SPATIAL DISTRIBUTION OF IRRIGATED AREAS BY PLANNING REGIONS

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ПРОСТРАНСТВЕНО РАЗПРЕДЕЛЕНИЕ НА НАПОЯВАНИТЕ ПЛОЩИ ПО РАЙОНИ ЗА ПЛАНИРАНЕ

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Abstract

The main objective of the paper[45] is to analyse the spatial structure of irrigated areas by planning regions and by categories of the utilised agricultural area in Bulgaria. Statistical data from the census of agricultural holdings were used for the empirical study, and from a methodological point of view, the correspondence analysis was applied. The results of the research can be used in the preparation of regional strategies covering the possibilities of mitigating the effects of climate change on Bulgarian agriculture through irrigated agriculture.

Key words: irrigated area by category, planning regions, correspondence analysis

JEL: Q12, Q15, C38

1. Materials and methods

The difficulties related to irrigated agriculture in Bulgaria and the need to develop a long-term vision for its development are recognised at the state level (Council of Ministers, 2016). On the other hand, the growing challenges to agriculture resulting from climate change can be overcome, towards adaptation, through irrigated agriculture. In scientific literature (Petkov Pl. et al., 2005), (Zagorova, 2008), attention is mainly paid to the problems with the legislation, the activity and the financing of the irrigation associations. The purpose of the paper is to analyse the spatial structure of irrigated areas by planning regions and by categories of utilised agricultural area in Bulgaria, for the period 2010 – 2016.

Actions until 2030, in the field of hydro-melioration in Bulgaria, must be implemented in two stages (Council of Ministers, 2016, p. 13):

- legislative – adoption of the Hydro-meliorations Act, regulating the transformation of "Irrigation Systems" EAD into Regional Hydro-melioration Enterprises;

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- institutional – amendment to the Hydro-meliorations Act, with the aim of transforming the Regional Hydro-melioration Enterprises into Regional Hydro-melioration Management Authorities.

As of July 2022, the Hydro-meliorations Act has not been adopted yet. There are 14 branches of “Irrigation Systems“ EAD (Irrigation Systems EAD, 2022). The available statistical information on the irrigated areas in Bulgaria is available from the Censuses of agricultural holdings (MAF, 2022), but in them it is presented by planning regions. The branches of "Irrigation Systems" EAD can be grouped by planning regions for the needs of the analysis, and the obtained results can be used according to spatial correspondences.

The branches of "Irrigation Systems" EAD fall within the boundaries of the planning regions, as follows:

- in the Severozapaden (Northwest) Planning Region – Vidin, Mizia and the Sreden Dunav (Middle Danube), while the boundaries of the Sreden Dunav (Middle Danube) include Gabrovo province, which by zoning falls into the Severen tsentralen (North-Central) Planning Region;
- in the Severen Tsentralen (North-Central) Planning Region – only one branch – Dolen Dunav (Lower Danube);
- in the Severoiztochen (Northeast) Planning Region – Shumen and the Black Sea;
- in the Yugoiztochen (Southeast) Planning Region – Gorna Tundzha (Upper Tundzha), Sredna Tundzha (Middle Tundzha) and Burgas;
- in the Yuzhen Tsentralen (South-Central) Planning Region – Topolnitsa, Maritsa and Haskovo;
- in the Yugozapaden (Southwest) Planning Region – Struma, Mesta and Sofia.

From a methodological point of view, the correspondence analysis (Michael, 2007) was chosen as a suitable statistical tool for two-dimensionally grouped data by category characteristics, because a reduction in the dimensionality of the source data is ensured through the relationships between the studied variables (Zhekova, 2008), in this case – planning regions and irrigated areas by crops.

2. Results and discussion

In order to trace the change in the spatial distribution of irrigated areas by planning regions, for the period of the three[46] censuses of agricultural holdings in Bulgaria, the correspondence analysis was carried out sequentially for each of the years – 2010, 2013 and 2016. The results are presented in Table 1.

[46] At the time of writing this publication, only preliminary data from the 2020 census of agricultural holdings has been released, which does not contain the necessary information for the needs of the current analysis.

Table 1. Summary of Correspondence

Dimension	2010			2013			2016		
	Inertia	Proportion of Inertia		Inertia	Proportion of Inertia		Inertia	Proportion of Inertia	
		Accounted for	Cumulative		Accounted for	Cumulative		Accounted for	Cumulative
1	0,131	0,661	0,661	0,116	0,573	0,573	0,125	0,601	0,601
2	0,042	0,211	0,872	0,055	0,272	0,846	0,057	0,275	0,876
3	0,013	0,064	0,936	0,025	0,124	0,970	0,018	0,084	0,960
4	0,009	0,045	0,981	0,004	0,021	0,991	0,008	0,038	0,998
5	0,004	0,019	1,000	0,002	0,009	1,000	0,000	0,002	1,000
Total	**0,198**	1,000	1,000	**0,203**	1,000	1,000	**0,208**	1,000	1,000
χ^2	170340,347			191321,424			17958,870		
Sig.*	0,000			0,000			0,000		

* 25 degrees of freedom

The number of dimensions depends on the number of active rows and column categories and is one fewer than the number of categories (Meulman & Heiser, 2005, p. 75). In this case all six variables have six categories. The maximum number of dimensions is five.

The coefficients from Table 1 are interpreted as follows:

✓ The total Inertia for all three years is about 20%;

✓ The part of the total Inertia that is due to the first Dimension is respectively: 66% for 2010, 57% for 2013 and 60% for 2016;

✓ After taking into account the second dimension as well, Cumulative Inertia reaches respectively: 87% for 2010, 85% for 2013 and 88% for 2016, indicating that the first two dimensions accounted for a significant proportion of the total variation;

✓ The significance of χ2-characteristic is below 0.000 for all three years, which proves that there is statistically significant relationship between the studied variables.

Table 2 shows the results of the participation of each of the six planning regions in the formation of the overall Inertia and the two Dimensions for the entire period.

Table 2. Overview Region Points[a]

Region	2010			2013			2016		
	Iner-tia	Contribution by Dimension		Iner-tia	Contribution by Dimension		Iner-tia	Contribution by Dimension	
		1	2		1	2		1	2
Severozapaden	0,020	0,060	0,152	0,028	0,048	0,158	0,010	0,002	0,028
Severen tsentralen	0,008	0,002	0,070	0,009	0,002	0,005	0,012	0,017	0,034
Severoiztochen	0,014	0,006	0,048	0,012	0,055	0,035	0,008	0,022	0,005
Yugoiztochen	0,027	0,002	0,584	0,032	0,029	0,456	0,045	0,044	0,649
Yugozapaden	0,112	0,849	0,029	0,096	0,824	0,002	0,108	0,861	0,006
Yuzhen tsentralen	0,017	0,082	0,117	0,024	0,042	0,344	0,025	0,054	0,278
Total	0,198	1,000	1,000	0,203	1,000	1,000	0,208	1,000	1,000

[a] Symmetrical normalization

✓ *The Yugozapaden Region* has the largest share in the total Inertia in all three years under consideration and dominates in the first Dimension;

✓ *The Yugoiztochen Region* ranks second in terms of share in the total Inertia and dominates in the formation of the second Dimension;

✓ *The Yuzhen Tsentralen Region and the Severozapaden Region* occupy the third place in terms of share in the total Inertia and significantly participate in the formation of the second Dimension;

✓ *The Severen Tsentralen Region and Severoiztochen Region* have a low share in the total Inertia and expectedly have no contribution in both Dimensions.

The participation of each category of irrigated crops in the total inertia in both dimensions is presented in Table 3.

✓ With the largest share in the total Inertia are potatoes, as this crop, grown under irrigated conditions, dominates in the formation of the first Dimension;

✓ The irrigated areas with *permanent crops* and *cereals* are ranked second in terms of share in the total Inertia, influencing the formation of the second Dimension. It should be noted that the areas with permanent crops show a tendency towards an increase in their share in the total variation, while in the case of cereals – the trend is the opposite;

✓ Third place is occupied by irrigated *fodder crops*, which also participated in the second Dimension;

Table 3. Overview Crop Points[a]

Irrigated crops	2010			2013			2016		
	Iner-tia	Contribution by Dimension		Iner-tia	Contribution by Dimension		Iner-tia	Contribution by Dimension	
		1	2		1	2		1	2
Cereals	0,032	0,159	0,199	0,026	0,084	0,258	0,021	0,028	0,247
Industrial crops	0,007	0,000	0,005	0,018	0,103	0,037	0,004	0,003	0,011
Fodder crops	0,009	0,000	0,109	0,035	0,019	0,371	0,016	0,001	0,056
Fresh vegetables and Strawberries	0,011	0,007	0,010	0,008	0,023	0,061	0,013	0,022	0,091
Potatoes	0,111	0,819	0,096	0,087	0,739	0,004	0,115	0,918	0,000
Permanent crops	0,028	0,015	0,581	0,029	0,032	0,268	0,040	0,028	0,594
Total	0,198	1,000	1,000	0,203	1,000	1,000	0,208	1,000	1,000

[a] Symmetrical normalization

✓ The irrigated areas with *fresh vegetables and strawberries, grown in the open air*, and with *industrial crops* have a small share in the total variation, and their participation in the formation of Dimensions is visible for industrial crops in 2013 in the first Dimension, and for fresh vegetables and strawberries, grown in the open area, in 2013 and 2016 in the second Dimension.

The situation annually can be traced through a graphical representation of the positioning of the regions and areas with irrigated crops in the two-dimensional space.

In 2010 (see Figure 1), closest to the average profile (the centre of gravity, or origin of the coordinate system) is the Yuzhen tsentralen region. With relatively close profiles and less distant than the average one, are: Severoiztochen, Yugoiz-tochen and Severen tsentralen. Severozapaden and Yugozapaden regions can be characterised as distant from the average profile.

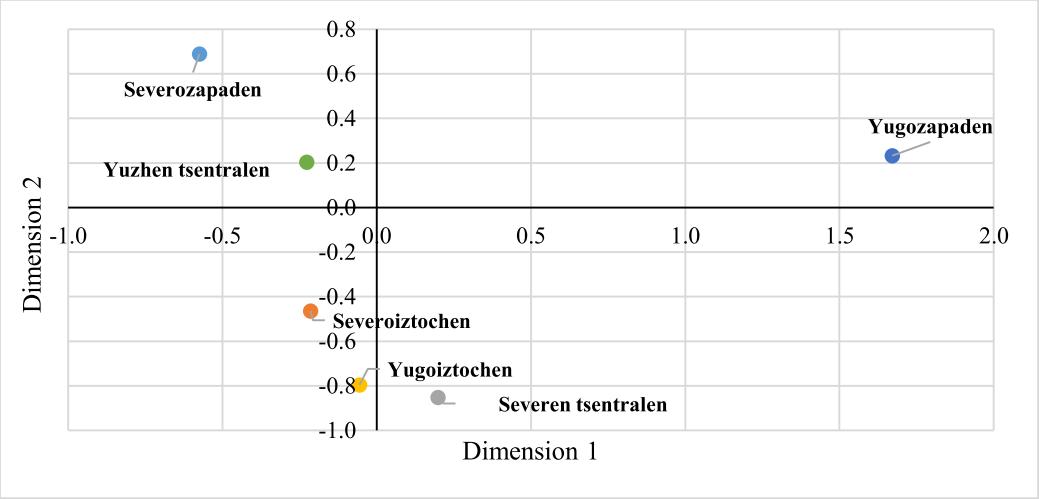

Figure 1. Row Points for Regions (2010)

Regarding the irrigated areas in 2010 (Figure 2), the average profile is described by industrial crops and fresh vegetables and strawberries, grown in the open area. Cereals are slightly distant, while the other three categories are more distant, with potatoes being the most distant.

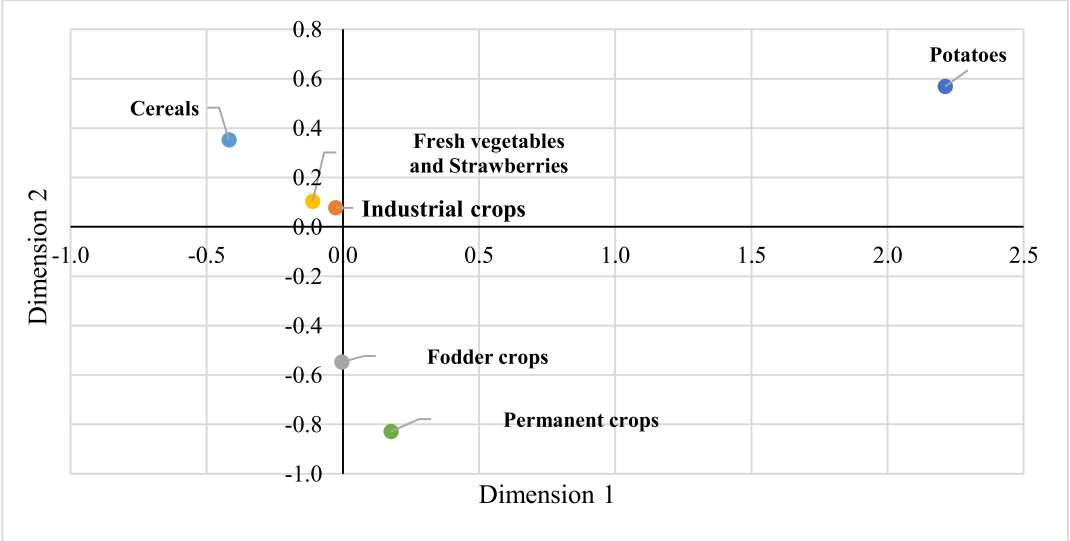

Figure 2. Column Points for Crops (2010)

In 2013 (see Figure 3 and Figure 4) the average profile changes, with the Severen tsentralen region being positioned closest to it. The Yugozapaden region remains remote. Convergence is observed in the profiles of the Yuzhen tsentralen and Severoiztochen regions, as well as of the Yugoiztochen and Severozapaden regions.

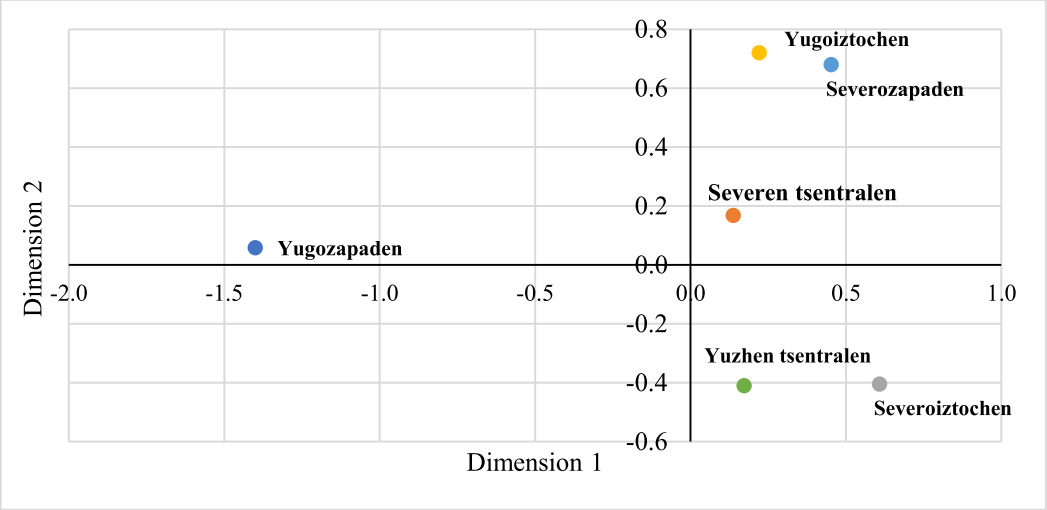

Figure 3. Row Points for Regions (2013)

When comparing the positions of the irrigated categories of agricultural crops in the two dimensions, it can be seen that despite the change in the quadrants, the proximity to the average profile is maintained. There is an exception for permanent crops, which are approaching the average profile, compared to their position in 2010.

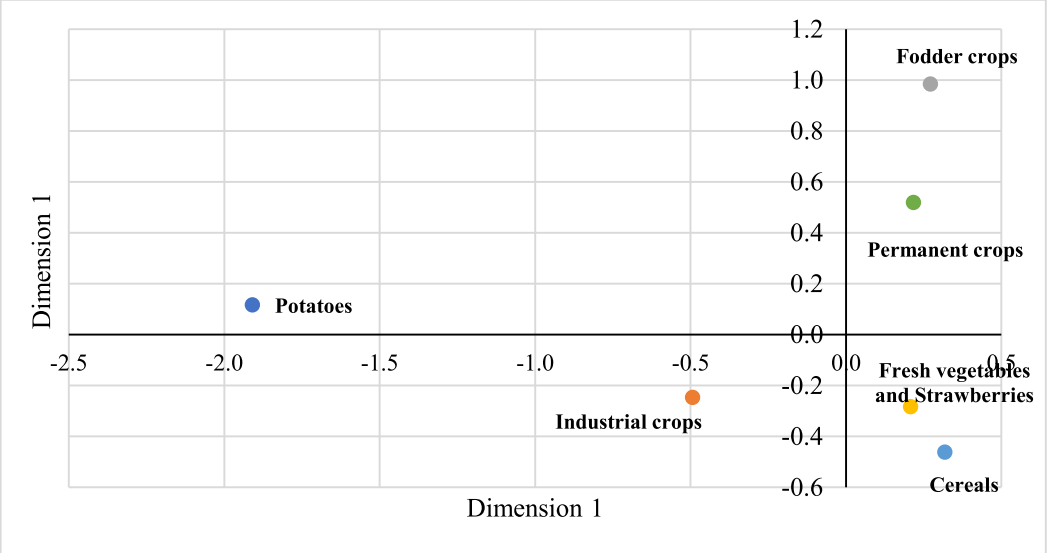

Figure 4. Column Points for Crops (2013)

The data for 2016, presented graphically in Figure 5 and Figure 6, testify to stabilisation in the profiles both by regions and by irrigated crops. Among the regions,

the Yugozapaden, the Yugoiztochen, the Severen tsentralen and the Yuzhen tsentralen retain their positions. The change is for the Severoiztochen region, which is closest to the average profile in 2016. The other change is for the Severozapaden region, which from a profile close to the Yugoiztochen region in 2013, shifts and approaches the Yuzhen tsentralen region.

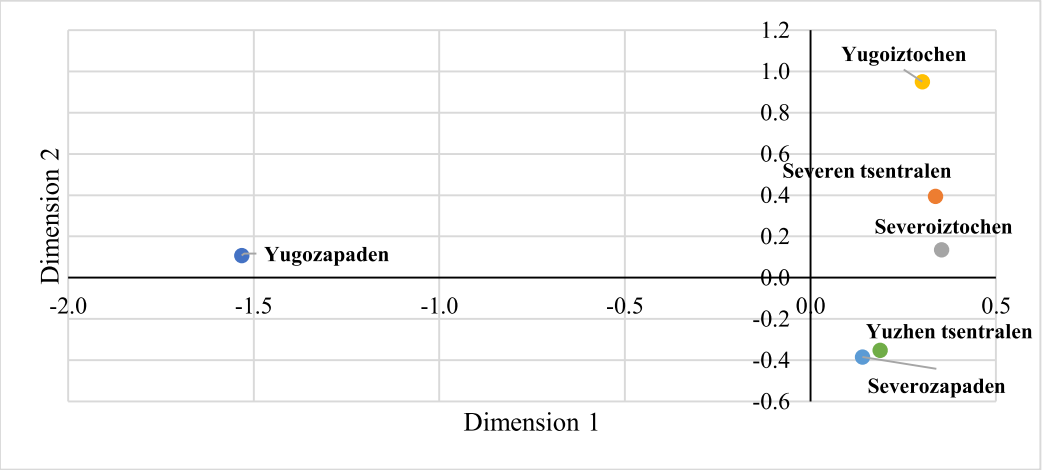

Figure 5. Row Points for Regions (2016)

Regarding the area of irrigated crops, the changes in the profiles in 2016 compared to 2013 are minor – namely, fodder crops are approaching the average profile.

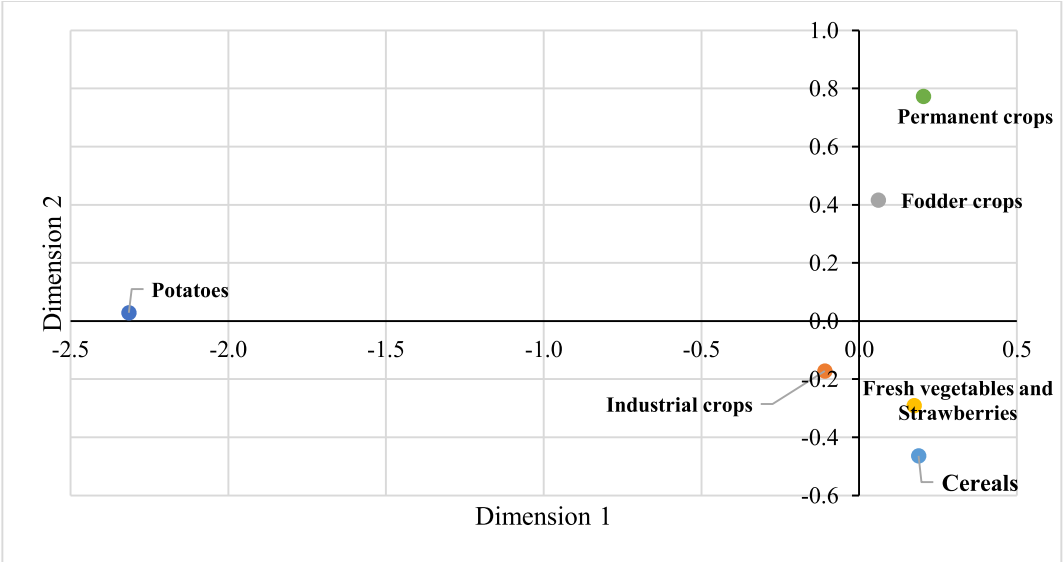

Figure 6. Column Points for Crops (2016)

From the correspondence analysis conducted, with data on the irrigated areas by types of crops and by planning regions, in Bulgaria for the period 2010 – 2016, the following generalisations can be made**:**

1) The largest share of irrigated crops in Bulgaria is formed by the Yuzhen tsentralen region. It is dominated by irrigated cereals, fresh vegetables and industrial crops, which characterise the average profile. These results correspond spatially to branches of "Irrigation Systems" EAD: Topolnitsa, Maritsa and Haskovo.

2) The Yugozapaden region is distant from the average profile, which is due to the high share of potatoes grown under irrigated conditions, which corresponds spatially to branches: Struma Mesta and Sofia. The position of the Southeast region is determined by the size of the irrigated areas with permanent crops and corresponds to branches: Gorna Tundzha (Upper Tundzha), Sredna Tundzha (Middle Tundzha) and Burgas.

3) The Severoiztochen region (corresponding to branches: Shumen and the Black Sea) has a similar profile to that of the Severen tsentralen (corresponding to the Dolen Dunav (Lower Danube)) in terms of the predominant crops, but the size of the areas is much smaller. The same conclusion applies to the proximity of the profiles between the Severozapaden (corresponding to branches: Vidin, Mizia and Sreden Dunav (Middle Danube)) and the Yuzhen tsentralen region.

Conclusion

The conducted analysis of the spatial distribution of irrigated areas by planning regions indicates to stabilisation in the profiles. The future persistence of these profiles should be followed by replaying the same analysis with data from Census '2020, etc. The results can be useful in the preparation of regional strategies for the development of irrigated agriculture both at the level of the planning region and at the level of regional hydro-melioration management authorities. The results of the analysis show the average profile by region and by irrigated crops and the deviations from it. Bulgaria needs to increase the size of irrigated areas to reach the average level for the EU. This can be done through a balanced regional approach, taking into account the geographical conditions and the characteristics of the cultivated crops.

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