# APPLICATION OF GIS TECHNOLOGIES FOR MONITORING LAND RESOURCES IN KAZAKHSTAN

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**Abstract**
Maintaining agriculture has always been a government level issue. The State is implementing a number of programs and projects, as well as increasing the amount of funding to improve the agro industrial complex and the condition of agricultural land. Kazakhstan having great land and resource potential should develop a strategy for the rational land use and protection of land. For the formation of state information resources on the state of soil fertility and the actual use of agricultural land, as well as better management of agricultural production, it is important to use modern geo information technologies. There is a need to update outdated topographic maps based on the new aero space images. The main task of this article - identify ways on creation of geographic information system for monitoring and resource accounting of agricultural land (further systems) using remotely sensed data (RSD). Application of GIS - technologies will allow to unite large volumes of cartographic and thematic information into a single system, and thereby create a single structure for the analysis of available data and information received. The designed system will increase the efficiency of tasks, simplify and speed up work on management decisions.
Key words: agricultural land, innovation, monitoring, fertility of farming lands, GIS.

## Introduction

Land is the basis of all the processes of society taking place in the political, economic, social, industrial, legal, environmental and other fields. In this regard, it has the right and is one of the most important conditions for the normal functioning and development of economy and society. Kazakhstan having colossal of land and resource potential should have a conscious approach to its use, develop a strategy for the rational use and protection of land (Seyfullin, 2000).

Given the high percentage of outdated topographic maps there is a need to updated state topographic maps based on the new aero space images. Due to the fact that filming of all the cities and villages, were carried out in 1960-1980 years there was an urgent need for a new large-scale plans of cities. Therefore, new, aerial survey has started since 2008, which was a base for renewed development plans of agricultural land, land settlements and so on.

Topographic maps of all scales created by the State agency display full information about the area and are the basis for the creation of various derivatives of the materials used in different regions of the country. Construction of the satellite geodetic network and the establishment of a unified state system of coordinates on the territory of the Republic of Kazakhstan for the widespread introduction of satellite technologies for solving problems in different sectors of the economy at present is the most actual task. Existing terrestrial surveying methods do not meet the scientific and practical requirements in accuracy, efficiency and economic benefits arising at geodesy, navigation, the study of geodynamic processes (Land administration guidelines, 1996).

In addition, existing methods cannot provide a clear transition to the coordinate system in which modern satellite navigation systems GLONASS (Global Navigation Satellite System - Russian Federation) and NAVSTAR GPS (Navigation Satellite Timing and Ranging Global Positioning System - global satellite navigation system of the United States of America) are functioning (Laboratory of Geographic Information…, 2015).

Origin of coordinates of navigation systems is provided in the center of the Earth, therefore it is necessary to take into account the difference between the coordinates of the point attached to the local geodetic network and the coordinates of the same point, attached to geodetic basis, starting at the center of the Earth. Due to the active automation and computerization, cartography became a storage and manager of huge amounts of information on the most important aspects of existence, interaction and functioning of nature and society. Computerization has penetrated into all spheres of science and practice - from high school to the public policy.

On the basis of information technologies in the earth sciences created geographic information systems (GIS) were created – a special hardware and software complexes for the collection, processing, display and distribute spatially coordinated data. One of the main functions of GIS is creation and use of computer and electronic maps, atlases and other cartographic products.

It is difficult to control large territories occupied by agricultural land, because of the lack of accurate maps, undeveloped network of operational monitoring of ground stations, including the weather, the lack of air support, since the high cost of content, etc. Moreover due to various kinds of natural processes, borders of areas under crops, soil characteristics and conditions of the vegetation are continuously changing from site to site. All these factors constitute obstacles to the objective and actual information necessary for ascertaining the current situation, its assessment and forecasting. Satellite images of agricultural territories can solve such problems (Centre for Remote Sensing…, 2015).

Typical problems in this area are:

- inventory of farming lands;
- monitoring of crops condition;
- allocation of plots with erosion;
- wetlands
- salinization desertification;
- determination of soil composition;
- tracking the quality and timeliness of various agricultural activities.

Observation of the dynamics of crop development and yield forecasting is possible with systematic satellites images shooting. For example, knowing the spectral characteristics of vegetation in the image it is possible to judge their agro technical condition. After the winter condition of winter crops can be evaluated by the difference in the color of healthy and dead plants, the state of winter and spring before harvest - based on the degree of coverage accounting with herbage and its uniformity of (Map of forage…, 2010).

The main task of this article - identify ways on creation of geographic information system for monitoring and resource accounting of agricultural land (further System) using remotely sensed data (RSD). Despite the obvious successes of the Ministry of Agriculture there are a lot of problems arising in achieving the objectives of the system at the state level, in the transition from a general analysis of the territory to the tracking information from specific regions, fields and experimental plots (Kuznetsov, 2015).

**Discussions and results**

The following principles are the basis for the System functioning:

- Annual declaration of agricultural producers area and characteristics of cultivated land with a connection to a unified digital cartographic basis and responsibility for the provision of information;
- Determination of the presence and area of arable land based on the joint RSD analysis with average (20-50m) and low (250-500m) resolution and detection of inconsistencies with the declared characteristics;
- Field checks of the results of RSD data analysis with the occurrence of the legal consequences in the case of final identification of inconsistencies;
- Conducting GIS analysis of the structure and composition of agricultural land, their legal status, tracking of changes in their legal status due to acts of regional and municipal level (transfer land to settlements, the establishment of regulations and restrictions on the use of land based on the zoning) or natural processes (desertification, wind erosion, and so forth.) on the basis of diverse RSD information;
- Maximum integration into the existing control system while minimizing the cost of establishing and operating the System (Centre for Remote Sensing…, 2015).

Modern space technologies have made an important contribution to the development of agro-industrial complex of the Republic of Kazakhstan .The use of remote sensing data for monitoring of agricultural land is particularly important for Kazakhstan, with its vast open spaces. Over the past 15 years JSC "National Center for Space Research and Technology" established a national system of space monitoring the Republic of Kazakhstan (Kuznetsov, 2015).

It consists of developed GIS technology for spatial monitoring of agricultural production in Kazakhstan. Enumeration of the tasks includes mapping of sown areas of spring crops, control the pace and scope of basic agronomic work, assessment of the state sowing and the forecast yield of grain crops (Map of forage…, 2010).

One of the problems of the forecast a yield from space is to determine the volume of weed vegetation in the green biomass of grain crops. A special technology for assessment of debris population and taking into account its impact on the future harvest was developed to evaluate this factor,. The main task of assessing the productivity of vegetation cover with the help of satellite imagery is finding a relationship between satellite data and parameters, characterizing biometric value or other characteristics of grain crops (Rachkovskaya et.al., 2003).

Agro meteorological and spectrometric measurements, assessment of the state soil and vegetation cover, characteristics of productivity elements and quality of the crop are conducted according to develop programs and instructions on the fields of economic entities during the growing season. In addition to annual stationary observations in the period of mass ear formation of cereal crops route fields survey is conducted in Kazakhstan. The parameters associated with the expected productivity (density of productive stems, the size of the ear, number of ears, their graining and so forth.) are defined during the inspection of cereal fields. Collected information is used for special calibration of satellite data and the forecast of yield of grain crops (Centre for Remote Sensing…, 2015).

In this case, curve of the dependence of spectral characteristics of the yield is built only for specially selected fields. These fields are with crops after the first pair, without weeds, planted at the optimum time. Their selection is based on the many years of spatial data monitoring of grain crops. In the following the forecast yield is corrected because of weather impact on crops early and late times of sowing, as well as reduced crop yields due to the high level of debris population. Verification of the forecast yield is held at the level of individual fields with the help of data obtained from stationary polygons (Rachkovskaya et.al., 2003).

The required information in necessary volumes can be obtained only on the basis of joint interpretation of remotely sensed data and ground-based observations and measurements. Therefore, in the future, to establish reliability, as well as possible adjustments of created maps, land-based research by basic types of pasture vegetation is planned.

The use of remotely sensed data of different spatial resolution can significantly reduce the time spent on ecological and economic assessment of damages. Application of RSD enables rapid evaluation and timely manner management activities and regulation of the land use as well. The essence of this method lies drawing the contour defined by space images with the help of visual interpretation, or automatic classification on the digital map of land. The use of satellite images made in different time will allow identifying the erosion and desertification of land monitoring the designated land use (Centre for Remote Sensing…, 2015).

**Conclusions and proposals**

Application of GIS technologies will allow uniting large volumes of cartographic and thematic information into a single system, and thereby creating a single structure for the analysis of available data and information received.

Over the past 15 years JSC "National Center for Space Research and Technology" established a national system of space monitoring of the Republic of Kazakhstan. It consists of developed GIS technology for spatial monitoring of agricultural production in Kazakhstan.

The designed system will increase the efficiency of tasks, simplify and speed up work on management decisions. GIS can be easily integrated to analyze remote sensing data and field studies. In this case, the real time scale is understood as a characteristic of the creation speed-use maps, that is the rate of that provides immediate processing of incoming information and its cartographic visualization for assessment, monitoring, management, control processes and phenomena that change at the same rate.

Satellite images observations make it possible quickly identify and pinpoint the coordinates of unexpected cases of major accident, dangerous manifestations disaster areas of natural processes that could cause to such accidents, as well as track and predict slowest unidirectional geodynamic deformation of the earth's surface.

Maps developed by using monitoring methods of satellite images and the use of land GIS technology allows visually observe a change of land state and make timely decisions on land improvement, subject to erosion and other processes of destruction of fertile layer of the earth's surface.

**References**

1. Сейфуллин Ж.Т. Земельный кадастр Казахстана. - Алматы: КазНИИЭОАПК,. 2000 г. - 225с.
2. Land administration guidelines. Economic commission for Europe, 1996. 112 p.

3. Геопрофиль - ГИСLANDИЯ: ГИС для кадастра и инвентаризации земель №2/ 2009г. http://internetgeo.ru/archive_ua
4. Map of forage lands of Republic of Kazakhstan. – M 1:1 500 000. – 2010 г.
5. Рачковская Е.И., Волкова Е.А., Храмцов В.Н. Ботаническая география Казахстана и Средней Азии (в пределах пустынной области). СП, 2003 г. 425 с.
6. Государственный земельный кадастр. Учебное пособие В. Л. Баденко, В. В. Гарманов, Г. К. Осипов. Под ред. проф. Н. В. Арефьева СПб, Изд-во СПбГПУ, 2002. 331с.
7. Кузнецов, С.Д. Основы современных баз данных Информационно-аналитические материалы Центра информационных технологий. Viewed 28 January 2015. http; // www.citforum.ru/index.html
8. Centre for Remote Sensing and GIS "Terra". Viewed 28 January 2015. http://www.gis-terra.kz/services/dz/use
9. Laboratory of geographic information systems. Viewed 28 January, 2015. http://ingeo.kz/index.php/ru/potentsial-instituta/laboratorii/geograficheskikh-informatsionnykh-sistem
10. Комитет по делам строительства и ЖКХ. http://kds.gov.kz/index.php/ru, 2015.

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