Using remote sensing methods to study changes in sediment transport and geomorphology associated with dam removal in the coastal zone

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The Future of Dams Project

- The Future of Dams Project is a large, interdisciplinary project that aims to improve the scientific basis for decision making.
- A part of this project is to study dam removal and its impacts on the ecological conditions of rivers.
- This poster presents the results of UAV flights conducted at the Oyster River Reservoir Dam near UNH in Durham, NH. The collected imagery is being used to develop methods that will quantify and evaluate ecologically-significant aspects of evolving fluvial environments.

Ecological Stream Assessment

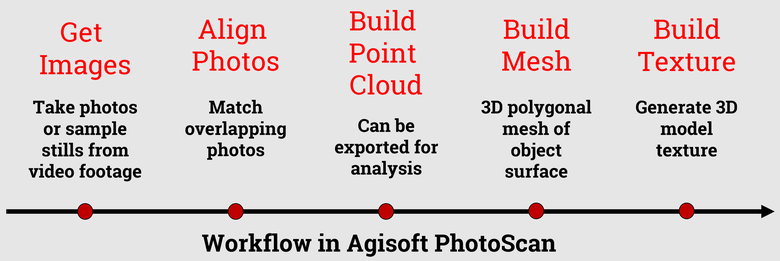
- The Stream Visual Assessment Protocol Version 2 (SVAP2) is a rapid visual assessment to determine the ecological condition of streams.
- The USACE tested the SVAP2 in June 2017 to add QA/QC measures and explore its use for compensatory mitigation credit allocation.
- UAS methods developed from the USACE SVAP2 study will be adapted to study dam removal. UAS methods will:
  - Provide an objective and consistent method for scoring certain elements. Elements deemed unsuitable for UAV study are in red below. Initial elements to be scored are in bold below.
  - Provide quantifiable metrics for holistic ecological assessment and, ultimately, accurate credit allocation for dam removal projects.

Stream Visual Assessment Protocol Version 2 Scoring Elements

Channel Condition	Riparian Area Quality	Manure or Human Waste	Aquatic Invertebrate Habitat
Hydrologic Alteration	**Canopy Cover**	Pools	Aquatic Invertebrate Community
Bank Condition	Water Appearance	Barriers to Movement	**Riffle Embeddedness**
Riparian Area Quantity	Nutrient Enrichment	Fish Habitat Complexity	Salinity

Methods

- A DJI Phantom 3 Professional was flown on three separate occasions at varying altitudes (10, 35, and 120 feet above ground level).
- 2-second interval photo stills were extracted from 4K video and used to construct planform panoramas in Microsoft ICE and 3D models in Agisoft PhotoScan.



Workflow in Agisoft PhotoScan

- The 35-foot and 120-foot point clouds were compared using CloudCompare. The point clouds were scaled to match, aligned using point pairs, and the distances between the clouds were calculated using the 'Cloud-to-Cloud distance' tool.

Results: 3D Models

The 2-foot white X's in the imagery are ground control points (GCPs) for future georeferencing and provide a sense of scale.

Figures I and II: Planform panoramas constructed in Microsoft ICE. Figure I is from 10-foot altitude UAV 4K video taken 6/22/2017. Figure II is from 120-foot altitude UAV 4K video taken 6/30/2017. These panoramas provide a quick visual accuracy check against the 3D models.

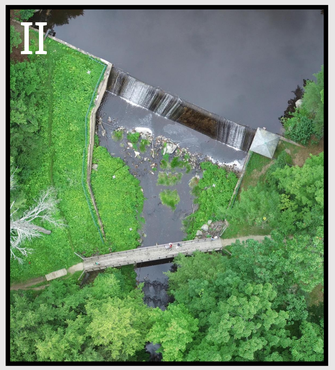
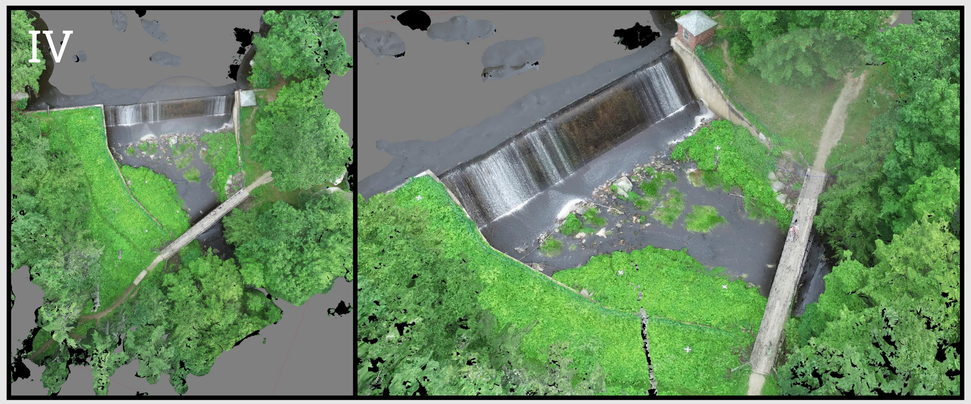


Figure III: Two views of the textured 3D model rendered in Agisoft PhotoScan using 370 stills from 35-foot altitude UAV 4K video taken 6/28/2017. The level of detail captured at lower altitudes will be useful for scoring instream elements, such as riffle embeddedness and habitat complexity.

Figure IV: Two views of the textured 3D model rendered in Agisoft PhotoScan using 314 stills from 120-foot altitude UAV 4K video taken 6/30/2017. Higher altitudes will be useful for evaluating elements that require more spatial coverage, such as channel condition and canopy cover.



Results: CloudCompare

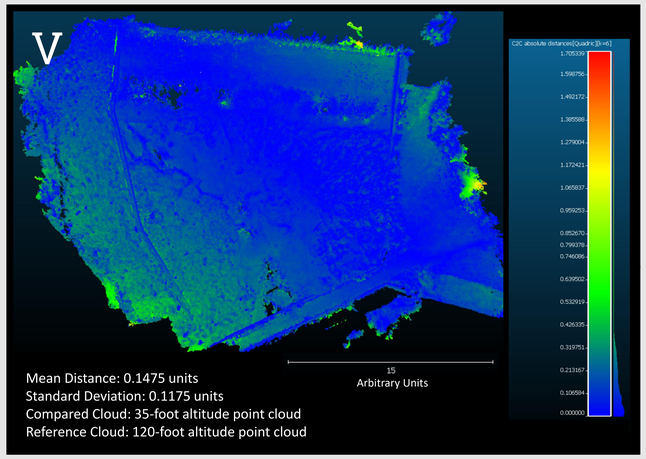


Figure V: Cloud-to-Cloud distance map from CloudCompare. A local quadric model was computed given 6 neighbors. Relatively greater differences occur in densely vegetated areas. In general, there is great agreement between the 35-foot and 120-foot altitude dense point clouds. This suggests that point clouds constructed from various altitudes at the same site will be consistent for scoring different elements at different scales.

Conclusions

- The methods developed thus far consistently model the given scene at different altitudes.
- The level of detail in the textured 3D models is promising for future ecological scoring.
- Certain altitudes may be more appropriate for scoring particular elements depending on the level of detail and the spatial coverage required.

Future Work

- Georeference models and import them into GIS software to begin quantifying ecological scoring metrics. Check accuracy of models with field measurements of GCPs and objects in the scene.
- Finish scoring Oyster River reach per SVAP2 procedure to compare UAV results.
- Apply developed UAV methodology to dam removal study site to quantify impacts of removal over repeated flights.
  - Future study site: Sawyer Mill Dams in Dover, NH

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