Final Report

Airborne LiDAR collection and analysis along Lulu Creek and the Colorado River in Rocky Mountain National Park, Colorado

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Introduction

An airborne Light Detection and Ranging (LiDAR) survey was completed in fall 2012 to assist with restoration planning of Lulu Creek, the Colorado River, and the Lulu City Wetland in Rocky Mountain National Park. LiDAR surveys provide high-resolution topography of the ground surface – a key component for accurate channel restoration planning. After major adjustments to channel bed- and planform geometry occurred during the high-magnitude, long-duration snowmelt runoff of 2011, the previous 2004 LiDAR survey of the study reach was deemed unsuitable for restoration planning. Differences between the 2012 and 2004 LiDAR surveys provide an opportunity to understand the controls on channel morphology at the site and to better constrain bed-material transport rates along the Colorado River.

Completed Tasks

LiDAR Collection by Merrick and Company

Airborne LiDAR and accompanying aerial photography was flown over the site on October 22, 2012 by the Denver-based engineering firm Merrick and Company. Previous to the flights, CSU researchers accompanied Merrick and Company staff in surveying several ground control points and placing large, plastic aerial photography control panels throughout the site. The LiDAR data were filtered and classified by Merrick and Company, and all final LiDAR files and aerial photography (including the older 2004 survey) were delivered to CSU researchers in January 2013. Additional LiDAR survey points were received from Merrick and Company in March 2013 after it was noticed that portions of Lulu Creek were missing from the initial LiDAR files.

Field Surveys tied to LiDAR

Two ground-based surveys were completed (October 2012 and June 2013) to tie the airborne LiDAR to existing channel monitoring gages and survey stakes throughout the site. The large control panels were used as reference points for these ground-based surveys, providing precise geographic locations of the existing site features. The white plastic LiDAR ground-control panels were removed in October 2013; however, the center survey nails were flagged and left in place for future use during restoration.

LiDAR Processing

Although initial processing of the LiDAR data was completed by Merrick and Company, additional data processing was required at CSU to satisfy the restoration planning needs. Merrick and Company filtered out all ground points within five feet of the channel to create a smooth transition between water and land; this inaccurately represented the channel and land surface in areas important for

restoration, so the removed points were returned to the final survey. Additionally, stray points within water features were removed to avoid inaccuracies during creation of the final elevation surface.

Ongoing and Future Tasks

Restoration Planning

The 2012 LiDAR survey has been used to create a one-foot contour map of the site. Additionally, valley-spanning elevation profiles spaced every 10 meters (~33 feet) along the valley axis were created. A combination of the topographic surface and the profiles will be used for cut-and-fill estimates for the proposed restoration design plans.

Evaluation of Geomorphic Controls

Progress is being made on evaluating the geomorphic controls along the Colorado River and Lulu Creek. Geomorphic change during the high-magnitude, long-duration snowmelt runoff of 2011 is being analyzed to determine the effectiveness of bankfull and greater events. LiDAR differencing (Wheaton, 2010) between the 2012 and 2004 datasets show areas of major degradation and aggradation along the Colorado River with considerable confidence. Aerial photography has been used to determine lateral changes in the river channel. A 'height above water surface' raster has been created to assist in determining confined and unconfined river reaches. All these variables will be combined with additional variables (channel slope, valley slope, and proximity to foot bridges and sediment sources) to understand present influences on channel morphology throughout the site. These influences will be used in considering appropriate locations and methods of channel restoration. The Master's thesis that documents this work will be completed by June 2014.

Bed-material Transport Estimation Using Inverse Method

Unnatural flow conditions and sediment inputs at the site (mostly caused by the flow routing of the Grand Ditch and the large debris fan at the base of Lulu Creek, respectively) have resulted in large differences between field-measured bed-material transport rates and rates estimated using published transport equations. The two LiDAR datasets straddle the geomorphically significant snowmelt runoff of 2011, allowing for the use of the 'inverse' method to better constrain sediment flux through the reach (Church, 2006). Bed-material transport will be computed by observing changes in river channel morphology and estimating the flux of sediment required to produce such changes. This analysis will be completed in spring 2014, and included in the previously mentioned Master's thesis.

References

Church, M., 2006, Bed material transport and the morphology of alluvial river channels: Annu. Rev. Earth Planet. Sci., 34, p. 325-354.

Wheaton, J. M., Brasington, J., Darby, S. E. and Sear, D. A., 2010, Accounting for uncertainty in DEMs from repeat topographic surveys: improved sediment budgets: Earth Surface Process and Landforms, vol. 35, pp. 136–156. doi: 10.1002/esp.1886