NATIONAL RESEARCH UNIVERSITY "TASHKENT INSTITUTE OF IRRIGATION AND AGRICULTURAL MECHANISM ENGINEERS"

Visualization and analysing the state of hydrotechnical construction via geospatial methods (on the example of Kharshi pumping stations cascade)

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Abstract.

In the given article the state of Kharshi pumping station, which is considered as one of the huge pumping stations cascade in Central Asia is described through analysing and visualising the geographic information systems (GIS) and remote sensing (RS) methods. As data there were used Shuttle Radar Topographic Mission - SRTM and high-resolution optical images of the area, provided by ESRI. For data processing and visualization, there was used the software of ArcGIS 10.5 by ESRI company and the results were obtained. At the same time the geographical location of pumping stations and water elevating points and the state of water flowing canals were analysed remotely along with the results from the cross-sectional area of cascade were obtained. In assessing, the accuracy of results it was compared with the data based on field search work and the obtained results from the distance showed 86% accuracy.

Introduction

- At present time it can be noticed the widespread use of Geographic Information Systems (GIS) and Remote Sensing (RS) technologies in water management. The main advantages of such technologies are high accuracy, low cost and key tool in quick decision making. Remote sensing and GIS play a vital role in the conservation and management of water resources[1]. GIS is used for spatial mapping of objects that integrates space science, survey and mapping. GIS can be used to manage the data as well as for integrating and analysing spatial data obtained from different sources (field surveys, remote sensing) with diverse structures, resolution and projections [2].

Introduction

- The object of the research is the cascade of Kharshi pumping stations, which is the largest pumping stations cascade in Central Asia, which is located 78.4 km from the head of the Kharshi main canal in the territory of the Republic of Turkmenistan. It is important to note that, Kharshi main canal supply with water about 30% of the agricultural lands of Uzbekistan. Kharshi main canal consists of a large complex of hydraulic structures with a length of 176.6 km. Karshi canal is discharged from Amudarya River by using seven pumping stations, which establish huge cascade, and leading to an elevating head of 132.2 m, normal flow is 175 m3/s, maximum of accelerated water flow is 195 m3/s [7].

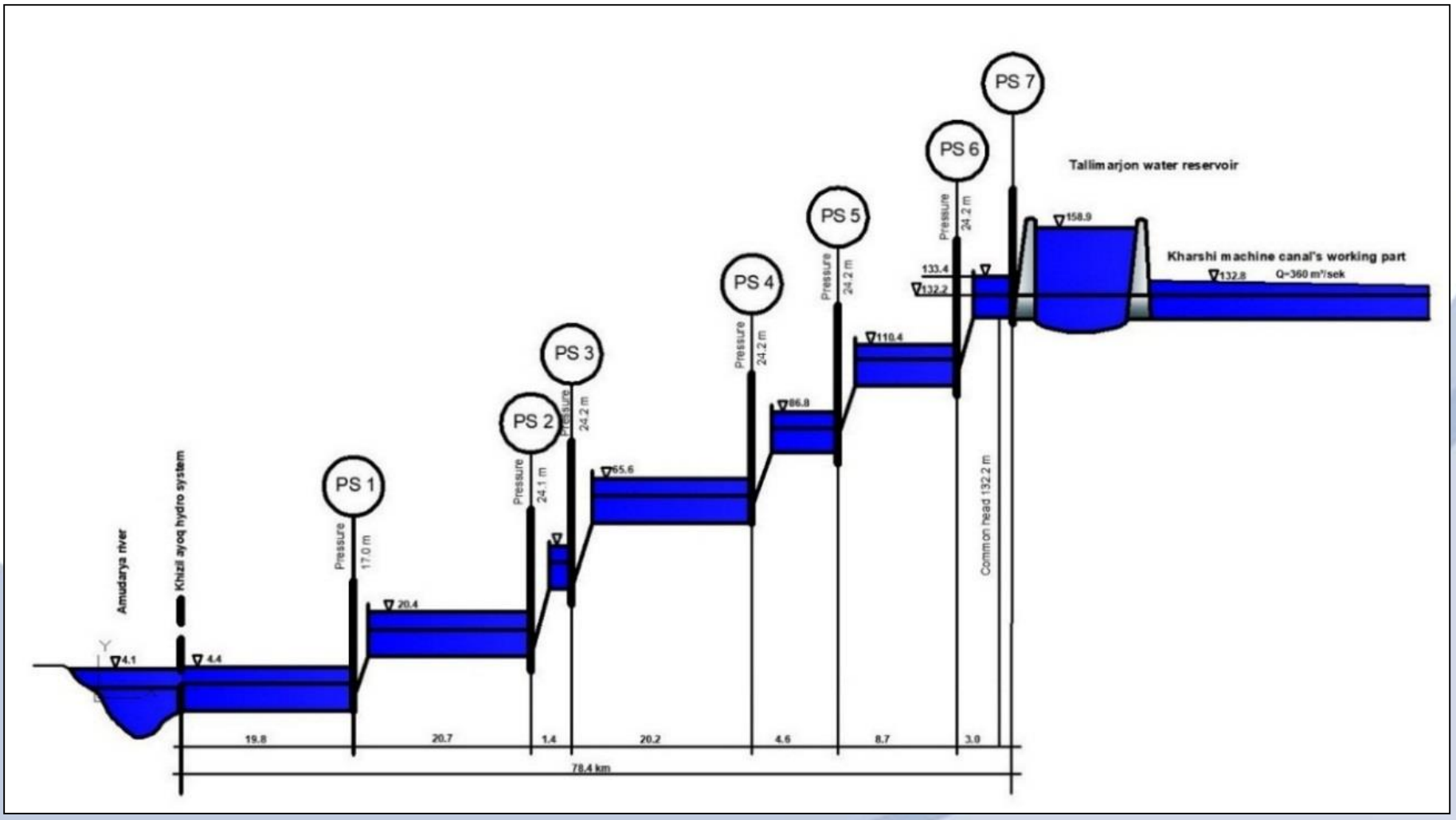
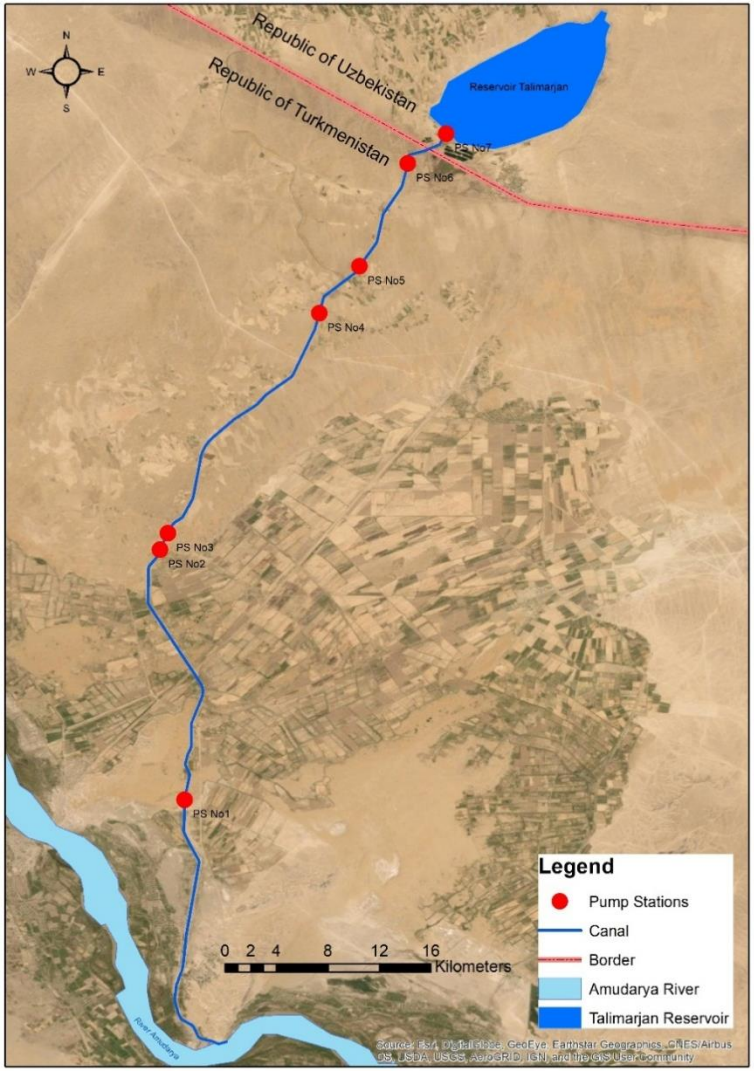


Figure 1. The scheme of the Kharshi pumping stations cascade.

Method and Materials

Initially, the database was developed by analyzing and visualizing the cascade of pumping stations. Based on active remote sensing method as the data of Shuttle Radar Topography Mission shows 1 arc-second for global coverage (~ 30 meteres), which is used for high resolution digital altitude data and high resolution space imagery provided by ESRI. The Shuttle Radar Topography Mission (SRTM) was flown aboard the space Shuttle Endeavour on February 11-22, 2000 [15]. The National Aeronautics and Space Administration (NASA) and the National Geospatial-Intelligence Agency (NGA) participated in the international project to acquire radar data, which were used to create the first near-global set of land elevations [14].

Figure 2. Overview of Kharshi Pumping Cascade



SRTM DEM data was resampled to 10 meters resolution of Sentinel 2 images using by ArcGIS 10.5 program. Image resampling method used to get accurate results which minimize of SRTM pixel size.

The high resolution of World Image, which is supplied by ESRI, utilized for presenting locations of Kharshi machine canal (KMC) and pumping stations with remarking directly using ArcGIS 10.5 (Fig. 2).

Analysis of the location of pump station cascade using resampled SRTM digital elevation model was performed and used for Arc Scene application of ArcGIS program in three-dimensional visualization. This application provides the opportunity to perform three-dimensional objects and spatial analysis. The three-dimensional model was developed to visualize the main 78.4 km of Kharshi machine channel, where pumping stations were located through the elevating system. (Fig.3.)

Source: Deloitte

Result

- The location map of Kharshi pumping station cascade, developed as a result of scientific research, shows that the cascade is located entirely in territory of the Republic of Turkmenistan and the distance between pumping stations is distributed unevenly. Changes in the direction of canal and location of pumping stations are determined by physical and geographical conditions of place and nature of the terrain. According to DEM SRTM, the lowest point of the cascade is about 245 meters and highest point is about 375 meters above sea level. It is obvious that the relief between the first and second pumping stations is relatively quite, and the relief between the third and seventh pumping stations undergoes drastic changes (Fig. 3.). Based on resampled SRTM DEM data, a cross-sectional area diagram of cascade was developed by using ArcMap application of ArcGIS 10.5 (Fig.4).

It was achieved with the usage of the Stack Profile command in the 3D Analyst panel in ArcGIS 10.5. At the command readings of the pixels of DTM SRTM data, corresponding to these distances are automatically extracted every 125 meters of the program of canal route. By using this profile, it is applicable to analyze the cascade of pumping stations, as well as to observe the effect of pixel parameters on the profile. Comparing to field research data, obtained 86 % of accuracy results.

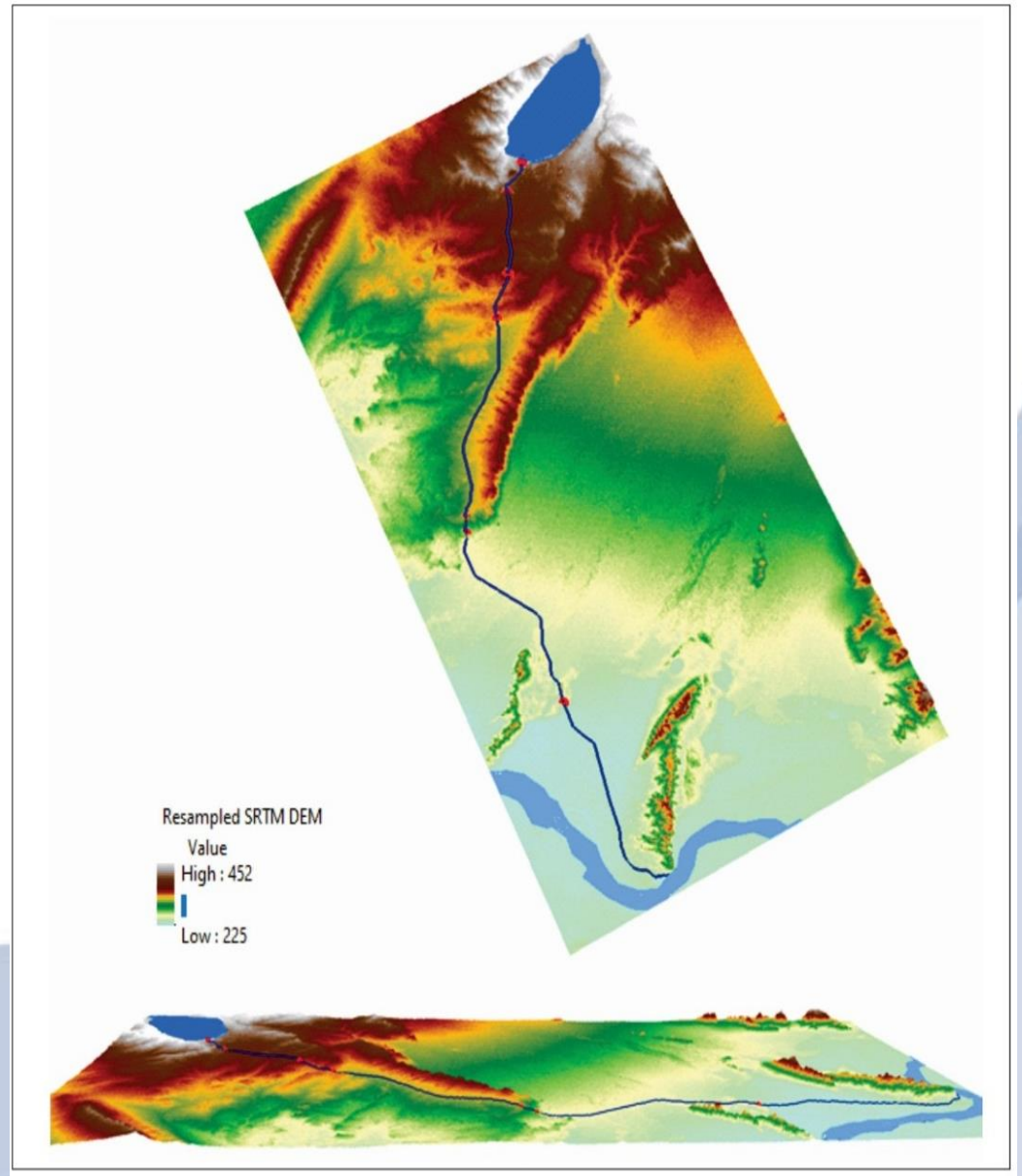


Figure 3. **A three-dimensional model of an area using ArcScene and resampled SRTM DEM data**

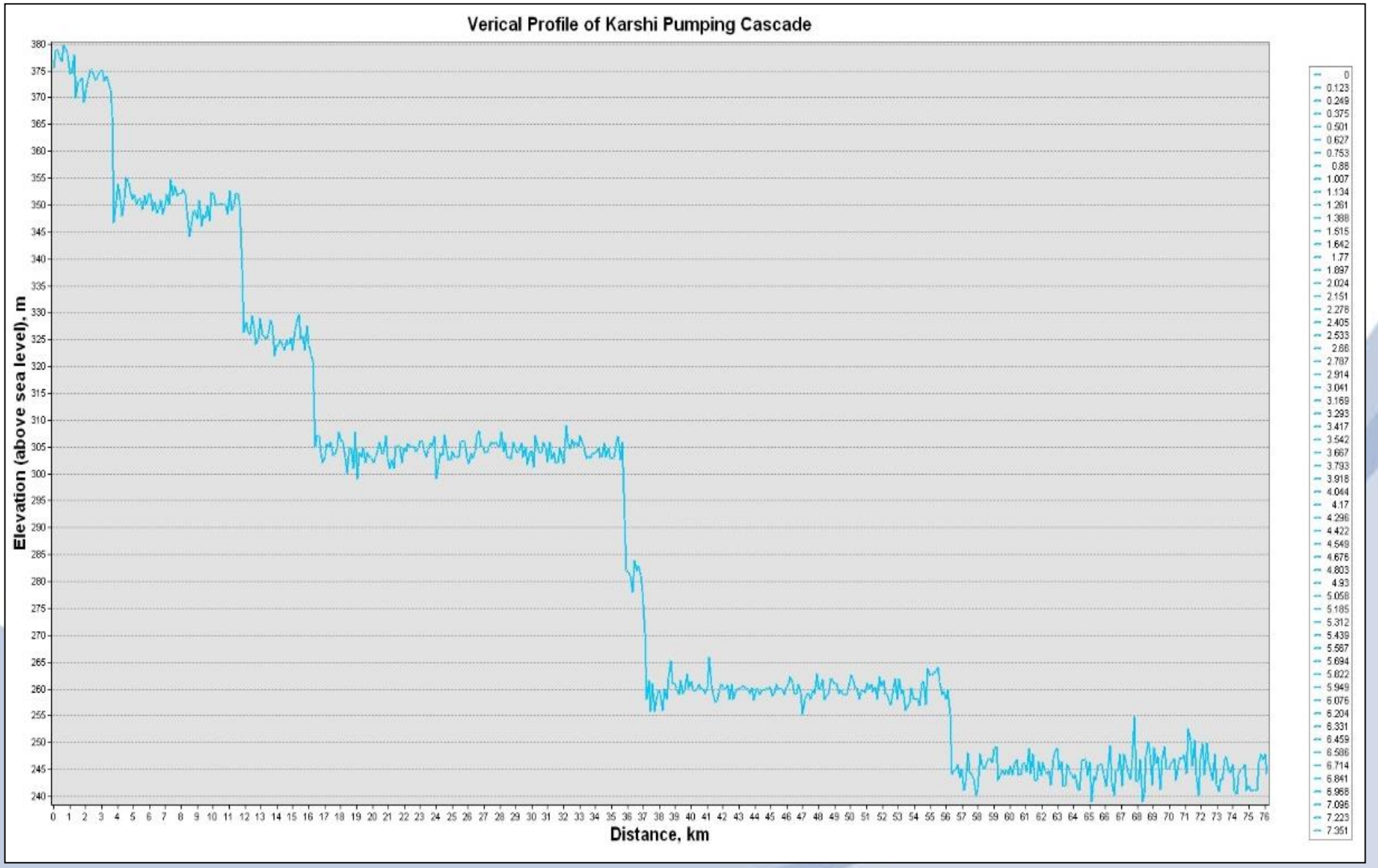


Figure 4. Vertical profile of Kharshi Pumping Cascade using Arc Map and resampled SRTM DEM data

Conclusion

One of the actual problems of present time is the creation of optimized models by using GIS and RS technologies for finding geographically convenient and suitable places for hydraulic structures and pumping stations. Based on the results of the study, the following conclusion can be suggested:

- using GIS and RS technologies, conditions will be created for the geographical analysis of large pumping stations and hydraulic structures, which is one of the most important issues of the 21st century;
- it will provide an opportunity to summarize a comprehensive assessment of the whole complex of an anthropogenic and physical-geographical factors, affecting the formation of water consumption and determining the role of monitoring in water resources management;
- three-dimensional visualization (modelling) will create the possibility to solve the controversial problems in water resources management with the help of hydraulic structures and pumping stations.
- there can be proposed a number of new methods for mapping hydraulic and pumping stations by using GIS and RS technologies;
- serves as the main source in the development of mathematical hydraulic and hydraulic models that reflect the ability to improve the operating mode of hydraulic structures;
- in developing supportive systems for quick decision-making in water resources management based on the GIS and RS technologies;
- in providing recommendations for solving various scientific and practical problems in the assessment and the impact of environmental and other factors on hydraulic structures.

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