Tools, resources and methods for assessing land use and land use change applicable to elucidating microbially mediated land-atmosphere feedbacks

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INRA
SCIENCE & IMPACT

Table of contents

Why Land Use & Land Cover?

- Land Use (LU) & Land Cover (LC) impact climate at local, regional and global level via their effects on:
  - Solar and thermal infrared radiation
  - Surface moisture, relative humidity, evapotranspiration
  - Sensible and latent heat, near surface temperature
  - Near surface energy balance
  - , ,

Furthermore, LC affects directly the Planetary Boundary Layer (PBL), i.e. the lowest part of the atmosphere, via topography, aerodynamic surface roughness, changes in the albedo, Bowen ratio, net radiation, etc.

From satellite images…

«Blue Marble»,1972

Kristineberg, 28.10.17, 09:43:01

…to land use classification

- Satellite imagery can hardly be used rough
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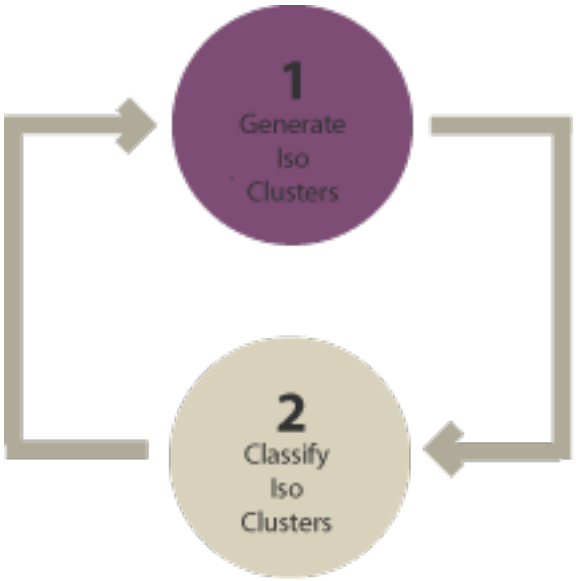
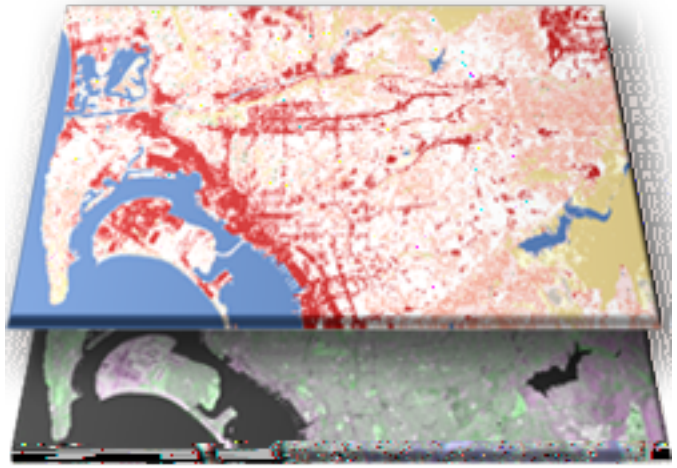
- The choice of the classes depends on the needs of the study:
  - Human-based classes (for cities and infrastructures)
  - Agriculture-based classes (for crop production)
  - Forest-based classes (for conservation and climate studies)

Unsupervised classification

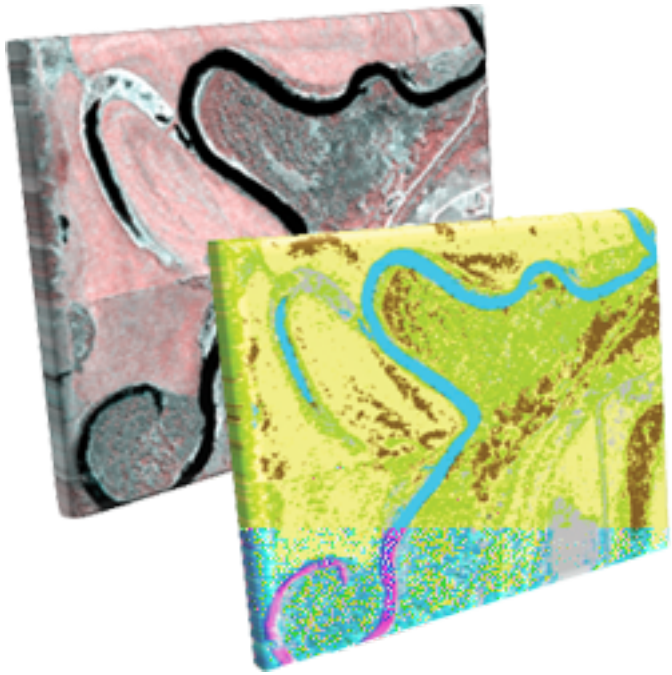
- First step: group pixels into clusters with similar characteristics and identify the number of groups
- Second step: assign each identified cluster to one group or class





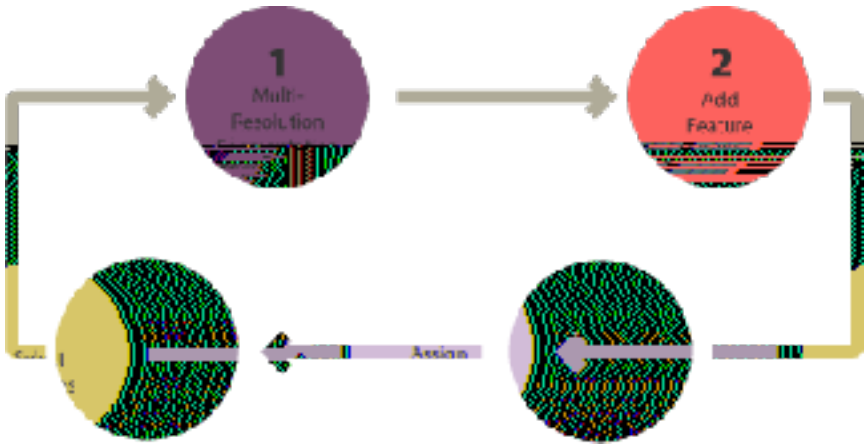
Supervised classification

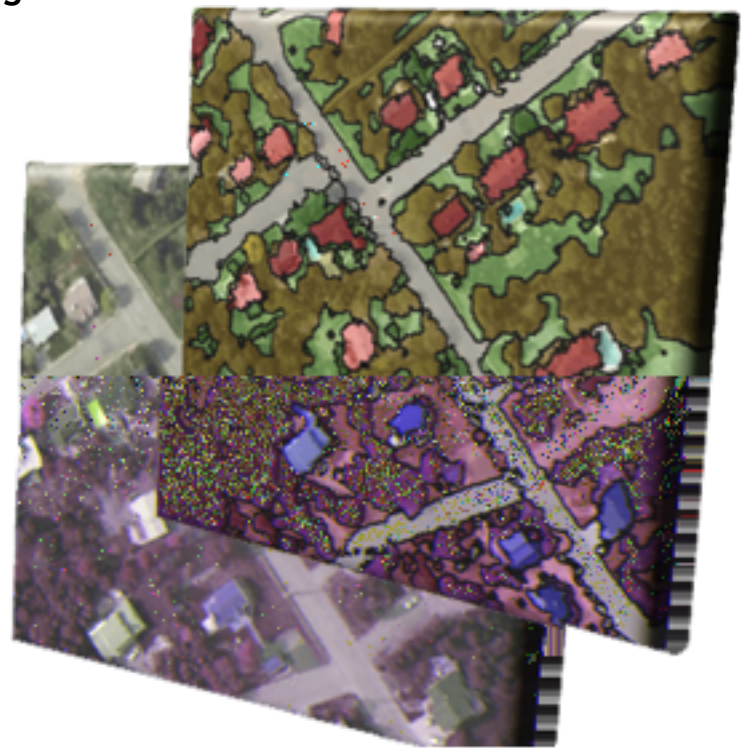
- First step: select representative samples for each land cover class
- Second step: train an algorithm to recognize these classes of land cover
- Third step: apply the classification algorithm to the entire area



Object-oriented Image Analysis Classification

- First step: multi-resolution segmentation produces objects by grouping pixels
- Second step: train an algorithm to recognize objects
- Third step: define statistics to classify images
- Fourth step: classify the entire area





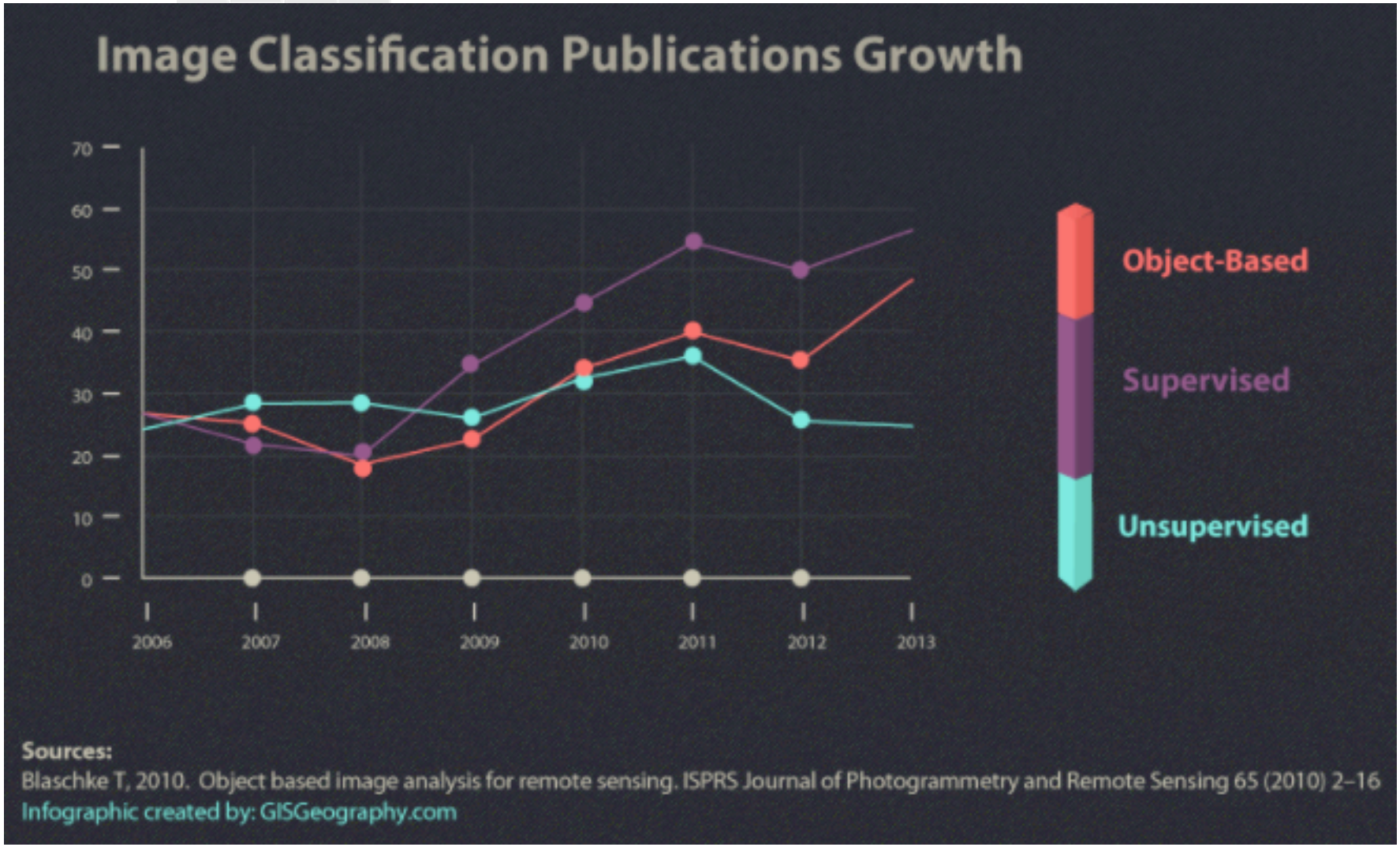
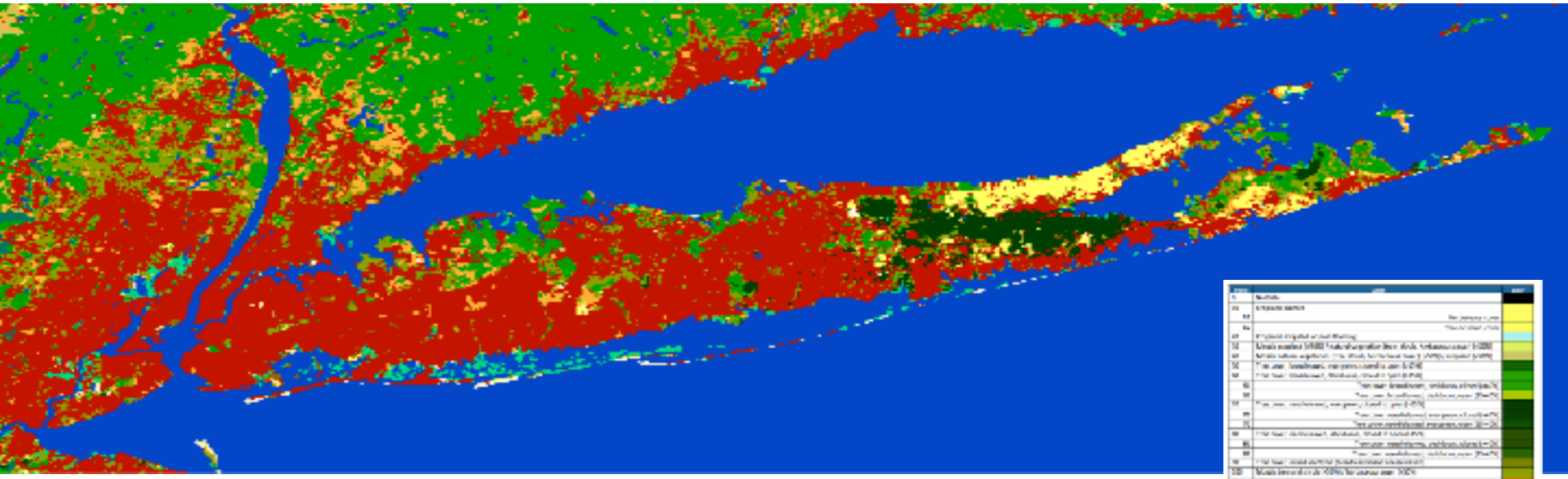


Image Classification Publications Growth
70
60
50
40
30
20
10
0
2006
2007
2008
2009
2010
2011
2012
2013
Object-Based
Supervised
Unsupervised
Sources:
Blaschke T, 2010. Object based image analysis for remote sensing. ISPRS Journal of Photogrammetry and Remote Sensing 65 (2010) 2–16
Infographic created by: GISGeography.com

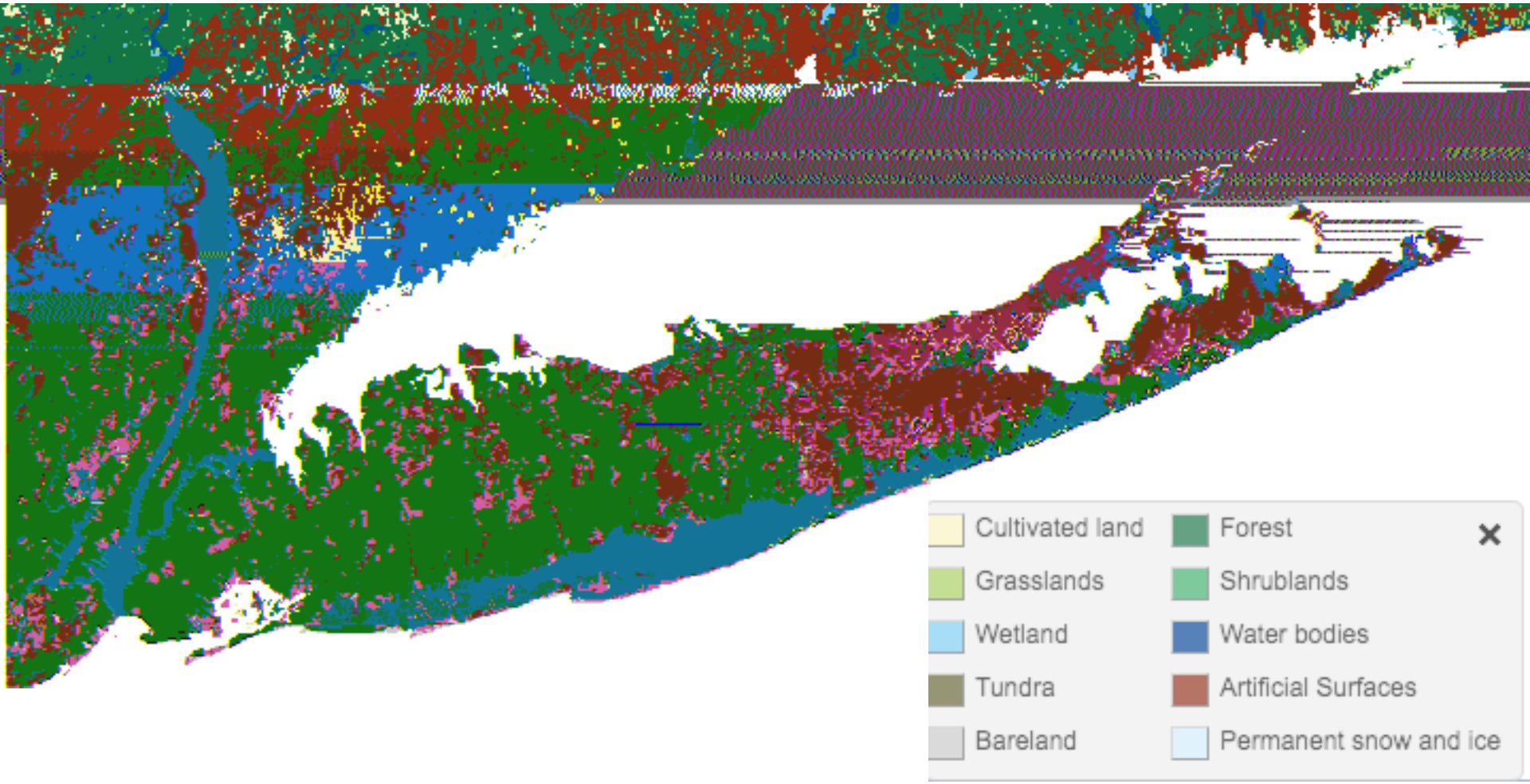
Free Land use/cover data

_____	38	300 m	1992 to 2015	Snow probability Burned area seasonal. Greenness seasonality
_____	10	30m	1998 2000	Documentation in Chinese
_____	12	1km	2014	% of consensus for LU
_____	~20	Object-based	Now	Better for built zones

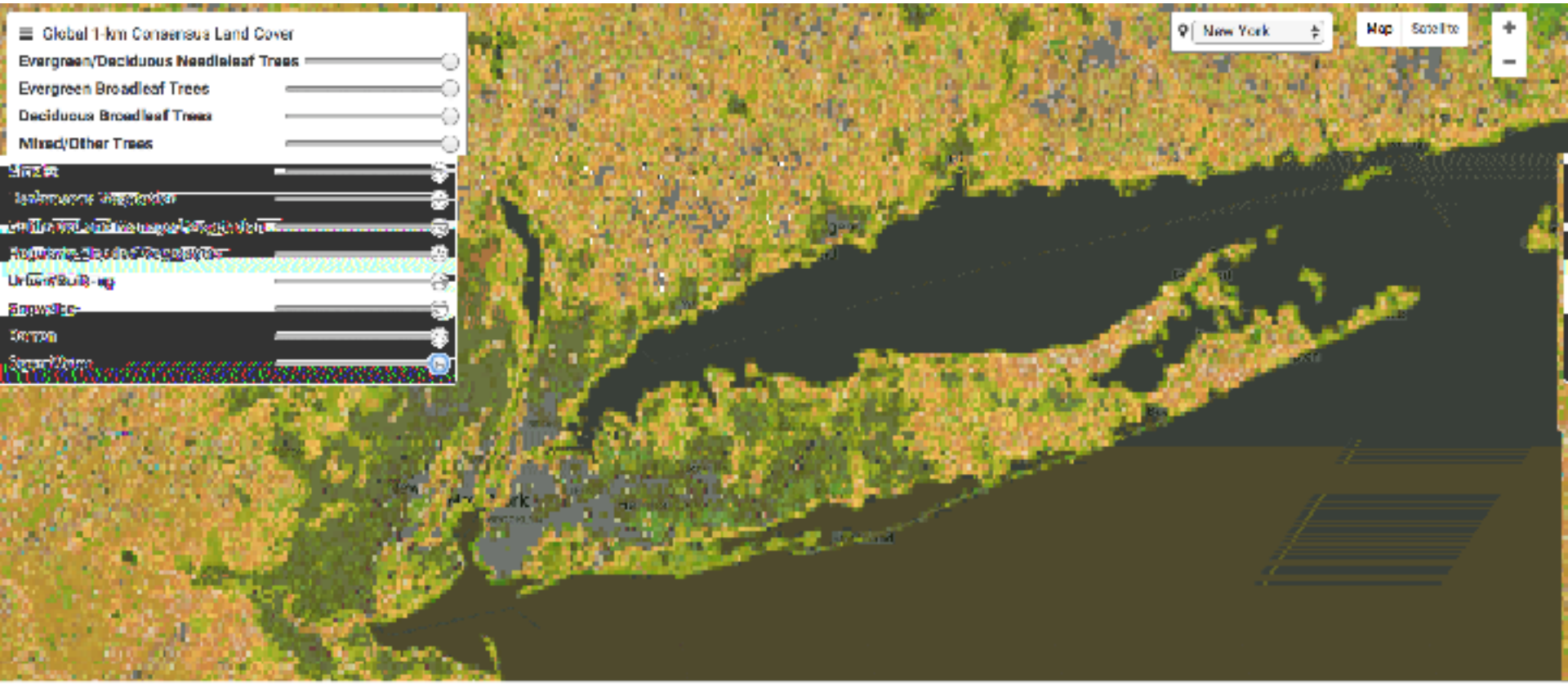
NY example - Maps Elie



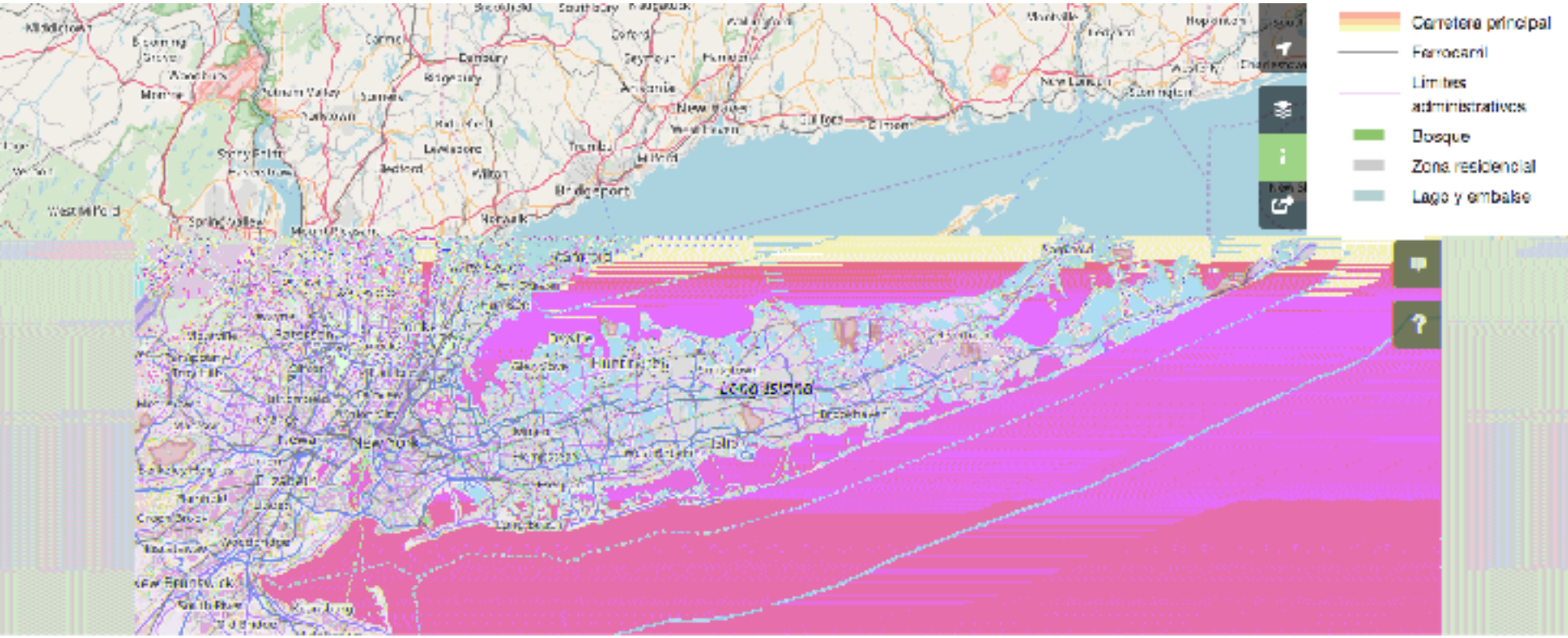
NY example - Global Land Cover



NY example - EarthEnv

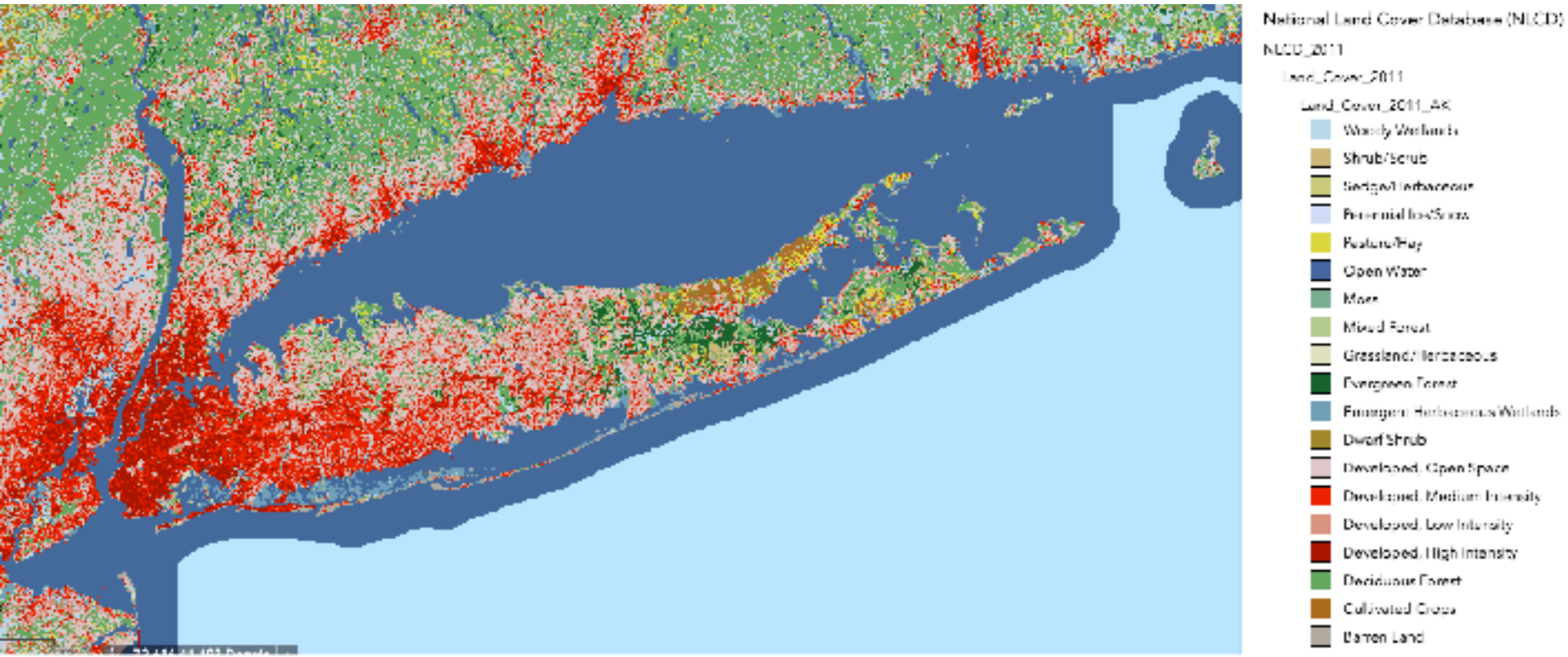


NY example - OpenStreetMap



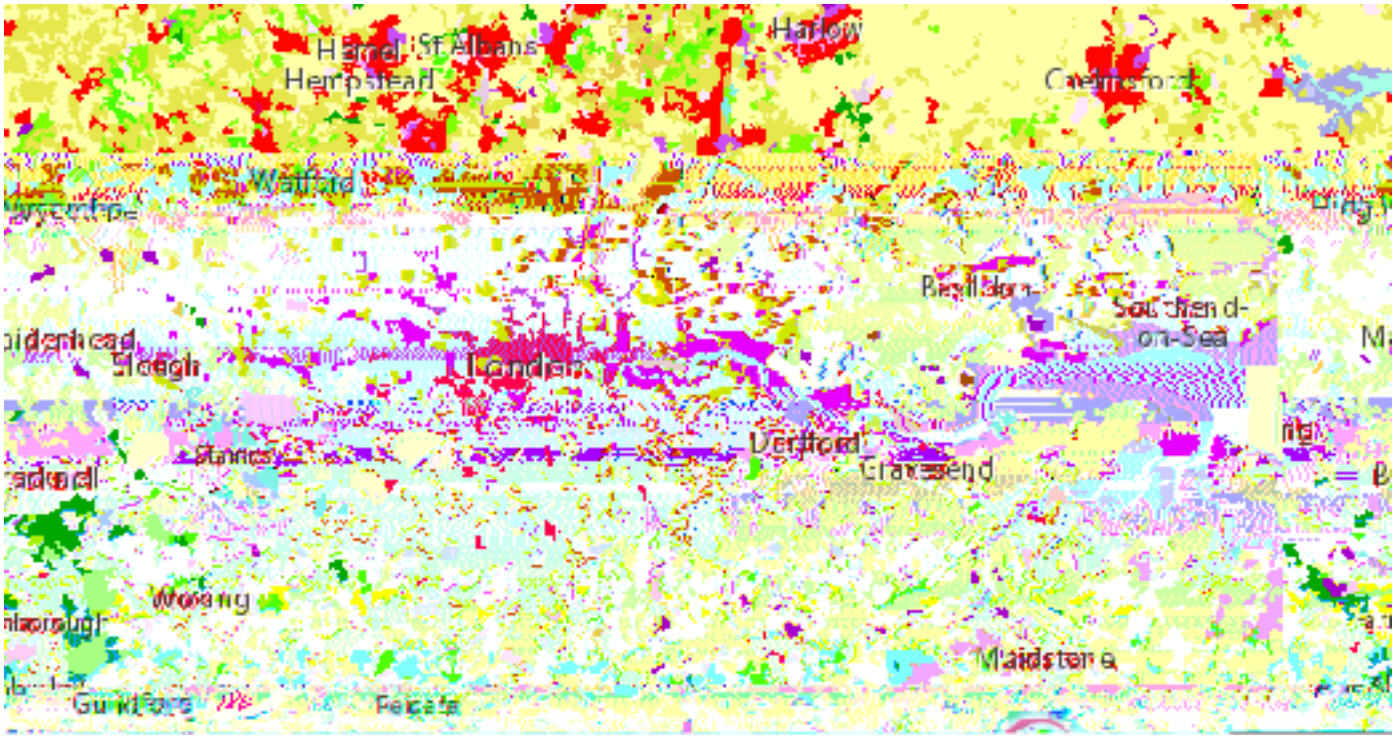
US

National Land Cover Database
Years 1992 - 2001 - 2006 - 2011
16-19 classes
15m pixel accuracy



Europe

[Corine Land Cover - Copernicus]
Years 1990 - 2000 - 2006 - 2012
44 classes
100m pixel accuracy



Agriculture

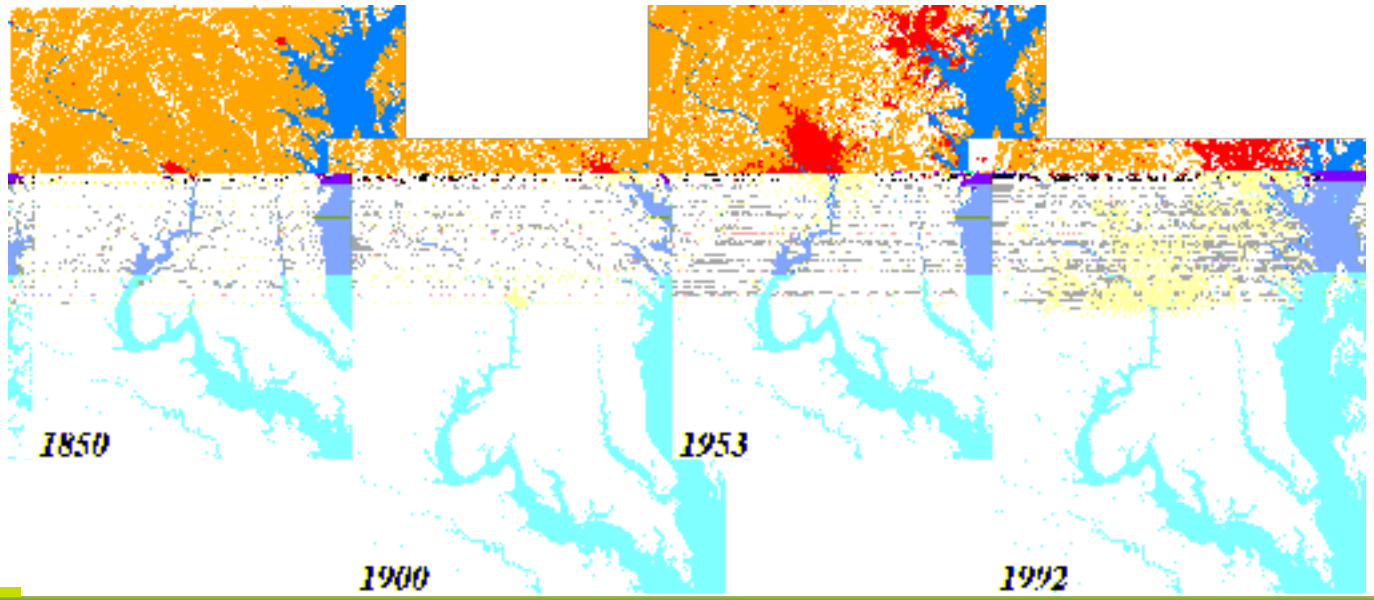
———	42	8-10km	2000 & 2005	Production/Yield Irrigated/Rainfed
———	175	8-10km	2000	Crops & Pastures Yield/Yield Gap Nutrient balance Carbon stock & GHG
——	28	10km	2000	Only irrigation
————	25	100m 10km	2010	Sowing & Harvesting Seasons

Forest

_____	30m - 250m	Daily Monthly Annualy	Forest Gain/Loss
_____	25m	2000 to 2016	Gain/Loss/Extent Tree cover
_____	25m	2009 to 2015	Forest/non-forest
_____	100m	Monthly	Fire incidence
_____	?	2010	Tree height in meters

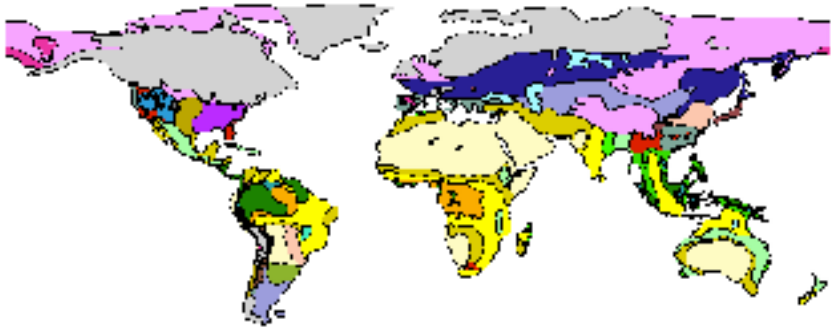
Land Use/Cover Change

- Urbanization (from previously agricultural land or forest)
- Deforestation for agricultural or urban purposes
- Afforestation/Reforestation
- Irrigation of grassland

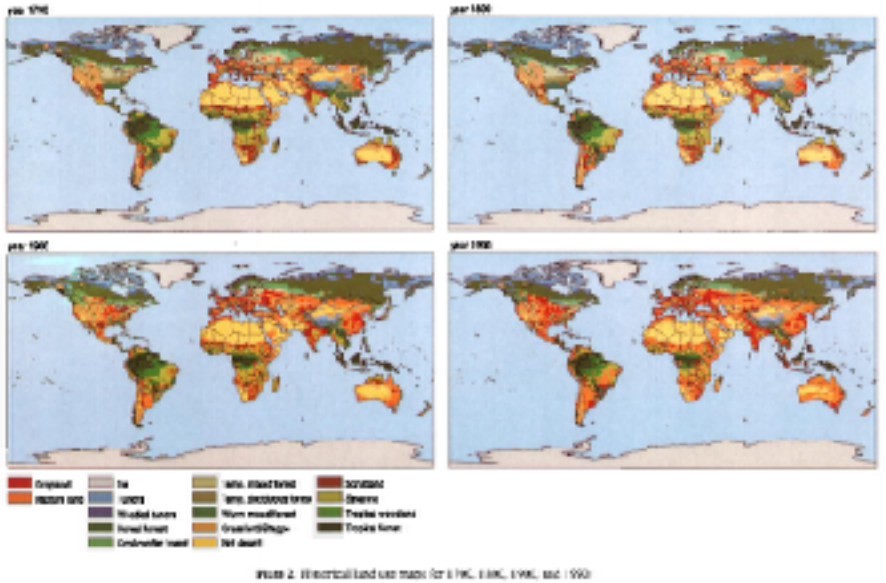


Land Use Change…in the past

GIS-based vegetation map of the world at the last Glacial Maximum
Years 25,000-15,000 B.C.
26 classes



HYDE site: History Database of the Global Environment
Years: 1600 to 2000
~10 classes



Land Use Changes… in the future

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- Great & at stake, such as
  - Price increase for developable land (urban sprawl due to population increase)
  - Mining opportunities (e.g. Orinoco Mining Arch, gold mines in Asturias, rare minerals in Campo de Montiel)
  - Deforestation for agriculture (Amazon rainforest, Borneo)
  - Water availability for irrigation (Ogalalla aquifer U.S. Midwest)
-
  - Improved data (land ownership, demographic & fiscal data, public policy and regulation)
  - Land-use choice models (mathematics, statistics and econometrics)

Modeling future land use changes

- 5 million parcels in PACA - Southern France - with highly detailed information
- We model the probability of a parcel of becoming (necessary condition for being constructed one day)
- Regression-like model. Set of variables explains the final decision on each parcel
- We account for spatial autocorrelation (neighboring parcels impacts decisions)
- ~95% accuracy

- Try to model multiple land use changes at the same time -> increased complexity

Some extras!

- Meteorology
- Urban Trees
- Soil Quality
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Meteorology

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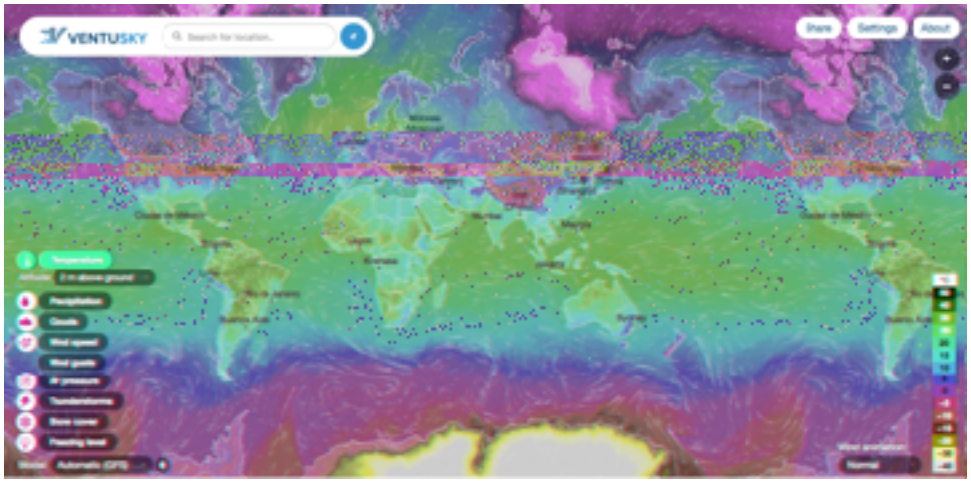

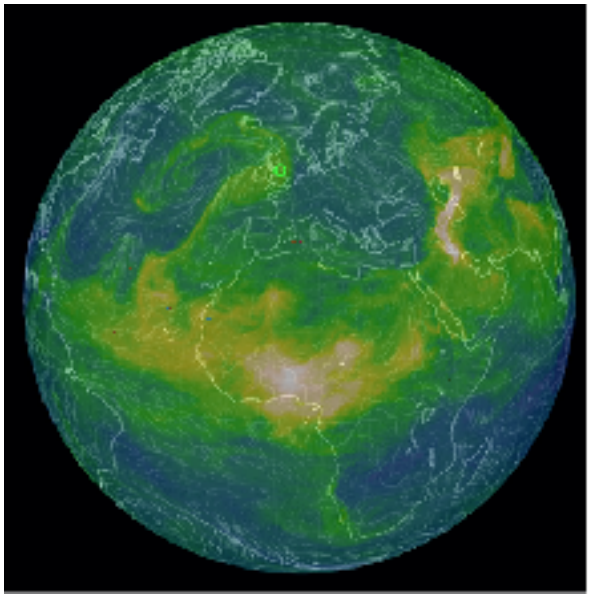

Urban Trees

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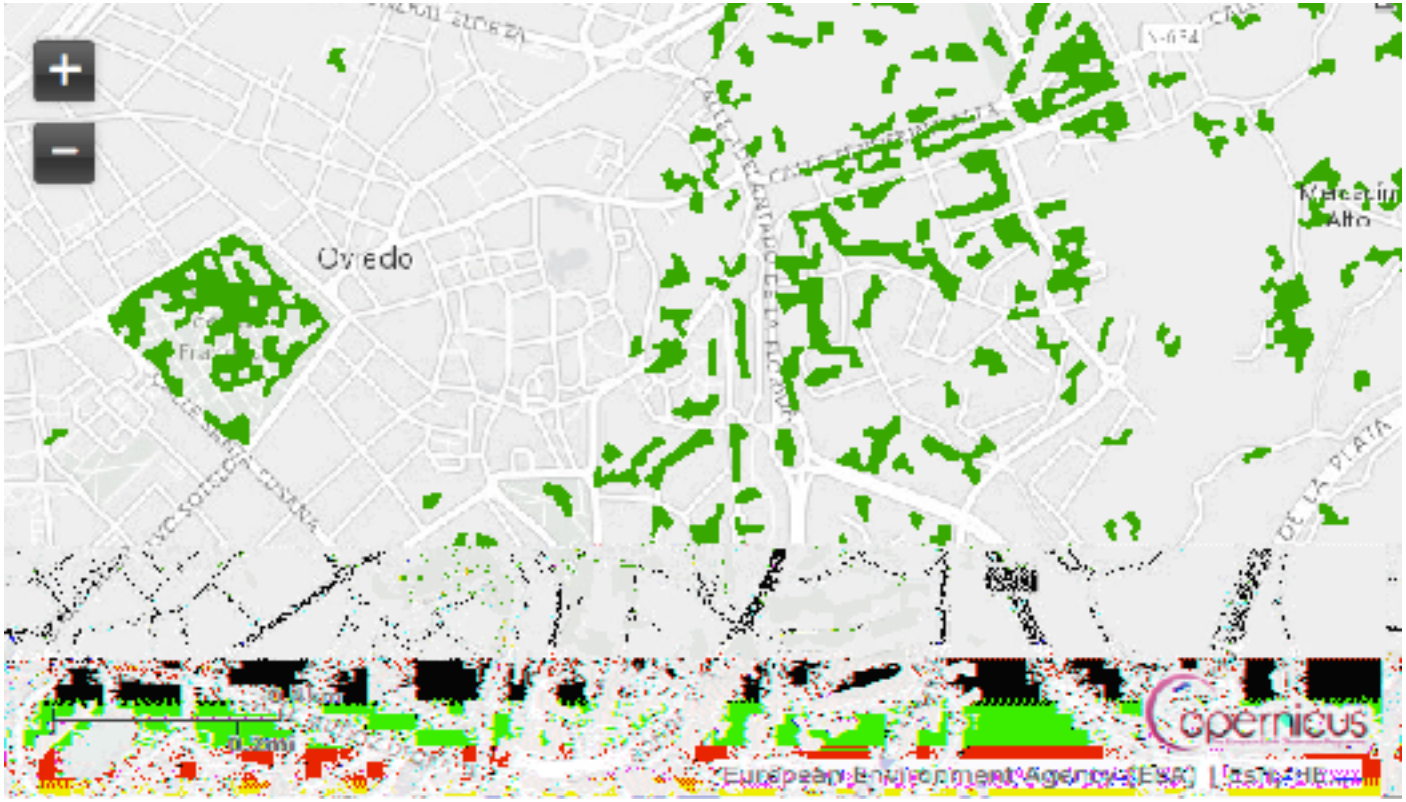
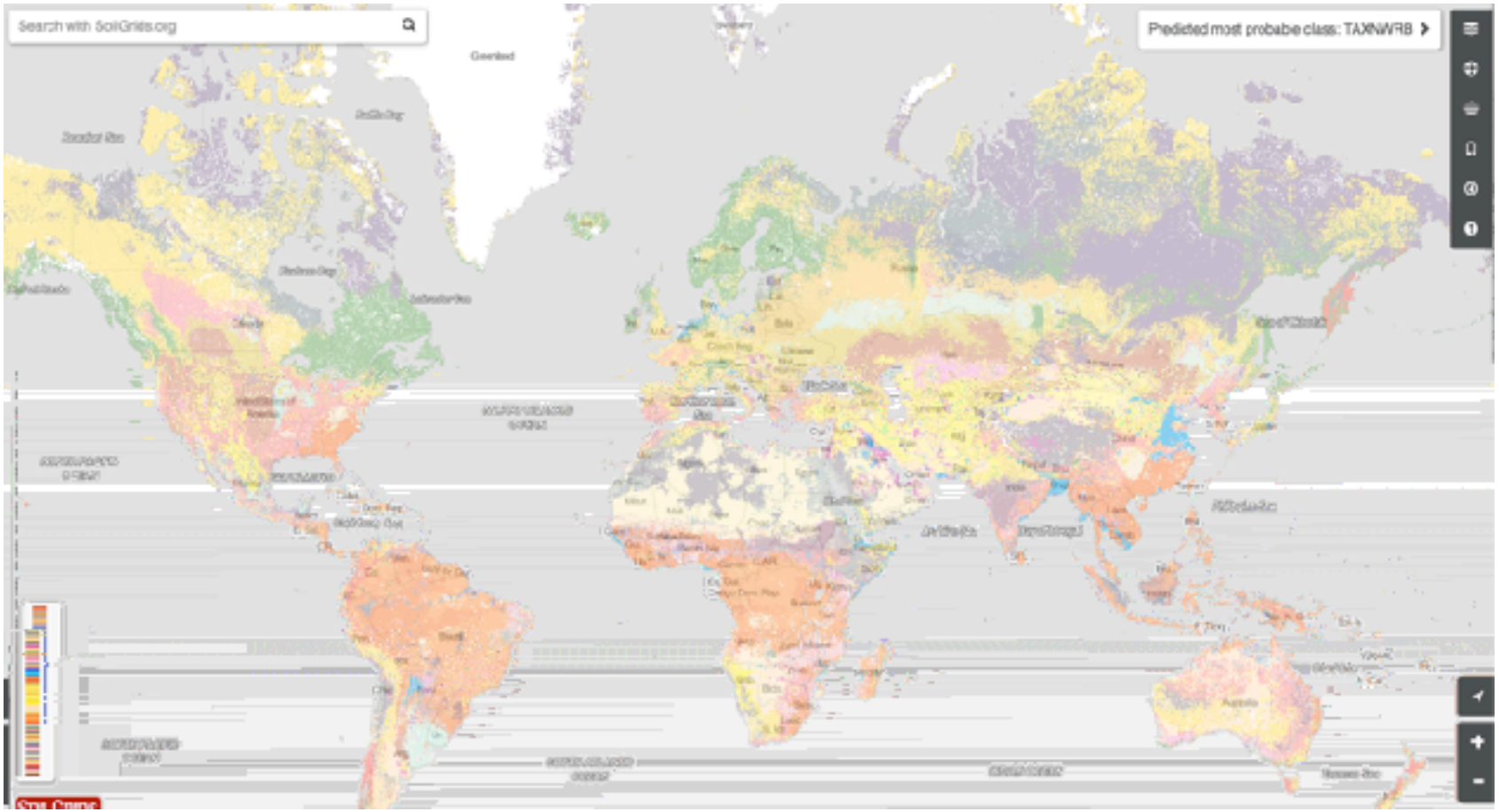
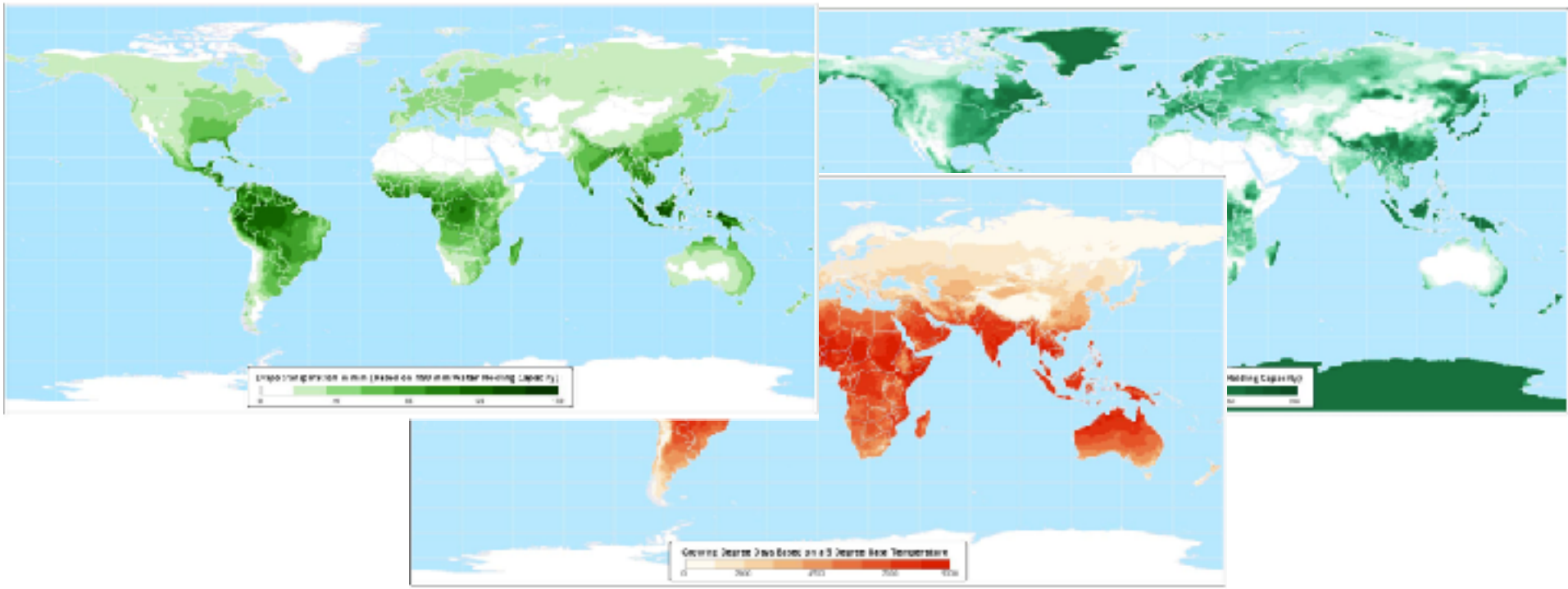


Soil Quality and Type



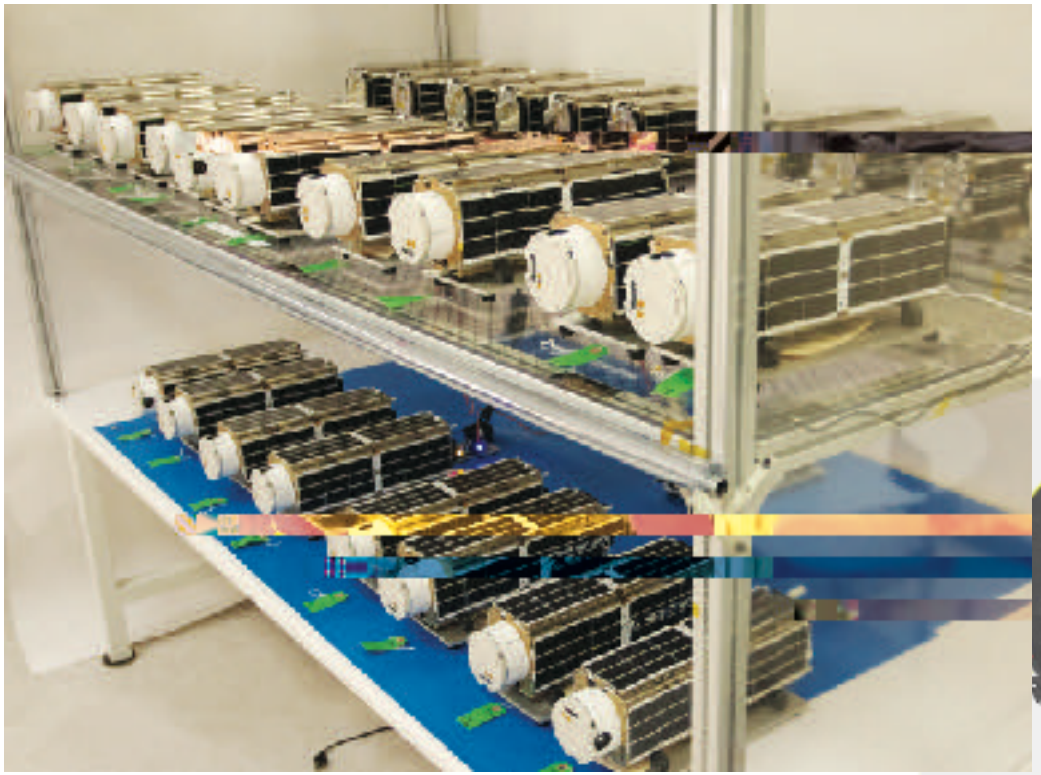
Ecosystems characteristics

- Annual Total Precipitation
- Average Annual Relative Humidity
- Average Annual Temperature
- Average Temperature Evapotranspiration
- Growing Degree Days
- Lakes and Wetlands
- Net Primary Productivity
- Potential Evapotranspiration
- Potential Vegetation
- Snow Depth
- Soil Moisture
- Soil Organic Carbon
- Soil pH
- Topography

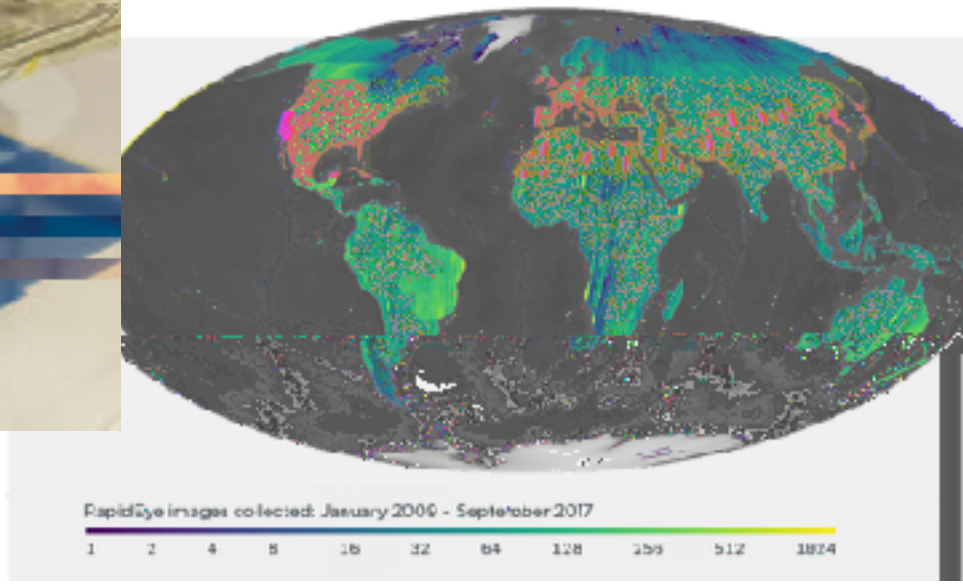


Daily high-resolution satellite images

- 250+ micro-satellites taking daily photos at 3 meters resolution



planet.



Repositories

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- http://landcover.usgs.gov/landcoverdata.php
- http://gisgeography.com/free-global-land-cover-land-use-data/
- http://freegisdata.rtwilson.com/
- http://glcf.umd.edu/data/

- http://gisgeography.com/open-source-remote-sensing-software-packages/
- http://gisgeography.com/supervised-unsupervised-classification-arcgis/