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S. Turguldinova[1], Ye. Oryngozhin[2], M. Alimbay[*3], N. Miletenko[4], U. Ramazanova[5], A. Kuandykova[6]

[1] PhD student (Kazakh National Agrarian Research University, Almaty, Kazakhstan; *turguldinova@list.ru*)
[2] Doctor of Technical Sciences, Professor (Al-Farabi Kazakh National University, Institute of Mining named after D.A. Kunaeva, Almaty, Kazakhstan; *e24.01@mail.ru*)
[3] *PhD student (Al-Farabi Kazakh National University, Almaty, Kazakhstan; ***mederkul95@mail.ru***),
[4] Candidate of Engineering Sciences, Senior Researcher (Academician Melnikov Institute of Comprehensive Exploitation of Mineral Resources - IPKON, Russian Academy of Sciences, Moscow, Russia; *nmilet@mail.ru*)
[5] PhD student (Al-Farabi Kazakh National University Almaty, Kazakhstan; *ramazanova.ud@gmail.com*)
[6] PhD student (Al-Farabi Kazakh National University, Almaty, Kazakhstan; *arailymemes@gmail.com*)

MAPPING OF IRRIGATED LANDS IN AGRICULTURE USING GEOINFORMATION SYSTEMS

Abstract. The scientific article presents the basic information for the development of research using geographic information systems for mapping irrigated lands in agriculture. In the modern world it is impossible to do without the use of information systems technologies, as well as provisions of ecological reliability and environmental protection. In the CIS countries, including Russia, for the first time, the meanings of creating geoinformation systems (GIS) for individuals and legal entities were proposed to urgently create Internet networks and other GIS technologies. These geoinformation processes are based on scientific advances and initiatives to substantiate software technologies based on geoinformation systems. In our country, Kazakhstan, our vast lands stretch 1,600 km from north to south and 3,000 km from east to west, covering a large area. Therefore, the use of geographic information systems is extremely necessary. Among them are areas suitable for grazing livestock in agriculture and farms producing products on irrigated fields in the region. The soils of settlements along the Syrdarya River are suitable for growing rice. Therefore, conducting research using geographic information systems to map irrigated agricultural lands in Kazakhstan is an urgent task.

Keywords: agriculture, irrigated lands, mapping, geographic information system, research.

Introduction. If we consider Kazakhstan, our country is a large country in area, it ranks 9th in the world. The territory of Ulaanbaatak occupies a large space, stretching for 1,600 km from north to south and 3,000 km from east to west. The area is mainly suitable for grazing cattle. There are also farms in this area that produce on irrigated fields. The barren soils along the rivers are suitable for planting rice. Since the soil fertility in the region is generally low, irrigation requires the use of nitrogen, phosphorus and organic fertilizers. According to use and suitability, it is divided into the following types [1, 2]:

arable land,
irrigated fields,
fallow lands,
perennial woody plants,
meadows,

pastures,
garden and subsidiary plots.

It is obvious that GIS should be used for mapping irrigated areas of all agricultural territories.

A geographic information system (GIS) is not only a center for processing all databases, but also a basis for synthesizing all necessary data and information, combining them into a single system, and a key element in making strategic decisions in all industries and sectors of the economy.

Analysis of world experience shows that GIS plays an important role in assessing natural resources, creating infrastructure, improving the environment and effectively managing the ecosystem as a whole. The development of GIS technologies allows us to improve information technologies and use them to solve many economic problems necessary for human life [3-15].

GIS technology consists of three main parts - the applied technological basis of geographic information systems, the management of existing data by creating information systems, and the general management of GIS technologies by integrating various information into the database, as well as supporting cross- and multidimensional analyses.

Geographic information systems in the Republic of Kazakhstan have developed very well over the past ten years. GIS capabilities have been implemented to some extent in pilot projects of various ministries, departments and agencies, but mainly at the local level. There were no concepts for creating such systems. All this led to fruitless marking time. In general, the full implementation of GIS as one of the powerful analytical tools for supporting the development of the state economy was at an early stage [15-21]. The use of geographic information systems for mapping irrigated areas in agriculture is very convenient and reliable for obtaining complete information.

Materials and Methods. In the modern developed world, there is no activity that does not use information sources or does not use the concept of information. Without information technology, science in all areas is the main tool for development. There are currently many technologies that transform and improve GIS in all countries. Today, thanks to the use of modern measuring systems and modern technologies, the study of agricultural lands is undergoing significant changes. In this area, the use of GIS technologies for collecting and processing remote sensing data of large agricultural areas comes to the forefront and becomes an urgent task. Actively using products with GIS technologies in the study of agricultural lands, is the field of geospatial digital engineering. It is in this area that the need arises for design, safe use and solving land use issues using digital maps created in a single coordinate system. At present, scientists from modern developed countries have begun to pay attention to the creation of virtual maps. There are also a number of foreign software packages in this area, with the help of which, adapting to the daily changing economic situation, the system of creating realistic maps and field plans on the Internet is becoming increasingly widespread.

In recent decades, there has been a shortage of water resources at the global and regional levels, so it is necessary to manage using modern technologies. One of the effective tools for assessing and monitoring water resources is which allows you to study spectral and temporal variations for a more accurate assessment of the necessary information.

Microwave remote sensing data allowed us to estimate soil moisture. Groundwater is one of the most valuable natural resources, supporting human health, ecological diversity, and economic development. Overexploitation of this vital resource threatens our ecosystems and the lives of future generations. The application of GIS technology in groundwater hydrology is important for better understanding of geographic space and spatial information such as water sources, catchments, landforms, land use, soil cover, precipitation, temperature, humidity, soil condition and composition, geology, atmospheric conditions, human activities, environmental data, etc. It also describes the challenges and importance of groundwater and freshwater management. The integration of GIS methods allowed for the assessment of aquatic vegetation growth, salt marsh quality and floodplain degradation over time, as well as for the detailed study of source materials and the creation of a database [17, 18].

Data preparation and preprocessing: The first step in time series analysis is to import the data of interest and plot it on a map of the region of interest. We started by loading the Landsat 8 dataset and plotting the points in the region of interest. Additionally, a time field was created. The MaskL8sr function is a cloud camouflage function that uses Landsat 8 quality bands to mask any pixels that are hidden, obscured, or overloaded by clouds. This is a Landsat 8 satellite function. In fact, other platforms required different settings to use this function.

Click the Export button next to the chart to see an interactive view of it. You can also rotate some of the data points to see the relationships between them. A line connecting two points at a 45-degree angle indicates that they are consecutive data points (note that there are relatively few consecutive points). We also see relatively large spikes in the data, with an increase between late March and April and a drop at the end of August. The data varies slightly from year to year, but it can be assumed that this is due to seasonal rains in the spring and the wilting of leaves in the fall.

The linear regression function (Gearbox) can be used to perform many interesting time series analyses. To estimate linear trends over time, I consider the following linear model, where $€_t$ is the random error:

$$y = \beta\ 0 + \beta\ 1X\ 1 + \ldots + \beta_n X_n + €_t\ .$$

We use this model to explain the upward or downward trend in the data by subtracting the observed values from the corresponding model values to determine the data. This trend model was fitted to the Landsat NDVI series using the ordinary least squares (OLS) method using the LinearRegression reducer.

The geographic information system is scientifically substantiated, analyzed, formed, used and applied to improve the basis of geographic information systems, and also provides programs with the necessary information for scientific, technological and industrial justification. In modern infrastructure, geographic information systems play a special role in the effective management of natural resources, the state of the environment and agriculture. The main function of GIS is called the analysis and collection of necessary data, creation of necessary databases, entering them into the systems in your computer, storing them for further use, processing all the data and transforming them for a specific presentation. GIS also allows you to re-display geoinformation based on the necessary data and creates cartographic schemes for a special industry, as well as formats and displays them in the form of tables and graphic text for convenient use at the right time. When using geographic information systems, a set of society sciences is used: digital cartography, automated control systems, planning of program works. Analyzing, we have identified and highlighted the following advantages and features of GAS [15, 16, 21-24]:

identify the necessary spatial information, compare the most appropriate measurements and data to obtain it;

be able to use the ArcGIS program and its capabilities.

ArcGIS is a GIS software suite, a developed and effective product of a modern, full-fledged GIS system. The fundamental uses of ArcGIS play a key role in strengthening GIS software, and its functions (the process of manipulating spatial data) are used in various industries and at various levels of agricultural work [15, 16, 21, 24-29].

It deals with issues of managing geographic information, its analysis and visualization in the form of geographic data sets, the structure of information about them, processes of modeling the geographic environment, as well as economics. Therefore, when creating a GIS program, it is envisaged to use modern equipment for collecting geographic data [15, 16, 21, 29-34]:

1. Geoinformation databases, farm databases, formation of their sets and presentation of the obtained information in a GIS program in the form of a common text model, including vector objects, rasters, topology, grids, etc.

2. Geovisualization is the creation of smart maps and other types of sets that model the relationships between spatial objects and objects on the Earth's surface. In addition, it is possible to create various maps, analyze the information on them, and create a "database window".

3. Geoprocessing is a set of tools for obtaining new geographic information from data using GIS, as well as a program that collects spatial data processing functions (geoprocessing) and stores the obtained results in a newly created information set by applying analytical functions to them [15- 16, 21, 25-26].

Results. The direction of development of GIS technologies in land management science, including the use of GIS systems for mapping irrigated lands in agriculture and thematic mapping using various data to identify its geographical features, is very relevant and enhances the use of modern GIS for the formation of thematic maps.

GIS applications in agriculture include monitoring of canopy biomass and vigor, drought stress, assessment of crop phenological development, cropland assessment and cropland mapping, mapping of disturbances and land use changes, and precision agriculture and irrigation management. The GIS-based mapping application helps to locate crops grown across the country and adjust various variables, monitor

the health of individual crops, estimate the yield in a particular field and maximize crop production. Using data collected through a variety of land-use tools, including mobile devices that can identify areas of food shortages and root causes of food insecurity, GIS plays a critical role in efforts to combat global hunger and is an integral part of automated field operations. Using data from sensors mounted on agricultural machinery can help make informed decisions when planning crops to increase productivity. Yields, topography, organic matter, moisture, and nutrient levels in the soil can help prepare for farming. Using GPS monitoring devices, it is possible to accurately measure crop yields, plant water content, and chlorophyll levels directly in the field. Geospatial technologies are essential for monitoring crop growth, identifying and managing various stresses, assessing crop yields, conserving natural resources, and increasing agricultural productivity. GIS plays a key role in identifying areas where crops and cropping patterns are changing and is a useful tool for crop research and mapping. Reliable and timely information on crop types, areas, and expected yields is essential for agriculture. Spectral information includes 9 aspects for crop modeling, which reflect the state and growth phases of plants. Crop maps are created by combining satellite images, geodetic survey data and providing useful data on the location of land plots for agribusiness, such as fertilizer companies. GIS can play an important role in scientific inventory of databases of various agricultural crops. Several studies have been reported using aerial photographs and digital image processing techniques. This helps to reduce the amount of field data collection and ensures high accuracy of estimation [2-16].

The history of GIS development shows that in previous periods, from the 1950-s to the 1970-s, significant advances were made in computing technology, i.e., in the development of GIS. At that time, electronic calculators, graph plotters, graphic displays, and various peripheral devices began to be used. During these years, during the development of GIS in the USA and Sweden, scientific research was carried out in the field of geography and spatial data, and numerical methods in the field of geoinformation analysis were proposed and developed at the forefront. Preparation of geoinformation for planned land management works of various scales was carried out using special scanning devices. In this direction, Canadian geoinformatics scientists began to offer new technologies based on GIS:

Automation of work with information in GIS programs, scanning of received graphic materials;

Thematic processing of information, division of data files by location of objects into thematic information files by common objects;

Performance of various cartometric operations, including calculation of areas of land plots.

The second stage of development - in the 1970-1980-s, GIS programs began to focus on the work of public administration systems and began to improve. The US Census Bureau was the first in the world to start working with GIS technology systems, that is, GIS began to develop in public administration. Then the topology and its significance were covered, the relationship of linear objects in mapping, the adjacency and intersection of objects, as well as their overlap and border with territorial objects were shown. In addition, these maps show node numbers and land parcel identifiers. A numbering and coding scheme for streets and squares was also presented. At these stages, most importantly, the effectiveness and relevance of the digitalization program was proven.

The 1980s and 1990s were the third period of rapid development. During this period, commercialization and market development became widespread. Various commercial programs were created and became available. Это развитие расширило сферу применения ГИС благодаря интеграции с геопространственными базами данных. The use of GIS expanded due to the development and integration of geospatial databases. They proposed design and engineering work using GIS in the direction of "nature management", identified and substantiated hardware and software, input of cartographic data, as well as requirements. In connection with this, the well-known ArcInfo program was created in these years. During these same years, the well-known ArcInfo program was created. The main advantage of the ArcInfo program is its availability and reliability for any technical operating system. ArcInfo was available for a variety of technical platforms and operating systems. ArcInfo also achieved great success in forestry applications [5, 6, 19-22].

The fourth stage of GIS development from 1990 to the present can be called modern. Competition in the sphere of using geoinformation technologies and their services has increased significantly. GIS users have a very wide choice on the market. The availability of GIS programs has increased, there is an opportunity for their modern openness, ease of use, and modification if possible [11, 22-31].

Discussion. The goal of modeling is to simulate a data set to solve a specific problem using the simplest possible model while taking into account the largest possible amount of data. The previous example was used to illustrate the concept of breaking a time series into components. Moreover, although the example includes values measured at the same scale throughout the time series, we often encounter situations where the measured value changes. Visual results can be distorted when vegetation cover changes abruptly due to atmospheric conditions (fog, soil moisture, cloudiness). It is important to understand the characteristics of both the data and the object of measurement. Building a time series model to understand cyclical changes in crops can provide useful information for understanding crop productivity, but if problems in the data are not taken into account, you may build a time series model with erroneous results. Many time series modeling tools, such as ARIMA modeling, are not directly applicable in certain settings due to unavailability of data, non-standard data collection periods, and variable intensities due to atmospheric conditions. We focused on understanding linear trends and harmonic modeling. Multi-temporal data in Earth Engine is represented as "image sets". The complexity factors discussed earlier are different from modeling time series analysis in Earth Engine. From a programming perspective, functions are created to aggregate data and reduce the time required to discover temporal relationships between elements in a set.

In Kazakhstan, the development of domestic GIS technologies reached its peak in the 1990s. In the course of their development, geographic information systems are finding ever wider application in such areas as technical and organizational processes, professional agriculture, geography, etc., as well as for information support for solving production problems. The main advantage of creating GIS software was the development of graphic information. Depending on the types of information and the tasks of its processing, special programs were developed, and a block process for editing information was developed. Thus, in the course of development of domestic GIS technologies, it was invented that in any editing program it is possible to automatically make changes to those parts of the drawing that contain the edited block. This has a positive effect on a significant reduction in labor costs for updating graphic documents.

Conclusion. Cartography is a science that studies the totality of natural and social phenomena, their interrelation and location, as well as their change over time, etc., using cartographic images. Star maps, globes and relief maps, their conventional designations in economics are called cartographic models. Its main areas [15, 16, 21-34]:

1. The subject of cartography, its methodology, cartographic projections, generalizations, as well as methods of their representation, conventional signs;
2. The science and history of cartography;
3. Cartographic data, their classification and theory of scientific information;
4. Technology of designing and producing maps;
5. Methodology of using maps.

Land condition mapping, in particular mapping of irrigated lands in agriculture, is carried out on a GIS technology platform. When mapping land plots, GIS technology models are used, as well as automated forms of GIS technology in cartographic work.

There is still little information about the transformation of the information obtained through GIS technologies, in particular, about the use of geographic information systems in mapping irrigated lands in agriculture. The algorithms and procedures for developing standards currently used can take into account the specifics of GIS technologies for a particular farm or their importance for mapping irrigated lands in agriculture:

to solve structural problems of developing a computer algorithm;
be able to perform standard processing procedures automatically;
display data at different levels of detail;
minimize human intervention in the process of solving specific problems.

The main tasks when using GIS technologies are: collecting data necessary for the work process, processing and updating them, storing, performing transformations, performing calculations and publishing. All of them are the main documents for consumers of GIS information.

In conclusion, several comments can be made that the presented work on the use of geographic information systems for mapping irrigated lands in agriculture is an additional contribution to the use of GIS in order to improve the level of knowledge and science in this area.

The development of modern society is impossible without GIS technologies. The use of GIS for mapping irrigated lands in agriculture is impossible without information on production, sales prices, etc. Therefore, the creation of GIS is the concentration of information in specialized GIS centers for wide and effective use by the population. Such GIS centers can be created in industry or private organizations. In addition, a GIS center can be created at the federal real estate cadastre agency, which is intended to provide individuals and legal entities with information about land plots and buildings located on them.

Therefore, it can be said that the main stage of the process of using geographic information systems for land use planning, including mapping of irrigated lands in agriculture, is the use of land use GIS. However, the role of land management does not end there. It should be considered as a system of measures, a process of implementing planned measures. Construction of roads for transition from one type of territorial organization to another, creation of perennial plantings, forest belts, placement of crop rotations, fields, working areas, regulation of boundaries, etc. is necessary, this is possible only on the basis of relevant projects. In addition, it is necessary to know the natural and economic conditions of land ownership and land use, conduct topographic and geodetic, soil and geobotanical and other studies, understand the state procedure for the reorganization of the territory, develop and approve a working project, and, if necessary, conduct an examination and supervision. From this point of view, land management can be considered as a system of measures to organize the rational use and protection of land, create sustainable landscapes and map irrigated lands in agriculture.

Of all the above, land management planning, including the use of geographic information systems for mapping irrigated lands in agriculture, is a unique, extensive and important area of scientific and practical land management activity.

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С. Тургульдинова[1], Е. Орынғожин[2], М. Әлімбай[*3], Н. Милентенко[4], У. Рамазанова[5], А. Қуандыкова[6]

[1] PhD докторант (Қазақ ұлттық аграрлық зерттеу университеті, Алматы, Қазақстан; *turguldinova@list.ru*)
[2] Техника ғылымдарының докторы, профессор (Әл-Фараби атындағы Қазақ ұлттық университеті, Д.А. Қонаев атындағы Кен істері институтыны, Алматы, Қазақстан; *e24.01@mail.ru*)
[3] [*]PhD докторант (Әл-Фараби атындағы Қазақ ұлттық университеті, Алматы, Қазақстан; ***nmilet@mail.ru***)
[4] Аға ғылыми қызметкер, т.ғ.к. (Жер қойнауын кешенді игеру проблемалары институты – ИПКОН РҒА, Мәскеу, Ресей; *mederkul95@mail.ru*)
[5] PhD докторант (Әл-Фараби атындағы Қазақ ұлттық университеті, Алматы, Қазақстан; *ramazanova.ud@gmail.com*)
[6] PhD докторант (Әл-Фараби атындағы Қазақ ұлттық университеті, Алматы, Қазақстан; *arailymemes@gmail.com*)

АУЫЛ ШАРУАШЫЛЫҒЫНДАҒЫ СУАРМАЛЫ ЖЕРЛЕРДІ ГЕОАҚПАРАТТЫҚ ЖҮЙЕЛЕРДІ ПАЙДАЛАНА ОТЫРЫП КАРТАҒА ТҮСІРУ

Аннотация. Ғылыми мақалада ауыл шаруашылығындағы суармалы жерлерді картаға түсіру үшін геоақпараттық жүйелерді пайдалана отырып, зерттеулерді дамытудың негізгі мағлұматтары берілген. Қазіргі қоғамның дамуы ақпараттық технологияларды қолданбай мүмкін емес, өйткені кез-келген қызмет саласында шешім қабылдау үшін адамға қоршаған ортаның жай-күйі, тауарлар мен қызметтер нарығындағы тенденциялар, экологиялық жағдай және т. б. туралы өзекті білім қажет. Осыған байланысты Ресейде Internet және Intranet желілерін құру арқылы жеке және заңды тұлғалар арасында ақпарат алмасу процестерін жетілдіруге бағытталған бірқатар маңызды құжаттар қабылданады. Бұл процестерді іске асыру геоақпараттық жүйелерге негізделген технологияларға негізделуі керек. Еліміз Қазақстанд жер көлемі тұрғысынан салыстырған жеріміз кең, көлемі дүние жүзі бойынша тоғызыншы орын алады. Ұлан-байтақ территориясы терістіктен оңтүстікке қарай 1600 км, ал шығыстан батысқа қарай 3000 км аумаққа созылып үлкен кеңістікті қамтып жатыр. Аймақ негізінен мал жаюға қолайлы саналатын аумақ. Бұл өлкеде суармалы егістіктен өнім алатын шаруашалар да бар. Өзен бойларында орналасқан тақыр түстес топырақтар күріш егуге ыңғайлы. Топырақ құнарлығы жалпы облыс аумағында аз болғандықтан, суаратын кезде азоттың фосфорлық пен органикалық тыңайтқыштарды қолдану қажеттілігі туындайды

Түйін сөздер: ауыл шаруашылығы, суармалы жерлер, картаға түсіру, геоақпараттық жүйе, зерттеулер.

С. Тургульдинова[1], Е. Орынгожин[2], М. Әлимбай[*3], Н. Милетенко[4], У. Рамазанова[5], А. Куандыкова[6]

[1] Докторант PhD (Казахский национальный аграрный исследовательский университет, Алматы, Казахстан; *turguldinova@list.ru*)
[2] Д.т.н., профессор (Казахский национальный университет им. аль-Фараби, Институт горного дела им. Д. А.Кунаева, Алматы, Казахстан; *e24.01@mail.ru*)
[3] [*] Докторант PhD (Казахский национальный университет им. аль-Фараби, Алматы, Казахстан; ***mederkul95@mail.ru***)
[4] Старший научный сотрудник, к.т.н. (Институт проблем комплексного освоения недр им. академика Мельникова – ИПКОН РАН, Москва, Россия; *nmilet@mail.ru*)
[5] Докторант PhD (Казахский национальный университет им. аль-Фараби, Алматы, Казахстан; *ramazanova.ud@gmail.com*)
[6] Докторант PhD (Казахский национальный университет им. аль-Фараби, Алматы, Казахстан; *arailymemes@gmail.com*)

КАРТИРОВАНИЕ ОРОШАЕМЫХ ЗЕМЕЛЬ В СЕЛЬСКОМ ХОЗЯЙСТВЕ С ИСПОЛЬЗОВАНИЕМ ГЕОИНФОРМАЦИОННЫХ СИСТЕМ

Аннотация. Дана основная информация для развития исследований с использованием геоинформационных систем для картографирования орошаемых земель в сельском хозяйстве. Развитие современного общества невозможно без использования информационных технологий, поскольку для принятия решений в любой сфере деятельности человеку необходима информация о состоянии окружающей среды, тенденциях рынка товаров и услуг, состоянии окружающей среды и др., нужны реальные знания. В связи с этим принят ряд важных документов, направленных на совершенствование процессов обмена информацией между физическими и юридическими лицами посредством создания сетей Интернет и Интранет в Казахстане. Реализация этих процессов должна основываться на базе геоинформационных систем. По площади Казахстан стоит на девятом месте в мире, его территория протянулась с севера на юг на 1600 км и с востока на запад – на 3000 км. Орошаемые земли используются для производства разнообразной сельхозпродукции, в том числе животноводческой. Бесплодные почвы, расположенные вдоль рек, пригодны для посадки риса. Поскольку плодородие почв в целом по региону низкое, при орошении возникает необходимость использования азотных, фосфорных и органических удобрений.

Ключевые слова: сельское хозяйство, орошаемые земли, картографирование, геоинформационная система, исследования.