Bathymetry generation using sonar and satellite imagery

Introduction
Bathymetric information on lakes and reservoirs is important in hydrology. Besides water level – volume – lake area or stage curve relationships, multi-temporal comparison between bathymetries is an indicator for environmental changes like lake or reservoir sedimentation. From this information, lake ecosystem functioning, life times of reservoirs or erosion - sedimentation rates of catchments can be derived. Monitoring lake bathymetry has become attractive using recent advances in Global Positioning Systems, portable sonar sounders and remote sensing data. A methodology for rapid bathymetric survey and map generation, developed by the International Institute for Geo-information Sciences and Earth Observation (ITC) is described.

Methodology
Generation of a bathymetric surface or map basically consists of 3 parts: geo referenced depth data acquisition, generation of a bathymetric surface using interpolation methods and verification of mapping accuracy.

Data acquisition
Water depths are registered using a portable sounder connected to a Global Positioning System (GPS) installed on a small boat. The sounder uses a single frequency transducer of 200 kHz to measure the distance from sensor to lake bottom with an accuracy of 10 cm. The GPS records both the location coordinates and the depth measurement of the sounder. Depending on the type of GPS used (DGPS, WAAS-enabled GPS, and handheld GPS), the location can be measured with an accuracy varying from 15 meters to a few centimeters. Also pending the type and cost of the sonar instrument, varying from 15 meters to a few centimeters. Also pending the type and cost of the sonar instrument, the accuracy of the interpolation, the spilt data approach was used. The full sonar data set is randomly split into 2 sets; 1 set containing the data for interpolation (e.g. 80% of the total number of points), and 1 control set (e.g. 20% of the total number of points).

Data verification
The accuracy of the interpolation was then assessed by correlating the interpolated surface with the independent control point data set. A regression evaluation line is fitted and the root mean square error and rotational error is determined. All bathymetric studies by ITC show a correlation of 98 – 99% and little rotational error. A comparison between 2 bathymetric maps made 7 months apart in Poland at different water levels show a very good reproducibility of the measurements. This indicates the high accuracy of the methodology and equipment used and the usefulness of this application for comparative studies.

Conclusion
Rapid generation of lake or reservoir bathymetric maps using a GPS connected portable sounder and satellite imagery creates highly accurate maps. If the equipment is well operated, lakes that are difficult to access can now be surveyed using little time and with no need for complicated equipment or a specialized boat. Using the ITC methodology, hydrologists can now update their knowledge on lakes using little time and financial resources.

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References
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