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ПРИМЕНЕНИЕ МЕТОДОВ ТРЕХМЕРНОГО МОДЕЛИРОВАНИЯ ДЛЯ РЕШЕНИЯ ЗАДАЧ ПО РАЗРАБОТКЕ БАЗИСА СОЛЕВОГО СТОКА

APPLICATION OF THE THREE-DIMENSIONAL MODELING METHODS FOR PROBLEMS SOLUTION TO ELABORATE A SALT DRAIN BASIS

Бул долбоордун алкагында Арал деңизиндеги туздун агуу базисин заманбап интеграциялашкан ГИС-технологияларды жана үч кырдуу анализ усулун колдонуу менен иштеп чыгуу ишгелип чыккан. Биздин пикирибизде, ArcGIS программалык комплекси бул милдетти чечүүдө бир топ ыңгайлуу жана максатка дал келет. Бул программалык камсыздоодо картографиялык маалыматтар базасын алып баруунун өнүккөн интерфейси семантикалык база менен айкашкан.

Гидроэкологиялык параметрлер рельеф менен тыгыз байланыштуу. Рельефти салттуу түрдө эле горизонтал жаткан тегиздик деп элестетүү тематикалык картаны иштеп чыгууну жана гидроэкологиялык кырдаалды анализдөөнү татаалдаштырат. Долбоордо коюлган милдеттерди жакшылап чечүү жана кырдаалды анализдөө иштерин оңойлотуу максатында рельефтин санариптик моделин үч кырдуу элестетүү технологиясы колдонулду.

Андан аркы изилдөө иштеринде ArcGIS программасынын кошумча кызматтарын: Hydrology, The Filling tool, The Flow accumulation tool тобунун инструменттерин колдондук. Бул кошумча кызматтар автоматташкан режимде ишгелип чыккан тузду шилеп чыгаруучу башкы тракттын жана ага кирген негизги коллектордун схемасын аныктоодо пайдаланылды.

Сунушталып жаткан Аму дарыясынын оң жээгиндеги суу жана туз шилечү тракт региондогу экологиялык кырдаалды жакшыртууга жана соолуп бараткан Арал деңизинин түбүндө калган сууну сактоого, аймактагы кыртыштын сапатынын жакшырышына, айыл чарба өндүрүш деңгээлинин жогорулашына көмөкчү болот жана бул иш-чаралардын бардыгын Өзбекстандын аймагында жүзөгө ашыруу болжолдонуп жатат.

Ачкыч сөздөр: *гидрология, айыл чарбасы, ГИС-технология.*

В рамках данного проекта решалась проблема разработки базиса солевого стока бассейна Аральского моря с применением современных интегрированных ГИС-технологий и методов трехмерного анализа. По нашему мнению, программный комплекс ArcGIS является наиболее подходящим для решения поставленных в проекте задач. . Данное программное обеспечение вобрало в себя развитый интерфейс ведения картографической базы данных в сочетании с семантической базой.

Гидроэкологические параметры тесно связаны с рельефом. Традиционное представление рельефа в виде горизонталей часто усложняет разработку тематических карт и анализ гидроэкологической ситуации. Для решения поставленных в проекте задач на более высоком уровне и упрощения процедуры ситуационного анализа используется технология трехмерного представления цифровой модели рельефа

В наших дальнейших исследованиях использованы дополнительные функции ArcGIS: инструменты группы Hydrology , The Filling tool, The Flow accumulation tool. Эти дополнительные функции были использованы при определении схемы главного солеотводящего тракта и впадающих в него основных коллекторов, разработанных в автоматизированном режиме.

Предлагаемый водо- и солеотводящий тракт правобережья Амударьи будет способствовать оздоровлению экологической обстановки в регионе и сохранению остаточного водоем в глубоководной части высыхающего Аральского моря, улучшению качества почв в регионе, повышению уровня сельскохозяйственного производства, и все указанные мероприятия планируется реализовать в пределах Узбекистана.

***Ключевые слова**: гидрология, сельское хозяйство, ГИС-технологии.*

Within the framework of this the project it was solved the problem of development of the basis for salt drain of the Aral Sea basin with application of the modern integrated GIS-technologies and methods of the three-dimensional analysis.

In our opinion the ArcGIS is the most suitable program for the solution of tasks determined in the project. This software combines a developed interface of the map database reference in conjunction with a semantic database.

The hydroecological parameters are closely connected with the topography. The traditional view of the relief in the form of contour lines complicates often the development of thematic maps and hydro-ecological analysis of the situation. In order to achieve the objectives at a higher level and to simplify the situational analysis it has been applied the technology of three-dimensional representation of the digital terrain model.

The ArcGIS additional features have been used in our further studies: The tools of the Hydrology group, The Filling tool, The Flow accumulation tool. These additional features were used in the construction of the head salt removing tract schema and the main collectors flowing into it in the automated mode.

The proposed water and salt removing tract of the Amu Darya's right bank is designed to improve the environmental situation in the region and preserve the residual body of water in the deep part of the currently drying up Aral Sea, as well as to help in improvement of the soil quality in the region, raising the agricultural production level, and all these activities will be implemented within Uzbekistan.

***Keywords:** hydrology, agriculture, GIS-technologies.*

In the Republic of Uzbekistan the area of the irrigated lands makes about 10%, providing more than 90% of agricultural production. In recent years the environmental and demographic pressure amplifying from year to year on the earth became the burning issue for the Republic of Uzbekistan. At the remaining high increase of the population, the area of the irrigated lands per capita steadily decreases and makes 0.12 hectares for today. At the same time the potential of involvement in agriculture of new irrigated lands suitable for farming is close to exhaustion. Along with the above-mentioned, it is observed a continuous decrease in fertility and increase of pollution of arable lands, as well as decrease in productivity of crops.

One of the essential factors conducting to decrease in productivity is a secondary salinization as a result of the irrational use of water resources insufficiently proved from the scientific point of view. Under deficiency of water resources which became even more aggravated in a new geopolitical situation in the region, development of the scheme of networks for removal of salts, first of all, its scientific and technical basis, is represented actual and socially, economically and ecologically significant for the national interests of Uzbekistan. Creation of the networks for removal of salts is intended to promote a rational use of water resources, a sustainable development of the agriculture in the Republic of Uzbekistan in the conditions of deficiency of water resources and its quality deterioration.

Within the framework of this the project it was solved the problem of development of the basis for salt drain of the Aral Sea basin with application of the modern integrated GIS-technologies and methods of the three-dimensional analysis.

In 2008 the Goskomzemgeodezkadastr has purchased more than 100 licenses for the ArcGIS software. The licenses are purchased with varying degrees of using the software. Therefore, in this work, a most attention is paid to the use of this particular software.

In our opinion the ArcGIS is the most suitable program for the solution of tasks determined in the project. This software combines a developed interface of the map database reference in conjunction with a semantic database.

The demand for the digital mapping products was significantly increased in recent years. A growing number of the cartographic information users pay attention to the benefits of using the digital maps in their work.

The more different softwares are used to create the product, the more difficult is the process. The main reasons that allowed to extend the ArcGIS system to the manufacturing operations working with digital maps are the following:

- Availability of the necessary set of functions and well thought-out structure of the product;
- Ability to develop the system by connecting additional modules;
- Easy creation of applications;
- User-friendly (Russian) interface;
- Support for many formats;
- Presence of adjacent software (ArcInfo, MapObjects, ArcCAD, etc.)

As part of research to develop the concepts of salt removing networks have been used the digital topographic bases developed by us on the scale of 1: 200 000. The digital topographic base is developed on the basis of the general requirements to the process of creating and updating the digital topographic maps, the main requirements to the digital topographic maps, including requirements to the completeness of the initial information, to its actualization, accuracy and consistency of the information [1]. The digital topographic base as a whole reflects the current state of the area with the accuracy, completeness and reliability, meeting the requirements, which are imposed according to [2] on the topographic maps of the proper scales. Therefore, when creating and updating the digital topographic mapping are used aerospace and topographic materials (including those presented in the digital form) the reliability, completeness and accuracy of which satisfy the requirements of the digital topographic base of the created scale. When creating and updating a digital topographic base are also used the additional reference materials (including materials of the Central cartography and geodesy fund, Gosgeonadzor inspection and reference and information systems of other departments) ensuring the up-to-dateness of its information. The digital topographic bases contain all the objects of the topographic maps corresponding to their scale and the area as they describe, including:

- Mathematical basis;
- Reference points and aeronautical data;
- Relief of the land;
- Hydrography and hydraulic systems;
- Settlements;
- Industrial, agricultural and socio-cultural objects;
- Road network and road structures;
- Vegetation cover and soil;
- Borders and fences;
- Captions;
- Marginalia.

The content of the digital topographic objects includes an object number, its semantics and metric.

The digital topographic base per sheet is not an obstacle for creation of a single seamless coverage of the entire territory of Uzbekistan. A layered representation of the main load elements of the digital topographic base allows to include in consideration only the necessary layers while creating thematic environmental maps.

The hydroecological parameters are closely connected with the topography. The traditional view of the relief in the form of contour lines complicates often the development of thematic maps and hydro-ecological analysis of the situation. In order to achieve the objectives at a higher level and to simplify the situational analysis it has been applied the technology of three-dimensional representation of the digital terrain model [3-5].

The proposed modification of the collector clarifies its assignment as the main salt removing tract from the right bank of the Amu Darya and to some extent aimed at maintaining the residual water table of the Aral Sea and stabilization of the ecological situation in the region. The ecological significance of the proposed project seems to us very obvious.

The researches conducted earlier showed that for achievement of goals it is not enough to use mid-scale maps 1:500000 and 1:200000. It is necessary to elaborate the digital topographic maps with attraction of data on a relief received from more large-scale maps. For this purpose were developed hybrid digital topographic maps of scale 1:200000 on which were in addition applied the data of the reference points from the topographic maps of scale 1:100000 in strict accordance with coordinates of reference points and values of heights. On the basis of the hybrid digital maps it was developed a three-dimensional model for the studied territory.

Figure 1 shows a fragment of the digital topographic map with a scale of 1: 200 000 sheet of K-41-VII with addition of information on the reference points of the digital topographic maps with a scale of 1: 100 000.

The ArcGIS additional features have been used in our further studies. The necessary input data for the construction of the head salt removing tract and the main collectors flowing into it is a Digital elevation model (DEM) free of the local depressions. The presence of the local depressions can lead to the erroneous raster in determining the direction of flow. In some cases, data may contain the correct local decreases. It is important to thoroughly understand the morphology of the area in order to know which features can actually be a local decrease on the Earth's surface, and which are simply the errors in the data. We used the ArcGIS Spatial Analyst additional module for preparation of relief surface without depressions.

The tools of the Hydrology group (Hydrology) were used to simulate the flow of water on the surface.

The Filling tool (Fill) fills the local depressions in the surface raster to remove all the small errors and inaccuracies inherent in the data.

The local depressions (and spades) are often small errors that occur due to the resolution of the data or rounding the heights to the nearest integer.

The local depressions must be filled in order to ensure a more accurate selection of basins and streams. If the local depressions are not filled, the dedicated drainage network may be discontinuous.

The Filling tool (Fill) uses the equivalents of several tools, such as Focal flow (FocalFlow), Flow direction (FlowDirection), local depression (Sink), Watershed (Watershed) and Zonal fill (ZonalFill) for detecting and filling the local depressions.

The flow direction is determined by the direction of steepest descent, or maximum decrease, of each cell.

The Flow accumulation tool (FlowAccumulation) calculates the accumulated flow as the total weight of all the cells that flow into each cell down the slope of the output raster. If not given scales raster, each cell is assigned a weight of 1 and the value of the output raster cell is the number of cells that flow into each cell.

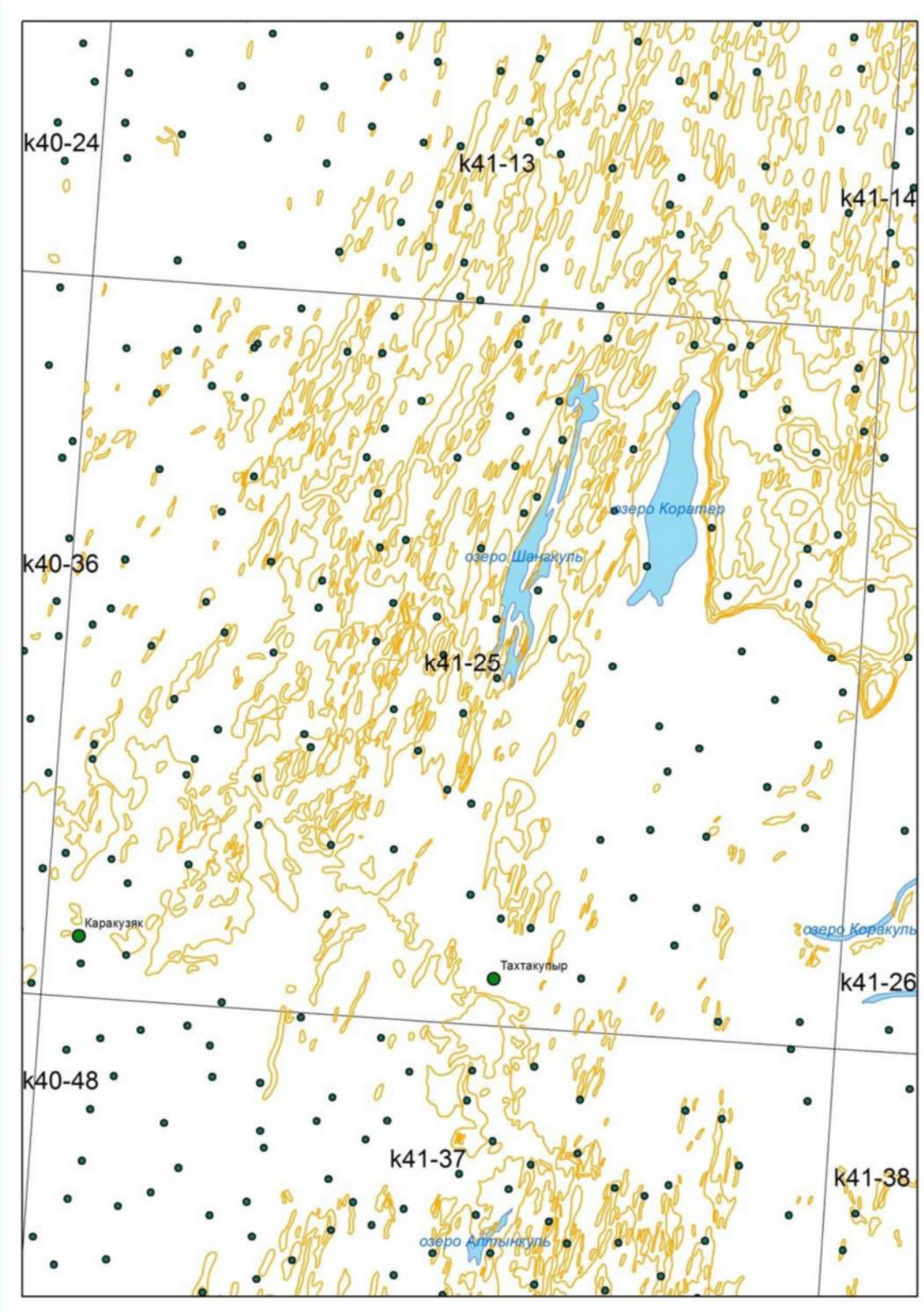

Figure 1. Fragment of the digital topographic map with a scale of 1: 200 000 sheet of K-41-VII with addition of information on the reference points of the digital topographic maps with a scale of 1: 100 000

The cells with high flow accumulation are the areas of concentrated flow; they can be used to determine the watercourses channels.

These additional features were used in the construction of the head salt removing tract schema and the main collectors flowing into it in the automated mode.

The three-dimensional model for the study area was developed based on the hybrid digital map. The figure 2 shows a three-dimensional model in the study area. The red line marked the proposed project of the head salt removing tract. For purposes of clarity and ease of analysis, the scale of the three-dimensional model of height has been increased by 1000 times. The figure 3 shows a perspective view of a three-dimensional model. The facilities provided by the used ArcGIS software complex allow analyzing the three-dimensional model with any points.

Figure 2. Three-dimensional model in the study area

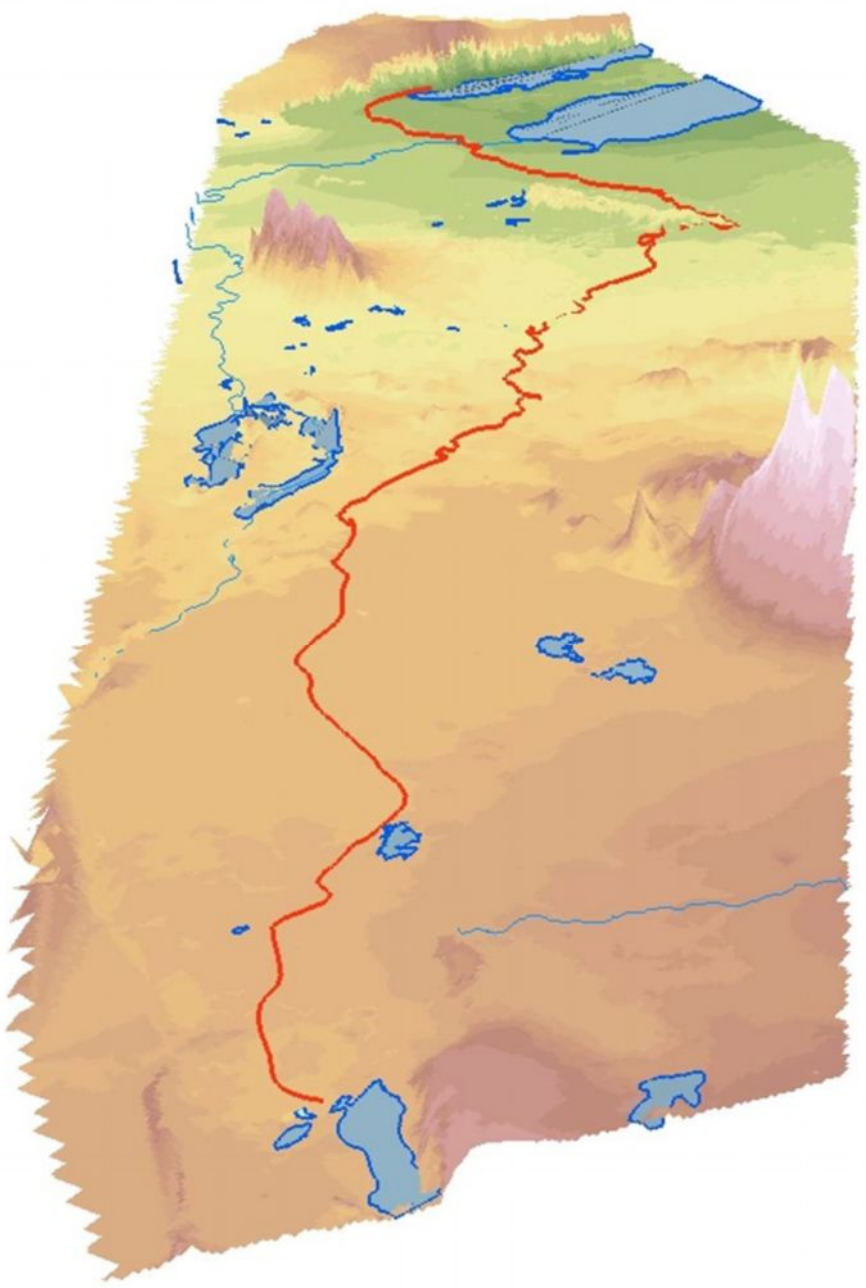

Figure 3. Perspective view of a three-dimensional model

The developed detailed three-dimensional area models for the studied territory are more detailed in comparison with the three-dimensional models on the basis of the digital topographic maps of scale 1:500000-1:200000 and they formed a basis for design of tracts for removal of salts from the irrigated territories to the main tract for salts removal and further to the Aral Sea as the main receiver of salts.

For a more detailed analysis it was built the vertical profiles of the tract. The analysis showed that the total tract length was 935km 200m. This height difference to the Aral Sea was 130m. Thus the head intake manifold of the right-bank is located below 10m compared to the more northern areas. Apparently, it is expedient to organize drainage channel through the Kashkadarya river to the East. The Dengizkul could be uses as a sub-regional evaporator. To the North the water goes by gravity to the Aral Sea, and all the flow from the basin of Zarafshan, Kashkadarya, Karshi canal and a large part of the Bukhara oasis will be sent to the right-bank collector. Such a reversal of the initial section of the trace will allow to avoid the machine water-lifting to about 10-12m, and therefore to avoid additional energy costs.

Designed in an automated mode, the head salt removing tract needs in analysis and possible adjustment by highly qualified hydrologists.

The proposed water and salt removing tract of the Amu Darya's right bank is designed to improve the environmental situation in the region and preserve the residual body of water in the deep part of the currently drying up Aral Sea, as well as to help in improvement of the soil quality in the region, raising the agricultural production level, and all these activities will be implemented within Uzbekistan.

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