US Army Corps of Engineers®
Engineer Research and Development Center

National Regional Sediment Management Program Omaha District (NWO):

Application of Shallow Acoustic Reflection Seismic (Chirp) Data to Reservoir Storage: Can we revisit the past and plan for the future? – Phase I – Exploration and Data Collection

Description

The use of shallow acoustic reflection (chirp) data to gain insight on stratigraphy, sediment budgets, and subsurface hazards has greatly increased in the Federal government in the past 10 years. Up to this point, the majority of chirp data collection and analysis has focused on marine environments. As USACE and Reclamation have begun to inventory reservoir surveys and analysis, it has become clear that there are significant data gaps in the historical story of reservoir sedimentation.

Figure 1. Cherry Creek Reservoir

Both USACE and the US Bureau of Reclamation (Reclamation) understand that the pre-reservoir impoundment terrain is now buried under decades of sediment delivered from the upstream river channel. If the interpretation of chirp data could allow for the determination of the current and pre-impoundment terrain, it could result in a more cost-effective estimate with greater spatial resolution than current methods.

Two reservoirs, Cherry Creek (USACE) and Shadow Mountain (Reclamation) will be surveyed with a chirp sub-bottom profiler to see if the current and previous surfaces (pre-sedimentation) can be identified. The two reservoirs are located near Denver, CO.

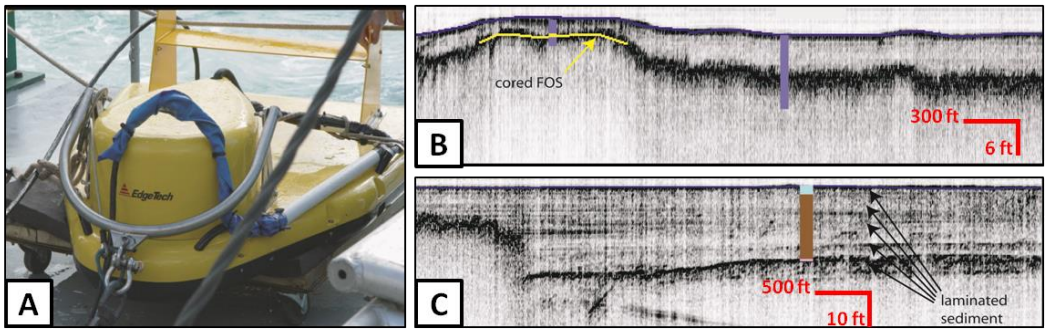

Figure 2: (A) Chirp sub-bottom profiler. (B) Example of sub-bottom data showing sediment overlying buried fossil oyster shell in the Chesapeake Bay, VA; (C) Stratigraphy of sediment in Lake St. Clair, MI, including vibracore data.

Phase I includes data collection in collaboration with Reclamation in FY20. Phase II is expected to analyze and assess the effectiveness of the methodology in FY21.

Issue/Challenge To Address

Chirp profiling has been recently been successfully used in rivers to identify subsurface stratification that is indicative of flow events, and to identify the change in material density associated with a hard channel bottom. Similar stratification occurs in reservoirs, often identified as a low-density layer of organic material delivered during a high flow event.

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The successful application of chirp data collection in reservoirs may be realized if the method can address these concerns:

- Will low density organic layers obscure the true reservoir bottom?
- Can deposition due to flood events be identified?
- Will consolidation of long-buried sediments make them indistinguishable from the true bottom? Will this vary depending on the physical properties of the sediments (e.g. massive bedding of gravel on the true bottom vs. alternating layers of silts and clays?).
- Can chirp reduce or eliminate the need to use expensive deep cores to determine true bottom?
- What level of pre-existing data (surveys, bed material samples, cores) is necessary to reduce all practical uncertainty?

Successes Lessons Learned

This will be the first large reservoir application of the chirp technology. Successful data collection will depend on establishing the proper support infrastructure and developing an efficient pattern to collection. Lessons learned will be incorporated into the summarization of the methodology in a future report.

Projected Benefits Cost Savings Value Added

Currently, hundreds of reservoirs in the Federal inventory have zero or one survey. In those cases, the pre-impoundment geometry has been lost under sediment deposition. To estimate that geometry, coarse estimates are made from maps or soil cores are used to look for varying statigraphy. If successful, this method could generate the current and previous geometry of the reservoir. In some cases greatly reducing error, and in others reducing cost.

Expected Products

- Chirp datasets for Cherry Creek Reservoir and Shadow Mountain Reservoir.
- ERDC Tech Note "Collection of Shallow Acoustic Reflection Seismic (Chirp) Data in Reservoirs"
- RSM IPR Briefing on the data collection effort

Stakeholders/Users

Federal, State, and Local dam owners and operators.

Leveraging Opportunities

Reclamation has provided partnering funds to participate in this collaborative study with USACE. Reclamation will provide the boat for chirp instrument deployment, local access and support, vehicle use and logistics for the data collection, and will partner in the final report.

Points of Contact

Paul M. Boyd, Ph.D. P.E.
Hydraulic Engineer
Omaha District RSM Program Manager
CENWO-EDH-F
Paul.M.Boyd@usace.army.mil
402-995-2350

Daniel Dombroski, P.E.
Reclamation Technical Service Center
ddombroski@usbr.gov

Participating Partners

US Bureau of Reclamation
Sedimentation and River Hydraulics Group
Technical Service Center
Lakewood, CO
https://www.usbr.gov/tsc/tscorganization/8200.html