Internship Project: Determining the optimal sample density of measurements for mapping stream geomorphology using land surveying

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Background

Humankind is significantly changing physical habitat in rivers worldwide through changes in climate, land-use, habitat, species composition, and other factors. NEON plans to generate high-quality maps of their stream sites using Digital Elevation Models (DEMs) to examine and model these changes. DEMs are useful for modelling anthropogenic changes to the environment because they provide a high-resolution view of topography.

However, it is impossible to determine the exact elevation of every point in a stream reach. Interpolations are used to approximate elevations that are not directly measured.

Since taking measurements using land surveying is time-consuming, NEON must identify the minimum number of points that a field crew has to take to maximize accuracy of the interpolation. Currently the NEON protocol for mapping geomorphology takes at least a week to execute due to the large number of points collected in the field.

Methodology

Points were recorded using field surveying techniques at a site on the Arikaree River, Colorado, a NEON wadable stream site.

- Points for the bankfull edge, toe slope, and thalweg were spaced 1-5m apart while points on the floodplain were spaced 10-15m.
- Points were also collected for five cross sections perpendicular to the stream. These are representations of measured channel geomorphology features that we used to test the accuracy of our interpolation.
- We performed 100 iterations of Monte Carlo simulations that randomly reduced the original data set to 50, 60, 70, 80, and 90 percent of the surveyed points, performed an inverse distance weighted (IDW) interpolation, and compared interpolated values to each point in our five cross sections. We then found the root mean squared error (RMSE) between the true elevation values and the interpolated values for each cross section.

Implications for Future Work

Sample density did not have a significant effect on the accuracy of the interpolation as assessed by total RMSE. Thus, up to half the data that was collected for the Arikaree River reach digital elevation model (DEM) can potentially generate an inverse distance weighted (IDW) interpolation with an accuracy that has not been significantly reduced.

The original sample density may have been high enough that lowering the sample density did not produce significant changes in accuracy.

Specific topographic nuances related to channel morphology, such as terraces, affected the accuracy of the interpolation. Such errors may have occurred because cross section topography is different from the topography required to collect other features. The interpolation may also have been impacted by point locations. IDW tends to produce very different interpolated values depending on where data was measured. A solution is to use a different interpolation method.

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