



Quantitative Analysis of Immediate Environmental Problems Using Inexpensive Drone Technology.

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The Problem

Landslides, rockfalls, and soil erosion become more problematical with increased rainfall. The frequency and intensity of heavy precipitation events continues to increase. These events are related to climate change and are most pronounced during the fall in the northeastern part of the nation (USGCRP 2017). Fall corresponds to a time when soil is susceptible to erosion because of the recently tilled fields. Soil erosion is directly linked to hazardous algal blooms on Lake Champlain because phosphorous is tied to sediment carried in streams. Landslides and rockfalls are also triggered by increased rainfall. Vermont's beautiful fields, stunning Lake Champlain, and majestic roads and homesteads, are all vulnerable to the effects of climate change. Knowledge about the volume of soil loss from fields, and the amount of material moved by erosion and landslides, is the first step in minimizing these types of natural hazards.

A Solution

A DJI Phantom 4 Pro drone, equipped with a high-resolution camera, captures georeferenced images. These images are used in two ways:

1. Geolocation on topographic and LIDAR maps.
 2. Volumetric calculations.
- Geolocation allows precise positioning of drone imagery (Figure 1) that will be used to locate loss of land to due to erosion and landslides (Figure 2). Volumetric calculations are made with Agisoft Photoscan – a software product used to generate 3D spatial data from digital imagery.



Figure 1. Example of geolocated images on the JSC campus.



Figure 2. Soil erosion and landslide in Jeffersonville, VT.

Methods

The plan is to use the drone to collect images in order to build a geolocated volume model for a given point in time. Subsequently, the drone will re-fly the area and build another volume model. The difference between the two models provides information on volume loss. Use of ESRI ArcGIS Pro software will allow for the determination of volume loss due to erosion, or change in position for rock slides and rock chutes, over time.

The project is in its nascent stage. The first 3D model and volumetric calculations were completed by flying the rock on the central campus of the College (Figure 3).

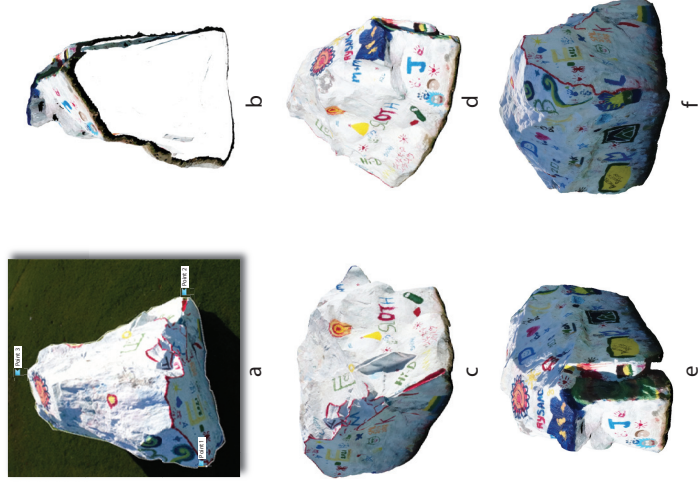


Figure 3. Volumetric calculations for the rock on the campus of JSC. Image 'a' is a photograph taken above the rock and has limits marked. Images 'b'–'f' are processed. Image 'b' depicts the bottom of rock (never photographed). Images 'c'–'f' are model representations of the rock rotated ≈90° to the left in each subsequent image (shadows are due to sun angle).

Current Status and Future Work

Drone imagery is georeferenced, yet we have to develop a seamless and automated process to bring the geolocated images into ESRI ArcGIS Pro. LIDAR data will then be incorporated into the model in order to gain the benefits of precise elevation data.

Volume modeling needs refinement. We are confident with our abilities to build 3D models, yet we need to ground-truth the volumetric calculations. The next step is to model a spherical sculpture on campus (or build a large cube with pallets) in order to check the accuracy of the volume models. We will use appropriately placed markers on the ground in order to set a length datum.

Once the programming bugs are resolved we will take aerial images of rock chutes at Smuggler's Notch, and repeat the process later, and compare the models to determine where rocks have moved (Figure 4). Fields will be similarly analyzed to measure the volume of soil loss over time associated with gully erosion and landslides.



Figure 4. Rock falls (a) and a rock chute (b) at Smuggler's Notch, VT.

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Reference

US Global Climate Change Research Program (USGCRP) (2017). *Climate Science Special Report: Fourth National Climate Assessment, Volume I*. Washington, DC, USA, 470 pp. doi: 10.7930/J0J964J6.

