HANA Resources - Plant Health Analysis using NDVI

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Who is HANA Resources

HANA Resources, Inc. is a certified woman-owned (WOSB, WBE, Federal SBE) environmental services firm; founded to simplify the environmental industry utilizing advanced technology. HANA was initiated as a vehicle to bring a data-driven methodology to the management, monitoring, and restoration of native habitats and produce objective, replicable, and process-driven compliance practices. Our objective is to remove the subjective components and provide data supported by science, standards, and transparency to our clients.

Our processes and technology

The Plant Health Analysis and Plant Recognition System are both widely-applicable innovations. The two apply commercially to the private and public sectors and various other organizations in need of environmental services and environmental analysis. HANA Resources has been able to realize customers in several markets; including Irvine Company, Irvine Ranch Water District (IRWD), Orange County Water District (OCWD), City of Chino Hills, Santa Ana Watershed Association (SAWA) and various homeowners' associations (HOAs). All of HANA's diverse customer base share very similar needs and concerns regarding environmental assessments. Previously, a traditional environmental assessment would require pedestrian surveys or manual sampling to acquire the data necessary for an environmental report. A typical pedestrian survey for analyzing plant health is traditionally done by walking vegetation transects. The surveyor will walk a straight line for a set number of meters while also recording data one meter to the left and to the right. The amount of transects recorded is proportional to the size of the property in acres, and these transects are randomly placed throughout the property to gather a diverse data set. While this has been the standard accepted method, there are a handful of issues related to this type of surveying. The biggest challenge is the cost. The amount of man-hours required to do such surveys on foot vastly outweighs the amount of time an unmanned aircraft (UA) takes to complete a survey. In terms of data collection alone, a 200-acre site on foot would take upwards of a week to survey completely, and the datasets collected are merely representative samples of the full picture. In comparison, a UA with hyperspectral cameras can perform a plant health survey in six hours. The

amount of time and money saved is staggering. Secondly, the data gathered is unambiguous and greatly reduces the natural subjectivity of a human surveyor.

The UA assembles a full picture of the site and not just samples of multiple transects. This provides a complete picture of all areas of the site. HANA's UAs also have the ability to traverse over difficult terrains or inaccessible parcels. When trying to assess areas dense with thick invasive species, such as *Arundo donax*, remote UAs shine at collecting accurate invasive species acreage of the project site. One of HANA's five patents illustrates the ability to collect samples remotely from the UA, namely water samples. Collection via UA would give surveyors the ability to gather samples and data from bodies of water that may be inaccessible or needlessly treacherous on foot. Using remote UAs also allows for consistency of surveying and increased safety of staff members. Where a pedestrian surveyor may run the transects of a site multiple ways over the course of a project's lifetime with varying results each time; each of HANA's flight plans are saved and stored for repeatability. HANA also employs the use of both real-time kinematics (RTK) and post-processed kinematics (PPK) to ensure the large orthomosaic maps are consistently geo-referenced every single flight.

HANA Resources technology provides the most benefit to customers at the management level. From project managers to property managers, HANA's technology greatly bolsters a manager's ability to allocate resources effectively, create more accurate cost estimates, and maximize project goals when faced with a budget constraint. The valuation of properties is often tied to the health of the surrounding vegetation and landscape, and this gives property managers a vested interest in the overall health of the landscape. The Plant Health Analysis can help property managers and HOAs determine the effectiveness of their irrigation systems and water schedules. It shows managers where overwatering and under-watering is occurring, and it gives them the tools to divert water resources judiciously for a more even distribution of water. The Plant Recognition System has proven valuable to project managers that seek to identify and map the growth of invasive species. Because these types of plants are dispersed throughout different habitats and properties, it is in the project manager's best interest to find where the largest and most concentrated areas are of these invasive species. Equipped with geo-referenced maps that delineate areas of concentrated invasive plants, project managers can effectively deploy their limited funds, resources, and manpower to areas where the most impact can occur.

Mission Planning and Compliance
Kittyhawk
HANA utilizes Kittyhawk.io for comprehensive pre-flight planning. Utilizing the features of their software, we are able to check airspace, no-fly zones, weather, etc., prior to a flight. Should we need to conduct operations in restricted airspace, we are able to gain immediate access through their LAANC (Low Altitude Authorization and Notification Capabilities) system, where applicable. The greatest advantage to using Kittyhawk in our work is all the data we need to collect before a flight can be aggregated in one place and serve as the historical record of our flight operations, compliance with FAA regulations, and any internal policies. Through Kittyhawk, we have the ability to track many types of checklists and risk assessments with each flight, including post-flight maintenance events. The convenience of this technology increases our situational awareness prior to flying and allows us to track the validity of our remote pilots' certifications and flight experience for organizational-level compliance.

Example Project

HANA Resources, Inc. (HANA) introduced new applications for Unmanned Aerial Vehicles (UAVs) with Orange County Water District (OCWD) to provide a "baseline" vegetation study of five transects within Prado Basin in order to assess the plant health for the OCWD Prado Flood Control Basin Plant Assessment Project.

The purpose of the baseline assessment was to evaluate the conditions of the riverine resources in its current condition utilizing HANA Resources' patented modeling program. In the subsequent months and years, this assessment can be replicated and used for comparison to assess plant health over seasonal changes and evaluate long term trends to see if the OCWD Prado Flood Control Basin Plant Assessment Project would impact tree health.

In order to obtain plant health, HANA flew five transects totaling 173.4 acres using a UAV system equipped with a multispectral camera and an ultra-high resolution 4K digital camera. HANA utilized Kittyhawk to assist with the pre-planning portion of the flight. Plant health values were derived using the Normalized Difference Vegetation Index (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 zero.

HANA found varying degrees of plant health within the project site that were further broken down into plant strata layers. Since the data acquired was the baseline health, the need for additional data acquisition would allow this information to be part of the decision-making process going forward within the basin.

By introducing a UAV system equipped with a multispectral camera to OCWD, HANA was able to accurately monitor data and eliminate the need for human interaction to gain transect data in the field. Traditionally, the standard methodology for measuring vegetation diversity and changes overtime has been the implementation of the pedestrian point-intercept method. However, the ability to accurately and consistently reproduce the vegetation data acquired from these surveys is rather low due to the inherent difficulty in consistently relocating the exact same transect location over successive measurements, either seasonally or annually. In contrast, the application of current drone technology allows for the accurate and reproducible acquisition of vegetation data every time it is utilized.

Developments

HANA is developing and implementing technology to advance remote sensing for Plant Health and Plant Species Recognition using machine learning algorithms. The Plant Health project utilizes sUAS and multispectral cameras to obtain high-resolution aerial imagery and NIR data. The NIR and RGB data from the multispectral camera is used to calculate the Normalized Difference Vegetation Index (NDVI). HANA Resources, Inc uses TrueNDVI to calculate our plant health

assessments. Utilizing our special double 4K multispectral camera, HANA can obtain accurate sub-centimeter resolution plant health assessments. By using quality equipment and innovative post-processing techniques, HANA can create results that can be used as a tool for plant health management. Because healthy plants absorb red light and reflect NIR, the difference between these two variables can be calculated to obtain the plant health and density. The resulting index values range from -1 to 1 and correspond to how healthy and dense the vegetation is. Previously, NDVI could only be calculated with satellites at low resolution and longer intervals. Because these were calculated at such high altitudes, many atmospheric effects caused disruption in the data. We've conducted several studies to utilize the appropriate vegetation indices and post-processing techniques for different clients to produce an ultra-high-resolution aerial and plant health analysis for each project site. This provides an accurate, alternative, and cheaper method to evaluating plant health and determining a management plan.

Contact HANA Resources today to speak to an expert about adding our Plant Health Analysis or Plant Recognition System to your operations.