Geoinformation and Automated Systems as the Main Tools for Maintaining a Water Cadastre (Using the Example of the Kharkiv Region)

A. Siedov, *S. Vynohradenko (*State Biotechnological University*), **V. Gurskienė** (*Vytautas Magnus University*), **O. Stupen** *(Stepan Gzhytskyi National University of Veterinary Medicine and Biotechnologies of Lviv),* **Yu. Pohrebniak** (*State Biotechnological University*)

SUMMARY

The article considers the use of geographic information systems (GIS) for maintaining a water cadastre in Ukraine using the example of Pidborivske Lake on the territory of Bezlyudivska united territorial community, Kharkiv district, Kharkiv region. In the conditions of partial occupation of the region and difficult security conditions, remote methods of studying the components of water management facilities are becoming especially popular. The basis of the study was geodetic surveys, which included point measurements of water levels, topographic survey of islands, as well as echo sounder depth measurements. The use of devices with an automatic compensator made it possible to perform high-quality work even in difficult conditions. QGIS and AutoCAD software were used for data processing and visualization, which made it possible to create detailed drawings with isobaths and conduct a comprehensive assessment of the facility. The proposed methodology contributes to increasing worker safety, optimizing inventory, and forms a reliable basis for the future water cadastre. The results obtained demonstrate the effectiveness of integrating modern geotechnologies into the field of water use and the prospects for further research using remote sensing.

Keywords: Water Cadastre; Geodetic Survey; Geographic Information Systems (GIS); QGIS; AutoCAD; Remote Sensing.

Corresponding Author: s.vinogradenko15@gmail.com

Introduction

The modern world has wide opportunities with the help of modern technologies and the latest technical support. Such progress and development has not bypassed our industry - geodesy. But more often such integration is found in land management and land management.

Currently, there are many sectoral cadastres in Ukraine, but their development was restrained until recently, until geographic information systems were introduced into the work of land managers. GIS systems are also relevant due to the ease of use and functionality of the tools. For example, in the State Water Cadastre, which began to be developed in the summer of 2024, there was an urgent need to travel to a certain object in the Kupyansky district, which is 30% occupied territory (Deep State Map, 2026), despite the fact that the process of studying one object of different divisions of the Regional Office of Water Resources in the Kharkiv region can take up to a week.

Thus, the use of modern technologies, updated databases, as well as space and aerial photographs makes it possible to remotely obtain a significant amount of information about water bodies and their condition, which, in turn, contributes to increasing the safety of specialists' work. At the same time, a full replacement of field research with remote methods is impossible for all areas of water management activity. In particular, groundwater research requires the use of a complex of hydrogeological, geophysical and laboratory methods. A system of specialized observations is used to monitor groundwater resources in the Kharkiv region, which is carried out on separate research sites. Based on the results of such observations, as well as laboratory research data, the Regional Office of Water Resources in the Kharkiv region and the State Agency of Water Resources of Ukraine are able to assess the current state of water resources and identify potential environmental risks. Additionally, the research process takes into account reporting data from enterprises on emissions of hazardous substances into the environment that may affect the quality of surface and groundwater.

Method and Theory

The Water Cadastre (State Water Cadastre) is a systematized summary of information on the country's water resources (CMU, 2025). Currently, the process of maintaining this professional cadastre in Ukraine is quite active due to the constant updating and improvement of relevant portals, as well as regulatory legal acts on water bodies, ponds and rivers (Siedov A. et al, 2025). Filling it with data is ongoing. As of today, it is considered a completed project and is on the website of the State Water Agency of Ukraine

According to the order of the Ministry of Ecology and Natural Resources “On Approval of the Procedure for Developing a Water Facility Passport”, the procedure for creating a water facility passport should begin, the data from the passport is later entered into the project water cadastre for accounting and actual inventory. The water management passport contains basic data that is researched and entered according to the template about the water facility or structure, including their geographical reference, water source, technical characteristics, information about the operating mode, water protection measures, as well as information about owners or users. This document is an important tool for ensuring rational use, conservation of water resources, monitoring the condition of the facility and is the basis for legal regulation of the tenant's water use *(MENRU, 2021)*. At the same time, it is important to keep records of groundwater, which is part of the water fund of Ukraine. According to current legislation, state accounting of groundwater is carried out through systematic observations of its quantitative and qualitative indicators, and the obtained data are included in the State Water Cadastre (MEPNRU, 2023).

Each section contains a description of the object with its water level at the moment, the normal support level for all time, the dead volume and the forced level, which is determined by the surveyor for the hydraulic structure. First, the specialist goes to inspect the object for a geodetic survey of the dam, spillway and/or structures, the pond itself and conducts a study of the depths of the reservoir. The team of performers moves on a boat throughout the water body and uses an echo sounder to measure the depths, for further determination of the relief with subsequent construction of isolines (horizontals) of the object (Kireitseva H., 2024; Vynohradenko S. et al.,2025).

The object of the study is Pidborivske Lake, located in the north of the village of Bezlyudivka, Kharkiv region of Ukraine. This water body is an example of the transformation of an industrial landscape into forest land, and then into water land, after the excavation of underground water sources. Water began to flow into the quarry in the late 1980s, since then a water body with an area of 62.3490 hectares has begun to form. In order to preserve the natural environment and prevent the resumption of quarrying on the territory of the community, priority tasks have been identified for the transfer of the object from state to municipal ownership. To implement the lease procedure, it is necessary to develop a passport for the water body, which confirms its belonging to the water fund of Ukraine and certifies its environmental and economic significance for the Kharkiv region (RWRO, 2025).

Field geodetic measurements were carried out during the day under favorable weather conditions for visibility and permissible temperature indicators. When performing surveying work, an electronic total station "South" was used, with the help of which the planned-height base of the territory was created. One of the important requirements for the equipment used during field work is the presence of protection against moisture and precipitation, since measurements are often performed in difficult natural conditions and near water bodies.

Based on the results of field research, office work was performed. To assess the accuracy of measurements, an analysis of angular and linear residuals is performed, after which the detected errors are distributed between points in accordance with the accepted methods of leveling geodetic networks. The determination of the normal support level is found out by analysis and interpolation from topographic materials with contours on a scale of 1:10,000. The level of dead volume and the forced support level are determined after the spillway structure (pipe, trough or well located in the middle of the dam).

Results

The first stage in the implementation of a practical task for geodetic support of surveying such a reservoir was a field trip and development of drawings. Field trips and geodetic surveys of the object were described above, so in this section we will consider how drawings are developed for inventory in the water cadastre using QGIS and AutoCAD software (Siedov A. et al, 2025). First, you need to set up the project in the QGIS software in the appropriate coordinate system (USK-2000). In the future, a polygon is created, with which the necessary manipulations are carried out during the subsequent stages of work and solving tasks.

Later, a group of surveyors on a business trip travels across the lake by boat and sends via messenger the coordinates of the points whose depths they determined during the measurements. These coordinates are plotted on the project map using the “Lat Lon Tools” plugin in QGIS and signed with the “Label” function, for convenience in further calculations and easy orientation in the drawing. Figure 1 shows this procedure.

To calculate the heights and create further isobaths (horizontals), we took a map cutout with real heights and isolines already created by the Water Resources Office in Kharkiv Oblast, where we determined the absolute elevation of the hydraulic structure, from which the normal reservoir support level is then calculated (MENRU, 2021). The other values of the elevation points were determined using a simple formula:

$$\boldsymbol{Pel = NSL - Pd}$$

where, Pel – the elevation point that needs to be determined, NSL – the normal reservoir support level, which is constant, Pd – the depth point measured on the ground.

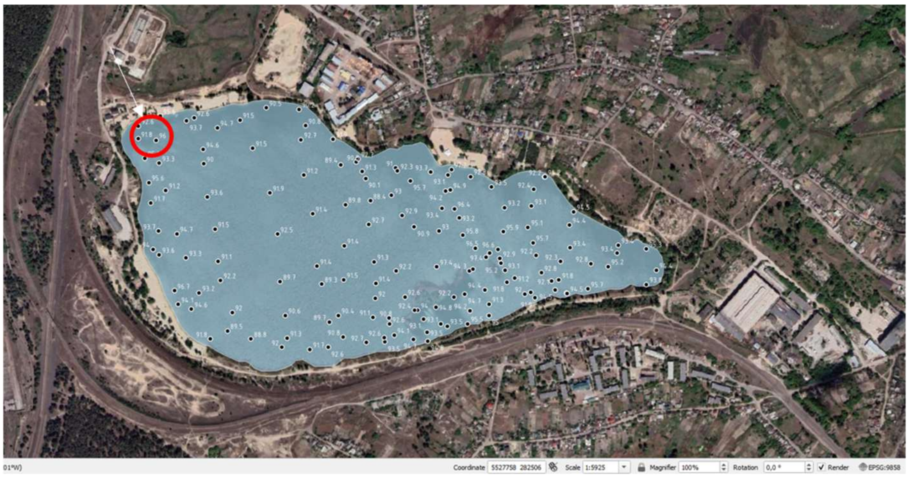

Figure 1. The result of plotting depth values by coordinates on the map

This formula was entered into the corresponding field of the attribute table in QGIS, to automatically list all points (over 100 points). Subsequently, the necessary information was selected and distributed to the appropriate thematic layers. This data is exported to the *.dfx file type for further processing in the AutoCAD software product. In this application, it is technically possible to apply isobaths not with a polygonal, broken line, but with a smooth one, to reflect the real situation on the ground and perform other graphic operations.

To create such lines, it is necessary to conduct a detailed analysis of depth points, perform interpolation of elevations and design isobaths in the software environment in accordance with the results of data processing. The significant area of the studied water body and the large volume of initial information significantly complicated the process of desk processing. It is because of this that it can be seen, as an example, how important and possible the combination of geotechnologies and software is for performers of different levels of training.

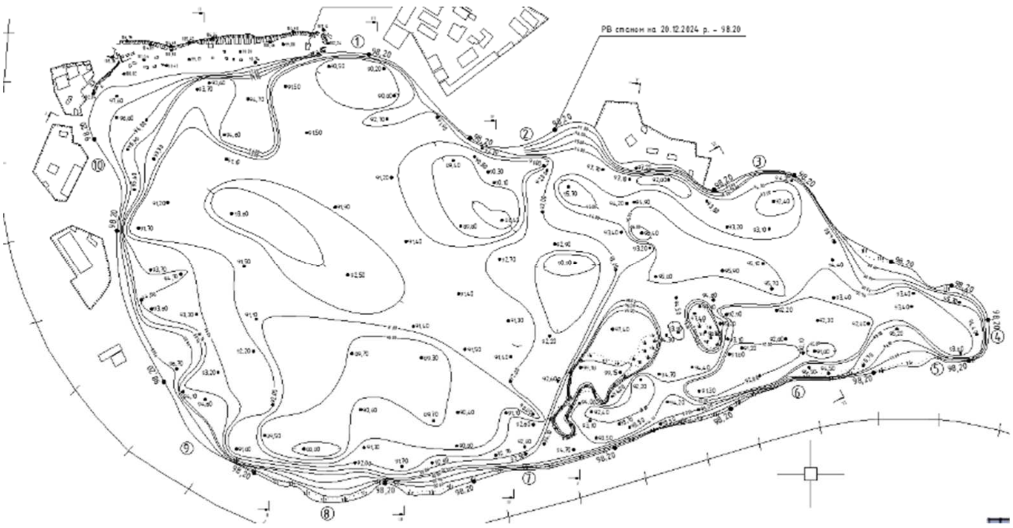

Figure 2. *The finished result of the study: Lake Pidborivske with depth markings and isobaths (horizontal lines)*

Conclusions

The study confirmed the effectiveness of combining QGIS as a geoinformation technology and AutoCAD as an automated graphic and geodetic product. When forming the information base of the water cadastre on the example of Pidborivske Lake, the use of modern geodetic equipment, as well as the use of software complexes ensured the receipt of data and their visualization with a high level of accuracy. The obtained materials can be used when maintaining the state water cadastre, developing measures to protect water bodies and making management decisions regarding their rational use. Of particular importance is the integration of such data with information on groundwater, which is an important component of the water resources of Ukraine. Systematic monitoring of aquifers, analysis of their qualitative and quantitative state, as well as the inclusion of relevant information in cadastral databases will contribute to more effective management of water resources and prevention of their depletion or pollution.

A promising direction for the further development of the water cadastre is the wider implementation of remote sensing technologies and modern geoinformation platforms. The use of satellite data, unmanned aerial vehicles and digital terrain models will increase the efficiency of information updating and the quality of accounting data. Further scientific research should be directed towards improving methods for integrating heterogeneous geospatial data, automating their processing processes and creating unified information systems that will cover both surface and groundwater to ensure comprehensive and sustainable water resources management.

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