Plant Health Assessments Using Drones in the Prado Basin

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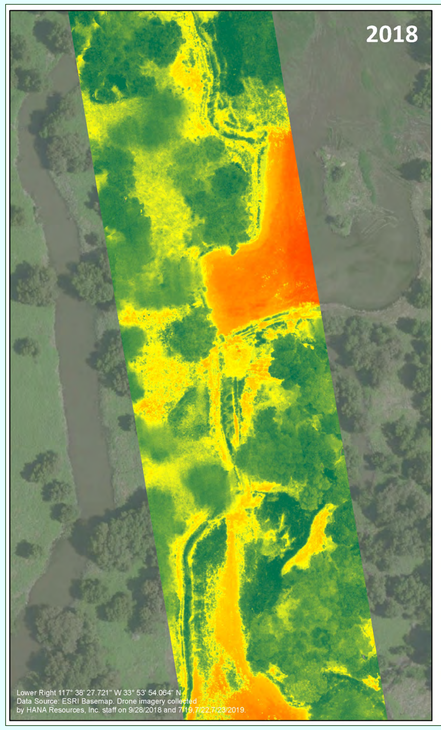
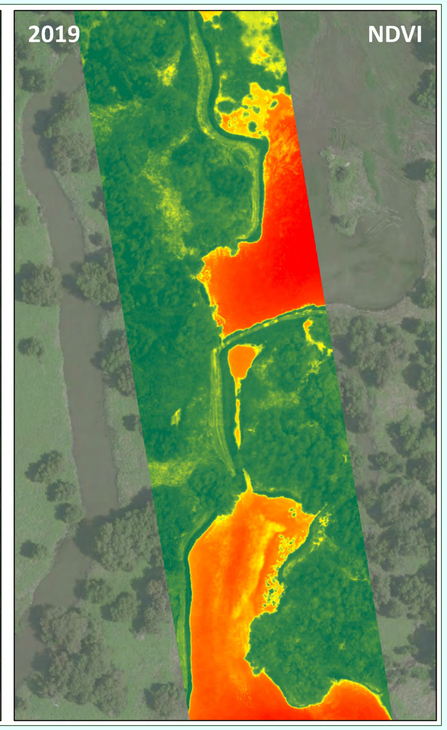
Abstract

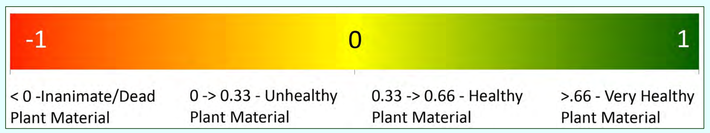
In Prado Basin, the Orange County Water District (OCWD) is attempting to quantify the effects of water retention on sensitive riparian habitat occupied seasonally by endangered least Bell's vireos (*Vireo belli pusillus*). HANA Resources, Inc. (HANA) and OCWD partnered using the latest unmanned aerial vehicle (UAV) technology to evaluate the conditions of the riverine resources across an elevational gradient affected by inundation for water conservation. Using a UAV drone platform, HANA mapped a project site within the Prado Basin. The system processed the images to create an orthomosaic image of the land, where each pixel in the orthomosaic image was associated with a Normalized Difference Vegetation Index (NDVI) value. The system then used plant species to NDVI value mappings and the orthomosaic image to identify current plant growth. Vegetation health at each layer (herb, shrub, and tree) was calculated.

Methods

HANA's UAV operators and Federal Aviation Administration (FAA) drone pilots flew five transects (Chino Creek Leg 1, Chino Creek Leg 2, Chino Creek Leg 3, 505 North, and 505 Northeast) totaling 173.4 acres. They used a UAV platform to transport both a thermal imaging camera and an ultra-high resolution 4K digital camera to map the Project site. The images were knitted together to form an orthomosaic output that delineates vegetation index profiles which were compared to rain data. This allowed for an accurate assembly of critical monitoring data and eliminated the need for human interaction to gain transect data in the field.







Results

Rainfall data collected by U.S. Army Corps of Engineers, Los Angeles District, Reservoir Regulation has been chronologically aggregated and compared against HANA's multispectral sensor NDVI data which has also been chronologically aggregated (see figure below). For the 2018 rainfall window, the timeframe spans from October 2017 to April 2018. In this time, the Prado Basin accumulated 3.75 inches of rain. For the 2019 rainfall window, the timeframe spans from October 2018 to July 2019. In this time, the Prado Basin accumulated 19.29 inches of rain.

After regressing the percent change in rain data over time against the change in NDVI values represented by acres over time, the data was shown to have an R-value of 0.91 and an R^2-value of 0.83. This indicates that the amount of increased rainfall to the basin has a strong, positive, linear correlation with plant health. There is also a high percentage of NDVI variance that is accounted for by the rainfall variable.

Discussion

Plant health values are derived using the NDVI. NDVI, which quantifies vegetation, measures the difference between the near-infrared (reflected by vegetation) and red bands (absorbed by vegetation) of the electromagnetic spectrum, as follows:

$$NDVI = \frac{(NIR - Red)}{(NIR + Red)}$$

Resulting values range from -1 (Red) to +1 (Green), where -1 is equivalent to surface water and +1 represents dense vegetation, like that found in tropical forests or crops at peak health. Roads, dirt paths, and building surfaces typically show values closer to 0 (usually -0.1 or -0.2).

Conclusions

The exact flight path can be replicated to compare the plant health over time. Limitations associated with conventional monitoring methodologies have been overcome by this rapidly advancing technology. Remote sensing at a much larger scale removes issues associated with point-based monitoring methods, such as quadrats or transects, and is more representative of the area of interest's performance.

Factors that can affect plant health are fire, insect infestation (polyphagous shot-hole borer), pathogen outbreaks, drought, flood, etc. Tracking the progress or decline of plant health can help land managers determine management strategies.