UDC 911.3

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COMPONENT ANALYSIS OF THE DEVELOPMENTAL VECTOR OF HEALTH CARE SYSTEM IN THE DISTRICTS SOCIOGEOSYSTEMS OF VOLYN REGION

The article deals with the features of using multi-dimensional space to analyze the development process of sociogeosystems. Together with a common vector analysis were explore its projection on the axis of space – into time derivatives of each parameter is set the process of change, which is allows to research the development of sociogeosystems at the level of each parameter. The specific examples of using this methods for the analysis of health care system development in the districts sociogeosystems of Volyn region are given.

Key words: *multidimensional attribute space, sociogeosystem, parameters of development, developmental vector, the time derivatives of parameters.*

Тарас Погребський. КОМПОНЕНТНИЙ АНАЛІЗ ВЕКТОРУ РОЗВИТКУ СИСТЕМИ ОХОРОНИ ЗДОРОВ'Я У РАЙОННИХ СОЦІОГЕОСИСТЕМАХ ВОЛИНСЬКОЇ ОБЛАСТІ. *У статті розглянуто особливості застосування багатовимірного ознакового простору для аналізу процесу розвитку районних соціогеосистем. Із загальним аналізом вектора досліджувалась його проекції на вісь простору – за часовими похідними кожного параметру процесу встановлюються їх зміни, що дає можливість вивчати розвиток соціогеосистем на рівні кожного параметру. Наводяться конкретні приклади використання даної методики для аналізу розвитку системи охорони здоров'я у районних соціогеосистемах Волинської області.*

Ключові слова: *багатовимірний ознаковий простір, соціогеосистема, параметри розвитку, вектор розвитку, часові похідні параметрів.*

Тарас Погребский. КОМПОНЕНТНЫЙ АНАЛИЗ ВЕКТОРА РАЗВИТИЯ СИСТЕМЫ ЗДРАВООХРАНЕНИЯ В РАЙОННЫХ СОЦИОГЕОСИСТЕМАХ ВОЛЫНСКОЙ ОБЛАСТИ. *В статье рассмотрены особенности применения многомерного признакового пространства для анализа процесса развития районных социогеосистем. С общим анализом вектора исследовалась его проекции на ось пространства – по временным производными каждого параметра процесса устанавливаются их изменения, что дает возможность изучать развитие социогеосистем на уровне каждого параметра. Приводятся конкретные примеры использования данной методики для анализа развития системы здравоохранения в районных социогеосистемах Волынской области.*

Ключевые слова: *многомерное признаковое пространство, социогеосистема, параметры развития, вектор развития, временные производные параметров.*

Introduction. Geographical space, as a fundamental concept of modern geography, has a dual character. On the one hand, its elements are discrete geographic objects (GO), which form a spatial structure and interact within it. On the other hand, the reaction in GO is carried out by means of continual fields of different nature which are presented, in particular, by mathematical models. Thus, depending on the representation of GO quantitative characteristics, two types of tasks are solved. In the first case, if the parameters of GO are treated as deterministic values and do not contain random errors, the task of their fields modeling is reduced to interpolation – minimizing errors analogy. In the second case, when the value of the field at the reference points is presented as random variables, approximation methods are used with varying degrees of model approximation to the true values of the field. Thus, the epistemological problem of the geographical space study is that between the epistemological representation of the spatial structure of GO fields parameter and its ontological essence there is a conflict due to the methodological limitations of science. Therefore, in geographical study it is important to find in existing episteme the approximation method that is most appropriate for the research purpose and the most clearly spatial structure reflects the studied fields [1].

The main material. Nowadays, spatial analysis and spatial models gained significant values in geographical research. Modern geography can analyze objects not only in the usual physical three-dimensional space, but also in the virtual multidimensional attribute space. One example of such spatial modeling synthesis is the modeling of developmental trajectory.

We carried out the simulation of developmental trajectory of the health care system in districts sociogeosystems. This modeling makes it possible to determine the direction of their motion in normalized multidimensional attribute space relative to the optimal developmental trajectory. Main figures of the movement: the projection on an optimal developmental trajectory (displays speed and direction of development), the deviation from an optimal developmental trajectory (reflecting the efficiency of development) and the projection progress coefficient – positions the current point of location in the space of possible events or advancement in development. The developmental trajectory of the health care system is convenient to display on the phase plane in coordinates "projection on an optimal developmental trajectory" – "deviation from an optimal developmental trajectory" [3].

According to a comparative analysis the geographical distribution of districts sociogeosystems due to the development of the health care system in the period from 2007 to 2012 is shown in the table 1 and in a figure 1.

An average distribution of sociogeosystems shows that for the projection vector of health care system on an optimal developmental trajectory the worst conditions are observed in Starovyzhivskiy district, Lutsk district and Gorokhiv district. The best conditions of health care system development are in Kovel district, Vladimir-Volynskiy district, Turiysk district and Lokachi district.

To identify a generalized trajectory of health care system development in the region was used

centrographic method. Its essence is that on each current time were calculated the projection vectors of health care system on an optimal developmental trajectory and deviations from it. That is, sociogeosystems were virtually replaced by imaginary objects with average coordinates on the phase plane. Thus, for each current time we got the coordinates of objects that reflect the average value of sociogeosystem due to the entire billing period. Later, consistently connecting these coordinates, we obtained an average trajectory of health care system development in sociogeosystems, which is represented in figure 2.

Table 1

Average trajectory parameters of the health care system in sociogeosystems for the entire study period (2007-2012 years)

District	Projection on an optimal developmental trajectory	Deviation from an optimal developmental trajectory	Projection progress coefficient
Vladimir-Volynskiy district	5,952	3,203	0,536
Gorokhiv district	5,381	3,349	0,484
Ivanichi district	5,483	2,93	0,523
Kivertsi district	5,675	3,279	0,516
Kovel district	6,255	2,818	0,495
Kamin-Kashirsky district	5,452	3,405	0,555
Lokachi district	5,824	3,953	0,561
Lutsk district	5,373	3,446	0,484
Lyubeshiv district	5,435	3,676	0,518
Lyuboml district	5,414	3,461	0,514
Manevychi district	5,404	3,757	0,485
Ratne district	5,616	3,424	0,554
Rozhysche district	5,606	3,577	0,513
Starovyzhivski district	5,24	3,832	0,49
Turiysk district	5,888	3,934	0,561
Shatsk district	5,416	4,257	0,499
The city of Lutsk	5,583	3,187	0,499

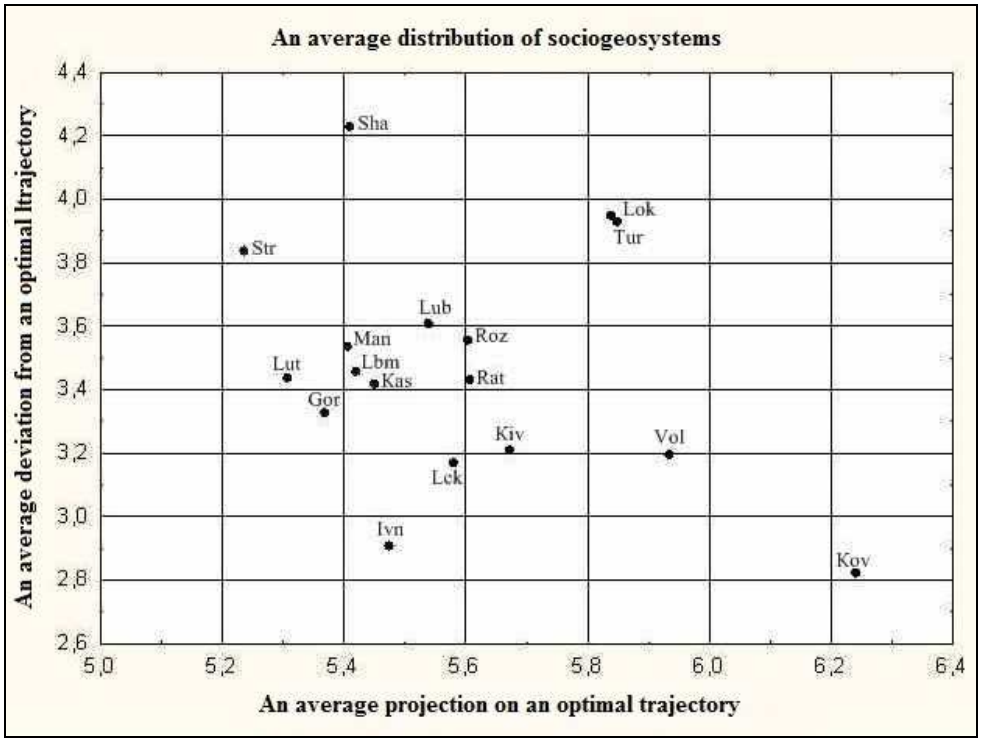

Fig. 1. Average distribution of sociogeosystems on the phase plane due to the development of health care system for the entire period (2007-2012 years)

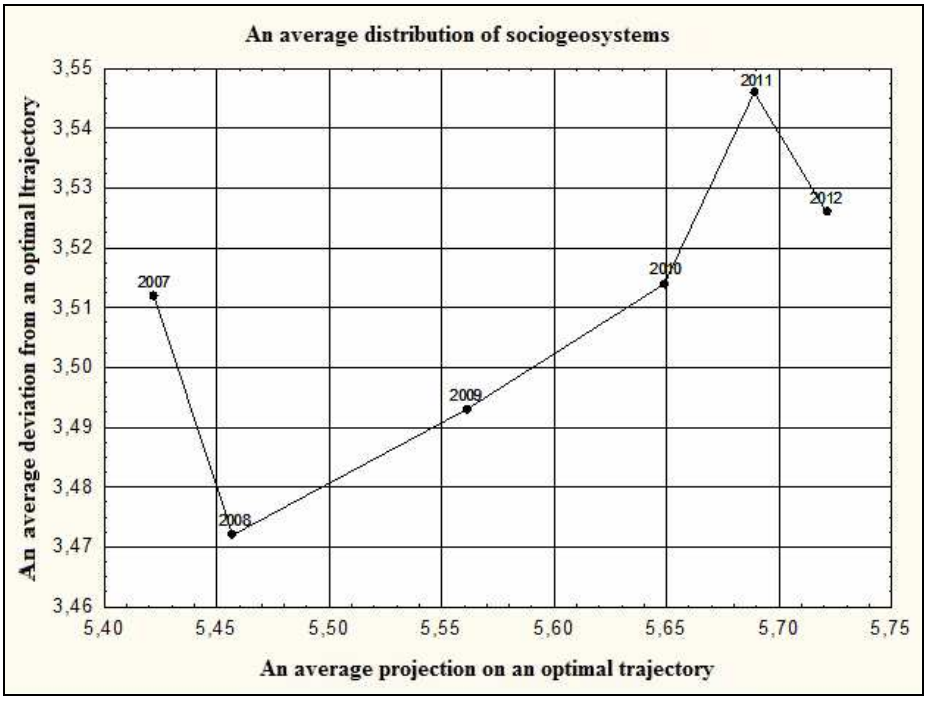

Fig. 2. An average trajectory of health care system development in sociogeosystems

From the above graph we can see that an average trajectory of health care system development in sociogeosystems has a continuous trend of progressive development (2007-2012 years). Accordingly, the best level of development health care system reached in the end of the study period. The greatest efficiency of sociogeosystems movement is observed in 2008, and the lowest – in 2011. An average speed of sociogeosystems movement for all billing periods is approximately the same, indicating a balanced development of health care system.

Modeling the trajectory of health care system development in sociogeosystems except of comparing the trajectories of each sociogeosystems with an optimal developmental trajectory allows to compare them with each other. This information is important in terms of understanding the mechanisms of influence on the study process of internal and external factors in terms of sustainable regional development.

Cosine of the angle between the vectors of health care system in sociogeosystem is an indicator of consistency of direction vectors. Using this property of trigonometric functions, we can determine the similarity of conditions and the level of health care system development between sociogeosystems [2].

The calculation results of average cosine of the angle between the vectors of health care system development in the sociogeosystems are given in the table 2.

Table 2

Matrix of an average cosine of the angle between the vectors of health care system development in the sociogeosystems

Districts	**Districts**								
	Vol	***Gor***	***Ivn***	***Kas***	***Kiv***	***Kov***	***Lok***	***Lut***	***Lub***
Vol	1,00	0,20	0,24	0,35	0,33	0,35	0,16	0,18	0,18
Gor	0,20	1,00	0,36	0,44	0,53	0,09	0,13	0,51	0,25
Ivn	0,24	0,36	1,00	0,36	0,29	0,18	0,11	0,27	0,24
Kas	0,35	0,44	0,36	1,00	0,35	0,13	0,22	0,33	0,27
Kiv	0,33	0,53	0,29	0,35	1,00	0,15	0,20	0,42	0,38
Kov	0,35	0,09	0,18	0,13	0,15	1,00	0,22	0,13	0,29
Lok	0,16	0,13	0,11	0,22	0,20	0,22	1,00	0,09	0,20
Lut	0,18	0,51	0,27	0,33	0,42	0,13	0,09	1,00	0,31
Lub	0,18	0,25	0,24	0,27	0,38	0,29	0,20	0,31	1,00
Lbm	0,20	0,47	0,31	0,38	0,51	0,16	0,27	0,42	0,51
Man	0,24	0,53	0,35	0,24	0,42	0,20	0,18	0,38	0,38
Rat	0,22	0,49	0,24	0,25	0,44	0,22	0,31	0,38	0,42
Roz	0,42	0,24	0,27	0,42	0,38	0,27	0,22	0,24	0,35
Str	0,11	0,36	0,24	0,20	0,29	0,04	0,13	0,53	0,33
Tur	0,35	0,20	0,20	0,24	0,22	0,09	0,47	0,16	0,36
Sha	0,11	0,13	0,07	0,20	0,13	0,16	0,33	0,09	0,15
Lck	0,05	0,38	0,25	0,24	0,36	0,20	0,16	0,40	0,38
Sum	**3,67**	**5,31**	**3,98**	**4,60**	**5,38**	**2,87**	**3,40**	**4,84**	**5,00**

(continuance of the table)

Districts	Districts							
	Lbm	***Man***	***Rat***	***Roz***	***Str***	***Tur***	***Sha***	***Lck***
Vol	0,20	0,24	0,22	0,42	0,11	0,35	0,11	0,05
Gor	0,47	0,53	0,49	0,24	0,36	0,20	0,13	0,38
Ivn	0,31	0,35	0,24	0,27	0,24	0,20	0,07	0,25
Kas	0,38	0,24	0,25	0,42	0,20	0,24	0,20	0,24
Kiv	0,51	0,42	0,44	0,38	0,29	0,22	0,13	0,36
Kov	0,16	0,20	0,22	0,27	0,04	0,09	0,16	0,20
Lok	0,27	0,18	0,31	0,22	0,13	0,47	0,33	0,16
Lut	0,42	0,38	0,38	0,24	0,53	0,16	0,09	0,40
Lub	0,51	0,38	0,42	0,35	0,33	0,36	0,15	0,38
Lbm	1,00	0,47	0,51	0,31	0,53	0,22	0,18	0,53
Man	0,47	1,00	0,49	0,44	0,36	0,29	0,11	0,49
Rat	0,51	0,49	1,00	0,31	0,31	0,25	0,05	0,40
Roz	0,31	0,44	0,31	1,00	0,16	0,42	0,16	0,29
Str	0,53	0,36	0,31	0,16	1,00	0,16	0,24	0,33
Tur	0,22	0,29	0,25	0,42	0,16	1,00	0,18	0,22
Sha	0,18	0,11	0,05	0,16	0,24	0,18	1,00	0,22
Lck	0,53	0,49	0,40	0,29	0,33	0,22	0,22	1,00
Sum	**5,98**	**5,56**	**5,29**	**4,89**	**4,31**	**4,04**	**2,51**	**4,91**

In the last row of the table there are the sum of cosines for each district. It determines the overall consistency of health care system development. The higher the value of this amount, the higher the level of consistency in relevant sociogeosystem. The data visualized in Pareto chart.

From the above table and Pareto graph can be seen that most agreed with other districts by the development of health care system are Lyuboml district, Manevychi district and Kivertsi district. The worst consistency differ Shatsk district, Kovel district and Lokachi district.

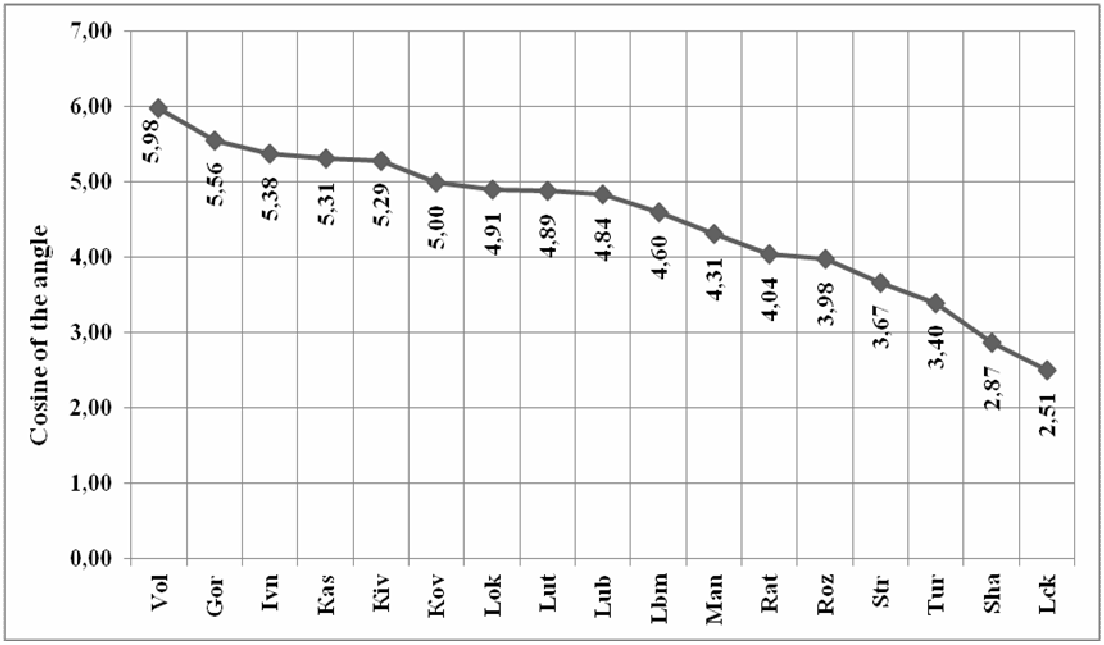

Fig. 3. Pareto Chart of average cosine of the angle between the vectors of health care system development in sociogeosystems

To research the uniqueness or specificity of sociogeosystems by the specifics of health care system development we used the method of generalization of local classifications. Its essence is to detect certain frequencies hit of sociogeosystems in one class of classification. Local classifications were based on various indicators of system development. The results of the research of regional specificity of sociogeosystems are presented in the table 3.

As in the previous research, in the last row of the table are the sum of frequency association between sociogeosystems in all local classifications. The lower the value of this amount, the higher the level of uniqueness or specificity of corresponding sociogeosystem. The data visualized in Pareto chart.

Table 3

Matrix of frequency association of sociogeosystems in local classifications

Districts	Districts								
	Vol	***Gor***	***Ivn***	***Kas***	***Kiv***	***Kov***	***Lok***	***Lut***	***Lub***
Vol		11	13	19	18	19	9	10	10
Gor	11		20	24	29	5	7	28	14
Ivn	13	20		20	16	10	6	15	13
Kas	19	24	20		19	7	12	18	15
Kiv	18	29	16	19		8	11	23	21
Kov	19	5	10	7	8		12	7	16
Lok	9	7	6	12	11	12		5	11
Lut	10	28	15	18	23	7	5		17
Lub	10	14	13	15	21	16	11	17	
Lbm	11	26	17	21	28	9	15	23	28
Man	13	29	19	13	23	11	10	21	21
Rat	12	27	13	14	24	12	17	21	23
Roz	23	13	15	23	21	15	12	13	19
Str	6	20	13	11	16	2	7	29	18
Tur	19	11	11	13	12	5	26	9	20
Sha	6	7	4	11	7	9	18	5	8
Lck	3	21	14	13	20	11	9	22	21
Sum	**202**	**292**	**219**	**253**	**296**	**158**	**187**	**266**	**275**

(continuance of the table)

Districts	Districts							
	Lbm	***Man***	***Rat***	***Roz***	***Str***	***Tur***	***Sha***	***Lck***
Vol	11	13	12	23	6	19	6	3
Gor	26	29	27	13	20	11	7	21
Ivn	17	19	13	15	13	11	4	14
Kas	21	13	14	23	11	13	11	13
Kiv	28	23	24	21	16	12	7	20
Kov	9	11	12	15	2	5	9	11
Lok	15	10	17	12	7	26	18	9
Lut	23	21	21	13	29	9	5	22
Lub	28	21	23	19	18	20	8	21
Lbm		26	28	17	29	12	10	29
Man	26		27	24	20	16	6	27
Rat	28	27		17	17	14	3	22
Roz	17	24	17		9	23	9	16
Str	29	20	17	9		9	13	18
Tur	12	16	14	23	9		10	12
Sha	10	6	3	9	13	10		12
Lck	29	27	22	16	18	12	12	
Sum	**329**	**306**	**291**	**269**	**237**	**222**	**138**	**270**

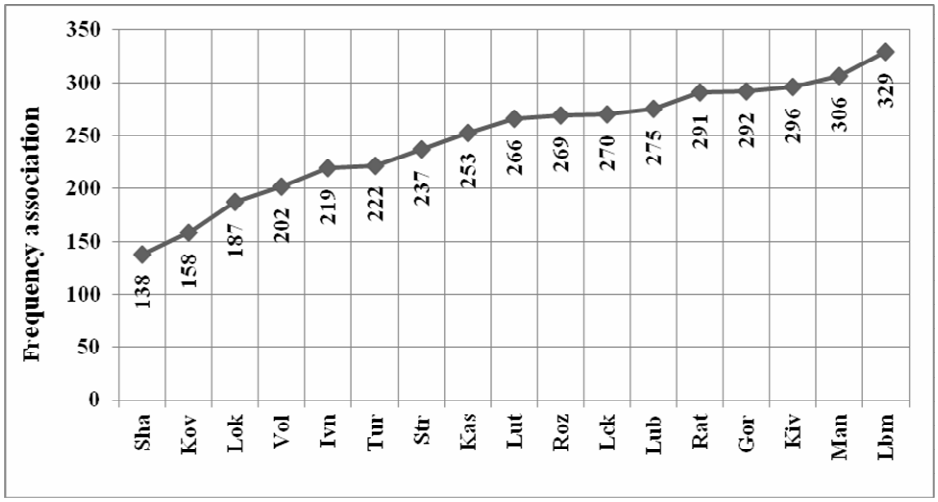

Fig. 4. Pareto Chart of frequency association of sociogeosystems

From the above table and Pareto graph we can see that the highest level of specificity of sociogeosystems by the specifics of health care system development observed in Shatsk district (frequency 138), Kovel district (158) and Lokachi district (187). The least specific in terms of health care system development observed in Lyuboml district (frequency 329), Manevichy district (frequency 306) and Kivertsi district (frequency 296).

To identify and to explain the dynamics of health care system development in sociogeosystem, you have to carefully examine its state changes over time in the operating space. To do this, we used the vector component analysis. The essence of this method is to determine the projections of the vector on each axle of multidimensional attribute space with a detailed analysis of meaningful change. This allows to move from a general assessment of conditions and the level of sociogeosystem in integral form to research of individual components. The results can be used in solving such tasks as planning, forecasting and optimization of development and management (eg in the context of the concept of sustainable development) [5].

Calculating the time derivatives have three possible outcomes:

1) if the parameter during the calculation period remained unchanged (the process by a considerable margin stable), the derivative is 0 and that result is assigned code 0;

2) if the parameter is reduced (the process behind it regresses), the derivative is negative, in accordance with result code -1;

3) if the parameter increases (process behind it progresses), the derivative is positive, in which case the result code 1.

The proposed code selection (split into three groups for a nominal scale) is suitable for further analysis. Thus, in the aggregate indices of statistical parameters of health care system development, its enough to calculate the amount of codes of corresponding derivative groups. The total amount of code shows adjustments prevail. Due to the large volume of all tables to give the results of calculations in the paper is impossible. We conducted a statistical analysis of the amounts indices parameters of the process. The results are presented in the table 4 [4].

Table 4

Amounts index changes of parameters of health care system development in the districts sociogeosystems for the billing period

Period	Codes of temporal derivative indices by district								
	Vol	***Gor***	***Ivn***	***Kas***	***Kiv***	***Kov***	***Lok***	***Lut***	***Lub***
1	18	8	8	14	29	12	-2	15	6
2	14	34	9	-8	14	2	2	-1	14
3	-14	11	1	-8	10	21	23	21	8
4	15	-11	5	23	3	-1	-3	-4	4
5	-7	8	6	4	-4	5	4	-7	2
сума	**26**	**50**	**29**	**25**	**52**	**39**	**24**	**24**	**34**

(continuance of the table)

Period	Codes of temporal derivative indices by district							
	Lbm	***Man***	***Rat***	***Roz***	***Str***	***Tur***	***Sha***	***Lck***
1	19	12	-36	10	-3	1	-3	7
2	10	7	3	-4	20	12	5	17
3	3	5	24	42	19	-2	25	-19
4	13	21	22	-5	20	5	-10	24
5	13	-2	-27	2	-6	-5	18	-7
сума	**58**	**43**	**-14**	**45**	**50**	**11**	**35**	**22**

Note: The calculation periods: 1 - 2007-2008; 2 - 2008-2009; 3 - 2009-2010; 4 - 2010-2011; 5 - 2011-2012.

Using the above table we can see that sociogeosystems are very differentiated by changing parameters of statistical indices of health care system development. It is observed a significant difference of the total amount for the entire study period – the minimum -14 (Ratne district) to maximum 58 (Lyuboml district). This is evidence that the research process is quite complex and has many features.

Leaders in the total change in the index of statistical parameters of health care system development are such districts as Lyuboml (58), Kivertsi (52), Gorokhiv (50), and Starovyzhivskiy (50). The smallest amount of common characteristic are observed in Ratne district (-14) and Turiysk district (11).

Conclusions. The proposed method of investigation of sociogeosystems is an effective tool for solving forecasting, optimization, monitoring and control on this process. It is complements the analysis of development processes by taking into account changes in each parameter of the process and expand the knowledge base addressing the above problems. The detail analysis at the level of each parameter allows to increase the threshold monitoring and take into account all the peculiarities of the development process for rapid response to critical situations. An optimal spatial and temporal organization of monitoring makes possible resource management in online mode, which greatly improves the efficiency of the development of sociogeosystems.

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Summary

Taras Pogrebskyi. COMPONENT ANALYSIS OF THE DEVELOPMENTAL VECTOR OF HEALTH CARE SYSTEM IN THE DISTRICTS SOCIOGEOSYSTEMS OF VOLYN REGION.

Geographical space, as a fundamental concept of modern geography, has a dual character. On the one hand, its elements are discrete geographic objects, which form a spatial structure and interact within it. On the other hand, the reaction in geographic objects is carried out by means of continual fields of different nature which are presented, in particular, by mathematical models.

Nowadays, spatial analysis and spatial models gained significant values in geographical research. Modern geography can analyze objects not only in the usual physical three-dimensional space, but also in the virtual multidimensional attribute space. One example of such spatial modeling synthesis is the modeling of developmental trajectory.

We carried out the simulation of developmental trajectory of the health care system in districts sociogeosystems. This modeling makes it possible to determine the direction of their motion in normalized multidimensional attribute space relative to the optimal developmental trajectory.

The proposed method of investigation of sociogeosystems is an effective tool for solving forecasting, optimization, monitoring and control on this process. It is complements the analysis of development processes by taking into account changes in each parameter of the process and expand the knowledge base addressing the above problems.

Key words: multidimensional attribute space, sociogeosystem, parameters of development, developmental vector, the time derivatives of parameters.