A Multispectral Analysis of the Vegetation Health of the Urban Oak Savanna in West Salem

By Serenna Thorsen

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Table of Contents

Summary of Scope

On August 19, 2022, an incidental fire erupted in the West Salem oak savanna off of Orchard Heights Rd NW. The fire was started by a mower that sparked the dead summer grass. Ironically, the mower was mowing a safety perimeter around the field. Thankfully, it had completed a full strip around the perimeter before the fire ignited, which aided in protecting the surrounding neighborhoods. While the area was directly behind a Salem Fire Department station, the firefighting crew was already out on another call. The residents living in the neighboring houses took action in trying to put off the fire until the crew arrived. Thanks to the quick action of the residents, none of the houses were harmed. Nonetheless, approximately 70% of the savanna was burned.

This project analyzes the vegetation health of the urban oak savanna ecosystem located in West Salem, Oregon a year after the incidental fire. The multispectral data for this project was collected on March 15, 2023 by drone. This data would then be used to create a multispectral analysis using the Pix4D software. The outputs from this process were then used to analyze the

vegetation health of the project area. It was found that multispectral analysis was successful in showing significant vegetation recovery in the oak savanna.

Project Area

The project area for this research is located in the middle of West Salem, between Orchard Heights Rd NW(to the North) and Chapman Hill Dr NW (to the South). The oak savanna is in the middle of a neighborhood and right behind the Salem Fire Department Station 11. The area is approximately 11 acres and is managed by the City of Salem, the Glenn and Gibson Creeks Watershed Council, Willamette University, and other community organizations. Figure 1 to see Google Earth imagery of the oak savanna in July, 2022 (before the fire) compared to imagery from July, 2023 (a year after). See Figure 2 for a polygon outlining the area that the data encompassed.

Figure 1: Google Earth imagery from July, 2022 (left) before the fire and July, 2023 (right) a year after the fire. The firestation can be seen to the North. The area has small oak trees and grass. In the later image, we can see that the perimeter of the area had been mowed for fire protection and that the area appears to be overall much drier and bare.

Figure 2: Google Earth Imagery from 2023 of the project area featuring a polygon that highlights the area that the project data encompasses. The area includes the oak savanna as well as some overlap over the houses.

Research Questions

This project includes both analytical and methodological research questions. The analytical research question for this project is, “What is the vegetation health of the oak savanna in West Salem a year after the fire on August 19, 2022?”. The methodological research question is, “Is multispectral analysis a successful approach to researching vegetation recovery?”. These questions will provide insight into the recovery and health of the oak savanna as well as information about the usefulness of multispectral data from drone collection.

Methods

The project methodology begins with the data that was collected. The drone multispectral imaging for this project was collected on March 15th, 2023. The drone that was used to collect this data was a DJI Matrice 200 v. 1 and the multispectral scanner attached to the drone was a MicaSense RedEdge MX. The app that was used to create an automated flight grid pattern for the mission was DJI Fly. The elevation was set to 180 AGL with a 80% forward and side overlap. To see the flight grid, see Figure 3 below. Six ground control points (GCPs) were used and had been converted to UTM. The placement of these GCPs was identified by using a Reach RS2 GNSS receiver and used corrections from an ODOT NTRIP account.

During the data collection process, 674 total photographs were taken. Each photo target had one image from each of the ten multispectral bands, resulting in a total of 6740 images total. Since this was an extremely large amount of data, this project only used the photographs from one of the cameras, resulting in 3375 photos. The bands in this camera were red, green, blue, red edge, and near infrared bands.

The photographs were processed through the software Pix4D. The default coordinate system that was used was WGS 84/UTM zone 10N (EGM 96 Geoid) in meters. The data was processed as an Ag Multispectral project. Each of the processing steps, “1. Initial Processing”, “2. Point Cloud and Mesh”, and “3. DSM, Orthomosiac, and Index” were run separately. Before “2. Point Cloud and Mesh” was run, “LAS” was deselected and “Classify Point Cloud” was selected. For the Point Cloud and Mesh Geometry, green was selected, and for Mesh Texture, all of the options were selected. Before “3. DSM, Orthomosiac, and Index”, "GeoTIFF " and "Merge Tiles” was selected for the Raster DSM and “GeoTIFF” and “Google Maps Tiles” was selected for the Orthomosiac file. The irradiance calibration was then checked. Immediately

before and after the flight, the calibration panel images were taken. These images were then used to calculate the reflectance factor. After the processing was completed, both a Normalized Difference Vegetation Index (NDVI), and a Green Normalized Difference Vegetation Index (GNDVI) were generated. Both of these indices analyze the chlorophyll content.

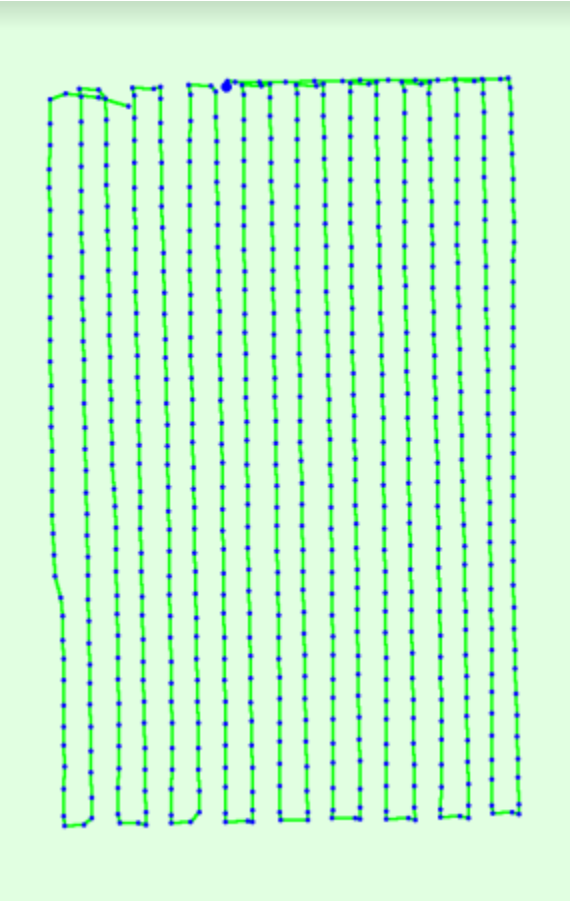

Figure 3: This image shows the initial image positions generated by the quality report. The green line follows the position of the images in time starting from the large blue dot to the end of the path.

Results

The total processing took approximately five total hours to complete. Of the 3375 photos, 3370 were calibrated (99%), and 15 were disabled. The ground sampling distance (GSD) was 3.51cm. The outputs of this project are three different .kml files: a Digital Surface Model (DSM), a NDVI, and a GNDVI. See the figures below for pictures of these outputs.

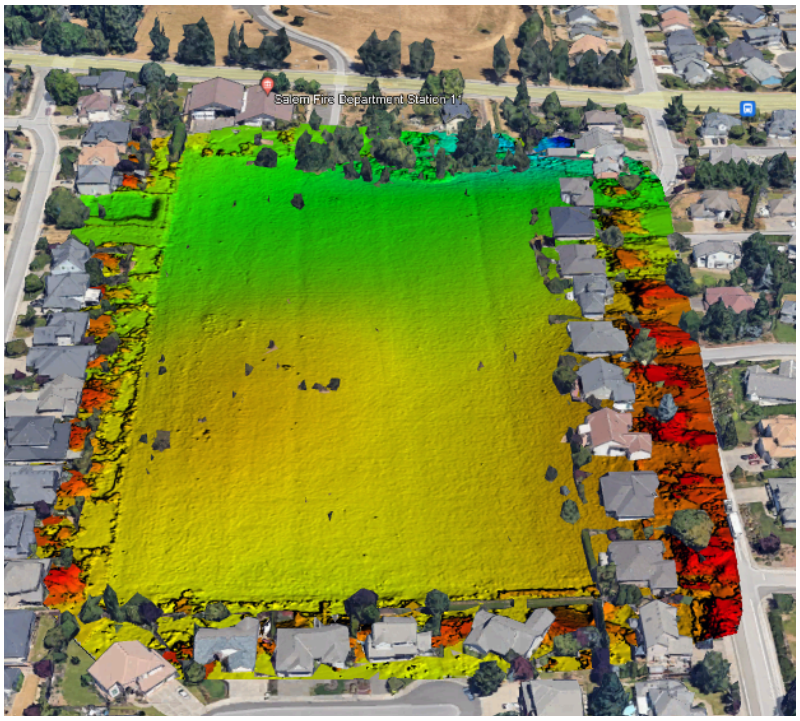

Figure 4: This is an image of the Digital Surface Model (DSM) represented through Google Earth. This image shows a topographic map of the project area.

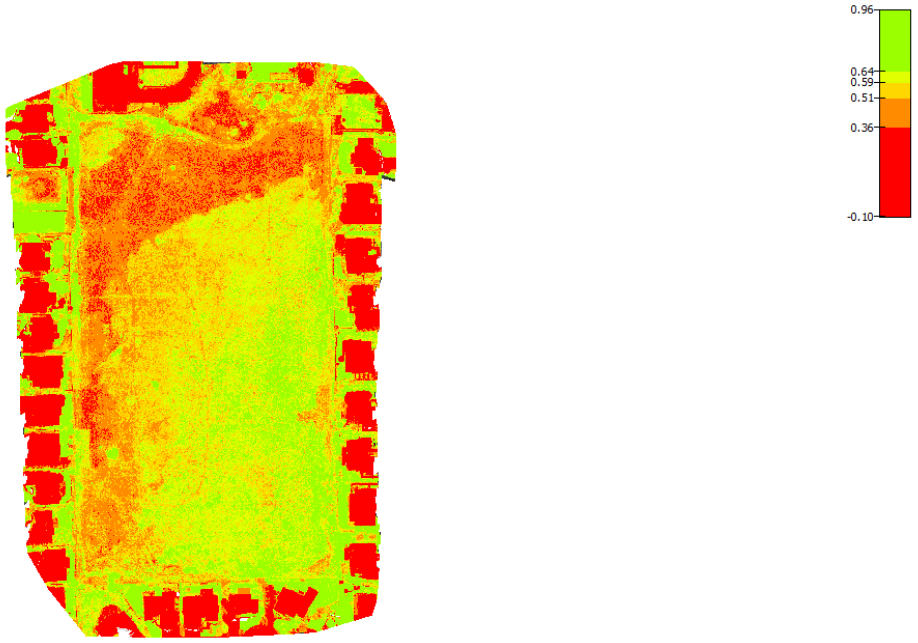

Figure 5: This is an image of the Normalized Difference Vegetation Index (NDVI) with the color key as shown in Pix4D.

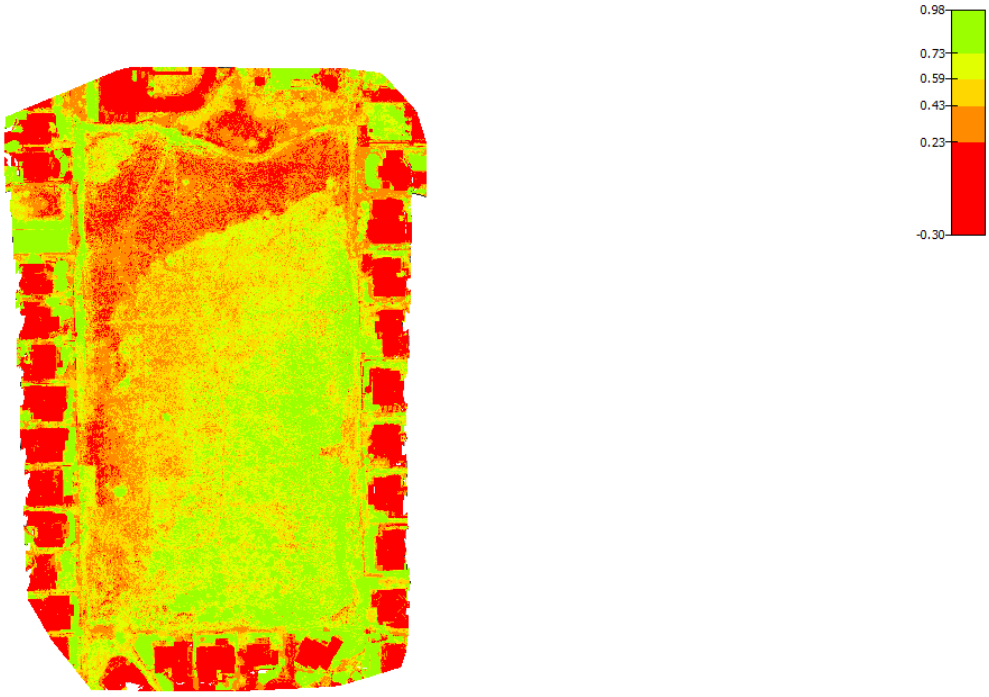

Figure 5: This is an image of the Green Normalized Difference Vegetation Index (GNDVI) with the color key as shown in Pix4D.

Analysis

This project turned out to be extremely successful and a great example of the strength of multispectral data analysis. To address the analytical research question for this project, “What is the vegetation health of the oak savanna in West Salem a year after the fire on August 19, 2022?”, we can see some significant vegetation recovery. When looking at both of the vegetation indices, there is noticeable green and yellow coloring in the South-East corner of the field. This coloring represents a higher amount of chlorophyll content picked up by the multispectral sensor. This is very different from the North-West corner of the field that consists of a large amount of red coloring picked up by the sensor, meaning that this area has much more dead or unhealthy vegetation. When approaching the North-West corner of the oak savanna, we can see a harsh line that separates the yellow coloring from red coloring. This line could potentially represent where the fire had stopped spreading further into the field.

To address the methodological question of this project, “Is multispectral analysis a successful approach to researching vegetation recovery?”, the results proved multispectral analysis as a successful method. Both indices (NDVI and GNDVI) were very effective in showing the chlorophyll content of the oak savanna.

Conclusion

Overall, this project was successful in analyzing the recent vegetation recovery and proving the effectiveness of multispectral analysis from drone data collection. From this research study, we can see the large potential that sUAS have in research of biome restoration and recovery. While the project was successful, there are ways that this project could be improved in the future. Lengthening the time of the overall research project and capturing data from multiple

different years would allow for further analysis into the vegetation recovery. Another improvement to the project would be increasing the amount of vegetation indices generated and analyzing the differences between multiple indices.