Field interpretation of earth remote sensing data and ground field surveys in the Republic of Kazakhstan, Kostanay region in the pre-sowing season

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Abstract. The aim of the research is to carry out field and office work on conducting a sub-satellite survey on test sites of the Kostanay region of the Republic of Kazakhstan. Grain-sowing districts of the Kostanay region were selected as the objects of examination: Karabalyk, Fedorov, Mendykara, Uzunkol, Sarykol, Altynsarin, Kostanay, Denisov, Karasu, Taranov, Zhitikara, Auliekol, Kamysty, Naurzum. The determination of the reserves of productive soil moisture in the 0-100 cm layer by control points (100 points) carried out in the pre-sowing season of 2019 showed that the soils are characterized by satisfactory and, for the most part, insufficient moisture. The fields fixed in the coordinate system were evaluated by five indicators - pH, humus, nitrate nitrogen (N-NO₃), mobile phosphorus (P₂O₅), and exchange potassium (K₂O). Most of the soils examined had a soil solution reaction that was neutral or close to neutral. In terms of humus content, soils of the Karabalyk, Fedorov, Uzunkol and Sarykol districts had an average degree of availability, which exceeded the indicators of other districts of the Kostanay region and depended on the type of soil. The content of the basic elements of plant nutrition - nitrogen and phosphorus - varied within various limits, and, to a large extent, was determined by the previous culture, tillage, fertilizer application, and climatic conditions of the year. The level of exchangeable potassium in the soils of the examined districts of the Kostanay region was characterized as elevated or very high.

1 Introduction

There is a rapid growth in the introduction of digital technology in the solution of agricultural issues, the field of crop cultivation is especially active. And in this direction the technology of precision farming occupies a special place [1]. The introduction of precision

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farming elements will significantly increase production efficiency. The elements of precision farming include: electronic field maps, data from a weather station, sensors and sensors for differential application of both fertilizers and herbicides, space monitoring which preliminary shows the presence of both vegetation and all other necessary data for farmers to work [2]. With the help of geological positioning systems, satellite images and maps of agrochemical field surveys, farmers are given the opportunity to absolutely accurately apply fertilizers, process the fields, determine crop seeding rates and crop rotation patterns. As a result, costs are reduced, and the return of arable land is growing at times. In real time, the main aspects of agriculture are monitored, the level of moisture and mineralization of the soil, the level of light that plants feed on is estimated. [3], [4].

The digitization of the fields carried out today allows the farmer to submit online applications for various types of sub-granting.

Digital technologies offer Kazakhstan farmers equal opportunities with foreign right now.

The purpose of digitalization of the agro-industrial complex is to increase productivity and efficiency through the introduction of digital technologies. In the process of digitalization, electronic field maps are created. To date, 24 million hectares of arable land have been digitized, almost 100% of the total sown area. Also, work has begun on digitizing pastures. Farm productivity is boosted by technologies such as:

- prediction of optimal time for harvesting
- “smart watering”
- intelligent mineral fertilizer application system
- pest and weed control system
- systematic crop rotation system

Such a concept as “precision farming” is based on a deep and thorough analysis of soil composition [5]. On traditional farms, one analysis per 75 ha is carried out. On smart farms, the soil for analysis is taken from each hectare. This method helps to more accurately determine the volume and composition of fertilizers, and also determines the most suitable methods of cultivating the land. A lot of work is performed by artificial intelligence in the form of computer programs, while manual labor is minimal. Computer systems can simultaneously process large amounts of data and constantly adapt the conditions for the favorable growth of agricultural products. As part of a pilot project on the introduction of precision farming, 9 Kazakhstani farms are already using new technologies and are showing excellent results. The best of the best digitization of the agro-industrial complex lead Akmola, Kostanai and Karaganda regions. Kostanay region produces 22% of the total grain volume in the country and 27% of the total volume of food products falls on the Kostanay region. [6] In the region, 20 agricultural enterprises with good production indicators and efficient growth and development were selected for the implementation of digitalization [7], [8].

Literature review

Environmental monitoring is a comprehensive system for observing the state of the environment, assessing and forecasting changes in its state under the influence of natural and anthropogenic factors. Monitoring involves a process of systematic or continuous collection of information on environmental parameters to determine trends in their changes. Monitoring can be carried out using a network of stationary points, however, observations at individual points or profiles do not always reflect spatial changes. Therefore, the use of aerial and satellite images (Earth remote sensing data - RS) is a prerequisite for regular observations of the current state of ecosystems. Comparing them with the results of surveys

performed in past decades allows you to accurately capture the changes that have occurred.[9].

Remote sensing is the process by which information about an object, territory or phenomenon is collected without direct contact with it. Remote sensing includes all types of non-contact surveys that are conducted from various measuring platforms: aircraft and spacecraft (airplanes, helicopters, spaceships, satellites, etc.), ships and submarines, ground stations [10]. In this case, a snapshot is defined as a two-dimensional metric image of specific objects, obtained purposefully as a result of remote registration and (or) measurement of intrinsic or reflected radiation, and represents the most appropriate form of measuring, recording and visualizing radiation that carries geographical information about the objects being studied. Over the past decades, the volume, variety and quality of remote sensing materials have increased significantly. To date, a huge fund (more than 100 million) of aerospace images has been accumulated, fully covering the entire surface of the Earth, and for a significant part of the regions with multiple overlapping. [11], [12]

The success of using multi-temporal, heterogeneous, with varying degrees of detail shooting data, as well as all available cartographic materials, depends on the involvement of modern geographic information technologies. It is advisable to create geographic information systems of a local level that can combine detailed thematic and general geographic data, materials from aerial and space surveys of different years, the results of stationary observations at test sites and other additional data available in the studied area of protected areas.[13],[14].

The prospective development of digital automated systems for photogrammetric processing, as well as systems for automatic decryption and transmission of images, requires an effective approach for the description and modeling of images. Any image can be characterized as the result of displaying at a fixed point in time and a given limited surface or plane a set of integrated radiation or reflection sources (decomposition elements, pixels) located outside a given surface.

The aim of the research is to carry out field and office work on conducting a sub-satellite survey on test sites of the Kostanay region of the Republic of Kazakhstan.

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2 Materials and methods

The central Kazakhstan province includes 2 zones: a dry-steppe zone with subzones of dark chestnut and chestnut soils with an area of 8180.6 thousand ha, including farmland 7661.7 thousand ha, arable land - 2186.6 thousand ha and semi-desert zone with a subzone of light chestnut soils, with an area of 3209.2 thousand ha, including farmland - 2944.2 thousand ha.

Aral-Balkhash province includes a desert zone, with a subzone of brown desert soils. Its area is 1624.6 thousand ha, including farmland 1436.1 thousand ha.

The vast territory of the Kostanay region caused very significant differences in climatic conditions, soil cover structure and soil quality.

Changes in bioclimatic factors in the meridional direction influenced the allocation of three soil zones in the region: a) chernozem zone; b) the area of chestnut soils; c) the zone of brown soils of the northern desert. Their presence is associated with an increase in aridity of the climate from north to south.

At the same time, the hydrothermal coefficient varies from north to south from 0.9 to 0.3, the annual rainfall is from 360 to 175 mm or less, and the wetting coefficient is from 0.37 to 0.09. The sum of active temperatures in the north of the region is 2400 °C, in the south - 3100 °C.

A very significant change in agroclimatic factors affected the soil fertility of the region. High-fertile chernozems of moderately arid steppes, with a humus content in the arable layer of up to 6%, pass in the south into almost barren (0.8% of organic matter) brown soils of the northern desert.

The soils of the region are very diverse. It is enough to note that more than 1,500 soil varieties are identified on its territory.

According to the soil survey, the main structural units of the region's soils are represented by the following subtypes: ordinary chernozems - 2.9 million ha; southern chernozems - 3.2 million hectares; dark chestnut soils - 3.9 million ha; chestnut soils - 3.7 million hectares; light chestnut - 2.9 million hectares; brown soils - 1.4 million hectares.

The best soils in the region are ordinary chernozems. They are located in the north of the region, within the West Siberian Lowland and partially the Trans-Ural Plateau. They are distinguished by high fertility, favorable agrophysical and chemical properties. Their low-humus species prevail, containing 4-6% humus in the arable layer. These soils are characterized by high absorption capacity, the absorption capacity is 35-40 mg / equiv. per 100 g of soil. Their soil absorbing complex is saturated with calcium. The soil reaction is neutral (pH = 7) or slightly alkaline (pH = 7.2-7.5). The mechanical composition of the soil is heavy and medium loamy. Light loamy and sandy loamy varieties are found in small massifs; they are less humus-rich (2-3% humus), are low-structural, and can undergo deflation. It should be noted the presence of carbonate taxa in these soils, characterized by increased alkalinity and worse agrophysical properties. Quite widespread (up to 450 thousand ha) among ordinary chernozems are complexes of solonetztes and solonetzic chernozems. These soils are characterized by negative agrophysical and chemical properties. Their use as part of arable land is highly undesirable.

The subzone of southern chernozems is located within the southern margin of the West Siberian Lowland, the Predturgay Plain, and the Trans-Ural Plateau and occupies the central part of the region. A large difference in geographical terms caused the formation in the region, among the black earths of the southern, significant areas of solonetztes, saline and rocky soils, which often in combination with zonal soils, negatively affect the fertility of the latter. Compared to chernozems of the northern regions of the region, chernozems of the south are characterized by smaller reserves of organic matter. Low humus species prevail among them, with a humus content in the arable layer of 3.5–4.0%, and in varieties of light mechanical composition from 1.8% to 3%. Among southern chernozems carbonate soils of heavy mechanical composition are also widespread.

Significant areas in the south of the region are occupied by dark chestnut soils, which were formed within the northern part of the Turgai canteen of the country. Among the dark chestnut soils, carbonate genera and varieties of light (sandy loam) mechanical composition prevail. Soils differ sharply in fertility, agrophysical and chemical compositions. Sandy-sand varieties are characterized by a very low content of organic matter - 1.5-2.0%, fragile-lumpy structure, and eroded varieties are generally structureless. Their absorption capacity is very low, the absorption capacity is 10-12 mg / equiv. per 100 g of soil. These are the most low-yielding soils of the region. The carbonate genera of dark chestnut soils are characterized by much better properties. They are more fertile. They contain up to 3.5% humus in the arable layer. Their mechanical composition is loamy and clayey.

Similar properties have chestnut carbonate soils, which prevail in the subzone of chestnut soils, but they are less fertile, their humus content does not exceed 3%.

Most of the soils described above are used in agricultural production as arable land.

In the extreme south of the region, in the zone of very dry steppes and the northern desert, light chestnut and brown soils formed. They are characterized by a sandy mechanical composition, low organic matter content of 0.8% and very low natural fertility. They are used as grazing land.

Grain-sowing districts of Kostanay region were selected as objects of examination: Karabalyk, Fedorovsky, Mendykarinsky, Uzunkolsky, Sarykolsky, Altynsarinsky, Kostanaysky, Denisovsky, Karasusky, Taranovsky, Zhitikarinsky, Auliekolsky, Kamystinsky, Naurzum.

Determination of productive soil moisture reserves in a meter soil layer was carried out at 100 control points in the pre-sowing period.

The pH of the soil, the content of humus and mineral nutrition elements (NPK) in the seed soil layer (0-30 cm) were determined by 100 control points in the pre-sowing period.

Laboratory agrochemical analysis of the selected soil samples was carried out in accordance with the following regulatory documents:

GOST 28268-89 Soil.Methods for determining moisture, maximum hygroscopic humidity and moisture of sustainable wilting of plants.

GOST 26483-85.The soil.Preparation of salt extract and determination of its pH according to the method of the Central Research Institute of Agrochemical Services.

GOST 26213-91.The soil.Methods for the determination of organic matter.

GOST 26951-86.The soil.Determination of nitrates by the ionometric method.

GOST 26204-91.The soil.Determination of mobile compounds of phosphorus and potassium according to the Chirikov method as modified by the Central Scientific Research Institute of Agrochemical Services.

GOST 26205-91.The soil.Determination of mobile compounds of phosphorus and potassium by the method of Machigin in modification Central Research Institute of Agrochemical Services.

3 Results

The main objectives of the research are:

- implementation of field and desk work to conduct a satellite-based survey on test sites of the Kostanay region of the Republic of Kazakhstan;
- determination of stocks of productive soil moisture in a layer of 0-100 cm from control points (100 points), carried out in the pre-sowing season of 2019

Sampling for the productive moisture of the meter layer of soil was carried out according to the list of control points on the map of the districts: Karabalyksky - 7 points; Fedorovsky district - 13 points; Mendykarinsky district - 7 points; Uzunkol district - 6 points; Sarykol district - 4 points; Altynsarinsky district - 5 points; Kostanay district - 10 points; Denisovsky district - 7 points; Karasu district - 12 points; Taranovsky district - 3 points; Auliekol district - 7 points; Zhitikarinsky district - 3 points; Kamystinsky district - 10 points; Naurzum district - 6 points (Figure 1).

Fig. 1. Reserves of productive moisture in the 0-100 cm soil layer (mm) at the control points of the districts of the Kostanay region in the pre-sowing season of 2019

Soil moisture was determined by the selected samples using a soil drill from 0-100 cm layer using the thermostat-weight method (drying soil samples in an oven at a temperature of 105 ° C). The weights of weights were weighed after sampling, and after drying and by the difference in soil mass, the reserves of productive moisture were determined [15] (table 1).

Table 1 Assessment of productive moisture reserves in the soil (A.F. Vadyunina, Z.A. Korchagina)

The thickness of the soil layer, cm	Water reserves, mm	Number of points	Quality assessment
0-100	>160	10	very good
	160-130	19	good
	130-90	28	satisfactory
	90-60	25	bad

	<60	18	very bad
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The moisture indicator of a meter layer of soil ranged from 17.8 to 173.0 mm. Of the given 100 points for sampling moisture in 18, soil moisture was below 50% of the lowest field moisture capacity. In the rest, from 50 to 67% of the lowest field moisture capacity with the norm adopted for typical soils of 170-180 mm.

The greatest moisture reserves were recorded in the northern regions of the Kostanai region located in the zone of ordinary chernozems: Fedorovsky - up to 180 mm (Figure 2), Karabalyksky - up to 177 mm, Uzunkolsky - up to 173 mm, Mendykarinsky - up to 164 mm. In addition, very good moisture reserves (up to 168 mm) were observed in the Kostanay region, located in the zone of southern chernozems. It is worth noting that in the Karasu region both very good moisture reserves were found - 136.5 mm, and the lowest - 17.8 mm (Figure 3). With the advance to the south of the region (the zone of dark chestnut and chestnut soils), there was a gradual decrease in productive moisture reserves in the soil: Auliekol district - up to 55.1 mm, Kamystinsky - up to 31.7 mm, Naurzumsky - up to 52 mm.

Fig. 2. Control point No. 88 (Fedorovsky district), the highest content of productive moisture in the 0-100 cm soil layer - 180.0 mm

Fig. 3. Control point No. 29 (Karasu district), the lowest content of productive moisture in the 0-100 cm soil layer - 17.8 mm

To determine the pH of the soil, the content of humus and elements of mineral nutrition in the seed soil layer at each test site, combined soil samples were taken from a soil layer of 0-30 cm for subsequent laboratory agrochemical analysis (Figure 4). [16]

Fig. 4. Soil samples for agrochemical soil analysis, 2019.

The Machigin method is designed to extract mobile compounds of phosphorus and potassium from the soil and is accepted as standard for carbonate chernozems, chestnut, brown, brown soils and serozems. To extract mobile phosphorus and potassium from non-carbonate soils, the standard Chirikov method is adopted. Therefore, laboratory agrochemical analysis of soil samples was performed depending on the type of soil (table 2).

The fields fixed in the coordinate system were evaluated by five indicators - pH, humus, nitrate nitrogen (N-NO₃), mobile phosphorus (P₂O₅), and exchange potassium (K₂O).

Most of the soils examined had a soil solution reaction that was neutral or close to neutral, which is favorable for most cultivated agricultural crops. of cultures.[17]

In terms of humus content, the soils of Karabalyksky (4.22-5.40%), Fedorovsky (4.17-5.39%), Uzunkolsky (4.85-5.37%) and Sarykolsky (4.10- 5.19%) of the districts, which exceeded the indicators of the remaining districts of the Kostanay region and depended on the type of soil.

The content of the basic elements of plant nutrition — nitrogen and phosphorus — varied within various limits, and, to a large extent, was determined by the previous culture, tillage, fertilizer application, and climatic conditions of the year. Especially drastic changes depending on these conditions are subject to the content of nitrates in the soil.

The level of exchangeable potassium in the soils of the examined districts of the Kostanay region was characterized as elevated or very high.

Table 2. The content of nutrients in soils at control points of the districts of the Kostanay region in the pre-sowing season of 2019.

Contr ol point numb er	Coordinates	Content in the soil layer (combined sample), 0-30 cm									
		pH	environ ment	humu s, %	degree of security	N general (NO ₃)	degree of security	P ₂ O ₅	degree of security	K ₂ O	degree of security
Karabalyk district											
77	62° 16' 3,503" E 53° 10' 54,964" N	6,18	neutral	4,26	average	6,5	low	127	increase d	138	high
78	62° 9' 47,186" E 53° 17' 40,206" N	6,69	neutral	4,43	average	12,3	average	7	very low*	421	very high*
80	61° 54' 59,291" E 53° 27' 21,722" N	6,21	neutral	5,09	average	10,7	average	31	low	138	high
81	61° 52' 30,583" E 53° 33' 44,684" N	6,62	neutral	5,40	average	31,0	high	69	average	404	very high
82	61° 57' 25,870" E 53° 37' 4,150" N	6,77	neutral	4,22	average	10,7	average	9	very low*	470	very high*
83	62° 3' 22,190" E 53° 40' 13,527" N	6,84	neutral	4,27	average	9,6	low	64	average	336	very high
84	62° 7' 8,560" E	5,72	close to	4,43	average	5,1	low	67	average	132	high

	53° 44' 23,896" N		neutral								
Fedorov district											
74	62° 50' 13,607" E 53° 26' 47,768" N	6,34	neutral	3,55	low	9,8	low	40	low	272	very high
75	62° 42' 9,986" E 53° 28' 4,260" N	6,70	neutral	3,76	low	18,6	high	24	low	108	increase d
76	62° 30' 28,541" E 53° 15' 31,067" N	6,89	neutral	4,85	average	10,2	average	0	very low	192	very high
85	62° 18' 50,636" E 53° 43' 59,407" N	6,41	neutral	4,88	average	4,7	very low	64	average	198	very high
86	62° 34' 49,880" E 53° 39' 58,809" N	6,37	neutral	4,40	average	9,1	low	56	average	336	very high
87	62° 42' 16,2" E 53° 39' 58,5" N	6,60	neutral	4,55	average	8,7	low	75	average	300	very high
88	62° 44' 32,093" E 53° 49' 33,820" N	6,74	neutral	5,17	average	12,3	average	12	low*	583	very high*
89	62° 53' 41,721" E 53° 55' 59,569" N	6,50	neutral	5,20	average	10,0	average	183	high	576	very high
90	63° 1' 24,876" E 53° 58' 13,874" N	6,49	neutral	5,39	average	28,8	high	79	average	366	very high
91	63° 13' 18,278" E 53° 58' 41,666" N	6,47	neutral	4,97	average	10,2	average	123	increase d	402	very high
92	63° 8' 39,232" E 53° 50' 2,021" N	6,63	neutral	5,32	average	34,7	high	8	very low*	648	very high*
93	63° 16' 32,181" E 53° 44' 14,323" N	6,78	neutral	4,26	average	4,1	very low	39	low	564	very high
94	63° 18' 16,446" E 53° 41' 42,512" N	6,74	neutral	4,17	average	9,1	low	9	very low*	486	very high*
Mendykara district											
3	64° 9' 16,359" E 53° 38' 25,764" N	5,98	close to neutral	3,03	low	11,0	average	52	average	216	high
4	64° 10' 54,141" E 53° 42' 12,874" N	5,60	close to neutral	3,35	low	9,1	low	39	low	138	high
5	64° 11' 40,741" E 53° 44' 17,091" N	5,52	slightly acidic	3,21	low	8,9	low	32	low	144	high
6	64° 27' 25,126" E 53° 48' 21,800" N	6,18	neutral	2,98	low	9,8	low	39	low	210	high
7	64° 50' 57,216" E 54° 1' 34,565" N	6,05	neutral	3,73	low	12,9	average	69	average	396	very high
8	64° 49' 26,118" E 54° 8' 9,068" N	6,37	neutral	4,67	average	14,8	average	61	average	474	very high
9	64° 46' 52,166" E 54° 18' 19,520" N	5,98	close to neutral	3,03	low	11,0	average	52	average	216	very high
Uzunkol district											
10	64° 54' 32,193" E 54° 18' 34,320" N	6,55	neutral	4,88	average	47,4	high	50	average	348	very high
11	65° 0' 3,340" E 54° 14' 51,448" N	6,69	neutral	5,37	average	17,0	high	15	average *	593	very high*
12	65° 13' 42,761" E 54° 10' 58,758" N	6,40	neutral	4,85	average	17,0	high	11	low*	567	very high*
13	65° 18' 8,651" E 54° 3' 24,275" N	6,04	neutral	5,20	average	25,7	high	68	average	312	very high
14	65° 18' 28,477" E 53° 52' 44,044" N	5,81	close to neutral	4,96	average	14,1	average	45	low	204	very high
15	65° 24' 0,592" E 53° 43' 51,249" N	6,39	neutral	5,32	average	14,8	average	76	average	276	very high
Sarykol district											
16	65° 28' 41,529" E 53° 40' 2,963" N	6,37	neutral	4,57	average	14,8	average	63	average	282	very high
17	65° 33' 27,133" E 53° 29' 36,481" N	6,46	neutral	5,19	average	16,6	high	88	average	396	very high
18	65° 32' 46,086" E 53° 21' 14,978" N	6,53	neutral	4,15	average	7,4	low	93	average	324	very high
19	65° 15' 31,3" E 53° 19' 31,3" N	6,45	neutral	4,10	average	21,9	high	49	low	378	very high
Altynsarin district											
20	64° 48' 21,409" E 53° 15' 33,066" N	5,65	close to neutral	3,43	low	5,0	low	60	average	228	very high
21	64° 31' 40,9" E 53° 11' 12,2" N	5,41	slightly acidic	4,00	average	17,8	high	83	average	366	very high
22	64° 15' 48,998" E	5,63	close to	2,66	low	6,5	low	41	low	192	very

	53° 9' 18,115" N		neutral								high
23	64° 33' 7,756" E 53° 0' 56,653" N	6,55	neutral	3,15	low	12,6	average	9	very low*	642	very high*
24	64° 51' 43,890" E 53° 0' 34,460" N	5,95	close to neutral	3,56	low	17,8	high	52	average	270	very high
Kostanay district											
1	63° 52' 57,993" E 53° 17' 12,032" N	6,30	neutral	4,49	average	12,3	average	18	average *	300	high*
2	63° 55' 52,318" E 53° 19' 38,163" N	5,77	close to neutral	3,84	low	7,4	low	48	low	373	very high
73	62° 54' 3,269" E 53° 9' 41,109" N	6,53	neutral	3,63	low	5,1	low	43	low	282	very high
79	63° 47' 24,7" E 53° 12' 15,7" N	6,61	neutral	3,13	low	6,0	low	42	low	398	very high
95	63° 21' 16,063" E 53° 35' 54,365" N	6,85	neutral	3,63	low	20,0	high	13	low*	469	very high*
96	63° 23' 07,1" E 53° 33' 55,5" N	6,75	neutral	4,09	average	10,2	average	15	average *	454	very high*
97	63° 20' 25,531" E 53° 31' 22,103" N	6,82	neutral	3,65	low	9,8	low	8	very low*	486	very high*
98	63° 21' 12,648" E 53° 25' 11,156" N	6,86	neutral	3,83	low	6,5	low	71	average	192	very high
99	63° 30' 16,415" E 53° 18' 45,292" N	6,80	neutral	3,36	low	11,2	average	6	very low*	518	very high*
100	63° 32' 40,733" E 53° 17' 26,204" N	6,36	neutral	3,35	low	3,6	very low	34	low	150	high
Denisov district											
63	61° 34' 14,4" E 52° 19' 26,3" N	6,79	neutral	2,60	low	6,0	low	57	average	168	high
64	61° 42' 53,013" E 52° 30' 50,263" N	6,77	neutral	4,32	average	9,1	low	8	very low*	551	very high*
65	61° 39' 0,825" E 52° 35' 35,257" N	6,90	neutral	3,60	low	6,0	low	6	very low*	356	very high*
66	61° 35' 51,279" E 52° 44' 26,441" N	6,99	neutral	3,15	low	7,2	low	7	very low*	227	very high*
67	61° 34' 31,544" E 52° 41' 55,674" N	7,06	neutral	4,24	average	7,2	low	6	very low*	356	very high*
68	61° 36' 7,624" E 52° 37' 40,689" N	6,49	neutral	3,11	low	7,4	low	77	average	528	very high
69	61° 41' 41,486" E 52° 29' 21,315" N	6,75	neutral	4,38	average	10,9	average	8	very low*	636	very high*
Karasu district											
25	65° 16' 54,656" E 52° 45' 22,762" N	6,55	neutral	4,16	average	33,9	high	9	very low*	745	very high*
26	65° 24' 26,475" E 52° 40' 57,097" N	6,70	neutral	3,76	low	16,6	high	6	very low*	551	very high*
27	65° 24' 33,884" E 52° 34' 18,219" N	6,88	neutral	3,43	low	23,5	high	8	very low*	502	very high*
28	65° 16' 55,530" E 52° 23' 45,799" N	6,90	neutral	3,64	low	21,4	high	5	very low*	405	very high*
29	65° 4' 33,762" E 52° 19' 45,863" N	6,97	neutral	2,99	low	15,9	high	9	very low*	418	very high*
30	65° 12' 29,191" E 52° 12' 21,307" N	7,09	neutral	3,70	low	8,4	low	65	average	282	very high
31	65° 31' 50,583" E 52° 4' 5,767" N	7,07	neutral	3,78	low	7,2	low	79	average	402	very high
32	65° 23' 3,467" E 51° 58' 28,028" N	7,13	neutral	3,61	low	14,8	average	92	average	420	very high
33	65° 19' 29,727" E 51° 53' 45,291" N	7,14	neutral	3,67	low	9,6	low	139	increase d	420	very high
34	65° 13' 47,493" E 51° 47' 59,850" N	7,36	neutral	2,96	low	8,9	low	63	average	324	very high
35	65° 12' 50,651" E 51° 38' 57,954" N	7,47	neutral	3,25	low	10,7	average	79	average	342	very high
36	65° 9' 10,695" E 51° 30' 36,507" N	7,48	neutral	3,05	low	11,0	average	58	average	276	very high
Taran district											
70	62° 18' 11,792" E 52° 32' 53,103" N	6,86	neutral	2,85	low	11,5	average	58	average	348	very high
71	62° 38' 58,704" E 52° 42' 48,319" N	6,44	neutral	3,37	low	4,9	very low	93	average	390	very high

72	62° 50' 42,460" E 52° 50' 35,190" N	6,39	neutral	3,80	low	4,0	very low	65	average	204	very high
Zhitikara district											
60	61° 31' 33,637" E 52° 2' 44,102" N	7,06	neutral	3,49	low	8,9	low	94	average	216	very high
61	61° 20' 15,302" E 52° 9' 5,701" N	7,02	neutral	3,67	low	13,8	low	79	average	222	very high
62	61° 26' 6,194" E 52° 14' 22,329" N	7,03	neutral	3,55	low	8,5	low	72	average	204	very high
Auliekol district											
39	64° 14' 22,373" E 52° 11' 45,785" N	5,93	close to neutral	2,25	low	4,4	very low	22	low	291	very high
40	64° 10' 51,216" E 52° 16' 36,306" N	6,26	neutral	1,72	very low	3,5	very low	28	low	216	very high
41	64° 4' 30,081" E 52° 33' 54,700" N	6,86	neutral	3,20	low	6,2	low	90	average	210	very high
42	63° 59' 41,979" E 52° 40' 14,313" N	5,60	close to neutral	2,49	low	7,2	low	24	low	204	very high
43	63° 56' 15,822" E 52° 44' 56,548" N	6,02	neutral	2,60	low	1,7	very low	20	very low	274	very high
44	63° 57' 18,438" E 52° 16' 8,546" N	5,80	close to neutral	2,37	low	2,8	very low	12	very low	84	increased
45	63° 17' 40,024" E 51° 47' 54,210" N	6,64	neutral	1,83	very low	10,0	average	102	increased	408	very high
Kamysty district											
50	63° 38' 26,726" E 51° 3' 12,810" N	6,92	neutral	2,13	low	7,4	low	60	average	90	increased
51	63° 38' 59,372" E 51° 9' 43,230" N	7,02	neutral	2,60	low	6,2	low	71	average	228	very high
52	62° 23' 28,253" E 51° 31' 46,327" N	6,94	neutral	2,78	low	15,5	high	67	average	162	high
53	62° 21' 44,487" E 51° 37' 2,153" N	6,92	neutral	3,07	low	5,4	low	111	increased	156	high
54	62° 22' 0,563" E 51° 42' 43,649" N	7,00	neutral	2,98	low	7,4	low	75	average	174	high
55	61° 59' 27,066" E 51° 47' 9,591" N	7,04	neutral	3,43	low	5,9	low	65	average	198	very high
56	61° 51' 11,303" E 51° 38' 29,985" N	6,98	neutral	3,20	low	6,2	low	89	average	276	very high
57	61° 42' 47,325" E 51° 34' 31,744" N	6,99	neutral	3,72	low	11,2	average	67	average	156	high
58	61° 36' 32,579" E 51° 40' 49,275" N	7,04	neutral	3,43	low	7,4	low	72	average	162	high
59	61° 32' 46,9" E 52° 01' 38,3" N	7,04	neutral	3,33	low	9,4	low	108	increased	300	very high
Naurzum district											
37	64° 52' 31,5" E 51° 31' 40,0" N	7,46	neutral	2,84	low	16,2	high	69	average	270	very high
38	64° 53' 46,725" E 51° 39' 23,866" N	6,46	neutral	2,34	low	8,1	low	49	low	258	very high
46	63° 17' 29,719" E 51° 40' 15,636" N	6,87	neutral	3,31	low	11,8	average	69	average	192	very high
47	63° 42' 44,079" E 51° 13' 27,350" N	6,82	neutral	2,13	low	5,9	low	12	very low	108	increased
48	63° 35' 7,009" E 51° 8' 57,764" N	6,96	neutral	2,96	low	33,1	high	80	average	150	high
49	63° 32' 55,206" E 51° 3' 55,733" N	7,02	neutral	2,54	low	8,9	low	68	average	147	high
* –GOST 26205-91. The soil. Determination of mobile compounds of phosphorus and potassium by the method of Machigin in modification Central Research Institute of Agrochemical Services.											

4 Discussion

According to the results of field trips conducted prior to sowing in 2019, it was revealed that 70% of the surveyed fields in the Kamystinsky district had very low reserves of productive moisture. The study of the remaining control points located outside the zone of ordinary black soils also revealed fields with a very poor degree of supply of productive

moisture: in the Naurzum district - 17% of the studied fields, in Zhitikarinsky and Taranovsky districts - 67% of the fields, in Karasu district - 8% and in Denisovsky district - 28% of the studied fields.[18]

Assessing the fluctuations in the content of basic nutrients, it is important to emphasize that in the open spaces of Northern Kazakhstan, the leading role belongs to mobile phosphorus along with nitrate nitrogen in the formation of a high-quality crop. In addition, the soils of Northern Kazakhstan, as a rule, are poor in phosphorus. Meanwhile, this element affects the development of the root system, and hence the plant as a whole. In addition, our previous studies show that subsequently it is almost impossible to correct the deficiency of mobile phosphorus in the soil by non-root regulation.[19]

As a result of this work, a deficit of nitrate nitrogen was revealed before sowing in the Kostanay region in 60% of the fields studied, in Mendykarinsky - 43% of the fields, in Sarykol - 25% of the fields, in Altynsarinsky - 40% of the fields, in Karasu - 33% of the fields, in Naurzum - 50% of the fields, in Auelikolsky - 86% of the fields, in Kamystinsky - 80% of the fields, in Zhitikarinsky - 67% of the fields, in Denisovsky - 86% of the fields, Taranovsky - 67% of the fields, in Fedorovsky - 46% of the fields, in Karabalyksky - 43 % of the studied fields.

Assessing the deficit of mobile phosphorus, it is worth noting that in the Kostanai region, a low degree of soil supply with this element was observed in 50% of the fields, and a very low degree in 20% of the fields. In addition, a low degree of availability of soil with mobile phosphorus was observed in the following districts of the Kostanai region: in Mendykarinsky district - by 43% of the studied fields, in Uzunkolsky - by 33% of fields, in Sarykolsky - by 25% of fields. In the remaining regions, the following picture emerged: some of the fields studied had a low degree of provision with mobile phosphorus, and some were very low. So, in Altynsarinsky district, a low degree of security was observed at 20% of the fields and another 20% a very low degree of security, in Karasu district at 42% of the fields a very low security was observed, in Naurzum district, a low security was observed at 17% of the fields and 17% very low degree of security, a low degree of security was observed in 43% of the fields in Auelikolsky district and 28% of fields had a very low security level, in Denisovsky district a very low degree of availability of mobile phosphorus was found in Denisovsky district, 31% in Fedorovsky observed low degree of security and 23% very low degree of security in the area Karabalyk 14% of fields observed low degree of security and 29% of the fields very low degree of security.[20]

5 Conclusion

Extremely dry years always cause significant damage to the grain-growing region. However, there are obvious omissions of farmers, because of which weather conditions become the starting point of a number of problems. So, in addition to weather conditions in areas such as Kamystinsky, Taranovsky, Auelikolsky, Zhitikarinsky, Denisovsky and Naurzumsky, there is a lack of a systematic approach to solving agricultural problems, as evidenced by the availability of productive moisture, nitrate nitrogen and mobile phosphorus. One of the solutions to the problem should be more effective short-rotation crop rotation for these areas, working out the issues of mineral nutrition of plants and more efficient assimilation and preservation of autumn-winter precipitation in order to use them productively.

References

- 1 J. Denègre, *Thematic Mapping From Satellite Imagery: A Guidebook*, 296, (January 1994)
- 2 Philippe Lagacherie, Alex McBratney, Marc Voltz, *Digital Soil Mapping*, 658, (December 2006)
- 3 E.V. Truflyak, *Main elements of precision farming system*, 39, (Krasnodar: Kubgau, 2016)
- 4 E.V. Truflyak, *Experience of application of precision farming systems*, 22, (Krasnodar: Kubgau, 2016)
- 5 L.-H. LyuSpace, *Weather Study Using Multipoint Techniques*, 374, (Pergamon, 8th May 2002)
- 6 URL: <https://foodindustry.kz/tsifrovizatsiya-apk-v-kostanajskoj-oblasti/>
- 7 URL: https://tengrinews.kz/kazakhstan_news/tsifrovizatsiya-apk-kostanae-umnyie-fermyi-tochnoe-353141/
- 8 I.A. Labutina, E.A. Baldina, *Using remote sensing data for monitoring protected area ecosystems*. Methodological guide, I.A. Labutina, E.A. Baldina; world wildlife Fund (WWF of Russia). UNDP / GEF / ICI project *Conservation of biodiversity in the Russian part of the Altai-Sayan Ecoregion* 88 (Moscow, 2011), Nicolas Baghdadi, Mehrez Zribi , *Land Surface Remote Sensing in Agriculture and Forest* September, 496, (2016)
- 9 Methods of remote sensing and GIS technologies for assessing the state of the environment, inventory of land and real estate: *Proceedings of the IX international scientific and practical conference*, 82 (Italy, May 14-21 2005), M.D. Steven, J.A. Clark, *Applications of Remote Sensing in Agriculture*, 440 (Butterworth-Heinemann, July 1990)
- 10 Shunlin Liang, Xiaowen Li Jindi Wang, *Advanced Remote Sensing*, 800 (Academic Press, August 2012)
- 11 E.N. Sutyryna, *Remote sensing of the earth: textbook manual*, 165 (Irkutsk, IGU, 2013)
- 12 A.A. Vorobyova, *Remote sensing of the earth*, Educational and methodical manual, 168 (Saint Petersburg, 2012)
- 13 E.V. Truflyak, *Differentiated technologies*, 44 (Krasnodar: Kubgau, 2016)
- 14 A.F. Vadyunina, Z.A. Korchagina, *Methods of research of physical properties of soils*, 416 (M.: Agropromizdat, 1986)
- 15 M Frissel, *Cycling of Mineral Nutrients in Agricultural Ecosystems*, 364, (1st January 1978)
- 16 Y. Pachepsky, W.J. Rawls, *Development of Pedotransfer Functions in Soil Hydrology*, Elsevier Science, 542 (November 2004)
- 17 Janusz Pawliszyn, *Sampling and Sample Preparation in Field and Laborator*, 1166 (September 2002)
- 18 Prashant Srivastava, George Petropoulos, Y.H. Kerr, *Satellite Soil Moisture Retrieval*, 440, (May 2016)