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Mapping Agrochemical Properties of Typical Irrigated Serozem and Newly Irrigated Serozem-Meadow Soils of Jizzakh Region Using GIS Technologies

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Annotation: This article presents data on mapping the humus, nitrogen, and phosphorus content of typical irrigated gray and newly irrigated gray-meadow soils distributed in the Jizzakh region using GIS systems and technologies. Thematic maps of the distribution of humus and nutrients in irrigated soils have been developed.

Keywords: Soil, irrigated typical serozem, serozem-meadow, humus, nitrogen, phosphorus, potassium, geoinformation technologies, thematic maps, soil layer.

Introduction. GIS technologies have been widely used in agriculture internationally since 1970. This technology has been used in the agricultural sector to study, evaluate, collect, store, and re-analyze land resources. In addition, it studies soil erosion and its protection, and monitors land [1].

Today, the main tasks of GIS in agriculture include assessing crop yield and soil fertility, monitoring agricultural crops, and managing fertilizers and weeds. In recent years, the need for GIS technologies has increased in an era of increasing climate change risks to expand agricultural production and ensure food security [2].

In the agricultural sector, geographic information systems (GIS) are becoming increasingly important in data analysis, computation, remote sensing, monitoring of agricultural crops, and increasing their productivity [3].

Research object and methods. Typical irrigated serozem soils of the “Laylak Uya” massif of the Zamin district of the Jizzakh region and newly irrigated seozem-meadow soils distributed in the “Kazakhstan” massif of the Arnasay district were selected as the research objects.The procedure for conducting soil surveys and compiling soil maps for maintaining the state land cadastre was carried out based on the instructions [11] and generally accepted methods. General chemical and physicochemical soil analyses were performed according to generally accepted methods based on the manuals of Ye.V. Arinushkina [4]. Analysis based on geographic information systems was performed using the ArcGIS program and its Geostatistical Analyst modules.

Research results and their analysis. Data on the humus and agrochemical status of typical gray and newly irrigated gray-meadow soils of the selected area were summarized. As stated in the literature, soil agrochemical properties are the main indicators of soil condition assessment, which are of great importance for monitoring, precision farming, and effective management of land resources [5].

The tables presented show a certain pattern in which humus and nutrients decrease in the upper layer of the soil cross-section towards the lower layer, and the levels of nutrients (total N, P, K in %) and mobile nutrients in mg/kg are reflected in terms of intermediate differences.

To prevent the depletion of organic matter in the soil, the application of organic, organomineral fertilizers, the widespread introduction of crop rotation, and the use of composts are used to enrich the soil with organic matter (humus) [6]. The humus content in the topsoil layer of soils ranges from 0,885-1,200%, and in the subsoil layers from 0,656-0,985%. These soils are low (0,5-1,0%) and medium (1,0-1,5%) in humus.

In these soil layers, the total nitrogen content, depending on humus, is 0.071-0,082% and 0,055-0,075%, respectively, and the carbon-to-nitrogen ratio is 6,2-8,4. Total phosphorus is 0,135-0,183% and 0,129-0,178%, respectively, and total potassium is 1,10-1.22% and 0,720-0,985%. The amount of mobile phosphorus in the topsoil is 17,0-28,0 mg/kg and decreases to 6,0-14,0 mg/kg towards the bottom. The soils are very low (0-15 mg/kg) and low (15-30 mg/kg), medium (31-45) in mobile phosphorus and very low (0-100 mg/kg), low (100-200 mg/kg), medium (200-300 mg/kg) and high (300-400 mg/kg) in exchangeable potassium (table-1). Enriching the soil with organic matter and applying organic fertilizers is important for increasing and restoring soil fertility [8].

Table-1. Humus and nutrient content of typical irrigated serozem soils

Section №	Layer depth, cm	Humus, %	Nutrients					
			Total, %				Mobile, mg/kg	
			N	C:N	P	K	P_2O_5	K_2O
1	0-31	1,200	0,082	8,5	0,165	1,220	17	330
	31-55	0,985	0,075	7,6	0,160	1,050	14	322
	55-86	0,897	0,064	8,1	0,147	0,980	11	280
	86-115	0,655	0,056	6,8	0,135	0,895	9	250
	115-157	0,441	0,034	7,5	0,129	0,830	7	210
12	0-32	0,905	0,074	7,1	0,135	1,100	17	274
	32-61	0,775	0,066	6,8	0,129	1,020	15	265
	61-91	0,522	0,049	6,2	0,110	0,981	13	243
	91-123	0,345	0,030	6,7	0,103	0,950	9	190
	123-156	0,177	0,015	6,8	0,095	0,765	6	110
16	0-28	0,990	0,074	7,8	0,171	1,100	28	120
	28-57	0,775	0,065	6,9	0,168	0,985	25	110
	57-88	0,643	0,053	7,0	0,150	0,960	21	87
	88-121	0,488	0,040	7,1	0,137	0,876	17	61
	121-152	0,174	0,012	8,4	0,124	0,785	14	50

20	0-30	0,885	0,071	7,2	0,183	1,200	22	256
	30-60	0,656	0,055	6,9	0,178	1,010	19	243
	60-89	0,345	0,026	7,7	0,160	0,987	16	201
	89-121	0,155	0,013	6,9	0,139	0,870	13	175
	121-152	0,120	0,010	7,0	0,121	0,720	11	95

Based on this data, a 1:10,000 scale map of soil humus was created using interpolation methods using GIS software.

Picture -1

Picture -1.Map of the level of humus supply of typical serozem soils irrigated in the "Laylak Uya" massif of Zamin district.

Today, Geographic Information Systems (GIS) are used as software for the production and management of agricultural products, as computer systems have developed [9].Using the research results and laboratory analysis data, an interpolation method was used using the ArGis program to create a 1:10,000 scale map of mobile phosphorus and potassium in the soil (picture-2 and picture-3).

Picture-2

Picture-2.Map of mobile phosphorus content of typical serozem soils irrigated in the "Laylak Uya" massif of Zamin district.

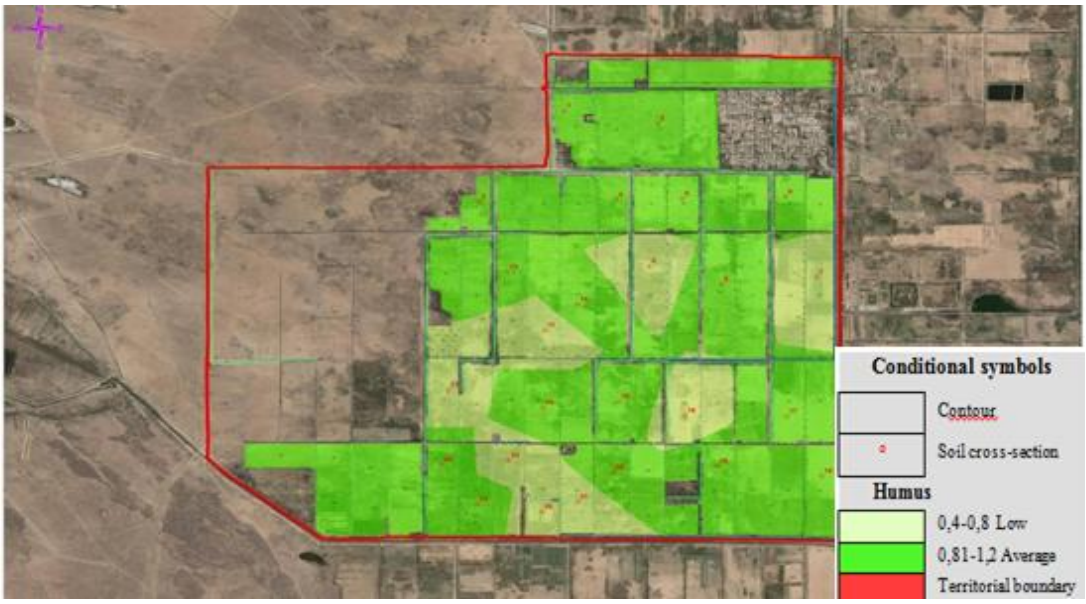
Picture-3.Map of mobile potassium content of typical serozem soils irrigated in the "Laylak Uya" massif of Zamin district.

A sufficient amount of humus in the soil leads to high soil fertility indicators. In addition, it has a positive effect on all soil properties.

Table-2. The level of humus and nutrient supply of newly irrigated serozem-meadow soils

Section №	Layer depth, cm	Humus, %	Nutrients					
			Total, %				Mobile, mg/kg	
			N	C:N	P	K	P_2O_5	K_2O
5	0-30	0,915	0,079	6,7	0,144	1,51	16,3	237
	30-57	0,869	0,063	8,0	0,132	1,42	15,1	220
	57-86	0,685	0,052	7,6	0,098	1,25	13,8	180
	86-116	0,476	0,034	8,1	0,083	1,11	11,4	143
	116-149	0,301	0,019	9,2	0,073	0,98	8,3	110
8	0-30	0,880	0,074	6,9	0,144	1,30	28	245
	30-57	0,805	0,071	6,6	0,135	1,020	25	230
	57-87	0,703	0,063	6,5	0,122	0,987	21	185
	87-120	0,480	0,035	8,0	0,115	0,952	19	150
	120-153	0,225	0,017	7,7	0,095	0,875	16	110
21	0-29	0,992	0,085	6,8	0,177	1,20	14	262
	29-58	0,785	0,065	7,0	0,173	0,985	12	251
	58-88	0,655	0,052	7,3	0,155	0,970	9	230
	88-117	0,370	0,029	7,4	0,144	0,845	7	198
	117-150	0,125	0,011	6,6	0,123	0,683	6	102
23	0-30	0,850	0,073	6,8	0,183	1,10	25	212
	30-57	0,698	0,053	7,6	0,178	0,987	23	197
	57-87	0,575	0,045	7,4	0,155	0,871	19	173
	87-118	0,245	0,018	7,9	0,137	0,653	17	151
	118-148	0,159	0,015	6,1	0,119	0,515	15	108

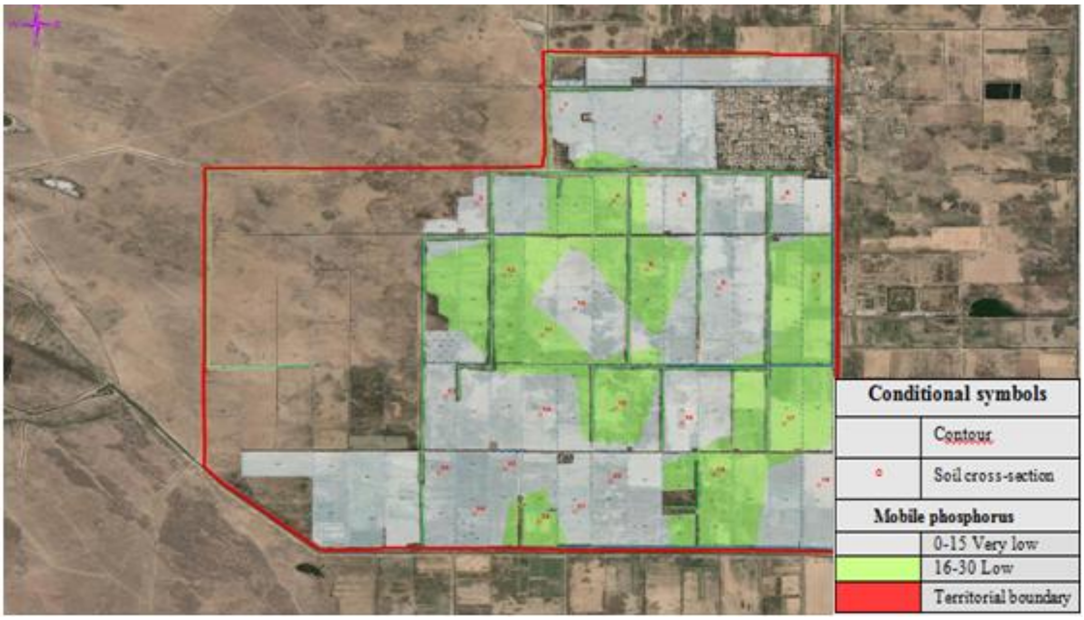
Based on this data, an interpolation method was used using the ArGis program to create a 1:10,000 scale map of the humus content in the newly irrigated meadow-serozem soils studied (picture-4 and picture-5).



Picture-4. Map of the level of humus supply of newly irrigated serozem-meadow soils of the "Kazakhstan" massif in the Arnsay district.

The importance of phosphorus in the production of agricultural products is very high. In particular, it plays an important role in increasing the strength of the plant body. In particular, in the studied irrigated serozem-meadow soils, total phosphorus is 0,144-0,183% and 0,132-0,173%, total potassium is 1,10-1,51% and 0,985-1,42%, respectively. The amount of mobile phosphorus in the topsoil is 6-28 mg/kg, exchangeable potassium is 212-237 mg/kg, and the soil is very poorly supplied with mobile phosphorus (0-15), poorly (15-30 mg/kg), and poorly (100-200 mg/kg), moderately (200-300 mg/kg) supplied with exchangeable potassium(table-2).

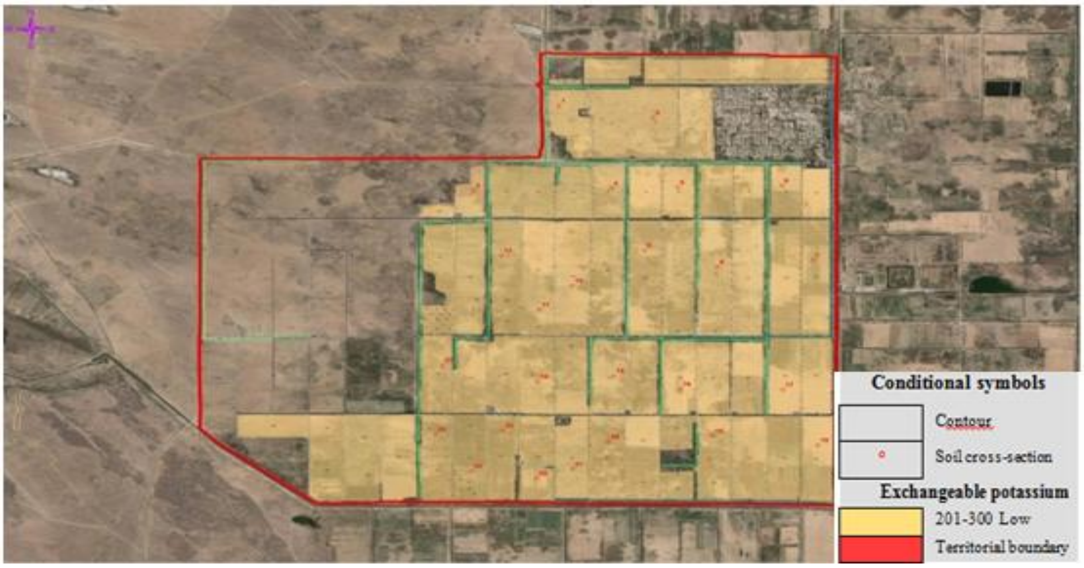
Based on this data, an interpolation method was used using the ArGis program to create a 1:10,000 scale map of the exchangeable potassium content in the studied newly irrigated serozem-meadow soils (pictue-5).



Picture-5. Map of mobile phosphorus content in irrigated serozem-meadow soils of the "Kazakhstan" massif in the Arnsay district.

Applying fertilizers to agricultural land at the required level has a positive effect on soil fertility. GIS software can greatly help identify areas of agricultural land that are at risk of phosphorus loss.[10]

The amount of nutrients in the soil depends mainly on humus, which was found to be somewhat low in the soils of the studied massifs. The results of this analysis also show that the amount of humus and nutrients in typical irrigated serozem soils differs from newly irrigated serozem-meadow soils.



Picture-5.Map of the mobile potassium content of irrigated gray-meadow soils of the "Kazakhstan" massif in the Arnsay district.

In conclusion, it is worth noting that, according to the results of the study, these soils belong to the groups of very low, low, medium, high humus supply, and very low, low, medium, high phosphorus and potassium supply. The distribution of humus and nutrients in irrigated soils using thematic maps developed on the basis of geographic information systems technologies will help to effectively and rationally use agricultural lands, maintain and increase soil fertility, scientifically apply mineral and organic fertilizers in irrigated areas, optimize fertilization systems, and obtain high yields of agricultural products.

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