Hydrographic Control Measurements of Sediment in the Accumulation Basin of the HPP Salakovac using Multibeam Echosounder

Bosko PRIBICEVIC, Almin DAPO and Branko KORDIC, Croatia

Key words: hidrographic measurement, multibeam echosounder, Neretva river, HPP Salakovac

SUMMARY

This paper describes the work of hydrographic surveying reservoir basin HPP Salakovac for control measurements of sediment. HPP Salakovac is located on the Neretva River in the Republic of Bosnia and Herzegovina. It was necessary to conduct hydrographic survey of the bottom of the reservoir and the coast from the HPP Grabovica to HPP Salakovac in total length of about 25 km, and the tributaries. The average width of the accumulation basin is 150 meters, with depths up to 40 m and the flow rate at the HPP Salakovac up to 860m3/s. Hydrographic survey performed by the Faculty of Geodesy, University of Zagreb. For hydrographic survey was used multibeam echosounder Odom ES3-M. Measurements performed by the multibeam echosounder are to be compared to the initial survey done before the establishment of the accumulation basin and should be used to create the recent model of the accumulation and as control measurement of the sediment in the accumulation.

Hydrographic Control Measurements of Sediment in the Accumulation Basin of the HPP Salakovac using Multibeam Echosounder

Bosko PRIBICEVIC, Almin DAPO and Branko KORDIC, Croatia

1. INTRODUCTION

This paper describes the work of hydrographic surveying reservoir basin Hydro Power Plant "Salakovac" for control measurements of sediment.
Area of the river Neretva basin is one of the most important in Bosnia and Herzegovina from the standpoint of energy. The morphology of the terrain in the area of the basin and uneven precipitation in winter and spring period cause the sudden occurrence of floods with significant flows.
HPP Salakovac is located on the Neretva River in the Republic of Bosnia and Herzegovina, Neretva Canton, 15 km upstream from the town of Mostar. It is the dam power plant with a 70m high gravitation dam and it has installed power of 210 MW (three sets) and average annual production - 410 GWh. Construction of the Hydro Power Plant lasted from 1977 to December 1981. HPP "Salakovac" is connected to the power system with 220 kV transmission line: HPP "Salakovac-Kakanj" and HPP "Salakovac - Mostar 3". Reservoirs of the Hydro Power Plant cover the Neretva River and all its tributaries upstream of Salakovac to HPP Grabovica.
It was necessary to conduct hydrographic survey of the bottom of the reservoir and the coast from the HPP Grabovica to HPP Salakovac in total length of about 25 km, and the tributaries. The average width of the accumulation basin is 150 meters, with depths up to 47 m and the flow rate at the HPP Salakovac up to 860m3/s.
Last survey of the HPP Salakovac basin was done prior to the building of the dam of HPP Salakovac in 1969 with 47 cross sections and and in 1977 the tributary Drezanka, which is errosioanally active and the main sediment supplier to the basin, was surveyed with additional 35 cross sections. So, the initial survey of the accumulation basin consisted of the 82 cross sections of the river Neretva canyon. The new survey needs to establish the 3D model of the current situation of the accumulation basin and to compare with the initial survey in order to determine the difference. The Figure 1. shows the 25 km accumulation basin of the HPP Salakovac with the position of the initial cross sections.
Hydrographic survey performed by the Faculty of Geodesy, University of Zagreb. For hydrographic survey was used multibeam echosounder Odom ES3-M. Measurements performed by the multibeam echosounder are to be compared to the initial survey done before the establishment of the accumulation basin and should be used to create the recent model of the accumulation and as control measurement of the sediment in the accumulation.

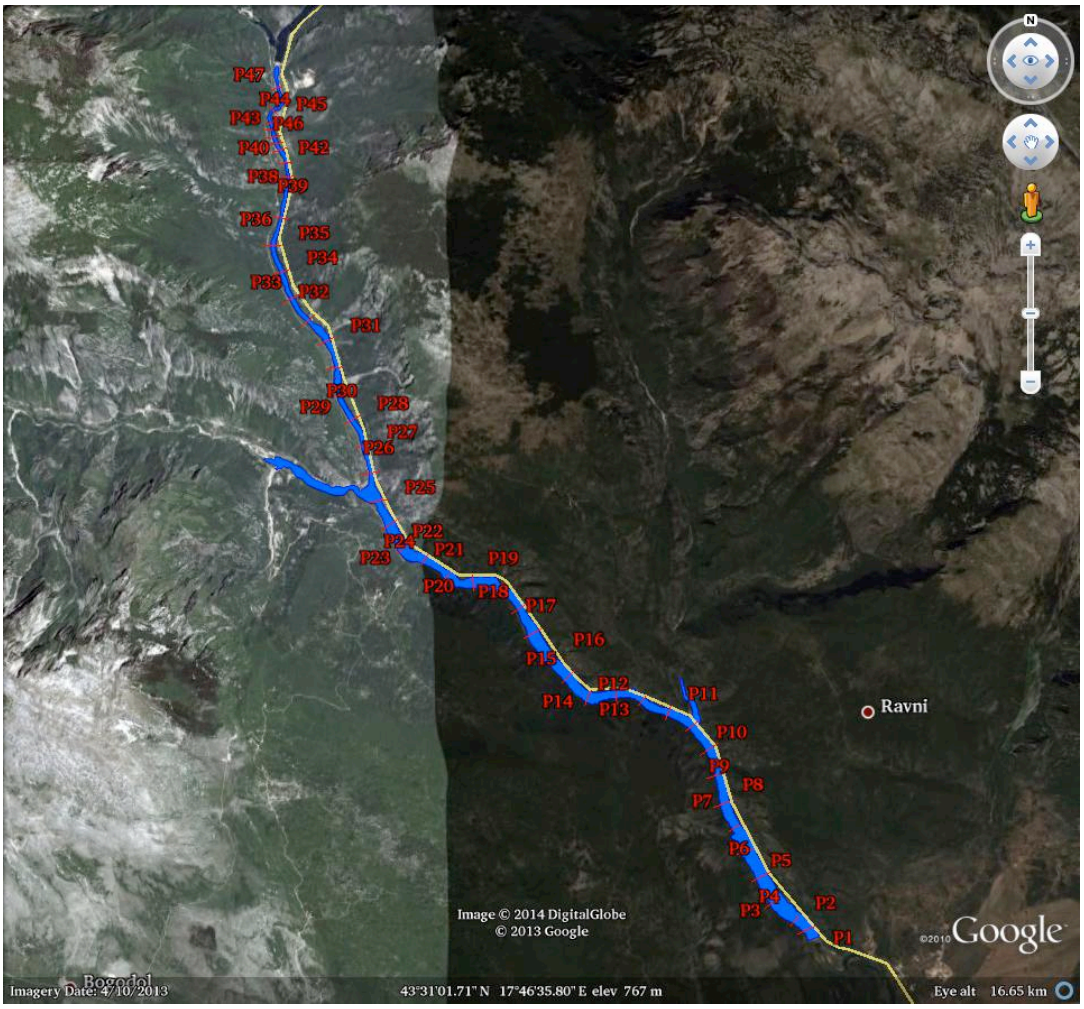


Figure 1. The 25 km accumulation basin of the HPP Salakovac with the position of the initial cross sections

2. MULTIBEAM MEASUREMENT IN THE ACCUMULATION BASIN

Hydrographic survey performed by the Faculty of Geodesy, University of Zagreb. For hydrographic survey multibeam echosounder ES3M Odom with TSS DMS 25 motion sensor and heading sensor 100 Hemisphere was used, and Trimble R8 GNSS RTK was used as a positioning device. The main characteristics of this system are the compactness and functionality that allow it to be installed on a small boat. This is made possible by setting up complete system on a common adapter, which allowed removing the error of determining the offset between the individual sensors (URL 1).
Field measurements were carried out in the period 23.-26. of September 2013. The system is installed on the ship to maintain accumulation basin obtained from HPP showed on the Figure2.
Prior to start of measurements with multibeam echosounder it was necessary to calibrate the system with the patch test. The patch test procedure is the first stage required in any

multibeam echosounder survey. The patch test is designed to precisely determine the static configuration of the sonar head (roll, pitch, yaw) and the latency remaining between the reception of the GPS fix and its integration by the acquisition system. An imprecise knowledge of these four values introduces bias when computing the real 3D geographic location of each beam. In the proposed patch test program, these four values are sequentially computed, according to tailored track acquisitions. An extended set of measured information is involved, such as the dynamic attitude, position and heading of the support ship, the geometric offsets of each acquisition unit (MRU, GPS, MBES, compass) and some environmental features (sound velocity profile). The computation mainly relies on performing a matching between specific sea-bottom profiles extracted from each overlapping track. (Gueriot et al. 2000).
During measurements, areas designated for fish farming were bypassed, and areas that are shallow to measure with multibeam echo sounder and those which for security reasons was not possible to measure were measured with single beam echosounder. Three days of survey was necessary to cover the basin.

Figure 2. Dam service boat performing multibeam measurement on Neretva

3. ANALYSIS AND RESULTS

Analysis of the data was conducted using HypackMax-Hysweep software (URL2). Processed and cleaned data was exported and the 3D model of the accumulation basin was created using Autodesk Civil 3D. Figure 3 shows the part of the 3D model of the basin.

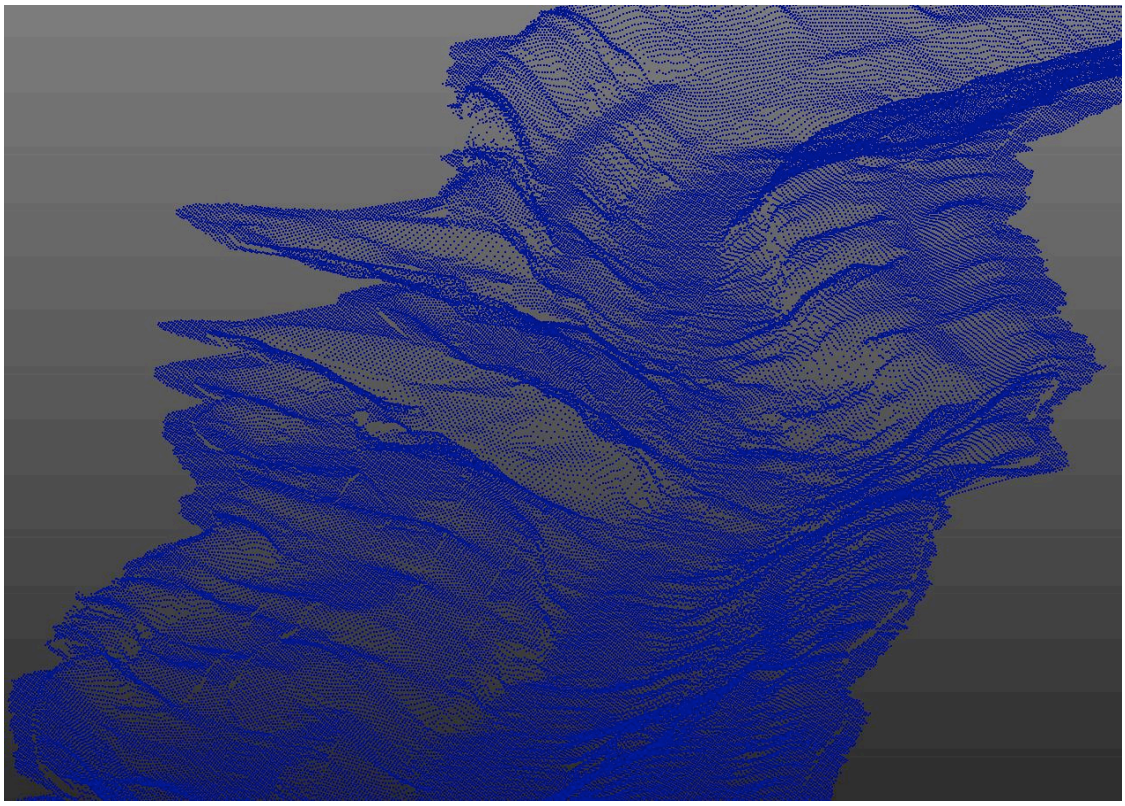
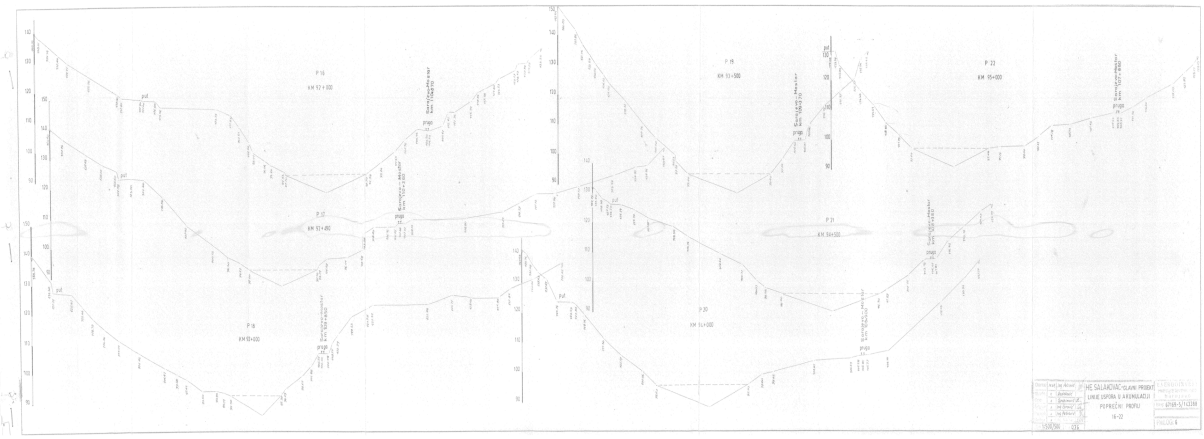


Figure 3. Part of the 3D model of the HPP Salakovac accumulation basin

Survey measurements form 1969 in the form of the 82 cross sections were digitized in the Civil 3D and compared to the new cross sections created from the new model of the basin which was created from multibeam measurements. The figure 4 shows the scanned images of the surveyed cross sections of the accumulation basin from 1969 (HPP Salakovac Archives).



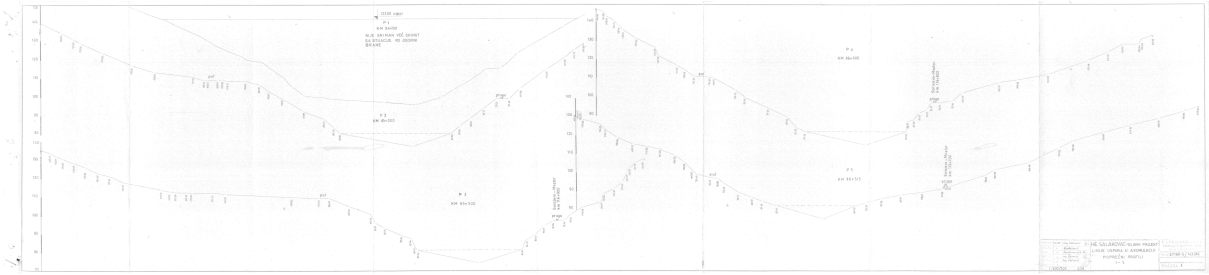


Figure 4. Scanned images of the initial survey of cross sections from 1969.

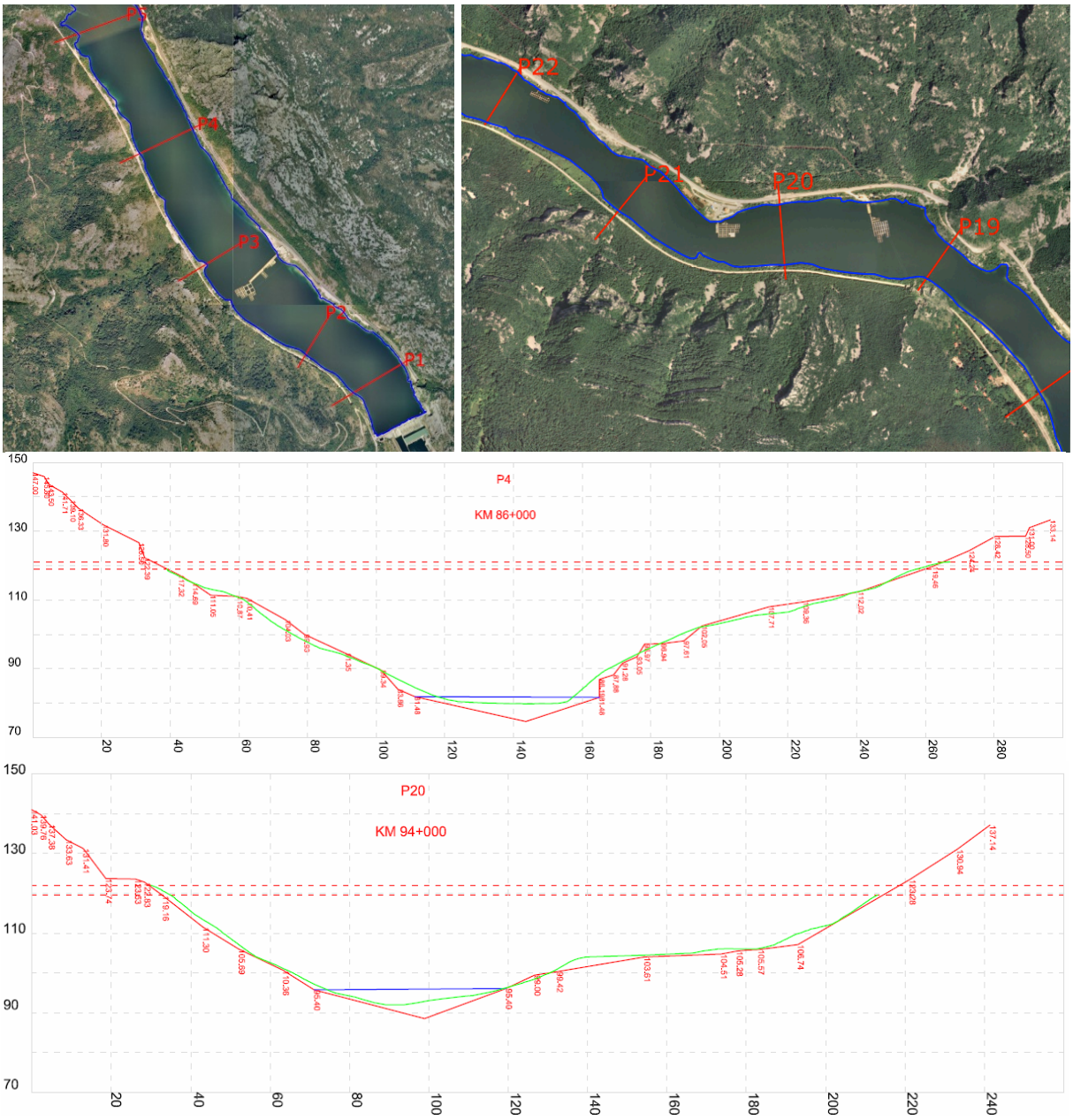


Figure 5. Comparison of the cross sections from 1969 and 2013.

Figure 5 shows the comparison of the cross sections from the survey conducted in 1969 prior

to establishment of the accumulation basin and new multibeam survey conducted in 2013. Red line represents the 1969 measurement and the green line is the bottom line from 2013 multibeam survey. Water line form 1969 is shown in blue line. Two dashed lines represent the water level at the time of measurement and the max water line on the dam crown at 123 m.

4. CONCLUSION

For the purpose of hydrographic control measurements of sediment in the accumulation basin of the HPP Salakovac multibeam echosounder was used. This technology enebled acquiering milions of underwater points of the accumulation basin with high density and creation of precise 3D model of the basin. In this way it was possible to compare the initial survey data of the basin form 1969 wit h the current situation. The results presented in this paper clearly show the difference between the two. The bottom line is now much smoother due to 40 years of river flow and layer of sediment on the bottom which can be recognized form the survey comparison between 1969 and 2013. The results are yet to be confirmed by subbottom profiling which is scheduled to take place in near future and the 3D model of the accumulation basin of the HPP Salakovac created from the multibeam measurement will now serve as the reference for future control measurements.

REFERENCES

URL1: http://www.odomhydrographic.com/
URL2: http://www.hypack.com/
Gueriot, D. Chedru, J. Daniel, S. Maillard, E. (2000): The patch test: a comprehensive calibration tool for multibeamechosounders RESON Inc., Goleta, CA; OCEANS 2000 MTS/IEEE Conference and Exhibition Vol. 3, p: 1655-1661
HPP Salakovac archives – main project – Energoinvest, Sarajevo 1969 (Br. 67169-5/143388).

BIOGRAPHICAL NOTES

Branko Kordić was born on June 07. 1979. in the town of Rijeka in the Republic of Croatia. He has a M.sc. degree in geodesy and geoinformatics, and works as a research assitant at Faculty of Geodesy, University of Zagreb, where is also a Ph.D. student. He has 12 years of experience in the field of geodesy and geoinformatics. In that time he worked on large number of projects in different fields of geodesy and geoinformatics.

CONTACTS

Branko Kordić, dipl.ing.geod.
University of Zagreb, Faculty of Geodesy
Kačićeva 26, Zagreb
CROATIA
Tel. +38514639466
Fax + 38514639414
Email:bkordic@geof.hr
Web site: www.geof.hr