

HyspIRI VQ5: Ecosystem and Human Health

Elizabeth Middleton

Phil Townsend

Kevin Turpie

Overarching Question

- How do changes in ecosystem composition and function affect human health, resource use, and resource management?

Context

- HyspIRI will provide the capacity to measure components of ecosystems with high relevance to human livelihood and well-being.
- Some of these measures overlap and intersect with other components in the VSWIR portfolio (biogeochemistry, biodiversity, etc.).

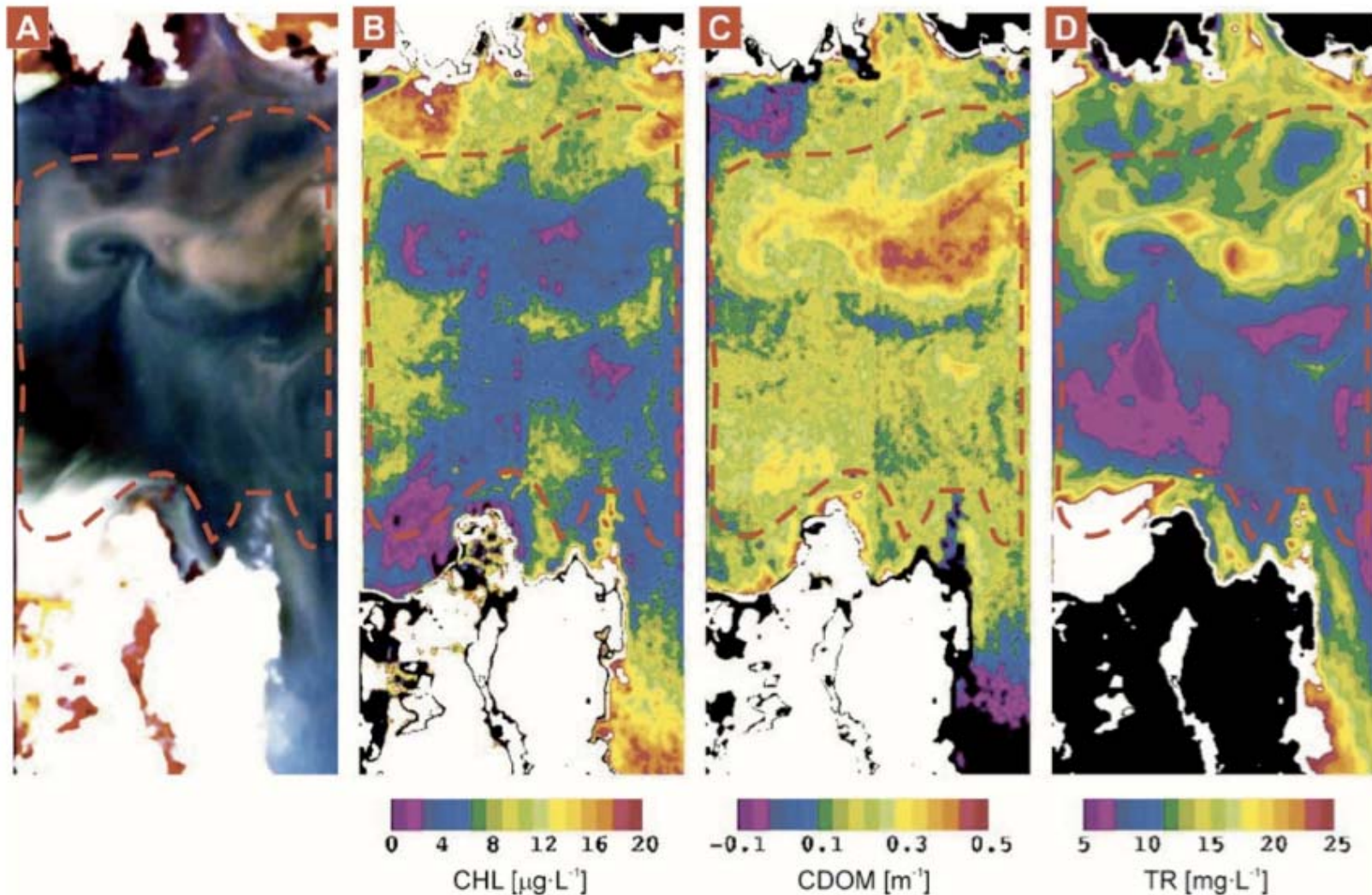
Ecosystem and Human Health

- This is about *what affects humans*....
- Water quality
- Resource availability and quality
- Invasive and undesirable plant species
- Exposure to factors in the environment related to disease
- All of which may ultimately impact social, economic and political behavior

Water Quality

- Direct measurement
 - We are able to directly measure many components of water quality using hyperspectral imagery (especially in coastal water and larger lakes)
 - Water quality is important for drinking supplies, food supply, and human health.
 - A large literature:
 - Chlorophyll concentration (related to eutrophication)
 - CDOM
 - Particulate matter
 - Harmful algae blooms
 - Ability to capture seasonal variations is significant

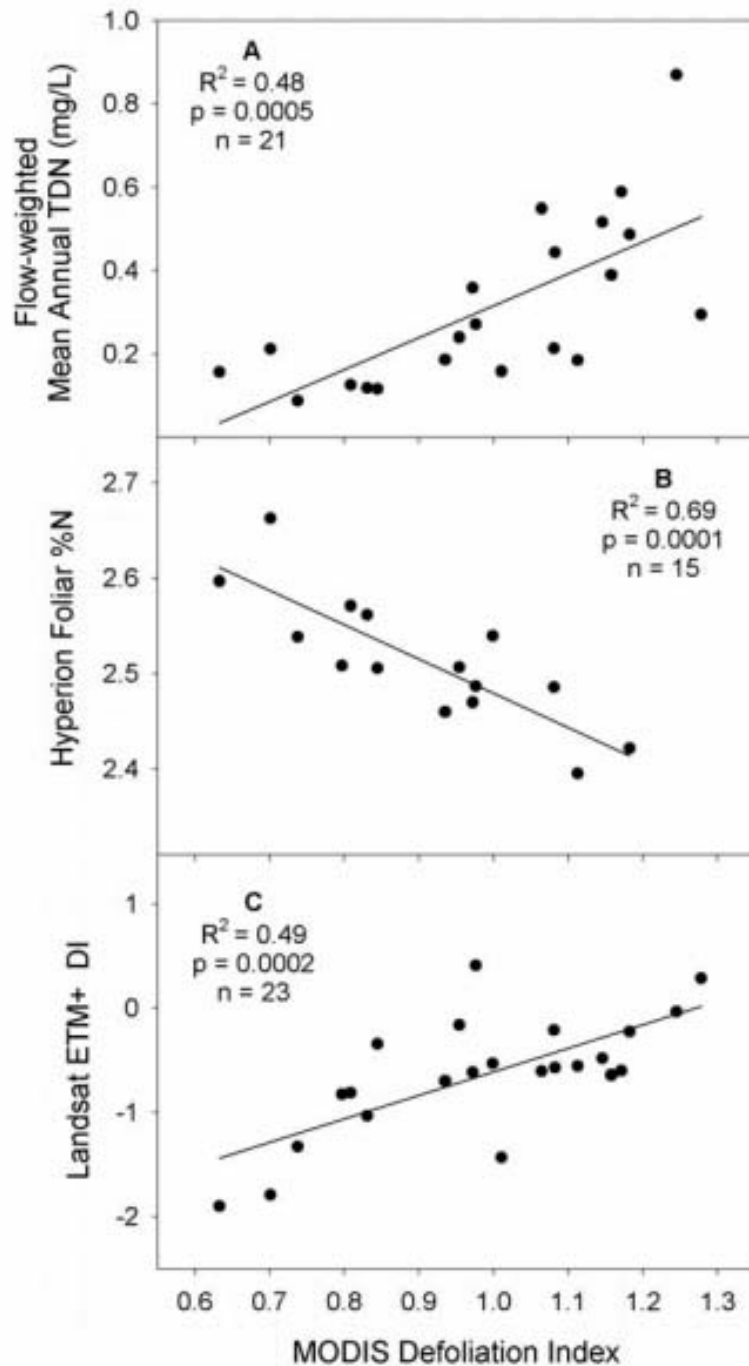
Example 1: Direct measurement of water quality in coastal waters.



From Brando and Dekker (2003). (a) Image derived from filtered Hyperion scene over Deception Bay and processed to estimate concentrations of (b) Chlorophyll, (c) Chromophoric Dissolved Organic Material (CDOM), and (d) tripton (TR). The dashed red line delimits the clear-sky, optically deep water pixels in this scene.

Water Quality

- Indirect measurement
 - Measurement of ecosystem/watershed properties with direct bearing on water quality of receiving bodies of water.
 - Stream water quality is important for drinking water, and its effects on downstream lakes or estuaries (eutrophication).
 - We know that all of the following affect WQ:
 - Species composition and functional traits
 - Disturbance
 - Foliar biogeochemistry

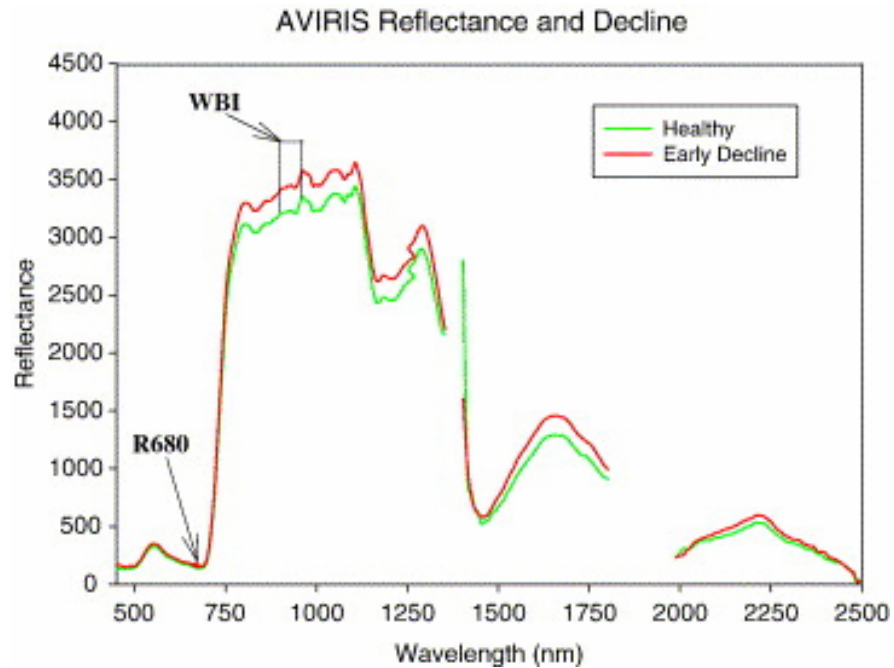


Example 2: Variability in forest foliar nitrogen concentration, and its relationship to stream water quality.

From McNeil et al. (2007). Watershed-scale ecosystem responses to disturbance, specifically related to stream water quality (Panel A: TDN = Total dissolved nitrogen concentration). Disturbance is measured using MODIS imagery (X-axis) and Landsat (panel C), illustrating an inverse response stream nitrogen (A) and foliar nitrogen (B), as derived from Hyperion.

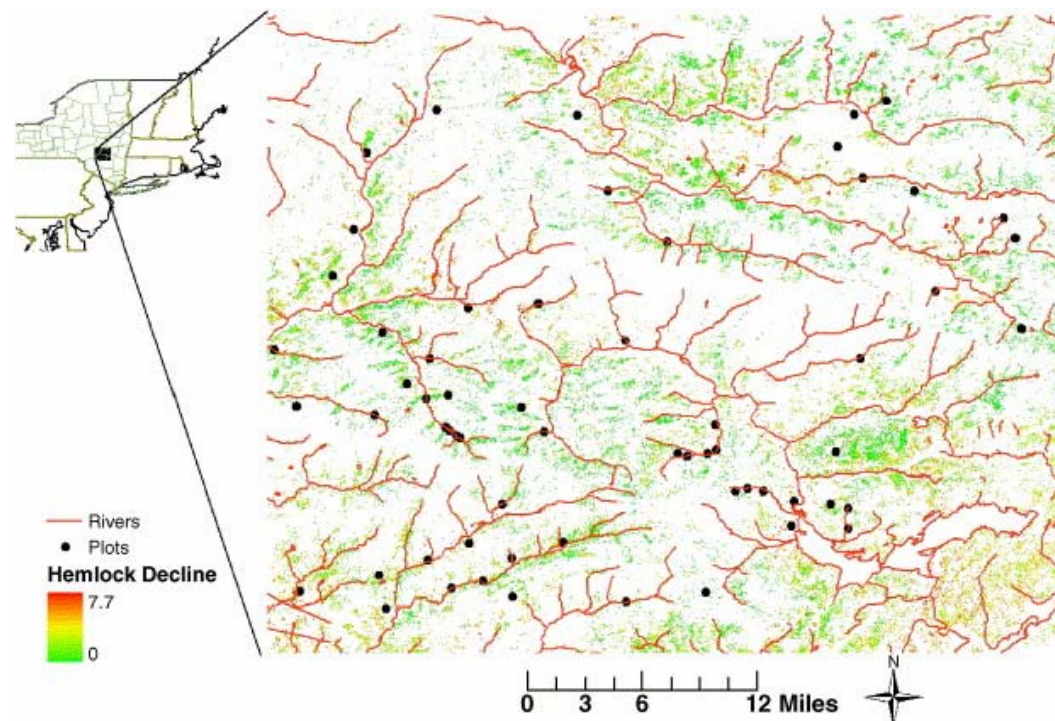
Resource Availability and Quality

- Plant stress and disease
 - HypsIRI offers unprecedented capacity to detect stress in vegetation that is highly relevant to resource management, and human economic well-being
 - Affects food and fiber.
 - An extensive literature:
 - Forestry (pre-visual detection of infestations)
 - Agriculture (especially disease, but also nutrient/water status)
 - Importance of repeat imaging (yearly) to track changes



Example 3. Pre-visual detection of hemlock wooly adelgid infestation.

From Pontius et al. (2005).
 Differences in AVIRIS reflectance for healthy hemlock and hemlock in early decline, and a resulting map of hemlock decline derived from AVIRIS for the Catskills.

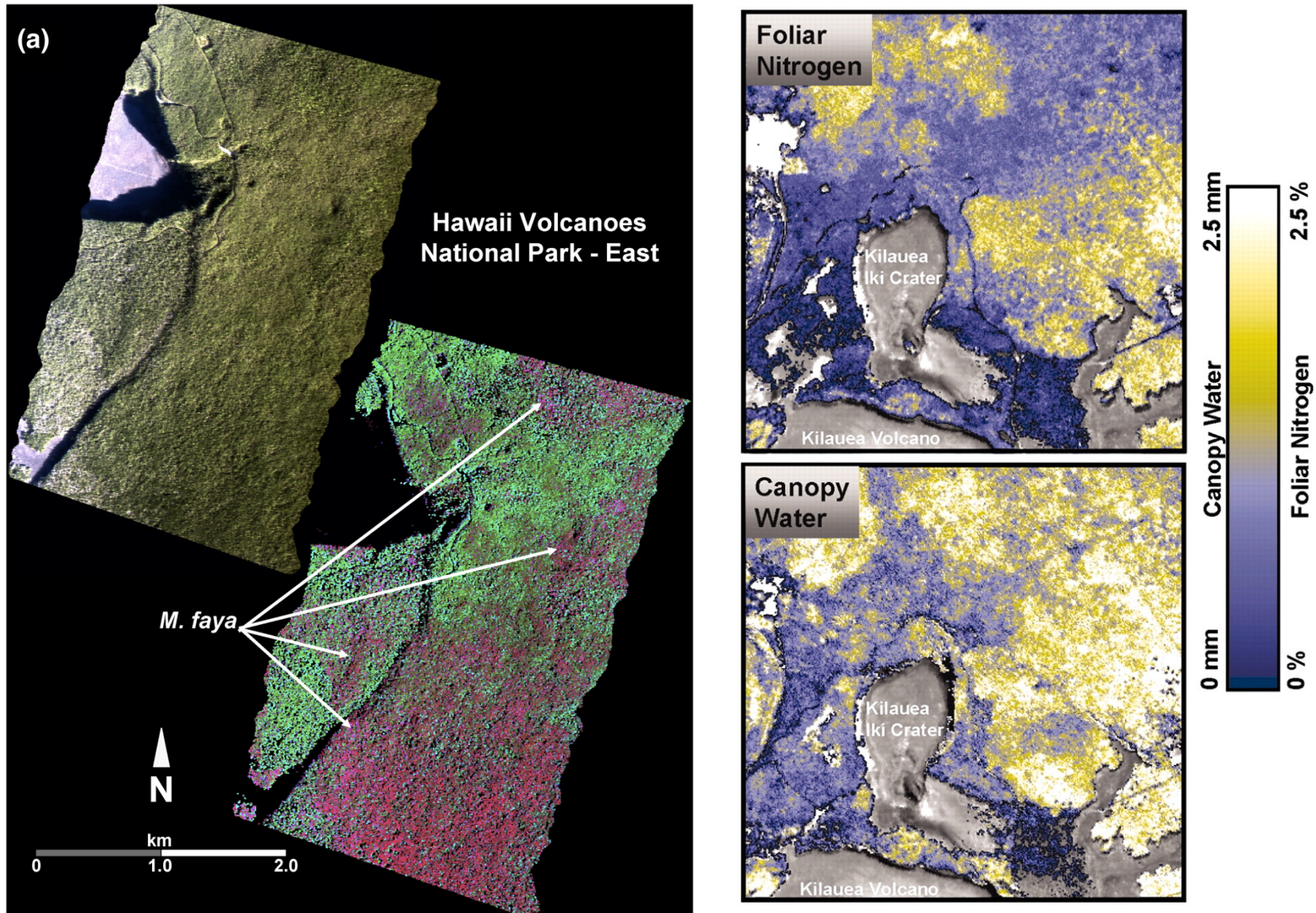


Non-native and Invasive Plants

- Pose a significant threat to ecosystems worldwide:
 - Displacing native species used for food/fiber
 - Can change terrestrial or aquatic nutrient dynamics (because of differing functional and nutrient assimilation strategies)
 - Ultimately affect biodiversity and fauna
- Hyperspectral imagery is a critical tool for mapping:
 - Species composition
 - Nutrients
 - Leaf water content
 - All may be associated with changes due to invasive plants
- Importance of repeat imaging (yearly) to track changes

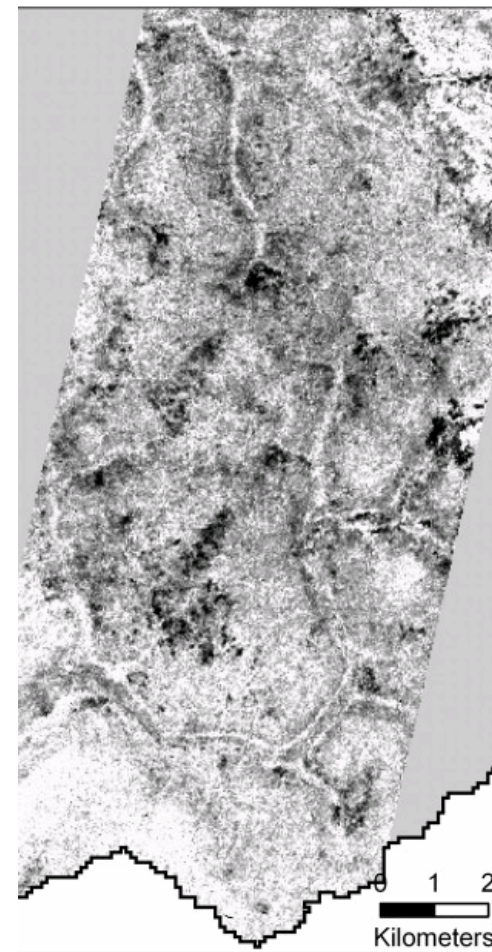
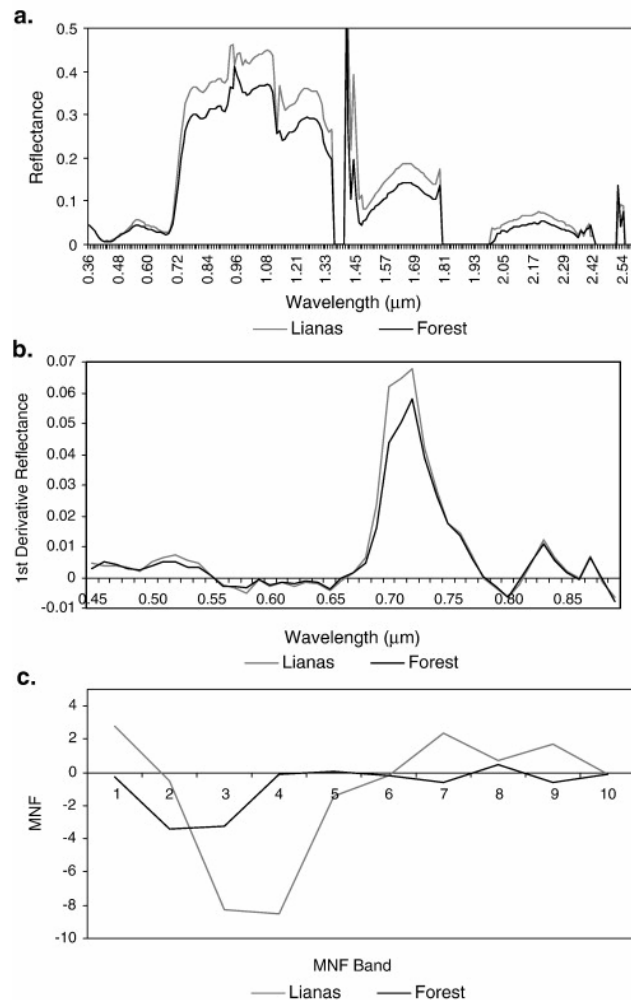
Example 4. Invasion of the N-fixing *Myrica faya* in Hawaii.

Detection of *Myrica faya* using AVIRIS-lidar fusion (left, Asner et al. 2008) and foliar nitrogen and water concentrations derived for areas with the invasive *Myrica faya* (right: high N, high water content, Asner & Vitousek 2005).



Example 5. Liana invasion of tropical forests.

From Foster et al. (2008). Replacement of canopy trees by lianas affects long-term carbon accumulation and water relations in tropical forests. Left: Mean reflectance (a), 1st derivative reflectance (b), and minimum noise fraction (c) from EO-1 Hyperion lianas (gray) and tropical forest (black). Right, contrast between lianas (black) and forest (light) mapped from Hyperion MNF in Noel Kempff NP, Bolivia.



Summary

- Information derived from HypsIRI will facilitate mapping components of ecosystems that are important to long-term human well-being.
- Seasonal and multi-year measurements will enable tracking changes through time.
- Ultimately, early detection using HypsIRI may provide the opportunity to develop management plans to reduce risks to human populations.