Consistency in Coastal Monitoring

Lakeshore Boulevard, Marquette, MI

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Figure 3: This is a 2D orthomosaic model of the Lakeshore Boulevard project area in Marquette, MI. The model is comprised of over 400 images taken with a UAV oporating unter a draft coastal erosion drone survey protocol.

0 mi 1/16 1/8
0 km 1/10 1/5

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Drone Technology for Coastal Monitoring

1 Introduction

Rising water levels and increased frequency of extreme weather events are rapidly eroding coastlines around the world. Despite the challenges posed by ongoing climate change, resiliency projects have the potential to mitigate the negative consequences of climate change in coastal communities. Flying unmanned aerial vehicles (UAVs) to document coastal restoration projects and natural disasters is becoming more popular as UAV technology is becoming cheaper and more user-friendly. Global efforts are underway to restore coastal ecosystems and ecosystem services that lessen the impact of climate-induced natural disasters and promote native biodiversity, but the integration of UAV acquired coastal inventory data is lacking consistency. I examined case studies from a diverse group of restoration projects using UAV derived data to identify best practices and develop a standardized UAV coastal inventory protocol. I tested the draft protocol on a green infrastructure project on the southern coast of Lake Superior in Marquette, Michigan (Marquette City Commission, 2019). Lake Superior is experiencing record wave heights and higher than average water levels, intensifying coastal erosion along Lakeshore Boulevard (Figure 1). I propose standardizing coastal inventory data collection to allow for consistency in the comparison of future coastal resiliency projects. The implications of comparative photographic analysis derived from the standardized UAV coastal inventory protocol will allow project partners to compare past results with increased transparency.

Figure 1: A January 2019 photo of damage to Lakeshore Boulevard caused by a winter storm.

2 Materials & Methods

The UAV used to collect the photographic data was a DJI Phantom 4 Pro with a 20 megapixel 4K video camera. The survey flight path was planned using the app Pix4Dcapture version 4.5.0 for iOS (Figure 2). The UAV collected 402 images that were processed online by Pix4Dmapper version 4.4.12.

To keep the UAV within my line of sight in compliance with FAA regulations, the project area was divided into North and South subunits (Dorr, 2018). I uploaded each subunit boundary into Pix4Dcapture and set the flight altitude to 75 m above ground level at the takeoff location. The UAV captured images with its camera at a 90° angle with an overlap of 70%. Image data from each subunit was then uploaded to and processed to create 2D orthomosaic models of each subunit. The subunit models were combined using Adobe Photoshop to produce a model of the entire project area (Figure 3).

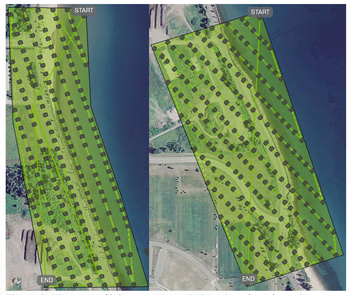


Figure 2: These are flight patterns and photo locations from the Pix4Dcapture app of the North (left) and South (right) subunits.

3 Results

The images speak for themselves. UAV derived 2D orthomosaic models operate at higher resolution than Google Earth (Figure 4). The combined subunit model (Figure 3) can be zoomed in to view features less than 1 ft in length in high resolution. The same can not be said for other publicly available imagery. Figure 3 is the baseline model for monitoring purposes during and after the Lakeshore Boulevard project.

Figure 4: These images, taken 2 months apart, show a comparison in resolution between Google Earth satellite imagery (top) and the UAV derived model (bottom). Refer to the red rectangle in Figure 3 for the location of these images.

4 Future Research

The Superior Watershed Partnership (SWP) has been provided the methods and owns the materials to collect annual orthomosaic 2D models with its UAV. Continued annual UAV monitoring of the project area will allow the SWP and Marquette City Commission to evaluate the outcomes of their efforts in great detail with high resolution models (Figure 5).

Monitoring coastal erosion and resiliency projects using UAVs is gaining popularity, but lacks consistency. Comparing the results, even between very similarly designed projects, is confusing without significant effort to standardize data. Therefore, I am drafting a proposal for a coastal erosion drone survey protocol. This protocol will standardize in-flight operation and model creation procedures and adhere to the protocol development guidelines outlined by the U.S. Fish and Wildlife Service (2013).

Figure 5: A conceptual rendering of the completed Lakeshore Boulevard project. This is a two phase project which includes both rerouting of human traffic and the renaturalization of the coastal ecosystem.

Flora Monitoring

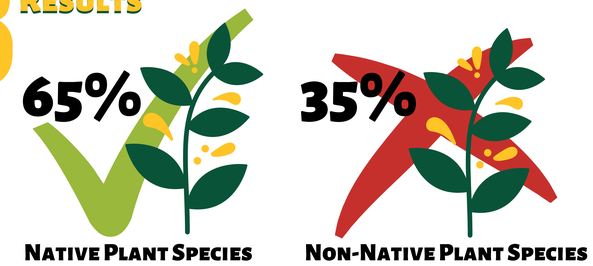
1 Introduction

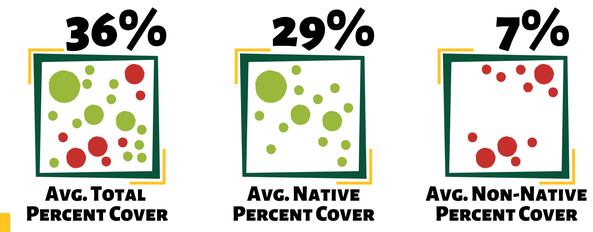
A later phase of the Lakeshore Boulevard project involves naturalization of the area between the new road and the shoreline. As construction begins and native plants are reintroduced to the ecosystem, it is important to monitor the abundance and density of native and non-native species alike. The coexistence of recreation and a healthy freshwater coastal ecosystem are vital to the location's function for the community and the biota that call it home. This collection of plant species metrics will serve as the baseline for determining progress during and after the completion of the project.

2 Materials & Methods

The plant species metric data was collected using a transect quadrat method. This data was collected north of the project site at a successfully renaturalized dune ecosystem. I created two permanent 255 ft transects perpendicular to the coast. Each transect had 17 quadrats and each quadrat was 1 square meter. Each plant species within a quadrat was identified and the percent cover of its canopy was estimated. This plant species survey is to be completed annually with this 2019 survey used as the baseline to monitor and compare the results of renaturalization between locations (National Coastal Resilience Fund, 2019).

3 Results





4 Future Research

With baseline plant species metrics, SWP staff will be able to track the presence and density of native and non-native species in the Lakeshore Boulevard project area. This annual monitoring method will be used for reporting the outcomes of the project to the National Fish and Wildlife Foundation (NFWF) and to inform decision making during project implementation.

References

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