

# **TWO-FREQUENCIES BATHYMETRY OF PLITVICE LAKES**

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## **ABSTRACT**

Faculty of Geodesy, University of Zagreb, recently acquired the latest technology for performing the precise hydrographic surveying. 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. 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. The results of the application of this method in measuring two lakes in the National Park Plitvice Lakes are shown in this paper.

## **HYDROGRAPHIC SURVEYING EQUIPMENT AND FACILITIES**

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).

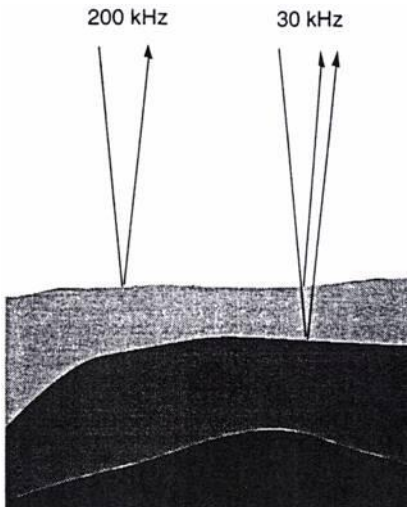
The position of the transducer is determined with Real Time Kinematics GPS pair of Trimble R8 receivers, the latest word of wireless positioning technology, which - in addition to standard radio system - can use GSM signals for transmitting corrections from the base station to the rover.

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.

## **MEASUREMENTS ON LAKES KOZJAK AND PROSCANSKO**

At Plitvice Lakes, the lake Kozjak and lake Proscansko have been measured with the combination of GPS receiver 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.

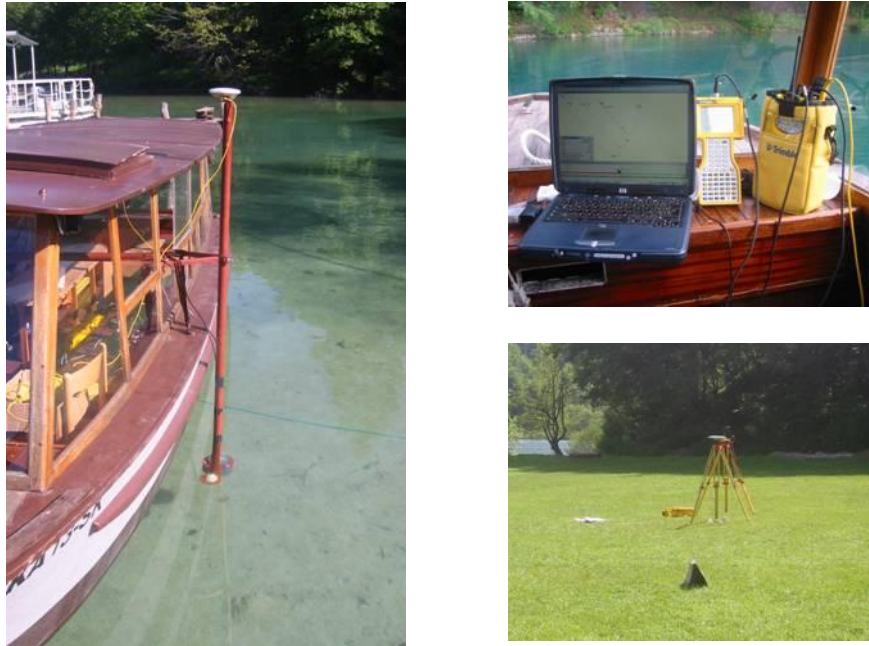


**Figure 1. Two frequency bathymetry principle**

**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.**

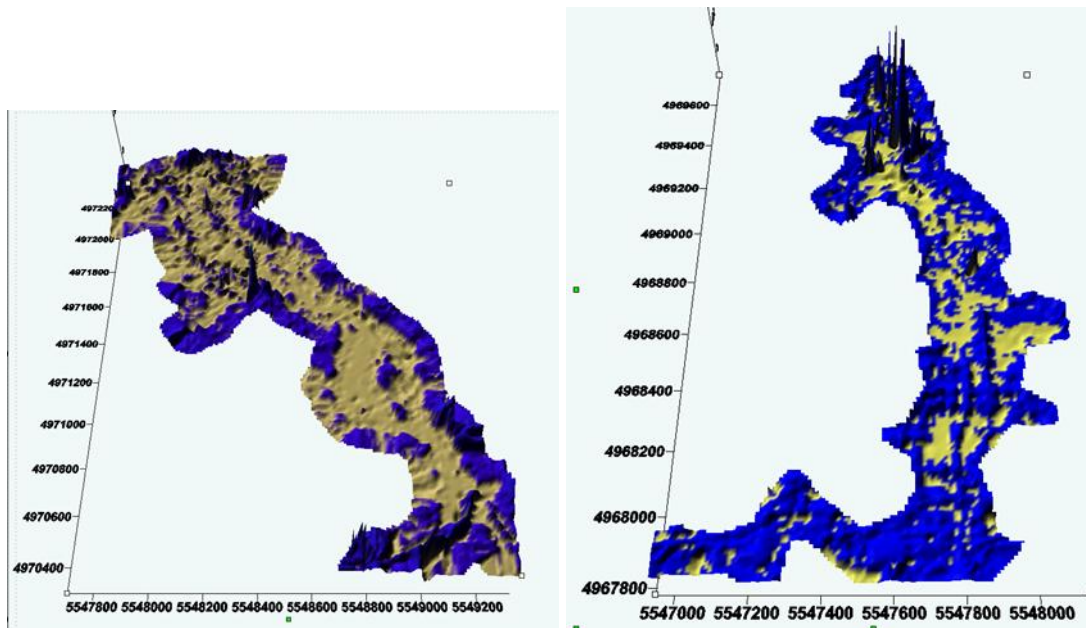
**Points of GPS network were used as base points for RTK-supported bathymetry and will be used for geodynamic measurements.**

**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 equipment: GPS/RTK combined with echosounder**

**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.**



**Figure 3. Residuals between high and low frequency measurements on lakes Kozjak (left) and Proscansko (right)**

## **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.

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