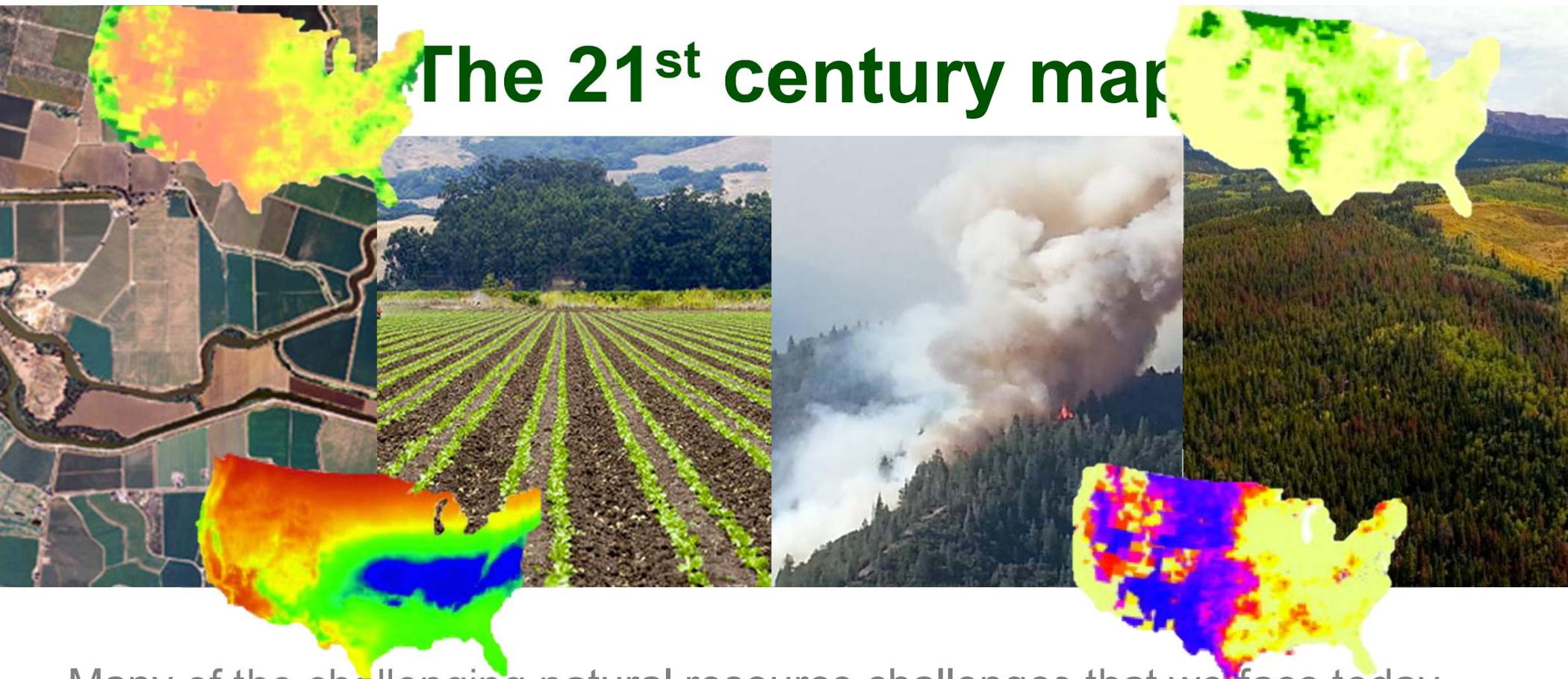


Spatial Data Science:

- the 21st century mapping toolkit
- case studies in remote sensing and participatory informatics
- where to get more information

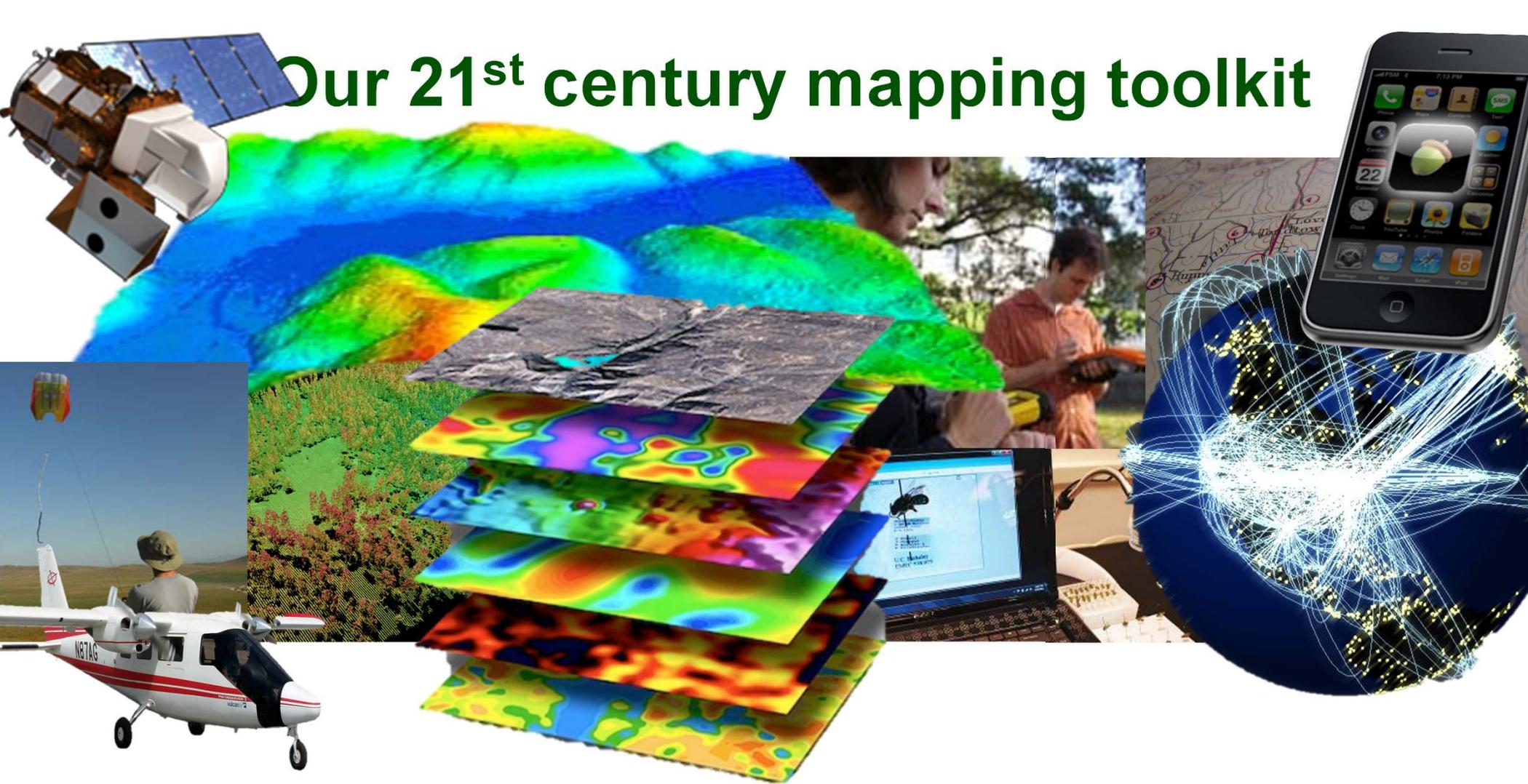
Maggi Kelly, University of California at Berkeley

The 21st century map



Many of the challenging natural resource challenges that we face today – such as invasive species, water, food scarcity, fire, climate change – are large in spatial scale and impact diverse public groups.

Addressing these challenges requires *coordinated monitoring, data collection and synthesis, novel analytical tools, and increased communication and cooperation* between scientists and citizens.



Our 21st century mapping toolkit

We analyze data from satellites... other lidar and other remote platforms... existing GIS layers... historic data... VGI... mobile... all served and integrated on the web

We use these data to answer questions about our environment

This is *spatial data science*

Spatial Data Science

revolves around the *integration of data* – from aircraft, satellites, mobile phones, historic collections, the web;

core spatial concepts – spatial data is characterized by location or neighborhood, by format: field, object, network, event, and by scale and accuracy

application of methods – understanding spatial density, pattern and distribution, coincidence or interactions of factors across space, probability or risk of an event occurring in space, and measures of interconnectedness; and of

collaborations of people - scientists, policy-makers, and the public.

My research and outreach program

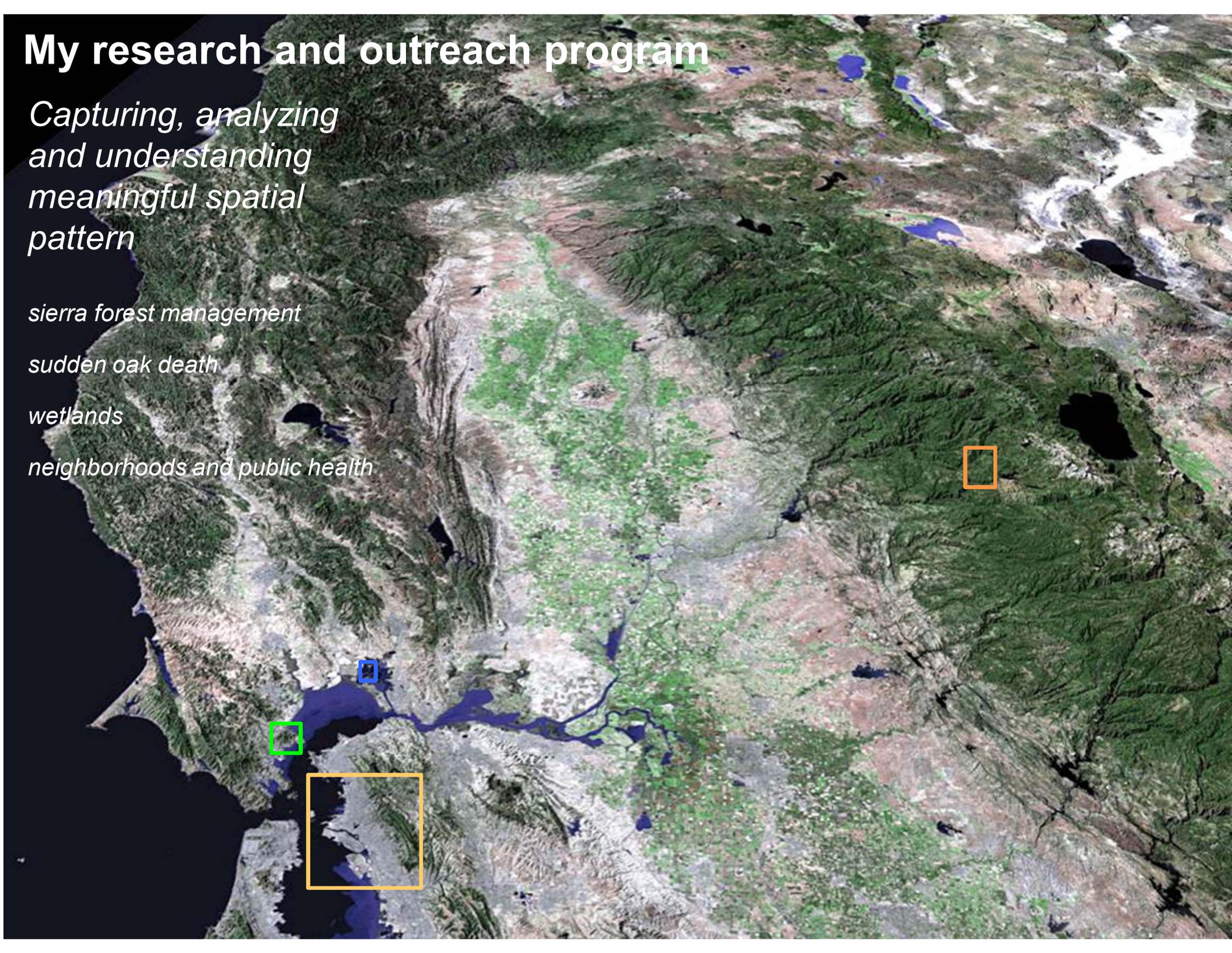
*Capturing, analyzing
and understanding
meaningful spatial
pattern*

sierra forest management

sudden oak death

wetlands

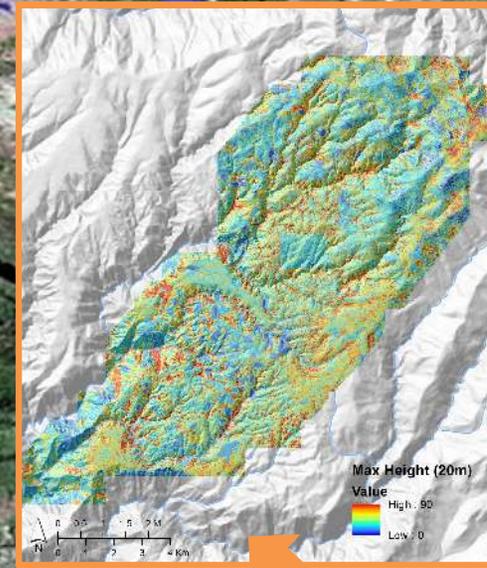
neighborhoods and public health



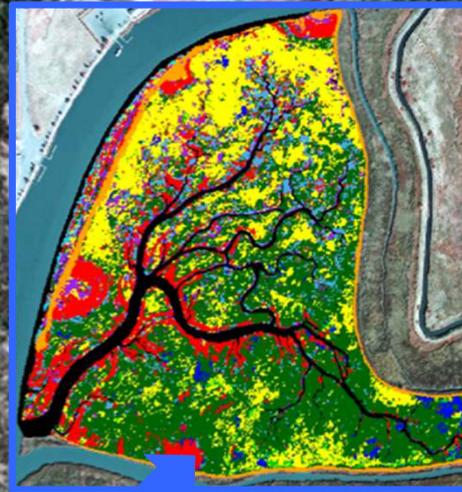
My research and outreach program

Capturing, analyzing and understanding meaningful spatial pattern

sierra forest management



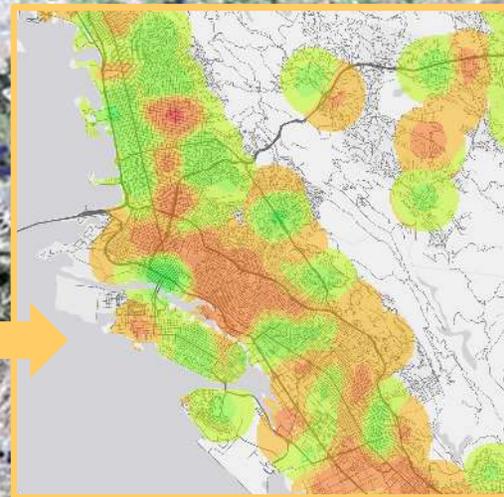
wetlands



sudden oak death



neighborhoods and public health

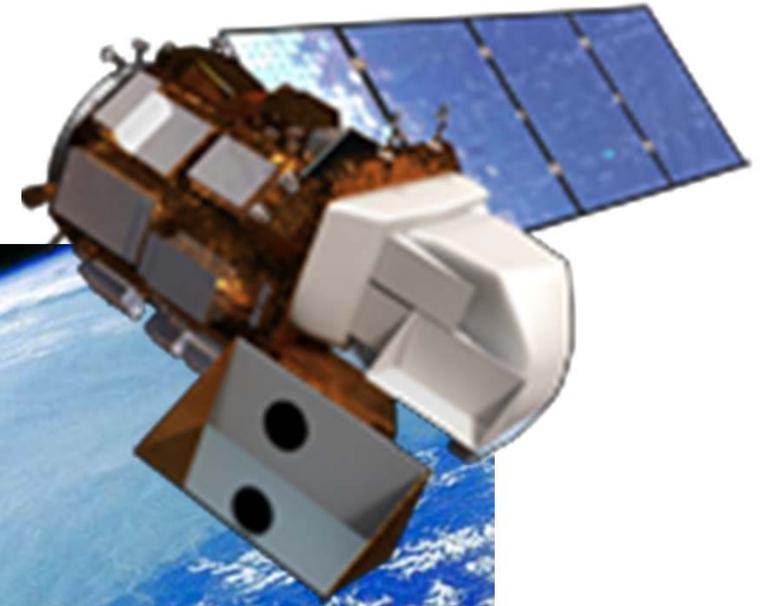


Case 1: Remote sensing of aboveground biomass: spectral information

Landsat: 30m, 7 bands

Hyperion: 30m 200 bands

WorldView-2: 1.8m, 8 bands



We used simulated bands and actual data from:

1. Hyperspectral, moderate spatial resolution Hyperion sensor
2. Multispectral, high spatial resolution Digital Globe World View-2 sensor
3. Multispectral, moderate spatial resolution Landsat 7 sensor

to scale up the best statistical models and produce maps of aboveground biomass over a range of spatial, temporal and spectral resolutions.

Mapping predicted above-ground biomass

World View-2



Landsat 7



Hyperion



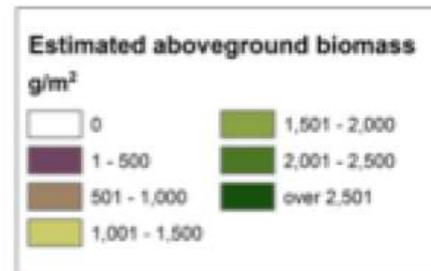
Sherman Island

Measured biomass, 8/15/12: 2,303 g/m²

Hyperion: 1,103 g/m²

Landsat 7: 1,977 g/m²

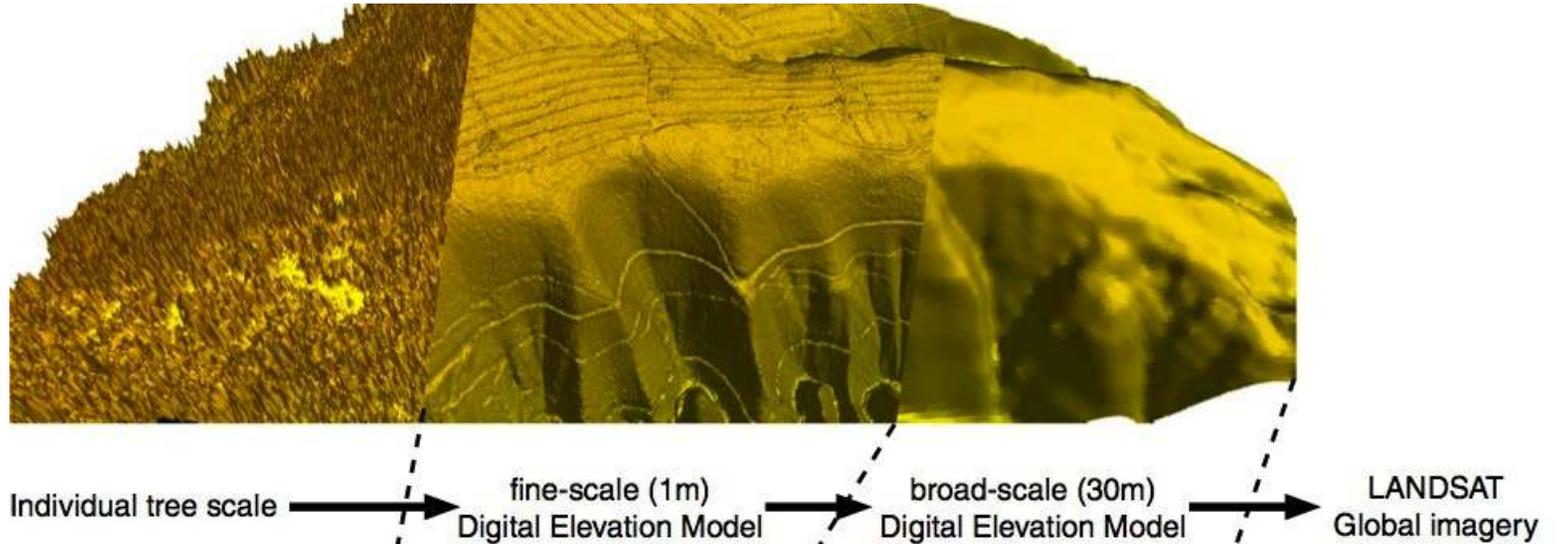
World View-2: 3,004 g/m²



0 125 250 500 750 1,000
Meters



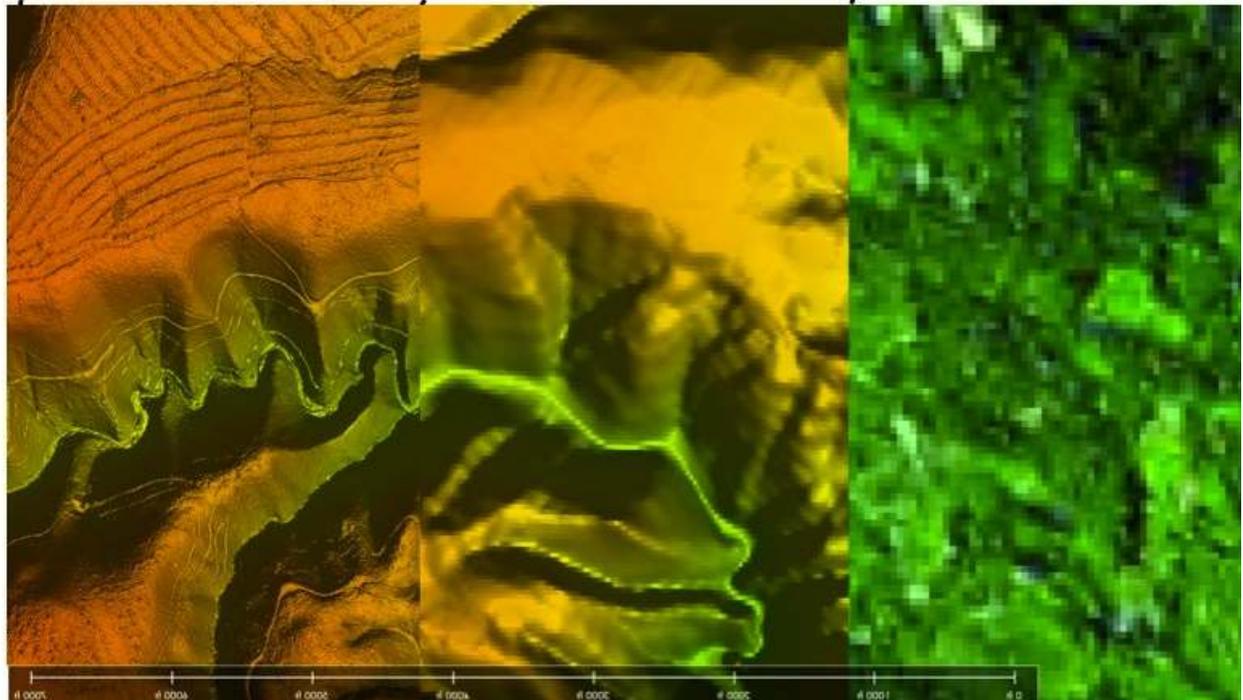
Case 2: Mapping forest structure to understand water, wildlife and fire



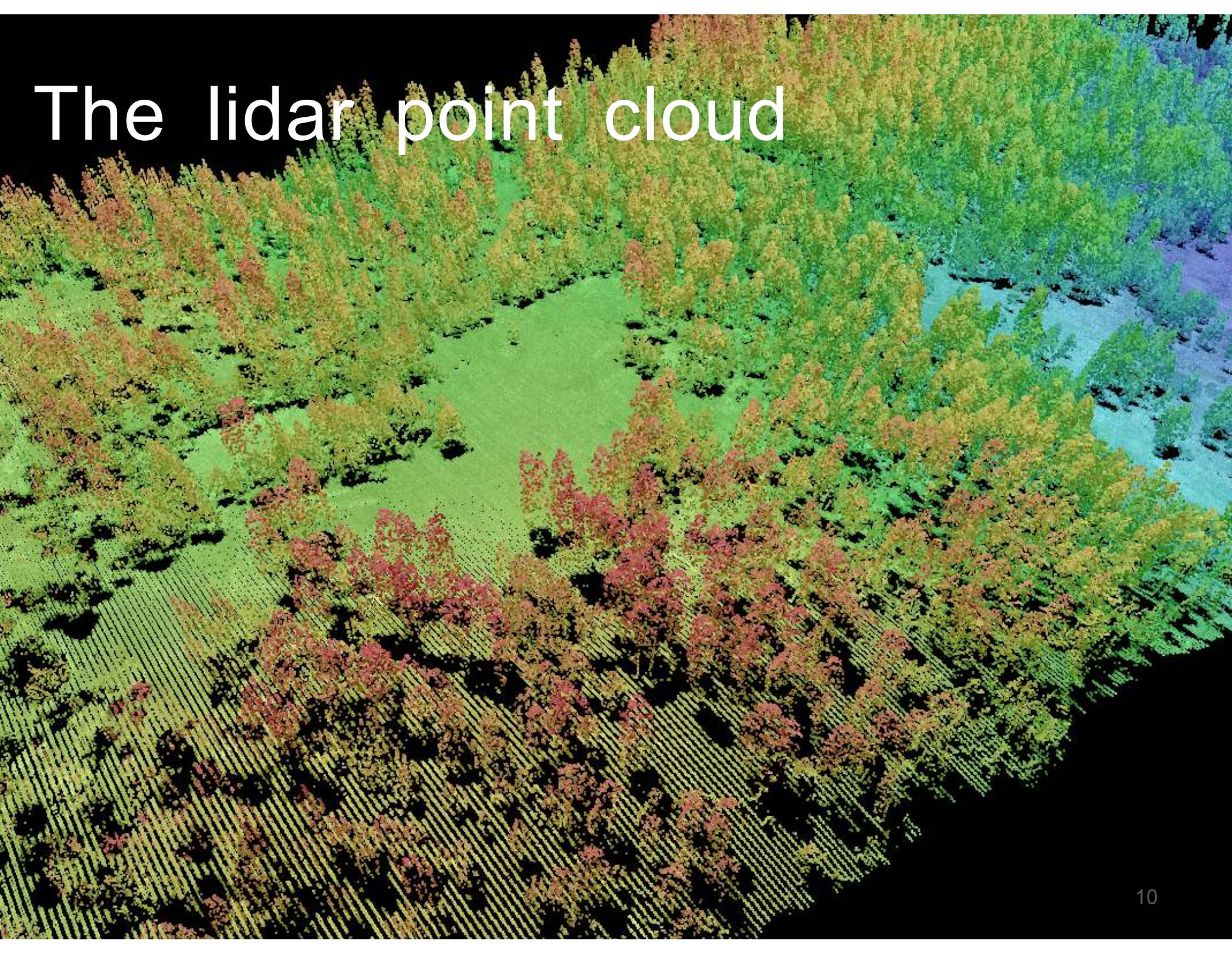
The spatial structure of forests: horizontal, vertical and social, influences how they function:

- How fire might spread;
- How water quality and quantity are delivered;
- How animals use the forests before and after fuel treatments

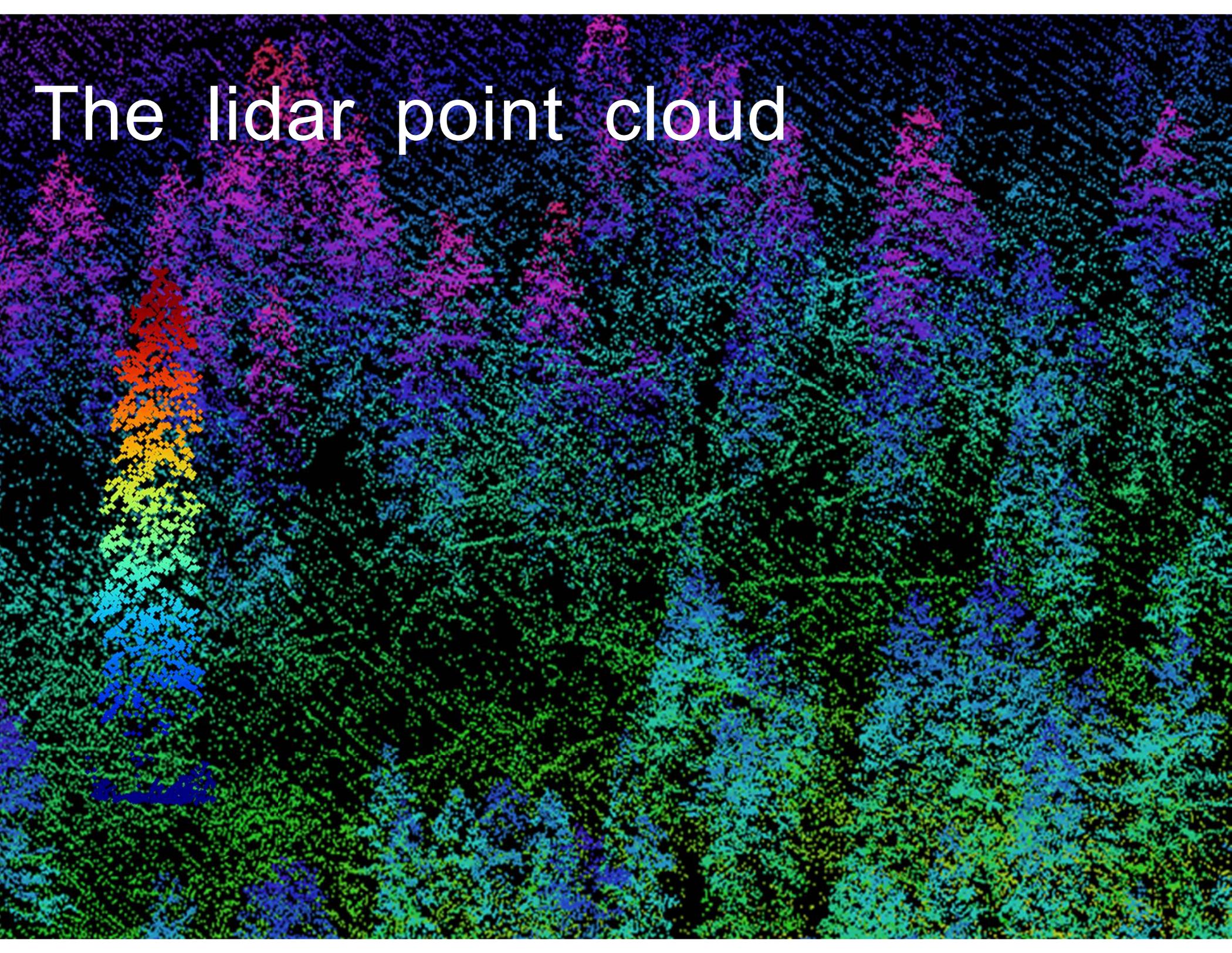
These are scientific as well as management questions



The lidar point cloud



The lidar point cloud

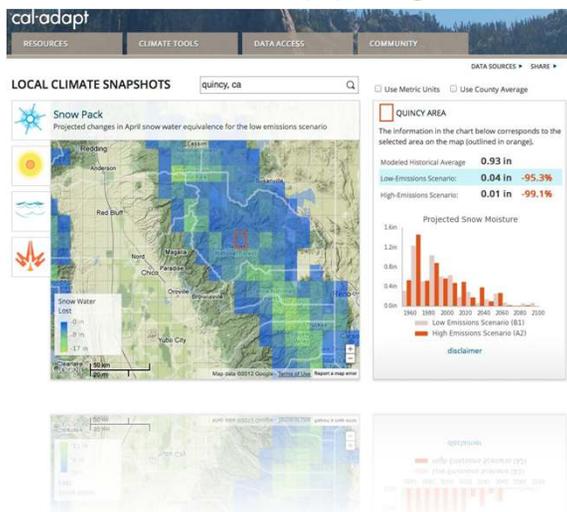


Case 3: Participation in the age of information

The breadth, transparency and low comparative cost of exchanging information on the Internet provides an efficient form of communication between the public and planners, managers, and decision-makers.

Mapping makes these exchanges more powerful.

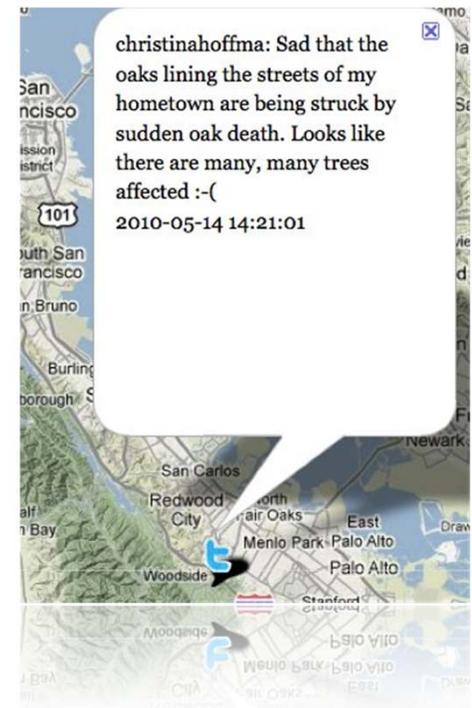
web mapping



citizen involvement

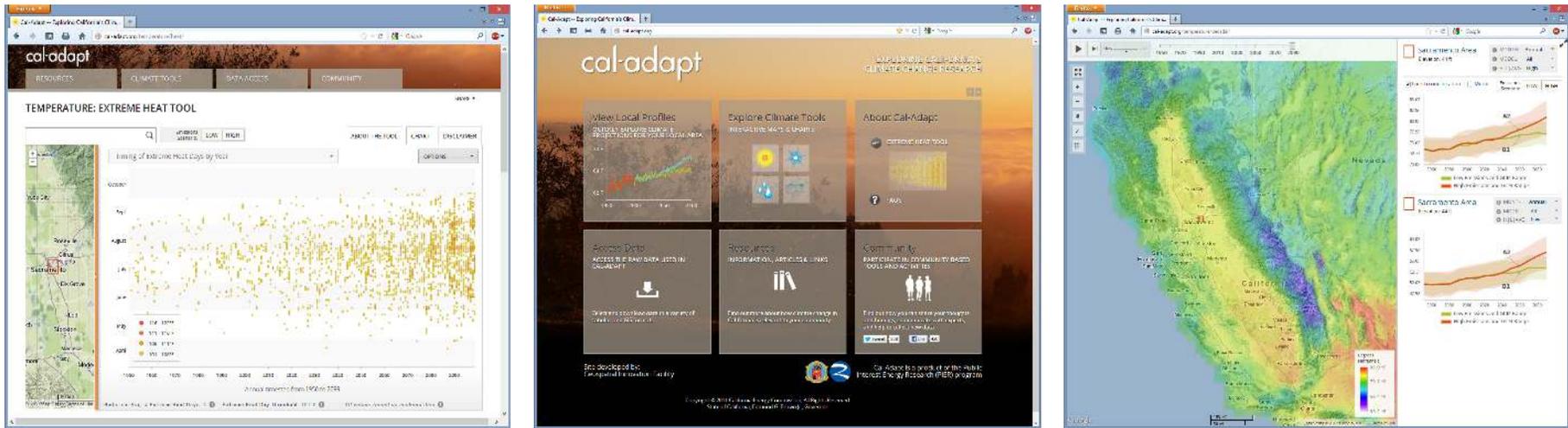


disaster response



Cal-Adapt.org

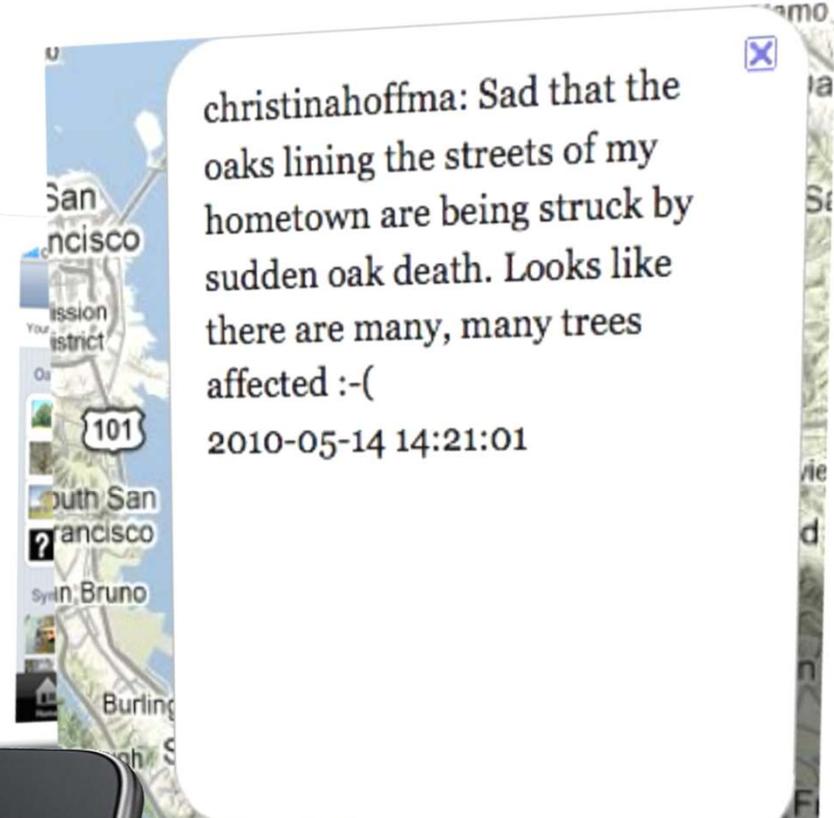
Exploring California's Climate Change Research



Partner: California Energy Commission

<http://cal-adapt.org>

Oakmapper.org



Citizen science and mapping for forest disease monitoring

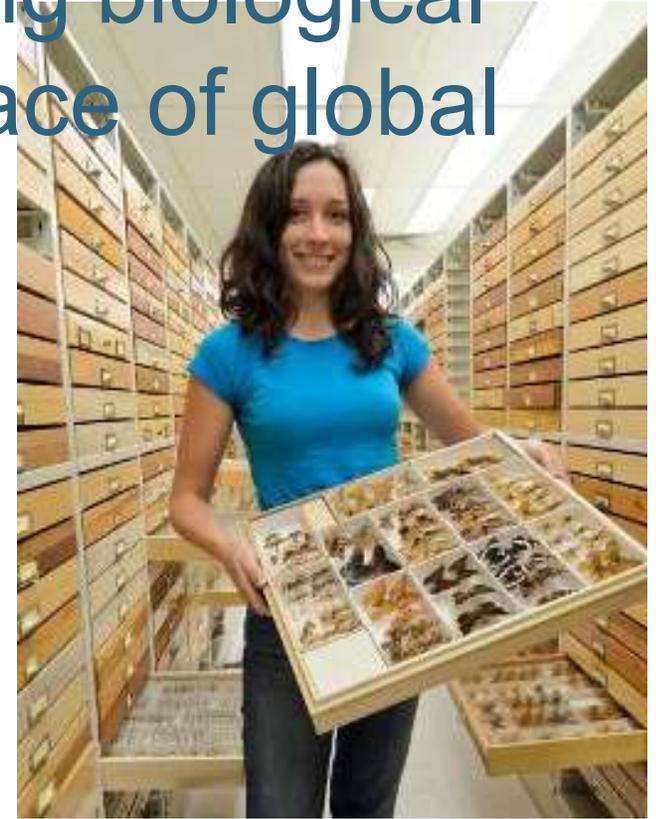


Case 4: Rescuing and integrating biological and environmental data in the face of global change

Data sources: Geolocated specimens

Berkeley Natural History Museums

- Vertebrates: 700,000 specimens (100% digitized)
- Plants: 2.2 million specimens (~16% dig.)
- Fossils: 6.5 million specimens (<5% dig.)
- Insects: 6.5 million specimens (<2.5% dig.)

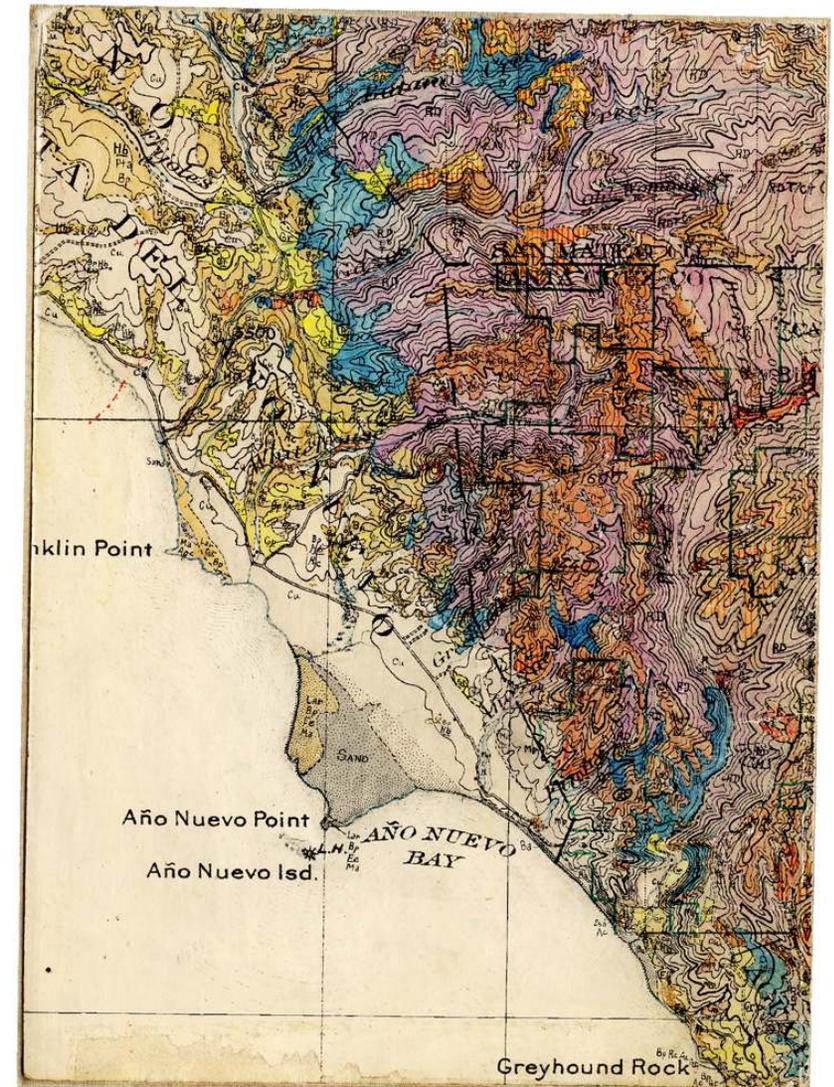


HOLOS

BERKELEY ECOINFORMATICS ENGINE

Data sources: Vegetation Type Mapping survey

- Hand drawn vegetation maps
- Dominant overstory vegetation mapped in the field directly on topographic maps
- “Mosaic” types vs “natural” plant associations



Data sources: Vegetation Type Mapping survey

- Hand drawn vegetation maps
- Dominant overstory vegetation mapped in the field directly on topographic maps
- “Mosaic” types vs “natural” plant associations



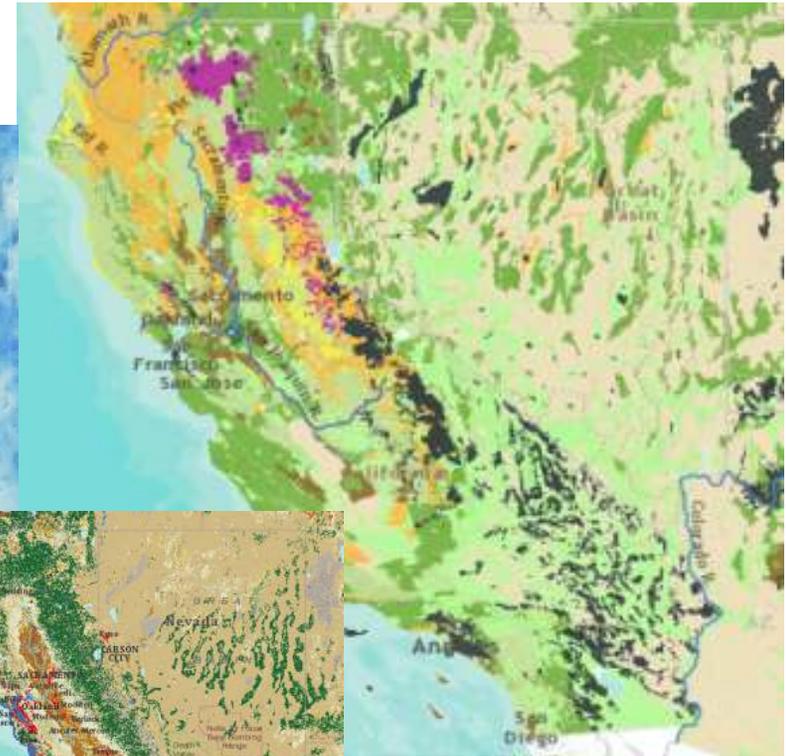
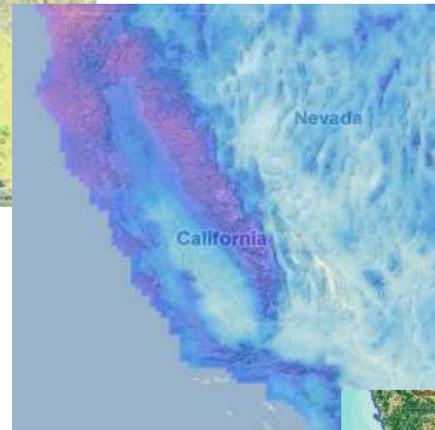
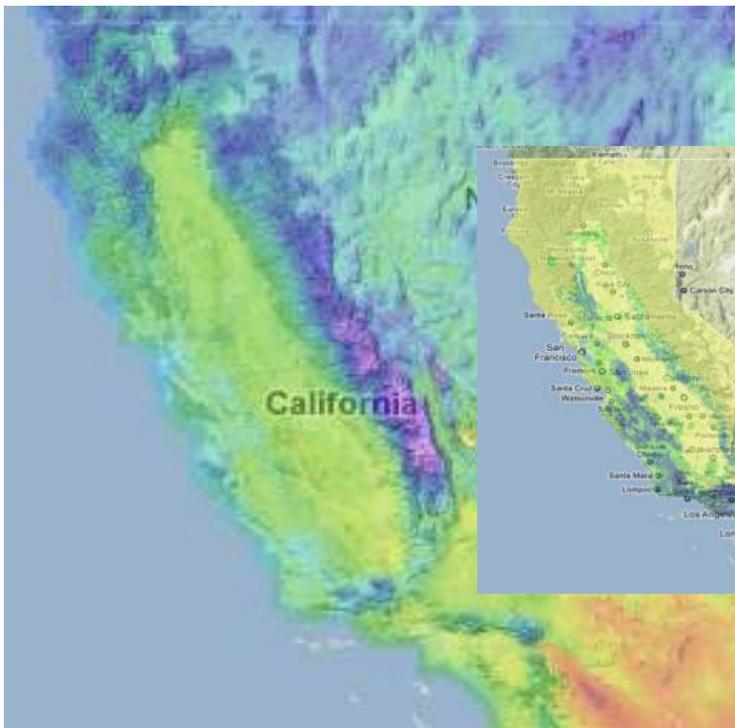
Data sources: VTM Photos

Photographs:

- ~3100 black and white photos
- Location often linked to maps
- Document typical and atypical stand conditions and consequences of disturbance



Data Sources: Big Spatial Data



Satellite data: Landsat, MODIS...
GIS Layers: Landcover, DEMs, Soils...
Ecosystem models: Climate, Vegetation...

21st Century Challenge

“The overall message is, we have to start dealing with these environmental problems in a very **holistic** way, and we need to realize that means understanding how they interact”

- Anthony Barnosky
(2012 *Nature*)

Rescuing, digitization and sharing of *event* and *spatial data* through such frameworks as APIs creates:

- Increase in scope and scale of research;
- Novel combinations of models and data create new knowledge;
- New modeling approaches to predict future scenarios; and
- Technological improvements to foster collaboration

Spatial Data Science:

*integration of data
core spatial concepts
application of methods
collaborations of people*

The Geospatial Innovation Facility: <http://gif.berkeley.edu>

My lab and blog: <http://kellylab.berkeley.edu>

HOLoS: <http://ecoengine.berkeley.edu>

VTM collection: <http://vtm.berkeley.edu>

Cal-Adapt: <http://cal-adapt.org>

Oakmapper.org: <http://oakmapper.org>

Maggi Kelly, University of
California at Berkeley