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, Altynsar, 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 Kostanai 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.

The article was prepared as part of the implementation of the republican budget program 010 "Ensuring the safety and expansion of the use of space infrastructure" subprogram 102 "Services for the provision of satellite images to government bodies and organizations received from the space system of remote sensing of the Earth of the Republic of Kazakhstan".

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 solonetzes 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 solonetzes, 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; Uzunkolsky 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).
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               |

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
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.

|   | <60 | 18 | very bad |
|---|-----|----|----------|

**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]
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 sereozems. 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.

| Control point number | Coordinates                  | pH  | environment | humus, % | degree of security | N general (NO₃) | degree of security | P₂O₅ | degree of security | K₂O | degree of security |
|----------------------|------------------------------|-----|-------------|----------|-------------------|-----------------|-------------------|------|-------------------|-----|-------------------|
| 77                   | 62° 16' 3,503”E 53° 10' 54,964”N | 6.18| neutral     | 4.26     | average           | 6.5             | low               | 127  | increased         | 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              |
| E3S Web of Conferences 176, 04001 (2020) | https://doi.org/10.1051/e3sconf/202017604001 |
|----------------------------------------|------------------------------------------------|
| **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' 20,211" 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* |
| **Mendykarra 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° 9' 8,068" 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' 36,483" 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 |
| **Altnysar 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 |
| Latitude | Longitude | Climate | Temperature | Humidity | Pressure | Wind | Clouds | Visibility | Pressure | Description |
|----------|-----------|---------|-------------|----------|----------|------|--------|------------|----------|-------------|
| 52° 42' 48,319" N | 35° 36' 18,413" W | neutral | 3,15 | low | 12,6 | average | 9 | very low | 642 | very high |
| 52° 39' 18,313" N | 35° 36' 18,413" W | neutral | 3,56 | low | 17,8 | high | 52 | average | 270 | very high |

**Kostanay district**

| Area Code | Latitude | Longitude | Climate | Temperature | Humidity | Pressure | Wind | Clouds | Visibility | Pressure | Description |
|-----------|----------|-----------|---------|-------------|----------|----------|------|--------|------------|----------|-------------|
| 1 | 53° 07' 12,032" N | 35° 36' 18,413" W | neutral | 4,49 | average | 12,3 | average | 18 | average | 300 | high |
| 2 | 53° 07' 12,032" N | 35° 36' 18,413" W | close to neutral | 3,84 | low | 7,4 | low | 48 | low | 373 | very high |
| 3 | 53° 07' 12,032" N | 35° 36' 18,413" W | neutral | 3,63 | low | 5,1 | low | 43 | low | 282 | very high |
| 4 | 53° 07' 12,032" N | 35° 36' 18,413" W | neutral | 3,13 | low | 6,0 | low | 42 | low | 398 | very high |
| 5 | 53° 07' 12,032" N | 35° 36' 18,413" W | neutral | 3,63 | low | 20,0 | high | 13 | low | 469 | very high |
| 6 | 53° 07' 12,032" N | 35° 36' 18,413" W | neutral | 4,09 | average | 10,2 | average | 15 | average | 454 | very high |
| 7 | 53° 07' 12,032" N | 35° 36' 18,413" W | neutral | 3,65 | low | 9,8 | low | 8 | very low | 486 | very high |
| 8 | 53° 07' 12,032" N | 35° 36' 18,413" W | neutral | 3,83 | low | 6,5 | low | 71 | average | 192 | very high |
| 9 | 53° 07' 12,032" N | 35° 36' 18,413" W | neutral | 3,36 | low | 11,2 | average | 6 | very low | 518 | very high |
| 10 | 53° 07' 12,032" N | 35° 36' 18,413" W | neutral | 3,35 | low | 3,6 | very low | 34 | low | 150 | high |

**Denisov district**

| Area Code | Latitude | Longitude | Climate | Temperature | Humidity | Pressure | Wind | Clouds | Visibility | Pressure | Description |
|-----------|----------|-----------|---------|-------------|----------|----------|------|--------|------------|----------|-------------|
| 63 | 12° 34' 14,4" E | 52° 19' 26,3" N | neutral | 2,60 | low | 6,0 | low | 57 | average | 168 | high |

**Karasu district**

| Area Code | Latitude | Longitude | Climate | Temperature | Humidity | Pressure | Wind | Clouds | Visibility | Pressure | Description |
|-----------|----------|-----------|---------|-------------|----------|----------|------|--------|------------|----------|-------------|
| 25 | 16° 54,465" E | 52° 45' 22,762" N | neutral | 4,16 | average | 33,9 | high | 9 | very low | 745 | very high |
| 26 | 16° 54,465" E | 52° 45' 22,762" N | neutral | 3,76 | low | 16,6 | high | 6 | very low | 551 | very high |
| 27 | 16° 54,465" E | 52° 45' 22,762" N | neutral | 3,43 | low | 23,5 | high | 8 | very low | 502 | very high |
| 28 | 16° 54,465" E | 52° 45' 22,762" N | neutral | 3,64 | low | 21,4 | high | 5 | very low | 405 | very high |
| 29 | 16° 54,465" E | 52° 45' 22,762" N | neutral | 3,11 | low | 15,9 | high | 9 | very low | 418 | very high |
| 30 | 16° 54,465" E | 52° 45' 22,762" N | neutral | 3,70 | low | 8,4 | low | 65 | average | 282 | very high |
| 31 | 16° 54,465" E | 52° 45' 22,762" N | neutral | 3,78 | low | 7,2 | low | 79 | average | 402 | very high |
| 32 | 16° 54,465" E | 52° 45' 22,762" N | neutral | 3,61 | low | 14,8 | average | 92 | average | 420 | very high |
| 33 | 16° 54,465" E | 52° 45' 22,762" N | neutral | 3,67 | low | 9,6 | low | 139 | increased | 420 | very high |
| 34 | 16° 54,465" E | 52° 45' 22,762" N | neutral | 2,96 | low | 8,9 | low | 63 | average | 324 | very high |
| 35 | 16° 54,465" E | 52° 45' 22,762" N | neutral | 3,25 | low | 10,7 | average | 79 | average | 342 | very high |
| 36 | 16° 54,465" E | 52° 45' 22,762" N | neutral | 3,05 | low | 11,0 | average | 58 | average | 276 | very high |

**Taran district**

| Area Code | Latitude | Longitude | Climate | Temperature | Humidity | Pressure | Wind | Clouds | Visibility | Pressure | Description |
|-----------|----------|-----------|---------|-------------|----------|----------|------|--------|------------|----------|-------------|
| 70 | 18° 11,792" E | 52° 32' 53,103" N | neutral | 2,85 | low | 11,5 | average | 58 | average | 348 | very high |
| 71 | 18° 11,792" E | 52° 32' 53,103" N | neutral | 3,37 | low | 4,9 | very low | 93 | average | 390 | very high |
### 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.

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| Zhitikara district | 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 |
|--------------------|------------------------------------|------|---------|------|-----|-----|---------|-----|---------|------|---------|
|                    | 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 |

### Auliekol district

| Kamysty district | 50 | 63° 38' 26.726" E 51° 3' 12.810" N | 9.2 | neutral | 2.13 | low | 7.4 | low | 60 | average | 90 | increase d |
|------------------|----|------------------------------------|------|---------|------|-----|-----|-----|-----|---------|------|---------|
| Auliekol district | 40 | 64° 10' 51.216" E 52° 16' 36.306" N | 6.26 | neutral | 1.72 | very low | 5.5 | very low | 28 | low | 216 | very high |

### Naurzum district

| Zhitikara district | 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° 20' 15.302" E 52° 9' 5.701" N | 7.02 | neutral | 3.67 | low | 13.8 | low | 79 | average | 222 | very high |

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* –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.
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, in 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 Kostanay 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 Kostanay region: in Mendykarinsky district - by 43% of the studied fields, in Uzunkolsky - by 33% of fields, in Sarykol - 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.
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