SITING + PERMITTING

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G. MALEK-MADANI[1]

1. Olsson, Lincoln, Nebraska

Employing Remote Sensing for Decision Making in Renewable Energy Site Selection

INTRODUCTION

- It is important to identify environmental constraints early in the siting process. Identifying them early allows developers to avoid these areas of concern from the outset, reducing revisions to layouts later.
- Many constraints, such as sensitive species habitat, are based on land cover types.
- Existing, freely available land cover datasets such as NLCD and Cropscape can be out of date and have poor spatial resolution at project scale.
- Remote sensing allows Olsson to develop project-specific land cover datasets to inform siting decisions.
- Data sources for remote sensing models can come from freely-available satellite or aerial imagery, LiDAR point cloud data, or from Olsson piloted Unmanned Aerial Systems (UAS).
- Model parameters, inputs, and scale can be customized to fit a specific project.

SATELLITE AND AERIAL MULTISPECTRAL IMAGERY

- Landsat (USGS, 30-m resolution), Sentinel 2/3 (ESA, 10-m resolution), NAIP (USDA, spatial resolution varies) can all be utilized for classifications. Data source can be chosen to fit a specific project.
- A time series of data is used when Sentinel or Landsat data is utilized. Normally, a date in the spring during green-up, a date in the summer during peak growing season, and a date in the fall during senescence are chosen. This helps to capture phenological differences between vegetation species.
- Typically, green, red, and near-infrared bands from multispectral imagery are used as model inputs. Additional inputs derived from these bands such as normalized difference vegetation index (NDVI) and green leaf area index (gLAI) can also be calculated and used as inputs to the model.
- Random forest (Breiman 2001) or support vector machine ((Huang et al 2002) supervised classifiers are typically used and chosen based on project specifics. An Iso-cluster (Lemenkova 2021) unsupervised classifier is also used for certain projects.
- Accuracy is assessed using a training-testing dataset containing thousands of points. 75% of points are used for training, when using a supervised classifier, while 25% of points are reserved for testing. When using an unsupervised classifier, all points are used for testing.
- Overall accuracy, sensitivity, specificity, and Out of Bag (OOB) error rate are used to evaluate classification.

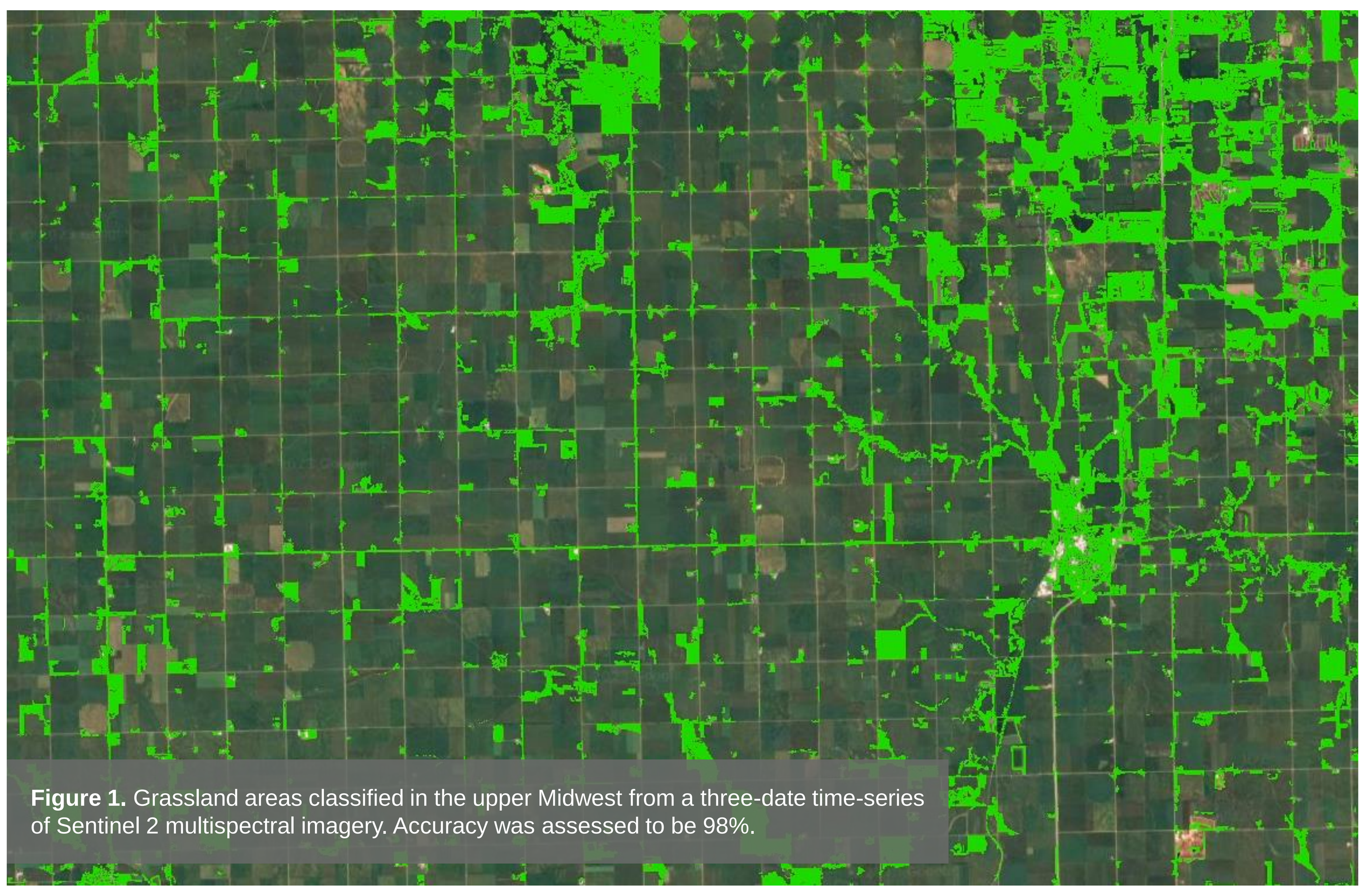

Figure 1. Grassland areas classified in the upper Midwest from a three-date time-series of Sentinel 2 multispectral imagery. Accuracy was assessed to be 98%.

LIDAR

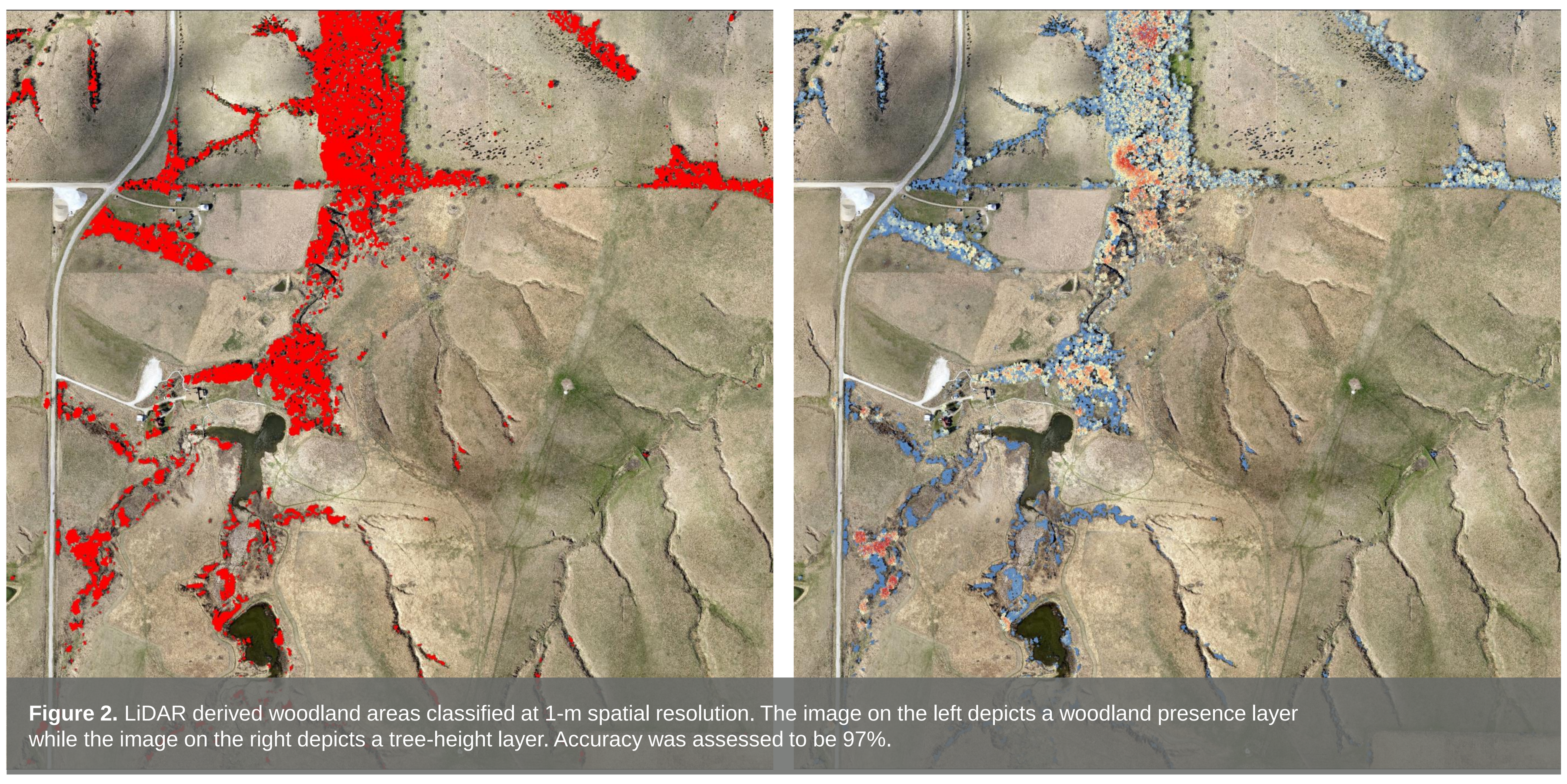

Figure 2. LiDAR derived woodland areas classified at 1-m spatial resolution. The image on the left depicts a woodland presence layer while the image on the right depicts a tree-height layer. Accuracy was assessed to be 97%.

- LiDAR point cloud data from the USGS 3DEP program is used by Olsson in developing forested habitat layers for constraints packages.
- 1-meter or 2-meter spatial resolution data sets are developed which have high spatial accuracy.
- Two datasets can be created from the LiDAR point cloud. The first is a binary presence/absence dataset that can be used for general woodland habitat avoidance or species habitat modeling. The second is a tree height dataset that not only shows tree presence but also the average vegetation height for a given pixel. The tree height dataset has been used by solar clients attempting to avoid tall woodland patches due to possible shadow casting.
- Forested data sets can then be analyzed for habitat quality specific to the species of concern.
- Similar to the multispectral analysis, accuracy assessments are performed on the data sets to provide the developer and the agencies with the measure of confidence they can have in avoiding these sensitive areas in siting decisions.
- Spatial accuracy is commonly higher than 90% with this method due to the redundancy of the high-density point clouds. In most cases overall accuracy is around 98%.

UNMANNED AERIAL SYSTEMS

- A Sentera 6x multispectral sensor mounted to a Flightwave Edge-130 VTOL fixed wing UAS is used by Olsson for analyzing smaller areas in which either more control of data collection or higher spatial resolution is required. The UAS is capable of surveying roughly 160 acres per flight.
- Classification and accuracy assessment of this data is similar to that of the multispectral satellite analysis.
- The UAS is utilized for crane paths, access roads, turbine pads, and turn radii for more infrastructure-based classifications and damage assessments.
- The UAS is useful in long-term vegetation monitoring for wetland or vegetation mitigation areas or for areas of re-vegetation in which the success of such post-construction efforts will need to be monitored and quantified.

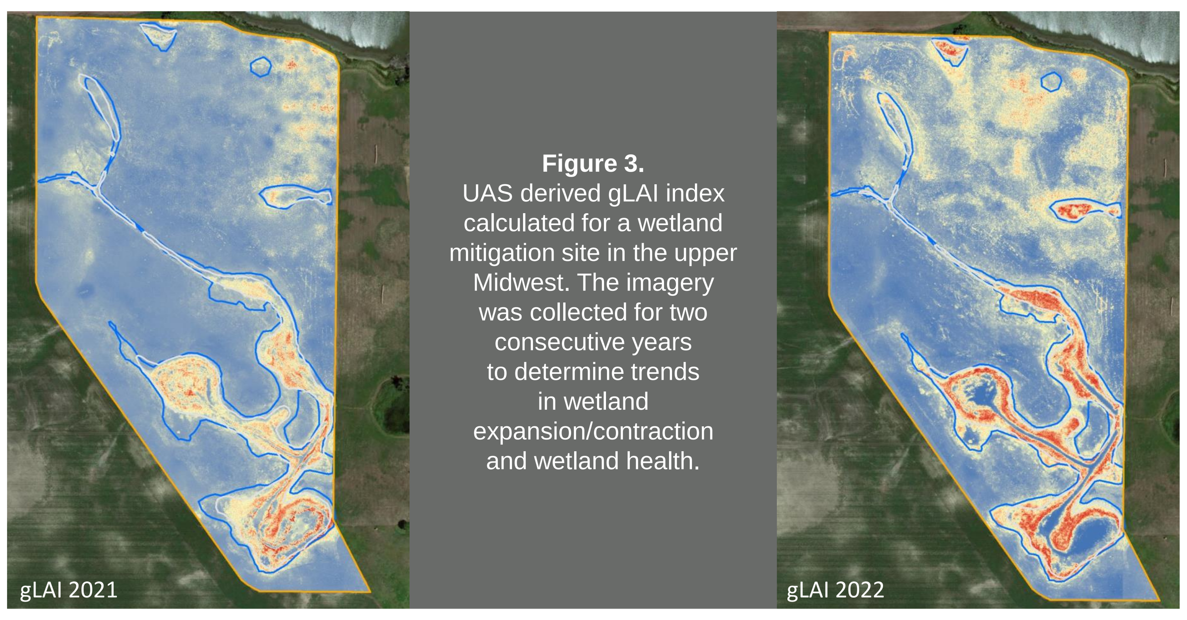

Figure 3. UAS derived gLAI index calculated for a wetland mitigation site in the upper Midwest. The imagery was collected for two consecutive years to determine trends in wetland expansion/contraction and wetland health.

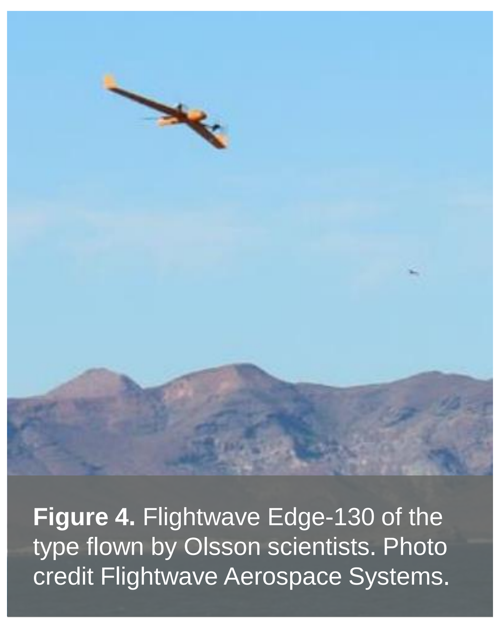

Figure 4. Flightwave Edge-130 of the type flown by Olsson scientists. Photo credit Flightwave Aerospace Systems.

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CONTACT INFORMATION

Gunnar Malek-Madani

Olsson

E-mail: gmalek-madani@olsson.com