PRECISE GEODETIC AND HYDROGRAPHIC MEASUREMENTS IN KARST AREAS

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ABSTRACT

Recent advances in GPS-technology (GNSS) enable hydrographic surveyors to capture the topography of the bottom and the water surface with even more accuracy. Faculty of Geodesy, University of Zagreb, recently acquired the latest technology for performing the precise hydrographic surveying: Trimble R8 GNSS receiver that is going to be used with already used echo sounding equipment. The GSM signals are used for transmitting corrections from the base station to the rover. Thus, it is possible to use single-frequency DESO 14 for two-frequencies bathymetry through repeating the course of the vessel on exactly the same points with both transducers. It is expected that the new technology shall yield more accurate results and increase measurement speed, because the OTF times should be significantly shortened.

INTRODUCTION

During last 7 years, scientists from the Faculty of Geodesy of the University of Zagreb are performing precise geodetic and hydrographic measurements in the National Park Plitvice Lakes. This area is listed as UNESCE World Heritage and has been proclaimed as International Geodynamic Test Area during the Scientific Meeting in Dubrovnik 1998. The main phenomenon of the lakes is the formation of travertine, which builds the bareers between the lakes. Changes in water level or travertine sediments are scientifically interesting question, since the existence of the lakes depends on these changes. Therefore, as a part of CERGOP2/Environment project, a number of measurement campaigns has been performed. In this paper, we are describing the usage of latest positioning technology combined with bathymetry performed by echosounders with two frequencies.

HYDROGRAPHIC SURVEYING EQUIPMENT

The equipment consists of ATLAS DESO 14 surveying echosounder with two transducers: one with high frequency (210 kHz) and second with low frequency (33 kHz).

The position of the transducer is determined with Real Time Kinematics GPS pair of Trimble R8 receivers, the latest word of wireless positioning technology, which - in addition to standard radio system - can use GSM signals for transmitting corrections from the base station to the rover. During the season 2006/2007, the latest GNSS R8 Trimble receiver was used, excelling in fast initialization.

Hydrographic software Hypack-MAX is used on a laptop computer for planning and combining bathymetric data gathered with echosounder and position data from GPS. Calibration of above mentioned equipment was conducted in laboratory conditions at Brodarski institut Zagreb. According to (Lurton, 2001), this step is necessary for accurate measurements under water.

HYDROGRAPHIC MEASUREMENTS

At Plitvice Lakes, the lake Kozjak and lake Proscansko have been measured with the combination of GPS reciever and echo-sounder. The advantage of this approach is that with the high frequency (210kHz) - echo bounces of the closest bottom layer, while with the low frequency (33kHz) - signal penetrates the mud and soft bottom layer and echo bounces of the hard bottom layer (rock), as shown on the Figure 1.

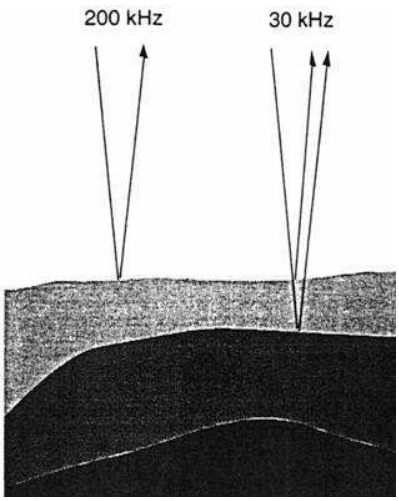

Figure 1. Two frequency bathymetry principle

The position of the transducer is determined with Real Time Kinematics GPS pair of Trimble R8 receivers, thus, it is possible to use single-frequency Atlas DESO 14 for two frequencies bathymetry through repeating the course of the vessel on exactly the same points with both transducers. Compared to the methods of terrestrial classical surveying (Ingham, 1992)

Navigation over the same tracks is successfully performed using hydrographic software Hypack MAX. The software was used not only to process the data but also for planning the measurements. Boat sails over predetermined survey lines simultaneously determining position (GPS/RTK) and depth (echo-sounder).

Figure 2. Measuring equipement: GPS/RTK base station

Two frequency bathymetry enabled collecting information about the thickness of layers on the lake bed. Results give new insight in hydrological processes in the lakes. Preliminary results of data analysis show places of high concentration of mud, and also show possible correlation between faulting on the Plitvice lakes area, and high peaks in residual model of two frequency bathymetry.

The model has been produced by geostatistical method of kriging (Cressie, 1991). This method preserves the values of measured depths (or any other attribute) in points of measurements. The spatial interpolation is done using the weights obtained by semi-variogram model.

The processing revealed anomalies in several places at Kozjak lake. The depths measured by lower frequency transducer were very large, indicating possible cracks at the bottom of the lake. Fig. 3 shows the spatial distribution of depth anomalies, while a typical cross-section is shown on Fig. 4.

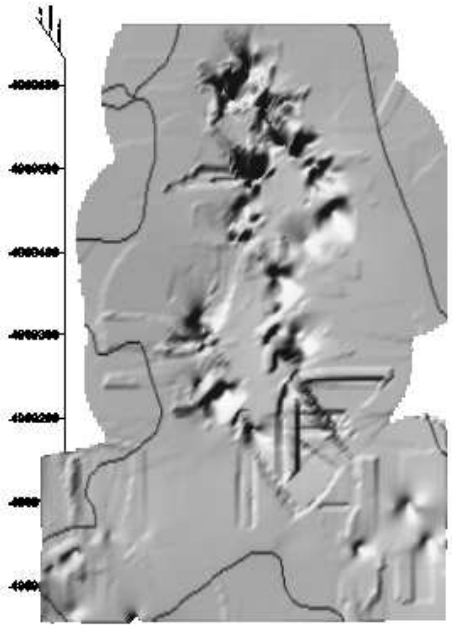

Figure 3. Residuals between high and low frequency measurements

Figure 4. Cross-section of residuals between high and low frequency measurements

CONCLUSIONS

The combination of GPS/echosounder measurements with two transducer frequencies have shown that the lake bottom is not built of compact material, but the thick layer of material is present. Monitoring of this layer through repetitive measurements using the modern hydrographic instruments is necessary to gain more insight about the past, present and the future of the travertine formation in the international geodynamic test area of the Plitvice lakes. Determination of surface evidence of faulting and creation of structural map and further hydrographic investigations may show mutual correlation. This project confirms the hypothesis that a multisensor measurements can be used for environment protection purposes. Anomalies in depths measured by the lower frequency transducer deserve further research.

REFERENCES

Cressie, N. (1991): Statistics for Spatial Data. John Wiley & Sons, New York.

Ingham A.E: Hydrography for the Surveyor and Engineer. Oxford, Blackwell Scientific Publications; London. Third edition revised by V.J.Abbot 1992.

Lachapelle, G.: Hydrography. TU Delft, Netherlands 2002.

Lurton, X. (2002): An Introduction to Underwater Acoustics; Principles and Applications Springer.

Medak, D., Pribičević, B.: A Dynamic Three-dimensional Model of the National Park Plitvice Lakes, Barriers and Tributary Streams. UNESCO World Heritage Project Final Report Contract No. 700.759.9. Zagreb, Pariz 2000.

Medak, D., Pribicevic, B. Boško (2004): Research on the International Geodynamic Test-Area Plitvice Lakes within CERGOP-2 Project // Reports on geodesy / Warsaw University of Technology, 81-88.

Pribicevic, B., Medak, D. (2001): Programe of Geodynamic and Environmental Studies in the Region of Plitvice Lakes. Proceedings of the EGS G9 Symposium "Geodetic and Geodynamic Programmes of the CEI (Central European Initiative)", Nice, France 25-30 March 2001. Reports on Geodesy No.2. Warsaw University of Technology, 219-224.