CREATING 3D MODEL AND BATHYMETRIC CONTOUR MAP USING A MODERN TOPOGRAPHICAL APPROACH

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***Abstract**: Bathymetry is the science of determining the topography or shape of the rivers, lakes, seas, or the ocean floor, is the underwater equivalent to hypsometry or topography. Originally, bathymetry involved the measurement of water depth through depth sounding. Early techniques used a pre-measured heavy rope or cable lowered over a ship's side. This technique measures the depth, only at a single point at a chosen moment, and so it is inefficient. It is also subject to movements of the ship and currents moving the line out of true and therefore it is inaccurate. The data used to make bathymetric maps today comes usually from an echosounder (sonar) mounted beneath or on the side of a boat, "pinging" a beam of sound downward at the seafloor or from remote sensing LIDAR or LADAR systems. In this paper the authors explain the principle and a method regarding this aim used to create a 3D model both on land and underwater.*

***Keywords:** Bathymetry, bathymetric contour maps, 3D model, GPS survey.*

1. Introduction and background information

Romania has many areas with lakes, rivers and also see. In most of the cases these areas are well known territorially but for the most of these cases there aren't so many studies regarding the bottom of the water and the shape of the "seafloor ". The science who solves this aspect is bathymetry and in simple words it can be said that "Bathymetry is the science of measuring the depth of water" or at least this is what it used to be. The results of bathymetric measurement are bathymetric maps and these is the process of mapping depths of oceans, seas or other large quantities of water. Sailors and fishermen use bathymetric maps to guide them and prevent shipwrecks. Two of the ways scientists use bathymetric maps are to understand currents and to predict where tsunamis may inundate the land.
One of the first representation of sea floor is close to Figure 1.

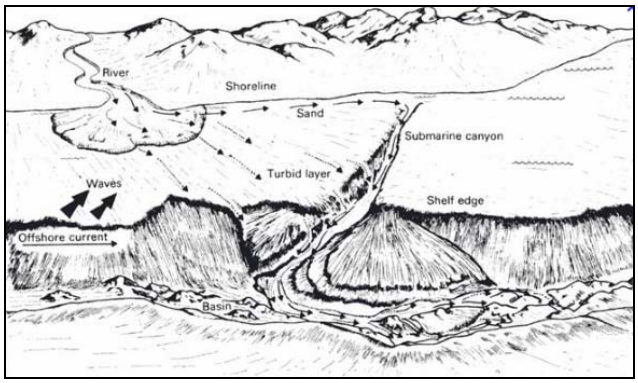

Figure 1. Map with the representation of topography

Nowadays bathymetric information is of fundamental importance to coastal and marine planning and management, nautical navigation, and scientific studies of marine environments and also from economical perspective of using natural resources on the coast.

2. Analysis and methods of measuring cost and lake floor

For our study we have chosen the water storage basin called Rediu, located on the Martine□ti creek, left affluent of Racilor, situated upstream from the village of Martine□ti, Cluj county.

Figure 2. Storage basin Rediu

In the data aquisition process have been used more types of measurements, which had the objective, both the lake itself and the adjacent area. The terrestrial measurements have been realized with the GPS Leica GPS900 CS through the procedure RTK radio. After having preliminarily determined the most favorable time frame for realizing the measurement using the Leica Geo Office software, it has been stopped using a stable GPS in a point of known coordinates and by using a mobile GPS has been measured the detail point to obtain the map scale table. The bathymetrical measurements have been done using a motor boat, having installed a Garmin GPS map 178c Sounder sonar on it, to which GPS technology is also adapted. This sonar offers the possibility to the user to measure in real time through the correlation of data provided by the two components. Data is being collected in different systems of reference, meaning that depth is also associated to a GPS point with determined coordinates. The device can be configured differently depending on the provided density of the points. For this paper I have set the sonar to make a determination at every 3 seconds. Since the effective reading data time is less than one second, the constant speed of movement of the craft is of approximately 10 km/h.

The data provided by the GPS component of the system can be also used for the navigation of the craft. The navigator has the possibility to define before starting the measurements the so called drilling lines, that can allow the realization of a uniform points network. If this option is not used, cardinal points or other steady points from the area should maintain a navigation course, which should ensure the coverage of all studied areas. The positioning of the boat is made in the Stereografic 1970 system with an incorporated GPS system and it can use up to 12 satellites simultaneously, for a better accuracy. The accuracy of

the sonar is influenced by the depth of the water, which in our case is of maximum 10 meters and this is how we have achieved an accuracy of 0,1-0,2m.

Figure 3.The path of the craft

3. The realization of the digital model and the interpretation of the results

After the completion of the data acquisition process follows the processing stage. It is a stage, in which the operator has the possibility to check, if errors have occured in the measurement stage.

Taking into consideration that so many measurements have been made, both terrestrial and bathymetric, their initial processing, which consisted in obtaining the coordinate inventory of the measured points, has been done with different programs. With the Leica Geo Office Combined software have been downloaded the data taken over by the Leica GPS900 CS , while the bathymetrical measurements have been processed by using the Map Source software. It has been obtained a set of points of the coordinates E,N,H , located in the same Stereographic 1970 projection system, which was the basis of the entire realization process of the digital model.

Such a set of data can be exported in different CAD or GIS programs, like MAP SOURCE, MAP INFO, SURFER 8, AUTOCAD, etc.

In the present case, the decision of using the SURFER 8 software has been made, because it allows the realization of complete reports and it offers the possibility to control the calculation parameters.

The plans with level curves generated by Surfer can be customized as required, by changing the intervals, the thickness, the coloring and the labeling of the level curves. The surfaces can be colored according to the level, after a scale of colours or striped, in order to create plans prepared for printing and publishing. The labeling of curves is done at ranges given by the user or through positioning along the curve.

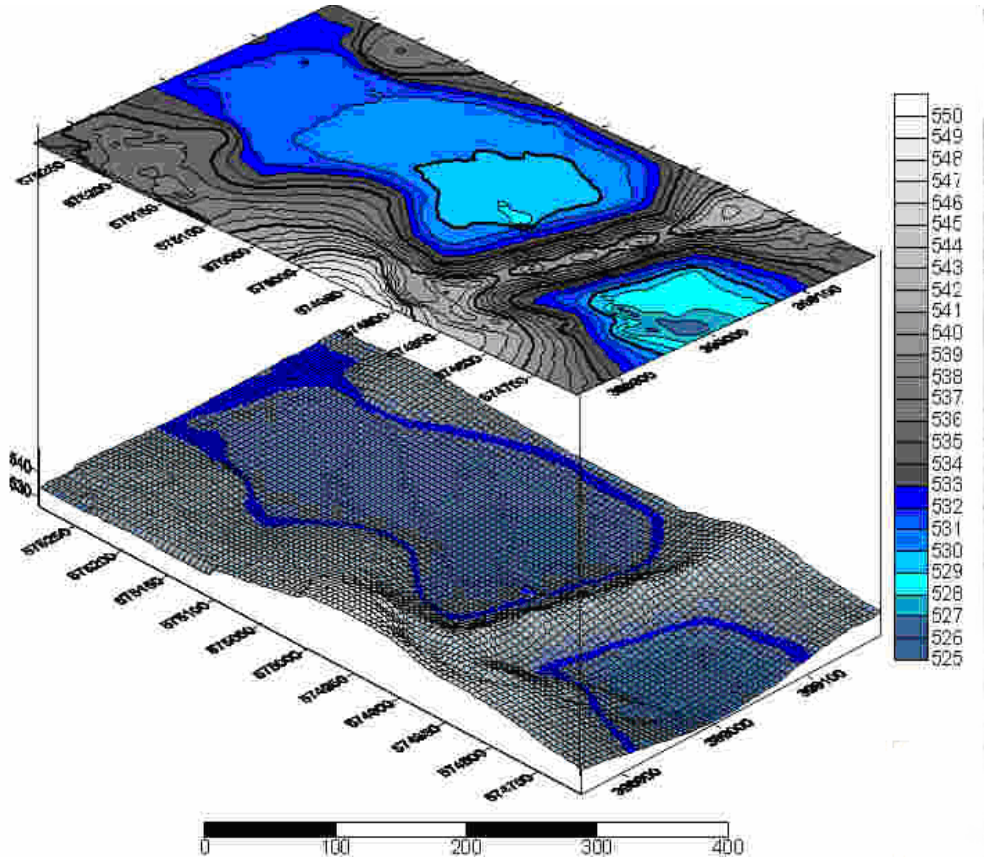

Figure 4. The 3D model – superposing the maps

By superposing the maps, these can be aligned in horizontal direction. The role of superposing is the alignment of the maps, which are in similar coordinate systems. The command allows the display of two or more separate maps in vertical direction, but at the same time they keep their horizontal alignment relatively. After generating the 3D model we can obtain any desired vertical profile by intersecting it with a plan in that position. This doesn’t require the alignment of the measured points in profiles, while by interpolation the level is automatically determined in the desired position. In order to determine the volume of water from the storage, the exact knowing of its bottom is necessary. The wave emitted by a sonar has the capacity to detect what type of surface is found on the lake floor and so the extent of silting could be determined.

The proposed measurement method allows obtaining a relatively large number of points of the border of the lake basin with a relatively low economic effort.

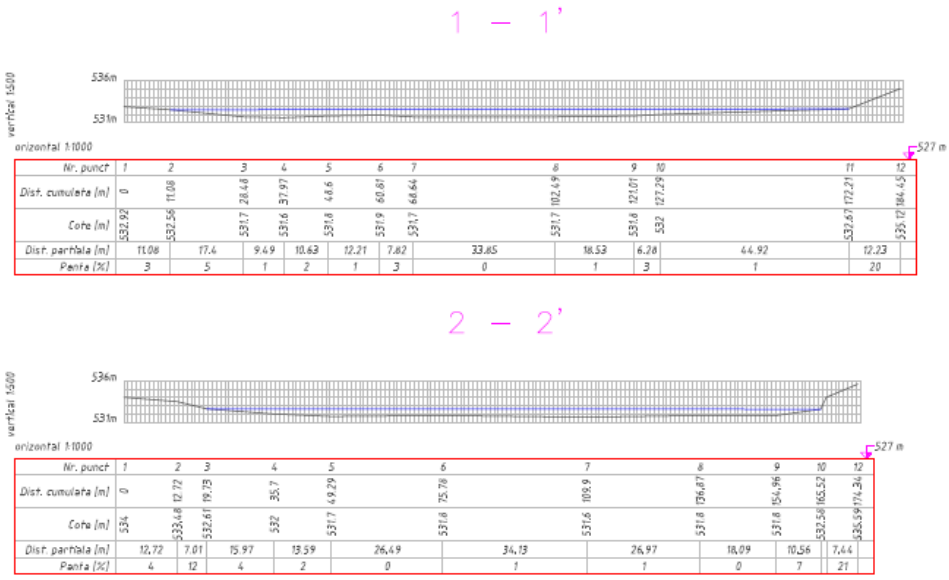

Figure 5. Sectional area

4. Conclusions

Creating a 3D model using the bathymetrical measurements is being done by considering the accuracy of the required data. This can be obtained mainly by using equipment according to the technical specifications, which accompany the device. Therefore it is very important to synchronize and correlate the determination of the position provided by the positioning system with the depth value. Considering that we have set the sonar to record at every 3 seconds in areas, in which the speed of the craft was lower than 10 km/h, the density of the points increased.

The measurements of water depth were corelated with land measurements and the 3D model was created both for the land area and underwater and thus we can say that representation of the model is complete.

The main purpose of this paper was to determine the water volume. Because measurements have been also carried out in the adjacent area of the lake, the water volume could be calculated according to different levels, at which water has been found in the dam. Many situations could be anticipated, because the created 3d model can be intersected with the same number of horizontal sections, that could represent the water level in certain situations.

The reflection of sound signals from the bottom can help us to determine the degree of clogging. With bathymetric measurements can be monitoring this degree.

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