BULLETIN OF NATIONAL ACADEMY OF SCIENCES
OF THE REPUBLIC OF KAZAKHSTAN
ISSN 1991-3494
Volume 6, Number 376 (2018), 179 – 187 https://doi.org/10.32014/2018.2518-1467.43

UDC 528.88

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ASSESSMENT OF THE AGRICULTURAL VEGETATION DYNAMICS OF THE KARASAI DISTRICT (ALMATY REGION) BASED ON MULTISPECTRAL IMAGES

Abstract. The article contains the results of research and development, which can be considered as a solution to the scientific problem concerning the selection and development of methods of decoding the occurring at different times series of multispectral images for monitoring and evaluation of the dynamics of agricultural plants of Karasai district of Almaty region.

The methods of pretreatment of multispectral imagery of medium spatial resolution (LANDSAT-7,8) based on structural and spatial model allows to more efficiently decrypt the agricultural plants of Karasai district of Almaty region in comparison with the classification of the original zonal images. The reliability of decryption by using the structural and spatial model is increased by an average of 16%. Experiments on classification of agricultural plants of Karasai district of Almaty region according to multispectral imagery by means of structural and spatial models have shown the ability of decrypting alpine forests, mixed forests, bushes that are in the rivers basin and forest covers, cultural lands of gardeners, agricultural lands especially rain-fed and irrigated lands with a sufficient reliability level. The obtained results of decrypting the agricultural plants according to the occurring at different times multispectral images LANDSAT-7, 8 provide an ability to create and update maps of vegetation, scale 1: 100 000, and also create the maps of vegetation dynamics, scale 1: 100 000.

Spectral analysis of agricultural plants of Karasai district of Almaty region showed that the most informative areas of agricultural land especially the rain fed and irrigated land are green and middle infrared band.

Keywords: LANDSAT-7, 8, vegetation classification, multispectral images.

Introduction. Remote sensing means to obtain information about the state of the Earth's surface measured at a distance, without a direct contact with the sensor surface, the characteristics of electromagnetic radiation.

Since the early 70-ies of our century, remote sensing of the Earth was rapidly developing as a multidisciplinary field of research in science and practice. Based more than on half a century experience in aerial photography and thematic use of its results (the classical methods of remote sensing), it is used today in geography, forestry, agriculture, oceanology and oceanography, while planning the construction area [1-3].

Since 1980 in Kazakhstan, the remote sensing first was used for topographic and special maps using satellite images obtained by satellites of the USSR and foreign satellites of France, the United States. Aerospace methods are used to monitor vegetation cover since 2000.Over the past decade, a large volume of work was carried out in the field of remote sensing of vegetation, including forest health assessment, determining the area of agricultural land, the creation and updating of topographic maps of different scales [4-6].

It is known that human activities are accompanied by negative processes like soil erosion, disturbance of agricultural land, pollution of surface water, etc.This usually leads to serious local and global environmental changes that need to be analyzed and evaluated, and it is necessary to predict their development with the purpose of comprehensive study of the target earth's surface, and increase of efficiency of using its natural resources.Aerospace methods make it possible to solve the issues of assessing the dynamics of the earth's surface, including the dynamics of vegetation [7, 8].

Plants, including agricultural land, are the main type of agricultural resources of Kazakhstan and play an important role in the economy.But with the increasing versatile anthropogenic influence, agricultural lands in Kazakhstan strongly change.These changes are displayed on satellite images, respectively, the relevant one is the development of new ones and adaptation of existing methods, which would allow to carry out regular monitoring of vegetation, assess and map its dynamics in order to take action for the conservation and restoration of natural ecosystems.Analysis of the contemporary state of the problem showed that space multispectral imagery have significant potential for the use in vegetation monitoring.Currently, vast amounts of space-based information, which is updated with the new of a period of several days are accumulated, at the same time in Kazakhstan there is a need in the methods of decoding satellite images, adapted to the peculiarities of its geographical area, especially for vegetation monitoring. In the article the questions of the development of new methods ensuring the monitoring of agricultural vegetation of Karasai districtof Almaty regionaccording to the data of multispectral imagery for assessing its condition and dynamics [9, 10].

The relevance of the article topic is, thus, conditioned by the unresolved problems of information support for monitoring of agricultural vegetation of Karasai districtof Almaty regionaccording to the data of multispectral imagery.

The goal of the study is to solve the urgent problems of adaptation and development of modern methods of decoding agricultural vegetation of Karasai districtof Almaty region, in order to assess its dynamics of the occurring at different times space multispectral images.

To achieve this goal it was necessary to solve the following objectives:

– to conduct the data collection and data pre-processing of multispectral imagery in representative areas of Karasai districtof Almaty region;

– to explore and compare the performance of agricultural vegetation decoding of Karasai districtof Almaty regionby single-level controlled classification and modern methods of multi-level classification based on structural and spatial model of the source images;

– to investigate the possibility of developing a new index images for decoding kinds of agricultural vegetation of Karasai districtof Almaty region.

Materials for the research were the occurring at different time space multispectral imagery from the satellite LANDSAT 7 and 8, topographic and thematic maps (geographicmaps and vegetation maps).

The subject of the research article is the development of state estimation techniques and dynamics of agricultural vegetation on a series of multi multispectral images.

Study area. The study area is the territory of Karasai districtof Almaty region (figure 1), which has an area of2.1 thousand km^2 [11]. Suitable for agricultural use area of which is 512.3 thousand hectares, including 49.3 thousand hectares set aside for arable land, 22.1 thousand hectares of pasture and 1.4 thousand hectares of grassland, 13.2 thousand hectares of forests.

South and south - eastern part of the area are occupied by the mountain range (the highlands of the Ili Alatau mountain), the middle part is a very complex watershed plains and the lower part - a piedmont - piedmont plain with a general slope to the north.The highest point of the district is located on the source of the river Aksay, starting with the peak Aydatau having 4029 m, which is covered with ice and snow.The peak is located near the border with Kyrgyzstan.In the western part of the Ili Alatau mountainthere is a series of mountains and passes (Ushkonyr, Tikka, Kebezhe, Aygaytas, Kokozek, Koktobe, Kumbel, Kaskelen and others.), which exceed the 3000 meter mark. Densely populated and mastered density of the district is located within the 800-1100m height above sea level [12].

Materials and Methods. With regard to the tasks of mapping of vegetation cover of geographic information systems (GIS) a hardware and software systems are used, the basis of them are digital maps with attached to them databases.It consists of 2 large blocks: electronic map database and supporting the functioning of GIS tools.

Figure 1 – Karasai district of Almaty region

The last one is divided into hardware (computers, local area networks, monitors, printers, plotters, scanners, GPS-systems, etc.), software (a program for the construction of a GIS-. MapInfo, ArcView, ArcInfo, Ergas Imaging, etc.) and human ones (operators that create and maintain GIS).

Application of GIS for agroecological land evaluation allows you to transfer to a new qualitative basis for a solution to this complex problem, particularly when designing intensive farming systems and agricultural technologies, without mentioning the high agro-technologies and adaptive-landscape systems of agriculture of high accuracy.Creating land valuation basis for precision farming systems is virtually impossible without the GIS technology. Its most important advantages are as follows:

– ease of processing the large amounts of information. (GIS provides ample opportunities for the combination, sorting, sample data, easy to calculate the area and outlines the parameters);

– greater clarity of presentation of information achieved by providing a large number of thematic maps;

– possibility of automation of maps creating process;

– ease of making changes, the ability to create systems of automatic changes to the database;

– possibility of widespread use of information coming from the means of remote sensing (air and space);

– high precision maps, especially when using global positioning systems (GPS);

– possibility of creating interactive reference and advisory systems;

– convenience of storage, copying, reproduction of the information in any medium, the higher reliability of information storage.

The use of GIS technology in the preparation of the landscape map is primarily due to the digitization of cartographic material.Some multiple sampling methods are used, depending on your hardware, software and staff development.The common position is scanning the topographic base and assigning the coordinates to receive the raster imaging.The choice of the coordinate system depends on the topographic base.If there is a grid basis, the designing are carried out in the coordinate system of topographic base, while using GPS-systems the data obtained with the help of GPS-receivers are used [13, 14].

Currently, methods of remote sensing (RS) has been widely used to solve a variety of tasks, including assessing the vegetation cover condition. Remote sensing of vegetation cover allows to evaluate the dynamics of development and the state of vegetation cover, with varying degrees of generalization of the information from global research on the scale of countries, regions and continents to small areas of vegetation.

One of the modern trends of the use of remote sensing data and best information technology is precision farming, for the conduct of which the preparation of large-scale NDVI maps are realized.

But the use of remote sensing data to solve practical problems of agrolandscape is still only in the initial phase of its commercial use.This is connected primarily to the relatively high cost of remote sensing data and some technical character limitations.Because of this, for our work, we used the free satellite imagery from http://glovis.usgs.gov/ site, representing the United States Geological Survey archives (Eng. United States Geological Survey, the USGS abbreviated) (figure 2).

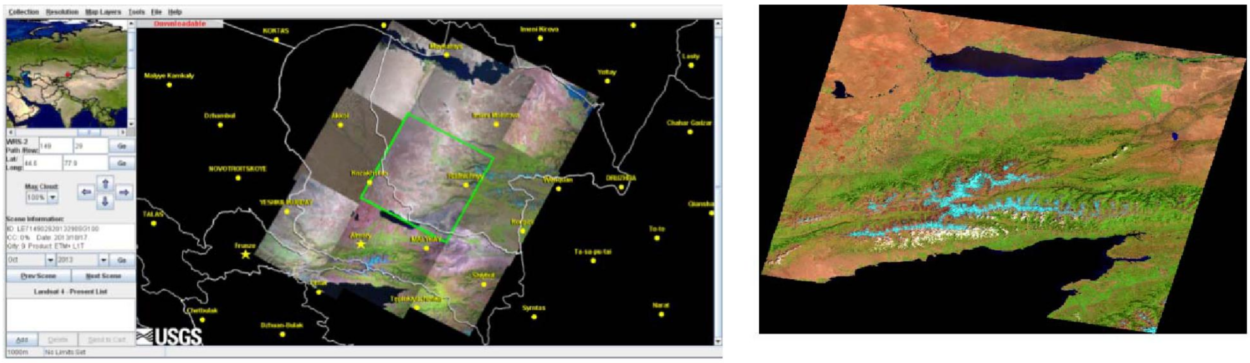

Figure 2 – Search with satellite imagery Glovis directory

In conducting research the images from the spacecraft, Landsat-7 and 8 are used.Viewed image was acquired in September 1999 and 2015 on the territory of Karasai district of Almaty region. This work shows a portion of a single image from a series of images from the spacecraft Landsat-7 and 8, where algorithms NDVI with learningwere used.

All processes related to the processing of satellite imagery we are doing in the software package ArcGIS 10.1. The ArcGIS software package, available from the ESRI American corporation, provides the most comprehensive set of features for editing, visualization and processing of remote sensing data (RS) and their integration into geographic information systems (GIS).A distinctive feature of ArcGIS software system is an open architecture and the availability of the Python programming language, with which you can significantly extend the functionality of programs for specialized tasks: automate the existing algorithms, as well as create their own data processing algorithms and perform batch processing of remote sensing data. The advantages of ArcGIS includes an intuitive ArcToolbox, allowing novice users to quickly learn all the necessary data processing algorithms.Logic drop-down menus make it easy to find a function that is needed in the analysis or data processing [15].

Regardless of the task standing before the researcher, the image processing includes the following processing steps:

– Selection and preparation of images (figure 2);
– channel bonding (figure 3);
– Cut the study area (figure 4);
– classification of NDVI (figure 5);
– processing and interpretation of results (figure 6, 7).

Initially, the images received from the satellite, require calibration, geometric correction, and brightness distortion hardware and coordinate referencing.This process is now well developed. Our task here is to determine the scale levels and spectral bands.Obviously, with all the choice of variety, there are objective limitations, such as the technical capabilities of existing imaging systems, the properties of the objects themselves and transmitting environment, weather conditions, and also features the work of organizations that prepare the image.

In our case, we must first unite the downloaded multichannel data into a single file. And it gives us some advantages:

– Data are more convenient to be managed (copied, moved, etc.);
– Data can be visualized in full color (RGB), selecting the desired combination - a combination of channels;

– Analysis of the data also can be done on several channels, rather than for each one separately (eg classification, index calculations, etc.).

To start we upload the individual zones and combine with the commands add data → Open → ArcToolbox → Data Management Tools → Raster→ Raster Processing → Composite Bands (figure 3):

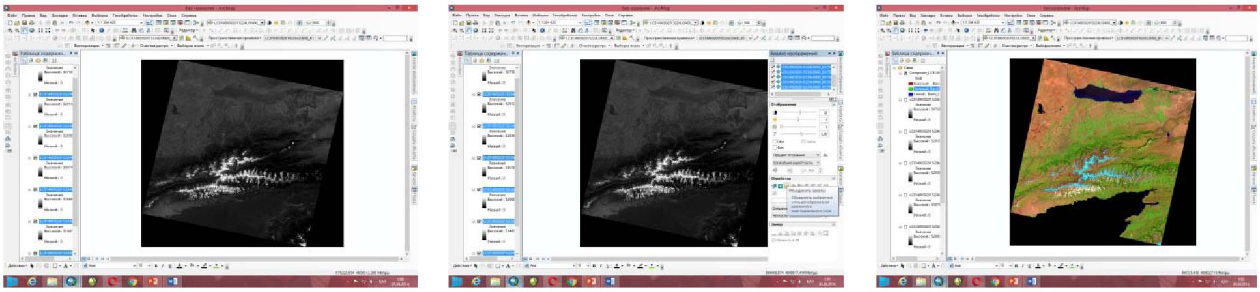

Figure 3 – Add the data and their union

Next, we extract their territory of the images using the command ArcToolbox → the Spatial Analyst Tools → Extraction → Extract byMask (figure 4):

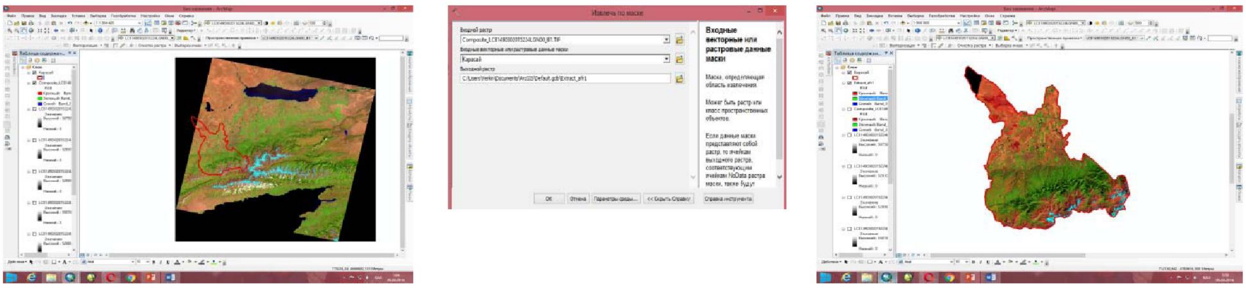

Figure 4 – Remove the territory on the border

After that, we will prepare an image for the classification of NDVI.To do this in ArcGIS-lo, we go into the Analysis of the image and open the Image Analysis Options.There we make setting on the Red channel, select Channel 7, and in select Infrared Channel 4, the check mark is put on the output of scientific data.Next we choose the cut satellite images and click on the NDVI symbol.After that, the result comes out in black and white using Image property → Symbols → The choice of colors (figure 5):

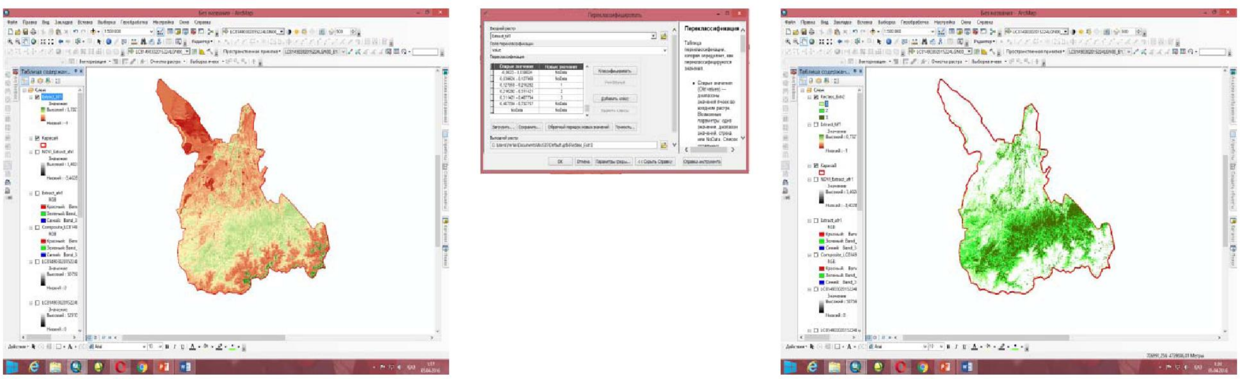

Figure 5 – Classification methods of NDVI

Results and discussion. Development of computer spatial data analysis technologies has resulted in the current use as object classification of grid cells (matrix), regularly covering the entire territory.Each cell of the grid has a certain linear size and geographic coordinates.In accordance with the terminology of K.V. Zworykin [16] the cell may be referred to regional carriers of information. However, in order to emphasize the indivisibility of this unit, we will use the term - elementary territorial unit [17]. Selecting areas on the genetic basis of (mono-, parageneses) begins with the definition of objects and the factors influencing them.As there is no coordination and subordination between the various factors, the grouping can be performed on several grounds, regardless.Integrated physical and geographical studies include three stages: preparation, field and desktop.Due to the increasing technical equipment of expeditions and the constant improvement of methods of analysis and fieldwork ratio of durations of the three of stages recent times changes to the side of increasing time spent in pre field and desktop.Their average ratio can be determined as 2:1:3, whereas previously the ratio was 1:1:2 [18].

Final NDVI map, showing the genesis of morphological characteristics and vegetation patterns, will be a synthesis of pre-NDVI maps and content information collected in the field.

On the basis of the classification criteria of NDVI and signs of their isolation, the proposed by V.A. Nikolayev [19], each type was differentiated on the vegetation.To implement this separation as classification signs VI Kiryushin [20] proposes to use the level of sub-types of soils and sub-plant formations, which are the major functional components of NDVI systems.Therefore, adhering to these principles, we have the outline of each vegetation have been clarified in the study region.They are described in detail and shown in the "Map NDVI of Karasai districtof Almaty regionof the RK» scale 1: 100 000.The total number of plant cover is divided into 3 classes.As a result, it is shown in comparative tests in 1999 and 2015.2015 was more favorable for agricultural land. By comparing in 1999 agricultural landscapes-developed a little, it is shown in figure 6.

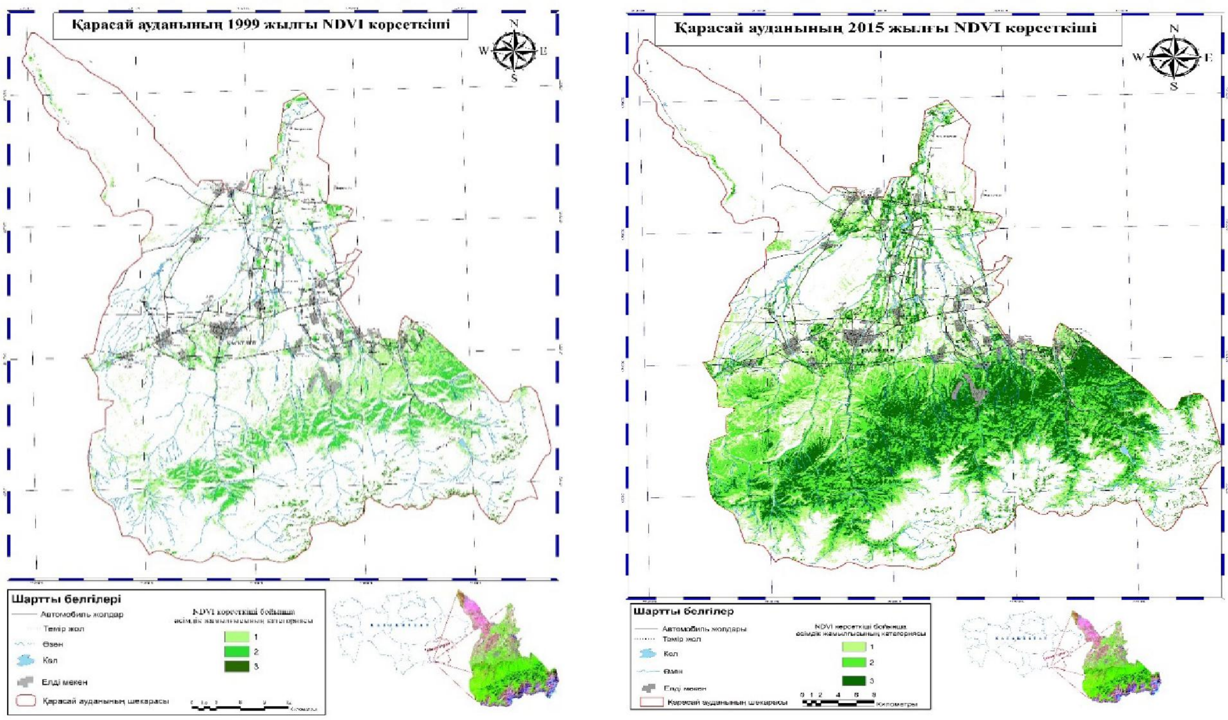

Figure 6 – Map fairness of NDVI 1999 and 2015 Karasai district of Almaty region

The results of the development of agricultural land in 1999, the total area was 8399 hectares. Of these, 5005 ha of rainfed land, 3394 hectares of irrigated land.

The results of development of 2015, performance doubles. The total area was 1986 hectares (figure 7). Of these, 9922 ha are rainfed land, 9064 hectares irrigated land.

Conclusion. Collection and data pre-processing of multispectral imagery of representative areas of Karasai districtof Almaty region were performed. For processing the data Landsat satellite image and software maintenance ArcGIS 10.1 was selected; A comparative and data analysis on efficiency of decoding agricultural vegetation of Karasai districtof Almaty regionby single-level controlled classification and modern methods of multi-level classification based on structural and spatial model of the source images were carried out. Analysis of these studies were realized according to our order system. First we

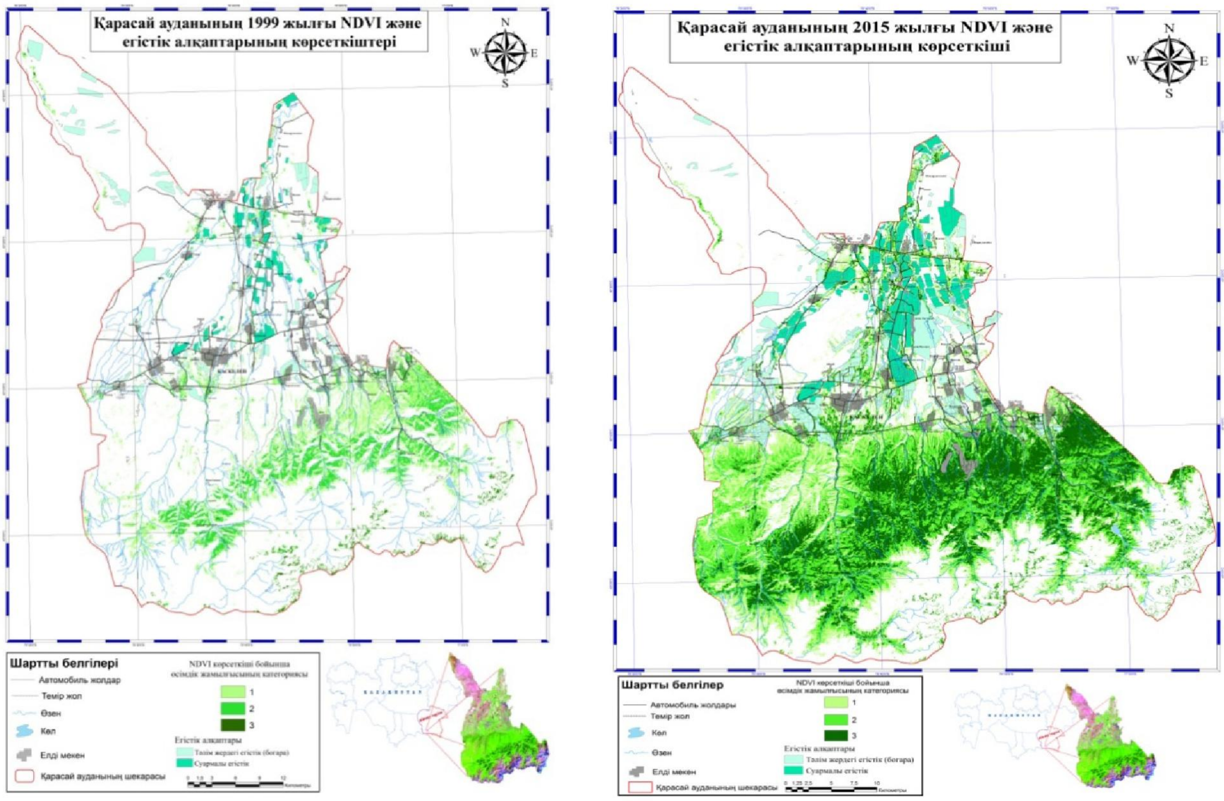

Figure 7 – Map fairness of NDVI and Plot of agricultural land in 1999 and 2015 Karasai district of Almaty region

conducted channel bonding and comparison for decrypting the desired channels. Then, classifications NDVIwere made. Thereafter, a determination of the dynamics of change, which correspond to the contours of plant formations was done. As a result, "Demonstration map of NDVI in 1999 and 2015 of Karasai districtof Almaty region" in the scale of 1: 100,000was compiled; On the basis of the above card stock materials using GIS technology ArcGIS made electronic versions of "Demonstration map NDVI and agricultural land of 1999 and 2015 in Karasai district of Almaty region" in the scale of 1: 100,000 were compiled. This job also required a system and order. First of all, analyzed maps (each separately) were digitized through a geographic information system to specifically determine the extent of the contour in differentiated subtypes of agricultural landscapes. Thus, through vegetation the types of agricultural landwere determined. In conclusion, - In the end, using GIS technology, the electronic version of the comprehensive maps of agricultural land have been obtained.

The study of agricultural land, consisting of rainfed and irrigated lands has shown that its comparison of 1999 to 2015 doubled the agricultural landscapes.

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ҚАРАСАЙ АУДАНЫНЫҢ (АЛМАТЫ ОБЛЫСЫ) АУЫЛ ШАРУАШЫЛЫҚ ӨСІМДІКТЕРІНІҢ ДИНАМИКАСЫН МУЛЬТИСПЕКТРАЛЬДІ БЕЙНЕЛЕР НЕГІЗІНДЕ БАҒАЛАУ

Аннотация. МақаладаАлматы облысының Қарасай ауданындағы ауылшаруашылық өсімдіктерінің динамикасын бақылау және бағалау үшін әртүрлі уақыттық серияларда пайда болатын мультиспектральді бейнелерді шешуге арналған әдістерді таңдау және өңдеу бойынша ғылыми проблеманы шешудегі зерттеу менөңдеу нәтижелері келтірілген.

Құрылымдық және кеңістіктік модельдер негізінде орта кеңістіктік ажыратымдылықтың (LANDSAT-7,8) мультиспектральді бейнелерін алдын-ала өңдеу әдістері Алматы облысының Қарасай ауданындағы ауыл шаруашылық өсімдіктерін бастапқы зоналық бейнелерді жіктеуге қарағанда тиімдірек шешуге мүмкіндік береді. Дешифрлеу сенімділігі құрылымдық және кеңістіктік модельді пайдалану арқылы орта есеппен 16%-ға артады. Құрылымдық және кеңістіктік модельдердіпайдалана отырып, Алматы облысының Қарасай ауданындағы ауылшаруашылық өсімдіктерінің жіктелуі бойынша эксперименттер альпі ормандарын, аралас ормандарды, өзен бассейндерінде және орман екпелерінде, көгалданған жерлерді, ауылшаруашылық жерлерін, әсіресе, қолдан суарылмайтын және суарылатын жерлерде дешифрлеу деңгейі жеткілікті сенімді. Ауыл шаруашылық өсімдіктерін дешифрлеуден алынған нәтижелері LANDSAT-7, 8 мультиспектральді бейнелердің әр түрлі кезеңдерінде болуына сәйкес 1:100,000 масштабтағы өсімдіктер карталарын жасауға және жаңартуға, сондай-ақ 1:100,000 масштабта өсімдіктердің динамикасының картасын жасауға мүмкіндік береді.

Алматы облысының Қарасай ауданындағы ауыл шаруашылық өсімдіктерінің спектралды талдауы бойынша ауылшаруашылық жерлерінің, әсіресе, қолдан суарылмайтынжәне суарылатын жерлердің ең ақпараттандырылған аудандары жасыл және орташа инфрақызыл болып табылады.

Түйін сөздер: LANDSAT-7, 8, өсімдіктердің жіктелуі, мультиспектральді түсірілімдер.

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ОЦЕНКА ДИНАМИКИ СЕЛЬСКОХОЗЯЙСТВЕННОЙ РАСТИТЕЛЬНОСТИ КАРАСАЙСКОГО РАЙОНА (АЛМАТИНСКАЯ ОБЛАСТЬ) НА ОСНОВЕ МУЛЬТИСПЕКТРАЛЬНЫХ ИЗОБРАЖЕНИЙ

Аннотация. В статье представлены результаты исследований и разработок, которые рассматриваюся как решение научной проблемы, касающейся выбора и разработки методов дешифрирование происходящих в разных временных рядах мультиспектральных изображений для мониторинга и оценки динамики сельскохозяйственных растений Карасайского района Алматинской области.

Методы предварительной обработки мультиспектральных изображений среднего пространственного разрешения (LANDSAT-7,8) на основе структурной и пространственной модели позволяют более эффективно расшифровывать сельскохозяйственные растения Карасайского района Алматинской области по сравнению с классификацией исходных зональных изображений. Надежность дешифрования с использованием структурной и пространственной модели увеличивается в среднем на 16%.Эксперименты по классификации сельскохозяйственных растений Карасайского района Алматинской области по мультиспектральным изображениям с помощью структурных и пространственных моделей показали способность расшифровывать альпийские леса, смешанные леса, кусты, находящиеся в бассейнах рек и лесных насаждениях, культурные земли садоводов, сельскохозяйственные угодья, особенно богарные и орошаемые земли с достаточным уровнем надежности. Полученные результаты дешифрирования сельскохозяйственных растений в соответствии с наличием в разное время мультиспектральных изображений LANDSAT-7, 8 обеспечивают возможность создания и обновления карт растительности масштаба 1: 100 000, а также создание карты динамики растительности в масштабе 1 : 100 000.

Спектральный анализ сельскохозяйственных растений Карасайского района Алматинской области показал, что наиболее информативными областями сельскохозяйственных угодий, особенно богарными и орошаемыми землями, являются зеленый и средний инфракрасный диапазон.

Ключевые слова: LANDSAT-7, 8, классификация растительности, мультиспектральные изображения.

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