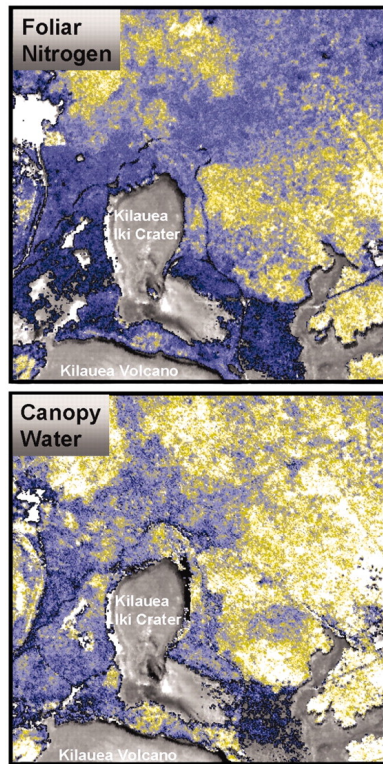# VQ5. Ecosystem and Human Health
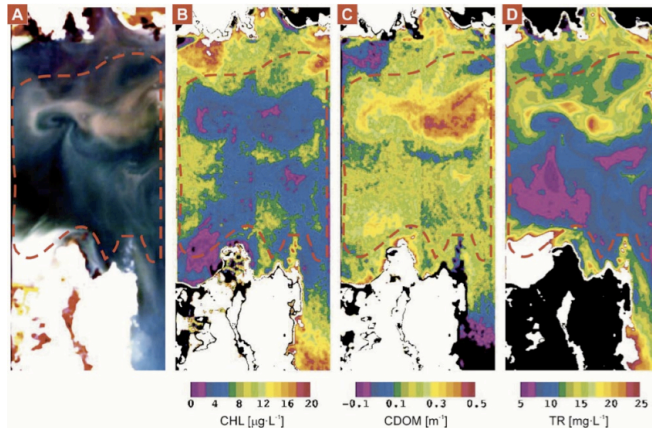
How do changes in ecosystem composition and function affect human health, resource use, and resource management?

VQ5: How do changes in ecosystem composition and function affect human health, resource use, and resource management? (DS 152-153)

Left: Detection of foliar nitrogen and water concentrations derived for areas with the invasive Myrica faya (high N, high water content) in Hawaii (from Asner & Vitousek, 2005: PNAS 102:4383-4386).

Below: Hyperion derived estimated concentrations of chlorophyll, chromophoric dissolved organic material (CDOM), and (d) tripton (TR) (from Brando and Dekker, 2003: TGARS 41:1378-1387).

Science Issue:

• Ecosystem condition affects the humans dependent on those ecosystems for life and livelihood. How do changes in ecosystem composition and function correlate with famine, exposure to harmful biotic growth, the spread of infectious disease, and disease vectors and other causal agents? What are the implications of ecosystem changes such as invasive species for sustained food production, economic infrastructure, water supplies, and other ecosystem services? Can ecosystem changes be used to anticipate regions for targeted interventions to reduce adverse outcomes?

Tools:

• Satellite observations from HyspIRI. Requires measurements from 0.4 – 2.4 µm at 5-10 nm resolution for water quality measurements, to detect vegetation stress related to pests and pathogens, and to quantify foliar nutrient concentration related to invasive species and other ecosystem changes.

• *In situ* and lab measurements of ecosystem properties as well as spectral libraries from validation activities are necessary to derive and validate scaling relationships between ground and spectral data.

• A time series of ground data and imagery are required to identify and track changes in ecosystem properties.

• Published models relate spectra to hyperspectral imagery.

Approach:

• Use systematically collected HyspIRI images to develop baseline measurements of importnant ecosystem properties such as water quality, community composition (including terrestrial and aquatic vegetation), and nutrient status.

• Field campaigns to collect baseline measurements (including spectra) of key ecosystem properties across the range of ecosystem types.

• .Elucidate linkages between ecosystem properties measured with HyspIRI and resources important to human health and well-being.

VQ5. Ecosystem and Human Health

- How do changes in ecosystem composition and function affect the spread of infectious diseases and the organisms that transmit them[DS155, 160, 161]?

- How will changes in pollution and biogeochemical cycling alter water quality?

- How are changes in ecosystem distribution and productivity linked to resource use, and resource management?

- How will changes in climate and pollution affect the health and productivity of aquatic and agricultural resources?

- What are the economic and human health consequences associated with the spread of invasive species?

- How does the spatial pattern of policy, environmental management, and economic conditions correlate with the state and changes in ecosystem function and composition? (DS 155 [5-5]?, 230 [8-7])

- What are the impacts of flooding and sea-level rise on ecosystems, human health, and security? [DS 195, 224, 227, 348, 357]

From presentation Simon sent

VQ5. Ecosystem and Human Health

- How do changes in ecosystem composition and function correlate with famine, exposure to harmful biotic growth, the spread of infectious disease, and disease vectors and other causal agents (DS 113, 153-154, 179-182, 194, 199 Fig 7.3)

- What are the implications of ecosystem changes for sustained food production, economic infrastructure, water supplies, and other ecosystem services? (DS 196 Box 7.2)

- What are the economic and human health consequences associated with the spread of invasive species? (DS 196 Box 7.2)

- What are the impacts of flooding and coastal inundation on ecosystems and human health and security? (DS 25, 65 Fig 3.21, 224 Fig 8.4, 348-349)

- Can ecosystem changes be used to anticipate regions for targeted interventions to reduce adverse health outcomes? (DS 156)

- How do changes in ecosystem composition and function correlate with geographic patterns of conflict or economic and political stress?

**From white paper submitted by Townsend**

Water quality is important for drinking supplies, food supply, and human health.
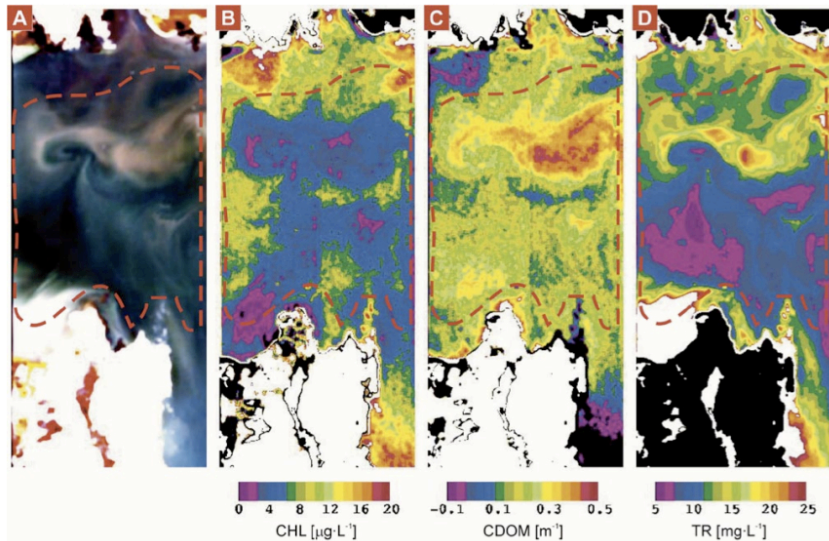
(a) Image derived from filtered Hyperion scene over Deception Bay and processed to estimate concentrations of (b) Chlorophyll, (c) Chromophoric Dissolved Organic Material (CDOM), and (d) tripton (TR). The dashed red line delimits the clear-sky, optically deep water pixels in this scene.

- Science Issue
  - Characterize conditions associated with microorganisms as well as suspended inorganic materials in areas at water/land interface
- Tools
  - Contiguous spectral measurement from 400 to 2500 nm at 10 nm spatial sampling at 60 m with high signal-to-noise ratio and with excellent spectral and IFOV uniformity.
- Approach
  - Measure and monitor
    - Chlorophyll concentration (related to eutrophication)
    - CDOM
    - Particulate matter
    - Harmful algae blooms
  - Ability to capture seasonal variations is critical

Stress in vegetation is highly relevant to resource management, and human economic well-being
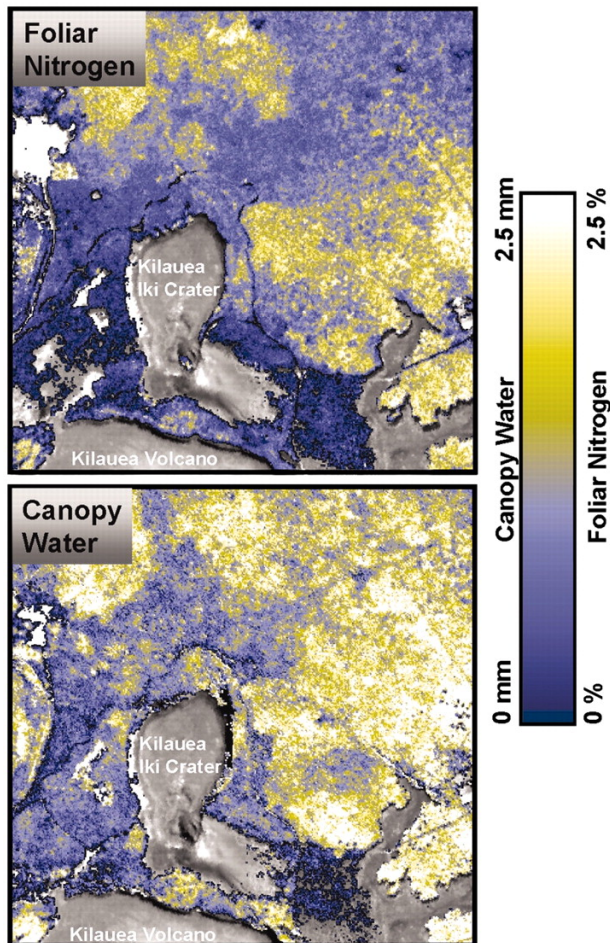

AVIRIS Reflectance and Decline
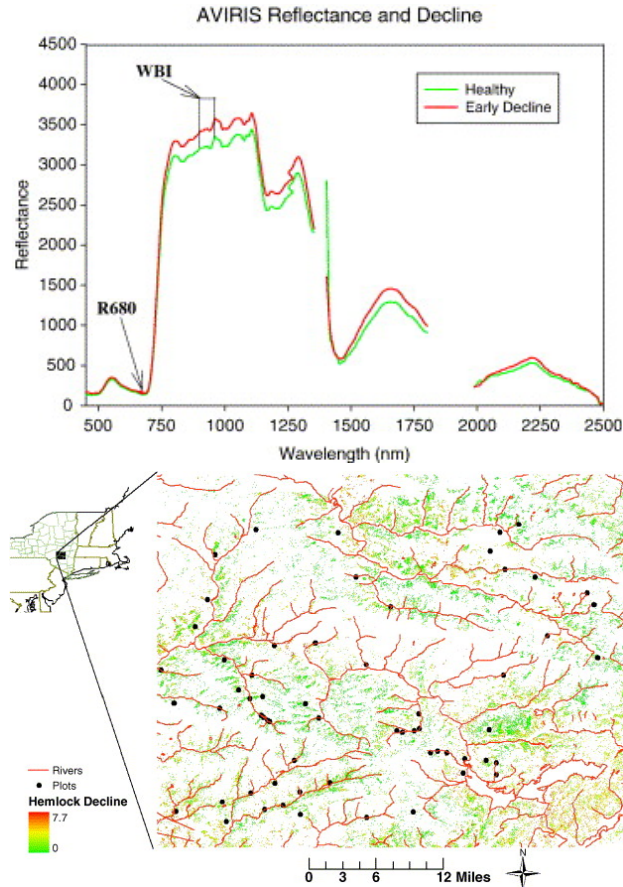
Hemlock is an important species in the Eastern U.S., but is threatened by the pest hemlock woolly adelgid. Differences in AVIRIS reflectance for healthy hemlock and hemlock in early decline, and a resulting map of hemlock decline derived from AVIRIS for the Catskills.

Pontius et al. (2005)

- Science Issue
  - Need to be able to detect environmental stress, infestations of pest species prior to visually detectable levels of effect occur.
- Tools
  - Contiguous spectral measurement from 400 to 2500 nm at 10 nm spatial sampling at 60 m with high signal-to-noise ratio and with excellent spectral and IFOV uniformity.
- Approach
  - Measure the optically available spectral signature of regions through several seasons
  - Use spectral signature and unmixing based algorithms and forward inversion approach to measure and characterize the composition, distribution and seasonal variability species composition, nutrients and leaf water content

Non-native and invasive species pose a significant threat to world's ecosystems

Detection of *Myrica faya* using foliar nitrogen and water concentrations derived for areas with the invasive Myrica faya (high N, high water content, Asner & Vitousek 2005).

- Science Issue
  - Invasive species pose a significant threat to ecosystems worldwide by displacing native species used for food/fiber, changing terrestrial or aquatic nutrient dynamics (because of differing functional and nutrient assimilation strategies)
  - Ultimately affects biodiversity

- Tools
  - Contiguous spectral measurement from 400 to 2500 nm at 10 nm spatial sampling at 60 m with high signal-to-noise ratio and with excellent spectral and IFOV uniformity.

- Approach
  - Measure the optically available spectral signature of regions through seasons over multiple years

  - Use spectral signature based algorithms to identify species composition and changes over space/time. Characterize the composition, distribution and seasonal variability in species composition to identify locations for surveillance and range changes of species.

  - Use published algorithms to estimate nutrient (nitrogen) and water content.

Changes in ecosystem functioning affect ecosystem services important to humans
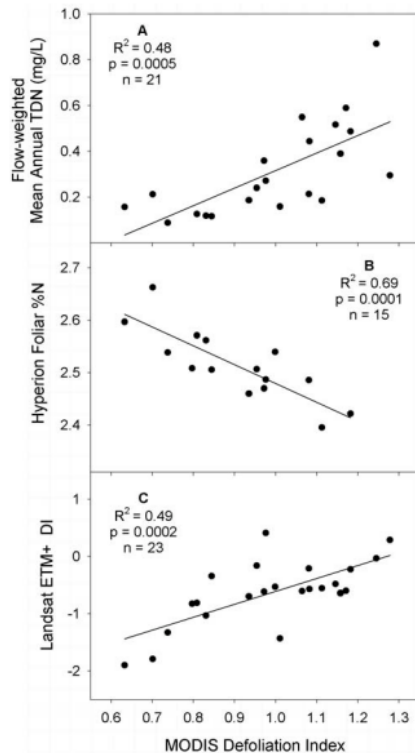
Biochemical changes in ecosystems due to insect defoliation are apparent in hyperspectral measurements of foliar nutrients (second panel), and are expressed in measurements of nutrient watershed-scale nutrient export (first panel, total dissolved nitrogen).
McNeil et al. (2007)

- Science Issue
  - Changes in ecosystem functioning due to many factors (including pests, diseases, invasive species, disturbance, climate change, land management) can threaten ecosystems worldwide by altering the ability of those ecosystems to either provide necessary service (water quality, food, fiber) or to buffer against negative impacts to those services.
  - Ties into ecosystem concerns, biodiversity, biogeochemical cycling, all of which are important to humans.

- Tools
  - Contiguous spectral measurement from 400 to 2500 nm at 10 nm spatial sampling at 60 m with high signal-to-noise ratio and with excellent spectral and IFOV uniformity.

- Approach
  - Measure the optically available spectral signature of regions through seasons over multiple years

  - Use spectral signature based algorithms to map species composition, functional traits, biogeochemical composition and changes over space/time. Characterize the disturbance and seasonal/annual variability in species or ecosystem properties to predict areas likely to be impacted.

  - Measure and monitor water quality, plan disease, pest distribution.