A MAN, HIS BOAT, AND A HECK OF A FISH FINDER: AN ECONOMICAL METHOD FOR CONDUCTING RESERVOIR SEDIMENTATION SURVEYS

Gary T. Snellings, USDA, Natural Resource Conservation Service, 100 West Capitol Street, Jackson, MS 39269, gary.snellings@ms.usda.gov; Frank A. Adams, USDA, Natural Resource Conservation Service, 100 West Capitol Street, Jackson, MS 39269, frank.adams@ms.usda.gov; Reginald K. Harris, USDA, Natural Resource Conservation Service, 100 West Capitol Street, Jackson, MS 39269, kim.harris@ms.usda.gov

Abstract Approximately 600 watershed dams have been constructed in Mississippi since 1948. The majority of these dams were built through the PL-566 or commonly known as the Watershed Protection and Flood Prevention Act of 1954. Most were constructed prior to 1970 and almost all planned with a 50 year design life. Many of these reservoirs have had residences and other high value infrastructure built downstream, resulting in a reclassification from a low or significant hazard to a high hazard category. At present it is estimated that 84 dams in Mississippi will require rehabilitation due to hazard classification changes. Reservoir sedimentation must be assessed in order to determine the structures ability to regulate floodwaters. The purpose of this study is to evaluate the use of off-the-shelf components for conducting reservoir sedimentation assessments. By combining consumer grade sonar with a common GIS application, it is possible to estimate reservoir thickness and determine sediment volumes. Consumer grade sonar units cost less than scientific units, and if they yield acceptable results, the necessary assessments can be completed in less time and at a lower cost. The project goal is to determine if consumer grade dual frequency sonar units are appropriate for conducting sediment evaluations in aging reservoirs.

A sediment survey was conducted in the 25 acre reservoir pool at Richland Creek 3, located near Brandon, MS, during the fall of 2009. The dam was built in 1978 as a low hazard floodwater retarding structure and has relatively shallow water depths, generally less than 11 feet. The watershed geology consists of alluvium and terrace deposits atop thinly bedded silty micaceous sands intermixed with clays. The land use consists primarily of forests with some urbanization. The geology and land use play a significant role in the deposition of sediment. Erosion and sedimentation rates in this watershed should be representative of the results from similar size watershed reservoirs in the same basin.

A Hummingbird 797si dual beam sonar with GPS was used for this study. The GPS was an external 16 channel, with WAAS differential capability. The dual beam sonar operates on 200 kHz and 83 kHz frequencies. The 200 kHz frequency does not penetrate the sediment; as a result it images the mud/water interface. The 83 kHz frequency penetrates more dense material, passing through the unconsolidated sediment and imaging mud/substrate interface. These two frequencies make it possible to estimate the depth to both the top of the sediment, and the bottom of the sediment in the pool area.

For this study an 18 foot johnboat, with vibracoring capabilities was utilized. The sonar transducer was mounted through a moon pool with an offset measured at 0.5 ft, representing its distance below the water surface. The sonar use options allow for single frequency operation, data collection for this study was conducted separately for each frequency. Sonar measurements

were collected along transects throughout the main reservoir, extending as possible into the upper reaches. Transects were collected in parallel segments to provide adequate spatial coverage. A number of tie lines were added to insure consistency in interpretation between profiles. Vibracoring equipment was used to collect six core samples from representative locations along the sonar transect. The cores were extracted and logged in the field. Water depth measurements were made at each core location.

Data processing involved importing two data sets into ArcGIS 9.3. The point data was referenced to mean sea level (MSL) and saved to a database file format. ArcGIS Geostatistical Analyst was used to statistically estimate the surface based on kriging data interpolation. Kriging produces an estimate of the underlying surface by a weighted average of the data, with weights declining with distance between the point at which the surface is being estimated and the locations of the data points. Kriging interpolation results were processed with the proper aerial extent, based on a confining boundary gathered from recent photography. The interpolated surfaces produced from each sonar frequency were independently converted to Digital Elevation Models. This made it possible to use ArcGIS Spatial Analyst to calculate the volumetric difference (sediment volume) and to produce a 3-dimensional map indicating sediment deposition patterns.

The initial results from this study indicate that data collection and processing is compatible with the methods described. Field collected core samples have produced measurements on a scale anticipated from the initial sonar data. Data processing and calibration continues and a refinement of the initial data collection and processing methods may be necessary for maintaining data quality.

The initial equipment cost for this assessment is less than $1,500, the majority of which was required to purchase the sonar equipment. The remaining hardware and software is typical of that already in use at most NRCS field and district offices. Without including the vibracoring samples, the time required for this assessment was approximately one day. Thus it should be possible, excluding extended travel times, to complete one assessment per day for typical flood control reservoirs. To conduct this assessment with two employees and minimal travel, this roughly translates to costs of $1,000 per reservoir.

Consumer grade dual frequency sonar in combination with standard ArcGIS software proves to be a simple, efficient and economical tool for conducting reservoir sedimentation surveys. With a minimum of 84 reservoirs in Mississippi requiring such an assessment, this method is useful for evaluating aging dams at a fraction of the cost of similar surveys which utilize research grade multi-frequency sonar units, and proprietary data collection and processing platforms.