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PRINCIPLES OF DIGITALIZING MECHANISMS OF QUALITATIVE ASSESSMENT OF AGRICULTURAL LAND

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Abstract

In this article, practical recommendations on digitalization of the monitoring system for the effective use of agricultural land in the conditions of Uzbekistan have been developed. Organization of effective use of agricultural land resources today covers issues related to land, including productivity, quality assessment, quantity calculation. Compared to traditional methods, digitalization of this process is one of the tools that space exploration, especially Earth Remote Sensing and GIS technologies, has experienced well. Accordingly, the organization of Geoservice activities, specializing in the continuous monitoring of agricultural lands, was founded and its activities were developed.

Key words: land resources, agricultural land, space monitoring, salinity, index, land fund, geodata, soil quality, digitization, database, plants, vegetation index.

Introduction. In the "Concept of efficient use of land and water resources in agriculture" of the President of the Republic of Uzbekistan dated June 17, 2019," [1] is defined as a task.

The use of digital technologies in determining the condition of agricultural land by land type is one of the most effective and fast methods today. The land fund of our state includes arable land, perennial orchards (orchards, vineyards, orchards, fruit tree seedlings, orchards), hayfields, pastures, and brownfields. Agricultural lands are specially protected lands. Because the role of agricultural lands in the economy of the republic and in various sectors of the national economy is incomparable. Irrigated land is one of the most valuable types of land and is of primary importance in the development of agriculture and, at the same time, the economy of the republic. Irrigated lands are also specially protected lands.

As a result of the conducted research, the condition of agricultural land in Kashkadarya region was determined. (Table 1) According to the data of the table, there have been various changes in the area of agricultural land over the years. For example, there was an increase in the area of agricultural land in Karshi district by 2402 hectares and in Mirishkor district by 1319 hectares. The reason for this increase is the increase in agricultural land as a result of the harvests carried out according to the government's decision. Also, the reason for the increase of irrigated land is mainly due to the fact that the land has been used as arable land by farms for many years. At the same time, we can see the reduction of irrigated land in Guzor, Dehkanabad, Kitab and Mubarak districts. The reason for this is the return of irrigated arable land used in the Republic of Turkmenistan, as well as the allocation of land for public and state needs, as well as the establishment of new (intensive) orchards, vineyards, and orchards, which led to a decrease in the amount of agricultural land and irrigated land.

Today, high technologies are rapidly being introduced in agricultural production. Among other modern technologies, Earth Remote Sensing (ERS) technologies are being advanced in agricultural work. Use of satellite imagery and drones. Such data are more reliable and reflect the state of agricultural land and vegetation, which is important. Satellite images allow not only to create a visual map of the land, but also to determine their actual use, as well as to identify unused plots or zones of

Table 1

The state of agricultural lands of Kashkadarya region in different years

№	Districts	2000		2005		2010		2015		2020		The difference between 2000 and 2020	
		agricultural land	irrigated	agricultural land	irrigated	agricultural land	irrigated	agricultural land	irrigated	agricultural land	irrigated	agricultural land	irrigated
1	Guzor	260178	35393	250702	34742	250554	34918	250101	34813	250041	34784	-10137	-609
2	Dekhonobod	344648	6413	339304	2937	298638	2843	287464	2844	287428	2844	-57220	-3569
3	Kamashi	157289	33329	166968	34417	156733	34466	146834	34404	145004	34380	-12285	+1051
4	Karshi	83688	45969	85947	48048	85501	48277	84931	47945	86090	48033	+2402	+2064
5	Koson	182364	72148	183022	73540	183271	73661	182395	73347	182363	73311	-1	+1163
6	Kasbi	70889	49551	70887	50069	70878	50542	70472	50535	70455	50531	-434	+980
7	Kitob	118761	20103	118762	20076	108637	19861	106497	19844	95350	19817	-23411	-286
8	Mirishkor	304665	60435	306707	61937	306500	62377	306033	63074	305984	63069	+1319	+2634
9	Muborak	302559	34166	281888	33965	281883	34055	281495	34078	281454	34045	-21105	-121
10	Nishan	187387	52088	177686	55803	177629	57359	177325	57154	177174	57019	-10213	+4931
11	Chiroqchi	278787	29790	278877	30012	273649	30226	267387	30210	267258	30205	-11529	+415
12	Shahrisabz	104378	25214	104306	25482	104214	25540	104041	25524	85353	25491	-19025	+277
13	Yakkabog	116156	32784	116147	0,33558	113936	34278	104085	34168	103830	34149	-12326	+1365
	Total	**2511749**	**497383**	**2481203**	**471028,3**	**2412023**	**508403**	**2369060**	**507940**	**2337784**	**507678**	**-173965**	**+10295**

improper use of agricultural land. Satellite imagery can be used to monitor erosion, waterlogging, soil erosion, and other conditions. Such an analysis will help in planning agriculture at the state level. Monitoring and analysis through continuous satellite images will greatly help in qualitative assessment of crop germination and ripening, early detection of diseases. Based on the results of remote sensing data processing, it is possible to create various maps on the state of crops, as well as recommendations on the differential application of mineral and organic fertilizers. With this, it is possible to remotely monitor all the processes of agriculture, as well as the projected profitability.

The main risks in agriculture are natural disasters such as drought and pests. History knows well that such natural disasters led to terrible famines. Of course, even today we cannot compete with nature, but we can be prepared for unexpected situations and stabilize irrigation and land reclamation.

At the level of agricultural companies, there are almost no barriers to using satellite data. Today, free and freely redistributable images of 10-30 meters are available from space every week. Free images are provided by the US National Geological Survey, NASA, or the European Space Agency. In this way, the farmer can use special web services to quickly monitor the status of crops. They allow rapid monitoring of agricultural crops and are becoming more and more popular today. However, political will is needed to implement space technologies in agricultural production at the state level. Technically, we have all the available satellite data, without which it would be impossible to do an inventory of agricultural land across the country.

As a result of the development of GIS and remote sensing, continuous communication between them, the effective practice of accurate accounting of agricultural land is being put into practice. In this regard, today, special (geoservice) services are being launched in space monitoring of agricultural lands. They can be complete information systems and subsystems or separate plug-in software modules.

Structure and composition of space monitoring geoservice. Like any GIS product, space monitoring geoservices have a basic functional structure and related data content.

Information sources. Space images are the main source of information about the condition of agricultural land. In this case, depending on the tasks to be solved, two groups of requests can be distinguished:

- space photos with a spatial resolution of 5 m for field decoding;
- periodic space pictures with high range spatial resolution.

When working with geoservices, it is necessary to have a database (register) of agricultural land, which contains a set of attribute tables, each line of records corresponds to the contour of the field. Such a database (DB) is a relational database in which all data have their own spatial representation on a map. It works on the basis of a database management system (DBMS), which supports working with special data by coordinate.

The control unit of the geoservice is responsible for working with the database. It is a set of software interfaces for entering information, creating logical queries and displaying the necessary information in the form of report materials. Data entry is carried out according to established forms, in general, their content is as follows:

- agricultural passport (field number for user numbering, data on the calculated area, importance of the calculated area in geoservices, information on growing crops, state cadastral data, etc.);
- information about landlords and tenants (information about users);
- information about agricultural work (type of work: planting, melioration measures, fertilizing, productivity; working day; work results: area of cultivated fields, volume of harvest, etc.);
- agrochemical indicators (humus and various chemicals in test sites);
- data on agricultural machinery (type, model, fuel consumption, working area, etc.);
- results of field observations (field reports, photos and videos), etc.

Database Management The database provides the ability to organize search queries into individual tables. They are based on the SQL programming language, but the user is usually provided with ready-made search templates. The test criteria are based on the content of the data with the help of identified experts. The space monitoring department is responsible for the main purpose of the geoservice and performs a number of tasks:

- organization and cataloging of reception of space images;
- processing of satellite images by mathematical methods;
- calculation of indicators of the state of vegetation and soil cover;
- calculation of soil fertility zones to justify fertilizer application;
- calculation of productivity;
- display monitoring results and record them in the database.

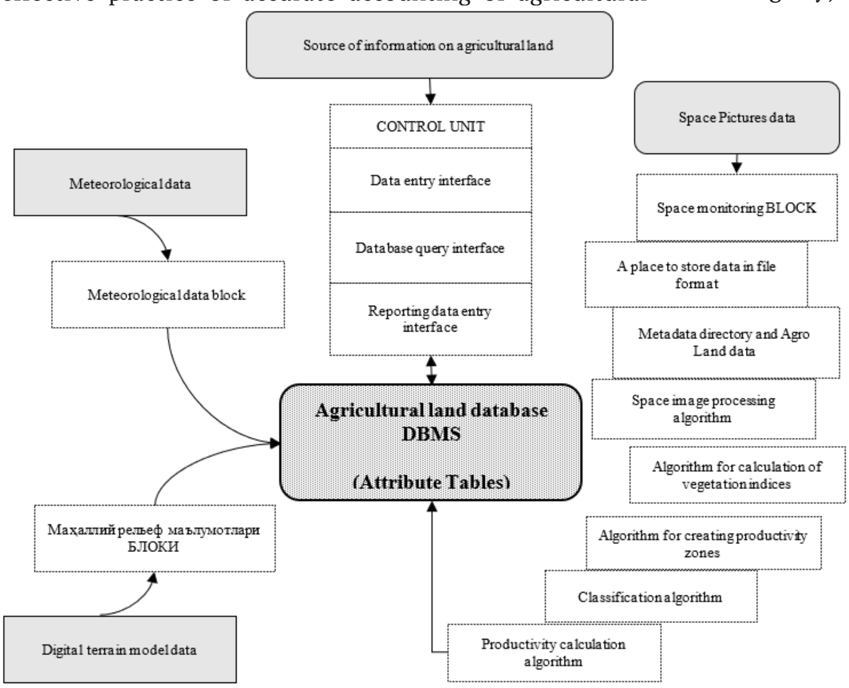

Figure 1. Functional structure of "Geoservis" for space monitoring of agricultural lands

Any satellite image is characterized by a certain set of attributes: time and date of image capture, instrument type, spatial resolution, spectral data, formats, etc. - all this is recorded in special metadata files. Classification based on the entire volume of images in approved catalogs and archives optimizes the process of analyzing them later with the help of software, and also increases the efficiency of selecting the desired image in the process of visual encryption.

Another advantage of spectral scaling is that we consider relative values rather than absolute luminance values, resulting in reduced topographical effects. Many complex coefficients have been created to estimate vegetation conditions, which include the sum and difference between the spectral ranges of different sensors. Based on the processed data, various indicators of the vegetation and soil cover of the studied agricultural land are calculated. In this case, the construction of vegetation indices takes a central place, and the most common method is to calculate the NDVI (Normalized Difference Vegetation Index) index, which reflects the ratio of two spectral zones for each pixel. It is known that the maximum absorption of solar radiation by chlorophyll lies in the red region of radiation (0.6-0.7 μm), and in the near-infrared (0.7-3.0 μm) the region of maximum reflection of the structure of leaf cells is located. Therefore, this indicator essentially describes the amount of actively growing plant biomass. In addition, there are more than 160 types of indexes.

Land cover change index. Its calculation is based on comparing the NDVI values of the current imaging period with the previous one. This is a classification of data on the type and intensity of continuous changes in photosynthesis. Its use makes it possible to identify different trends in the state of crops on agricultural land, and its main purpose is to identify damage zones caused by natural factors, as well as to monitor crop harvest.

The meteorological data unit is responsible for processing, analyzing and providing information on meteorological indicators. As a rule, in the geoservice, this information comes in the form of tables of user weather stations installed in the nearest state or directly at the agricultural enterprise. Incoming data is displayed in the form of graphs or charts of accumulated values. The availability of the necessary data on the date of the satellite photo acquisition is very important, because weather phenomena directly justify the observation results, for example, precipitation or snow, which leads to a false interpretation of the NDVI index.

The local reef information section provides information about its features in a set of maps. On the hypsometric map, the information about the absolute heights of the area is displayed in layered color, the relief forms and the direction of the water flow are clearly visible. The slope map provides a basis for the smoothness of the slopes and the intensity of the slope processes on a specified scale. The exposure map describes the area by isolation volume. Algorithms for constructing these maps are found in many modern GIS and are based on the processing of digital elevation models. However, the most common DEM today is the SRTM model created by the Endeavor spacecraft, which is used everywhere as part of space observation geoservices data.

Coefficient and indexing of image ranges is the most common operation used in remote sensing images for geological, environmental and agricultural purposes.

Standardized Index of Difference in Vegetation Cover (NDVI).

$(DN_{NIR} - DN_R) / (DN_{NIR} + DN_R)$

NDVI shows a high value (+ve) for thick vegetation, a very low value (-ve) for water, cloud, snow, and an average value (close to 0) for mountain, dry land.

The value of the NDVI index is calculated in the range from -1 to +1, and when analyzing vegetation, the index takes only positive values: the greater the green mass of vegetation at the time of measurement, the closer the NDVI value is to unity. However, the NDVI indicator is a very relative value, it does not indicate the absolute values of the biomass of green leaves. This indicator makes it possible to estimate how well or poorly the crops are developing. NDVI is completely ineffective on non-vegetative images. That's why NDVI gives a good result for the analysis based on the type of plant and its peak photosynthetic period. In our example, the process of photosynthesis of grain was studied. The most favorable time for this process is considered to be the month of May, when the photosynthesis rate of grain is the highest during this period. For cotton, the second half of June is the best time.

For the analysis, the region of Kashkadarya region was implemented in ArcGIS software. This involved downloading images of the area from 2013, 2015 and 2020 from the remote pixel.ca website.

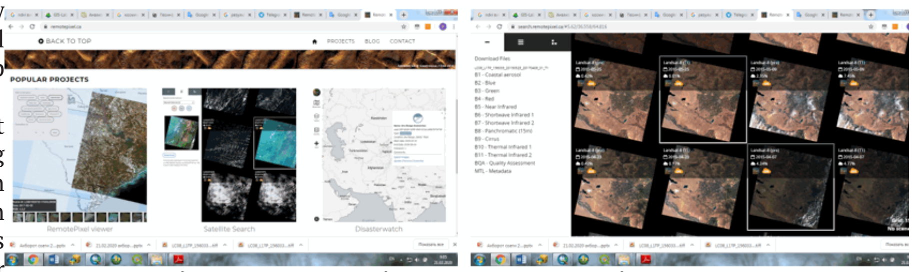

Figure 2. download space images through the remote pixel.ca geoportal

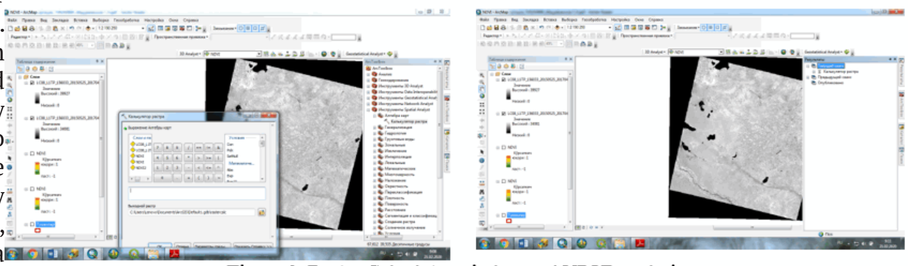

Figure 3. Raster Calculator window and NDVI analysis process

The results showed that we can see a decrease in average indices in Guzor, Karshi, Kasbi, Mirishkor, Mubarak, Nishon and Yakkabog districts. When describing the results of the indices, we can evaluate the following suggestion given by the researcher V. Sherimbetov to determine the process of soil desertification as a result of the processing of GIS and remote sensing data.

Table 2. Results of NDVI indices. Agricultural land in the territory of Kashkadarya region is considered to be almost at risk of desertification. This is certainly evidenced by the fact that scientific-based reclamation activities have

Table 2

NDVI analysis indices of irrigated agricultural lands of Kashkadarya region

№	Districts	Average NDVI indices			2020 2013 the difference +;-
		2013	2015	2020	
1	Guzor	0,44	0,48	0,43	-0,01
2	Dekhonobod	0,42	0,43	0,44	+0,02
3	Kamashi	0,43	0,48	0,43	0
4	Karshi	0,43	0,42	0,40	-0,03
5	Koson	0,43	0,43	0,41	+0,02
6	Kasbi	0,45	0,46	0,42	-0,03
7	Kitob	0,44	0,44	0,44	0
8	Mirishkor	0,48	0,47	0,43	-0,05
9	Muborak	0,41	0,42	0,40	-0,01
10	Nishan	0,43	0,42	0,39	-0,04
11	Chiroqchi	0,37	0,38	0,37	0
12	Shahrisabz	0,46	0,46	0,48	+0,02
13	Yakkabog	0,43	0,44	0,41	-0,02

not been carried out on agricultural land in recent years and that sufficient measures have not been established for the effective use of agricultural land. The main part of the irrigated soils of the region is in the group with low supply of humus (88.68%), 11.3% is in the medium and 0.02% in the high supply groups. This situation requires extensive use of organic and organomineral fertilizers to increase the amount of humus in the irrigated soils of the region.

Table 3

Indicators of vegetation cover evaluation indices

Object type	An image in the red zone of the spectrum	An image in the infrared zone of the spectrum	NDVI value
Thick vegetation cover	0,1	0,5	0,7
There is a risk of desertification regions	0,1	0,3	0,5
Soil	0,25	0,3	0,025
Clouds	0,25	0,25	0
Water	0,02	0,01	-0,25

Conclusion. In conclusion, it can be said that digitalization of continuous monitoring of the state of agricultural lands is one of the effective ways to rely on modern and accurate space services, remote sensing of the earth and geoinformation technologies. This is confirmed by the experience of countries with a high ranking in agriculture. Therefore, one of the ways of organizing the effective use of agricultural land is its digitization.

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