Geological Remote Sensing in the LTER Network: Terra Cognita?

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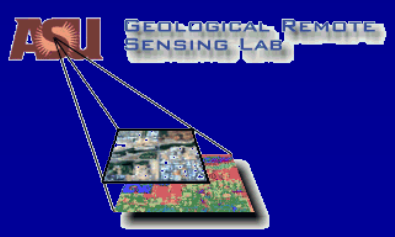
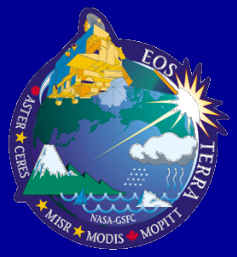
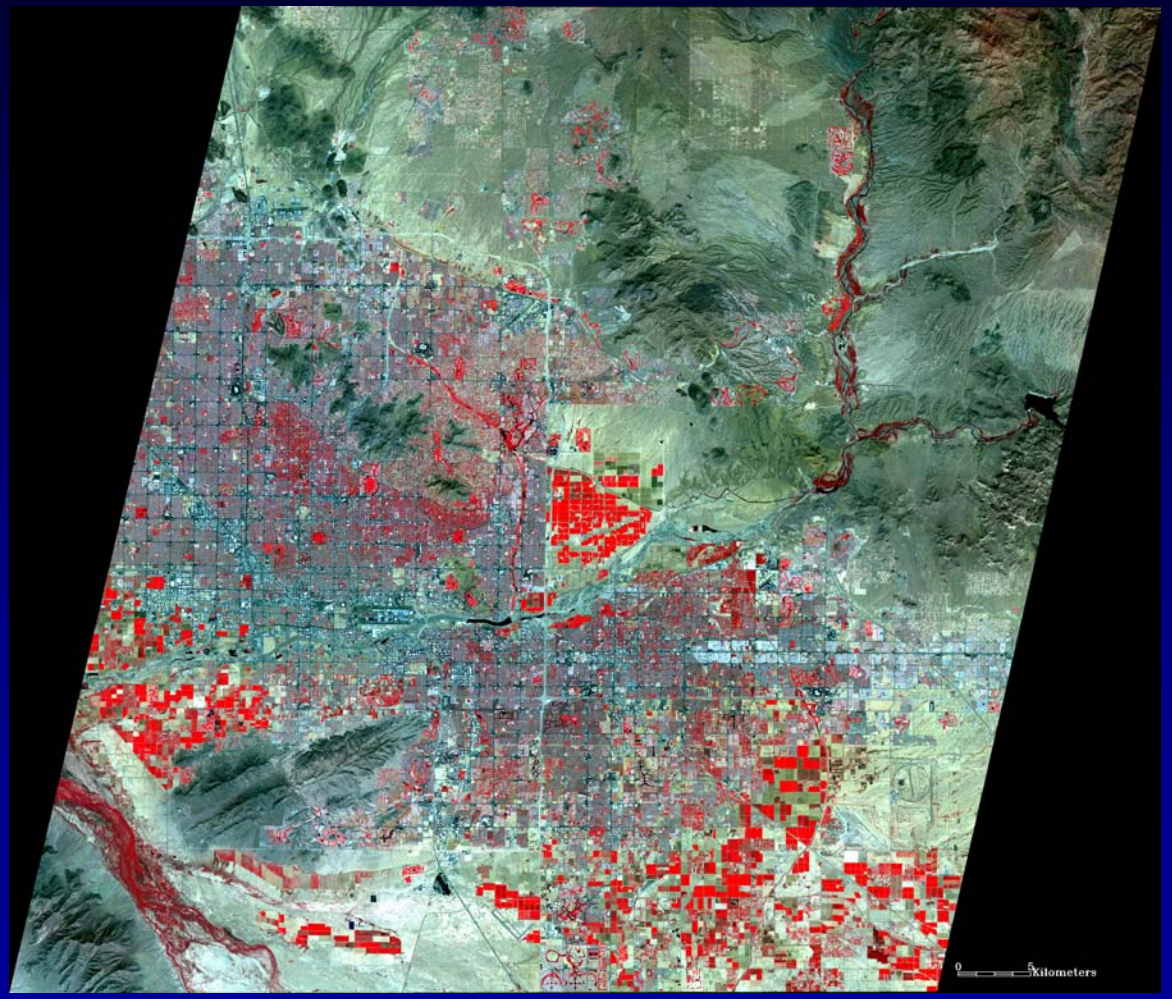




CAP LTER
Central Arizona-Phoenix
Long-Term Ecological Research

Overview

- General Geoscience/LTER Geoscience
- Site Examples (CAP, Andrews, VCR, Jornada)
- Urban Geoscience and Remote Sensing
- Published Strengths
- Summary



ASTER visible-near infrared mosaic of the central CAP LTER site, 19-Sep-00

Geological Remote Sensing

Geologic Mapping
- bedrock, structure

Economic Resource Assessment
- mineralogy, structure, vegetation

Hazard Assessment
- volcanoes, earthquakes, floods

Land Cover Mapping/Change
- patch dynamics, urbanization, vegetation

Geomorphology/Landscape Characterization
- particle size, mineralogy, topography

Soil Mapping
- agriculture, soil moisture, soil development

Hydrology
- drainage networks, vegetation, land cover, floods

Surface Fluxes
- albedo, emissivity, surface temperature, biological parameters

Environmental Monitoring
- air quality, anthropogenic contaminants, subsidence

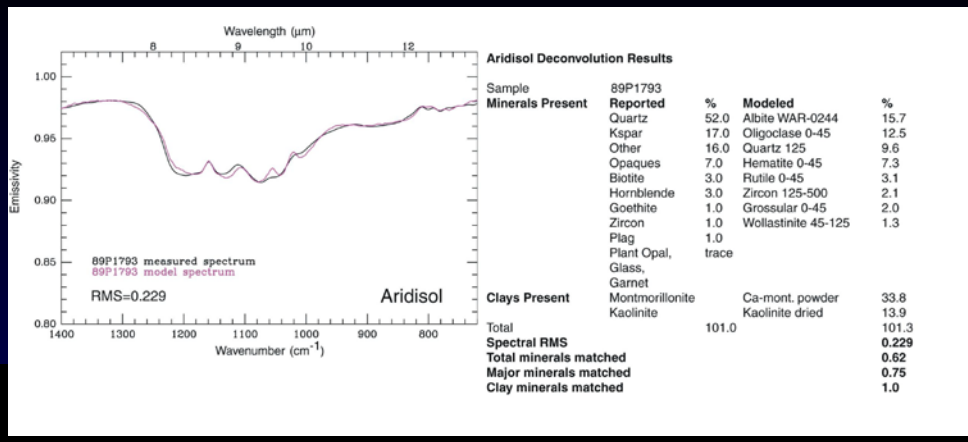
Central Arizona-Phoenix LTER

Investigation of hillslope geomorphic processes using TIR image (TIMS) and lab spectroscopy

-similar degrees of soil development and transport throughout study range on urban fringe

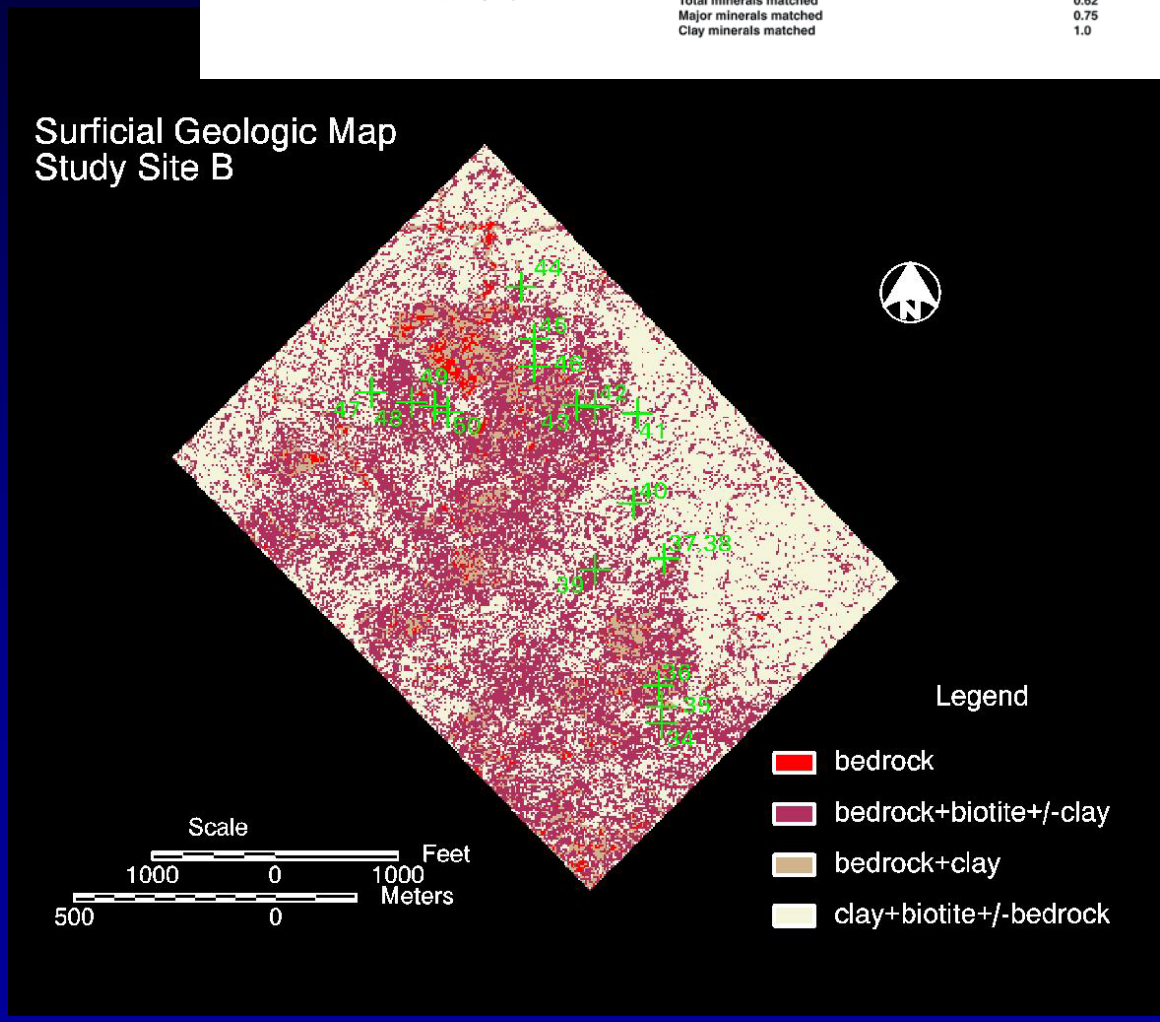
-insight into surface particle size controls on pediment development

-useful baseline for study of human alteration of geomorphic processes (upcoming MASTER flights)



Aridisol Deconvolution Results

Sample	89P1793			
Minerals Present	**Reported**	**%**	**Modeled**	**%**
	Quartz	52.0	Albite WAR-0244	15.7
	Kspar	17.0	Oligoclase 0-45	12.5
	Other	16.0	Quartz 125	9.6
	Opaques	7.0	Hematite 0-45	7.3
	Biotite	3.0	Rutile 0-45	3.1
	Hornblende	3.0	Zircon 125-500	2.1
	Goethite	1.0	Grossular 0-45	2.0
	Zircon	1.0	Wollastinite 45-125	1.3
	Plag	1.0		
	Plant Opal, Glass, Garnet	trace		
Clays Present	Montmorillonite		Ca-mont. powder	33.8
	Kaolinite		Kaolinite dried	13.9
Total		101.0		101.3
Spectral RMS				**0.229**
Total minerals matched				**0.62**
Major minerals matched				**0.75**
Clay minerals matched				**1.0**



Central Arizona-Phoenix LTER

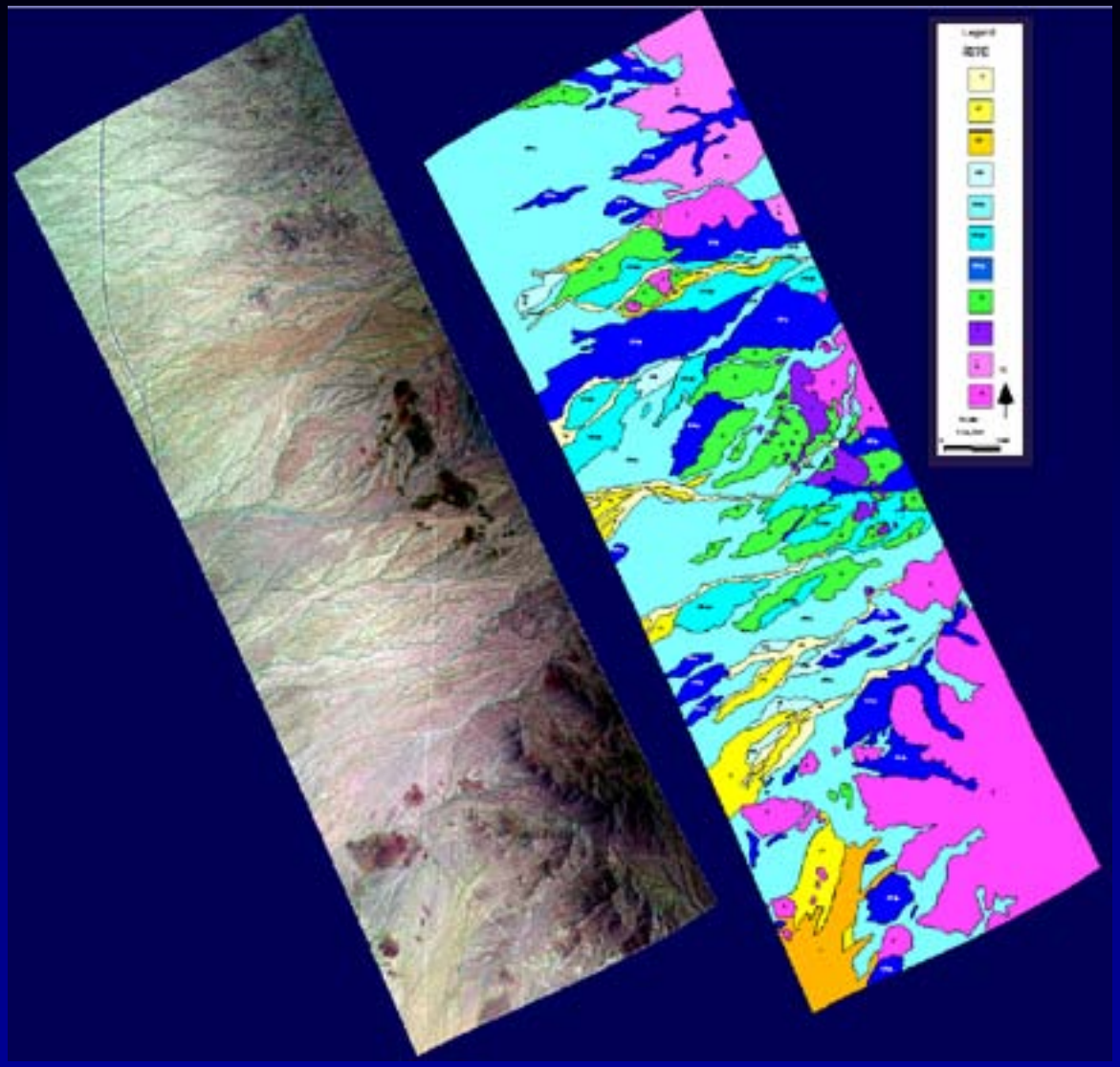
Determination of alluvial fan aggradation history using NS001 data and cosmogenic nuclide dating

-determination of periods of aggradation at 1.5-1.0 Ma and 0.8-0.5 Ma separated by stability and incision

-provides insight into regional climatic controls on landscape development in urban fringe area

-links geomorphic surface and history to biotic communities

-techniques useful for flood hazard mapping



NS001 image mosaic highlighting variations in alluvial fan surface mineralogy (left); geologic map derived from imagery and field mapping (right)

Image courtesy of Sarah Robinson, USGS; and Ramon Arrowsmith, Dept. of Geological Sciences, ASU

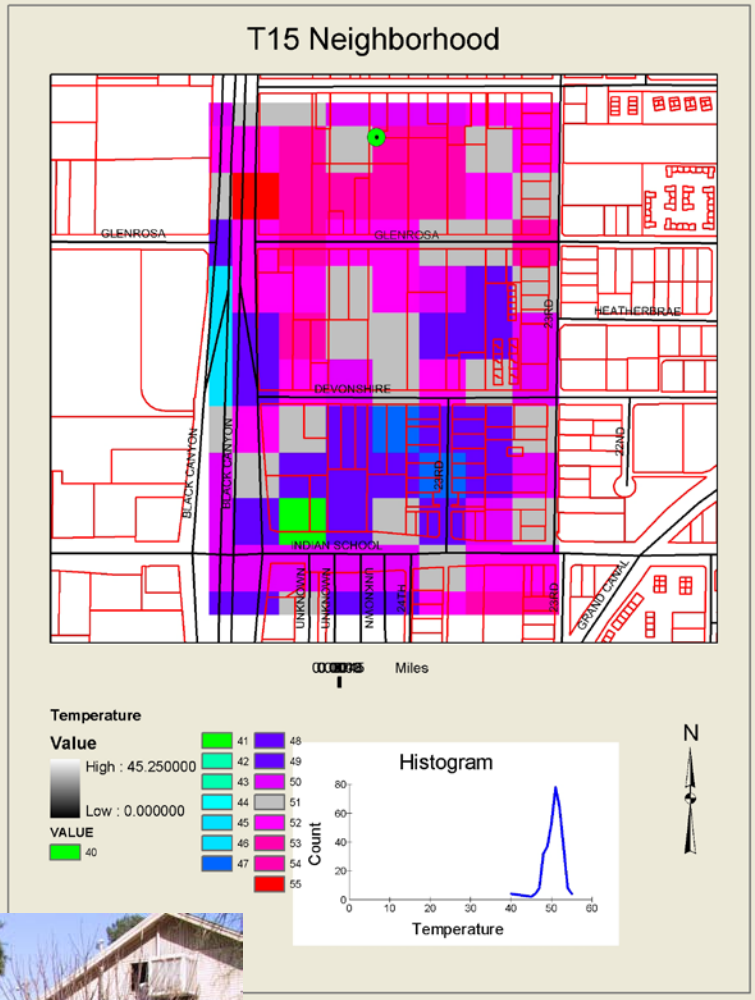
Central Arizona-Phoenix LTER

Neighborhood-scale microclimate study using Landsat, ASTER, and field data

-goal of study is to assess the potential role of human social patterns and choices on microclimate

-initial studies indicate no clear correlations between social indicators and biogeophysical parameters (surface temperature, vegetation density, air temperature, humidity)

-ongoing work includes analysis of historic Landsat data, climate records, and demographic trends to reveal presence/absence of social/physical lags (IGERT seminar)



Surface temperature map derived from ETM+ data (above); collection of field climatic data (left)

Andrews LTER

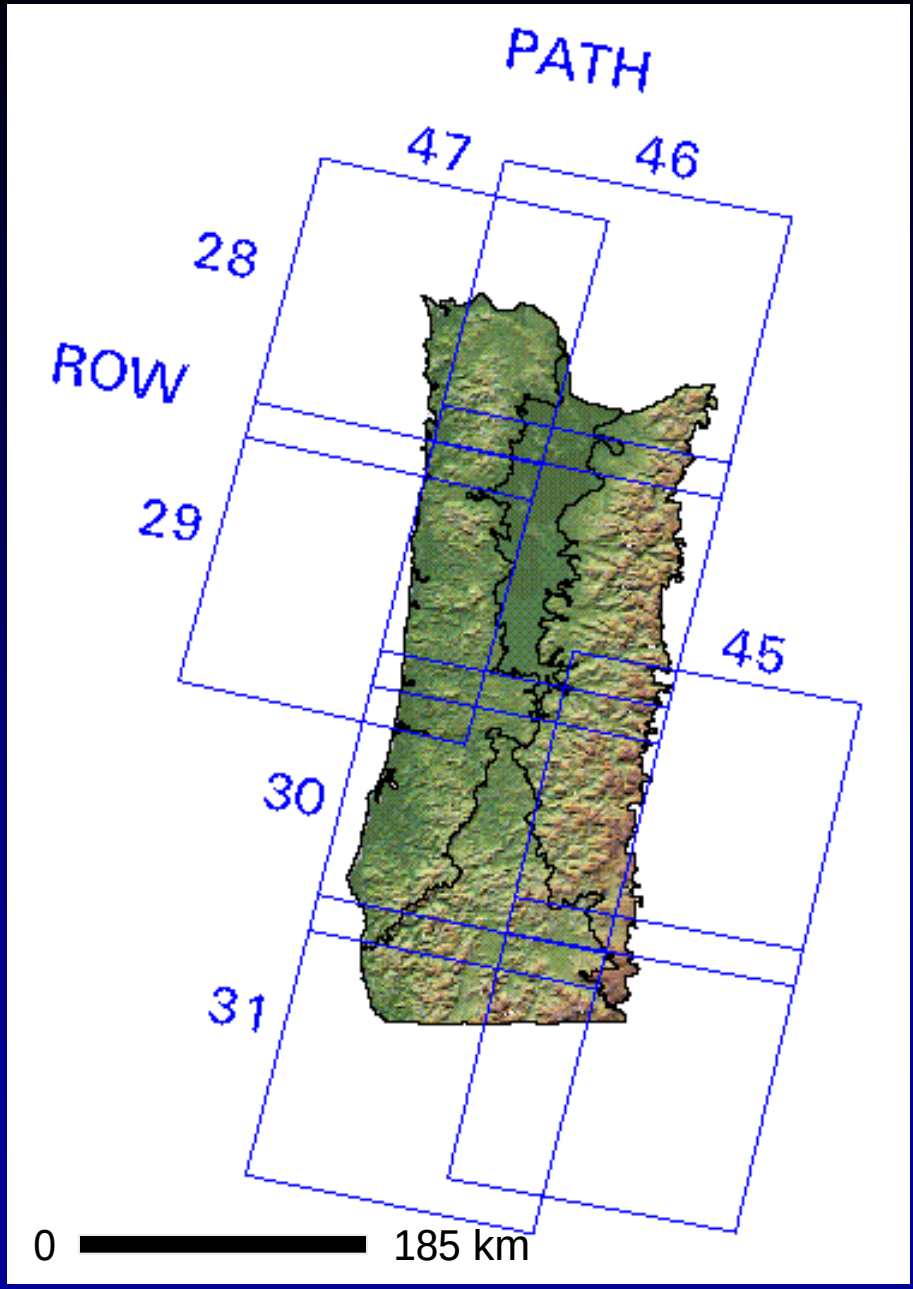
Vegetation cover and disturbance mapping using Landsat data

-various vegetation and land cover attributes mapped using Thematic Mapper, DEM, GIS, aerial photographs, and field data

-regression models used for multi-temporal image classification to remove radiometric variations and produce continuous data values

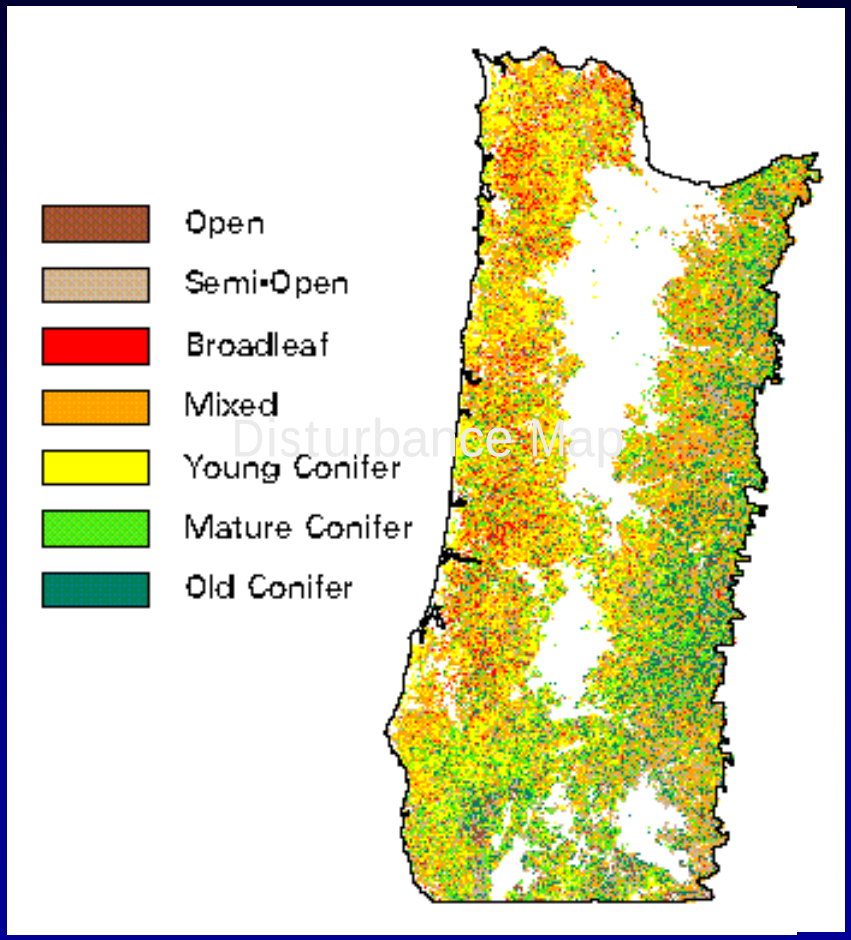
-produced a cost-effective means of mapping various vegetation types and parameters, and assessing disturbance regimes from 1972-1995

-useful for geomorphic and hydrologic studies



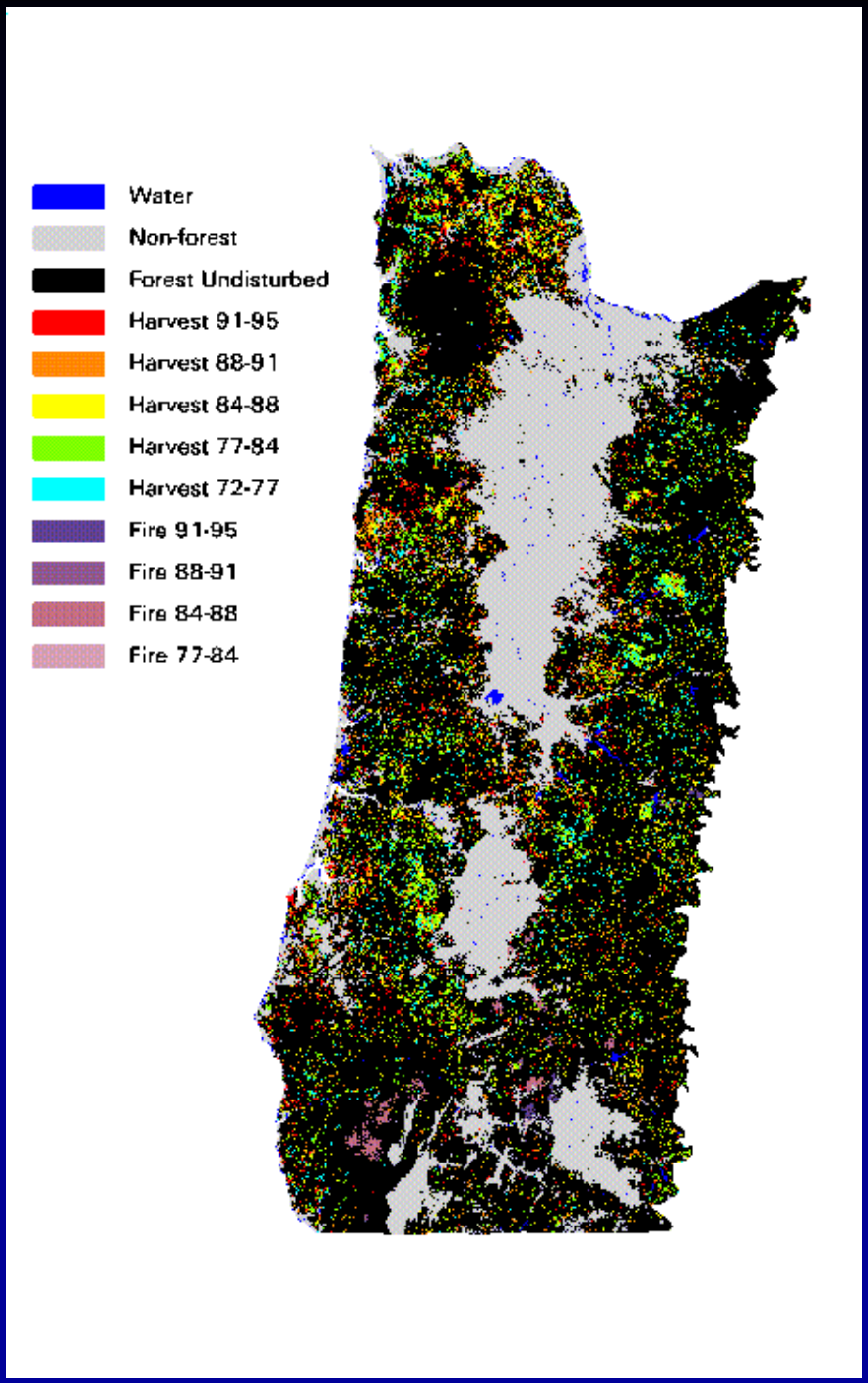
Landsat scene coverage for western Oregon; image courtesy of Warren B. Cohen, USDA

Andrews LTER



Initial unsupervised classification

Vegetation Map



Disturbance Map

Virginia Coast Reserve LTER

Maps and aerial photos used in concert with geomorphologic studies to obtain landscape history for Hog Island

-northern edge of island accreting
-southern edge of island eroding

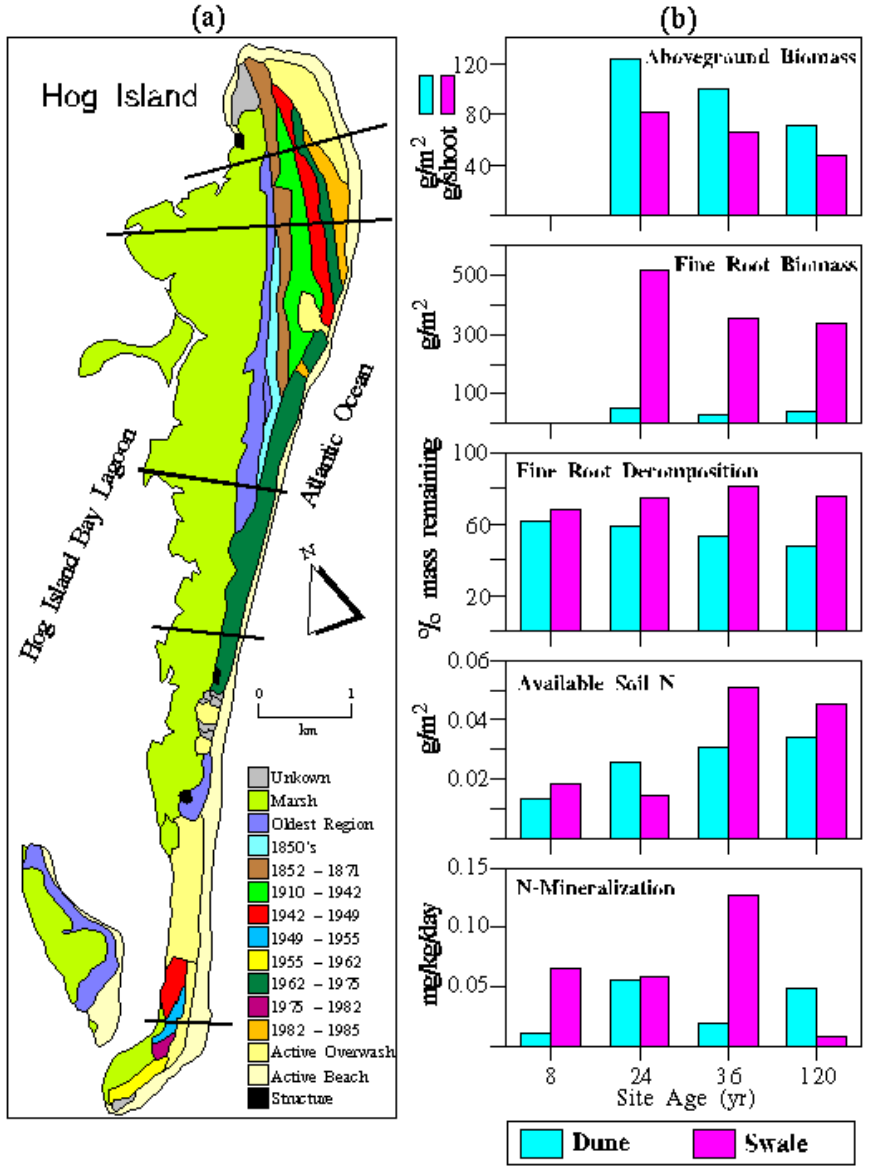


Image courtesy of Bruce Hayden & John Porter, Dept. of Environmental Science, U Virginia

Virginia Coast Reserve LTER

Use of aerial photos to assess change in Hog Island salt marsh boundaries due to 3.5 mm/yr sea level rise

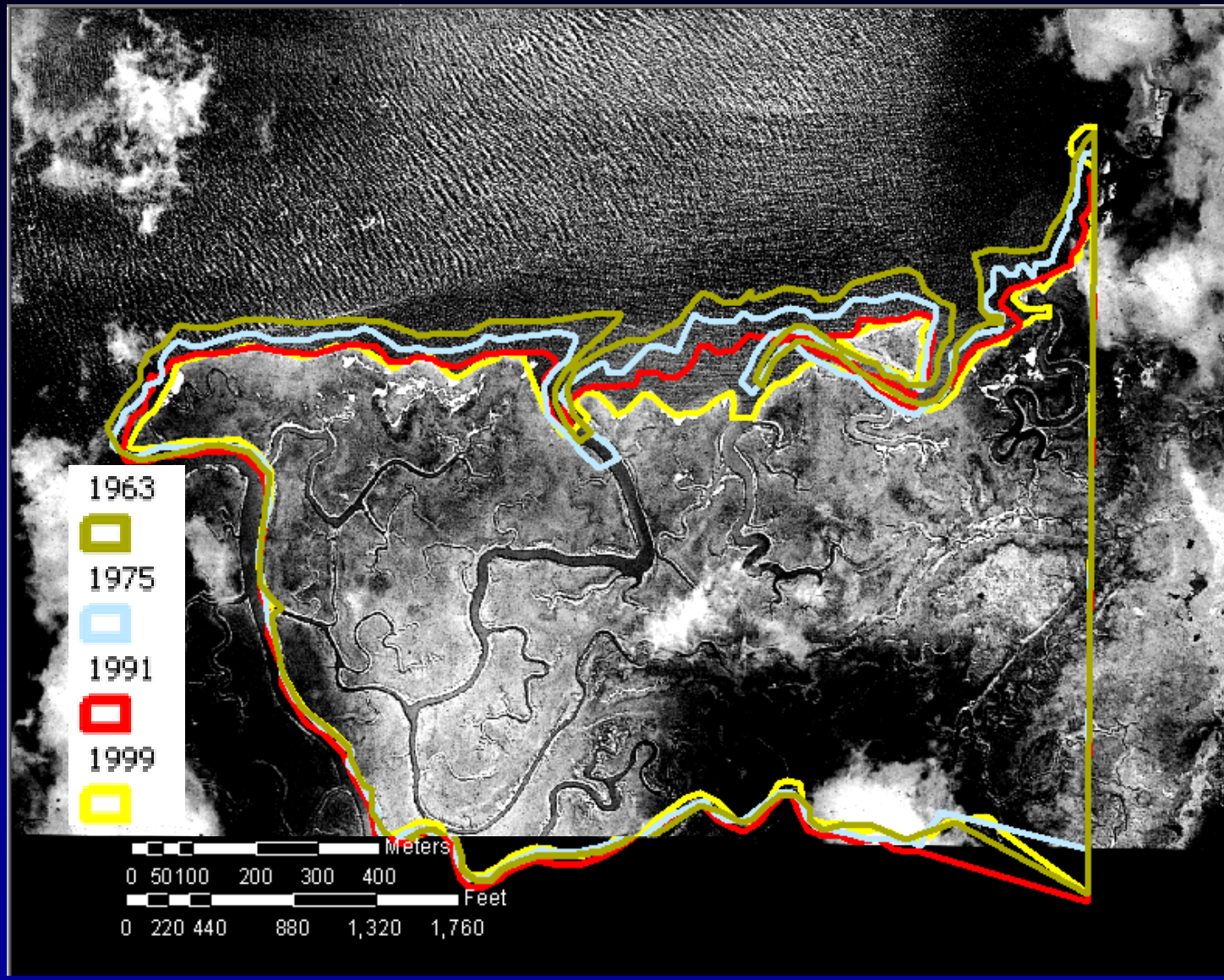


Image courtesy of Bruce Hayden & John Porter, Dept. of Environmental Science, U Virginia

Virginia Coast Reserve LTER

Study of elevational control on use of dunes and swales by colonizing shrubs on Hog Island

-individual shrub locations determined via 1m/pixel aerial imagery

-precise elevational data obtained using LIDAR (LIght Detection And Ranging); 15 cm vertical, 5 m horizontal accuracy

-statistical analysis of known vs. random shrub locations indicates that shrubs prefer dune sites

Known shrub locations
Random locations

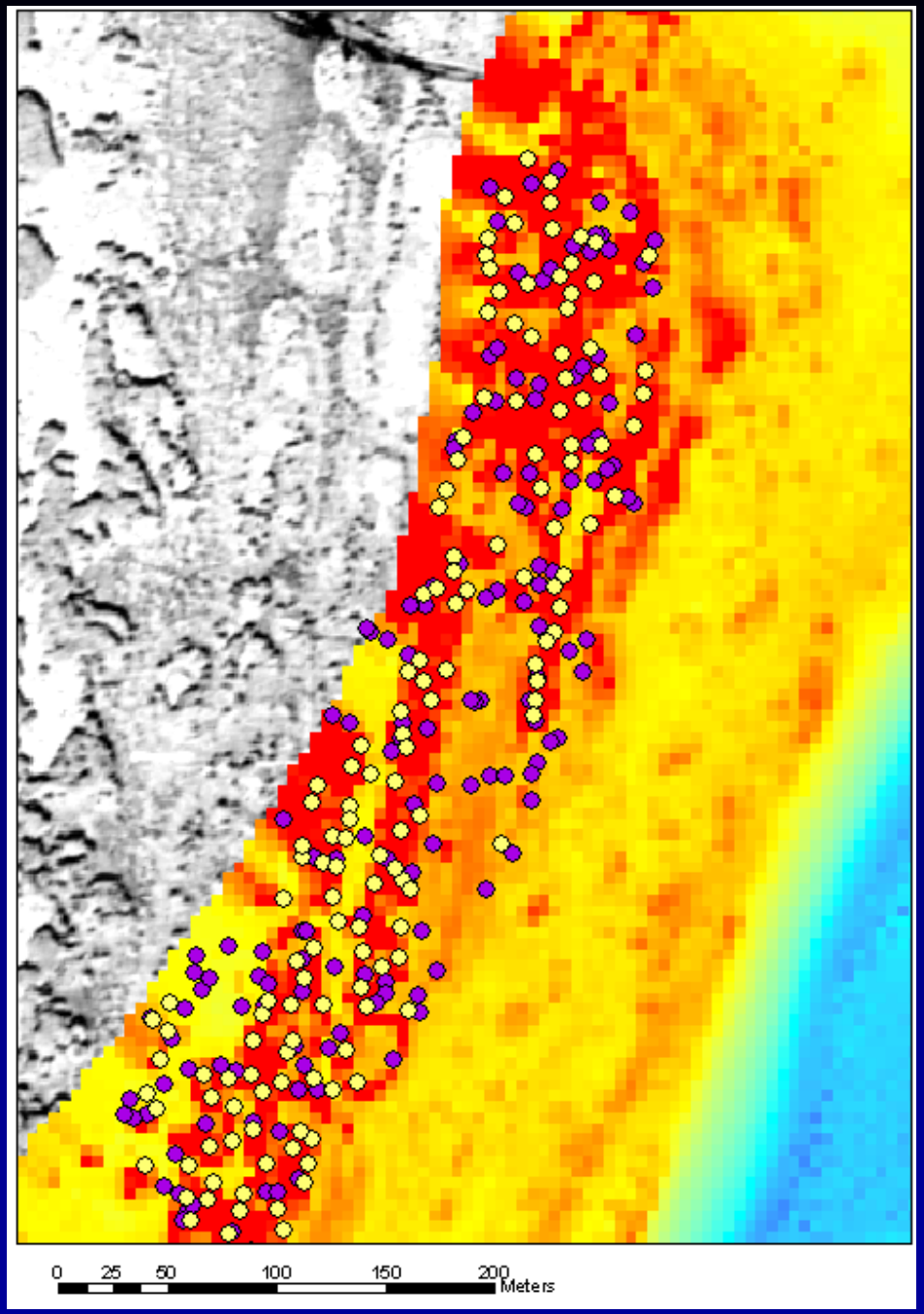
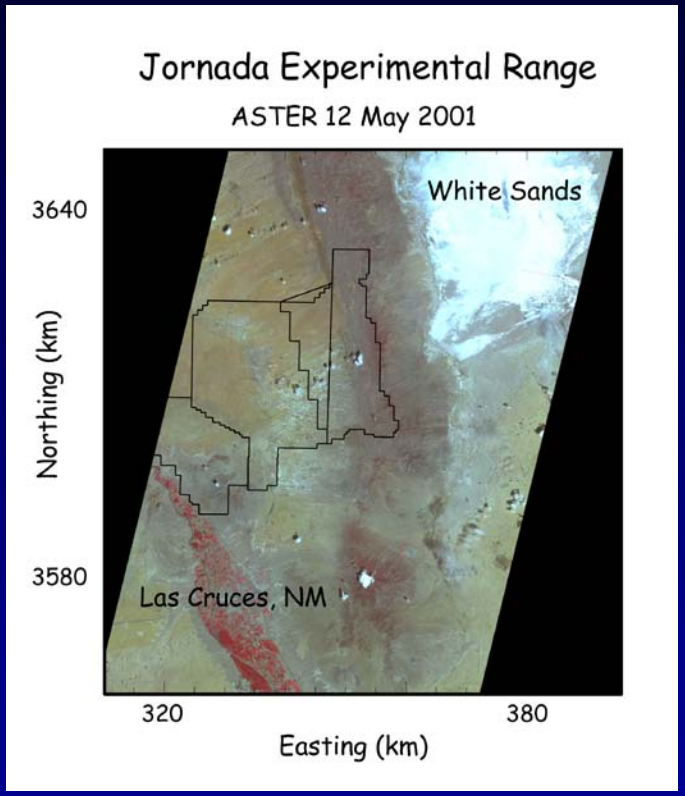
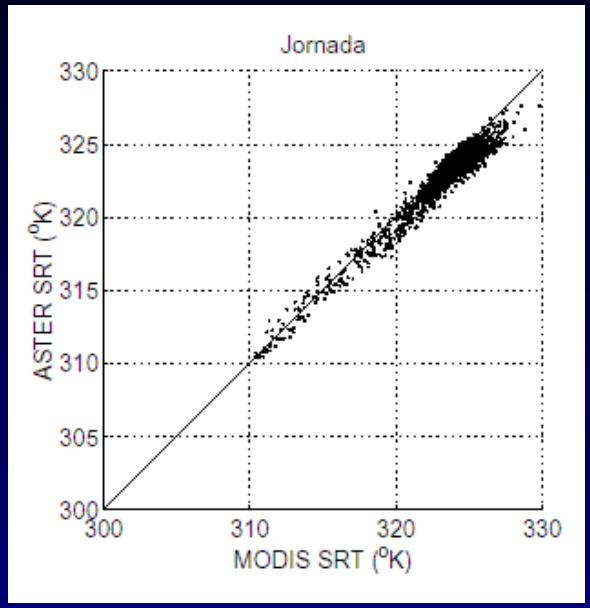


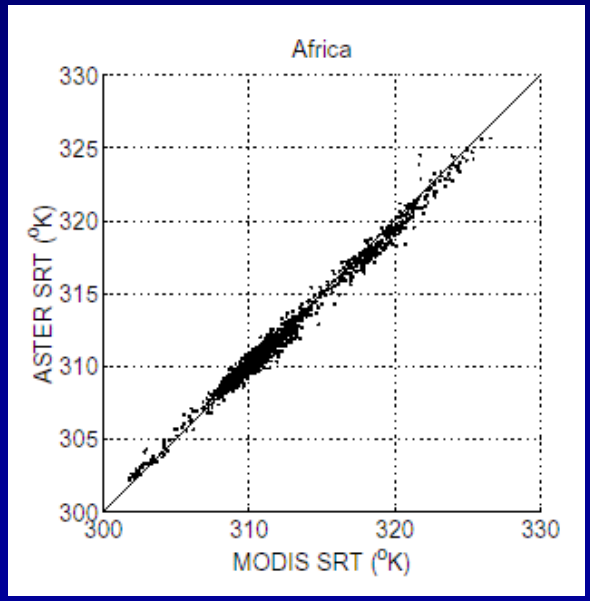
Image courtesy of Bruce Hayden & John Porter, Dept. of Environmental Science, U Virginia

Jornada LTER



Images courtesy of Tom Schmugge, USDA





Comparison of ASTER and MODIS surface emissity and temperature

-comparison of sensors on board Terra satellite key for use of data in multiscale studies

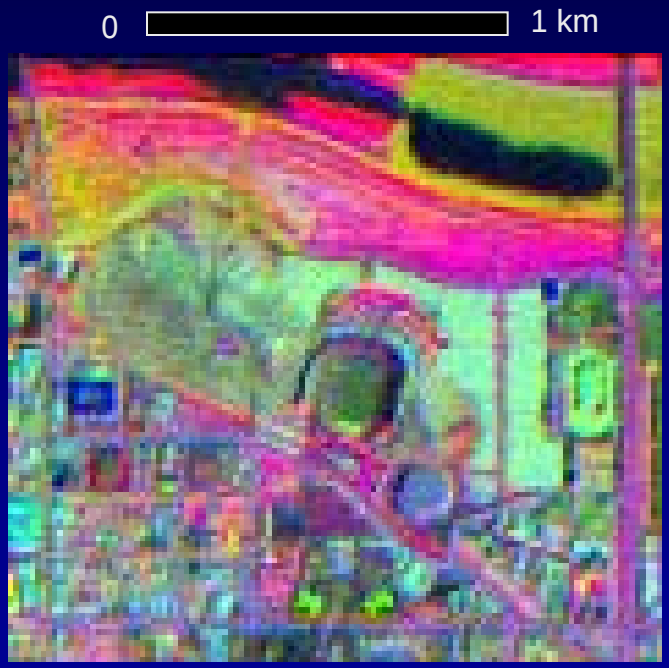
-agreement between two sensors is excellent

-MODIS data products of immediate use for biological, ecological, and surface energy balance studies (NPP, LAI, vegetation indices, albedo, emissivity, ET)

Urban Geological Remote Sensing

Opportunities for geoscience remote sensing in urban LTERs

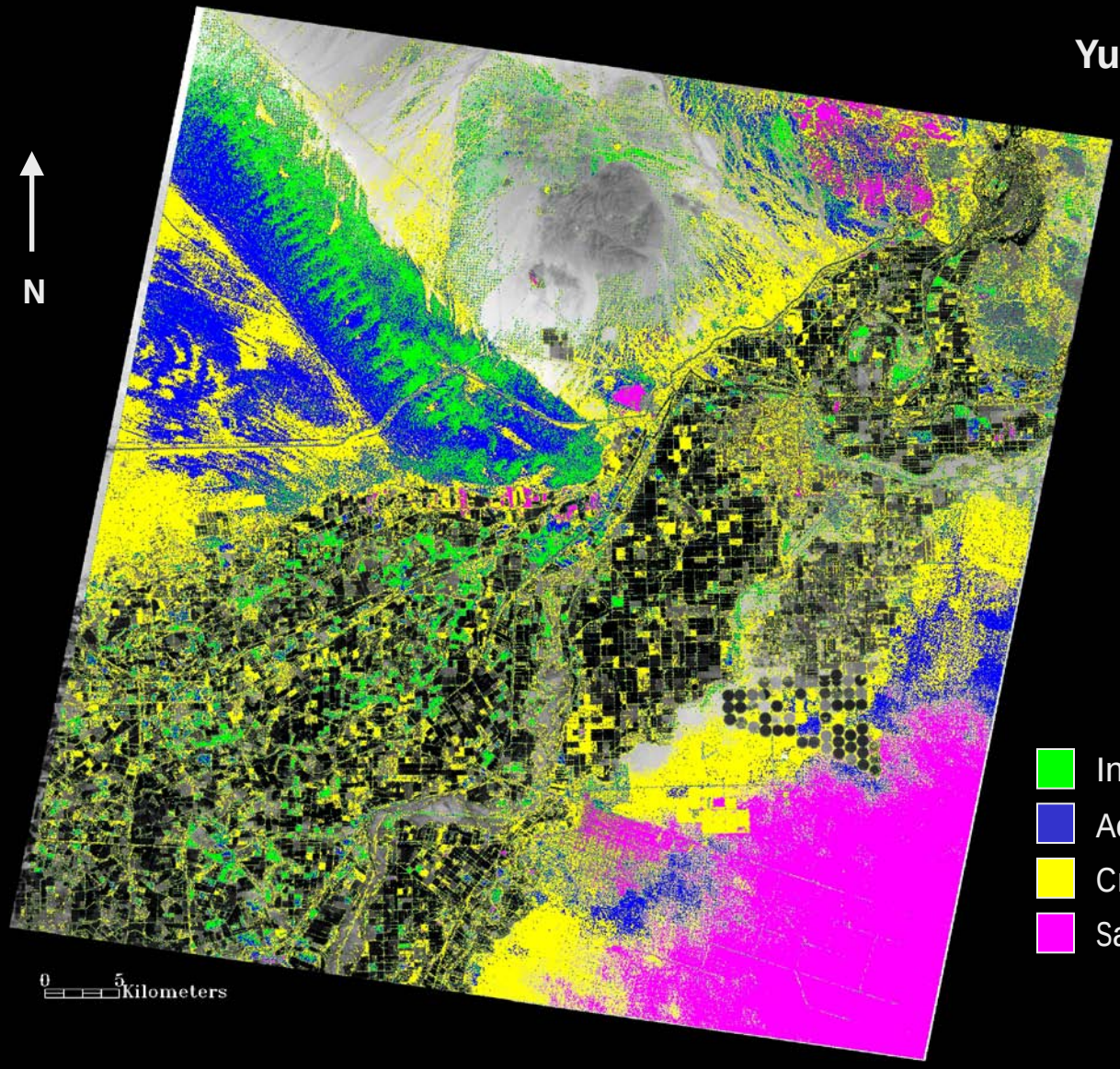
- detail spectral characterization/analysis of urban/exurban materials (climatology, land cover change, surface fluxes, disturbance)
- urban topography and subsidence studies using radar and lidar
- studies of humans as geologic agents (alteration of surficial geomorphic and hydrologic processes)
- environmental and geologic hazard monitoring (air quality, expansive soils, contaminants)



MASTER thermal infrared false-color image of Tempe Butte-ASU highlighting surficial material variations (both natural and built)

Fugitive Dust Processes

Yuma, AZ Air Quality Assessment



-SWIR and TIR bands allow for greater discrimination of surficial materials, such as soils

-Linear deconvolution and feature mapping approaches enable more detailed mineralogical/biogeochemical discrimination

- Interdune Soils
- Active Dune Sediments
- Crusted Soils
- Sandy Valley Fill

Image base is ASTER SWIR band 5; data acquired 2-May-02

Summary

- Many LTER sites doing geoscience-related remote sensing - primarily for land cover, vegetation, and hydrologic research

- LTER database returns 16 publications with geological remote sensing keywords

- Utilization of a wide range of both airborne and satellite sensors (and aerial photography)

- New super and hyperspectral sensors, and active sensor data (radar/lidar), should stimulate more detailed and quantitative studies of surficial processes and ecosystem responses

- LTER network presents an ideal locus for geologic research due to the volume of biogeophysical data available

- New sensors offer particular opportunities for increased urban geoscience