Assessing potential hyperspectral bioindicators for metal-induced vegetative stress

Kate Thompson
Advisor: Phil Townsend
University of Wisconsin-Madison
kmthompson24@wisc.edu

Abstract:

Nuclear facilities transform landscapes and local ecosystems by releasing both radioactive and non-radioactive contaminants. There has been ongoing research into how plant physiology and chemistry respond to diverse classes of contaminants including tritiated water, acute metal exposures, and petroleum products. However, vegetative response signals are driven by highly complex environmental interactions that are difficult to quantify and restrict how generalizable research findings are to new conditions.

Hyperspectral remote sensing, or imaging spectroscopy, has the potential to detect vegetation that has been exposed to pollutants, transforming our capacities for environmental monitoring. Though interest in characterizing plant stress using hyperspectral imaging is rapidly growing, most of these studies are conducted under laboratory settings. Far fewer have attempted to scale spectroscopic techniques to remote sensing platforms that might be applicable at regional or landscape scales. Identifying diagnostic hyperspectral features compatible with airborne sensors could enable remote, high-frequency, non-destructive environmental monitoring over large spatial areas. Local vegetation could then be used as a passive, low-cost bioindicator of exposure to industrial contaminants, which could assist in early detection of accidental releases, facilitate environmental remediation efforts, or help detect processing activities on the landscape.

Operationalizing this technology requires that we build capacity to: (i) quantify the physiological and chemical changes that contaminants induce in plants; (ii) differentiate between stress responses induced by exposure to contaminants rather than other environmental stressors; (iii) parse the interactive effects of multiple environmental stressors; (iv) characterize species-specific interactions between diverse plant species and contaminants.

I present an update on field experiments conducted over the fall and winter of 2021 in partnership with National Lab collaborators, including preliminary findings on the relative performances of potential bioindicators reported in the scientific literature.