IRSTI 39.19.31

Zh.B. Teleubay[1,2]*, A.Zh. Assylkhanova[2], M.K. Kadylbekov[1], B.B. Shmatov[1], E.B. Rayev[1]

[1]S. Seifullin Kazakh Agro Technical University, Nur-Sultan, Kazakhstan
[2]University of Szeged, Szeged, Hungary
**Corresponding author: zhanasyl_1st@mail.ru,*

Monitoring of rational use of the agricultural land: A case study of the Akmola region for 2018-2020 years period

Abstract. *The use of Remote Sensing methods and GIS technology which allow determining the dynamics and features of the rational use of agricultural land is competent. Up to now, there is no complete understanding of the assessment of the current state of unused agricultural land. It is important to monitor the effective use of arable land by farmers, which means timely sowing and rest of the soil. The degree of the rational use and non-use of agricultural land in the case of the Akmola region based on remote sensing data and satellite observations using GIS technology was determined and analyzed. Using the tool "Zonal Statistics", the maximum, minimum, and average NDVI values of each field were calculated. The rich agricultural potential of the Egindykol region has a great ability to ensure the food security of the Republic of Kazakhstan, constantly improving the rational use of agricultural land.*

Keywords: *land monitoring, rational use, remote sensing, arable land, NDVI.*

DOI: https://doi.org/10.32523/2616-6771-2021-137-4-43-56

Introduction

The issues of rational land use at the present stage are of great importance. As a result of land restructuring in the late twentieth and early twenty-first centuries in our country, there have been significant changes in the organization of legal and economic mechanisms of economic use which led to a significant reduction in exploited agricultural land and adversely affected the quality of most valuable arable land.

At present, the most pressing issues are the interpretation of the state land cadastre and the improvement of the existing land management system including the organization of land monitoring by remote methods.

Assessing the modern economic use of agricultural land based on the analysis of the development of negative processes seems to be a very important problem, as a large area of arable land is subject to degradation processes.

In the current situation, the use of modern Remote Sensing methods and GIS technology which allow determining the dynamics and features of the rational use of agricultural land is efficient. To date, there is no complete understanding of the assessment of the current state of unused agricultural land. It is important to monitor the effective use of arable land by farmers, which means timely sowing and rest of the soil.

The main motivation to research proper monitoring of agricultural crop fields is to highlight the problem related to the latifundists who receive subsidies from the government to take care of the land they own, to buy required technical equipment, and refill the seeds. The main issue is that landowners do nothing about pledged words after receiving the funds. Therefore, monitoring via using remote sensing and GIS is urgently necessary for the authorities to spend money rationally and punish unfair farmers.

The main purpose of the study is to analyze and determine the rational use and non-use of agricultural land in the case of the Akmola region based on remote sensing data and satellite observations using GIS technology.

As a result of the 1990s Land reform of Kazakhstan, the main results of which [1]:

- elimination of the state monopoly on land;
- implementation of the transition to paid land use;
- the creation of conditions for civil turnover of land;
- the creation of conditions for the establishment of peasant farms;
- the creation of target land resources;
- the system of the state real estate cadastre and registration of the rights to real estate is carried out;
- the Unified State Register of Lands came into force;
- development of the software that provides automated maintenance of real estate cadastre.

Land monitoring is a system of monitoring the state of land resources for the timely detection of changes, their assessment, forecasting, prevention, and elimination of the consequences of adverse processes.

The main objectives of state land monitoring are the timely detection of changes in land conditions, assessment of these changes, development of recommendations for the prevention and elimination of negative processes, information support of state land control, land use and protection, as well as land management.

Monitoring types are shown in the figure below (see Figure 1). Global (biosphere) monitoring of the Earth is carried out by the international geosphere-biosphere program “Global Change” [2]. It allows us to assess the current state of the entire natural system of the Earth to warn of emergencies. Monitoring is carried out by base stations in different regions of the planet, which are often located in biosphere reserves [2]. National monitoring is carried out by specially established bodies within the country. While regional monitoring is the observation of processes and phenomena within a large area. Processes and phenomena can differ both in their natural nature and in their anthropogenic impact on the basic background of the entire biosphere. Local monitoring of land is carried out at the territorial level, below the regional level, up to the individual land-use area, and the elementary structures of landscape ecological complexes. Based on the nature of changes in land conditions, background and impact monitoring are also distinguished. Background monitoring is the observation of non-human land conditions, which is carried out in biosphere reserves. Whereas impact monitoring is the observation of land conditions in areas directly affected by anthropogenic factors.

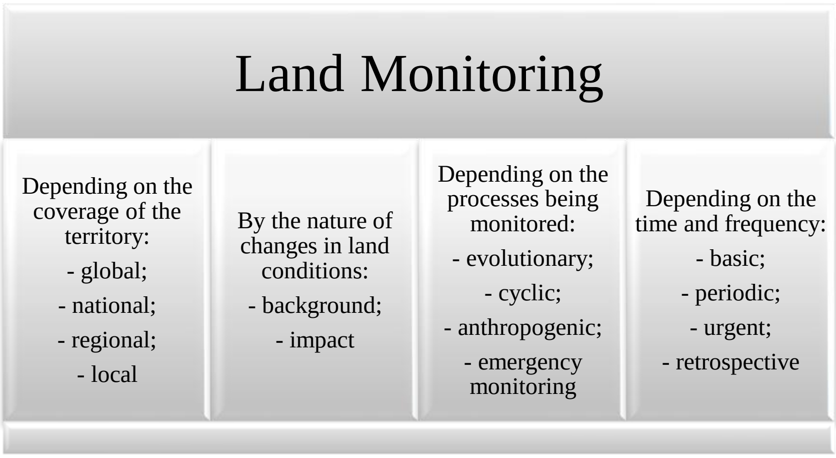

Figure 1. Types of land monitoring

Land monitoring is an internal system of state land monitoring and is the monitoring of changes in the fertility of agricultural land, their ecological and reclamation status, and other processes caused by natural and anthropogenic factors [3].

All existing methods of studying land resources can be divided into methods of land and remote sensing [4]. The land monitoring system includes a subsystem of land control, the main functions of which are the followings:

- identification of key indicators of land monitoring;
- assessment and verification of remote monitoring of land monitoring indicators;
- a collection of information on the condition of places where the use of remote sensing methods is impossible;
- calibration of technical means of remote sensing, geographical reference to objects of land control, correction of the atmosphere, the organization of primary data processing points.

Surface surveys are carried out in two ways: continuous and point surveys. The field is taken as an elementary unit in a continuous study. The point survey is conducted in specially designated areas specific to a particular area, and then the data obtained is extrapolated to the rest of the area [4].

Real farming often uses a variety of vegetation indices, of which NDVI is the most popular. This allows you to assess the condition of fields and plants anywhere in the world using satellite imagery.

NDVI (Normalized difference vegetation index) is a quantitative indicator of the quality and quantity of vegetation in a field [5]. It is calculated from satellite imagery and is based on how plants reflect and absorb light waves of different lengths. For example, plants are green to our eyes because the chlorophyll pigment reflects green waves well. Chlorophyll also absorbs red waves: this leads to photosynthesis, for instance, the growth and development of vegetation. The cellular structure of the plant is reflected in near-infrared waves. It turns out that a healthy plant, which is rich in chlorophyll and has a good cell structure, actively absorbs red light and reflects it in near-infrared. The diseased plant shows the opposite.

We need to understand that NDVI is an indicator of the state of the plant which does not say anything about the causes of a particular situation. Consider three scenarios for using the NDVI at the beginning, middle, and end of the growing season.

At the beginning of the season, according to the NDVI indicator, it is possible to understand how the plant overwintered. Typically, the logic is as follows [5]:

• If the NDVI is below 0.15, all plants in the area may be dead. Typically, these values correspond to plowed soil without vegetation.

• 0.15-0.2 is a low value. This may indicate that the plants overwintered in the early phenological phase before loosening.

• 0.2-0.3 is a relatively good indicator. It is possible that the plants went through a period of loosening and were able to restore the vegetation cover.

• 0.3-0.5 is a good indicator. High values of NDVI may indicate that plants are in a late stage of development. If the satellite image was taken before the renewal of the growing season, it will be necessary to re-analyze the condition of the site after the beginning of the period of growth and development of the plant.

• Above 0.5 is an abnormal value after winter. In this case, it is better to go out and check.

In mid-June, the NDVI index shows how plants grow in the steppe. If the index values are medium and high (0.5-0.85), then probably everything is fine in the field [6]. If the index is low, the plants on the site may be missing something, such as moisture or nutrients.

At the end of the season, using the NDVI index, you can determine which fields are ready to be harvested - the lower the index, the closer the field is to ripening. In this case, the optimal value of the index is 0.3-0.35 [6]. We also believe that the NDVI can be used to determine the rate at which dehydrating chemicals are used to dehydrate plants. This speeds up their ripening and makes them easier to harvest.

The plant has many indices, and they are very similar to each other. But NDVI is the most popular and widespread, and it also has one important advantage: if you use data from the Sentinel-2 satellite, high image resolution. In this case, channels with a resolution of 10 meters are used to calculate the NDVI [7]. This indicates that 1 pixel is between 10 and 10 meters. The resolution of the indexes (mostly very red) using additional light channels is 20 meters, for instance, 1 pixel is from 20 to 20 meters [7].

One of the disadvantages of NDVI is that the plants lose their sensitivity when they reach a certain limit. In other words, if the plant is developing very actively, then according to NDVI, it is impossible to distinguish an unusual green plant from a "normal" green. As with all other indices, their accuracy depends on the weather: if the cloud stays in a field for a long time, the satellite image will be wrong.

Study area

The study area of research is the agricultural land of Egindykol district, Akmola region. Egindykol district is located in the southern part of the Akmola region of the Republic of Kazakhstan, west of the capital (see Figure 2). In the south-west, it borders with Karaganda region, in the north with Astrakhan region, in the south - with Korgalzhyn region, in the west and north-west - with Atbasar region. It is located between the Ishim River and the Tengiz-Korgalzhyn depression. The relief is mostly flat, only the central part is cracked in the ravine and consists of small bumps (absolute height 350-400 m). The climate is continental, winters are cold, and summers are hot and dry. The average annual precipitation is about 472 mm [8]. The soil is dark kastanozem (dark chestnut). During the development of virgin and fallow lands, most of the land was plowed. There are plantations of oats, feather grass, wormwood, and alfalfa; on the shores of the lakes, there are a thick reed and others.

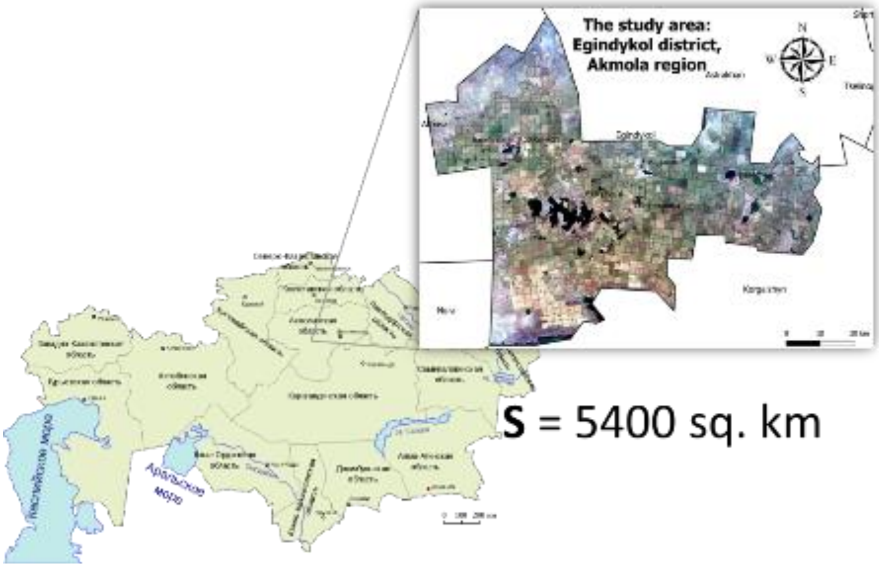

Figure 2. The study area: Egindykol district, Akmola region

In the structure of the regional economy, agriculture is 74.4%. The priority in agriculture is agriculture. The land area of the district is 543 978 hectares. Agricultural lands - 87% (472 thousand hectares) including 334 thousand hectares of arable land [8]. Land in this category is provided by 253 land users, of which 222 are farms, 30 LLPs, and 1 state varietal plot [8].

Data and methods

Unused agricultural land can be identified by expert interpretation of multispectral images with ultra-high spatial accuracy (1-2 m/pixels), but this method is time-consuming, especially if it is necessary to study tens or hundreds of thousands of hectares (our study area is about 550 thousand hectares). In addition, images of modern high-precision artificial satellites remain very expensive.

Because the reflective properties of unused lands at different stages of the growing season may be similar to those of other lands, it is difficult to automatically identify such lands based on uniform images. To date, there is an experience in using different types of satellite data to assess the condition of unused agricultural land [9, 10], however, the question of their effective mapping based on remote sensing data remains open. Due to the complexity of the spectral reaction of unused lands, it is necessary to use regularly received satellite information, including information on the reflected characteristics of the cultivated areas, over some time. Thus, taking into account the differences in the reflectivity of unused lands and cultivated lands, it is possible to identify lands that were previously arable land, but in recent years are not used for their intended purpose.

Currently, daily MODIS images have the highest reproducibility, which allows you to analyze the spectral characteristics of individual processed areas. However, in the course of the study, Sentinel-2 satellite images were selected for one main reason which is high spatial accuracy.

The experimental study included the following main stages:

• Formation of a model of arable or fallow lands, based on which to prepare a geographic database;

• Selection, download, and pre-processing of satellite data;

• Calculation of NDVI indices for July via using Formula 1 for each analyzed agricultural land in 2018, 2019, 2020;

• Preliminary statistical analysis of differences in plant index values for arable and fallow lands;

• Calculation of the average NDVI value of each digitized area using the tool "Zonal Statistics";

• Study of the obtained analytical sample by the method of analysis, determination, and analysis of the values of the most effective plant index for automatic recognition of unused lands;

• Division of unsown lands in 2018, 2019, 2020 into “fallow” and unused lands for their intended purpose.

NDVI was officially introduced by Brown and Herold in 2004 [11]:

$$NDVI = \frac{NIR-RED}{NIR+RED} \quad (1)$$

During the study, NDVI values were calculated using a raster calculator.

According to the third chapter of Article 92 of the Land Code of the Republic of Kazakhstan adopted on June 20, 2003 (forcible seizure of unused and undeveloped land from the owner and land user), “In case of improper use of arable land for two years in a row, such land is subject to compulsory seizure in the manner prescribed by Article 94 of this Land Code of the Republic of Kazakhstan”. Thus, during the study, there was a need to identify lands that were not sown for two years in a row, in 2018-2019 and 2019-2020, as well as unused lands for three years in a row.

Remote sensing images of 2 Sentinel-2 artificial satellites in July of each year were used to identify existing and unused areas between the 2018-2020 years (Table 1). Images were uploaded from the website of the American Geological Survey which is a US government research organization specializing in geological surveys and earth sciences at https://earthexplorer.usgs.gov. During the filtering, only images with a degree of cloudiness of less than 5% were selected [12], so it was not possible to take two images taken in 2018 in one day. As a result, the study continued with images T42UVB and T42UWB with an interval of 5 days. Each bar of images was merged and corrected using the Merge tool. The Sentinel-2 multispectral images were subjected to radiometric calibration, which converted the numerical values of the remote sensing images into luminosity values, and then the light images were converted into reflection images of the earth using atmospheric correction of rapid linear analysis of spectral hypercubes [13].

Table 1

Sentinel-2 images used to obtain NDVI values

NAME	YEAR	MONTH	DAY
L1C_T42UVB_A006967_20180707T063455	2018	JULY	07
L1C_T42UWB_A015947_20180712T062629	2018	JULY	12
L1C_T42UVB_A015264_20190727T062631	2019	JULY	27
L1C_T42UWB_A002156_20190727T062631	2019	JULY	27
L1C_T42UVB_A052651_20200711T062631	2020	JULY	11
L1C_T42UWB_A021516_20200711T062631	2020	JULY	11

In addition, the ability to analyze high-resolution satellite images available on the Google Earth web service was used to identify leaks. With the help of the program's so-called "historical images" tool, we tried to visually determine whether the land was used for its intended purpose during the study years and compared it with our results.

The main source of information used to identify used/unused land for its intended purpose is the area of each area for 2018-2020. The average NDVI values were obtained using "zonal statistics" and are tabulated in Table 2.

Table 2

Average NDVI values for July of the survey years in the arable lands of Egindykol district

Number of the arable land	Area of the land, Ha	NDVI, 2018 year	NDVI, 2019 year	NDVI, 2020 year
1	198,6	0,472	0,358	0,245
2	373,1	0,203	0,334	0,152
3	234,2	0,383	0,273	0,244
4	154,8	0,303	0,237	0,272
5	299,3	0,477	0,374	0,451
6	402,7	0,351	0,376	0,435
7	398,8	0,448	0,292	0,375
8	404,7	0,337	0,351	0,391
9	400,1	0,368	0,340	0,355
...	...	...	...	...

Results and Discussion

In general, based on a joint analysis of satellite imagery in Egindykol district for the 2018 year, 171 unsown areas with an area of more than 59,000 hectares were identified (Table 3). This is a record for the years of the study and amounted to 17.7% of total arable land. In 2019 and 2020, about 39,000 and 42,000 hectares of unsown land were identified. It was 131 and 103 fields, which accounted for 12.6% and 11.9% of the total 982 sown areas in Egindykol district. However, these calculations do not only show areas that are not being used for their intended purpose. This is due to the fact that farmers increase soil fertility this way, prevent erosion, and control weeds. Such arable lands are called fallow fields and there are several types: pure fallow - fields free of crops; black fallow - pure unused land, the main cultivation of which was carried out a year ago in summer or autumn; the first fallow - clean land, the main tillage of which is carried out in the spring of the year of fertilization; potential fallow - a clean land where crops are planted in rows or strips to retain snow and prevent soil erosion; sown fallow - a fallow field occupied by early harvested crops for a part of the growing season; sidereal/green fallow -

a field used for growing crops on green manure [14]. It is recommended to use sidereal/green fallow to increase and restore soil fertility. Green manure crops are used for sweet clover, yellow mustard, white mustard, spring canola, and millet. The use of green manure for green fertilization of these crops in a relatively short period allows obtaining a green mass of 180-250 c/ha which is equivalent to the introduction of 20 tons of manure and improves the physical properties of the soil.

Table 3

The state of lands for the period 2018-2020 years

Condition of agricultural lands	2018	2019	2020
Area of common lands, Ha	275068,5	292142,6	294603,5
The total area of unsown lands, Ha	**59220,3**	**42146,2**	**39685,4**
The proportion of total land use,%	82,3	87,4	88,1
Proportion of unsown land, %	**17,7**	**12,6**	**11,9**
Number of arable lands used	811	851	879
Number of unsown fields	**171**	**131**	**103**
The total area of arable land, Ha	334288,8	334288,8	334288,8

The first results mentioned above were based on the overall average NDVI values of the study area. That is, using the tool "zonal statistics", the maximum, minimum, and average NDVI values of each field were calculated, and areas with NDVI <0.2 were included in the list of unsown areas (Figure 3). If we look to the south of the study area, we can see that even in the cultivated areas, the value of a few dozen pixels is less than 0.2, that is, spots of different shapes are visible in the fields. In this case, there may be several reasons, for example, in some areas of the field, the sowing device may drop less grain than normal and reduce the germination rate. In addition, the lack of fertilizers in some areas or the presence of excessive amounts of weeds and pests can cause such spots on the NDVI map of arable land. In case of insufficient application of mineral fertilizers, the structure should contain legumes such as peas, chickpeas, lentils, and soybeans to maintain soil fertility. Legumes have a positive effect on the accumulation of nitrogen in the soil and improve the physical properties of the soil. However, based on the NDVI map, it can be seen that such measures are not carried out in the south of Egindykol district.

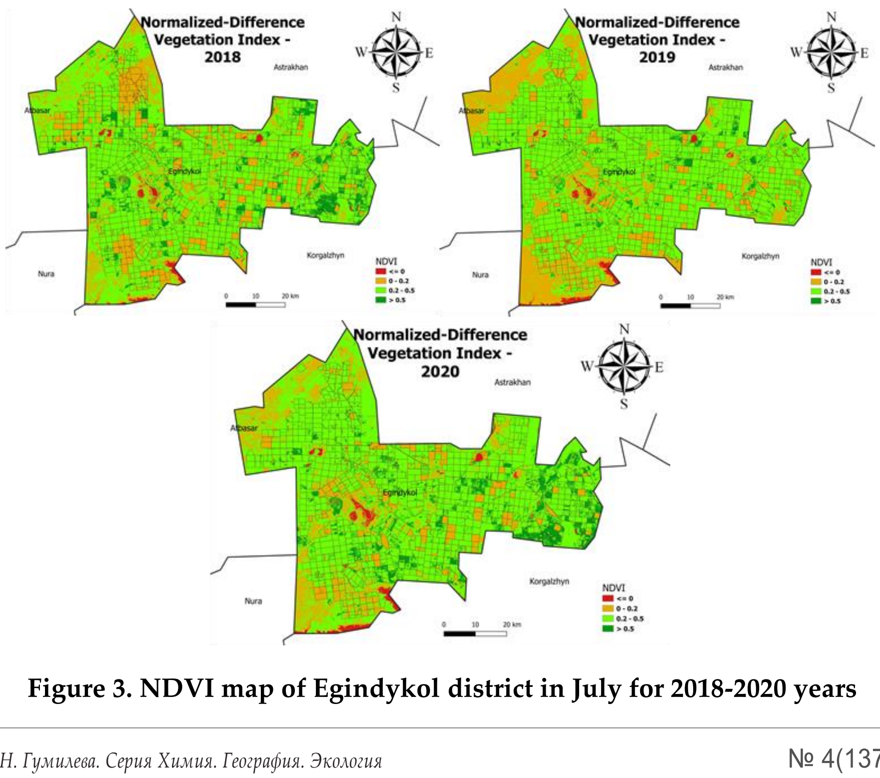

Figure 3. NDVI map of Egindykol district in July for 2018-2020 years

Before the start of the sowing season, each farm makes a comprehensive plan in the spring, based on the physical, chemical, and other characteristics of all the land. When forming the structure of arable lands, it is allowed to place crops of only one biological group in field rotations. For example, according to the rotation scheme, if there should be beans in the crop rotation, they can be replaced by chickpeas depending on the needs and circumstances. This applies to wheat and barley. A special requirement in determining the frequency of crop rotation is to select the best previous crop for the main group of common crops, to determine the optimal timing of their re-sowing. Crop rotation must be strictly observed in time and space as well as in all necessary technological operations carried out during the growing season. The plan also takes into account the winter climatic conditions, as during the winter snowmelt washes away the soil and causes water erosion. In order to prevent erosion, in the year of heavy snowfall, soil-protective crops are sown instead of crops that are in great demand in the market, and such lands are not approved as fallow fields. In general, to validate these results, it is necessary to obtain historical information for each field from the farms and compile a crop rotation table. Today, such information is not available to the public. Moreover, according to the Land Code of the Republic of Kazakhstan, the law does not apply any penalties to landowners who have not used the land for only 1 year. Therefore, the initial results map of lands used or not used for their intended purpose identified arable land with an area of about 40 thousand hectares (2019-2020) to 60 thousand hectares (2018) (Figure 4). The largest share of arable land is not plowed. The most reliable way to determine it is to collect spectral signatures of plowed and non-plowed soils and divide them into 2 classes. However, it requires a lot of money.

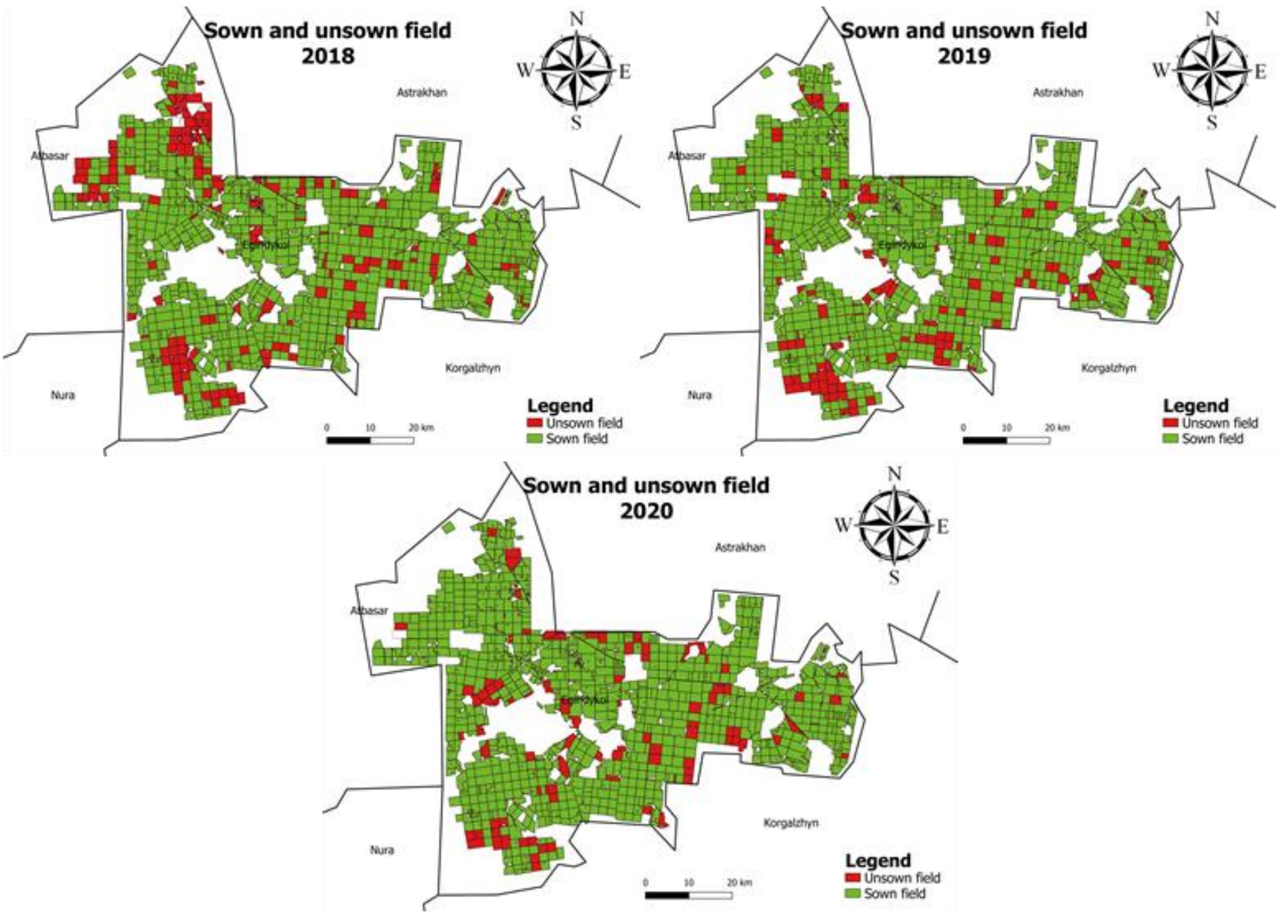

Figure 4. Map of sown and unsown fields for 2018, 2019, and 2020 years

In other words, there is a need to find a way to classify unsown fallow fields and unused lands at no cost. According to the encyclopedic dictionary of Brockhaus and Efron, if the land is not developed and cultivated for more than a year, it becomes a fallow land, for instance, obsolete land [15]. Thus, in 2018, 2019, and 2020, we identified and analyzed lands by filtering that had not been cultivated for 2 or 3 years in a row (Table 4).

Table 4

Lands that are not used for their intended purpose as a result of the analysis

Land without potential use	**2018-2019**	**2019-2020**	**2018-2019-2020**
Area of underground land for several years	**5084,4**	**5936,8**	**1913,8**
Percentage of unused land for several years,%	**1,5**	**1,8**	**0,6**
Number of unused lands for several years	**15**	**15**	**5**
Percentage of unused land for several years,%	**1,5**	**1,5**	**0,5**
Total field area, Ha	334288,8	334288,8	334288,8
Total number of sowing areas	982	982	982

To do this, we identified the same areas by matching the initial results map for each year. As a result, for two years in a row: in 2018-2019 and 2019-2020, the number of unsown lands was the same and accounted for 15. However, there were significant differences between districts. In 2018-2019, more than 5 thousand hectares of land were included in the category of unused land, and in 2019-2020 years about 6 thousand hectares. It made up 1.5% and 1.8% of the total sown area in Egindykol district, respectively, and was equal to 1.5% of the total sown area. In particular, in Egindykol district 982 arable lands with a total area of more than 334 thousand hectares were identified during digitization. Among them are lands that have not been sown and developed for 3 years in a row. In 2018, 2019, and 2020, 5 unused arable lands with an average area of about 240 hectares were identified. It took 0.5% of the total arable land of Egindykol district, which is 1913.8 hectares, and had some negative impact on the development of the local economy.

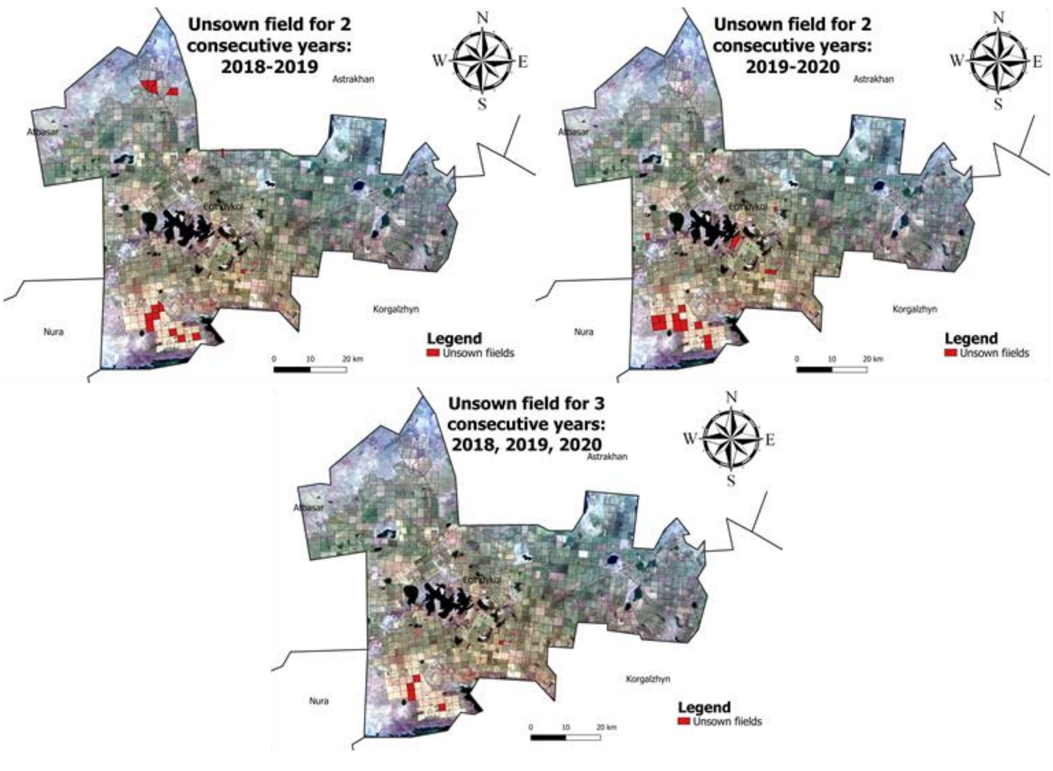

Figure 5. Map of unsown lands in Egindykol district for 2 and 3 consecutive years

Statistical results were calculated in Microsoft Excel Worksheet and QGIS platform geographic information system was used for visualization. If we pay attention to Figure 5, we see an illustration of unsown lands, which are not used for their intended purpose for 3 consecutive years (2018-2019, 2019-2020) and 3 years in a row (2018-2020 years). The analysis revealed several similarities and differences that occurred during the study years. On the map of unused lands in 2018-2019, we see that in the northern part of the study area there were 5 arable lands with a total area of 1550 hectares. These lands will be used not only in the first two years but from 2020 onwards. In addition, in the central part of the first map, according to our forecast, no crops were sown in two fields with the same area of 130 hectares. As for the lands not used for their intended purpose in 2019-2020, compared to the first two years, the area was relatively small (1170 hectares), but the number of areas was predominant and covered 6 arable lands. The main difference of the second biennial is the absence of unused land in the northern part of the study area. However, the most irrational use of agricultural land, arable land in the southern part of Egindykol district was equally abundant in the first and second biennium. Their area in 2018-2019 years was 3276.6 hectares and in 2019-2020 it reached 4779.5 hectares. It can be stated that the southern part of the study area was generally not developed satisfactorily, and NDVI values were low in all study years. In other words, we concluded that there are other reasons for the irrational use of agricultural land and the lack of arable land.

Based on the results of the work, several recommendations are given to local authorities and land monitoring specialists. In particular, the first thing to pay attention to before starting monitoring is the correct choice of satellite images. For ground monitoring, it is recommended to use space images with a spatial accuracy of fewer than 5 meters, preferably 0.5-1 meters. As evidence, as shown in Table 8, the lack of accuracy of the images leads to an increase in the error of the result. This depends directly on the area of the study area [16].

The second recommendation is to monitor the degree of cloudiness of the images for land monitoring. It is necessary to use the type of images with a degree of cloudiness not exceeding 5%, which has undergone radio calibration and atmospheric correction. This is because, during the calculation of NDVI, there is a light indicator on the red and near-infrared channels. Thus, the NDVI rate is low, which leads to erroneous outputs such as land monitoring results coming to a distorted conclusion. It is important to note that it is wrong to draw a conclusion based only on the NDVI and confiscate land from the owner of the field. To date, space monitoring has not grown to such a level that it can act as a coordinating tool for local executive bodies.

It is recommended to use a monthly NDVI time series to track used and unused land. We chose only the peak of the agricultural season which is July. The use of time chains allows you to observe the growing vegetation at each stage. Along the curve, we can see the development of crops and distinguish them from weeds and bushes.

Most importantly, it is necessary to create a single database with historical images and high-resolution satellite images covering the whole of Kazakhstan and the ability to calculate plant indices such as NDVI, NDRE, NDWI, and VHI. For the information to be transparent, the database must be accessible to everyone on the Internet.

It is required to create a regional system of integrated land monitoring to identify changes in the condition of land resources in Egindykol district promptly and reduce the negative impact of their degradation processes. Erosion processes, drought, desertification, salinization, and alkalinization in the Egindykol area should be considered as key factors to be considered when monitoring and assessing land conditions. Indicators of improving the efficiency of land use in the north of Kazakhstan, as well as natural, geological, and socio-economic characteristics of the region in the development of a set of measures to prevent and eliminate the negative processes of the impact of natural and anthropogenic factors on land resources. At the same time, it is necessary to ensure the interaction of the results of scientific research and the materials of comprehensive monitoring of soil fertility, with access to the cadastre and the national system of monitoring the condition of agricultural lands.

Conclusion

The study revealed that in the Egindykol district of the Akmola region, the anthropogenic load on agricultural land is very high; the population is relatively low in arable land, which creates many social problems for the region. This means that in the long run, the main tool of agricultural production in the region should be the spatial basis - the rational use of land and the solution of the greatest problems of the organization of all types of protection.

The rich agricultural potential of the Egindykol region has a great ability to ensure the food security of the Republic of Kazakhstan, constantly improving the rational use of agricultural land.

In general, based on a joint analysis of satellite imagery in Egindykol district in 2018, 171 unsown areas with an unsown area of more than 59,000 hectares were identified. This is a record for the years of the study and amounted to 17.7% of total arable land. In 2019 and 2020, about 39,000 and 42,000 hectares of unsown land were identified, respectively. It was 131 and 103 fields, which accounted for 12.6% and 11.9% of the total 982 sown areas in Egindykol district.

Particularly, 982 arable lands with a total area of more than 334 thousand hectares were identified during digitization in the Egindykol district. Some lands have not been sown and developed for 3 years in a row. In 2018, 2019, and 2020, 5 unused arable lands with an average area of about 240 hectares were identified.

The initial results map of lands used or not used for their intended purpose identified arable land with an area of about 40 thousand hectares (2019-2020) to 60 thousand hectares (2018). The largest share of arable land is not plowed.

In conclusion, five recommendations were made for effective and efficient land monitoring of arable land using GIS and ERS data in Egindykol district, Akmola region. It's worth noting that based on the NDVI vegetation index, agricultural landowners of the Egindykol district of the Akmola region have rationally used arable land for 2018-2020. Unsown lands in 2018, 2019, 2020 years were divided into “fallow” and unused lands for their intended purpose using satellite imagery. Using the tool “Zonal Statistics”, the maximum, minimum, and average NDVI values of each field were calculated, and areas with NDVI <0.2 were included in the list of unsown areas.

References

1. Қазақстан республикасында Мемлекеттік ЖЕР кадастрын жүргізу Ережесін Бекіту туралы. [Электрон. ресурс] – URL: http://adilet.zan.kz/kaz/docs/V1400010147 (дата обращения: 03.02.2021).

2. Guan X., Huang C., Liu G., Meng X., Liu Q. Mapping rice cropping systems in vietnam using an ndvi-based time-series similarity measurement based on dtw distance/ Remote Sens. – 2016. – Vol. 8(1). – P. 19.

3. Zhang M., Lin H., Wang G., Sun H., Fu J. Mapping paddy rice using a convolutional neural network (cnn) with landsat 8 datasets in the dongting lake area, China/ Remote Sens. – 2018. – Vol. 10(11). – P. 1840.

4. Shastry K.A., Sanjay H., Deexith G. Quadratic-radial-basis-function-kernel for classifying multi-class agricultural datasets with continuous attributes/ Appl. Soft Comput. – 2017. – Vol. 58. – P. 65–74.

5. Free apps for precision farming. (n.d.). [Electronic resource] – URL: https://onesoil.ai/en/ (Accessed: 24.04.2021).

6. Huete A., Didan K., Miura T., Rodriguez E.P., Gao X., Ferreira L.G. Overview of the radiometric and biophysical performance of the modis vegetation indices/ Remote Sens. Environ. – 2002. – Vol. 83(1–2). – P. 195-213.

7. Papageorgiou E.I., Markinos A.T., Gemtos T.A. Fuzzy cognitive map based approach for predicting yield in cotton crop production as a basis for decision support system in precision agriculture application/ Appl. Soft Comput. – 2011. – Vol. 11(4). – P. 3643-3657.

8. Егиндыкольский район. [Электрон. ресурс] – URL: http://map.akmol.kz/content/egindykol (дата обращения: 23.02.2021).

9. Prishchepov A.V., Radeloff V.C., Dubinin M., Alcantara C. The effect of Landsat ETM/ETM + image acquisition dates on the detection of agricultural land abandonment in Eastern Europe. Remote Sensing of Environment. – 2012. – Vol. 126. – P. 195-209. DOI: 10.1016/j.rse.2012.08.017.

10. Baldina E.A. Application of radar data to characterize the deposits in the Volga Delta. Geomatics. – 2012. – Vol. 4. – P. 28-33.

11. Braun M., Herold M. Mapping imperviousness using NDVI and linear spectral unmixing of ASTER data in the Cologne-Bonn region (Germany). Proceedings of SPIE. – 2004. – Vol. 5239. – P. 274-284.

12. Alex Elsu, Ramesh K., Hari Sridevi. Quantification and understanding the observed changes in land cover patterns in Bangalore// International Journal of Civil Engineering and Technology. – 2017. – Vol. 8. – P. 597-603.

13. Terekhin E.A. Influence of crop areas vegetation cover fraction on their spectral reflectivity properties// Current problems in remote sensing of the Earth from space. – 2016. – Vol. 13(3). – P. 67-71. DOI: 10.21046/2070-7401- 2016-13-3-61-71.

14. Экологический словарь, ГОСТ 16265-89 "Земледелие. Термины и определения". [Электрон. ресурс] – URL: http://www.ecoindustry.ru/dictionary.html (дата обращения: 23.02.2021).

15. Брокгауз Ф.А. Ефрон И.А. Энциклопедический Словарь в 86 полутомах с иллюстрациями и дополнительными материалами. Санкт-Петербург, 1890-1907.

16. Newcomers earth observation guide. (n.d.). [Electronic resource] – URL: https://business.esa.int/newcomers-earth-observation-guide#ref_3.1 (Accessed: 23.03.2021).

Ж.Б. Телеубай[1,2], Ә.Ж. Асылханова[2], М.Қ. Қадылбеков[1], Б.Б. Шматов[1], Е.Б. Райев[1]

[1]Сәкен Сейфуллин атындағы Қазақ агротехникалық университеті, Нұр-Сұлтан, Қазақстан

[2]Сегед университеті, Сегед, Венгрия

Ауылшаруашылық жерлерін ұтымды пайдаланудың мониторингі: 2018-2020 жылдарға арналған Ақмола облысының жағдайлық зерттеуі

Аңдатпа. Қашықтан зондтау әдістері мен ауылшаруашылық жерлерін тиімді пайдалану динамикасы мен ерекшеліктерін анықтауға мүмкіндік беретін ГАЖ технологиясын қолдану сауатты. Осы уақытқа дейін пайдаланылмаған ауылшаруашылық жерлерінің қазіргі жағдайын бағалау туралы толық түсінік жоқ. Фермерлердің егістік алқаптарын тиімді пайдалануын қадағалау маңызды, бұл уақытылы егу және топырақтың тынығуын білдіреді. Ақмола облысы жағдайында ауылшаруашылық алқаптарын рационалды пайдалану және пайдаланбау дәрежесі қашықтықтан зондтау деректері мен спутниктік бақылаулар негізінде ГАЖ технологиясын қолданып анықталды. «Аймақтық статистика» құралы арқылы әр өрістің максималды, минималды және орташа мәндері есептелді. Егіндікөл аймағының бай ауылшаруашылық әлеуеті ауылшаруашылық жерлерін ұтымды пайдалануды үнемі жетілдіре отырып, Қазақстан Республикасының азық-түлік қауіпсіздігін қамтамасыз ету үлкен қабілетке ие.

Түйін сөздер: жер мониторингі, ұтымды пайдалану, қашықтықтан зондтау, егістік жер, NDVI.

Ж.Б. Телеубай[1,2], А.Ж. Асылханова[2], М.К. Кадылбеков[1], Б.Б. Шматов[1], Е.Б. Райев[1]
[1]*Казахский агротехнический университет имени Сейфуллина, Нур-Султан, Казахстан*
[2]*Сегедский университет, Сегед, Венгрия*

Мониторинг рационального использования земель сельскохозяйственного назначения: на примере Акмолинской области на 2018-2020 годы

Аннотация. Использование методов дистанционного зондирования и технологий ГИС, позволяющих определять динамику и особенности рационального использования земель сельскохозяйственного назначения, является компетентным подходом. До сих пор нет полного понимания оценки текущего состояния неиспользуемых земель сельскохозяйственного назначения. Важно следить за эффективным использованием фермерами пашни, что означает своевременный посев и отдых почвы. Определена и проанализирована степень рационального использования и неиспользования земель сельскохозяйственного назначения в Акмолинской области на основании данных дистанционного зондирования и спутниковых наблюдений с использованием технологии ГИС. С помощью инструмента «Зональная статистика» были рассчитаны максимальное, минимальное и среднее значения NDVI для каждого поля. Богатый сельскохозяйственный потенциал Егиндыкольского района имеет большие возможности для обеспечения продовольственной безопасности Республики Казахстан на основе систематического совершенствования рационального использования земель сельскохозяйственного назначения.

Ключевые слова: мониторинг земель, рациональное использование, дистанционное зондирование, пашня, NDVI.

References

1. Kazakstan respublikasinda Memlekettik Zher kadastrin zhurgizu Erejesin Bekitu turaly [About approval of Rules of maintaining the State Land cadastre in the Republic of Kazakhstan]. [Electronic resource] – Available at: http://adilet.zan.kz/kaz/docs/V1400010147 (Accessed: 03.02.2021). [in Kazakh]
2. Guan X., Huang C., Liu G., Meng X., Liu Q. Mapping rice cropping systems in vietnam using an ndvi-based time-series similarity measurement based on dtw distance, Remote Sens, 8(1), 19 (2016).
3. Zhang M., Lin H., Wang G., Sun H., Fu J. Mapping paddy rice using a convolutional neural network (cnn) with landsat 8 datasets in the dongting lake area, China, Remote Sens. 10(11), 1840 (2018).
4. Shastry K.A., Sanjay H., Deexith G. Quadratic-radial-basis-function-kernel for classifying multi-class agricultural datasets with continuous attributes, Appl. Soft Comput. 58, 65-74 (2017).
5. Free apps for precision farming. (n.d.). [Electronic resource] – Available at: https://onesoil.ai/en/ (Accessed: 24.04.2021).
6. Huete A., Didan K., Miura T., Rodriguez E.P., Gao X., Ferreira L.G. Overview of the radiometric and biophysical performance of the modis vegetation indices, Remote Sens. Environ, 83(1-2), 195-213 (2002).
7. Papageorgiou E.I., Markinos A.T., Gemtos T.A. Fuzzy cognitive map based approach for predicting yield in cotton crop production as a basis for decision support system in precision agriculture application, Appl. Soft Comput., 11(4), 3643-3657 (2011).
8. Egindykolski raiyon [Egindykol district], (n.d.). [Electronic resource] – Available at: http://map.akmol.kz/content/egindykol (Accessed: 23.02.2021).
9. Prishchepov A.V., Radeloff V.C., Dubinin M., Alcantara C. The effect of Landsat ETM/ETM + image acquisition dates on the detection of agricultural land abandonment in Eastern Europe. Remote Sensing of Environment, 126, 195-209 (2012). DOI: 10.1016/j.rse.2012.08.017.
10. Baldina E.A. Application of radar data to characterize the deposits in the Volga Delta. Geomatics, 4, 28-33 (2012).

11. Braun M., Herold M. (2004). Mapping imperviousness using NDVI and linear spectral unmixing of ASTER data in the Cologne-Bonn region (Germany). Proceedings of SPIE, 5239, 274-284 (2004).

12. Alex Elsu, Ramesh K., Hari Sridevi. Quantification and understanding the observed changes in land cover patterns in Bangalore. International Journal of Civil Engineering and Technology, 8, 597-603 (2017).

13. Terekhin E.A. Influence of crop areas vegetation cover fraction on their spectral reflectivity properties. Current problems in remote sensing of the Earth from space, 13(3), 67-71 (2016). DOI: 10.21046/2070-7401- 2016-13-3-61-71.

14. Ecologicheski slovar [Ecological dictionary], GOST 16265-89 "Zemledelie. Terminy y opredeleniya" [Agriculture. Terms and Definitions]. [Electronic resource] – Available at: http://www.ecoindustry.ru/dictionary.html (Accessed: 23.02.2021). [in Russian]

15. Brokgauz F.A. Efron I.A. Enciklopedicheskij Slovar' v 86 polutomah s illyustraciyami i dopolnitel'nymi materialami. [Encyclopedic Dictionary in 86 half-volumes with illustrations and additional materials], Sankt-Peterburg, 1890-1907. [in Russian]

16. Newcomers earth observation guide. (n.d.). [Electronic resource] – Available at: https://business.esa.int/newcomers-earth-observation-guide#ref_3.1 (Accessed: 23.03.2021).

Information about authors:

Teleubay Zh.B. **–** Master of Geography Science, Head of Laboratory for Big Data Analysis, S. Seifullin Kazakh Agro Technical University, 62 Zhengis Ave., Nur-Sultan, Kazakhstan**.**

Assylkhanova A.Zh. **–** Master of Geography Science, Ph.D. student, University of Szeged, Dugonics ter 13, Szeged, Hungary.

Kadylbekov M.K. **–** Master of Science, Senior Lecturer of the Department of GIS and Cadastre, S. Seifullin Kazakh Agro Technical University, 62 Zhengis Ave., -Sultan, Kazakhstan.

Shmatov B.B. **–** Bachelor of Geodesy and cartography Science, Engineer of the GIS technologies centre, S. Seifullin Kazakh Agro Technical University, 62 Zhengis ave., Nur-Sultan, Kazakhstan.

Rayev E.B. **–** Bachelor of Science, Engineer of the GIS technologies centre, S. Seifullin Kazakh Agrotechnical University, Zhengis Avenue 62, Nur-Sultan, Kazakhstan.

Телеубай Ж.Б. **–** География ғылымдарының магистрі, үлкен деректерді талдау зертханасының меңгерушісі, С.Сейфуллин атындағы Қазақ агротехникалық университеті, Жеңіс даңғылы, 62, Нұр-Сұлтан, Қазақстан.

Асылханова Ә.Ж. **–** География ғылымдарының магистрі, докторантура студенті, Сегед университеті, Дугонич 13, Сегед, Венгрия.

Қадылбеков М.Қ. **–** Магистр, ГАЖ және кадастр кафедрасының аға оқытушысы, С.Сейфуллин атындағы Қазақ агротехникалық университеті, Жеңіс даңғылы, 62, Нұр-Сұлтан, Қазақстан.

Шматов Б.Б. **–** Геодезия және картография ғылымдарының бакалавры, ГАЖ технологиялар орталығының инженері, С.Сейфуллин атындағы Қазақ агротехникалық университеті, Жеңіс даңғылы, 62, Нұр-Сұлтан, Қазақстан.

Райев Е.Б. **–** Бакалавр, ГАЖ технологиялар орталығының инженері, С.Сейфуллин атындағы Қазақ агротехникалық университеті, Жеңіс даңғылы, 62, Нұр-Сұлтан, Қазақстан.