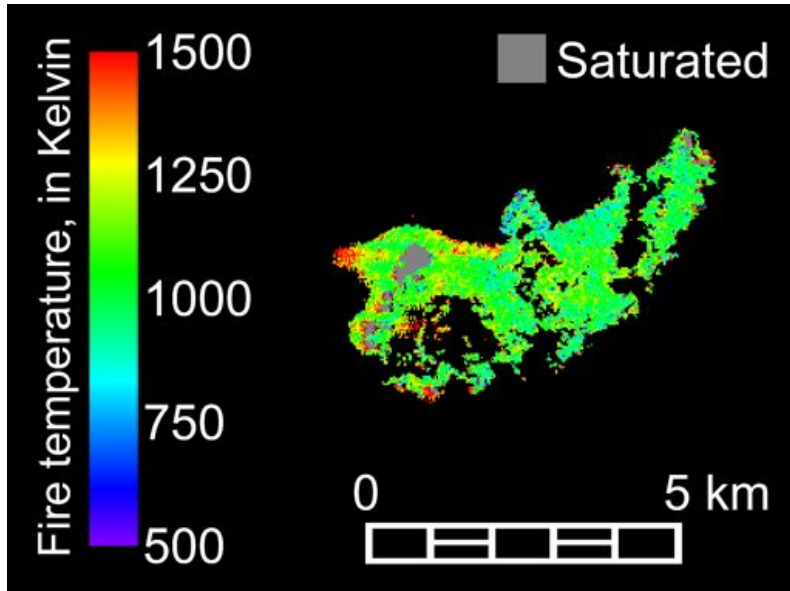


# CQ2. Fire and Vegetation Composition

How are fires and vegetation composition coupled?

## CQ2a: How does the timing, temperature and frequency of fires affect long-term ecosystem health?



Fire temperature retrieved from ASTER SWIR bands for the July 2007 Sawmill fire. (Eckman et al., 2009, in review for IJRS)

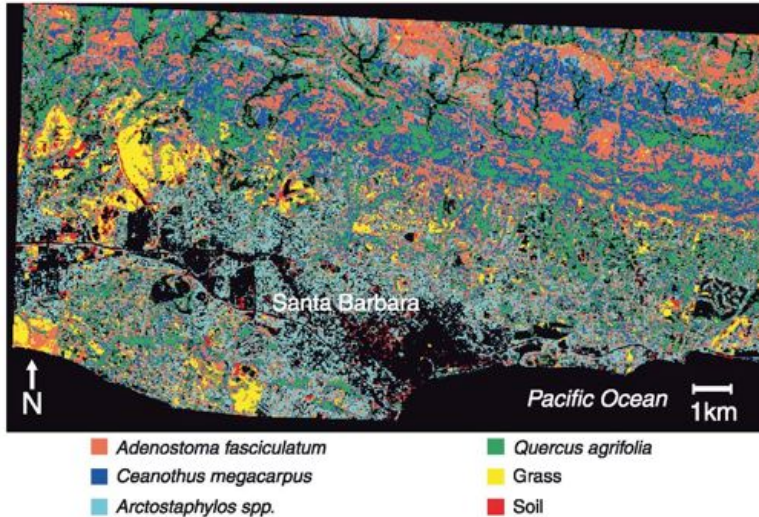


Fires can have significant impacts on ecosystem health ([http://www.pfc.cfs.nrcan.gc.ca/entomology/mpb/management/fire/images/tsacfire\\_lrg.jpg](http://www.pfc.cfs.nrcan.gc.ca/entomology/mpb/management/fire/images/tsacfire_lrg.jpg))

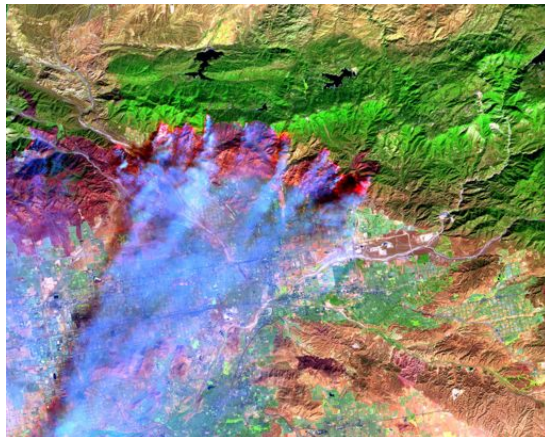
- Science issue  
The state of an ecosystem can be affected by changes in fire regime. Changes in both fire occurrence (both timing and frequency) and fire temperature can have long-term impacts on the state of the vegetation and the entire ecosystem.
- Tools  
Requires long-term, accurate, fire detection, fire monitoring, and mapping of fire intensity. HypsIRI TIR data are required to accurately map small and smoldering fires as small as 10 sqm in size. Further requires pre- and post-fire assessment of ecosystem health, which can be performed in part using HypsIRI VSWIR imagery. Requires possibly historical data from other sensor to supplement the temporal coverage of the HypsIRI data.
- Approach  
Use HypsIRI TIR data (and possibly data from other sensors) to map fire occurrence, temperature and frequency. This data can then be analyzed in conjunction with information on ecosystem health acquired from HypsIRI VSWIR data.

# CQ2b: How does vegetation composition and fire temperature impact trace gas emissions?

Hyperspectral VSWIR data allows for highly accurate and very detailed mapping of fuel type as shown here by an example for AVIRIS. Classification accuracy: 89%. (Dennison and Roberts, 2003)



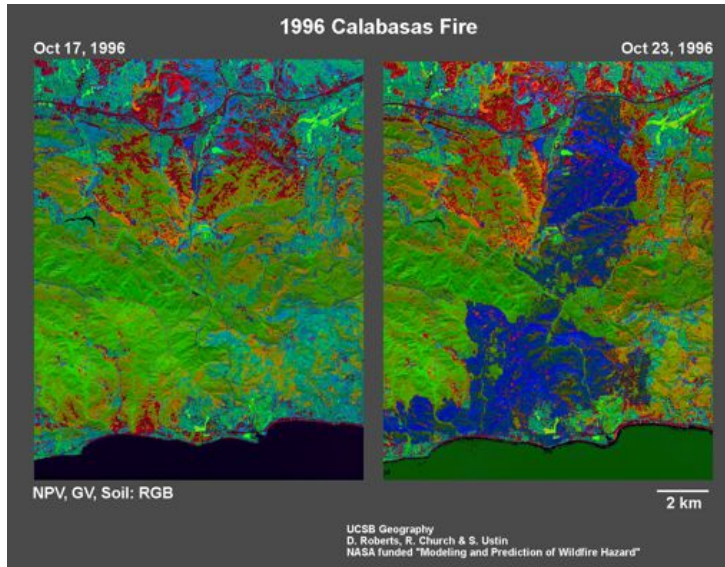
High-resolution imagery of fires is very valuable for modeling composition and behavior emissions as shown here by an ASTER image of the Grand Prix Fire



- Science issue  
Fires burn in a wide variety of vegetation types that differ in fuel type, fuel load, fuel condition etc. It is likely that the state of the vegetation does not only affect the behavior and severity of the fire but also affects the quantity and composition of emitted trace gases.
- Tools  
Requires hyperspectral HypsIRI VSWIR data to accurately characterize vegetation composition, including fuel type, fuel load, and fuel condition. Further requires HypsIRI TIR data to map fire temperature and fire extent.
- Approach  
Vegetation composition mapped using HypsIRI VSWIR data can be used in conjunction with fire temperatures to model trace gas emission of individual fires. Trace gases can also be mapped using VSWIR data. Validation can be carried out against other sources of information on trace gases in the atmosphere.

# CQ2c: How do fires in coastal biomes affect terrestrial biogeochemical fluxes into estuarine and coastal waters and what is the subsequent biological response? [DS 198]

Mapping of fuel condition using Spectral Mixture Analysis for the 1996 Calababas fire, which burned all the way to the ocean



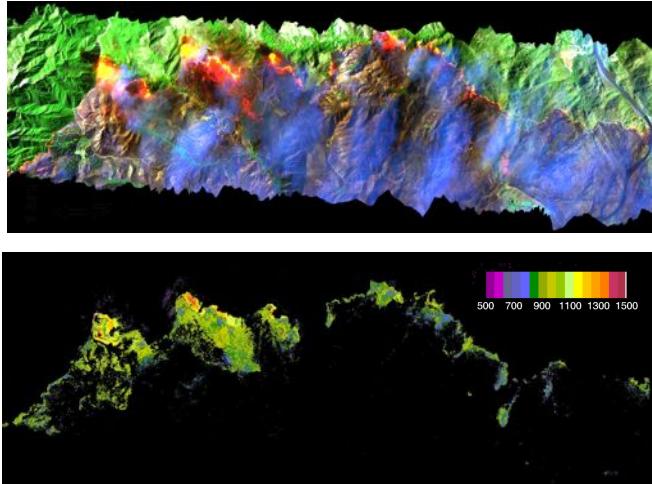
The 2008 Gap fire in Goleta, CA, provides another example for a fire occurring in a coastal biome with potential effects on the coastal waters (from [http://www.nasa.gov/images/content/258987main\\_ikhana\\_fire1\\_HI.jpg](http://www.nasa.gov/images/content/258987main_ikhana_fire1_HI.jpg))



- Science Issue  
Fires do not only burn inland but can also occur in coastal biomes. Such fires and their associated biogeochemical fluxes into nearby waters can cause changes in water characteristics.
- Tools  
Requires HypsIRI TIR data to detect occurrence of fires in coastal biomes and to further map their extent and intensity.  
Requires HypsIRI VSWIR data over coastal waters to assess impacts of biogeochemical fluxes such as changes in water clarity.  
Further requires additional information on biological response.
- Approach  
Use HypsIRI TIR data to detect and map fires in coastal biomes. Use HypsIRI VSWIR data to observe subsequent changes in water clarity and productivity. Use additional biological data to further explain and quantify the biological response.

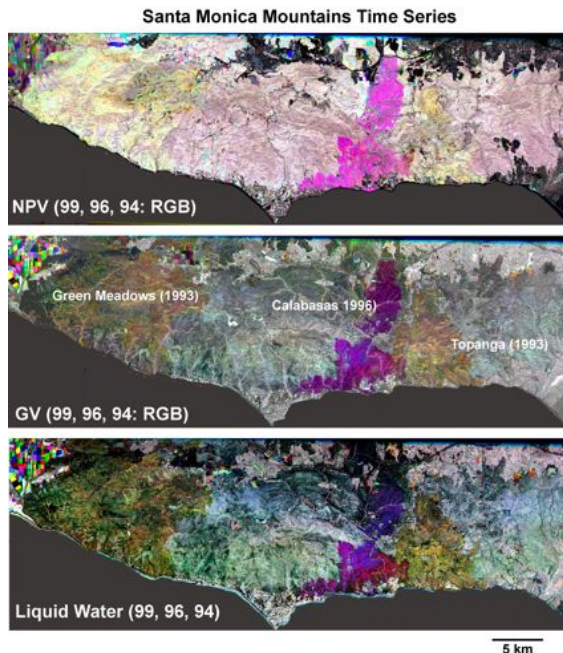
# CQ2d: What are the feedbacks between fire temperature and frequency and vegetation composition and recovery?

Fire temperature retrieval from AVIRIS imagery (Dennison et al. 2006)



- Science Issue  
The intensity of fires and their frequency are likely to have effects on postfire succession of vegetation. For example, frequent, low intensity fires might produce a type of conversion from shrubland to grassland.
- Tools  
Requires HypsIRI TIR data to determine frequency of fires on a larger scale and temperature of individual fires on a smaller scale. Further requires time series HypsIRI VSWIR imagery for long-term mapping and observation of vegetation composition and recovery after fires.

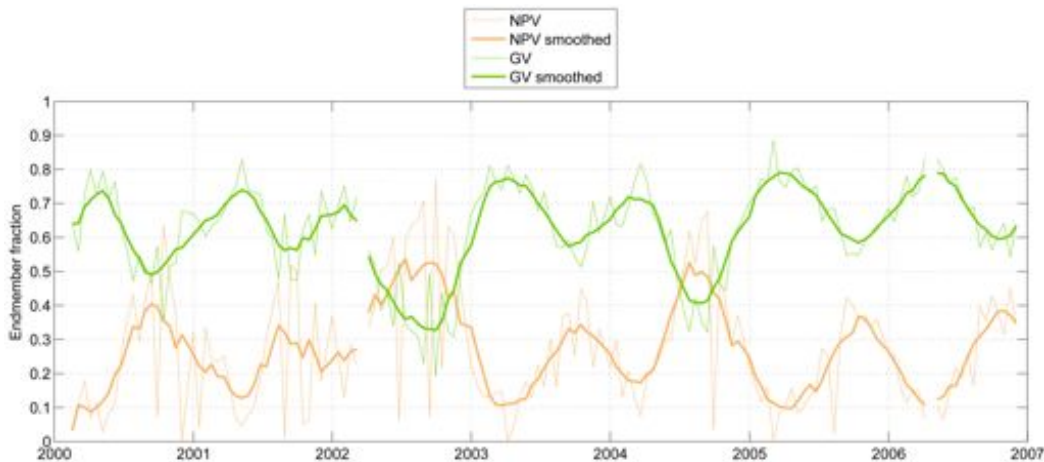
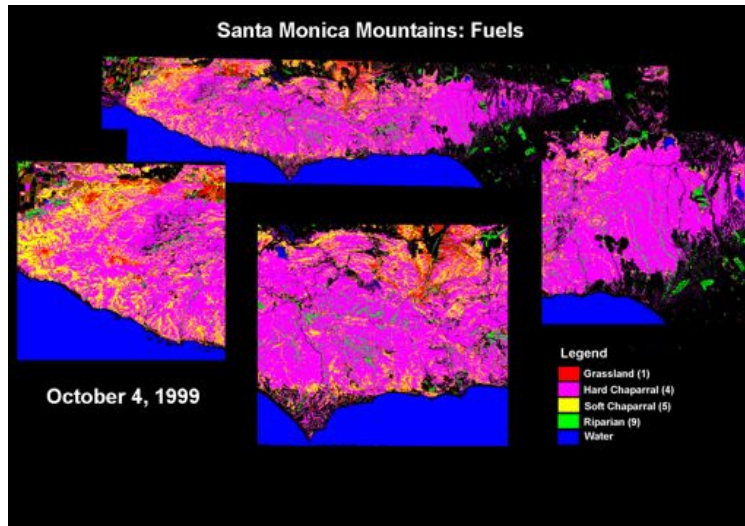
Post-fire response to three different fires, two in 1993 and one in 1996. Canopy moisture is the most sensitive measure of change, as shown by overlap between the 1996 and 1993 Calababas and Topanga fires. High fire return intervals in Southern California are impacting ecosystems, eliminating some shrub species. (Dar Roberts)



- Approach  
Use HypsIRI TIR data to detect fires and their frequency. Use the same data to map fire temperature and thus burn intensity. Use HypsIRI VSWIR pre-fire data to establish a baseline of vegetation composition, and use HypsIRI VSWIR post-fire data to monitor succession and post-fire recovery.

# CQ2e: How does vegetation composition influence wildfire severity?

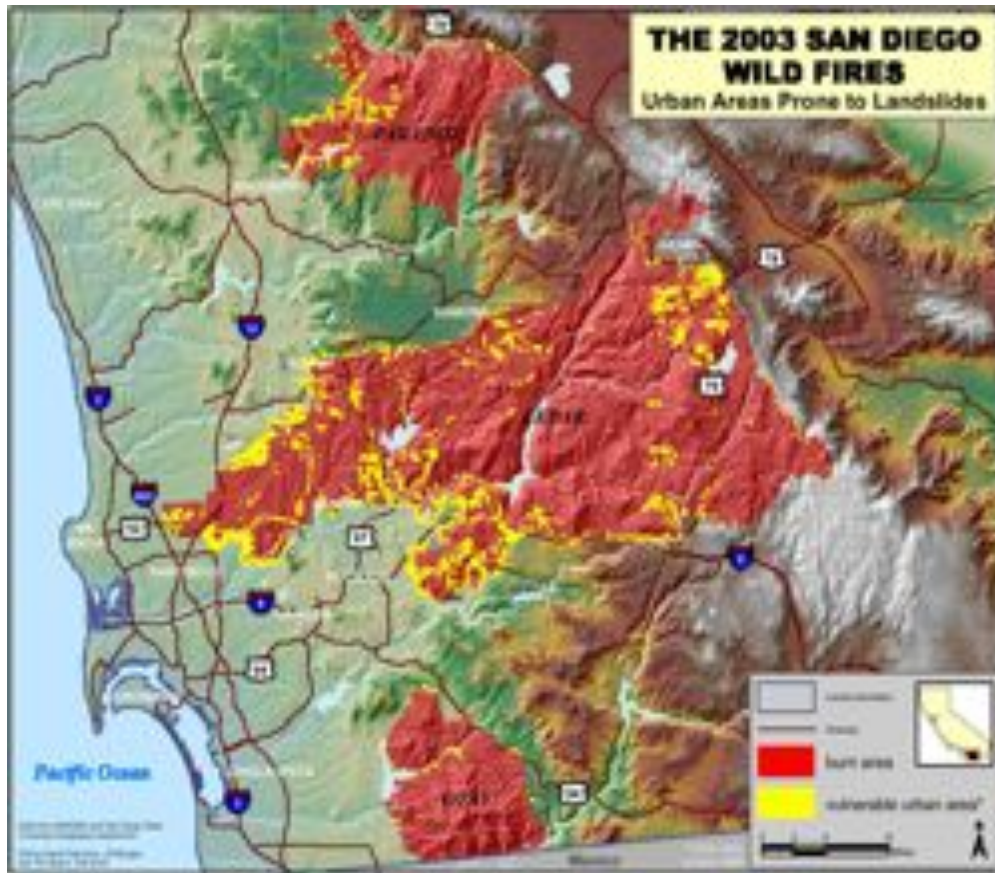
Fuels can be accurately mapped using hyperspectral imagery as shown here for the example of AVIRIS (provided by Phil Dennison)



Time series of fuel condition (fractions of Non-Photosynthetic vegetation and Green Vegetation) derived from MODIS using Multiple Endmember Spectral Mixture Analysis. Such measures can be used to evaluate the recovery of vegetation after fire (Schneider, 2008)

- Science Issue  
Vegetation composition, i.e. fuel type and fuel condition (the fractions of live and dead vegetation) affect fire temperature and fire behavior. In addition to images during the fire, quantifying the impact of vegetation composition on fire severity requires samples from a large number of fires.
- Tools  
Requires HypsIRI VSWIR data to determine vegetation composition pre- and post-fire. Further requires HypsIRI TIR imagery during the fire for estimating wildfire severity.
- Approach  
Gather TIR data from active fires and relate fire temperature as a proxy of fire severity to a wide variety of pre-fire vegetation states acquired from VSWIR data as a baseline. Vegetation states should include a wide variety of fuel types, fuel loads, and fuel conditions, and fuel moistures.

## CQ2f: On a watershed scale, what is the relationship of vegetation cover, clay-rich soils and slope, to frequency of debris flows?



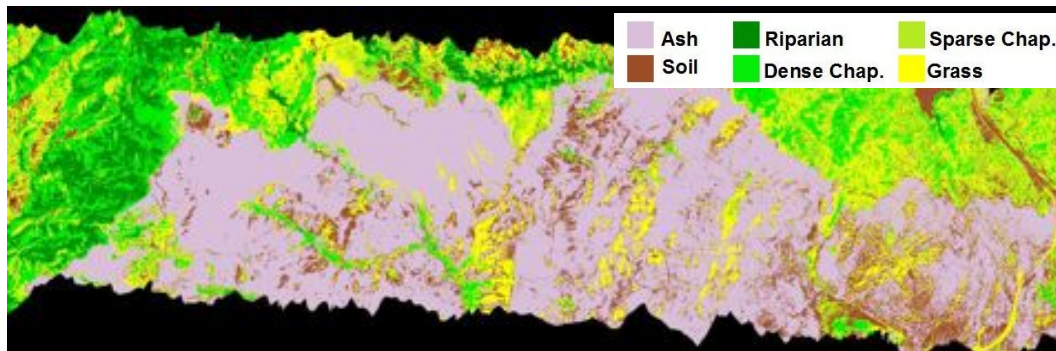
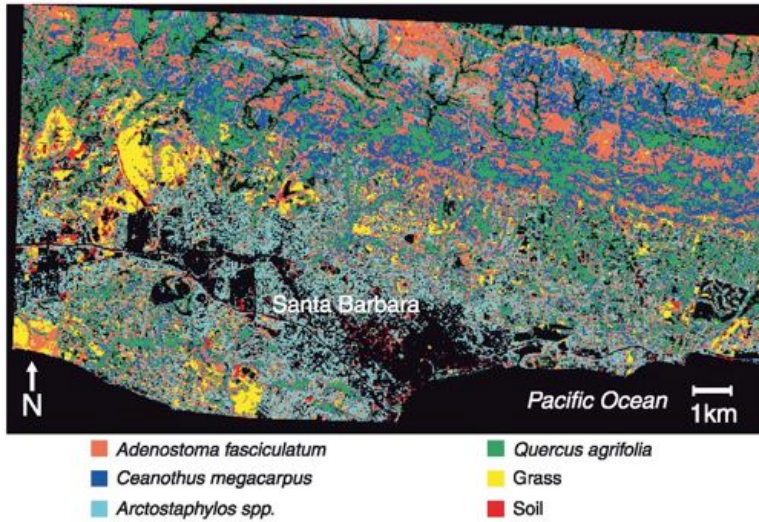
Analysis of landslide potential after the 2003 San Diego fires (Palomino et al., 2003)

- Science Issue  
Landslides are a common occurrence in recently burned areas. However, they occur a varying frequencies. It is likely that a combination of parameters such as vegetation, soils, and/or terrain affect the frequency of debris flows.
- Tools  
Requires HypsIRI TIR data for identifying areas of variable fire frequency. Further requires post-fire HypsIRI VSWIR data for determining vegetation cover. Use a combination of both data sets for identifying areas of clay-rich soils. Requires DEM as additional information to derive slope. Further use VSWIR data to map debris flows in affected areas.
- Approach  
Identify possible study sites using a combination of HypsIRI VSWIR and TIR data. Use TIR for identifying fire-prone areas, then use VSWIR for mapping vegetation cover, clay-rich soils, and debris flows. Use additional information on terrain.

# CQ2g: How does invasive vegetation cope with fire in comparison to native species?

Hyperspectral imagery provides the means for highly accurate and very detailed mapping of vegetation type, and is thus a good way of mapping invasive species.

(Dennison and Roberts, 2003)



Post-fire land cover classification for the 2003 Simi fire (Dennison et al., 2006)

- Science Issue  
Invasive species occur in many biomes together with native species. While fire affects them both, invasive species might have a different way of coping with fires than native species that have adapted to the existing fire regime.
- Tools  
Requires pre- and post-fire HypsIRI VSWIR imagery to produce accurate maps of vegetation type, in particular of invasive species. Further requires HypsIRI TIR data to detect fires in areas with both invasive and native species, and to map the fire temperature.
- Approach  
Use HypsIRI VSWIR hyperspectral imagery to accurately map vegetation type, with a particular focus on invasive species. Use HypsIRI TIR data to detect fires, map their extent, and estimate fire temperature. Use post-fire classifications of vegetation type in order to assess possible differences between invasive and native species in terms of succession and recovery.