Innovation in Environmental Monitoring with Remote Sensing Techniques

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Background/Objectives. Large or remote areas of land are often challenging and expensive to monitor using traditional ground-based methods. Remote monitoring techniques (i.e., satellite and drone imagery) is becoming a prevalent part of environmental monitoring and characterization. Recent developments in computer vision and artificial intelligence, combined with knowledge in ecological characterization, allow for the rapid analysis of large volumes of rapidly compiled remote sensing data for relevant signals and can provide unparalleled site understanding. These new data sources and methods applied to age old challenges around groundwater seep identification and contaminated site management require a range of demonstrated use cases. This presentation will focus on a brief introduction to how satellites, drones, and cloud-computing based artificial intelligence are changing the way environmental monitoring takes place. Following the technical introduction into these technologies, we will present a case study of remote sensing techniques utilized at a large (several hundred square-kilometer) alumina refinery in which the goal of the project was to understand environmental impacts sitewide and protecting sensitive habitat. The purpose of Ramboll's work with this project was to help the client rapidly assess the changing conditions of vegetation at its facility, and to better understand the impact of specific variables (i.e., drought, groundwater impacts) on the environment.

Approach/Activities. To accomplish this, Ramboll's Galago team analyzed a variety of data sources including high-resolution satellite and aerial imagery to document sitewide trends related to vegetation health and tree dieback. A temporal analysis of satellite imagery was completed to evaluate the region-wide impact of climatic variables, such as drought, on vegetation health using the Normalized Difference Vegetation Index (NDVI). High-resolution aerial imagery and a deep learning model were used to identify specific locations of tree dieback not visible in satellite imagery. Aerial imagery was analyzed using a convolutional neural network model to classify sections of the imagery as tree dieback. Multiple captures per year of aerial imagery allows for site-wide dieback monitoring throughout the year and help capture changes throughout the site. The analysis produced from this project enables an additional line of evidence to support other site investigation and monitoring activities and creates the possibility to deploy an advanced habitat monitoring system in an accurate, repeatable, and cost-effective manner.

Results/Lessons Learned. The success of this project is in its ability to quickly garner information about sitewide trends in vegetation, to supplement and focus ground-based investigations, and to provide an ability to compare the site with reference areas. The satellite imagery analysis provided a region-wide view of vegetative health and showed that the site was impacted by drought in a similar way to reference areas. The aerial imagery analysis showed that it's possible to quickly train and deploy a deep learning model for analysis of vegetation in high-resolution imagery. The advantage of creating a model to identify dieback is that it can be scaled across large areas and applied to new imagery as it becomes available. Overall, the client can now better understand drought impacts on sensitive habitats and will have the ability to measure vegetation dieback rates across the entire site and reference areas. Having this information allows a more efficient and effective implementation of remedial plans, and minimizes environmental impacts to sensitive habitats.