The Future of Dams Project *Research Briefs*

Unmanned Aerial Systems, Dam Management Decisions, and Ecological Assessment

By Alexandra Evans
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In a Nutshell

This work aims to improve the tools that scientists and regulators have available for evaluating ecological responses to stream restoration (e.g. dam removal projects). Small unmanned aerial systems (sUAS, a.k.a. "drones") may provide new effective ways of studying river systems and how they physically change with restoration efforts. Models and graphics produced using the sUAS approach may also serve to communicate visually about site conditions to facilitate community engagement and document site conditions in a simple but effective way.

The Current State of Stream Ecological Assessment and Needs

Dam decisions have impacts on surrounding ecosystems. For example, dam removal oftentimes results in the transformation of a reservoir to a free flowing river. There are many specific environmental changes associated with this transformation involving topography, sediments, vegetation, and habitat features - all of which influence the ecological condition of the system. These changes should be evaluated to determine whether a dam removal is achieving restoration goals.

There are different approaches to conventional river and stream ecological assessment, each accompanied by their own trade-offs. Some professionals choose to use qualitative ecological scoring approaches (e.g. the Stream Visual Assessment Protocol Version 2). While rapid to complete in the field and holistic, these qualitative approaches suffer from assessor subjectivity, questionable repeatability, and do not provide detailed quantifiable results desirable for statistical study design. Approaches involving transect- or plot-based, quantifiable measurements (such as the Stream Barrier Removal Monitoring Guide) provide more objectivity, repeatability, and detailed quantified information. However, these approaches often come with increased monetary expenses, time spent in the field, required technical expertise of a variety of instruments/methods, and most likely provide only a small coverage of data relative to the river system of interest.

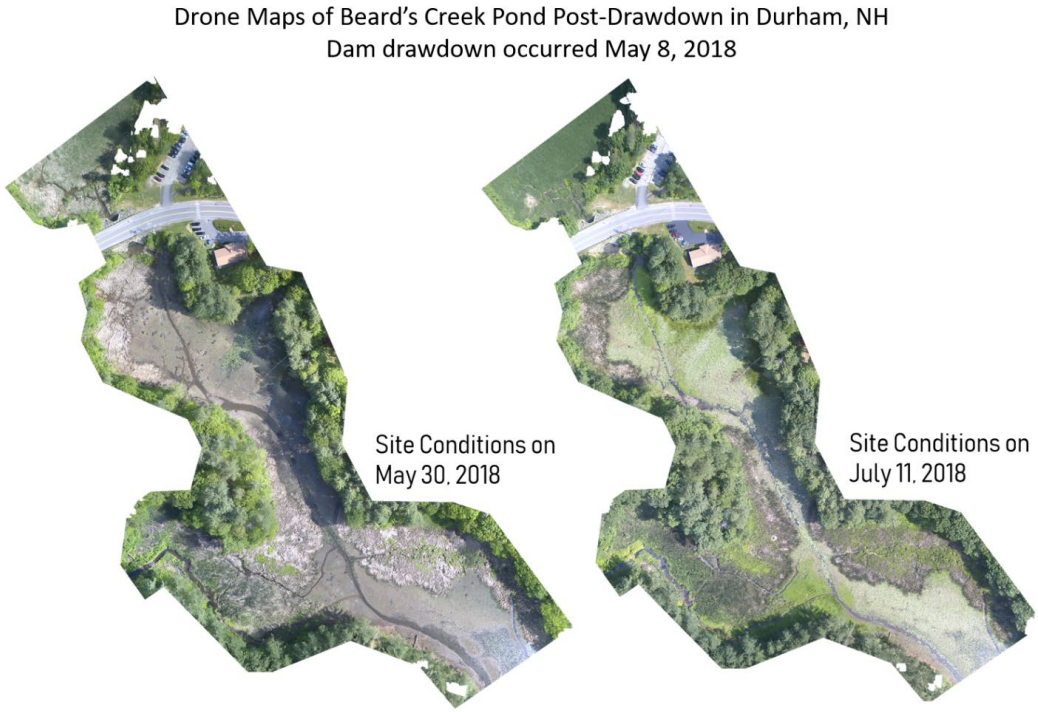
Developing New Approaches to Stream Ecological Assessment with sUAS

Methods of river and stream ecological assessment are evolving. Professionals are seeking holistic and robust ecological measurement methods that are repeatable, objective, and quantifiable without having to expend significant time and money. The recent widespread availability of consumer-grade sUAS has created opportunities to develop close range remote sensing assessment approaches that may fulfill this need. Structure-from-motion photogrammetry and spectral information from sUAS images can be used to assess various ecological metrics throughout a river, such as characteristics of riparian vegetation, substrate type and spatial patterns, and channel and floodplain topography. You can access examples of these data products here and here. We are developing approaches for the use of sUAS by studying dam-related projects and rivers using both the experimental sUAS approach and conventional stream ecological assessment methods. The results for various ecological metrics obtained by each approach is then compared to evaluate advantages, disadvantages, and the potential role sUAS can serve in stream ecological assessment. Through this process, we are developing novel assessment approaches and gaining new insights into the ecological consequences of dam decisions to inform future restoration efforts.

***Illustrating the Different Assessment Perspectives**: The top image shows some of our colleagues from URI setting up vegetation plots, a conventional approach to vegetation assessment, in an impounded area on the Bellamy River in Dover, NH. The bottom image is an sUAS photo taken from 100 feet above ground level of the same area (red circle denotes where the white vegetation plot stake is located). The drone image illustrates the aerial perspective and how it can help identify different patches and spatial patterns of vegetation that may be difficult to determine from the ground.*

sUAS Methods Serve a Variety of Stakeholders

By using sUAS, we are finding efficient ways of studying river landscapes using geospatial techniques for stakeholders who are interested in ecological changes from a regulatory, monitoring, or scientific perspective. Not only may the sUAS approach offer quantifiable, repeatable, and largely objective results, but it also creates beautiful graphics in the forms of maps, 3D models, and videos that can serve as a qualitative records of site conditions and be used as communicative tools with stakeholders. We are exploring new ways of visually communicating ecosystem responses to dam decisions to stakeholders of a variety of backgrounds and interests, such as interested



An Example of Illustrating Dam Management Decision Impacts with sUAS Imagery*: These are maps of Beard's Creek Pond in Durham, NH made with drone images. The pond's water level was lowered on May 8, 2018 in response to dam safety concerns downriver. The map to the left illustrates the pond's condition soon after the drawdown and shows the exposed sediment that used to be underwater. The map to the right illustrates the new creek's condition about two months after the drawdown and how vegetation is growing shaping the developing creek. These maps and their accompanying details are available on figshare here and here.*

community members and property owners. It is difficult to capture details across an evolving landscape, and the aerial perspective provided by the drone coupled with the ability to process the photos into maps and models may become a common tool for future ecological assessments and communicating their results.

Recent Work

Talk at SER (October 2018): Drones and River Restoration: Assessing Geomorphic Impacts Downstream of a Small Dam Removal with Aerial Remote Sensing Approaches

Authors: Alexandra Evans (UNH), Scott Greenwood (UNH), Dr. Kevin Gardner (UNH), & Dr. Denise Burchsted (Keene State College): This talk presents intermediate work about an ongoing study at the Sawyer Mill Dam removal project in Dover, NH. The lower dam at the apartment building is being removed, and members of the FoD team are evaluating changes in topography, substrate, and vegetation using conventional and sUAS approaches. This talk focuses on the comparison between conventional surveying and the topographic models produced using pictures from a sUAS. It was found that the sUAS approach performed well (had good accuracy compared to conventional surveying results) for dry, unvegetated areas, but complications exist for submerged areas and vegetated areas. Ways to correct the drone model for these surfaces to bring drone elevation values closer to conventional surveying elevation values are being explored with promising results. This work demonstrates that the drone is a promising tool for modeling topography across a tidal landscape.

Poster at NEGSWS (September 2018): Watching the Evolution of Beard's Creek Post-Route 108 Dam Drawdown Authors: Alexandra Evans (UNH), Scott Greenwood (UNH), & Dr. Kevin Gardner (UNH): The Route 108 dam in Durham, NH was deemed unsafe to pass high water flows. To remedy this risk, stop logs were removed from the dam to permanently lower the water level in its impoundment, Beard's Creek Pond. This work was done in response to local community concerns about the changing conditions and aesthetics of the former impoundment area as it transitions to a creek. UNH researchers flew a drone to collect photos of the area of the impoundment that was drained by the drawdown. These photos were used to create detailed maps and models that can be shared to communicate and illustrate how the exposed ground is vegetating and the now flowing water is creating a new creek channel. The maps can be analyzed to examine and quantify the spatial coverage of the growing vegetation and the different types of plants that make up the changing vegetation community structure. These methods are an ongoing area of research, and the measured traits are commonly used in regulatory ecological river assessments and are significant for habitat and overall ecosystem health.

Biography

Alexandra Evans is a PhD student at University of New Hampshire (Durham, NH) in the Natural Resources & Earth Systems Science PhD Program. Her advisor is Dr. Kevin Gardner. Alexandra is interested in how drones (a.k.a. Small unmanned aerial vehicles - "sUAS") and remote sensing techniques can be used to improve river ecological assessment, restoration, and regulations - particularly surrounding dam management decisions such as dam removal. She is also interested in exploring how maps, models, and videos created using drones can help communicate evolving river conditions to a variety of stakeholders, from scientists and regulatory agencies to interested community members and property owners. Alexandra earned her M.S. in Geology and B.S. in Environmental Science from Rensselaer Polytechnic Institute (Troy, NY) in 2015.

Researchers

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Researcher Links

Figshare Profile / Sketchfab Profile / SVAP2 Study Video

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