2019 was men and a little over than 25% was women. On the contrary, the gender distribution in towns and suburbs in the same year was equally balanced (33%) and in favour of women (41.6%) over men (37.9%) in the urban areas. The detailed gender distribution of the employed population aged 15-64 years by degree of urbanization/ rurality between 2016 and 2019 is depicted in Figures 5.9 and 5.10.

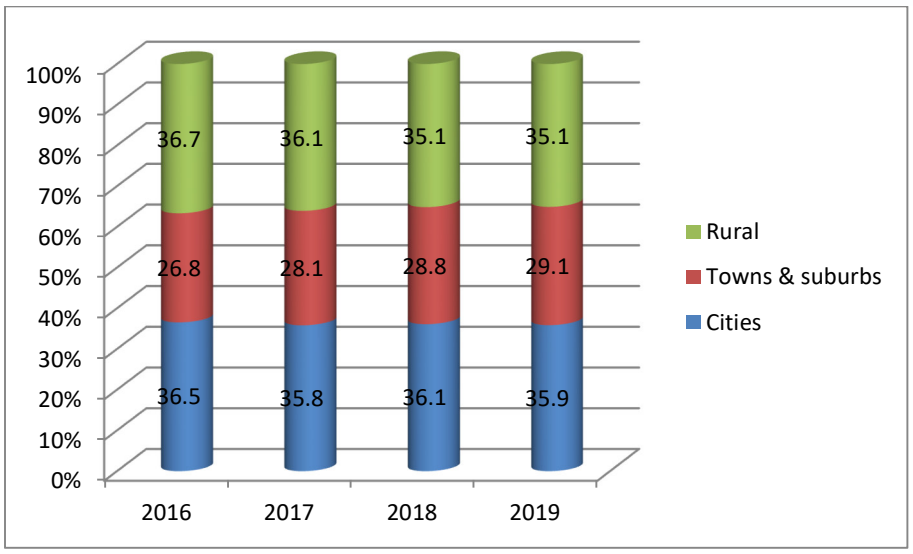

Figure 5.11 Percent of total population 65 years or over by degree of urbanization/rurality in Greece, 2016-2019

Overall, the total population trend in the rural areas, over the 2016-2019 period, appeared declining, while a similar declining trend was observed during the same period for the gender distribution too. On the other hand from the country's total population 65 years or over, that is the non-economically active population; a substantial part (35.1%) in 2019 lived in the rural areas, however appearing in a dwindling direction between 2016 and 2018.

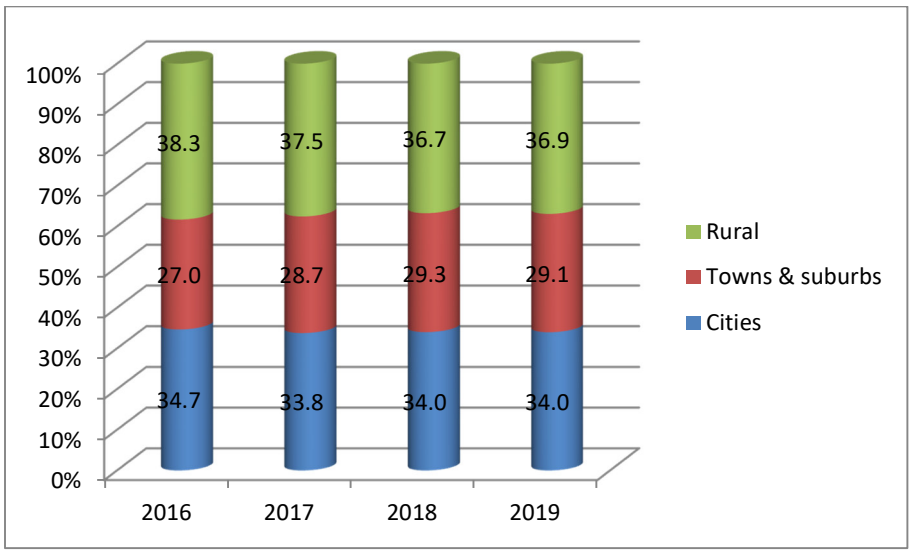

Figure 5.12 Percent of male population 65 years or over by degree of urbanization in Greece, 2016-2019

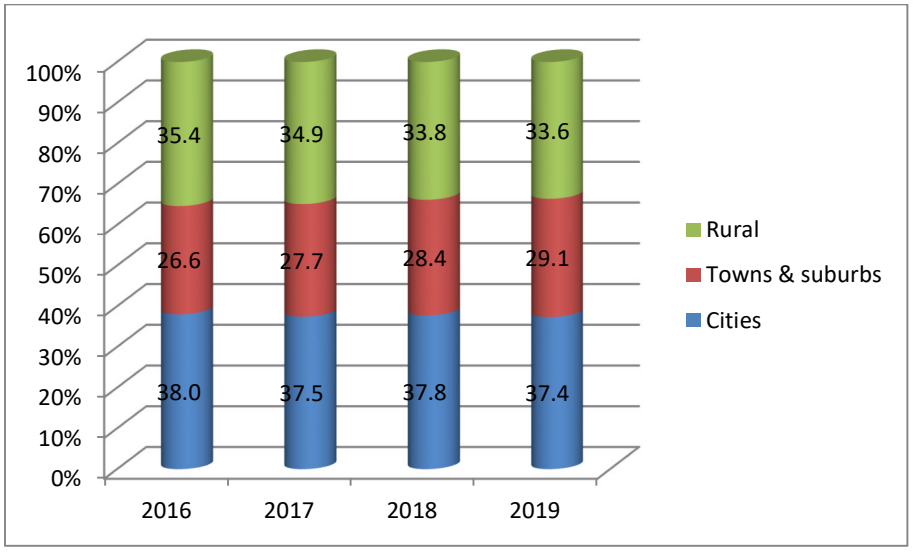

Figure 5.13 Percent of female population 65 years or over by degree of urbanization in Greece, 2016-2019

In terms of the gender distribution of the old population, as it shown in Figure 5.12 more men 65 years or over (36.9%) lived in the rural areas in 2019 compared to the corresponding aged population in towns & suburbs (29.1%) and urban areas (34%). The male population in the rural areas was slightly increased in terms of 2018, but it did decline between 2016 and 2018. The female population 65 years or over in the rural areas in 2019 was higher (33.6%) than the corresponding aged population in towns & suburbs (29.1%) but less than that of the urban areas (37.4%). The female population of the rural areas was also gradually reduced over the 2016-2019 period.

Most of the employed people in the rural areas work in the agriculture, forestry & fishing economic sectors. In 2017 more than half a million people were employed in these sectors, which constitutes approximately 12.5% of the total number of people employed in all the other economic sectors. The corresponding shares of the employed people in agriculture, forestry & fishery over the employed people in all the other economic sectors in 2015 and 2016 were about 14% and 15% respectively.

Table 5.3 Employment in the primary sector of economy in Greece, 2015-2017

	Number of people employed (1000)		
	2015	**2016**	**2017**
Agricultrure, Forestry & Fishery	479,1	587,4	516,1
All economic sectors	3.519,9	3.887,4	4.178,2

5.1.1.3.2 Economic activities of rural areas

The main economic activities of the rural areas of Greece are closely connected to the country's land use/land cover distribution, which is depicted in Table 5.4. The agricultural lands covered in 2016 an area of 6517000 ha, which constitutes a little over than 49% of the country's total area, while the non-agricultural lands, which include in addition to forest and semi-natural areas, the water surfaces, the buildings and other artificial surfaces form the remaining 51% of the country's land area. The arable lands along with the permanent crops comprise 21% of the agricultural lands, while the pastures and other agricultural areas cover 11% and 16% of the total agricultural land area (Figure 5.14).

Table 5.4 Land use/land cover distribution in Greece, 2016

Land use/Land cover	Area (ha)
Agricultural lands	6,517,000
- Arable lands	2,118,980
- Permanent crops	750,020
- Pastures	1,446,060
- Heterogeneous agricultural area	2,201,940
Non-agricultural lands	6,687,900
- Forests and semi-natural areas	6,248,650
- Water surfaces	179,800
- Buildings	213,400
- Other artificial surfaces	46,050
TOTAL	13,204,900

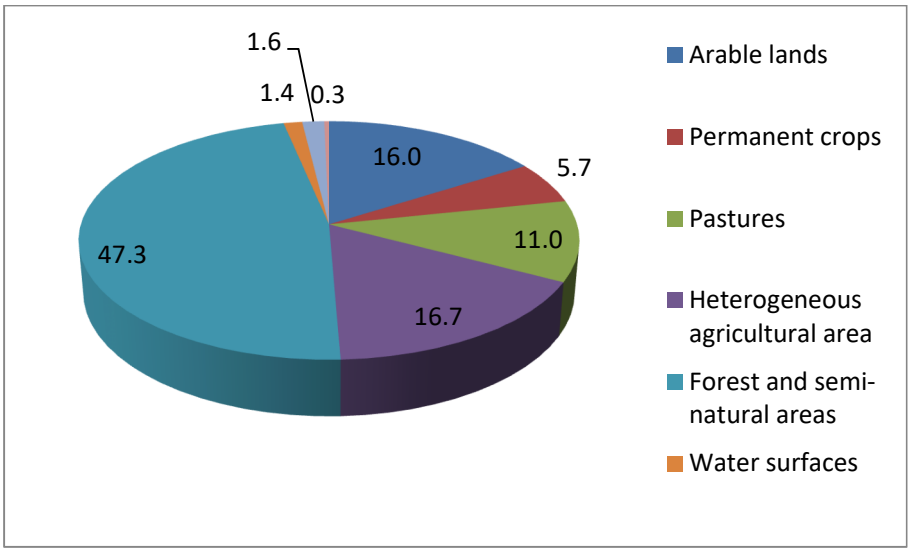

Figure 5.14 Percent land use/land cover distribution in Greece, 2016

Crop agricultural production

The percentage agricultural crop areas are presented in Figure 5.15. In 2018 the crops on the arable lands covered most 60% of the agricultural lands and the tree crops about 35%. Vineyards extended over 3% of the agricultural land surface and vegetable crops over 2%.

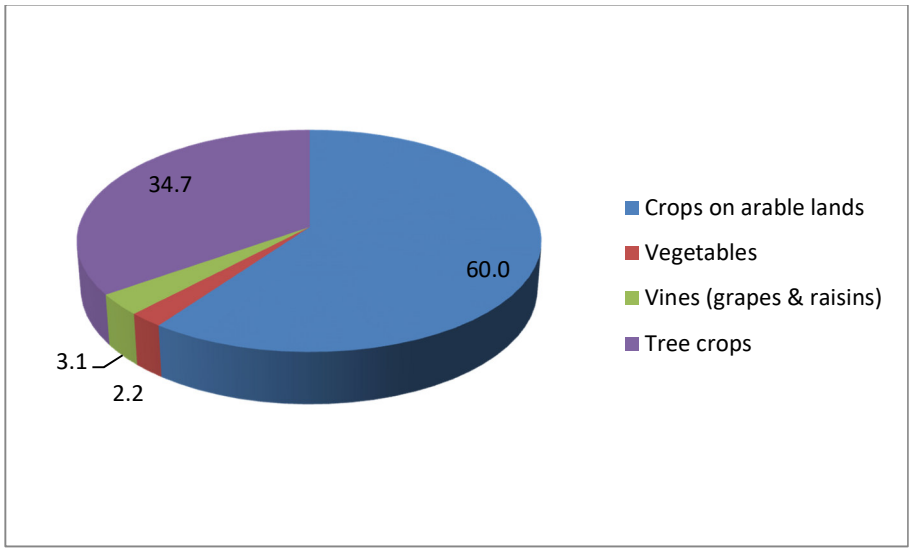

Figure 5.15 Percent distribution of agricultural crop areas in Greece, 2018

The main agricultural products in thousands of tons produced in Greece over the 2015-2018 period included wheat, cotton, tobacco, must, olive oil, oranges and lemons. The detailed production of those products is shown in Table 5.5. The most important change in the production of the agricultural products concerns the production of wheat, which has been steadily decreased over this period. The production of cotton and lemons was increased in 2018, while the production of the other agricultural products remained rather stable with small fluctuations between 2015 and 2018.

Table 5.5 Main agricultural products of Greece, 2015-2018 (thous. tons)

	2015	2016	2017	2018
Agricultural products				
Wheat	1459	1561	1357	1261
Cotton	818	739	809	860
Tobacco	37	38	33	31
Must	300	302	298	300
Olive oil	333	328	312	328
Oranges	809	806	727	745
Lemons	61	65	76	78

Animal agricultural production

The main animal capital measured in thousands of heads in Greece consists of bovines, pigs, sheep, goats and bees, which are measured in thousands of beehives. The detailed animal capital changes in thousands of heads for the years 2015 to 2018 are shown in Table 5.6. It is quite encouraging for the country's rural development that the animal capital with the exception of goats presented an upward trend over this period.

Table 5.6 Animal capital (thous. heads)

	2015	2016	2017	2018
Bovine	611	613	615	626
Pigs	714	698	717	720
Sheep	8746	8680	8828	8909
Goats	4128	3976	3998	3942
Beehives (thous.)	1519	1580	1647	1674

The main animal products of Greece include meat, milk, cheese and honey. The detailed animal production measured in thousands of tons from 2015 to 2018 is presented in Table 5.7. As it can be observed in 2018 there have been a small decrease of 3-5% for the meat, milk and hard cheese products and a small increase of about 1% for the soft cheese and honey products.

Table 5.7 Animal production (thous. tons)

	2015	2016	2017	2018
Meat	457	458	443	443
Milk	1972	1910	1921	1920
Cheese hard	36	35	34	33
Cheese soft	93	96	99	102
Honey	21	21	22	22

For the produced meat in particular Table 5.8 shows the detailed production of meet derived from bovines, sheep and goats, pigs and poultry. The data shown in Table 5.8 according to the Hellenic Statistical Authority 2018; 2019, refer to the total carcass weight of bovine animals and pigs slaughtered in slaughterhouses or on the farm, of sheep (including lambs) and goats slaughtered in slaughterhouses or elsewhere, as well as the total carcass weight of poultry slaughtered, where meat is declared fit for human consumption.

Table 5.8 Production of meat in Greece, 2016-2019 (thous. tons of carcass weight)

	2016	2017	2018	2019
Meet of				
Bovine	40.17	44.11	39.63	33.46
Sheep and Goats	74.52	71.32	70.10	72.33
Pigs	93.50	81.18	81.83	81.03
Poultry	212.65	214.30	219.91	229.95

5.1.2 Companies operating in the rural area or connected with the rural population

The number of commercial private legal entities, that is, the businesses operating in the rural areas or connected with the rural population of Greece is considered to be an important indicator that reflects the dynamics of specific economic sectors in these areas. Table 5.9 presents the annual change of the number of rural related businesses in the sectors of agriculture, forestry and fishery, mines and quarries, food industry, manufacture of beverages and wood industry. As it can be seen from Table 5.9 the most dynamic business field in the rural areas of Greece over the 2014-2017 period was agriculture, forestry & fishing, which appeared increasing particularly between 2014 and 2016.

Table 5.9 Number of businesses operating in the rural area or connected with the rural population of Greece during 2014-2017 classified by business activity

	2014	2015	2016	2017
Business activity				
Agriculture, Forestry & Fishery	463544	470286	528780	528632
Mines & Quarries	810	678	572	625
Food Industry	16353	15828	15231	15570
Beverages	1139	1105	1096	1190
Wood industry	3196	2824	2508	2476

The total number of the rural related businesses, that is, all the commercial private legal entities operating in the rural areas or connected with the rural population is depicted in the following Figure 5.16.

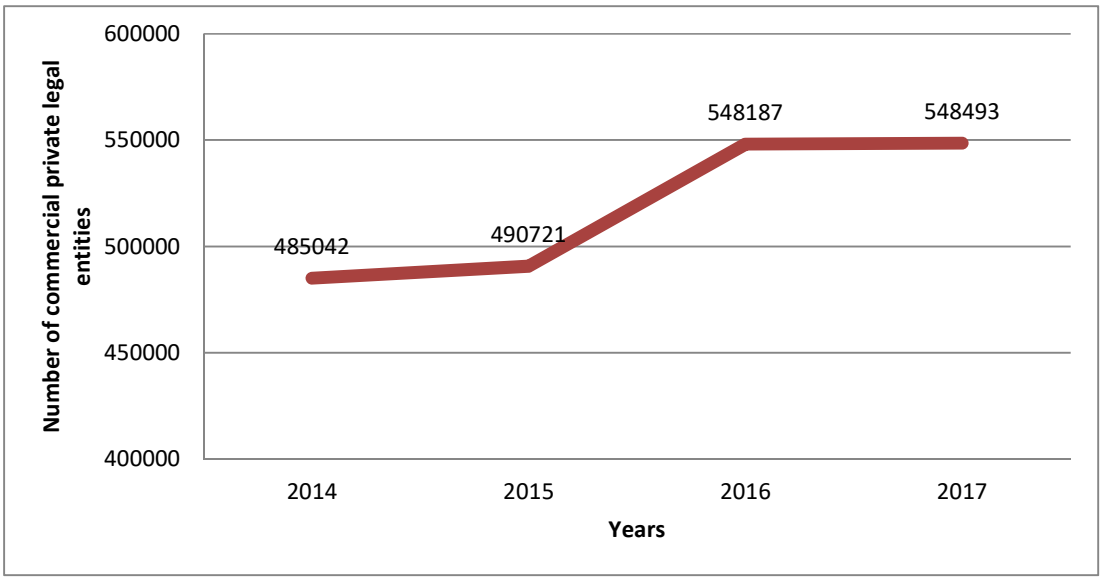

Figure 5.16 Number of commercial private legal entities in rural areas or connected with the rural population of Greece over the 2014-2017 period

5.1.3 Circular economy indicators: realization and perspectives in Greece

The European Union in 2015 adopted an action plan to support transition to a more circular economy where products, materials and resources would be maintained as long as possible and the waste generated would be minimized (EU Environmental Review Report – Country Greece 2019). This action plan was in line with the other EU priorities, such as growth, jobs, industrial innovation, investment, climate and energy and the efforts for sustainable development. In this context use of robust indicator frameworks it is considered important to monitor any progress towards circular economy. Although no widely accepted framework exists as yet for monitoring circular economy particularly due to the inherent systemic complexities of CE, the Eurostat has introduced an indicator framework which includes 10 indicators in 4 different thematic areas:

i) Production and consumption
- Self-sufficiency of raw materials for production in the EU
- Green public procurement (to be used as an indicator for financing aspects)
- Waste generation (to be used as an indicator for consumption aspects)
- Food waste

ii) Waste management
- Recyling rates (the recycled share of waste)
- Specific waste streams (packaging waste, biowaste, e-waste, e.t.c)

iii) Secondary raw materials
- Contribution of recycled materials to raw material demand
- Trade of recyclable raw materials between the EU Member States and with the rest of the world

iv) Competitiveness and innovation
- Private investments, jobs and gross value added
- Patents related to recycling and secondary raw materials as a proxy for innovation

The related indicators under the above 4 thematic areas for Greece are presented in

5.1.3.1 PRODUCTION AND CONSUMPTION

According to OECD (2020), the Domestic Material consumption (DMC) is the indicator used to represent the amount of materials, in terms of weight extracted or harvested in a country, plus the amount of materials and products imported, minus the amount of material and products exported. These materials include all types of materials used in the economy, such as metals, non-metallic minerals (construction minerals, industrial minerals), biomass (wood, food) and fossil energy carriers. The DMC for Greece expressed in tons/capita on an annual basis over the 2015-2019 period is shown in Table 5.10. The corresponding values of the EU-27/EU28 are also included in the table. There is a clear declining trend in the DMC of the country during this period reaching a total reduction of 20.53% in 2019 with respect to 2015, while the corresponding trend of the DMC in the EU 28 is slightly rising with a total increase of 2.8% in 2019 with respect to

2015. The DMC reduction in Greece clearly reflects the severe economic crisis the country suffered over the period in consideration and in particular the collapse of the manufacturing and construction sectors.

Table 5.10 Annual Domestic material consumption (DMC) per capita (tonnes/capita) in Greece and EU-27/EU28, 2015-2019

	Time				
Country	**2015**	**2016**	**2017**	**2018**	**2019**
GREECE	12.269	11.59	11.168	11.019	9.749
EU(27 countries-from 2020)	13.705	13.668	14.029	14.234	14.156
EU (28 countries)	13.054	12.999	13.328	13.473	13.42

https://ec.europa.eu/eurostat/tgm/table.do?tab=table&plugin=1&language=en&pcode=t2020_rl110

On the other hand the resource productivity in 2019, which is calculated as the ratio of GDP in PPS and DMC for Greece and the EU-27 is presented in Table 5.11. PPS (Purchasing Power) is an artificial common currency used by Eurostat to eliminate the effect of price level differences across countries due to fluctuations in currency exchange rates, when reflecting the differences between the purchasing power of, for example households. The resource productivity in Greece although lower it is close to the EU-27 index base value.

Table 5.11 Resource productivity in Greece and EU-27, 2019

Country	**GDP_{pps} per capita**	**DMC per capita**	**Resource productivity (GDP_{pps}/DMC)**	
	PPS per capita	tons per capita	PPS per kilogram	Index (EU-27=100)
GREECE	21040	9.7	2.2	97.9
EU-27	31105	14.2	2.2	100

GDP in current prices, PPS: Purchasing Power Standards

Eurostat (online data codes: env_ac_mfa, nama_10_gdp, demo_gind)

The total hazardous and nonhazardous waste in Greece as shown in Table 5.12 constitutes about 2.85% of the total EU-28 corresponding waste. The primary waste in Greece accounts for 99.33% of the total waste, while at the EU-28 level the primary waste comprises 94% of the total waste. However, the waste generation per capita recorded in Greece is well above that of the EU-27, as it appears in Table 5.13.

Table 5.12 Generation of hazardous and nonhazardous waste in Greece and EU-28, 2016

Country	**Total waste (tons)**	**Primary waste (tons)**	**Secondary waste (tons)**
Greece	72,358,026	71,875,121	482,905

EU-28	2,537,770,000	2,386,840,000	150,930,000

Table 5.13 Waste generation per capita in Greece and EU-27, 2016

Country	Waste generation per capita (kg per capita)
Greece	6,715.0
EU-27	5,078.0

https://ec.europa.eu/eurostat/statistics-explained/index.php/Waste_statistics#Total_waste_generation

The distribution of waste generation per economic sector expressed in % share in tons both in Greece and the EU-27 is presented in Table 5.14. It is evident from this Table that the biggest waste generation in Greece is related to the mining and quarrying sector (almost three times higher than the corresponding one in the EU-27), while the biggest share in waste generation in the EU-27 is attributed to the construction and demolition sector. Almost equal is the waste generation share in the energy sector in Greece and the EU-27.

Table 5.14 Waste generation by economic activities and households in Greece and EU-27 (% share in tons), 2016

Country	Mining and quarrying	Manufacturing	Energy	Construction and demolition	Other economic activities	Households
Greece	78.4	6.4	3.5	0.8	4.2	6.6
EU-27	27.6	11.1	3.4	34.8	14.7	8.3

https://ec.europa.eu/eurostat/statistics-explained/index.php/Waste_statistics#Total_waste_generation

The generated municipal waste per capita appeared in slightly increasing trend both in Greece and the EU-28 over the 2014-2018 period as it is shown in Table 5.15. The quantity values of municipal waste per capita in Greece were ranging a little higher than those of the EU-28 by 2-3%. No relevant data was available for Greece in year 2018.

Table 5.15 Generation of municipal waste per capita (Kg per capita) in Greece and EU-28, 2014-2018

	Time				
Country	**2014**	**2015**	**2016**	**2017**	**2018**
GREECE	488	488	498	504	n.a.
EU-28	478	480	487	487	488

(Eurostat, dataset: CEI_PC031)

The waste generation per GDP unit except major mineral wastes, such as those related to the mining, construction and demolition sectors presented in Table 5.16 showed that the cost of waste in Greece was higher than the EU-28 over the 2010-2016 period, although the difference was substantially reduced from 77.6% in 2012 to 20% in 2016.

Table 5.16 Generation of waste excluding major mineral wastes per GDP unit (Kg per thousand euro, chain linked volumes 2010) in Greece and EU-28, 2010-2016

	Time			
Country	**2010**	**2012**	**2014**	**2016**
GREECE	99	119	113	78
EU-28	67	67	66	65

(Eurostat, dataset: CEI_PC032)

The percentage of waste generation except major mineral wastes over the Domestic Material Consumption in Greece and the EU-28 over the 2010-2016 period is presented in Table 5.17. This indicator reflects how efficient the use of materials in the economy is with smaller values showing a higher level of efficiency. In Greece this indicator was higher but close to the European average from 2010 to 2014 reaching an even lower value than the European average in 2016.

Table 5.17 Generation of waste excluding major mineral wastes per Domestic Material Consumption (%) in Greece and EU-28, 2010-2016

	Time			
Country	**2010**	**2012**	**2014**	**2016**
GREECE	12.7	15.6	15.1	11.5
EU-28	12.4	12.8	13.1	13.6

(Eurostat, dataset: CEI_PC033)

The quantities of specific categories of wastes that are mostly connected with the rural areas in Greece and the EU-28 over the 2010-2016 period expressed in tons are presented in Tables 5.18, 5.19, 5.20 and 5.21. Specifically Table 5.18 includes the paper and cardboard wastes, Table 5.19 the wood wastes, Table 5.20 the animal and vegetal wastes and Table 5.21 the animal and mixed food wastes. It is evident for those types of waste that Greece represent a very small part of the EU relevant total quantities comprising specifically 1% of the corresponding EU total in terms of paper and cupboard wastes, 0.17% of the EU total of wood wastes, 1.17% of the EU animal and vegetal wastes and 1.43% of the EU relevant animal and mixed food wastes.

Table 5.18 Paper and cardboard wastes (tons) in Greece and EU-28, 2010-2016

	Time			
Country	**2010**	**2012**	**2014**	**2016**
GREECE	651,665	521,713	480,210	526,586
EU-28	51,950,000	49,620,000	50,390,000	

				50,660,000

Table 5.19 Wood wastes (tons) in Greece and EU-28, 2010-2016

	Time			
Country	**2010**	**2012**	**2014**	**2016**
GREECE	349,810	120,974	91,782	94,996
EU-28	60,020,000	56,690,000	51,990,000	54,740,000

Table 5.20 Animal and vegetal wastes (tons) in Greece and EU-28, 2010-2016

	Time			
Country	**2010**	**2012**	**2014**	**2016**
GREECE	651,665	521,713	575,225	1,115,124
EU-28	88,280,000	85,670,000	88,220,000	95,280,000

Table 5.21 Animal and mixed food wastes (tons) in Greece and EU-28, 2010-2016

	Time			
Country	**2010**	**2012**	**2014**	**2016**
GREECE	340,963	341,437	398,760	371,959
EU-28	25,880,000	23,700,000	23,040,000	26,000,000

(Eurostat, online data code: env-wasgen)

5.1.3.2 WASTE MANAGEMENT

The thematic area of waste management is intended to monitor the share of waste which is recycled and it is returned into the economy. The recycling rates of specific waste streams under monitoring towards transition to the circular economy include the municipal waste, all the waste excluding major mineral waste, the packaging waste, the e-waste, the construction and demolition waste expressed in percent (%) and the recycling of biowaste expressed in kg/capita. The performance of these indicators for Greece and the corresponding average EU-28 values are depicted in Tables 5.22 to 5.26, with the exception of the indicator concerning the recycling rate of all waste excluding major mineral waste because the relevant data estimation was not available.

The general trend in the performance of the above indicators in Greece from 2014 onwards is increasing indicating improvement in waste management as regards transition towards the circular economy. However, the recycling rate of municipal waste which shows the share of the recycled municipal waste over the total municipal waste generated including material recycling, composting and anaerobic digestion was almost 60% lower when compared to the EU-28 average. Similarly a much lower performance in comparison to the EU-28 average showed the recycling of biowaste by being almost 75% less than the EU-28 average. On the other hand, the recycling rate of packaging waste was close and even a little higher to the EU-28 average in 2017. Also the recycling rates of e-waste over the 2014-2017 period and the recovery rate of construction and demolition mineral waste recycled were close to the corresponding EU-28 rates; the latter in particular exhibiting a very rapid increase moving from 0 to 88% near to the 89% EU-28 rate.

Specific waste streams

Table 5.22 Recycling rate of municipal waste (%) in Greece and EU-28, 2014-2018

	Time				
Country	**2014**	**2015**	**2016**	**2017**	**2018**
GREECE	15.4	15.8	17.2	18.9	n.a.
EU-28	43.4	44.7	46.0	46.5	47.1

(Eurostat, dataset: CEI_wm011)

Table 5.23 Recycling rate of packaging waste by type of packaging (%) in Greece and EU-28, 2014-2017

	Time			
Country	**2014**	**2015**	**2016**	**2017**
GREECE	53.8	60.3	66.1	68.6
EU-28	65.5	65.8	67.2	67.0

(Eurostat, dataset: CEI_wm020)

Table 5.24 Recycling of biowaste (kg/capita) in Greece and EU-28, 2014-2018

	Time				
Country	**2014**	**2015**	**2016**	**2017**	**2018**
GREECE	15	12	17	21	n.a.
EU-28	87	80	85	81	82

(Eurostat, dataset: CEI_wm030)

Table 5.25 Recovery rate (%) of construction and demolition mineral waste recycled in Greece and EU-28, 2010-2016

	Time			
Country	**2010**	**2012**	**2014**	**2016**
GREECE	0	0	0	88
EU-28	n.a	n.a	89	89

(Eurostat, dataset: CEI_wm040)

Table 5.26 Recycling rate (%) of e-waste in Greece and EU-28, 2014-2017

	Time			
Country	**2014**	**2015**	**2016**	**2017**
GREECE	29	32.7	34.2	32.9
EU-28	32.2	35.8	41.2	39.4

(Eurostat, dataset: CEI_wm050)

5.1.3.3 SECONDARY RAW MATERIALS

In terms of the secondary raw materials two are the most important indicators measured at the European level is the annual circular material use rate and the trade in recyclable raw materials.

The circular material use, also known as circularity rate is defined as the ratio of the circular use of materials to the overall material use, which is the share of material recovered and fed back into the economy in overall material use. This indicator in other words expresses the extraction savings of primary raw materials. A higher circularity rate value means that more secondary materials substitute for primary raw materials thus reducing the environmental impacts of extracting primary material. Table 5.27 shows an increasing trend in the circularity rate in Greece over the 2014-2017 period. However, in 2017 the circularity rate it only reached 20% of the EU28 average circularity rate leaving a lot of space for improvement.

Table 5.27 Annual circular material use rate (% of total material use) in Greece and EU-28, 2014-2017

	Time			
Country	**2014**	**2015**	**2016**	**2017**
GREECE	1.4	2	2.3	2.4
EU-28	11.5	11.7	11.9	11.7

(Eurostat, dataset: CEI_srm030)

The trade in recyclable raw materials concerns the imports and exports of waste destined for recycling, which are approximated from the European statistics on international trade in goods. Specifically, this indicator measures the quantities of selected waste categories and by-products that are shipped between the EU Members States (intra-EU) and across the EU borders (extra-EU). Five classes have been selected: plastic; paper and cardboard; precious metal; iron and steel; copper, aluminum and nickel. The trend of the recyclable raw materials trade in Greece over the 2015-2019 period in Greece, expressed in tonnes, is increasing as it shown in Table 5.28. However, it remains much lower than the EU-27 average and therefore, improvement efforts should be pursued.

Table 5.28 Trade in recyclable raw materials (tonnes) in Greece and EU-27, 2015-2019

	Time				
Country	**2015**	**2016**	**2017**	**2018**	**2019**
GREECE	222,002	496,690	506,196	624,698	719,814
EU-27	9,234,860	8,729,722	9,317,020	9,271,636	8,877,945

(Eurostat, dataset: CEI_srm020)

5.1.3.4 COMPETITIVENESS AND INNOVATION

Competitiveness and innovation in circular economy are measured for the private investments, jobs and gross value added in different sectors of circular economy. These include the known as three R, recycling, repair and reuse, as well as the rental and leasing sectors. Specifically, these indicators are defined as follows.

-The value added at factor cost according to the Structural Business Statistics includes the gross income derived from operational activities following adjustment for operating subsidies and indirect taxes. It is measured in Mio euro and as a percentage of the gross domestic product (GDP)

- The gross investment in tangible goods involves any investment made on existing or new goods, even if they are bought or produced for own use, as long as they have a lifetime for over one year. Land is included in the measurement of this indicator, but intangible and financial possessions are excluded. It is measured in Mio euro and as a percentage of the GDP.

- The persons employed. It is in numbers and as a percentage of total employment concerns all the persons working and paid by the companies.

- The patents related to recycling and secondary raw materials.

Tables 5.29 up to 5.34 show the progress of the above described indicators in Greece over the 2014-2017 period and the corresponding EU-28 average values.

Table 5.29 Value added at factor cost (Mio Euro) in Greece and EU-28, 2014-2017

Country	2014	2015	2016	2017
GREECE	617.7	638.1	616.8	644.8
EU-28	140429.1	145797.3	146742.7	154790.1

(Eurostat, dataset: CEI_cie010)

Table 5.30 Value added at factor cost-percentage of gross domestic product (GDP) In Greece and EU-28, 2014-2017

Country	2014	2015	2016	2017
GREECE	0.35	0.36	0.35	0.36
EU-28	1	0.98	0.98	0.99

(Eurostat, dataset: CEI_cie010)

The value added at factor cost appeared much lower than the EU-28 corresponding value. This holds true even when this indicator was calculated in relation to the corresponding population numbers. For example in year 2017, the value added at factor cost for Greece amounted to 60 euros per resident, while the corresponding value for the EU-28 to 302 euros per resident, that is 80% less than the European average. These calculations refer to resident populations of 10724599 and 511378572 people in Greece and the EU-28 correspondingly. The same trend applies when this indicator was expressed as a percentage of the gross domestic product, although in this case it was about 65% less than the European average.

Table 5.31 Gross investment in tangible goods (Mio euro) in Greece and EU-28, 2014-2017

Country	2014	2015	2016	2017
GREECE	76.7	76.7	66.4	95.4
EU-28	15156.2	17171.3	17490.1	18421.5

(Eurostat, dataset: CEI_cie010)

Table 5.32 Gross investment in tangible goods-percentage of gross domestic product (GDP) in Greece and EU-28, 2014-2017

Country	2014	2015	2016	2017
GREECE	0.04	0.04	0.04	0.05
EU-28	0.11	0.12	0.12	0.12

(Eurostat, dataset: CEI_cie010)

The gross investment in tangible goods when compared to the population of Greece in 2017 was 4 times less the EU-28 European average reaching just 9 euros per resident, while the corresponding EU-28 value was 36 euros per resident. This indicator value even when expressed as a percentage of the GDP remains 2.5 times lower in Greece than the EU-28 average.

Table 5.33 Number of persons employed in Greece and EU-28, 2014-2017

Country	2014	2015	2016	2017
GREECE	57973	67528	63084	68879
EU-28	3884595	3903500	4027400	4049384

(Eurostat, dataset: CEI_cie010)

Table 5.34 Persons employed-percentage of total employment in Greece and EU-28, 2014-2017

Country	2014	2015	2016	2017
GREECE	1.5	1.34	1.51	1.42
EU-28	1.71	1.7	1.73	1.71

(Eurostat, dataset: CEI_cie010)

With reference to the persons employed indicator in Greece less people appeared employed in the circular economy sectors although when this indicator was calculated as a percentage of the total employment in Greece and the EU-28 the difference in 2017 was small, as it is shown in Table 5.34.

Table 5.35 Patents related to recycling and secondary raw materials in Greece and EU-28, 2012-2015 (per million inhabitants)

Country	2012	2013	2014	2015
GREECE	0	0	0.09	0.09
EU-28	0.73	0.69	0.66	0.7

(Eurostat, dataset: CEI_cie020)

The indicator referring to patents related to recycling and secondary raw materials as it is shown in Table 5.35 in 2015 in Greece was well below the EU-28 average. Greece recorded even less than 0.1 patents per 1 million inhabitants while the corresponding EU-28 was 0.7 per 1 million inhabitants, leaving much room for innovation improvement of the country.

Overall, although the circular economy indicators in Greece have shown an upward trend, they remain below the EU-28 or EU-27 average values. Therefore, more intense efforts need to be undertaken to improve the current conditions of circular economy progress.

5.2 Circular economy in the Drama Regional Unit of Eastern Macedonia & Thrace Region

5.2.1 Presentation of the Eastern Macedonia and Thrace Region and the Drama Regional Unit

The Region of Eastern Macedonia and Thrace (Fig. 5.17) is one of the thirteen administrative regions of Greece (EU NUTS II-level division) with a total population of 608,182 people and population density of 43/km^2. It is located in the northeastern part of the country and its land borders Bulgaria to the north, Turkey to the east and the Region of Central Macedonia to the west, while it is surrounded to the southwest by the Aegean Sea and to the southeast by the Thracian Sea. Its surface area covers about 14,073 km^2 corresponding approximately to 10.7% of the total area of Greece.

The geomorphology of the Eastern Macedonia and Thrace region is very intense with many mountain massifs, dominated by the Rhodope Mountains in the north on the border with Bulgaria, as well as rivers, wetlands, and plains. Other high altitude mountains in the Region include Falakron, Orvilos, Menoikion, Paggaion, and Feggari-Saos mountains. In the southern parts of the Region several rivers and streams flow into the sea creating extensive wetlands and typical Mediterranean deltas, such as those of the rivers Evros and Nestos. The latter have been designated as wetlands of international importance under the Ramsar Convention.

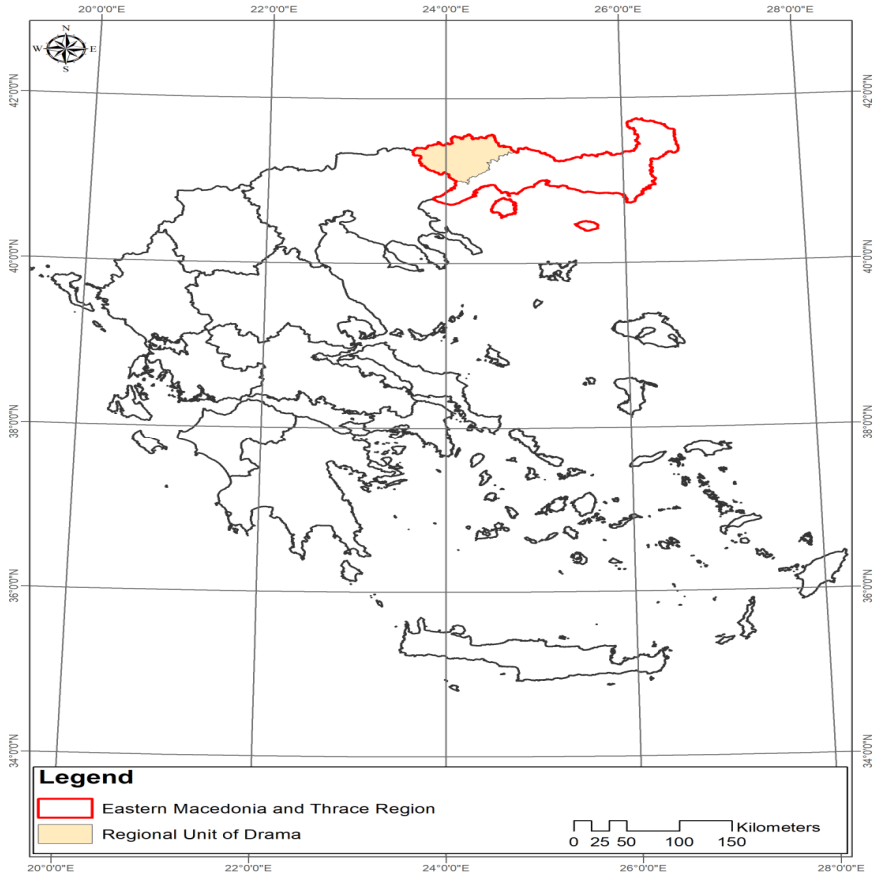

Figure 5.17 Location map of the Eastern Macedonia and Thrace Region and the

Water resources are abundant in the l, although 75 -80% of surface water comes from the cross-border Rivers Nestos, Strymon, and Evros.

Between lakes Vistonida and Ismarida, the complex of wetlands of Thrace includes nine main lagoons occupying an area of 244km^2. The landscape to the east of the Region is mainly flat, with the most extensive plains located in Xanthi, Komotini, and Orestiada-Didymoteicho.

The climate along the coastal zone of the Region is of Mediterranean type with an average of 120 sunny days per year, while in the rest of the Region is the continental type with hard winters, high rainfalls, and frequent snowfalls, particularly in the northern parts of the region. The maximum temperature reaches 38^{o}C in the summer and goes down to -5.8^{o}C in the winter, with the mean average ranging between 14^o- 16^{o}C. The mean annual rainfall highly fluctuates between a low of around 10.4mm in September and a high of 67.4mm in November.

The area of the Eastern Macedonia and Thrace Region is considered of very high ecological value, as plenty of important ecosystems coexist within a rather limited geographical extent. This explains the significant number of designated protected areas in the Region according to national and international regulations. Specifically, the legally protected areas of the Region include 4 national parks, 36 sites of the Natura 2000 European network, 2 aesthetic forests, 3 biogenetic reserves, 3 wetlands of international importance (Ramsar Convention), and 51 wildlife refuges, and 20 traditional villages.

The Eastern Macedonia and Thrace Region consists of the administrative Macedonian Regional Units of Drama, Kavala and Thassos and the Thracian Regional Units of Xanthi, Rhodope and Evros. The capital city of the Region is Komotini, which is the fourth largest city by population following Alexandroupoli, Kavala and Xanthi (Figure 5.18). The Region of Eastern Macedonia and Thrace along with the Region of Central Macedonia are supervised by the Decentralized Administration of Macedonia and Thrace based at Thessaloniki.

The Regional Unit of Drama, which is the focus case area in the MULTITRACES project, is located in the northwestern part of the Region. It borders Bulgaria to the north, the Regional Unit of Kavala to the south, the Regional Unit of Rhodope to the east and the Regional Unit of Serres to the west. The surface area of the Regional Unit of Drama is 3466 km^2 accounting for about 25% of the total territory of Eastern Macedonia and Thrace Region.

The majority of the Drama area (about 70%) is dominated by big mountain massifs, including the Mountains of Falakron (2232m), Frakton (1953m), Elatia (1826m), Menoikion (1936m) and Orvilos (2212m). The southern part of the Drama area is shaped by a big contiguous plain extending over 431km^2 of land. The main rivers crossing the Drama area include Nestos River, which originates from Bulgaria and Aggitis River, which collects its waters from the swamps of Philippi.

From the administrative point of view the Regional Unit of Drama consists of five Municipalities, Drama, Kato Nevrokopi, Prosotsani, Doxato and Paranesti, which are depicted in

Figure 5.20. The population distribution in the 5 municipalities of the Regional Unit of Drama is provided in the following Tale 5.36.

Table 5. 36 Population distribution per Municipality of the Regional Unit of Drama

Municipality	Population
Doxato	14516
Drama	58944
Kato Nevrokopi	7860
Paranesti	3901
Prosotsani	13066

(Source: ELSTAT, National Census 2011)

The capital city of the Regional Unit of Drama is the homonymous city of Drama.

5.2.2 Economic activities and population structure

According to the degree of urbanization/rurality about 97.5% of the Eastern Macedonia and Thrace territory is characterized as rural area, a land pattern similar to that of the country as a whole. Table 5.37 shows the detailed spatial land distribution of the Region.

Table 5.37 Land distribution according to degree of urbanization/rurality in Eastern Macedonia and Thrace Region, Greece, 2020

GRIDCODE	Area (ha)	km^2	Percentage (%)
Rural	1371647,14	13716,47	97,47
Towns and suburbs (Intermediate areas)	32038,14	320,38	2,28
Cities (urban)	3567,47	35,67	0,25
TOTAL	1407252,75	14072,53	100,00

The detailed land use distribution over the entire Region's territory and its administrative Regional Units (RUs) is depicted in Figure 5.18, while the land use percent distribution in the Region is shown in Figure 5.19.

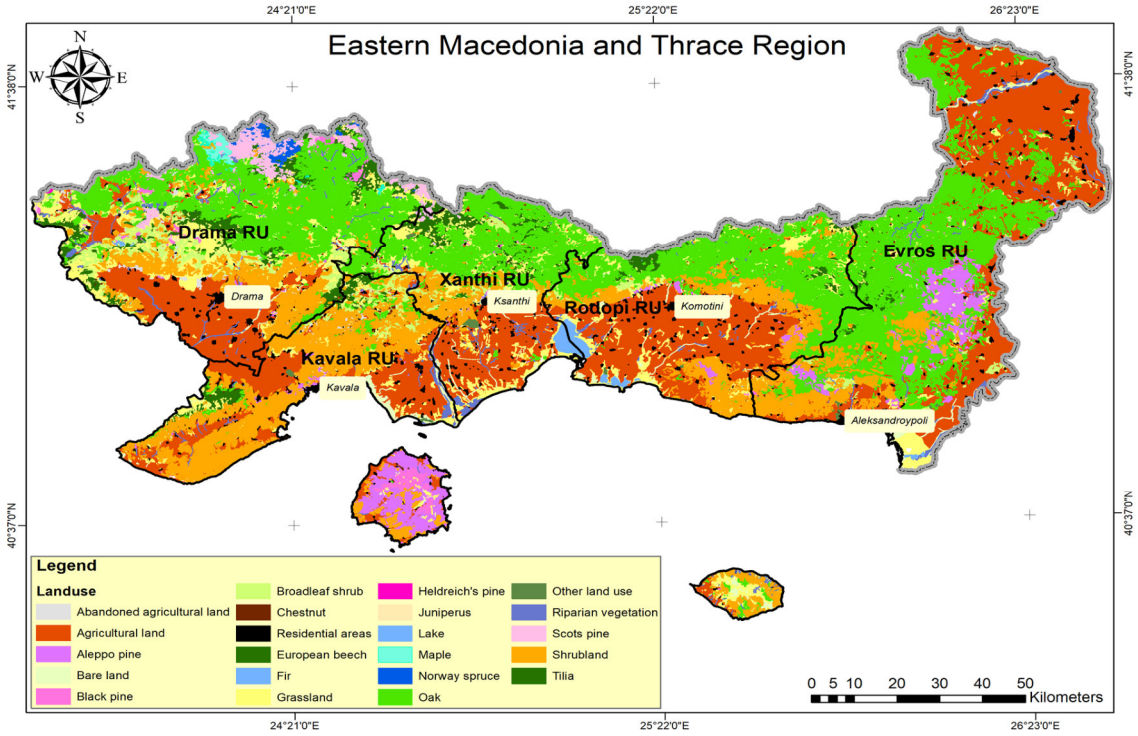

Figure 5.18 Land use of the Eastern Macedonia and Thrace Region and its administrative Regional Units (RU), Greece

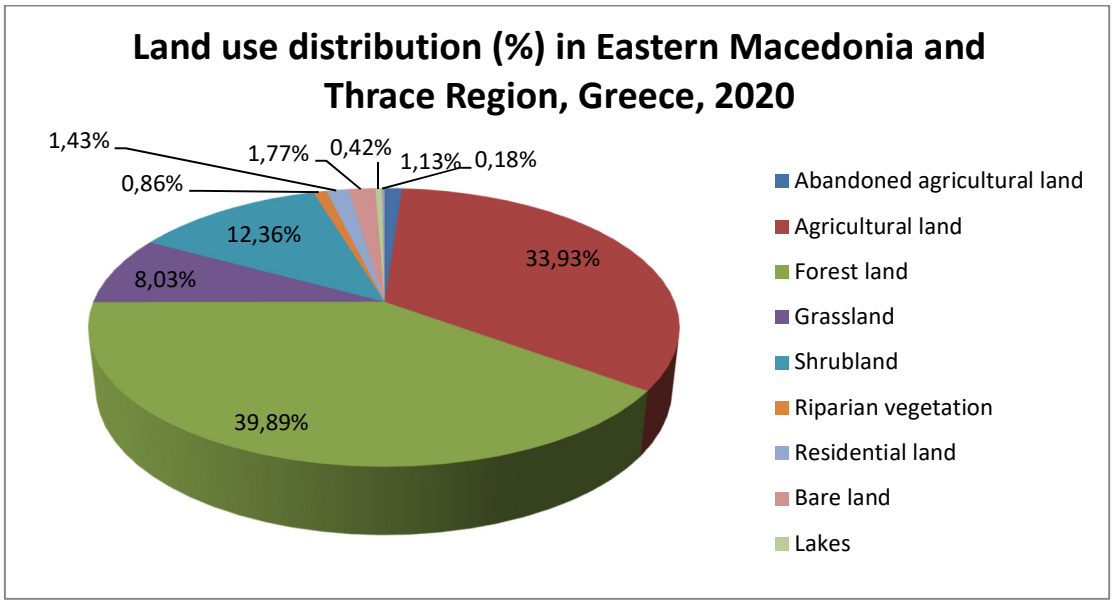

Figure 5.19 Percent land use distribution in the Region of Eastern Macedonia and Thrace, Greece

For the Regional Unit of Drama specifically, the spatial land distribution in terms of the degree of urbanization/rurality is shown in Table 5.38.

Table 5.38 Land distribution according to degree of urbanization/rurality in the Regional Unit of Drama, Greece, 2020

GRIDCODE	Area (ha)	km^2	Percentage (%)
Rural	337896	3378,96	97.50
Towns and suburbs (Intermediate areas)	8675	86,75	2.50
TOTAL	346571	3465,71	100,00

It is evident from Table 5.38 that there are no urban areas in the Regional Unit of Drama, while the great majority of its surface area, namely 97.5% similarly to the entire Eastern Macedonia and Thrace Region is classified as rural land. However, the population of the Regional Unit of Drama is almost equally split between the land classified as rural and the intermediate areas, that is towns and suburbs, as shown in the following Table 5.39, where it is clearly indicated that the rural territory of the Regional Unit of Drama is very sparsely populated with only 14.67 persons/km^2.

Table 5.38 Population distribution according to degree of urbanization/rurality in the Regional Unit of Drama, 2020

GRIDCODE	Population	km^2	Percentage (%)	Population density (persons/km^2)
Rural	49575,00	3378,96	50.44	14.67
Towns and suburbs (Intermediate areas)	48712,00	86,75	49.56	561.50
TOTAL	98287,00	3465,71	100,0	28.36

The land use distribution in the Regional Unit of Drama and its five Municipalities is depicted in Figure 5.20, while the percent land use distribution is presented in Figure 5.21. Similar to the land use pattern of the Eastern Macedonia and Thrace Region as a whole, the dominant land uses in the Regional Unit of Drama are agriculture and forestry covering 74% of its territory. The forests of Drama area are composed by several deciduous and coniferous species, in pure or mixed forms. They are under the management responsibility of the National Forest Service, and they are managed mainly for wood production, based on selective loggings in order to protect the forest soil properties. The productive forests of Drama occupy approximately 173303 ha or about 49,97% of the total Regional Unit area extending across all different elevations. The percent distribution of the forest area of the Regional Unit of Drama at different elevation classes is presented in the following Table 5.39.

Table 5.39 Percent forest area according to elevation classes

Elevation (m)	Forest percentage (%)
0 - 300	14.2
300 - 600	26.7
600 - 1200	41
1200 - 2000	18.1
>2000	-
Total	100

An important land use for the area form also the grasslands and shrublands , which occupy about 21% of the land making it suitable for livestock production.

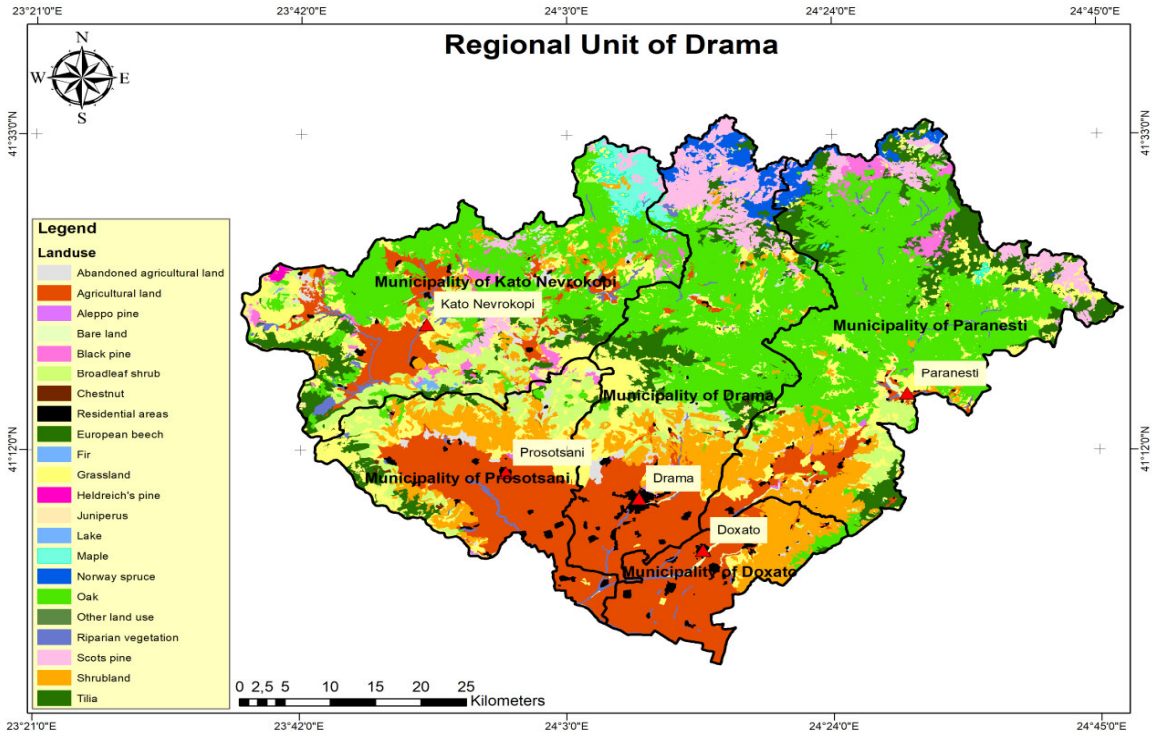

Figure 5.20 Land use distribution in the Regional Unit of Drama and its Municipalities, Eastern Macedonia and Thrace Region, Greece

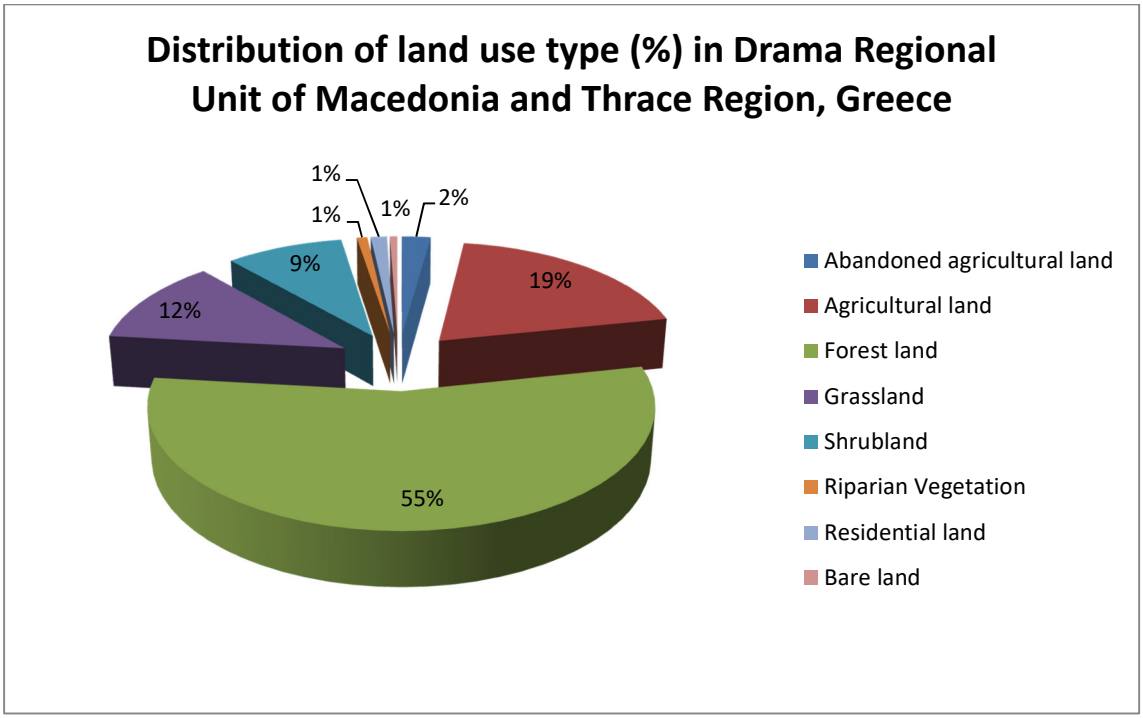

Figure 5.21 Percent land use distribution in the Regional Unit of Drama, Eastern Macedonia and Thrace Region, Greece

The total agricultural land in Drama regional unit is approximately 67557 ha. The mean area of agricultural occupation is about 7.01ha, while the mean land parcels per unit has been estimated at 11, thus corresponding to a mean value of 0.7ha per land parcel. The main agricultural crops in the Regional Unit of Drama include cereals, cotton, tomatoes, tobacco, vineyards, fruits and vegetables.

The forestry sector as a primary sector of production is also significant in the Regional Unit of Drama. The high productive forests located particularly in the northern part of the region consist mainly of pines, beeches, Norway spruces and oaks at various degrees of mixing. Despite the fact that the forest area of Drama represents only 2.6% of the country's total forest area, it contributes approximately 11% to the total produced wood at national level. The mean growing stock of the forest areas is 92.68m^3 per hectare, although this is not considered to be representative of the growth potential of the area due to the overexploitation that occurred during the past years. Hence, the growing stock potential is estimated to reach 300-350m^3 per hectare in the most productive forest sites of the area. According to the Forest Service of Drama the total woody volume of the 173303 ha of the Drama forest land is estimated to 16,061,470m^3.

The agricultural sector provides significant revenue to the region, contributing about 0.5% to the national GDP and about 1.5% to the total country agricultural production. A great economic asset with high economic potential also in the Regional Unit of Drama is the marble exploitation, which is carried out through the extended quarries' network of the area. About 80% of the total marble exports at national level are originated from the 80 active quarries of the Regional Unit of Drama, which comprise about 40% of the country's active quarries. In addition, the subsoil of the Regional unit contains significant amounts of minerals, such as manganese in Falakron

Mountain, uranium in the wider area of Paranesti and lignite in Mavrolefki, located in the central part of the Regional Unit of Drama. However, the investments required for the exploitation of the mineral resources of the Regional Unit of Drama as well as other parts of the Eastern Macedonia and Thrace Region are still an issue of public debate regarding the future development of the area particularly due to their potential negative impacts on the high-valued ecologically and aesthetically natural environment of the area.

The secondary sector of the area's economy includes mainly industries of small-medium size and fewer big ones established in the area during the past few years, in the fields of marble processing, metal and wood processing, as well as food and beverage production. The tertiary sector of the area's economy includes mainly businesses operating in the fields of transportation, storage, communication, social activities, wholesale and retail trade, catering services and financial services. Tourism is not well developed in the area although the alternative tourism potential has been well recognized by all the concerned stakeholders of the area. In the past few years however, more emphasis has been given to the development of the area's tourism opportunities and several investments in tourism infrastructure were realized particularly in hotel units and organization of large scale events through collaboration of the local authorities with professional associations in order to attract more tourists in the area.

The number of enterprises per sector type in the Regional Unit of Drama as recorded by the Commercial Chamber of Drama (2022) is presented in the following table 5.40.

Table 5.40 Number of active companies per sector type in the Regional Unit of Drama

Sector type	Number
Agriculture-Forestry -Fishery	81
Mines & Quarries	43
Food & Beverage Industry	161
Wood Industry	80
Manufacturing	604
Construction	250
Services	4984

(Source: Commercial Chamber of Drama, 2022)

As it is shown in Table 5.40 there are many more businesses operating in the services field, although the number of businesses in the fields of food & beverage, wood processing and manufacturing is also significant. Overall the agricultural sector is suffering a gradual decline in the area, following the general trend of agriculture at national level since 2003 onwards. This is clearly depicted in the following Figure 5.22, where the contribution of each sector of economy to the area's GDP.

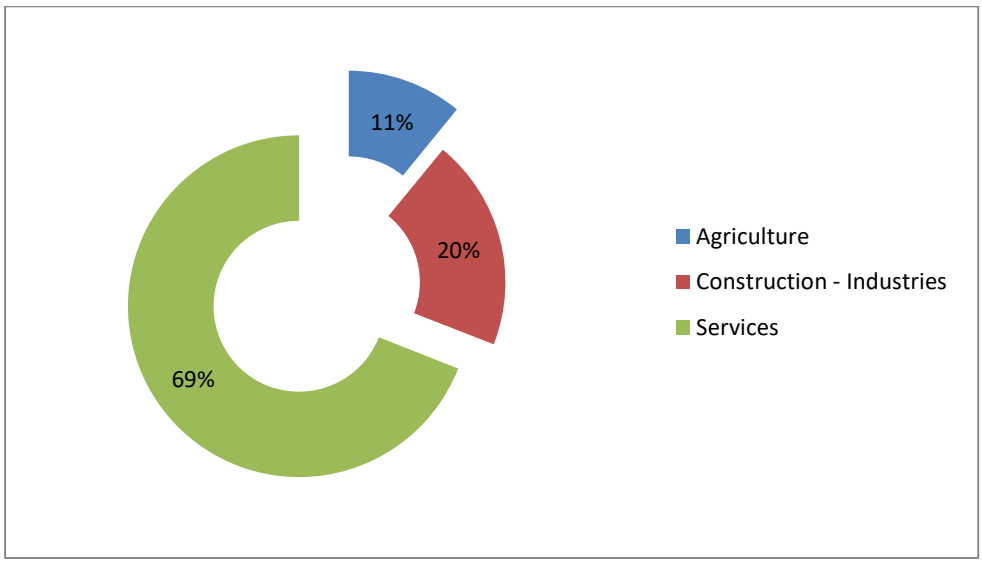

Figure 5.22 The contribution of the economic sectors to the total wealth of the Regional Unit of Drama

The population trend over the past 5 years, that is, during the period 2017-2021 for both the Regional Unit of Drama and the Eastern Macedonia and Thrace Region is presented in the following Table 5.41 (Eurostat 2022). The trend is clearly declining reflecting the general demographic problem of Greece, although the actual percent change of the population in the Regional Unit of Drama (-0.73%) is less than that of the Eastern Macedonia and Thrace Region (-1.31%).

Table 5.41 Total population of the Regional Unit of Drama and the Eastern Macedonia and Thrace Region, 2017-2021

	2017	2018	2019	2020	2021	% Change 2017-2021
Regional Unit of Drama	96836	96760	96845	96925	96133	-0.73
Eastern Macedonia and Thrace Region	602799	601175	599723	598613	594905	-1.31

The sex proportion in the Regional Unit of Drama is in favor of females (approximately 48% males and 52% females) with trend appearing rather stable over the period 2017-2021 (Figure 5.23).

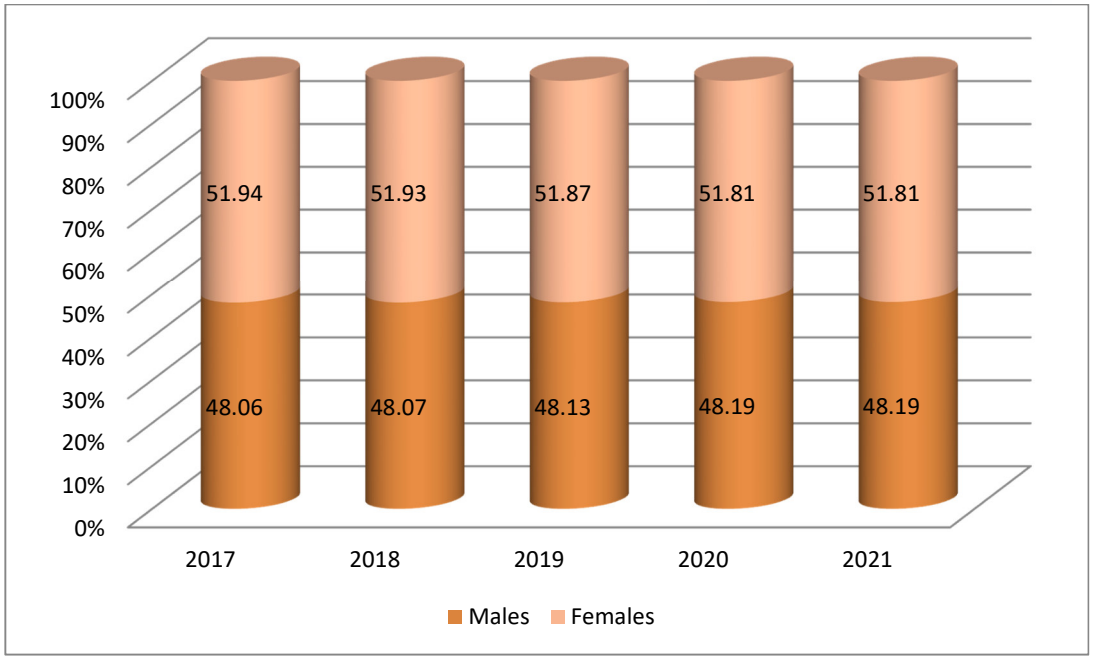

Figure 5.23 Population of the Regional Unit of Drama by sex, 2017-2021

The analysis of the total population decline trend by age groups in the Regional Unit of Drama (Table 5.42 and Figure 5.24) indicated that the births have decreased over the 2017-2021 period, since the percent change in the age group less than 15 years of age was more than -6%, while the deaths of elderly people were increased, since in the age group over 65 years of age an increase of 1.32% was recorded. This increase could be to a large extent also attributed to the Covid19 pandemic, as most of the Covid19 deaths in Greece have been related with the over 65 years of age group. The smallest decrease was observed in the economically active age group from 15-64 years of age (-0.32%).

Table 5.42 Population by age groups of the Regional Unit of Drama, 2017-2021

Age groups	2017	2018	2019	2020	2021	% Change 2017-2021
< 15 years	13155	13037	12871	12655	12345	-6.16
15-64 years	59139	59133	59177	59268	58922	-0.37
>65 years	24542	24590	24797	25002	24866	1.32
TOTAL	96836	96760	96845	96925	96133	-0.73

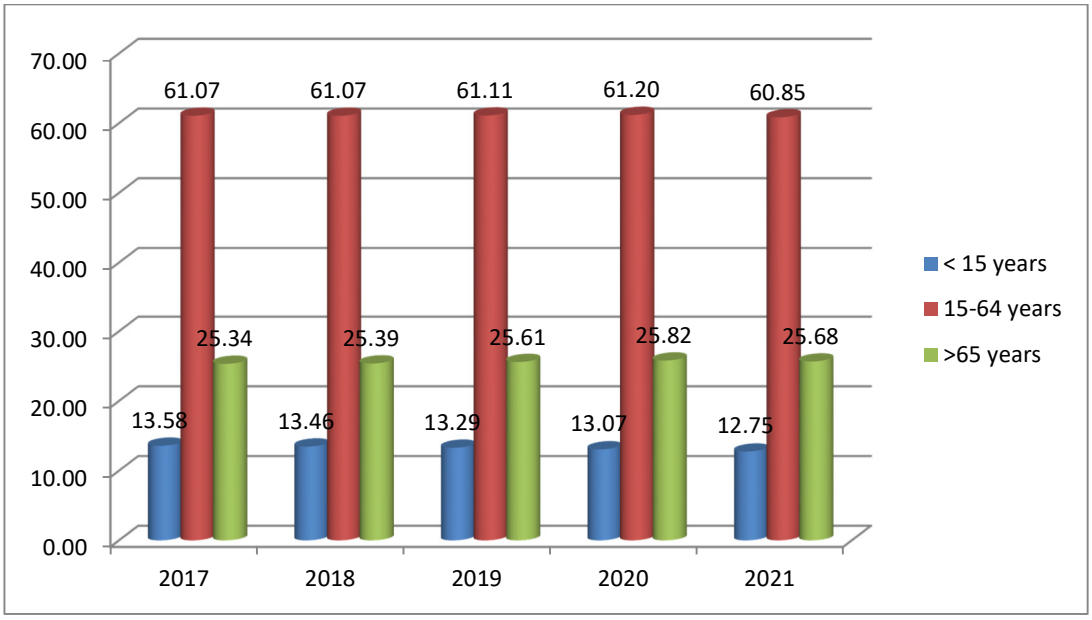

Figure 5.24 Percent population by age groups of the Regional Unit of Drama, 2017-2021

Regarding the marital status of the population in the Regional Unit of Drama more than half (52.6%) are married people, 35% are unmarried, 9.7% widowed and 2.7% divorced.

Employment in the Regional Unit of Drama has shown a positive trend over the 2017-2019 period both for the employed persons and the employers. Specifically, the number of the employed people increased by almost 5.5%, while the number of employers by 9% (Table 5.43). About 55% of the employed persons are in the sector of services, while in agriculture and industries (except construction) are employed 18% and 13% respectively (Figure 5.25). In terms of the employers, 52% are in services and 11% and 19% in agriculture and industries (except construction) (Figure 5.26). In Tables 5.44, 5.45, 5.46, 5.47 and 5.48 the employment trend over the 2017-2019 period is presented through the records of the number of both the employed persons and the employers (Eurostat 2022). As it is observed the highest increase occurred in the number of employers in the industry sector (10%) followed by the services sector (9.4%), the manufacturing sector (9.3%) and the agriculture, forestry & fisheries sector (8%). In all sectors the increase in the number of employers is significantly higher than the increase in the employed people in the corresponding sectors, which indicates that more people started their own businesses.

Table 5.43 Employment in the Regional Unit of Drama, 2017-2019

	2017	2018	2019	% Change 2017-2019
Employed (thous.)	26,41	27,68	27,85	5,45
Employers (thous.)	16,85	17,97	18,39	9,14

Table 5.44 Employment in the Agriculture, Forestry & Fisheries Sector of the Regional Unit of Drama, 2017-2019

	2017	2018	2019	% Change 2017-2019
Employed (thous.)	5,05	5,13	5,05	-
Employers (thous.)	1,88	2,00	2,03	7,97

Table 5.45 Employment in the Industry sector (except construction) of the Regional Unit of Drama, 2017-2019

	2017	2018	2019	% Change 2017-2019
Employed (thous.)	3,28	3,5	3,54	7,92
Employers (thous.)	3,1	3,3	3,42	10,32

Table 5.46 Employment in the Manufacturing sector of the Regional Unit of Drama, 2017-2019

	2017	2018	2019	% Change 2017-2019
Employed (thous.)	2,64	2,83	2,87	8,71
Employers (thous.)	2,58	2,82	2,82	9,30

Table 5.47 Employment in the Construction sector of the Regional Unit of Drama, 2017-2019

	2017	2018	2019	% Change 2017-2019
Employed (thous.)	1,2	1,19	1,2	-
Employers (thous.)	0,56	0,56	0,57	1,0

Table 5.48 Employment in the Services sector of the Regional Unit of Drama, 2017-2019

	2017	2018	2019	% Change 2017-2019
Employed (thous.)	14,24	15,03	15,19	6,67
Employers (thous.)	8,73	9,29	9,55	9,39

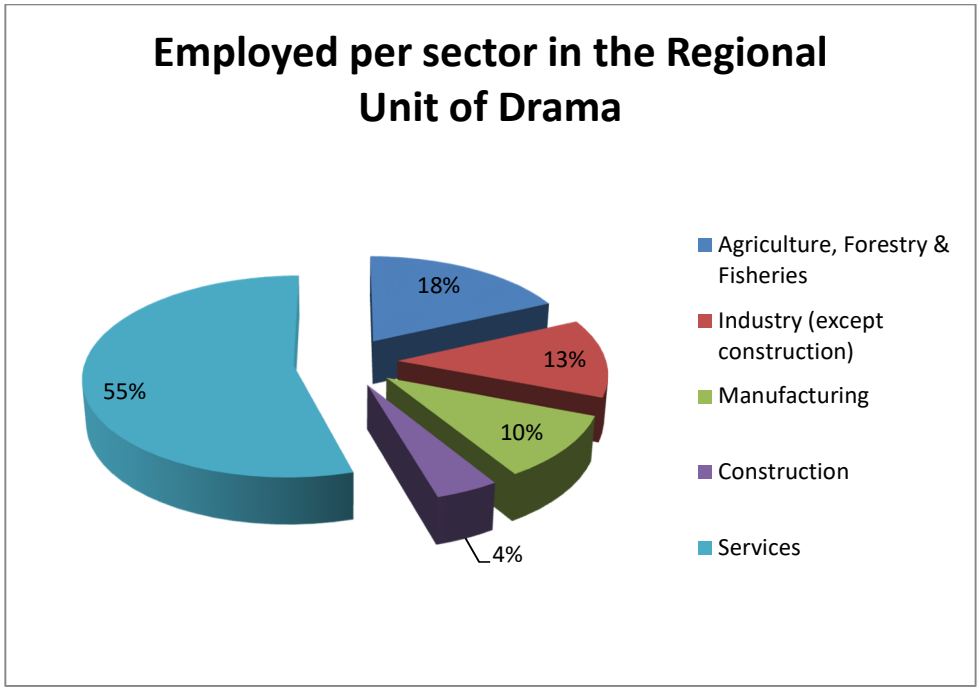

Figure 5.25 Percent distribution of employed persons per sector in the Regional Unit of Drama, 2019

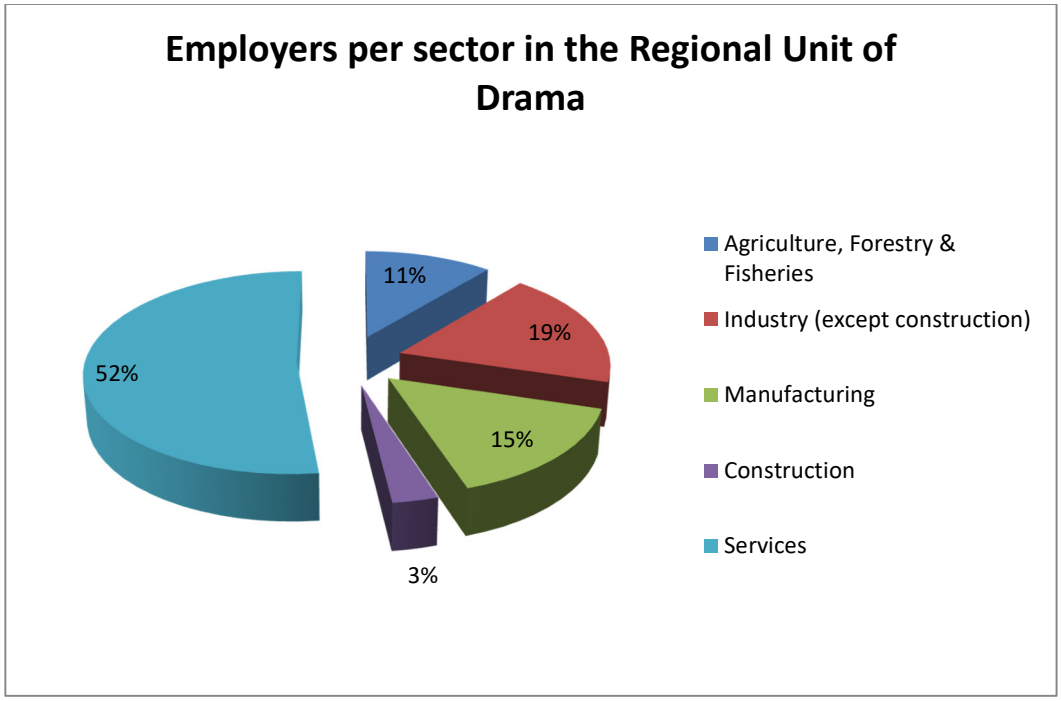

Figure 5.26 Percent distribution of employers per sector in the Regional Unit of Drama, 2019

In the Regional Unit of Drama there are 134 educational units (schools) of which 54 kindergartens, 45 primary schools, 18 secondary schools and 17 high schools, proportionally

distributed in the five municipalities of the region. In addition, a campus of the Faculty of the Geotechnical Sciences of the International Hellenic University is located close to Drama city with 2 Departments, the Department of Forestry & Natural Environment Sciences and the Department of Agricultural Biotechnology and Oenology.

Based on the Eurostat database (2022) the unemployment rate in the Regional Unit of Drama, as it is shown in Figure 5.27 increased significantly in 2017 reaching 26.7% with regard to 2011 (23.6%), when the financial crisis started in Greece. The Local Employment Centre of Drama has estimated the unemployment rate even higher, that is, about 30% in year 2018, varying between graduates of different levels of education as follows: 16.8% for primary school graduates, 12.3% for high school graduates, 30.2% for lyceum graduates and 32.4% for higher education graduates.

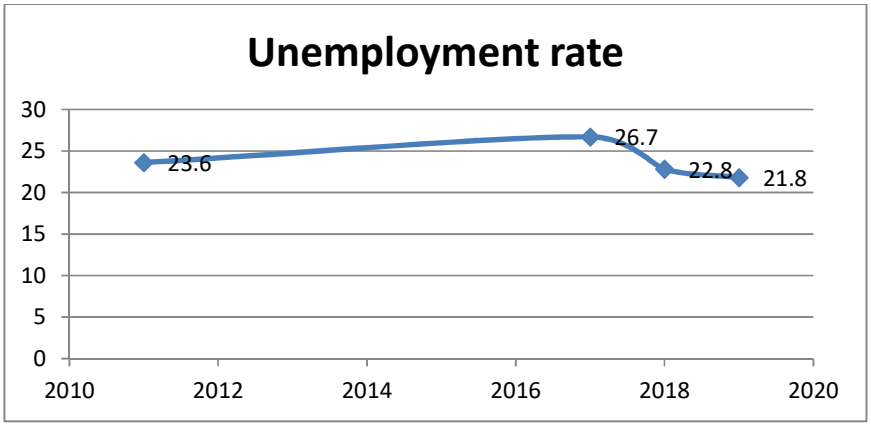

Figure 5.27 Unemployment rate in the Regional Unit of Drama

However, the trend for the unemployment rate in Drama appears declining in 2018 and 2019 going down to 21.8 in 2019.

The wealth of the Regional Unit of Drama and the Eastern Macedonia and Thrace Region as measured by the GDP indicator in million euros during the 2017-2019 period is presented in Table 5.49. GDP appeared increased for both Drama and the Eastern Macedonia and Thrace region during this period with a higher increase for Drama about 4%.

Table 5.49 GDP (million euros) of the Regional Unit of Drama and the Eastern Macedonia & Thrace Region, 2017-2019

	2017	2018	2019	% Change 2017-2019
Regional Unit of Drama	982,37	1006,86	1020,84	3,92
Eastern Macedonia & Thrace Region	6806,94	6888,03	6977,31	2,50

Table 5.49 shows that the contribution of the Regional Unit of Drama to the wealth of the Eastern Macedonia and Thrace Region was 14.6% in year 2019. Moreover, the agricultural

sector provides the raw materials required for the production of secondary products, while accounts for 42% of the region's total exports.

5.2.3 Natural resources for sustainable development

The spatial distribution of the different types of renewable resource facilities, namely solar energy, wind energy, water energy and biomass in the Regional Unit of Drama, which were obtained from the geodatabase of the Hellenic Regulatory Authority of Energy (RAE) are in detail as follows.

Solar energy

A total of 57 photovoltaic stations are currently active within the Regional Unit of Drama (Figure 5.28).

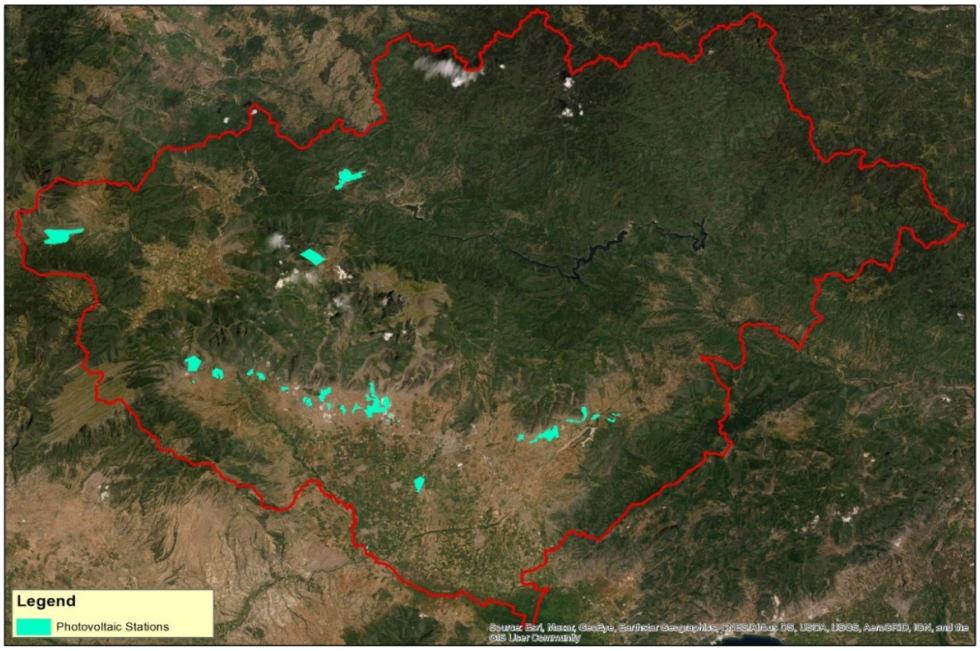

Figure 5.28 Spatial distribution of Photovoltaic Stations in the Regional Unit of Drama

The total area occupied by the photovoltaic stations is about 21.2 km^2, while the energy these stations produce is 1443.95 MW. As it can be observed these stations are mainly located at the south and southeastern part of the region, since the northern part is has steep slopes and it is covered by dense forests.

Wind energy

The total number of operating Wind Generators in the Regional Unit of Drama is 58, while the corresponding Wind Power Stations are 12, as they depicted in the following Figure 5.29.

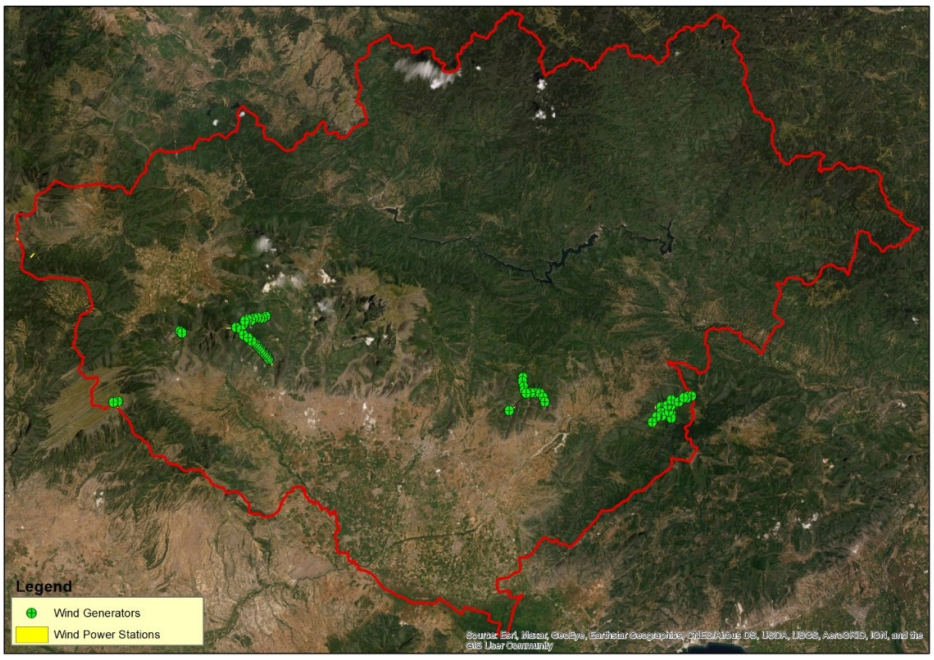

Figure 5.29 Spatial distributions of Wind Generators and Wind Power Stations in the Regional Unit of Drama

The mean diameter of the Wind Generators is about 108 meters, while the mean pillar height is 88 meters. The total power of the Wind Generators is estimated at 142 MW. In addition, according to the Regulatory Authority for Energy (RAE) the total power of the operational Wind Power Stations is estimated at 252.65 MW.

Water energy

According to RAE, 52 Small Hydroelectric Stations are in operation in the Regional Unit of Drama, as they are presented in the following Figure 5.30. The total amount of produced power is estimated at 106.3 KW. The majority of the Small Hydroelectric Stations is located at the northern part of the region, where most small streams of rapid water flow are found.

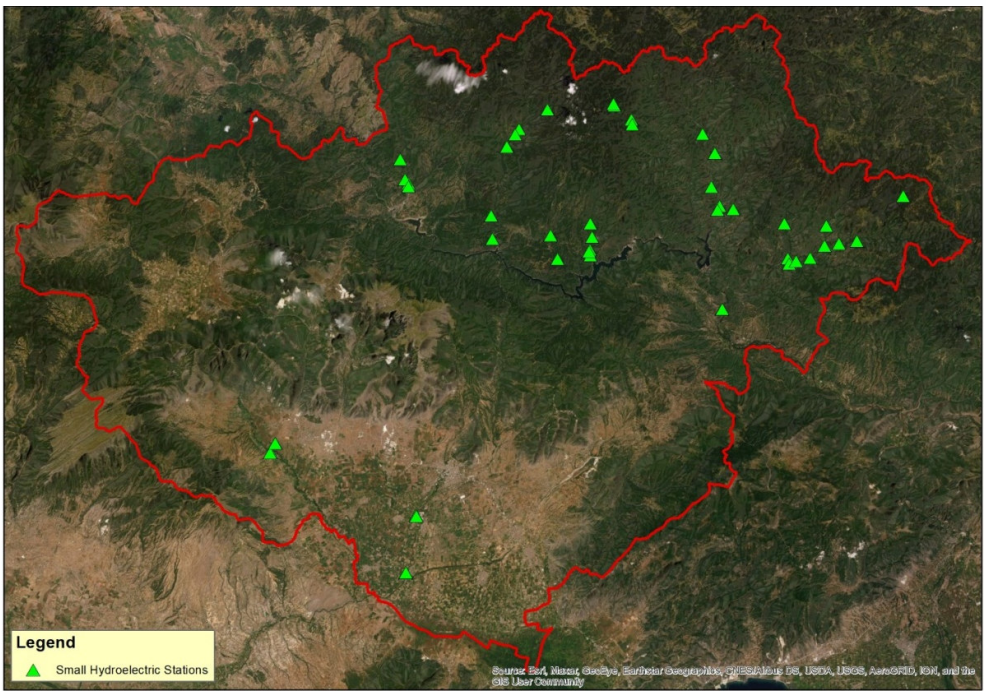

Figure 5.30 Spatial distribution of the Small Hydroelectric Stations network in the Regional Unit of Drama

Biomass Stations

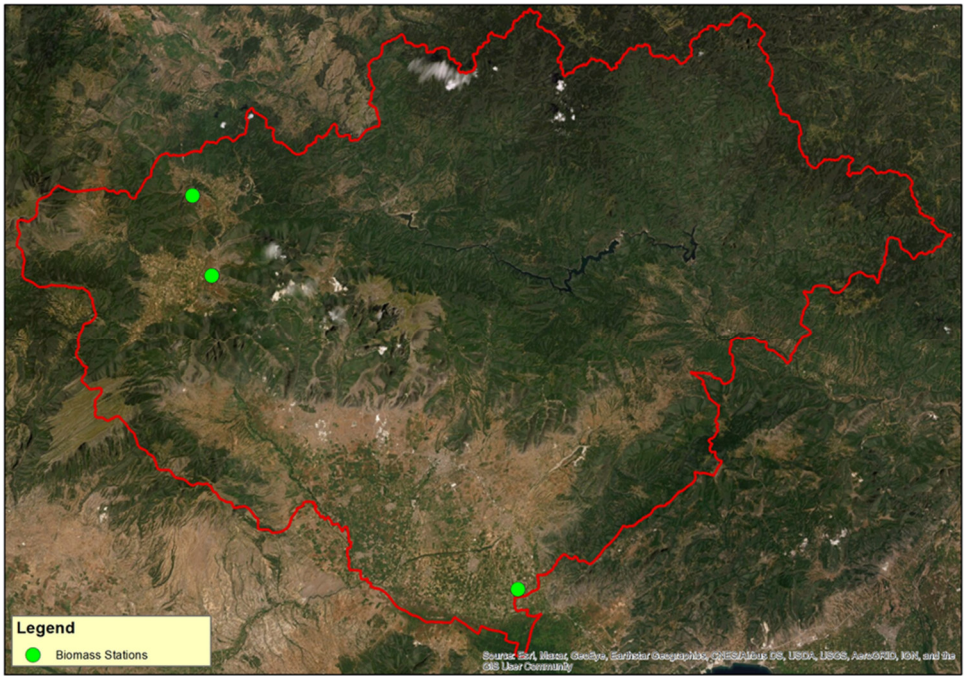

Figure 5.31 Spatial distribution of Biomass Stations in the Regional Unit of Drama

The majority of the produced wood from the region's forest lands is of high quality and it is mainly used for technical purposes. However, a significant quantity of low quality wood,

including logging trimmings is used for energy purposes. In the area, three (3) Biomass Stations (Figure 5.31) have been established and are currently in operation. The total amount of energy these biomass stations produce is estimated to 8,988 KW.

The cumulative statistics of the renewable natural resource energy facilities are provided in the following Table 5.50.

Table 5.50 Renewable natural resources energy facilities in the Regional Unit of Drama

Energy source	Number of facilities	Total power MW
Solar	**57**	**1443,95**
Wind	**58**	**252,65**
Water	**52**	**106,3**
Biomass	**3**	**8,988**
Total	**170**	**1811.89**

5.2.4 Secondary products and waste volume

The main secondary products in the Regional Unit of Drama involve the following.

Wood-based products: A significant number of businesses (80) in Drama produce building construction materials, wooden furniture, wooden constructions, pellets and briquettes. One of the big companies of this type, ALFAWOOD, which has also embraced circular economy activities, is described in section 5.2.6 of the current report.

Wines: Nine large scale wineries are in operation in the Regional Unit of Drama with a total production of over 600000 bottles per year and export activities to more than 25 countries around the world. All the wines of the area are quality wines with protected geographical indication (PGI), renowned in Greece and abroad. Seven of these wineries are also open to visits by the public.

Hydroponic vegetables: Two large scale investments have been made in the area for hydroponic production of vegetables, particularly tomatoes, peppers, cucumbers and eggplants in glass-made greenhouses. One of them in particular is considered as the largest greenhouse in Greece with a total annual production of more than 7000 tons of vegetables (tomatoes). The company has endorsed organic farming to avoid chemicals or use of any type of hormones. In addition, the company has introduced novel technology for energy saving and renewable energy sources. Heating for example is ensured by a sophisticated system, which combines electricity and heat through natural gas (LNG) consumption. The air composition is controlled electronically, and a novel system for water concentration and recycling has been installed in order to minimize further the water consumption. The greenhouses facilities are located at close distance from the city of Drama, as shown in the following map obtained from the RAE geodatabase (Figure 5.32).

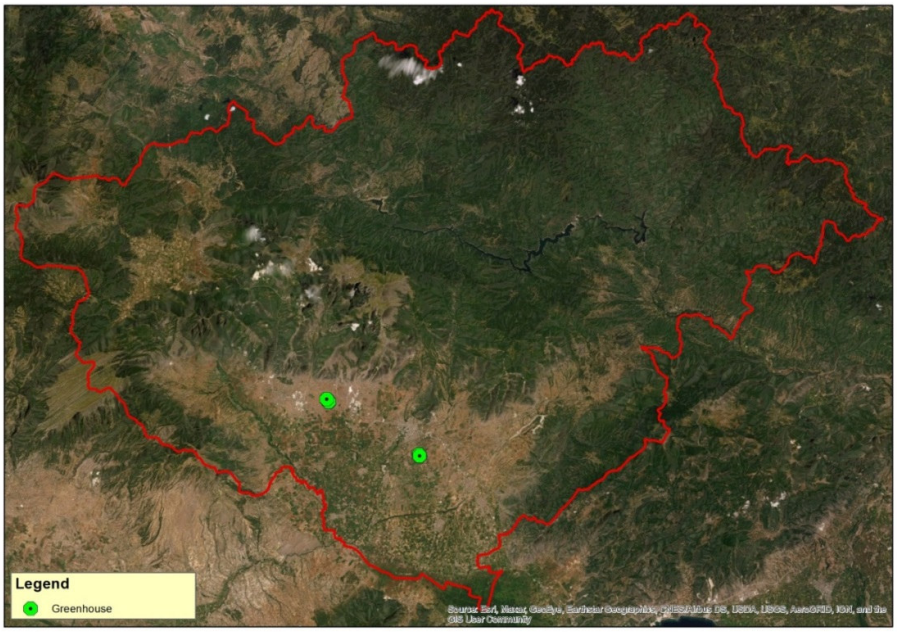

Figure 5.32 Spatial location of the greenhouses in the Regional Unit of Drama

Dairy products: Several companies of regional economic importance have been established in the territory of the Regional Unit of Drama during the couple past of decades in the field of manufacturing milk-based products. Such products include different types of milk (full-fat, semi-skimmed, skimmed, cocoa milk, chocolate milk, sour types of milk, etc.), different types of cheese products, yoghurts, cream puddings and rice puddings. Several of the area's dairy products have a protected designation of origin (PDO). In the area of Drama also the production facilities of the biggest Greek company for processed cheese products of plant origin, called ARIVIA, have been established. ARIVIA has been recently bought by the multinational company Upfield Group B.V. The company now produces about 500 different types of plant-based dairy products, it employs about 450 people and it exports to 50 countries around the world.

Bakery, Pastry and confectionery products: These are products made from cereal flours, which can be consumed ready or pre-processed and then consumed with some additional operations. The most common of such products produced in Drama are various types of bread, traditional types of pasta, bulghur, pastries pies, tarts, filo pastry, cookies and ready-made pastry. The bakery and pastry products of Drama are produced mainly in local SME enterprises. Worth mentioning also are the 2 confectionery production units, which produce traditional tahini (made from sesame) of various types and halva and lokums of various types, all products with protected geographical indication, very well-known and consumed not only locally and regionally, but also in many places nationwide. The companies started recently exporting these products in other European countries too.

Cured meat products: A variety of cured meat products most of which with protected geographic indication (various types of sausages, pastrami, prosciutto, salami etc.) are produced with traditional methods by two well established in the Regional Unit of Drama cured meat industries. These companies sell these products through an extended network of delicatessen shops not only

in local and regional markets, but also in many places nationwide, as well as specific European countries. Smaller scale businesses for meat packaging have also been established in several places of the rural territory of Drama.

The municipal solid wastes in tons/year that have been produced in the Regional Unit of Drama during the 2016-2020 period are presented in the following Table 5.51.

	2016	2017	2018	2019	2020
Regional Unit of Drama	40237	41839	42450	43069	43698

Table 5.51 Solid Municipal Wastes (tons/year), 2016-2020

(Source: DIAAMATH, www.diaamath.gr)

The solid wastes that are being produced in the Regional Unit of Drama are managed by the Waste Management Authority of Eastern Macedonia and Thrace Region (DIAAMATH) (https://www.diaamath.gr/), a legal authority that has also the responsibility to manage the solid wastes being produced in the entire Region of Eastern Macedonia and Thrace. Specifically, the aims of DIAAMATH include: i) the integrated waste management of the municipalities of the Eastern Macedonia and Thrace Region, ii) the development of local plans for the collection of recyclable materials, iii) the supervision of the regional systems' operation for the transfer and recycle of waste, iv) the planning and organization of participation in Alternative Waste Management systems for special waste, such as packaging material, end of life vehicles, waste oils, WEEE, batteries, etc., v) the provision of technical consulting services, related to solid waste management, with care for protection of the environment, the public health, as well as the quality of life in Eastern Macedonia and Thrace Region.

The existing waste management infrastructures in the Eastern Macedonia and Thrace Region include five (5) Recycling Material Sorting Centers in Didymoteicho, Alexandroupolis, Komotini, Xanthi and Drama, a network of thirteen (13) Waste Transfer Stations in various sites all over the Region and three (3) Landfills in Komotini, Xanthi and Kavala.

DIAAMATH oversees the installation and operation procedures of the required waste management infrastructure according to the Regional Plan for Waste Management. These procedures concern the processing of the Region's Municipalities mixed solid wastes and the diversion of their organic fraction before their final disposal, as well as the implementation of the central and regional Waste Processing Units. Since 2019, the mixed waste is subject to treatment before landfilling at the landfills of Komotini and Kavala as well as at the Mechanical Sorting Unit of Drama.

The municipal solid waste per material category in the Regional Unit of Drama in year 2020 is shown in the following Table 5.52.

Table 5.51 Estimated quantity of municipal solid waste per material category in the Regional Unit of Drama, 2020

Materials	Quantity (tons/year)
Organic	**15294**
Paper	**7123**
Plastic	**7385**
Metal	**1617**
Glass	**2010**
Wood	**4326**
Other	**5943**

(Source: DIAAMATH, www.diaamath.gr)

The following waste management infrastructure projects are in the process of implementation in the Regional Unit of Drama: i) the Local Waste Management Unit of Municipality of Paranesti, where a Waste Transfer Station, a green point and a Composting Unit of pre-selected organic waste will be put in operation, ii) the Bio Waste Treatment Unit of Municipality of Drama, where pre-selected organic waste will be processed, iii) the Local Waste Management Unit of Municipality of Prosotsani, where a Waste Transfer Station and a Unit for aerobic treatment of pre-selected organic waste and iv) the Waste Transfer Station of Municipality of Doxato.

5.2.5 Assessment of the labour needs for specialists in circular economy

Circular economy has become already a mainstream development policy model both in urban and rural areas. This implies that the labour market in order to implement circular economy activities should identify the knowledge required both in terms of specific fields, technologies and tools, as well as personal skills. At this stage, sound information for the rural areas in particular regarding the identification of labour needs for circular economy specialists is completely lacking at least in Greece and therefore, research is needed to fill this knowledge gap in order to support implementation of circular economy in rural businesses and/or organizations.

Through the MULTITRACES project a social survey was conducted to identify at this initial stage of circular economy implementation the specific labour needs for specialists in rural businesses in Greece. Most of the companies (90% of responses) from those participating in our research stated that during the past 5 years they started implementing some circular economy activities, which mainly included the minimization of waste by recycling or reusing waste or selling it to another company. It is worth to note, however, that less than 20% of the companies which responded in our research have used renewable energy sources. The least implemented circular economy action by the companies participating in the survey was the Life Cycle Assessment.

The great majority of the companies (87%) stated that they need specialized professionals/ experts to support the implementation of circular economy activities. Their foreseen needs to a

bigger extent are related to the scientific fields of economics/finance, energy management, production engineering, environmental engineering, product design and service design.

In terms of the specific kind of knowledge in the field of circular economy about 60% of the companies recorded the need for knowledge of the regional supply chains, the methodologies of circular economy and the impacts of economic decisions regarding circular economy. In terms of the circular economy processes, they emphasized the need for knowledge of the processes for the higher valorization of the byproducts, waste management, measurement of the environmental impacts and technological innovation. In terms of the natural resources, the companies stated the need for knowledge of the natural resource capacity assessment, knowledge of the technologies for the sustainable exploitation of renewable energy sources and knowledge of the technology for the sustainable exploitation of the local raw materials. Also, the companies stated the need for knowledge of business management, business plan development, and opportunity investments for circular economy, knowledge of norms and legislation for environmental protection, knowledge of norms and legislation for waste management and knowledge of the cost for meeting standards. Least, but equally important the companies, which participated in our survey stated that personal skills are also required to succeed with circular economy aims placing emphasis on coaching skills, observational skills, self- motivation and flexibility.

5.2.6 Study case – implementation of circular economy in the rural area of Drama Regional Unit

This section focuses on a case of a company, called ALFAWOOD company, operating in the rural area of the Drama Regional Unit in Eastern Macedonia and Thrace Region in northern Greece (Figure 5.33), which has embraced environmentally friendly policies and is implementing circular economy.

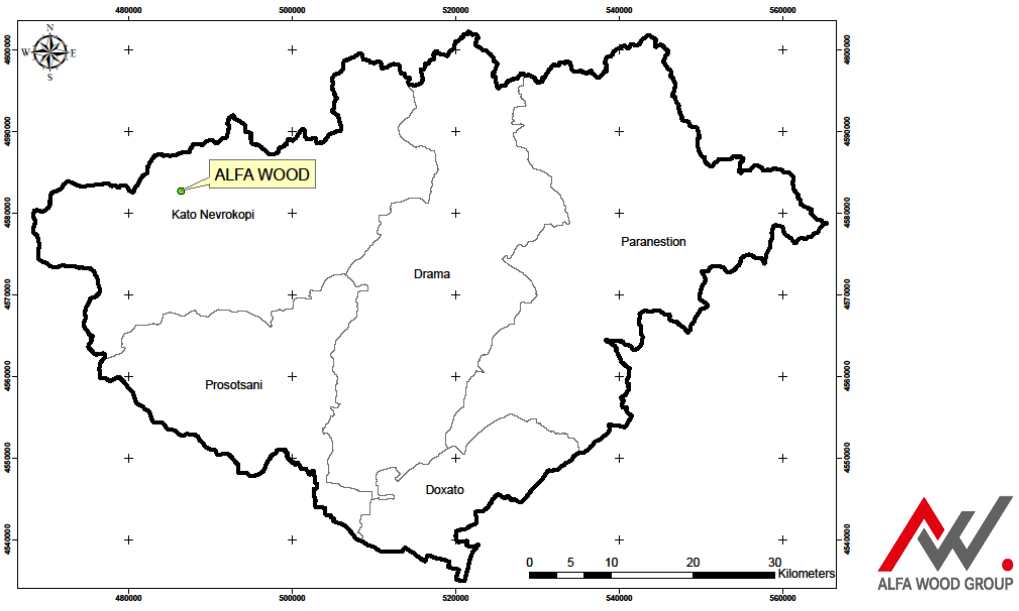

Figure 5.33 ALFAWOOD company at Kato Nevrokopi-Drama location map

The ALFAWOOD company forms part of the ALFAWOOD group, a family-run business, which states proud for having adopted a personal business approach with its working people, its partners and its land resources. The company was established in 1981 and since then it had a continuous growth rendering it the largest wood processing industry in Greece with remarkable international activity. The ALFAWOOD group has industrial facilities and exhibition areas in three different Regions: i) in the Region of Thessaly at the industrial area of Larissa producing mainly veneered particleboard and fiberboard panels, as well as work benches, profiles and interior doors, over an area of 50.000 m^2 ii) in the Region of Western Macedonia in Grevena manufacturing fiberboard (MDF), veneered fiberboard panels, laminate flooring and lacquered fiberboard over an area of 107.000 m^2, and iii) in the Region of Eastern Macedonia and Thrace, Regional Unit of Drama near the town of Kato Nevrokopi producing wood pellets, wood briquettes and wood garden chips (Figure 5.34), over a an area of 228.000 m^2. In addition, 1MWH power is produced by using biomass in each of the company's premises in Larissa and Nevrokopi.

Figure 5.34 Wood pellet processing facilities of the ALFAWOOD company at Nevrokopi- Drama, Greece (Source: http://en.alfawood.gr//about/Facilities used with permission from ALFAWOOD Group)

Overall the annual quantities of the various products of the ALFAWOOD Group are as follows:

Table 5.52 Average annual production of the ALFAWOOD group

Product	Quantity
Power output	2 mw
Pellet	60.000 t

Briquettes	7.000 t
Bare fiberboard	100.000 m^3
Melamine	122.000 m^3
Veneered panels	17.000 m^3
Kitchen counters	7.000 m^3
Lacquered fiberboard	10.000 m^3
Acrylic panels	4.300 m^3
Laminate flooring	5.300 m^3
Door casing	300.000 l.m
Profiles	730.000 l.m
Frames for casing	730.000 l.m
Interior doors	12.000 pcs

(Source: http://en.alfawood.gr//about/statistics)

The ALFAWOOD Group employs 350 people and has a network with 10 distributors in Greece and 39 points of sale through local partners in other countries. The company exports about 40% of its annual production in 39 countries.

The company has embraced a business environmentally friendly policy both on the production and on the sales processes. This policy is based on the following pillars:

-Protection. The company applies production practices, methods and equipment harmonized with national and international environmental standards in order to minimize environmental impacts and promotes environmental awareness to all its employees.

- Recycling. The company re-uses wood residues for wood and energy production, thus leading to savings in raw materials and a reduction in forest loggings. The company also covers the thermal energy and much of the electricity production needs through processing of wood wastes in an attempt to reduce the carbon dioxide (CO_2) emissions and minimize impacts on land, water and air. Moreover, the company encourages the recycling of wood waste by other producers through advising on appropriate management solutions and preventing unnecessary deposition of wood by-products in non-designated areas.

- Renewable energy sources. ALFAWOOD processes all kind of timber residues, such as timber, plant tissue waste, wood packaging and other materials, which then uses to produce alternative fuels.

- Sustainable forestry and Sustainable Development. The company uses timber and forest biomass as raw materials for the production of industrial products and renewable energy derived

from sustainably managed certified forests, both by national and international agencies, such as the Forest Stewardship Council (FSC). During the production process the company implements certified management systems for quality management, low formaldehyde emission, fire and water resistance, such as ISO 9001: 2015, CE, FSC, CARB, E0, FIRE RETARDANT AND WATER RETARDANT. The company safeguards that the products reach the consumers in full transparency by adopting the Environmental Product Declaration (EPD), which provides full information on the environmental and health aspects of the manufacturing process of each product.

All wood processing by-products and those not suitable for sale are re-entering the production process and used either for new wood panel production or for biomass energy production, depending on their origin. Moreover, biomass is used through the combustion process to generate heat and "green electricity".

In the frame of circular economy ALFAWOOD has fully embraced the "receive-process-recycle" motto instead of the "receive-process-reject" one, aiming at extending biomass's life cycle by creating added value to it. To this end the company is implementing solid biomass recycling, that is the re-use of organic materials, such as the wood-based materials, which have direct or indirect biological origin. The re-used organic materials are at the end of their life cycle, either as a result of the industrial process they have been subjected to or as a waste left for not being able to be used for the production of any other product. These materials are typical wood wastes derived from discarded products, such as pallets or packaging materials or forest biomass, such as bark, tree trunks, branches etc., plant tissue wastes, such as crop residues, sawmill residues or derivatives containing wood products and resulting at different stages of the production process. The biomass after being collected is subject to specific treatment in the company's facilities in order to be used for the production of green energy for heat and electricity. The company proudly states that through the green energy it produces by re-using about 75.000 tons of biomass every year provides electricity to 6.000 homes on an annual basis, while saving approximately 200.000 tons of carbon dioxide (CO_2) every year.

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