Evaluating the accuracy of vegetation indices derived from NEON Imaging Spectrometer data

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Introduction

Background: Field sampling has been a central tool used by land managers to assess ecosystem health. Issues with this approach include field tech accessibility, costs, and scalability across space and time. A solution to this problem is to use remote sensing techniques to obtain data on foliar chemical traits, which are often indicators of ecosystem health and status. This project used data collected from a high resolution airborne imaging spectrometer along with foliar chemistry measurements to identify problems with current well established vegetation indices by evaluating correlations between vegetation indices and foliar chemical data.

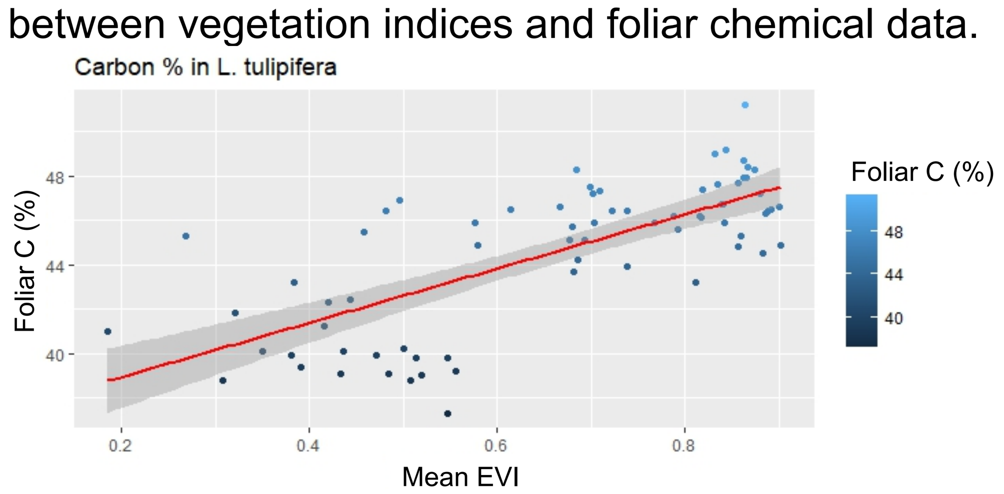


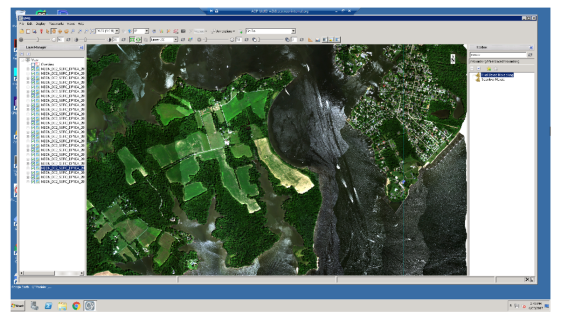
Figure 1: A scatterplot with a linear regression of percent carbon found in L. tulipifera tree samples, compared to the value obtained from the Enhanced Vegetation Index (EVI) mean.

Ideally, we expect similar relationships to the one shown in the figure above. We do not expect there to be a strong positive correlation with all the foliar chemistry values, but a linear correlation should exist between some of the foliar traits and related Index values.

Field and Data Analysis Procedures

NEON uses a standardized sampling method across all field sites to conduct canopy foliage sampling. The field samples collected in 2016 were obtained from 3 sites during the period of peak vegetation greenness, and in conjunction with remote sensing overflights. Peak greenness is the period where the vegetation in the area has the highest photosynthetic activity. Only sun-lit vegetation was sampled.

The foliar chemical data obtained was comprised of seven different csv files, which were combined using Rstudio. A NEON shiny app was used to obtain geolocations of the samples from data stored in Fulcrum data entry applications. Once data organization was complete, the full data set was used to map each foliar sample to a region of interest (ROI) on the hyperspectral data, using the ENVI software.



NEON high resolution imaging spectrometer data yields 7 vegetation index products, but only 5 were used here:

- Enhanced Vegetation Index (EVI)
- Normalized Difference Lignin Index (NDLI)
- Normalized Difference Nitrogen Index (NDNI)
- Normalized Difference Vegetation Index (NDVI)
- Soil Adjusted Vegetation Index (SAVI)

Tree Crown Mapping

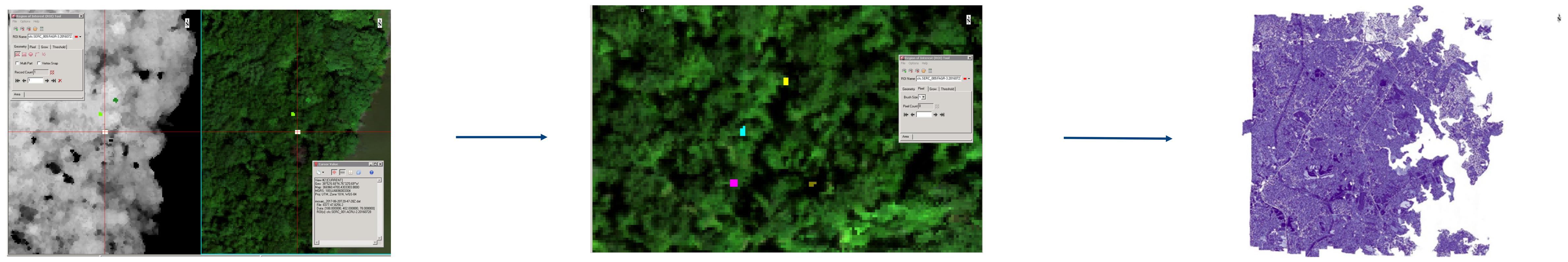


Figure 2 :The left image shows the process of creating ROIs for the Smithsonian Environmental Research Center (SERC) field site. The elevation data (black and white) and the RGB image are two linked images used to ensure each tree crown was mapped to the correct tree. The middle image is the process of exporting the ROIs into a .shp file to be imported back into ENVI with each tree as its own separate ROI. The right image is a completed mosaic of SERC for the EVI, where the ROI values are extracted into a txt file. After extracting index values for each ROI, they were combined with the foliar chemistry data. Linear regressions were run to test how well the chemistry data correlated to the indices.

Results

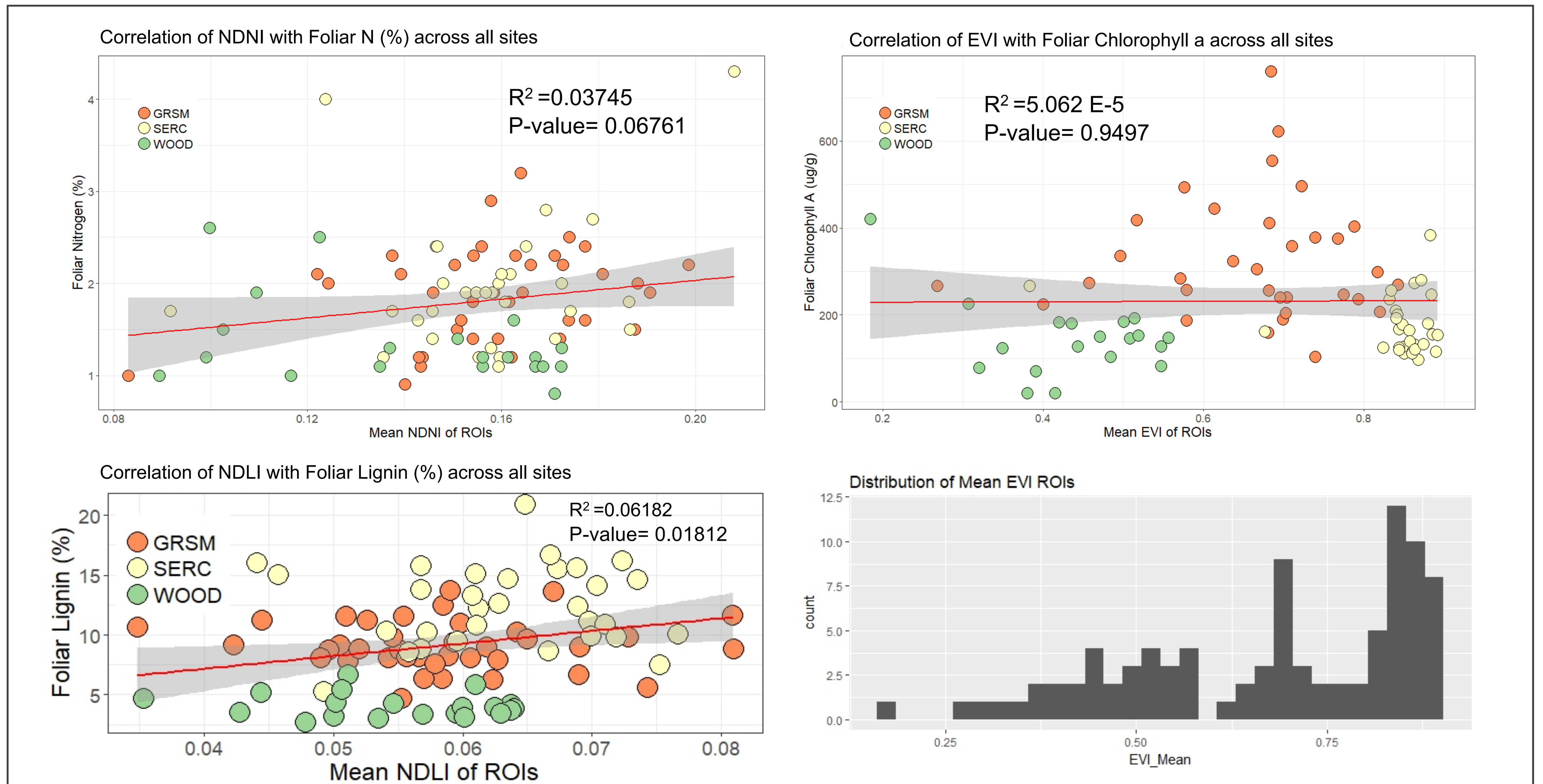
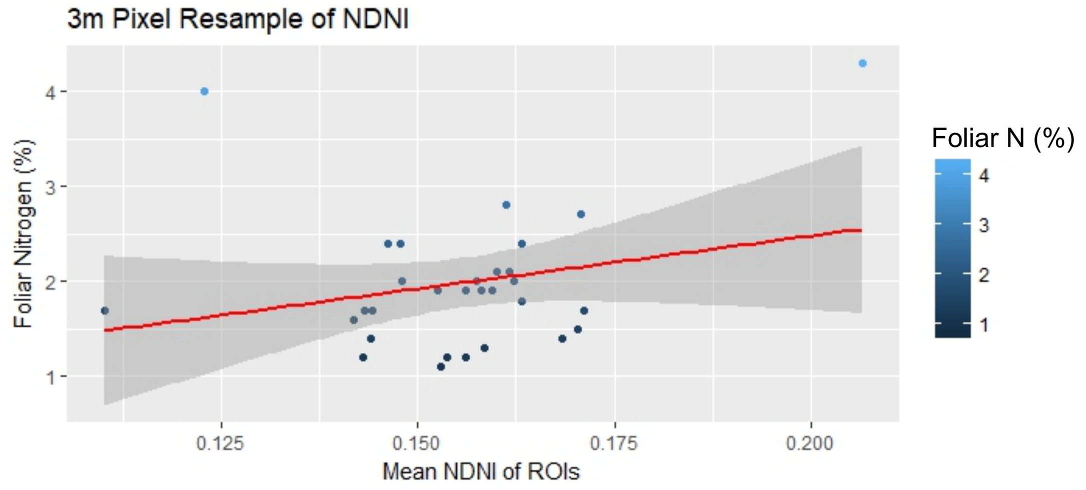


Figure 3: Contrary to our expectations, the regressions in the three scatterplots above showed weak to no linear trends between vegetation indices and observed chemistry values. The bottom right figure displays the distribution of the all the samples obtained from the EVI index (mean of each ROI). Here we can see that the data is not normally distributed, which might be a reason for the lack of linear correlations in the data. Neither a log, square root, nor cube root transformation improved the distribution of EVI data.

Discussion

Figure 4: One idea to improve the correlations was to resample the spectrometer data to 5 m^2 and 3 m^2 pixels. This test was done using the SERC ROIs and foliar N data, but based on the results the same issue persists.



Future Plans

Future experiments and next steps for this project may include finding a way to automate selection of ROIs for tree crown mapping for large sample sizes, and trying to merge together multiple vegetation indices and using their covariance as a predictor to improve correlations with foliar traits.

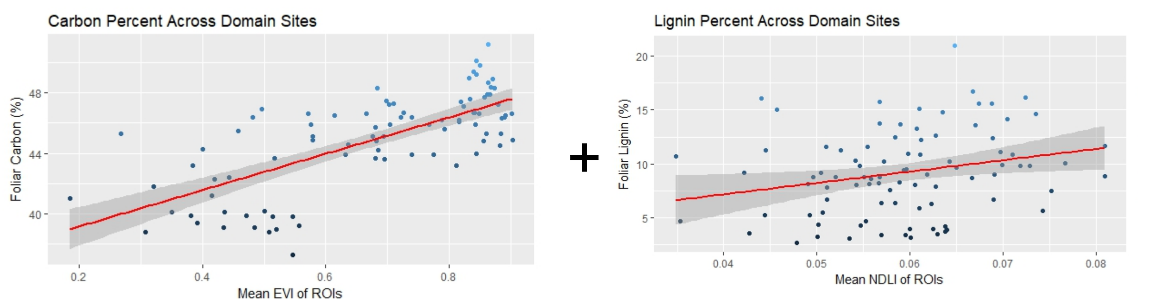


Figure 5: Combining one index that works well with a foliar trait may help improve another index if they are merged together.

NEON is a project sponsored by the National Science Foundation and proudly operated by Battelle.