technology, especially the diet. Increasing the yield and quality of grain crops, including spring barley, is the basis for the economic sustainability of agricultural enterprises. Sustainable growth in grain production today is associated with the intensification of the technological process of cultivation, aimed at creating highly productive crops, improving the quality of grain while maintaining environmental safety, reducing resource and energy costs. It is known that in order to grow stable yields of spring barley with high grain quality indicators, it is important to provide plants with nutrients from the very beginning of the growing season by applying mineral fertilizers. The article presents experimental data on the vegetation and grain yield of spring barley from the use of different rates of mineral fertilizers and methods of primary soil cultivation during the vegetation of spring barley

Key words: barley, yield, quality, fertilizer, soil.

IRSTI 68.05.29: 68.05.35: 68.05.37 **DOI** https://doi.org/10.37884/4-2024/28

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THE USE OF GIS TECHNOLOGY AND SPATIAL ANALYSIS FOR THE DIAGNOSIS OF SOILS AND CROPS IN THE NORTH KAZAKHSTAN REGION

Abstract

The article presents research on spatial analysis for the diagnosis of soils and crops using GIS technologies in the North Kazakhstan region. An analysis of the application of the geostatistical Kriging method is given, which allows you to build predictable maps based on limited data, and also allows you to interactively explore the spatial behavior of any values and assume their further change or state by interpolating data on objects without specified values. In these studies, the forecast of changes in soil and agrochemical parameters was considered: nitrogen, phosphorus and humus. When Kriging, the program uses mathematical functions for a certain number of points. Variograms and covariance functions were created to estimate the values of statistical dependence, and unknown values were predicted for various crops of the fertilized background and control. To verify the accuracy of the interpolation data, a comparison of the forecast map and the cartogram of mobile phosphorus and humus was carried out in the article. As a result of comparing the maps, similar areas of phosphorus and humus content changes were revealed to a greater extent, which indicates a working model of Kriging interpolation and some inconsistencies, which may indicate errors in the method.

Key words: *soil fertility, soil diagnostics, geoinformation technologies, spatial analysis, interpolation, agricultural crops, soil treatment, mineral fertilizers.*

Introduction

Currently, with the intensive use of digital technologies in agriculture, or rather the use of geoinformation technologies for monitoring and evaluating soil and vegetation, it is more in demand and relevant than outdated methods for diagnosing changes in soil cover and vegetation [1-3].

Plant nutrition diagnostics is a systematic set of measures aimed at identifying and/or establishing the availability of plant nutrients [4]. That is, the identification of deficient nutrients necessary for the full-fledged growth and development of culture [5].

In this work, in the conditions of our time, the diagnosis of plant nutrition, or rather the dynamics of changes in soil and vegetation cover, will be considered taking into account the use of GIS systems and spatial analysis by the Kriging method [6].

The geostatistical Kriging method allows you to build predictable maps based on limited data [7]. The method allows interactively investigating the spatial behavior of any values and suggesting their further change or state by interpolating data onto objects without the specified values[8, 9].

During screening, the program uses mathematical functions for a certain number of points [10].

Objective: To study spatial analysis for the diagnosis of soils and crops using GIS technologies in the North Kazakhstan region.

Tasks:

- Diagnostics of geomorphological conditions using GIS technologies;
- Conducting spatial analysis for the diagnosis of soils and crops on common chernozems.

The object and methodology of the study

The research object is located in the sharply continental climate of the steppe zone on ordinary chernozems in the North Kazakhstan Experimental Agricultural Station LLP in the Akkayyn district of the North Kazakhstan region. The area is 16 ha.

The experimental plots were placed on a controlled and fertilized background. The size of the experimental plots is 126 m long, 8 m wide, and 163 plots in total. Crops: spring wheat, oilseed flax, baleen peas, sunflower, triticale, and simply. Soil samples were taken from each plot for soil-agrochemical analysis from a depth of 0-20 cm.

Soil and agrochemical analysis was carried out: NO3, P2O5, K2O, pH and humus. An estimated (predicted) map of the battery content was constructed using the Kriging method (geostatistical interpolation method).

The results of the study

Using the QGis 2.28 GIS program, a digital relief map was compiled to diagnose the geomorphological conditions of the experimental plots under study, which reflects the distribution of moisture in the soil depending on the microrelief and affects the growth and productivity of crops (Figure 1).

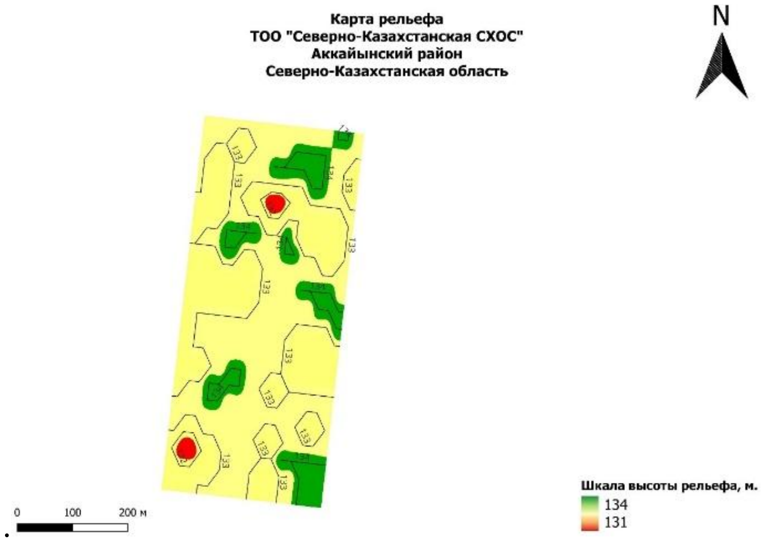

Figure 1 - Digital terrain map

After the soil-agrochemical laboratory analysis, the diagnosis of soil condition changes was carried out using geoinformation and spatial analysis by Kriging. In these studies, the forecast of changes in soil and agrochemical parameters was considered: nitrogen, phosphorus and humus.

In order to complete the task, a two-step process was performed using the Kriging method: 1. Creation of a variogram and a covariance function for estimating statistical dependence values; 2. Forecasting unknown values.

75 plots out of 163 were selected as input data for predicting the content of nitrate nitrogen, mobile phosphorus and humus in the field under study in North Kazakhstan Agricultural Cooperative LLP (Table 1).

Table 1 - The location of the plots (colored) selected for the input data

Culture, sports	№ allotments	Fon P90	№ allotments	Fon control
Flax, Kostanay amber	1		88	
	2		89	
	3		90	
	4		91	
	5		92	
	6		93	
	7		94	
	8		95	
	9		96	
Peas , Aksai moustache 55	10		97	
	11		98	
	12		99	
	13		100	
	14		101	
	15		102	
	16		103	
	17		104	
	18		105	
Sunflower hybrid Baiterek	19		106	
	20		107	
	21		108	
	22		109	
	23		110	
	24		111	
Wheat Shortandinskaya 2012	25		112	
	26		113	
	27		114	
	28		115	
	29		116	
	30		117	
	31		118	
	32		119	
	33		120	
Wheat Semyonovna	34		121	
	35		122	
	36		123	
	37		124	
	38		125	
	39		126	
	40		127	
	41		128	
	42		129	

Culture, sports	№ allotments	Fon P90	№ allotments	Fon control
Karabalyk wheat 20	43		130	
	44		131	
	45		132	
	46		133	
	47		134	
	48		135	
	49		136	
	50		137	
	51		138	
Triticale Rossika	52		139	
	53		140	
	54		141	
	55		142	
	56		143	
	57		144	
	58		145	
	59		146	
	60		147	
Triticale Dauren	61		148	
	62		149	
	63		150	
	64		151	
	65		152	
	66		153	
	67		154	
	68		155	
	69		156	
Millet Omsk 11	70		157	
	71		158	
	72		159	
	73		160	
	74		162	
	75		163	

Based on 75 plots, a variogram was created that reflects the change in the predicted data depending on the distance of plots from each other with similar data. The variogram of nitrate nitrogen has a linear character and is marked at the beginning with a low content and changes linearly further. The mobile phosphorus variogram is linearly regressive, which indicates a decrease in the mobile phosphorus content depending on the distance between points that are similar in data to each other. The humus variogram has a circular character, which indicates a smooth increase in content and stable movement as the distance increases (Figure 2).

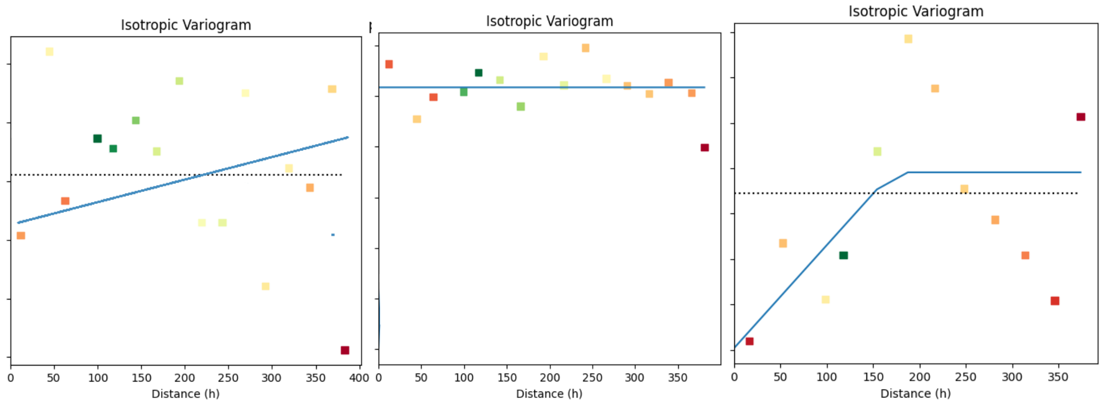

Figure 2 - Variograms of input data on nitrate nitrogen, mobile phosphorus and humus

Kriging interpolation made it possible to create a predictable map of the content of nitrate nitrogen, mobile phosphorus and humus in the soil.

The input data map reflects a certain number of points (75 data points) coordinated and linked to space, which is reflected along the vertical and horizontal axes. After performing the interpolation in the QGis 2.28 program, a forecast map is created based on the above variogram and statistical data analysis (automated program statistics), while simultaneously filling the space around the points for visual perception of the data in the form of polygonal objects.

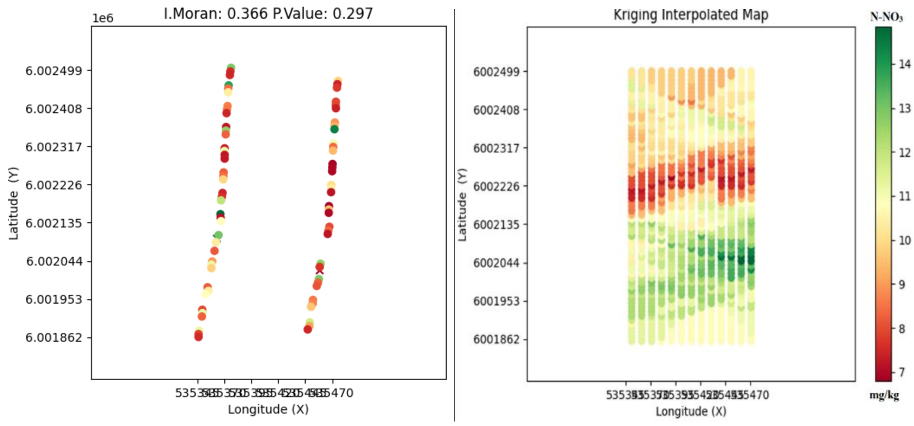

Figure 3-Input data map and forecast map of nitrate nitrogen content

To verify the accuracy of the interpolation data, a comparison of the forecast map and the cartogram of mobile phosphorus and humus was performed. As a result of comparing the maps, similar areas of phosphorus and humus content changes were revealed to a greater extent, which indicates a working model of Kriging interpolation and some inconsistencies, which may indicate errors in the method.

On the forecast map for all crops, the nitrate nitrogen content indicates its differentiated content by field (Figure 3).

The mobile phosphorus prediction map indicates a low phosphorus content in the upper part of the field (Figure 4), which corresponds to laboratory data from soil and agrochemical analysis.

The humus content according to the field forecast map varies from 3.8% to 5%. In plots with wheat and triticale, its content changes sharply to 4.8%-5% (Figure 19).

Thus, we can say that the Kriging method allows us to predict and visualize the content of plant nutrition elements in the form of a map in conditions of limited data. It is worth noting that the prediction map is interpolated by the Kriging method, shows more accurate values, up to tenths of a unit, and changes the color scale of the map.

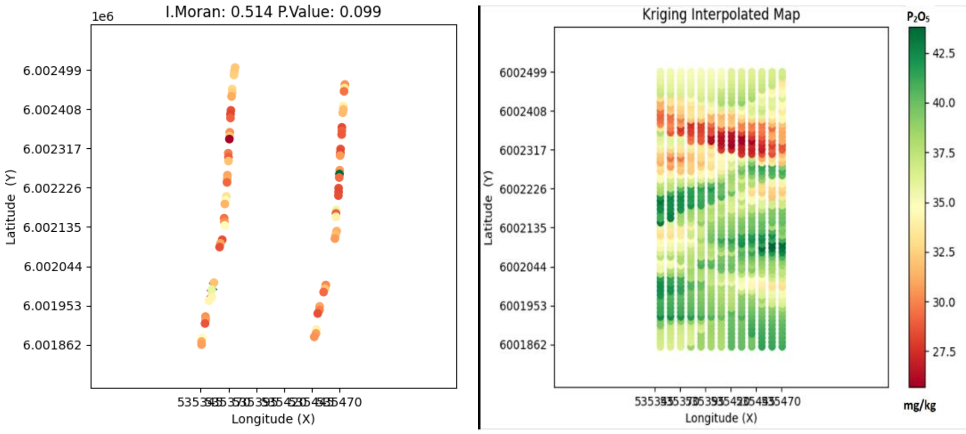

Figure 4 - Input data map and forecast map of underwater phosphorus content

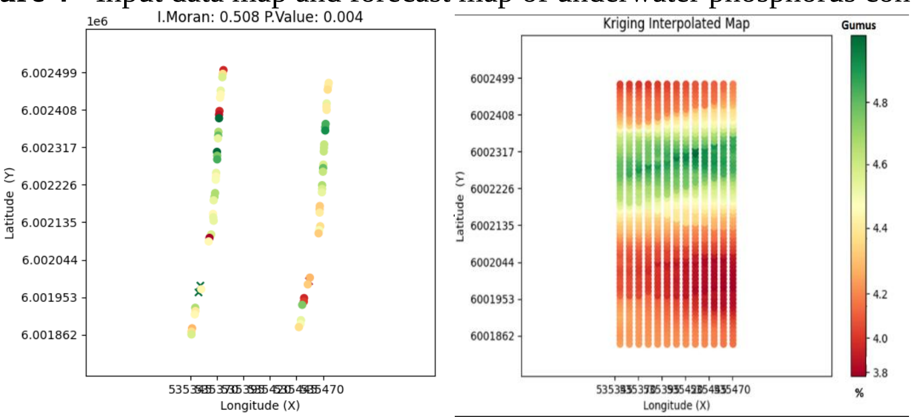

Figure 5 - Input data map and humus content forecast map

Conclusion

Evaluation of the use of geoinformation and spatial analysis for the diagnosis of soil fertility using GIS technologies and the Kriging method makes it easy to process large amounts of information on soil-agrochemical, geomorphological, hydrological and agroecological examination of soils (GIS provides extensive possibilities for combining, sorting, and sampling data; areas and contour parameters are easily calculated); interpolation of soil properties in space , etc .

The article was carried out within the framework of the PCF RK "Building a decision-making system for the production of basic types of agricultural crops based on the adaptation of the DSSAT model, the growth and development of agricultural crops, an integrated management system for livestock production based on Smart technologies, with the formation of an information base of scientific and technical documentation on agricultural technologies for agricultural subjects, with the purpose of creating Smart systems in agriculture"№

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СОЛТҮСТІК ҚАЗАҚСТАН ОБЛЫСЫНДА ТОПЫРАҚ ПЕН ДАҚЫЛДАРДЫ ДИАГНОСТИКАЛАУ ҮШІН ГАЖ ТЕХНОЛОГИЯСЫН ЖӘНЕ КЕҢІСТІКТІК ТАЛДАУДЫ ҚОЛДАНУ

Аңдатпа

Мақалада Солтүстік Қазақстан облысында ГАЖ технологияларын пайдалана отырып, топырақ пен ауыл шаруашылығы дақылдарын диагностикалау үшін кеңістіктік талдауды зерттеу бойынша зерттеулер ұсынылған. Шектеулі деректер негізінде болжанатын карталарды құруға мүмкіндік беретін, сондай-ақ кез келген мәндердің кеңістіктік мінез-құлқын интерактивті түрде зерттеуге және деректерді көрсетілген мәндерсіз объектілерге интерполяциялау арқылы олардың одан әрі өзгеруін немесе күйін болжауға мүмкіндік беретін геостатистикалық Кригинг әдісін қолдану талдауы берілген. Бұл зерттеулерде топырақ-агрохимиялық көрсеткіштердің өзгеру болжамы қарастырылды: азот, фосфор және гумус. Кригинг кезінде бағдарлама белгілі бір нүктелер саны үшін математикалық функцияларды қолданады. Статистикалық тәуелділіктің мәндерін бағалау үшін вариограммалар мен

коварияция функциялары жасалды және ұрықтандырылған фон мен бақылаудың әртүрлі дақылдарында белгісіз мәндерді болжау жүргізілді. Интерполяцияны құру деректерінің дұрыстығын тексеру үшін мақалада болжам картасы мен жылжымалы фосфор мен гумустың картограммасын салыстыру жүргізілді. Карталарды салыстыру нәтижесінде фосфор мен гумустың өзгеруінің ұқсас аймақтары анықталды, бұл Кригинг интерполяциясының жұмыс моделін және кейбір сәйкессіздіктерді көрсетеді, бұл әдістің қателіктерін көрсетуі мүмкін.

Кілт сөздер: топырақ құнарлылығы, топырақ диагностикасы, геоақпараттық технологиялар, кеңістіктік талдау, интерполяция, дақылдар, топырақты өңдеу, минералды тыңайтқыштар.

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ИСПОЛЬЗОВАНИЕ ГИС-ТЕХНОЛОГИЙ И ПРОСТРАНСТВЕННОГО АНАЛИЗА ДЛЯ ДИАГНОСТИКИ ПОЧВ И СЕЛЬСКОХОЗЯЙСТВЕННЫХ КУЛЬТУР В СЕВЕРО-КАЗАХСТАНСКОЙ ОБЛАСТИ

Аннотация

В статье представлены исследования по изучению пространственного анализа для диагностирования почв и сельскохозяйственных культур с использованием ГИС-технологий в Северо-Казахстанской области. Дан анлиз применения геостатистического метода Кригинга, позволяющий строить карты, прогнозируемые, на основе ограниченных данных, также позволяющий интерактивно исследовать пространственное поведение каких-либо значений и предположить их дальнейшее изменение или состояние, интерполируя данные на объекты без указанных значений. В данных исследованиях был рассмотрен прогноз изменения почвенно-агрохимические показателей: азот, фосфора и гумус. При Кригинге, программа, использует математические функции для определенного количества точек. Были созданы вариограммы и функции ковариации для оценки значений статистической зависимости и проведено прогнозирование неизвестных значений на различных сельскохозяйственных культурах удобренного фона и контроля. Чтобы проверить достоверность данных построения интерполяции было проведено в статье сравнение карты прогноза и картограммы подвижного фосфора и гумуса. В результате сравнения карт, в большей степени были выявлены сходные области изменения содержания фосфора и гумуса, что указывает на рабочую модель интерполяции методом Кригинга и некоторые несоответствия, что может указывать на погрешности метода.

Ключевые слова: плодородие почв, диагностика почв, геоинформационные технологии, пространственный анализ, интерполяция, сельскохозяйственные культуры, обработка почв, минеральные удобрения.