Investigating Salt Marsh Vegetative Community Health and Productivity with Remote Sensing

Kass Wojcik, Thomas J. Mozdzer
Bryn Mawr College Department of Biology

Introduction

- Coastal salt marshes provide key ecosystem services such as carbon sequestration and shoreline protection.
- Wetland environments are increasingly at risk from anthropogenic-induced nutrient loading and sea level rise.
- Monitoring how salt marshes change overtime in response to altered environmental conditions is important for understanding and protecting coastal ecosystems and biogeochemical cycles.
- Unmanned Aerial Vehicles (UAVs) provide a potential way to advance salt marsh monitoring and conservation by improving analysis techniques while reducing the amount of costly and arduous fieldwork needed to collect data.
- UAVs have cheaper and more controllable data acquisition as well as higher resolution imagery compared to satellite and manned aerial vehicle imagery. UAVs can also survey complex and difficult to access areas.

Objectives

- Modelling two similar studies conducted in the Florida Everglades in 2017 and 2018, we took drone imagery collected from three tidal salt marsh creeks in Plum Island, Massachusetts during the summer of 2019 as a part of the TIDE Project and used the photogrammetry software, Pix4Dmapper, to process the images with the larger goal of using the object-based image analysis software, eCognition, to identify and classify different salt marsh vegetation species as well as analyze the flowering phenology of the grass species, *Spartina alterniflora*.
- The results from pix4Dmapper and eCognition can potentially be used to assess how marsh vegetative communities and flowering phenology as well as plant health and biomass change overtime.

Methods

- The drone imagery of Sweeney, West, and Clubhead Creeks in Plum Island, MA was captured during the months of June, July, and August of 2019 with a DJI Phantom 4 Pro V2 and a DJI Matrice 200 V2 drone mounted with a Micasense Altum multispectral sensor.
- The images from each flight were radiometrically calibrated and then stitched into cohesive orthomosaics and reflectance maps for each of the Altum's spectral bands (red, green, blue, nir, red edge, lwir) using a custom template. A digital surface model (DSM) and an NDVI index map were also created in Pix4Dmapper.
- The orthomosaics were then stitched into a single multi-band image using QGIS.
- The single orthoimage and DSM will then be imported into eCogntion for object-based image analysis and classification using segmentation algorithms and machine learning classifiers.

Results

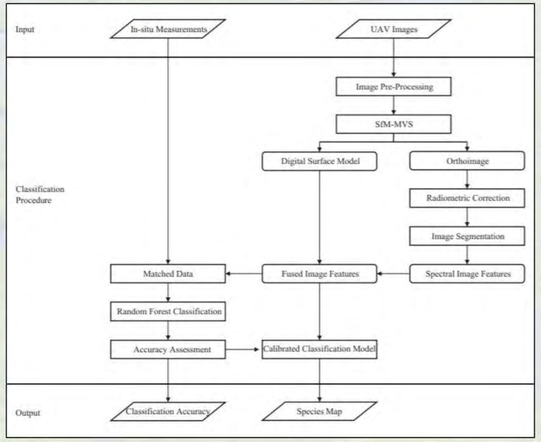

Figure 1. A methodology framework for processing and classifying the UAV derived data as presented in the book, *Multi-Sensor System Applications in the Everglades Ecosystems.*

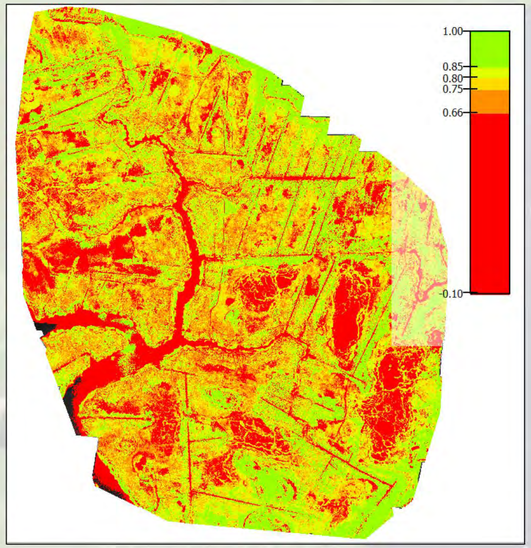

Figure 2. NDVI index map of West Creek from a July 17 flight created in Pix4Dmapper. Red indicates low primary productivity and green indicates high primary productivity. Indices such as these can be used to analyze plant health and productivity.

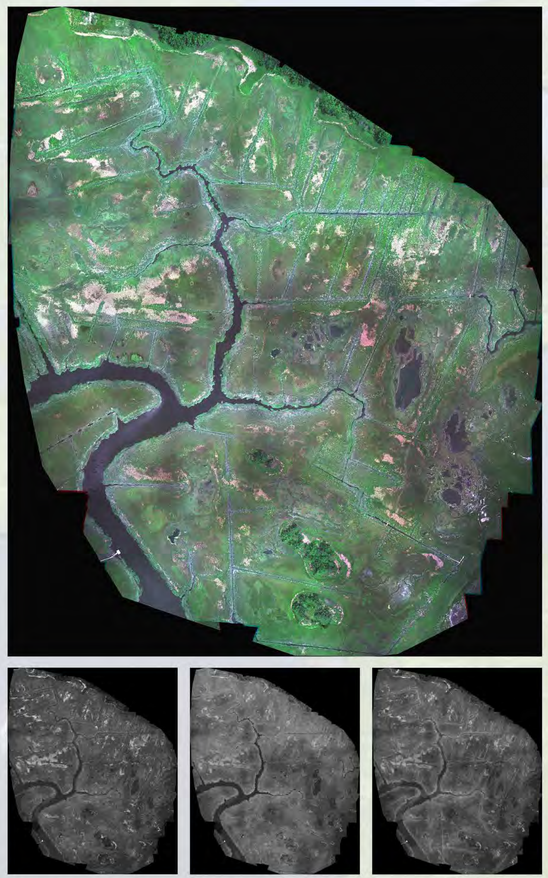

Figure 3. A Red-Green-Blue (RGB) orthoimage of West Creek (top) produced in QGIS by stacking red (left), green (center), and blue (right) single band orthomosaics initially processed using Pix4Dmapper.

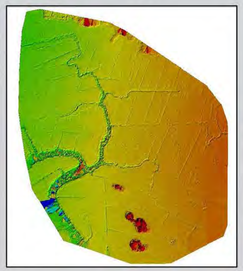

Figure 4. A DSM of West Creek from July 4 created with Pix4Dmapper. DSMs have the potential to increase species classification accuracy by adding vertical data to the spectral and textural data of the orthoimage.

Discussion

- While this study is still in progress, the overall goal is to use UAVs, photogrammetry software, and object-based image analysis to classify vegetation species and *S. alterniflora* flowering phenology in order to assess how the Plum Island salt marsh is changing overtime.
- Next steps for this study include uploading the multi-band orthoimage and DSM into eCognition for subsequent object-based image analysis to classify wetland vegetation species
- An additional goal is to estimate and classify flowering phenology of *S. alterniflora* using segmentation algorithms and machine learning classifiers like the Random Forest (RF) classifier.
- The results from the classification will then be compared with the data collected from in situ data vegetation surveys during the summer of 2019 by conducting an accuracy assessment using the k-fold cross-validation technique, error matrix, and kappa values.
- UAVs and machine learning software provide opportunities for advancing the scale and resolution at which we study salt marsh ecosystems which can ultimately be used to improve analysis and conservation techniques.

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