CREATING OF THE EXPERIENCE OF DESIGNING IRRIGATION CHANNELS USING THE GLOBAL MAPPER SOFTWARE

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Abstract. Creating systems supported by information technologies are now integral to nearly every field of engineering and construction. In the design of hydrotechnical structures, selecting the software package that best meets specific project requirements is crucial. A key priority is ensuring that these tools not only fulfill technical needs but also contribute to achieving self-sufficiency in design processes. This study aims to demonstrate the application of Geographic Information System (GIS) programs in the design of hydrotechnical structures, highlighting their potential to enhance both efficiency and effectiveness. By integrating GIS technology into the design process, engineers can optimize project planning, improve accuracy in modeling and analysis, and ultimately achieve significant economic benefits. The adoption of GIS in hydrotechnical design offers a more streamlined approach to managing spatial data, enabling better decision-making and resource management. This integration not only improves the quality of designs but also helps in reducing costs and increasing productivity. As the engineering and construction industries continue to evolve, the use of advanced GIS tools in hydrotechnical projects is becoming increasingly essential for achieving optimal outcomes and ensuring long-term sustainability.

Keywords: Global Mapper, irrigation channels, irrigation system design, channel design, geospatial data, digital mapping, GIS technologies, terrain analysis, hydrological modelling, water resource management.

ФОРМИРОВАНИЕ ОПЫТА ПРОЕКТИРОВАНИЯ ОРОСИТЕЛЬНЫХ КАНАЛОВ С ИСПОЛЬЗОВАНИЕМ ПРОГРАММНОГО ОБЕСПЕЧЕНИЯ GLOBAL MAPPER

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Аннотация. Создание систем, поддерживаемых информационными технологиями, в настоящее время является неотъемлемой частью практически любой области инженерии и строительства. При проектировании гидротехнических сооружений важнейшее значение имеет выбор программного пакета, наилучшим образом отвечающего конкретным требованиям проекта. Ключевым приоритетом является обеспечение того, чтобы эти инструменты не только удовлетворяли технические потребности, но и способствовали достижению самообеспеченности в процессах проектирования. Данное исследование направлено на демонстрацию применения программ географических информационных систем (ГИС) в проектировании гидротехнических сооружений, подчеркивая их потенциал в повышении как эффективности, так и результативности. Интеграция ГИС-технологий в процесс проектирования позволяет инженерам оптимизировать планирование проектов, повысить точность моделирования и анализа, а также получить значительные экономические выгоды. Внедрение ГИС в гидротехническое проектирование обеспечивает более рациональный подход к управлению пространственными данными, способствуя принятию оптимальных решений и управлению ресурсами. Эта интеграция не только улучшает качество проектов, но и помогает снизить затраты и повысить производительность. По мере развития инженерно-строительной отрасли использование передовых ГИС-инструментов в гидротехнических проектах становится все более важным для достижения оптимальных результатов и обеспечения долгосрочной устойчивости.

Ключевые слова: Global Mapper, оросительные каналы, проектирование оросительных систем, проектирование каналов, пространственные данные, цифровое картографирование, ГИС-технологии, анализ рельефа, гидрологическое моделирование, управление водными ресурсами.

Introduction

At first, geodetic works were carried out with the help of levels during the design of hydraulic structures. First, the longitudinal profile of the river is the main document when drawing up the project of various hydrotechnical structures. Water levels of characteristic points in a large part of the channel are determined to create a longitudinal profile. Since this level is constantly changing, it is not possible to perform leveling on all parts of the channel at the same time. Therefore, there is a problem of synchronizing height measurements made at different times in individual parts. To create a longitudinal profile, a high-class precision leveling path is carried out along a certain direction of the channel. From these waypoints, the elevation markers are sent to the workers located near the river bed. Working rapiers are used to level the surface of the water level of the channel. As a result, due to the fact that these works take a lot of manpower and time, it is possible to obtain effective results by developing geodetic works through GIS programs in the design of hydrotechnical structures.

the engineering analysis of the irrigation canal route, data processing begins with obtaining a digital topographic plan of the relevant section. This plan, which includes the existing canal route, is provided by the engineering-research department in JPG format, originally created using CREDO software. The next step involves importing and editing this digital topographic data within the GIS system to facilitate detailed analysis and design work. The use of GIS software allows for precise adjustments and improvements to the canal design, ensuring ac-curacy and efficiency in the research process.

Results and discussion

For flexibility of the project and optimal cooperation with the relevant departments, it was decided to use the function of quick connection to the data in Global Mapper entering the geographic information systems. A storage folder is created, then the regional coordinate of the surface shown in the digital plan is selected and edited with surface functions for the desired zone. The program has a very successful set of tools that allow you to significantly reduce the time of editing surface surfaces

(surface surfaces, point height determination, hydrographic layers, digital earth model, etc.).

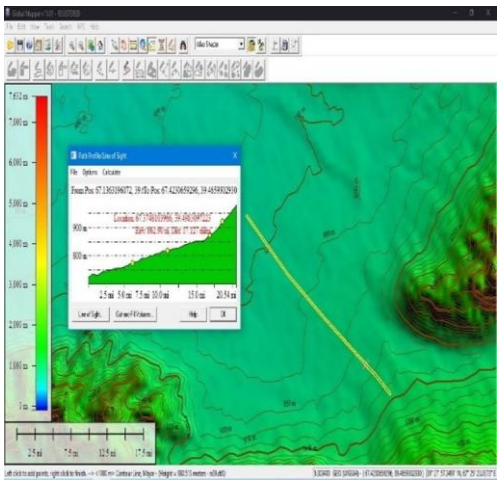
Then the surface representation method is corrected (contour lines step 1: 500 scale, their color and thickness), hydrographic layers are defined in Global Mapper and saved to the template.

As a result of editing, we present the existing (current) digital earth model (Figure 2).

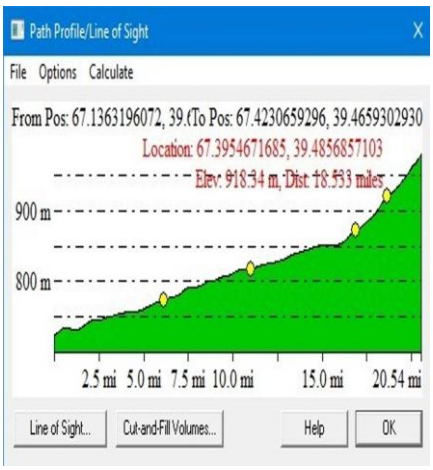
In the process of drawing up the route plan of irrigation canals and ditches and the existing profiles, mainly at this stage there is a difficult task of designing the adaptation of the plan. This is because the position of the future route and the geometry of the route, the technical means of traffic control (coordinates and elevation data) are determined by the location of the channel service facilities (horizontals). Experiments show that such problems can be solved quickly and effectively with the help of computers in GIS programs.

The drainage system is directly connected to the main of the irrigation canal, the exit to the canal crossing bridges and the presence of drainage facilities after that, which complicates the project (Figure 3).

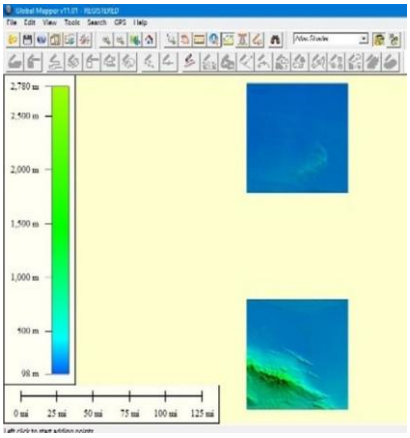
The center line of the track is obtained from the polyline using the SAS Planeta software tool. The tracing process is carried out first in camera conditions and then in field conditions. Global Mapper software was used to create profiles along the route of the irrigation canal. Then the track and surface built along the length of the channel were selected. This function is very convenient and allows you to create, graph and print a channel length profile in a few minutes. However, it takes a lot of time and labor to do these things manually.



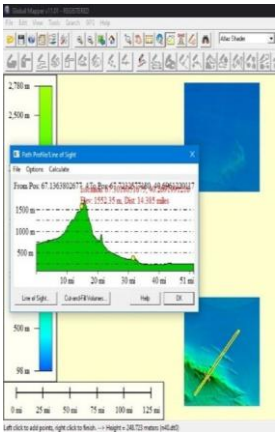
A (surfaces)



B (point height)



D (work with contour zones)



F (this profile)

Fig.2. Digital model edited using Global Mapper software.

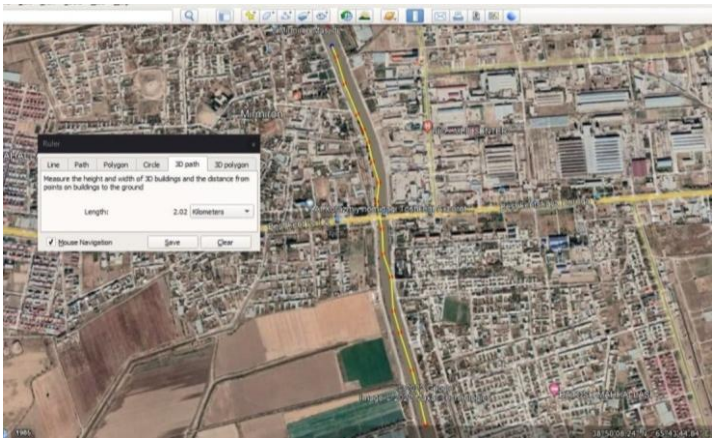


Fig. 3. A space image of the planned highway as it is taken down.

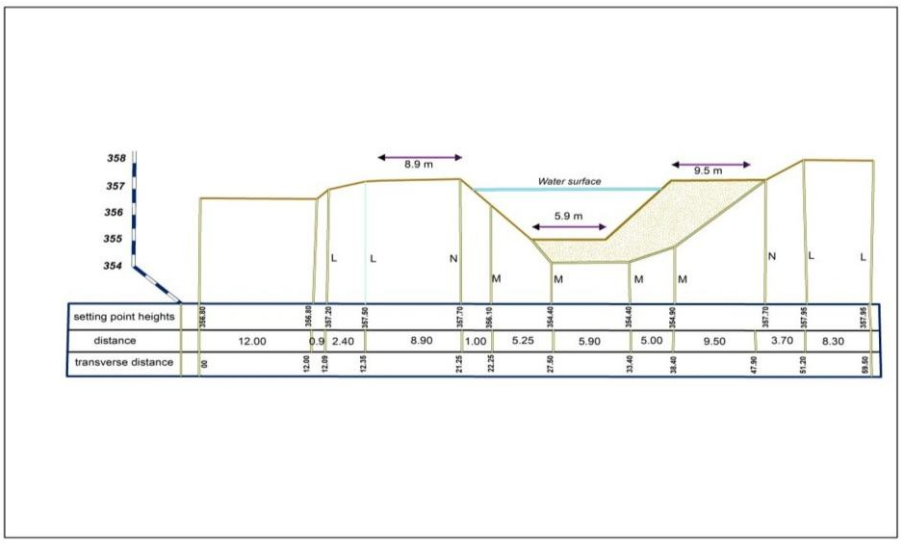


Fig. 4. Creating a design profile of the irrigation canal route using geodetic tools.

Where: Count taken from the left and right edge of the L-irrigation channel.

N- count taken from the water edge of the irrigation channel. Count taken from the water slope of the M-irrigation canal.

Three different types of profiles were created during the construction of the projected profile (in a certain section, along the initial exit direction and the sides of the crossing bridges along the exit direction). Created three project profiles to profile the existing terrain. Next, the project profiles via the Podobie profile command to the requested height. These prepared structures are mainly needed to describe the scope of work.

According to the technical conditions, the surface of the existing coating should be milled (crushed) to a depth of 10 cm, and then the three-layer irrigation channel with a total thickness of 75 cm will be described according to the height of the relief section and geological layers will be created.

After developing all the elements of the projected route (digital elevation model, route, surface profile, profile view, details), the development of a three-dimensional model (3D model) of the renovated section of the canal route begins. During work in Global Mapper, two main methods of designing 3D models were developed:

description of relief section through horizontals.

elevation of longitudinal and cross-section elevations to 3D for construction using

profile lines and objects.

It is worth noting that each of the above methods requires a certain amount of time, but it is significantly faster than the Global Mapper tools. Let's take a closer look at these methods. When using the first method, if you choose the correct targets for the channel coordinates and elements (tracks, displacement tracks, they are longitudinal profiles) and create a pre-thought-out design from the tool palette, the result will be a 3D model of the irrigation channel with a clear and clear relief (Figure 5).

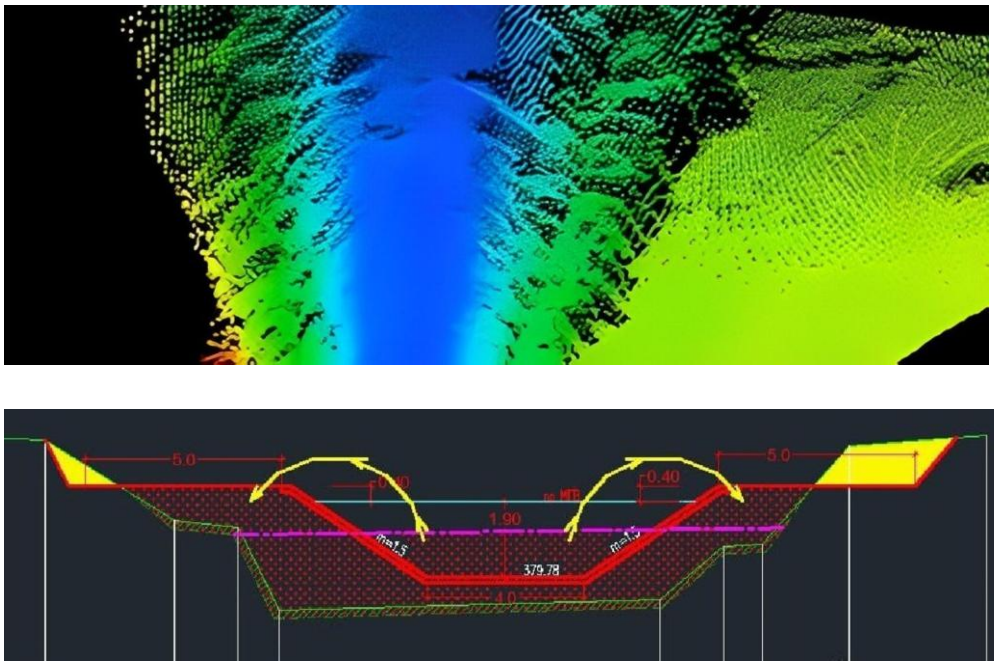


Fig. 5. 3D model of the planned irrigation canal route.

In the second method, you need to spend time describing the characteristic lines with point height, as well as the slopes that classify the objects. The disadvantage of the latter is that it is possible to calculate the amount of work on the construction of the projected area using Global Mapper.

We consider the intersection of the highway with two secondary roads (bridges), that is, the intersection of two engineering structures. As we know, there are several linear constructions crossing in irrigation canals, for example (gas pipes, power lines, roads and railways, etc.), creating crossings at crossing points and constructing crossings are two main methods through, we will consider them in detail.

The first method is suitable for constructing the intersection in semi-automatic mode

(Figure 6). Here, before building the junction, it is necessary to create and configure its basic structures:

limit the turn;

the main routing direction;

the main road consisting of the left and right traffic section;

the type of engineering structure that crosses the secondary road;

After the structures are created, the "Intersection" (Peresecheniye) command is launched and all the necessary intersection elements (structures, turning radius, expansion, etc.) are configured in the intersection wizard. The result will be an intersection in the form of a corridor. This intersection corridor can be built into the main corridor of the main irrigation canal. We will do the same for the second session. If you are designing a complex structure, when building a channel in semi-automatic mode, you can go to the Pekit range settings (Nastroyka koridora) and delete or reset the targets in the targets tab (Tseli) so that everything results as expected.

The second method requires more work, because more operations have to be performed, for example: the main highway will need to be divided into sections (before the intersection, it will be described taking into account the turning radii). But on the other hand, the

information between every 100 m picket is represented by height information on 2 levels, and imaging works are performed perfectly.

The resulting levels feature pre-made structures where they appear in settings along the side of the main track. After connecting the design marks, a secondary route is created at the intersection of the irrigation channel (along the longitudinal profiles) at the second height. Since the tracks intersect, there is no connection between the waterway and the edge data, so they must be displayed in elevation. Connections can be drawn using polylines (multiple lines) and then using Global Mapper's Create Horizontals from Objects command to convert the polyline to a route. Our experience shows that it is convenient to design with horizontals (reliefs). It can be used for various purposes during the design process.

In the properties of the secondary route, the left and right turning areas are added using the command “Add Base Area and Add New Routes”. In addition, it is possible to add targets so that the horizontals pass through the entire intersecting area and it is necessary to edit the target values on the added horizontal. The result is two relief section elevations. The first elevation of the main road is not intersected.



Fig. 6. Intersection status.

In order to comply with the technical conditions, it is necessary to take into account the cross-sectional profiles of the earth layer. With the help of the program, it is possible to create fast cross-sectional lines using the Path Profile function (by pickets, by step pickets). Then, it remains to create several cross-sectional views using the cross-section output wizard, and finally, it is necessary to indicate the point of placing certain types of cross-sections in the drawing.

Calculation of the volume of work is successfully carried out on a personal computer in the Global Mapper program. When building a 3D model of an irrigation channel or a structure from hydraulic facilities, it is easy to calculate the materials according to structural elements (pickets, horizontals, relief, etc.) and volume tables can be included according to the drawing. It is not an exaggeration to say that this mode is the dream of all designers, and the automatic calculation of earthworks is not only a dream, but it can be clearly seen from the above analysis that it is possible to achieve a certain economic efficiency through GIS software.

Conclusions

The results of scientific and practical substantiation on the improvement of geodetic and topographic field research in the design and construction of irrigation canals with the help of GIS technologies were analyzed.

As it can be seen from the above analysis, in the design and construction of irrigation canals, data processing, analysis, and implementation of project specifications in the field is a rather complex and laborious process. The use of the Global Mapper program, which be-longs to the class of GIS technologies, allows not only to increase the productivity of obtain-ing geodetic and topographic data, but also to save time and save money.

The results of geodetic and topographical research are directly used in the design of hydrotechnical structures, i.e., in the process of topographic research in irrigation canals, in addition to obtaining a number of elevations and plan data, they serve to update the scope of work to a certain extent.

If a three-dimensional (3D) model of the Kashkadarya main canal in the Kashkadarya region of the Republic of Uzbekistan is constructed using the GIS technology software called Global Mapper, it can assist in visualizing the canal's tracks, displacement tracks, and longi-tudinal profiles. Additionally, by utilizing the pre-existing design tools within the software, a well-defined 3D model of the canal with a clear and distinct relief can be generated. This model offers a comprehensive view of all the details regarding the renovated irrigation canal. Consequently, it enables a thorough analysis of the repaired sections, as well as identifying any areas that may have been buried or modified. It is not an overstatement to claim that these analyses provide valuable insights in terms of productivity, time management, and economic efficiency.

In addition, it can be said that the conducted IDW, Kriging, NDSI and NDVI analysis of agricultural land showed how they are related to each other, that is, the rise of seepage water is related to the rise of salinity and the development of crops, respectively. It showed that in 2021, the rise in the level of flood waters in April and July was negative, and in April it was positive. In 2022, the increase in the level of

seepage water depends on salinity and vegetation of crops showed a positive correlation in April and November. In July, it showed that it was at a negative level.

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