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Clustering analysis of the light industry in Bulgaria

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ABSTRACT

Light industry is one of the most important and priority industries in Bulgarian economy. It includes the production of textiles, clothing, and leather. Its development affects the state of the country's overall economy. Despite the numerous studies that use GIS, in Bulgaria there have been no publications on the application of statistical analysis with the use of ArcGIS software. This study aims to apply Geographic cluster analysis using ArcGIS software to analyze the light industry in Bulgaria as of 2010, 2015, and 2020. The grouping of areas by selected indicators in the present study was performed with the Grouping Analysis tool. NO_SPATIAL_CONSTRAINT was selected for the Spatial Constraints parameter and FIND_SEED_LOCATIONS – for the Initialization Method. In this case, we used the K-Means algorithm to partition features into groups. That algorithm is one of the most popular and widely used clustering algorithms in GIS applications. The areas were grouped into 10 clusters. The selection of indicators on which the clustering procedure was based, is following the generally accepted indicators for assessing the state and importance of the food industry in the structure of the economy. The following indicators were used: output for 2010, 2015, and 2020; number of employees and export earnings as of 2010, 2015, and 2020, for each administrative-territorial unit. The spatial distribution of the population, in combination with the historical and the modern economic development of the settlements, forms the regional differences in the development of the light industry in the country. The cluster analysis of certain indicators for the assessment of the light industry at the NUTS 3 level as of 2010, 2015, and 2020, shows some changes in the spatial development trends of the industry. The cluster analysis shows that there are slight spatial differences in production at the NUTS 3 level, with large consumer centers and markets being the most important.

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1. Introduction

Light industry satisfies people's needs for household items. Its produce is used by the entire population. This determines the important place of light industry among the secondary sector industries. A small part of its production is used in mechanical engineering, furniture production, and other industries. Light industry goods participate in the country's exports and contribute to the development of the agriculture and the chemical industry by using raw materials provided by them (cotton, wool, chemical fibers, etc.). It indirectly influences the development of power production, mechanical engineering, transport, and trade, using their goods and services. Light industry requires less investment for its activities in comparison with the branches of the heavy industry, while the capital invested in its production pays off in a shorter period.

During the so-called period of transition, including the years of the country's accession to the European Union, the light industry in Bulgaria underwent significant changes in its structural and spatial organization. Privatization, the creation of many micro- and small companies, the introduction of new standards in the production activities, the redistribution of markets, and the increase of investments, all led to the modernization of the production activities, increasing their competitiveness and production efficiency. Bulgarian textile and clothing production has become part of the global production networks, with many companies working as subcontractors.

The development of textile, sewing, and leather industry, as well as the production of shoes in the country, is mainly related to the participation of foreign capital (Greek and Italian), and as a result – several joint ventures were created. Their functioning is related to small investments, the performance of labor-intensive activities, the availability of cheap labor, and the low qualification of the employed persons. According to Roukova (2021), the production of textiles and clothing is one of the "most vulnerable activities in terms of their geographical mobility – their relocation to new areas and countries" (p. 3).

Regardless of the dynamic economic situation in the country, over the last two decades, the light industry in Bulgaria has developed relatively stable. In 2010 the production amounted to BGN 2 812 822 thousand, in 2015 the production amounted to BGN 3 744 097 thousand, and in 2020 the production amounted to BGN 3 522 119 thousand (NSI, 2022). In the period between 2010 and 2020, the income from the production of textiles and textile products, excluding clothing, grew at the highest rate – by more than 60%, while the processing of leather, the production of shoes, and other produce of processed furless hides, decreased by 13%. Light industry employs 87 183 people (mostly female workforce) or 20% of the employed persons in the processing industry (NSI, 2021). About 5 200 companies work in the production of textiles and clothing, shoes and leather goods, and over 80% of them are small and micro-companies.

The periods of the global financial crisis (2009-2011) and 2019-2020 (COVID-19) turned out to be crisis years for the industry, when, in conditions of financial uncertainty and loss of markets, a certain part of the national, mixed, and international companies reduced their production, while others went bankrupt. At the beginning of 2021, a slight increase in the main indicators characterizing the light industry in the country was reported.

An important and urgent problem to be solved in the development of the industry is the shortage of personnel. It is the result, on the one hand of the unfavorable demographic situation in the country, and on the other hand – of the lack of people willing to work in this field due to low wages and unfavorable working conditions.

Geographic information systems (GIS) in Bulgaria have been increasingly used for visualization, data processing, and analysis in various areas of geographic research, as well as in economic problems assessment (Koulov 2020; Roukova 2020; Roukova et al. 2019); demography (Kazakov 2014; Kazakov 2015; Mikova 2019; Ilieva et al. 2020, Ilieva 2022; Traykov and Tsvetkov 2021;); natural hazards (Nikolova and Nedkov 2012, Bournaski et al. 2021); geomorphological research (Belev 2014, Tcherkezova 2015, Tcherkezova, 2019, Belev 2020, Belev 2021); dynamics of land cover (Vatseva et al. 2016, Genchev and Vatseva 2017, Assenov and Grigorov 2018, Genchev 2019, Dimitrov et al. 2019a; Dimitrov et al. 2019b; Stoyanova et al. 2020); ecosystem and landscape research (Yaneva 2016, Kitev 2016, Petrova 2016, Zhelezov 2018, Prodanova 2018, Prodanova 2020, Zhelezov 2020, Prodanova 2021, Nedkov et al. 2021, Nikolova et al., 2021, Silvestriev et al., 2021, Nikolov et al. 2022).

Statistical approaches, including various methods of clusterization, have been increasingly used to classify economic data. The use of cluster methods is necessary for the differentiation of homogeneous groups of administrative-territorial units (countries, regions, districts, etc.). In cluster analysis, there is a consistent merging of the closest spatial units into groups that are relatively identical to a certain extent and are following certain indicators to implement specific economic policies and measures (Manov 2002; Tchorbadjieff et al. 2019; Aydarova et al. 2020). Cluster analysis has been applied in a wide variety of fields, including GIS, because a large amount of data requires minimization of the time complexity for data analysis algorithms in general, and clustering algorithms in particular (Hamfelt et al., 2011).

Despite the numerous studies in Bulgaria that use GIS, so far there have been no publications on the application of statistical analysis with the use of ArcGIS software. In ArcGIS Desktop, statistical analysis functions are either nonspatial (tabular) or spatial (containing location). The Spatial Statistics toolbox contains several statistical routines for analyzing the distribution of a set of features, patterns, and identifying clusters: Geographic distribution measurements (tool: Measuring Geographic Distributions); Geographic pattern analysis (tool: Analyzing patterns); Geographic cluster analysis (tool: Mapping Clusters), and Regression analysis (tool: Modelling spatial relationships) (ArcGIS Desktop https://desktop.arcgis.com...)

This study aims to apply Geographic cluster analysis using ArcGIS software to study the light industry in Bulgaria as of 2010, 2015, and 2020.

2. Methods and data

This area of study includes the national territory of Bulgaria at the NUTS 3 level (28 administrative districts).

2.1. Methods

The whole process of cluster analysis of the light industry in Bulgaria takes six main steps, shown in Figure 1.

For the analysis process to store and organize the original data, Microsoft MS Excel software has been used, while for the spatial analysis data and the compile clusters of the light industry, the ArcGIS Desktop software has been used (ESRI ArcGIS, ArcMap 10.6.1) (Figure 1).

In the present study, the grouping of the areas by selected indicators was performed using the Grouping Analysis tool (Figure 1). NO_SPATIAL_CONSTRAINT was selected for the Spatial Constraints parameter and FIND_SEED_LOCATIONS – for the Initialization Method. In this case, the K-Means algorithm was used to partition features into groups (Figure 1). The algorithm seeks optimal partitioning of the data by minimizing the sum of the squared error (SSE) criterion. Due to its ease of implementation, the K-means algorithm is regarded as one of the most valuable clustering methods (Hamfelt et al., 2011). It, however, suffers from several major drawbacks: the iterative procedure cannot guarantee the convergence to a global optimum, although the convergence of K-means was proved. The second problem of the algorithm is that it requires that the number of clusters is known in advance by the researcher. Therefore, a very important topic in cluster analysis is identifying the number of clusters (Hamfelt et al., 2011).

The optimal number of groups was calculated with a pseudo-F-statistic for clustering solutions from 2 to 15 groups. Min, max, standard deviation, mean, and R2 results for each parameter from the reports generated by the program were also analyzed (Figure 2).

2.2. Data

The study is based on the National Statistical Institute data on the light industry in Bulgaria (textile, leather, and clothing production). A set of three variables was used to identify the grouping of districts in Bulgaria for three different years – 2010, 2015, and 2020 (Table 1, 2, and 3).

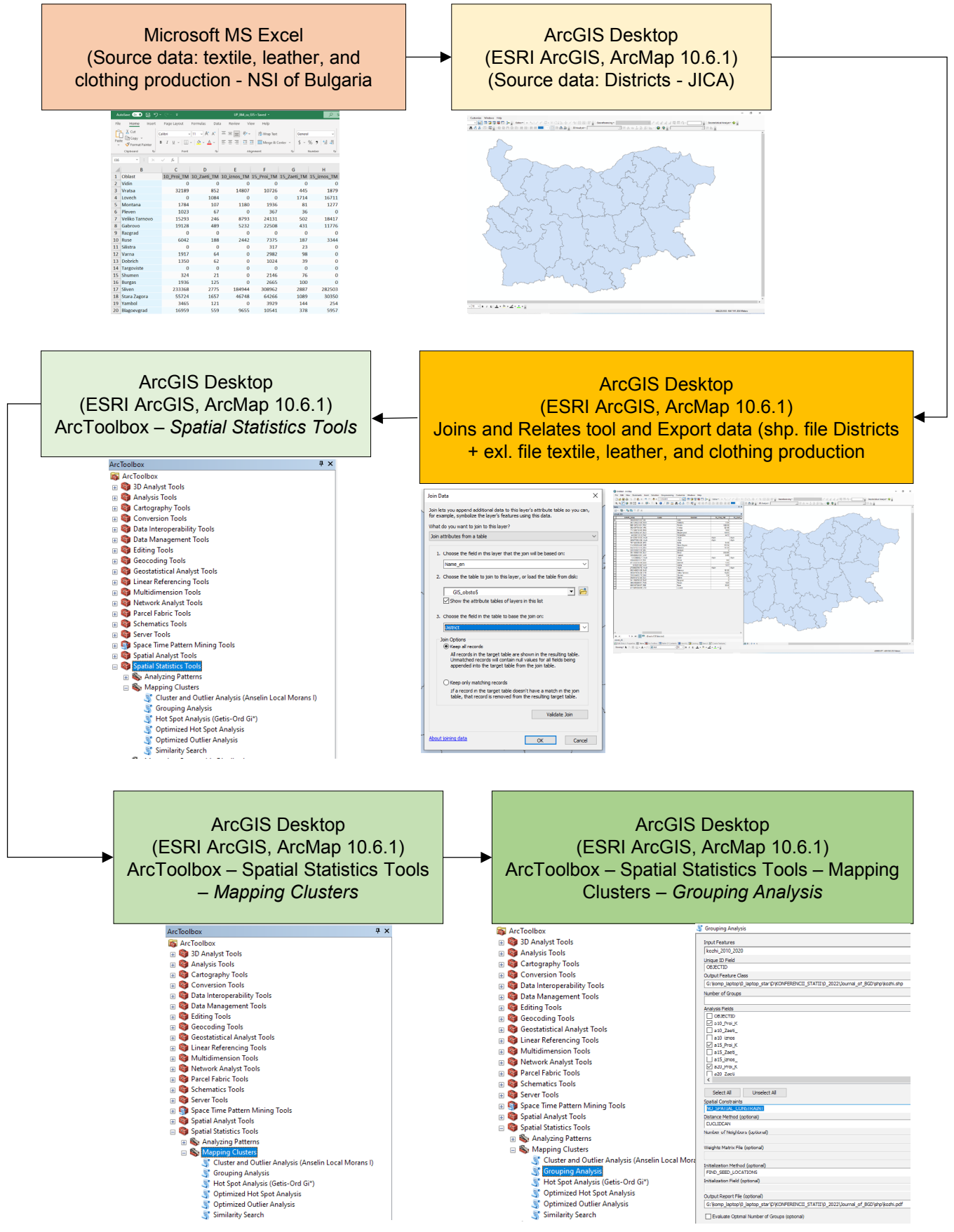
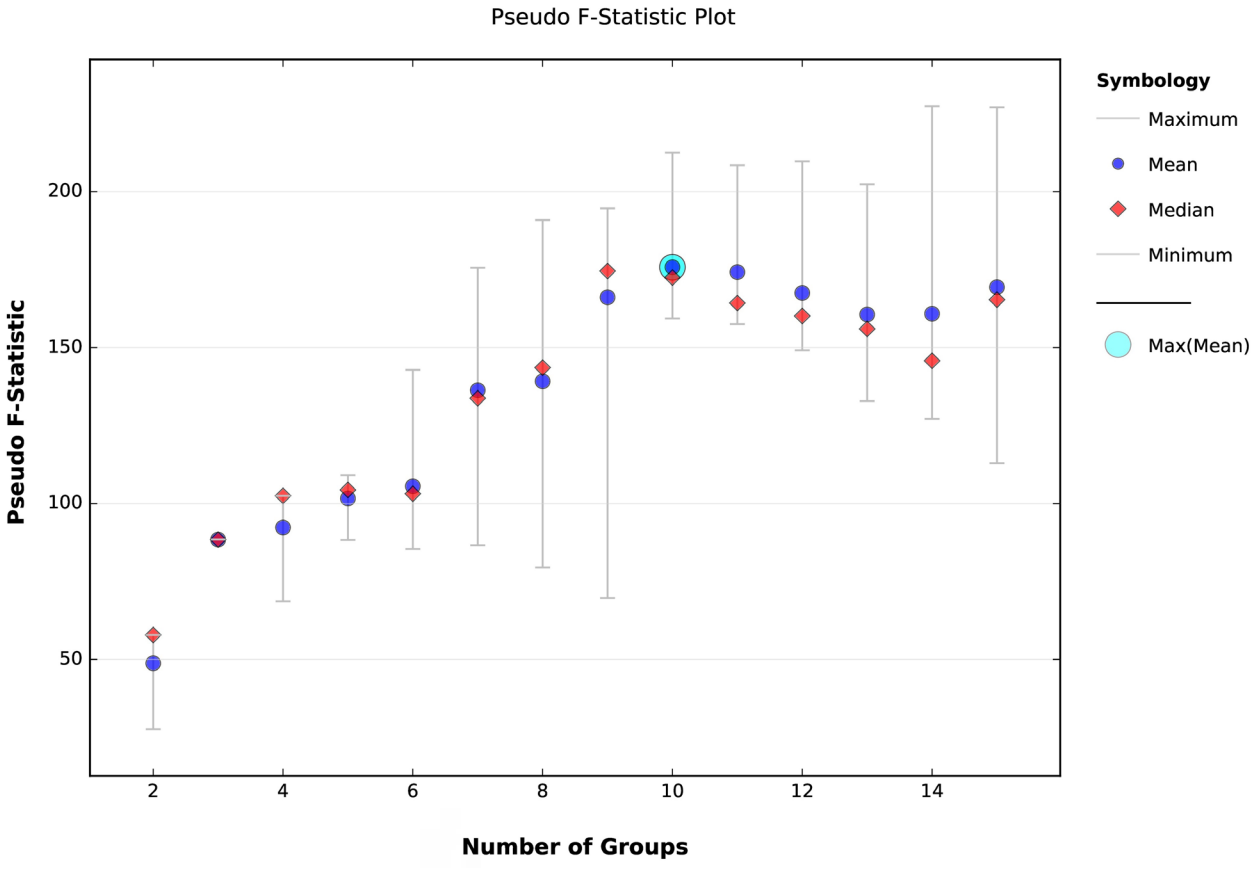
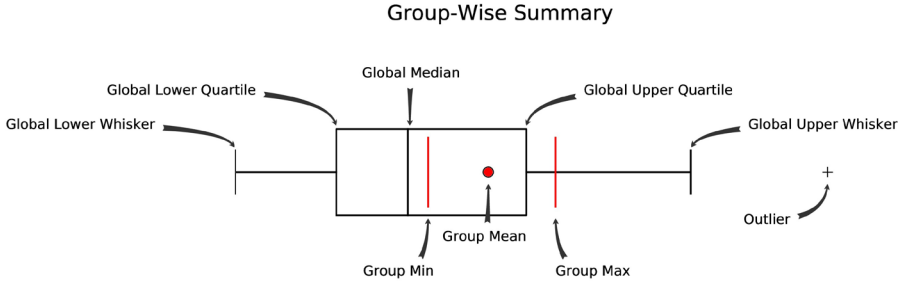


Figure 1. Cluster analysis flowchart of the light industry in Bulgaria.





Overall Variable Statistics: Count = 28; Std. Distance = 32893.7108; SSD = 8.5479

Variable	Mean	Std. Dev.	Min	Max	R2
A15_PROI_K	9188.5000	16138.1662	0.0000	56175.0000	0.9824
A15_IZNOS_	5987.8214	12623.3995	0.0000	42925.0000	0.9798
A20_ZAETI_	296.2857	577.5202	0.0000	2298.0000	0.9780
A15_ZAETI_	464.1071	868.6620	0.0000	3032.0000	0.9752
A20_IZNOS_	5091.4286	11106.2486	0.0000	40658.0000	0.9724
A20_PROI_K	7197.1071	13517.2212	0.0000	51907.0000	0.9709
A10_ZAETI_	526.7857	937.6934	0.0000	3294.0000	0.9548
A10_PROI_K	8270.6429	14983.2431	0.0000	59005.0000	0.9483
A10_IZNOS_	5275.7500	11387.5641	0.0000	43214.0000	0.9327

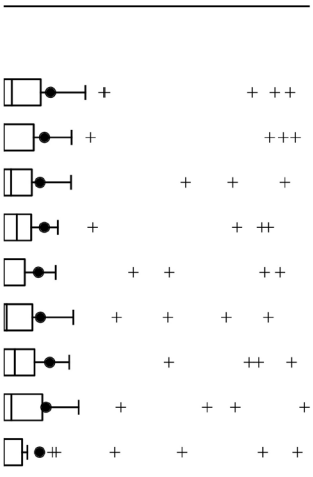


Figure 2. Evaluation of the optimal number of groups.

Table 1. Relative share of the produce, employees, and BGN equivalent of foreign exchange earnings from the export of textile products by administrative districts in Bulgaria as of 2010, 2015, and 2020. Source: National Statistical Institute (NSI) of Bulgaria.

Districts	2010			2015			2020			Cluster
	Produce	Employees	BGN equivalent of foreign exchange earnings from exports	Produce	Employees	BGN equivalent of foreign exchange earnings from exports	Produce	Employees	BGN equivalent of foreign exchange earnings from exports	
	%	%	%	%	%	%	%	%	%	
Vidin	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8
Vratsa	5.59	7.1	5.2	1.4	3.7	0.3	1.5	2.1	0.9	10
Lovech	0.00	9.0	0.0	0.0	14.1	2.8	15.8	15.3	17.7	9
Montana	0.31	0.9	0.4	0.2	0.7	0.2	0.2	0.5	0.2	8
Pleven	0.18	0.6	0.0	0.0	0.3	0.0	0.1	0.2	0.0	8
Veliko Tarnovo	2.66	2.0	3.1	3.1	4.1	3.0	4.5	4.2	4.4	1
Gabrovo	3.32	4.1	1.8	2.9	3.6	1.9	4.3	3.7	4.6	1
Razgrad	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8
Ruse	1.05	1.6	0.9	0.9	1.5	0.6	0.6	1.1	0.2	6
Silistra	0.00	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	8
Varna	0.33	0.5	0.0	0.4	0.8	0.0	0.5	1.0	0.1	8
Dobrich	0.23	0.5	0.0	0.1	0.3	0.0	0.0	0.3	0.0	8
Targovishte	0.00	0.0	0.0	0.0	0.0	0.0	0.3	0.6	0.3	8
Shumen	0.06	0.2	0.0	0.3	0.6	0.0	0.4	1.1	0.0	8
Burgas	0.34	1.0	0.0	0.3	0.8	0.0	0.5	0.9	0.2	6
Sliven	40.53	23.1	65.1	39.6	23.8	46.7	33.8	24.0	37.8	3
Stara Zagora	9.68	13.8	16.4	8.2	9.0	5.0	3.7	5.7	4.1	2
Yambol	0.60	1.0	0.0	0.5	1.2	0.0	0.4	1.0	0.0	6
Blagoevgrad	2.95	4.7	3.4	1.4	3.1	1.0	1.0	3.8	0.9	7
Kyustendil	0.45	1.4	0.4	0.3	0.7	0.1	0.3	0.6	0.0	6
Pernik	0.13	0.6	0.0	0.1	0.6	0.0	0.1	0.2	0.0	8
Sofia	0.94	1.3	0.9	0.0	0.4	0.0	0.1	0.4	0.0	8
Sofia (capital)	4.22	5.9	0.8	4.3	5.3	1.5	6.6	7.7	4.0	5
Kardzhali	0.40	0.8	0.0	0.5	1.0	0.0	0.7	0.8	0.0	6
Pazardzhik	0.78	1.6	0.6	0.3	0.8	0.1	0.4	1.2	0.1	6
Plovdiv	22.64	13.0	0.0	28.2	14.9	30.9	17.8	15.6	22.6	4
Smolyan	0.00	1.4	0.0	2.7	2.9	2.9	2.9	2.4	0.0	6
Haskovo	2.63	4.0	1.1	4.1	5.6	2.9	3.5	5.4	1.8	1

Table 2. Relative share of the leather industry by administrative districts in Bulgaria as of 2010, 2015, and 2020.
Source: National Statistical Institute (NSI) of Bulgaria.

Districts	2010			2015			2020			Cluster
	Produce	Employees	BGN equivalent of foreign exchange earnings from exports	Produce	Employees	BGN equivalent of foreign exchange earnings from exports	Produce	Employees	BGN equivalent of foreign exchange earnings from exports	
	%	%	%	%	%	%	%	%	%	
Vidin	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9
Vratsa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9
Lovech	1.8	0.2	1.6	1.5	1.4	0.0	1.0	1.4	0.0	8
Montana	1.3	0.2	1.7	0.9	1.3	0.0	0.0	0.0	0.0	8
Pleven	3.7	0.2	4.9	2.3	1.7	2.6	2.0	1.9	2.0	8
Veliko Tarnovo	0.4	0.0	0.0	0.0	0.4	0.0	0.2	0.2	0.2	9
Gabrovo	3.1	0.2	0.0	7.7	2.2	0.0	6.8	2.8	2.5	1
Razgrad	1.4	0.2	0.4	0.7	1.6	0.4	0.9	1.5	0.4	8
Ruse	2.0	0.2	2.3	2.2	2.3	2.7	2.4	2.0	2.6	8
Silistra	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9
Varna	0.3	0.0	0.0	0.4	0.4	0.0	0.0	0.4	0.0	9
Dobrich	9.9	1.3	11.1	6.2	7.8	6.0	5.8	6.6	5.4	7
Targovishte	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9
Shumen	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9
Burgas	0.0	0.0	0.0	0.0	0.4	0.0	0.2	0.1	0.0	9
Sliven	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9
Stara Zagora	0.0	0.0	0.0	1.9	0.2	0.0	0.1	0.1	0.0	9
Yambol	0.5	0.1	0.1	0.4	1.0	0.0	0.3	0.5	0.0	9
Blagoevgrad	19.6	2.2	25.8	19.0	23.3	23.3	16.0	17.9	17.1	2
Kyustendil	17.2	2.0	17.8	20.7	22.7	25.6	21.7	27.7	26.9	6
Pernik	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9
Sofia	0.8	0.1	0.0	0.3	0.5	0.0	0.0	1.0	0.0	9
Sofia (capital)	6.3	0.5	5.2	7.6	3.2	7.6	11.0	5.0	13.4	5
Kardzhali	0.0	0.0	0.0	0.5	1.4	0.2	0.6	1.4	0.0	10
Pazardzhik	25.5	1.9	29.3	21.8	20.5	24.5	25.8	22.6	28.5	4
Plovdiv	1.2	0.3	0.0	1.4	2.8	1.3	1.4	2.7	1.0	8
Smolyan	4.8	0.4	0.0	4.4	4.8	5.7	3.8	4.2	0.0	3
Haskovo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9

Table 3. Relative share of the clothing industry by administrative districts in Bulgaria as of 2010, 2015, and 2020.
Source: National Statistical Institute (NSI) of Bulgaria.

Districts	2010			2015			2020			Cluster
	Produce	Employees	BGN equivalent of foreign exchange earnings from exports	Produce	Employees	BGN equivalent of foreign exchange earnings from exports	Produce	Employees	BGN equivalent of foreign exchange earnings from exports	
	%	%	%	%	%	%	%	%	%	
Vidin	0.4	0.9	0.2	0.5	1.0	0.4	0.5	1.0	0.5	7
Vratsa	1.9	1.7	2.2	1.5	1.7	0.9	1.6	1.8	1.9	6
Lovech	0.6	0.8	0.7	0.5	0.7	0.5	0.4	0.7	0.5	7
Montana	1.8	2.6	2.7	1.3	2.0	2.1	1.5	2.3	2.1	6
Pleven	7.7	8.0	9.0	8.4	9.5	9.7	6.9	9.2	9.1	4
Veliko Tarnovo	2.0	2.8	1.6	1.9	3.0	1.6	1.6	3.2	1.2	9
Gabrovo	7.6	3.5	10.6	5.9	3.4	8.0	9.1	3.7	0.0	1
Razgrad	0.4	0.9	0.3	0.4	1.0	0.2	0.3	0.6	0.2	7
Ruse	7.6	8.0	6.8	10.2	8.2	10.2	7.7	8.1	8.3	4
Silistra	0.4	0.8	0.2	0.3	0.7	0.0	0.2	0.6	0.0	
Varna	1.1	1.5	0.3	2.4	2.2	0.0	1.8	2.1	1.5	6
Dobrich	0.9	1.9	0.3	0.8	1.7	0.4	1.5	1.7	1.5	7
Targovishte	1.5	2.0	1.5	0.9	1.6	0.7	0.8	1.3	0.9	6
Shumen	1.3	2.0	1.0	1.0	1.9	0.7	1.5	2.0	1.6	6
Burgas	2.3	2.2	2.7	4.1	2.5	5.4	2.4	2.9	2.5	8
Sliven	0.6	0.9	0.6	0.7	0.9	0.7	1.3	0.7	1.7	7
Stara Zagora	2.0	1.8	2.3	1.6	1.7	1.4	1.7	1.9	1.5	6
Yambol	0.4	0.8	0.2	0.3	0.6	0.1	0.4	0.6	0.2	7
Blagoevgrad	18.8	17.7	18.5	19.5	19.0	19.8	20.8	18.8	23.6	2
Kyustendil	1.4	2.5	1.2	1.3	2.4	1.4	1.4	2.5	1.6	9
Pernik	2.6	1.8	3.3	1.9	1.4	2.3	2.0	1.6	2.9	6
Sofia	1.5	1.0	1.4	1.1	0.9	1.3	0.5	0.9	0.4	7
Sofia (capital)	14.3	6.7	12.5	11.0	5.1	11.2	11.4	5.4	13.1	5
Kardzhali	3.4	5.0	3.1	4.1	5.4	4.6	3.9	5.7	4.0	3
Pazardzhik	1.9	3.1	2.1	1.2	2.2	1.1	1.1	1.7	1.1	6
Plovdiv	8.1	10.0	8.2	10.2	10.3	9.3	10.2	9.7	11.2	4
Smolyan	2.9	4.2	2.3	2.7	4.1	2.1	3.3	4.8	2.9	10
Haskovo	4.6	5.2	4.2	4.3	5.0	3.9	4.4	4.6	4.0	3

3. Results

3.1 Spatial distribution of the textile products clusters (2010-2020)

Figure 3 shows the changes in the spatial distribution of the textile products clusters for the period 2010-2020, computed with all predefined parameters and data. The research was done based on data for three individual years during the studied period - 2010, 2015 and 2020. The highest concentration of companies is observed in the Southwest region, followed by the South-Central region. At the opposite end, on the other hand, are the Northeast region and the Northwest region.

The cluster analysis shows that there are slight spatial differences in textile production at the NUTS 3 level. According to the indicators, on the basis of which the cluster analysis was made, the regions are divided into seven clusters, and the production of textiles and textile products without clothing, is of the highest significance for the regions falling into the following clusters: cluster 3 – Sliven, cluster 4 – Plovdiv, cluster 10 – Vratsa, cluster 5 – Sofia (capital), cluster 7 – Blagoevgrad, and cluster 1 – Veliko Tarnovo, Gabrovo, and Haskovo. At the NUTS 3 administrative-territorial level, textile production is concentrated in the historically-based production areas, the large economic and consumer centers, near the raw materials (spinning factories), and in areas of a favorable transport-geographical position, with a view to the import of raw materials and the export of finished products (some sewing workshops near the border with Greece for example).

Cotton textile industry is the leading subsector – it has the largest volume of production. This is due to the wide application of cotton fabrics. The district of Sofia (capital), Veliko Tarnovo, Yambol, Plovdiv, Tvarditsa, Vratsa, etc. are the main cotton textile centers.

Woolen textile industry works with local and imported raw materials. The centers of this production are Sliven, Sofia, Smolyan and Troyan.

Silk textile industry is relatively new. The production of silk fabrics is represented by Sofia, Ruse, Svilengrad and Haskovo.

Linen textile industry is represented by the production of linen fabrics in Samokov and Ruse.

3.2. Spatial distribution of the leather products clusters

Leather industry includes the processing of hides and the production of various products –leather clothing, coats, bags, suitcases, belts, and gloves – in Sofia, Plovdiv, Dobrich, Lovech, Gabrovo, Ruse, etc. Footwear industry is represented by the production of women's, men's, children's, and sports shoes from natural and artificial leather – in Sofia, Gabrovo, Peshtera, Dobrich, Plovdiv, Kyustendil, Haskovo, etc.

Figure 4 illustrates the spatial distribution of the leather products clusters for the period 2010-2020, computed with all predefined parameters and data. Cluster 4 – Pazardzhik, cluster 2 – Blagoevgrad, cluster 6 – Kyustendil, cluster 7 – Dobrich, and cluster 8 – Montana, Pleven, Lovech, Ruse, Razgrad and Plovdiv, are distinguished by their strongest development. At the opposite end we can find the districts falling into cluster 9 – Vidin, Vratsa, Veliko Tarnovo, Targoviste, Silistra, Shumen, Varna, Pernik, Sofia, Stara Zagora, Sliven, Haskovo, Yambol, and Burgas.

3.3. Spatial distribution of the clothing production clusters

The cluster analysis shows that there are slight spatial differences in the clothing production at the NUTS 3 level. The strongest development is observed in cluster 2 – Blagoevgrad, cluster 5 – Sofia (capital), cluster 1 – Gabrovo, and cluster 4 – Plovdiv, Pleven, and Ruse (Figure 5).

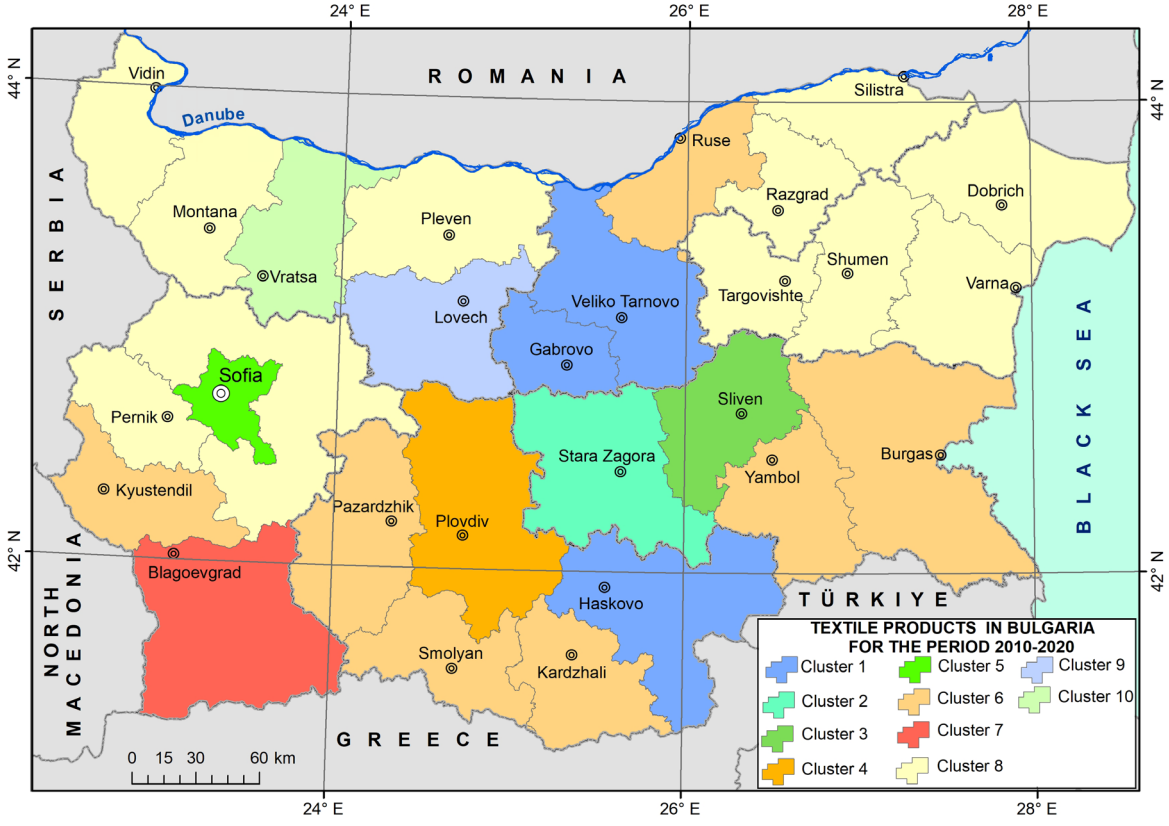


Figure 3. Spatial distribution of the textile products clusters

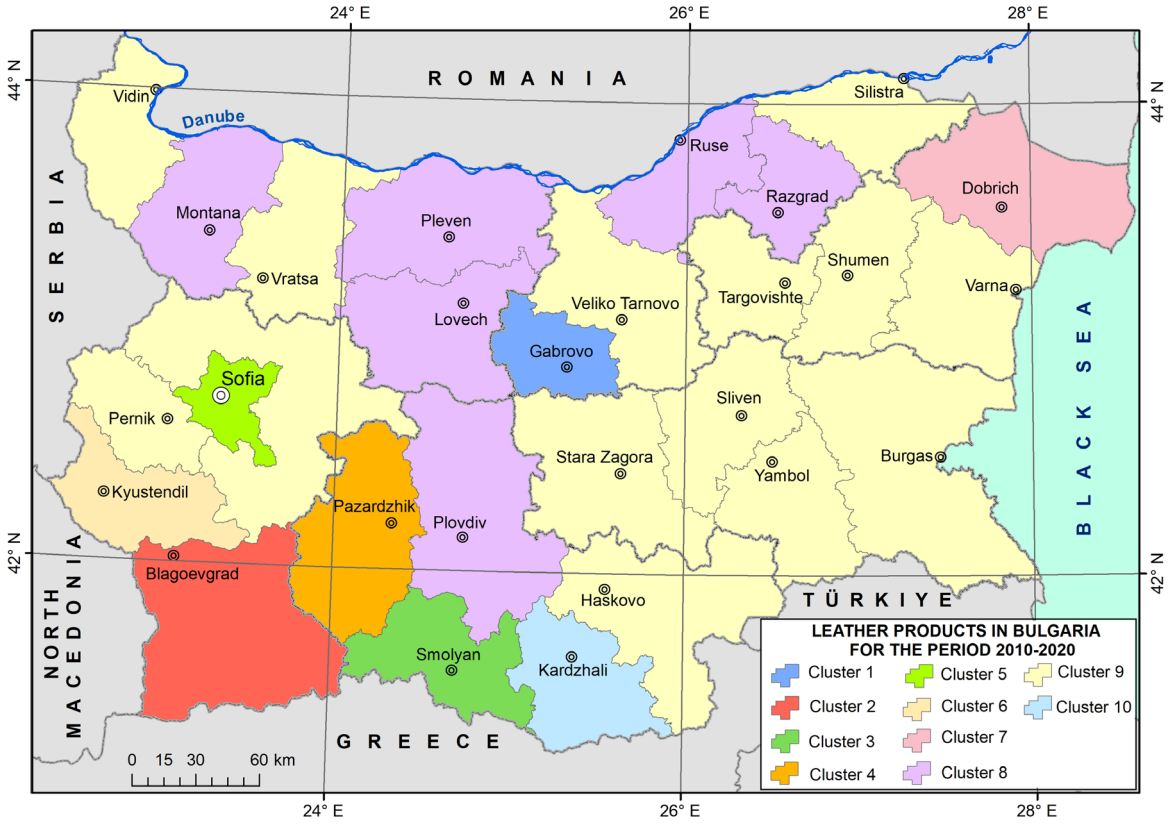


Figure 4. Spatial distribution of the leather products clusters

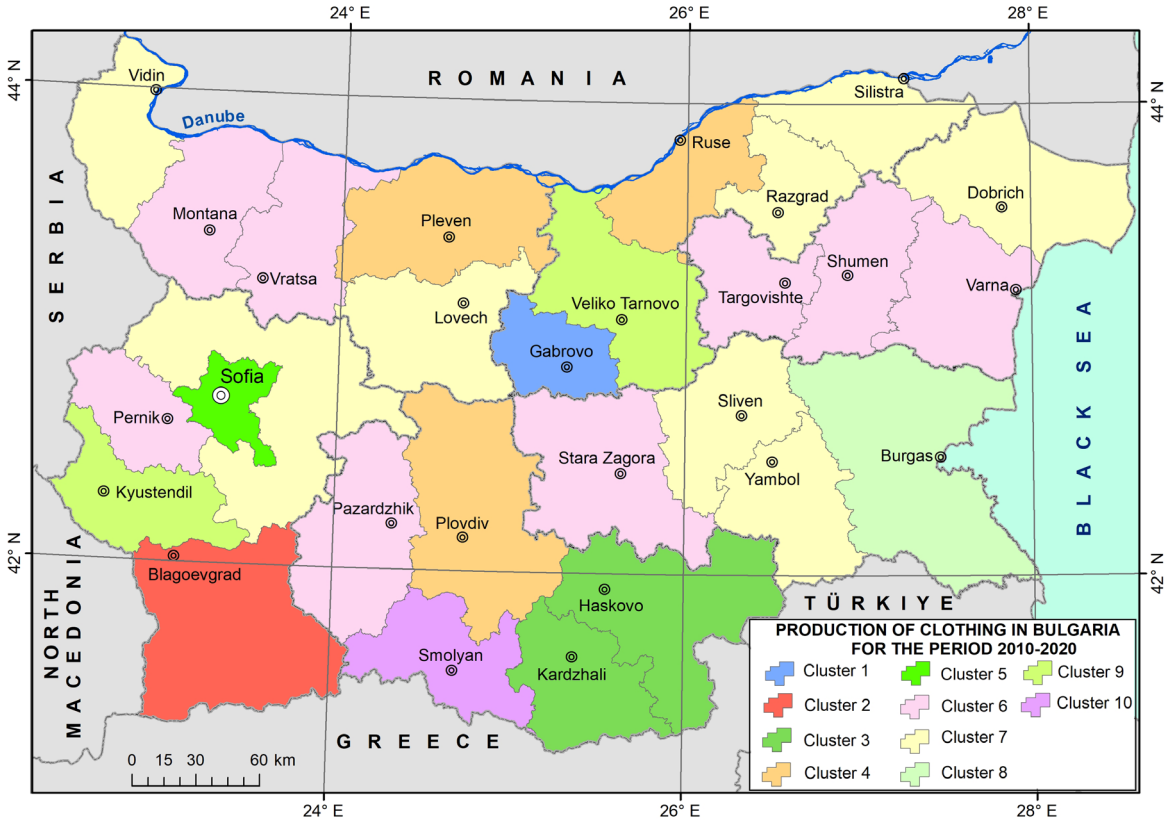


Figure 5. Spatial distribution of the clothing production clusters

3.4. Spatial distribution of the light industry clusters in Bulgaria as of 2010, 2015, and 2020

Figures 6, 7, and 8 show the spatial distribution of the light industry clusters in Bulgaria as of 2010, 2015, and 2020.

The analysis shows some changes in the spatial organization in the production of textiles and textile products, excluding clothing, as well as in the production of clothing and in the processing of hides; manufacture of shoes and other articles from treated furless hides. A slight expansion of the spatial organization of production is observed. In all three years, Blagoevgrad, Haskovo, Kardzhali, Plovdiv, Sliven, Gabrovo, Ruse, Pleven and Smolyan regions remained the leading centers. According to Roukova (2021), in 2016, 40% of those employed in the clothing industry in the country worked in the regions of Blagoevgrad, Kardzhali and Plovdiv, and 17% in Pleven and Ruse. Large companies in the industry are E. Mirolio EAD (Sliven), Dzalli OOD (Gabrovo), Balkantex (Sofia), Pelintex Bulgaria (Ruse), G and A Textil (Sandansdki), Ilma Tex (Sandansdki), Termo-Textil (Musomishta village), Dexa Trading (Kirkovo village, Kardzhali district), KHM Textil (Pleven), Brod & Company Holding (Sofia), and others.

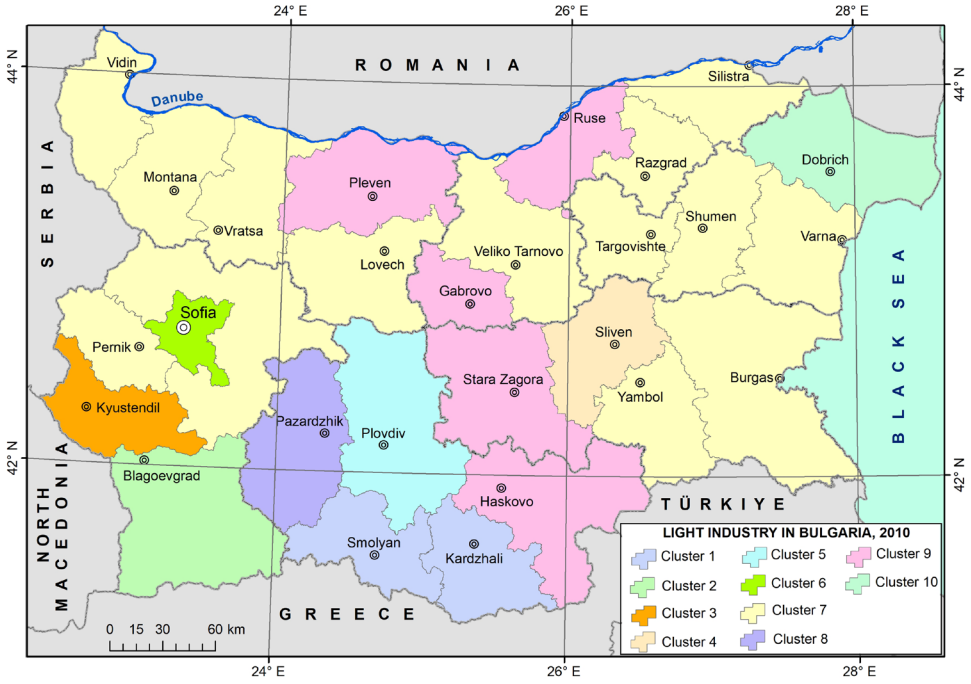


Figure 6. Spatial distribution of the light industry clusters as of 2010

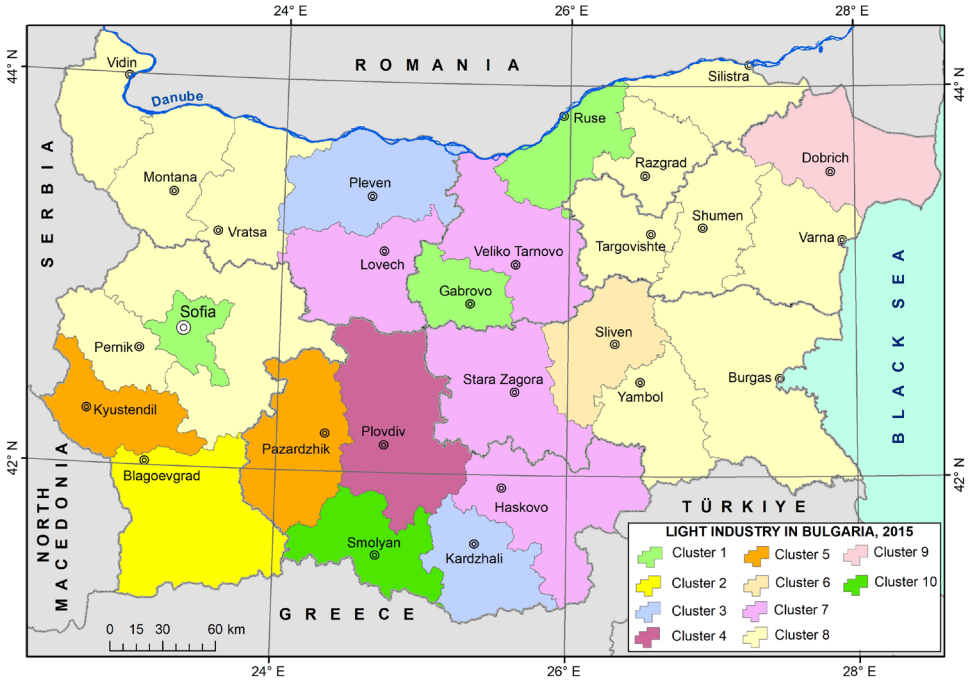


Figure 7. Spatial distribution of the light industry clusters as of 2015

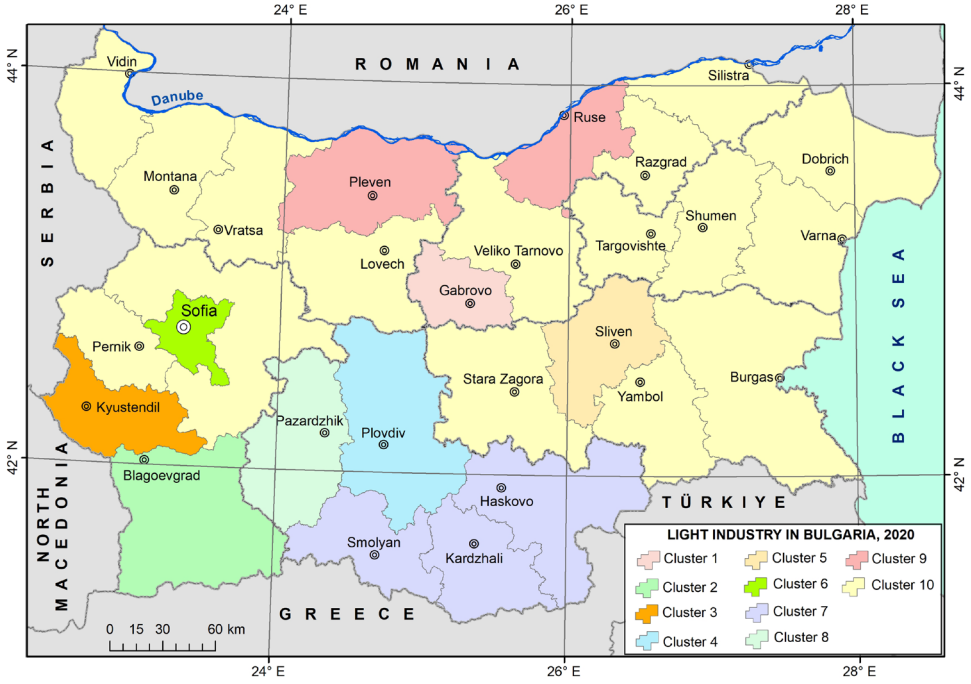


Figure 8. Spatial distribution of the light industry clusters as of 2020

4. Conclusion

In conclusion, it can be summarized that the chosen method of grouping – Grouping Analysis (K-means clustering) is suitable for the study because it presents the real state of the light industry in Bulgaria. Modern methods for spatial analysis in GIS environment allow easier statistical analysis of data. On that basis, specific economic policies and measures for individual clusters can be applied.

Over last two decades, significant changes in the organizational forms of the light industry production have been observed. The number of companies is growing, although most of them are micro- and small enterprises. New forms of organization are also observed. Regardless of this process, companies are still heavily dependent on foreign investment and with limited industrial sophistication (Roukova, 2021). Unlike the organizational structure of the light industry, its spatial structure underwent minor changes during the studied period. Despite the ubiquitous spatial development, the large consumer centers and the traditional production areas preserve their leading positions.

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