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

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2. Land Use Change

- D. Main types of LUC
- E. Challenges in predicting LUC

3. Lots of extras!!!

- F. Meteorology, trees & forests, soil quality, fires and much more!

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



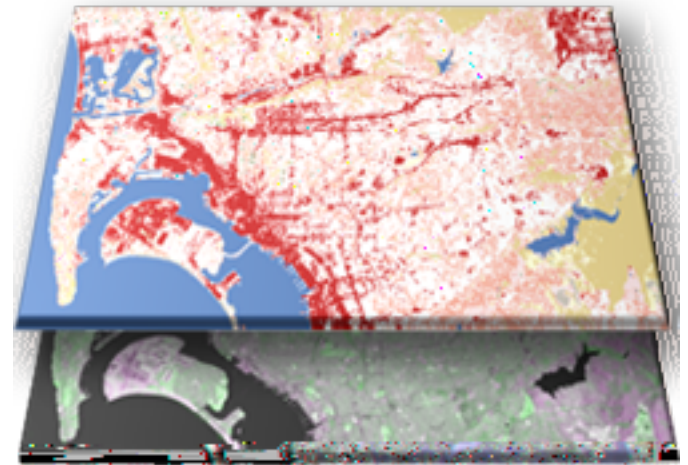
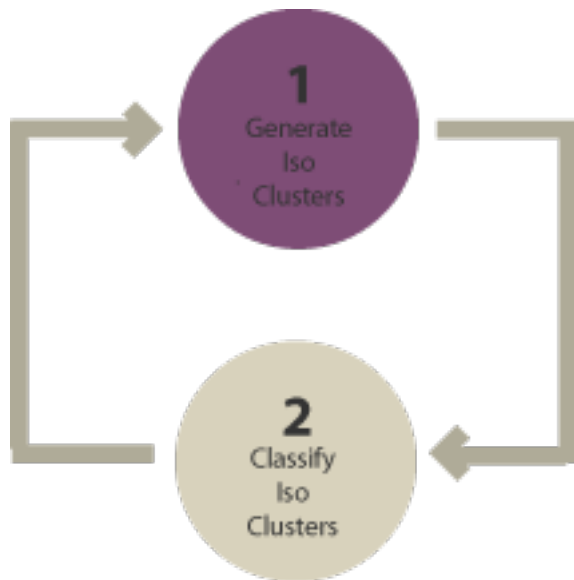
...to land use classification



- Satellite imagery can hardly be used rough
-
- 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)

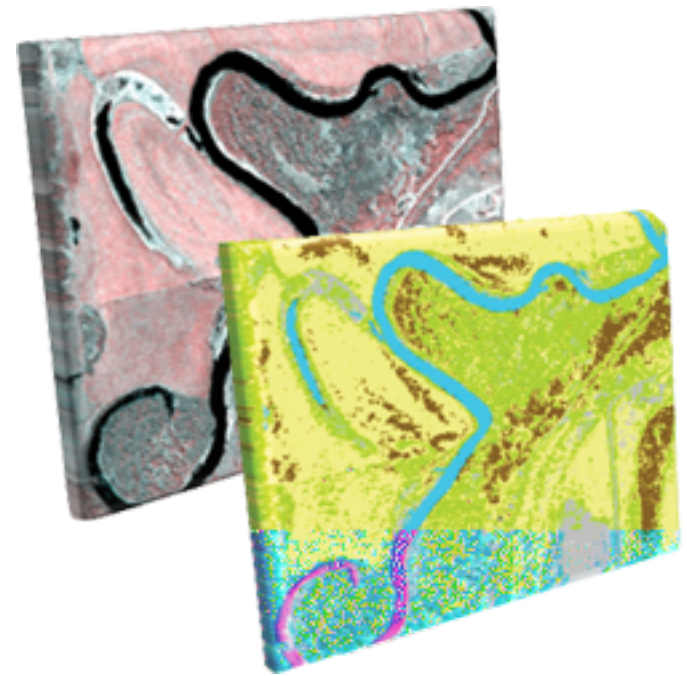
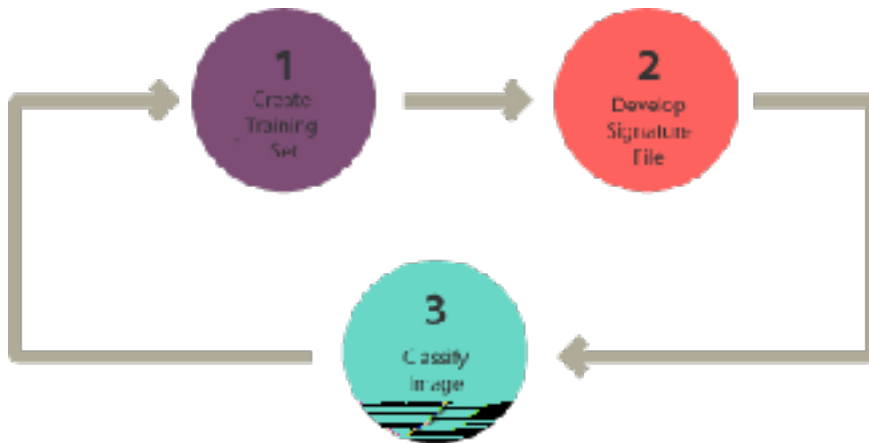
Unsupervised classification

- 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

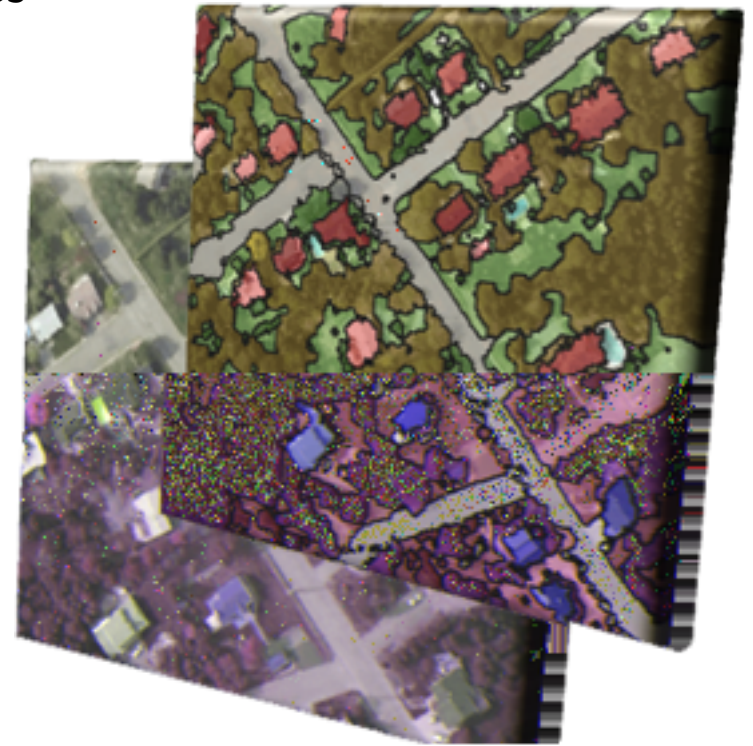
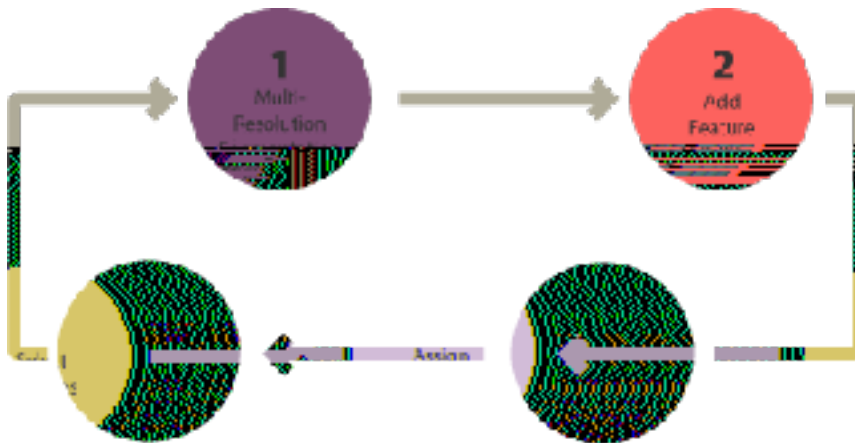
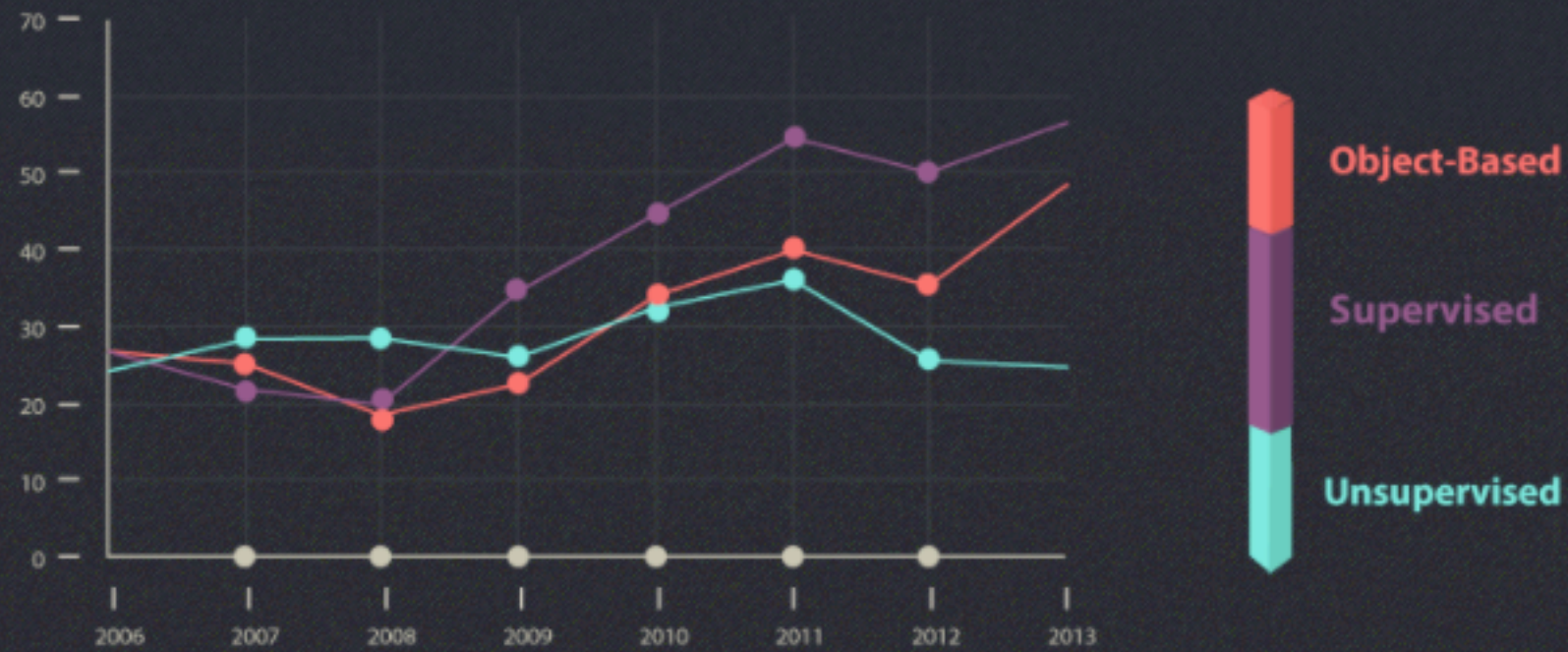








Image Classification Publications Growth

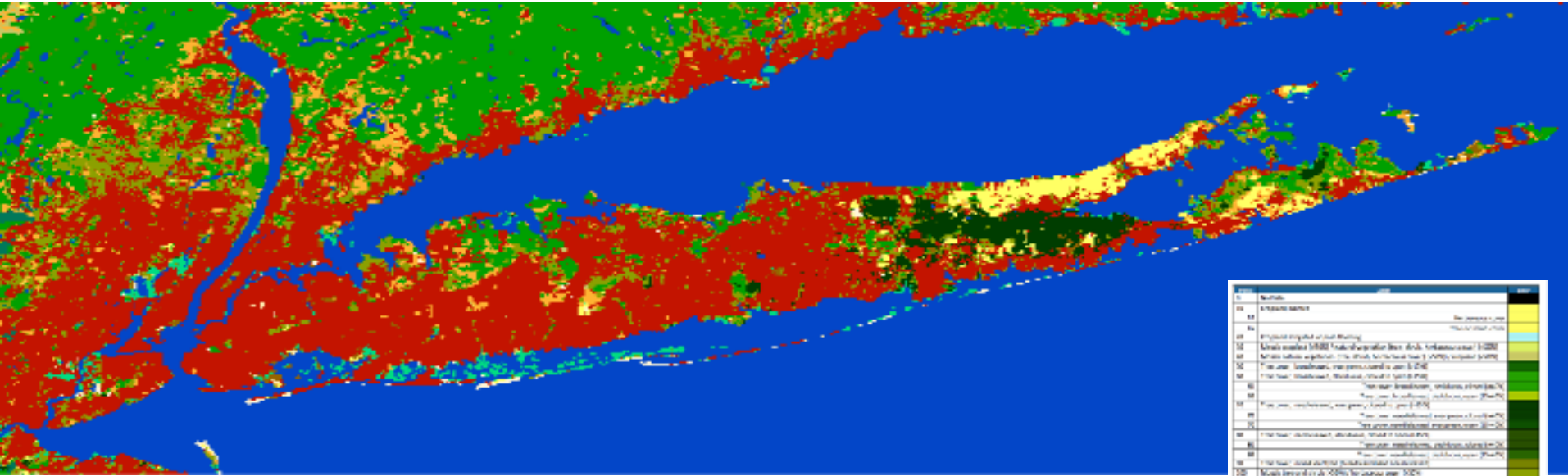


Sources:
Blaschke T, 2010. Object based image analysis for remote sensing. ISPRS Journal of Photogrammetry and Remote Sensing 65 (2010) 2-16
Infographic created by: GISGeography.com

Free Land use/cover data

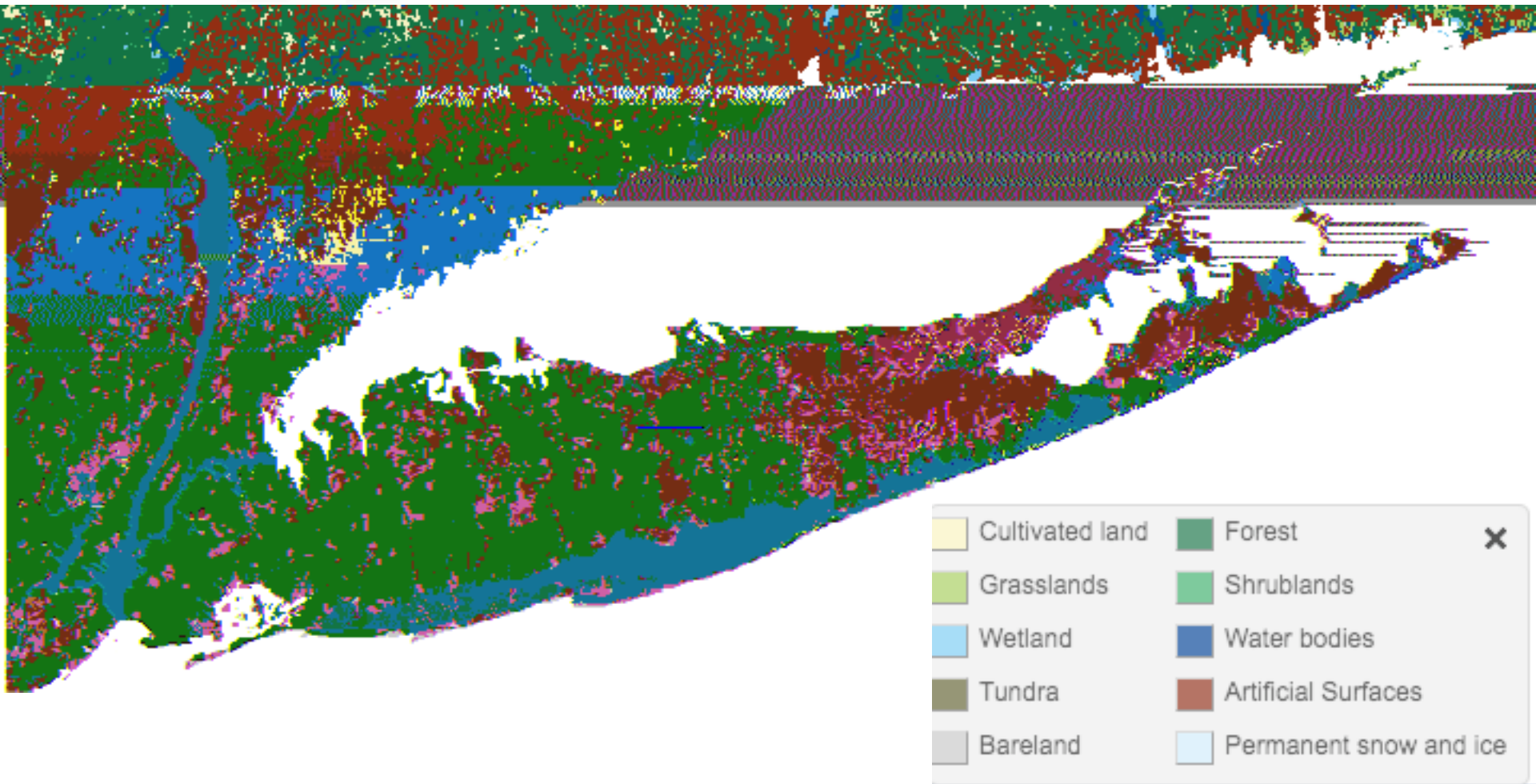
	38	300 m	1992 to 2015	Snow probability Burned area seasonal. Greenness seasonality
	10	30m	1998 2000	Documentation in Chinese
	12	1km	2014	% of consensus for LU
	~20	Object-based	Now	Better for built zones

NY example - Maps Elie



ID	Name	Color
0	Water	Blue
10	Water	Blue
11	Water	Blue
12	Water	Blue
13	Water	Blue
14	Water	Blue
15	Water	Blue
16	Water	Blue
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99	Water	Blue

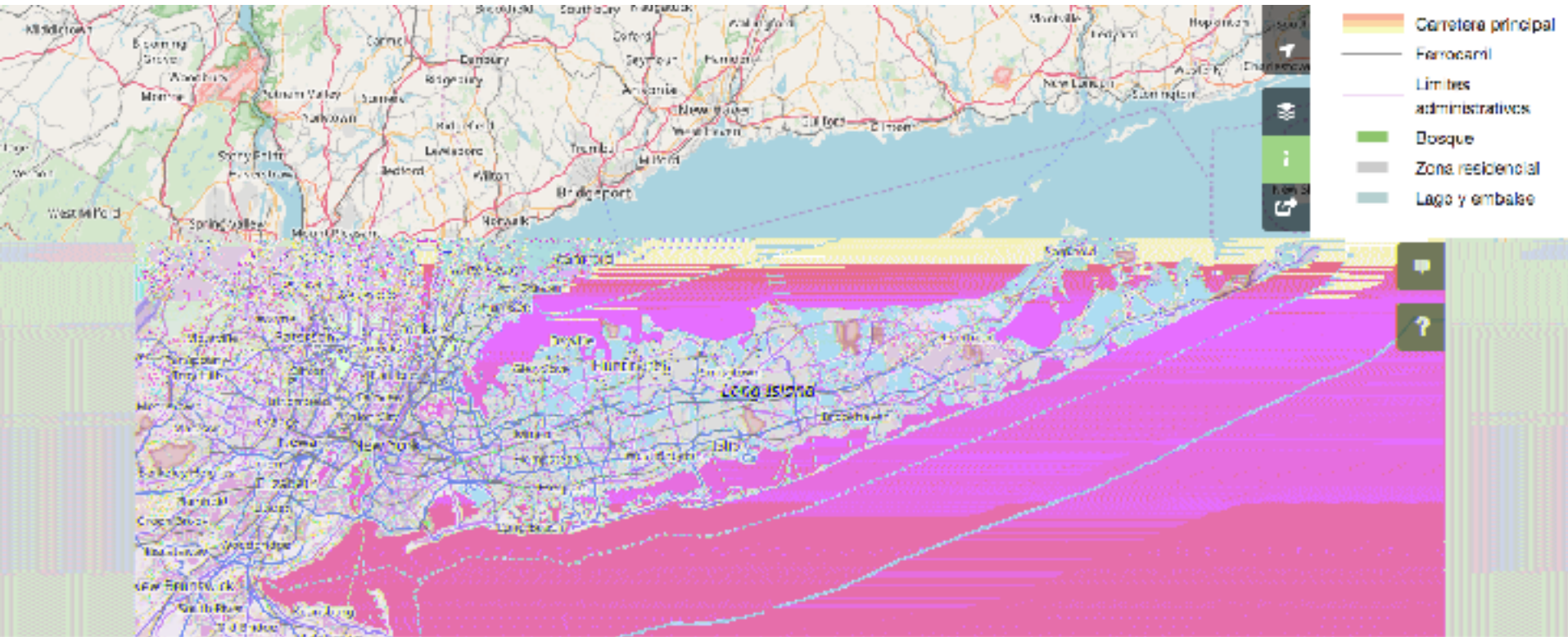
NY example - Global Land Cover



NY example - EarthEnv



NY example - OpenStreetMap

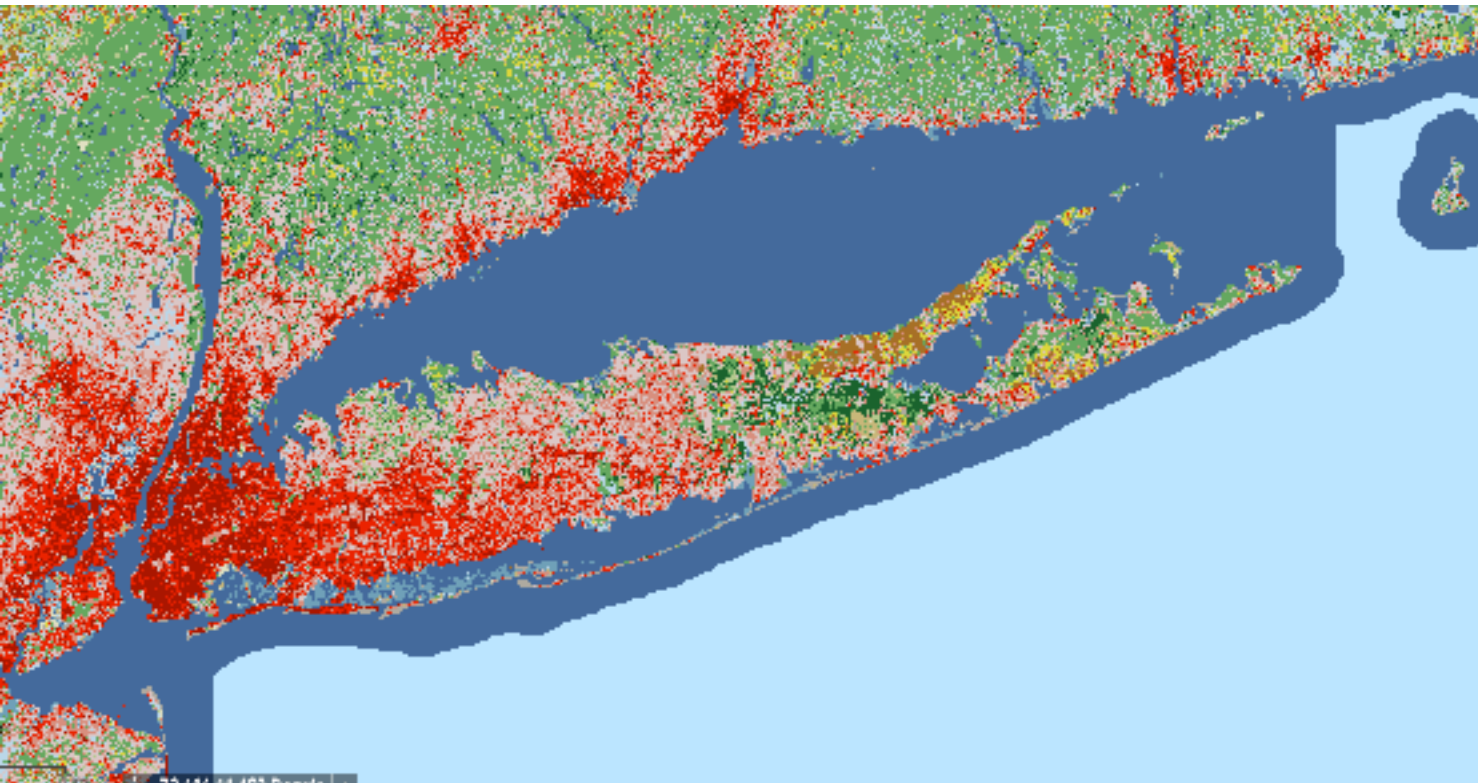


National Land Cover Database

Years 1992 - 2001 - 2006 - 2011

16-19 classes

15m pixel accuracy



National Land Cover Database (NLCD)

NLCD_2011

land_cover_2011

Land_Cover_2011_AK

- Wetlands
- Shrub/Scrub
- Wetland/Herbaceous
- Perennial Ice/Snow
- Palustrine/Marsh
- Open Water
- Moss
- Mixed Forest
- Grassland/Herbaceous
- Evergreen Forest
- Emergent Herbaceous Wetlands
- Dwarf Shrub
- Developed, Open Space
- Developed, Medium Intensity
- Developed, Low Intensity
- Developed, High Intensity
- Deciduous Forest
- Cultivated Crops
- Barren Land



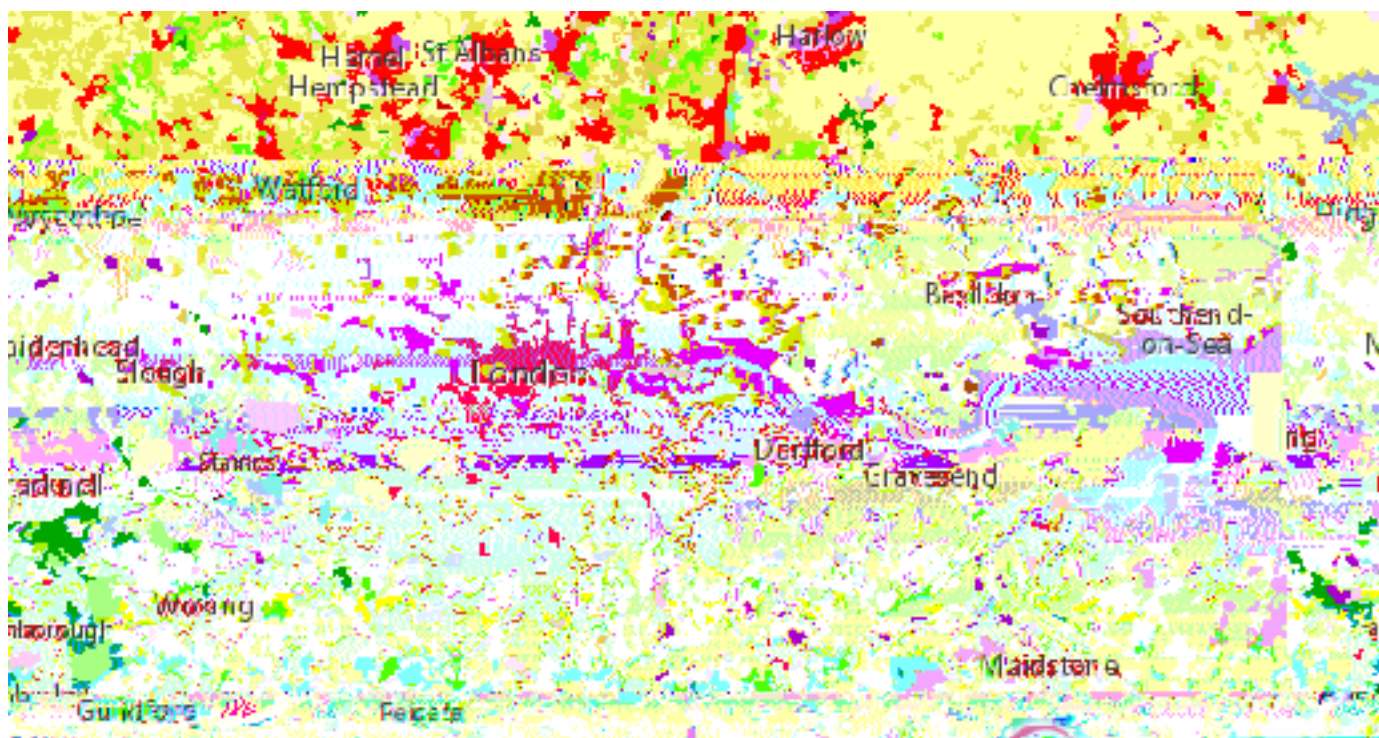
Europe

Corine Land Cover - Copernicus

Years 1990 - 2000 - 2006 - 2012

44 classes

100m pixel accuracy





Agriculture

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

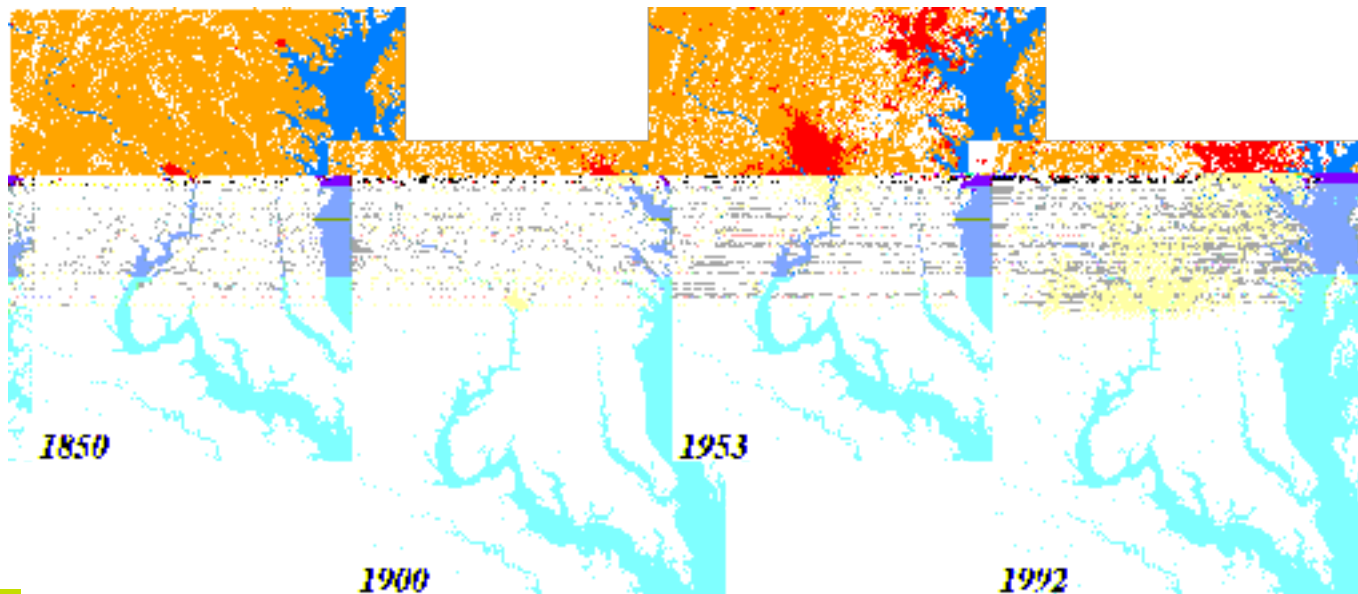


Forest

	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

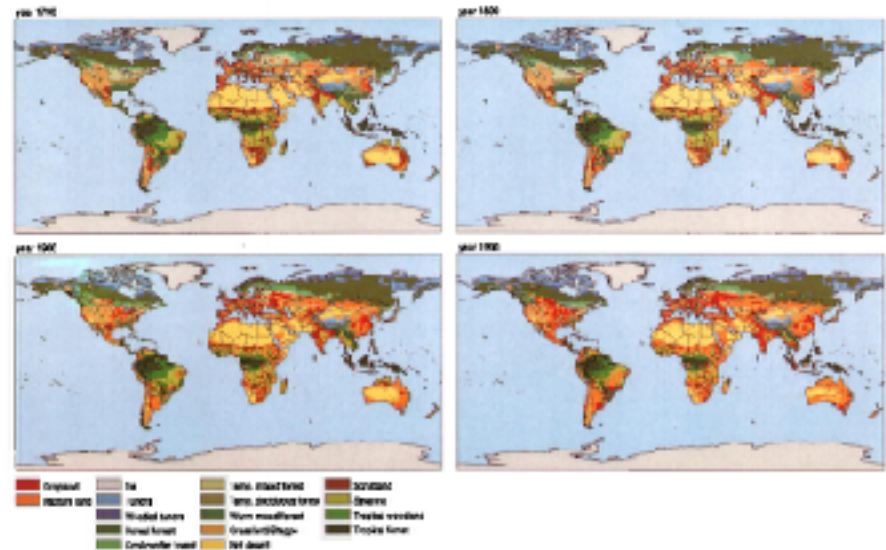
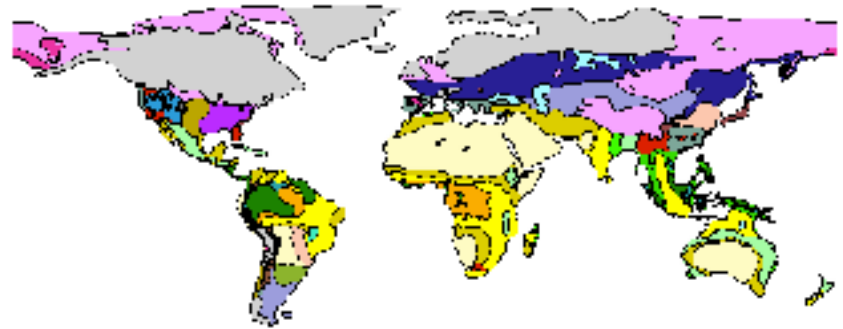


FIGURE 2. Historical land use maps for 1700, 1800, 1900, and 1990.

Land Use Changes... in the future

-
- 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





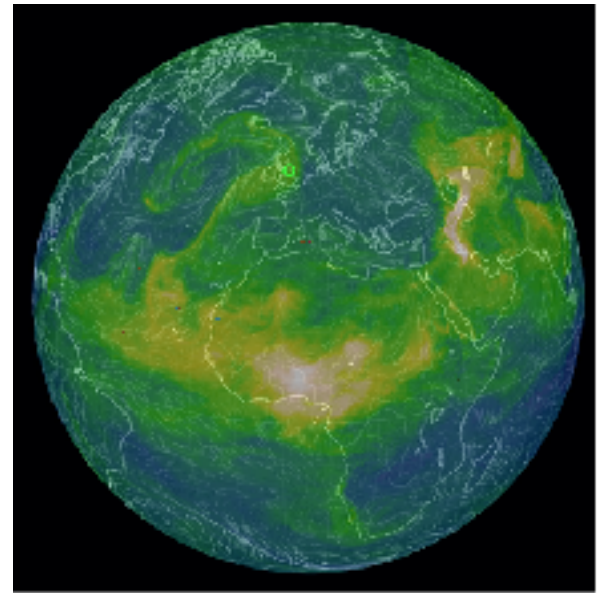
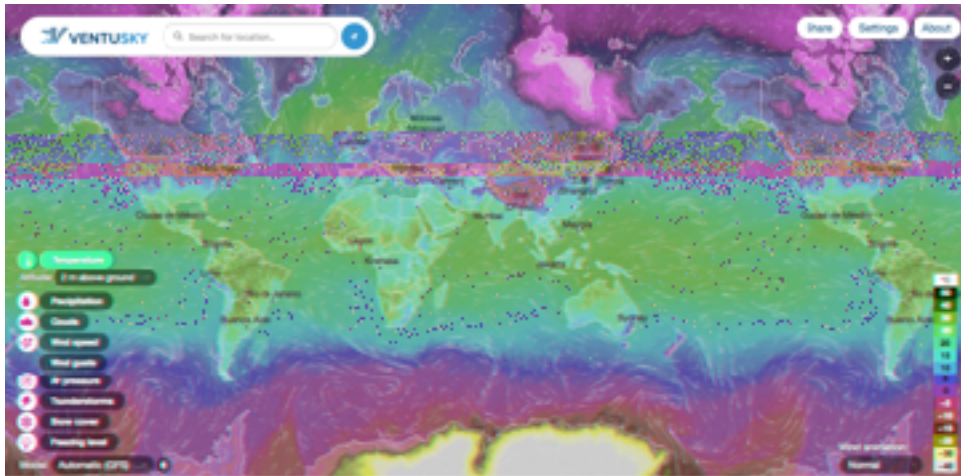
Some extras!

- Meteorology
- Urban Trees
- Soil Quality
-



Meteorology

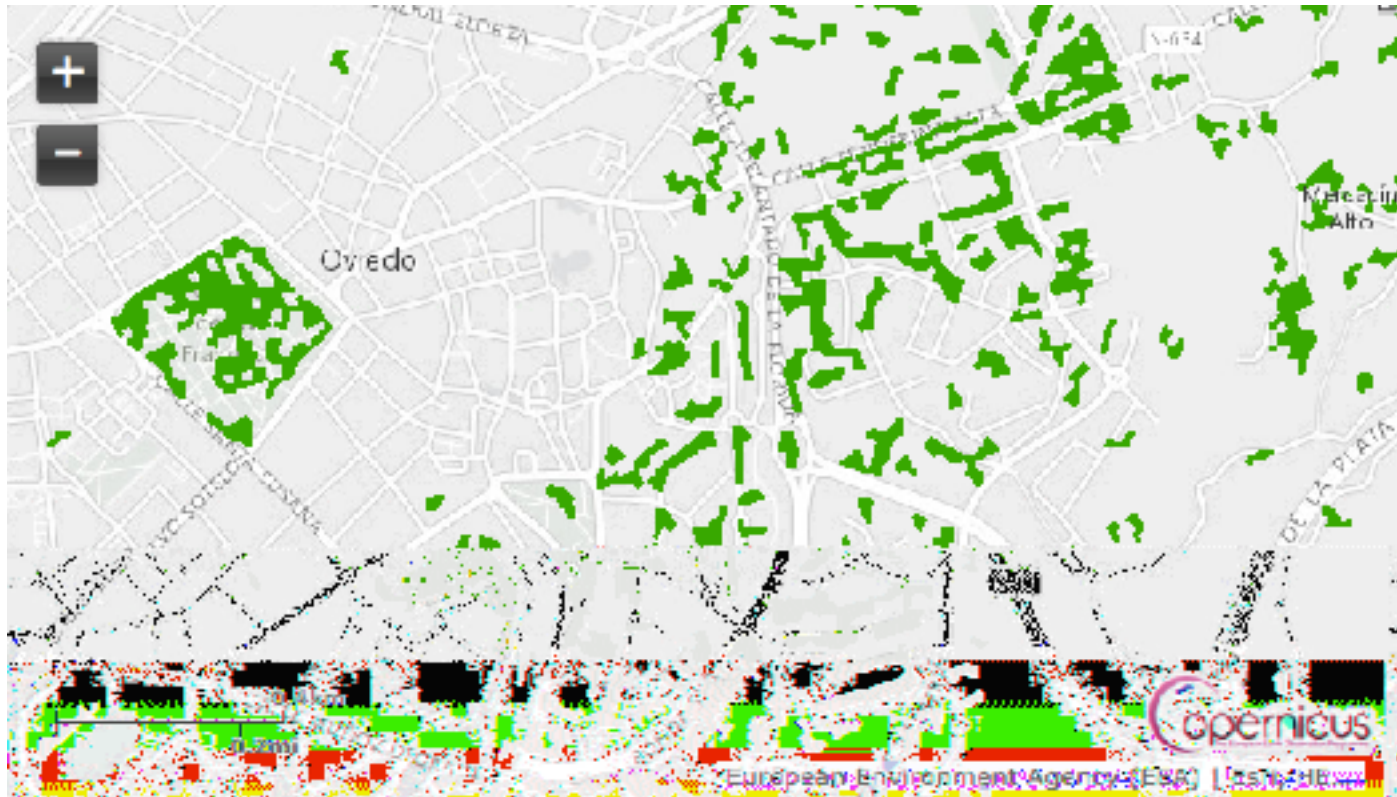
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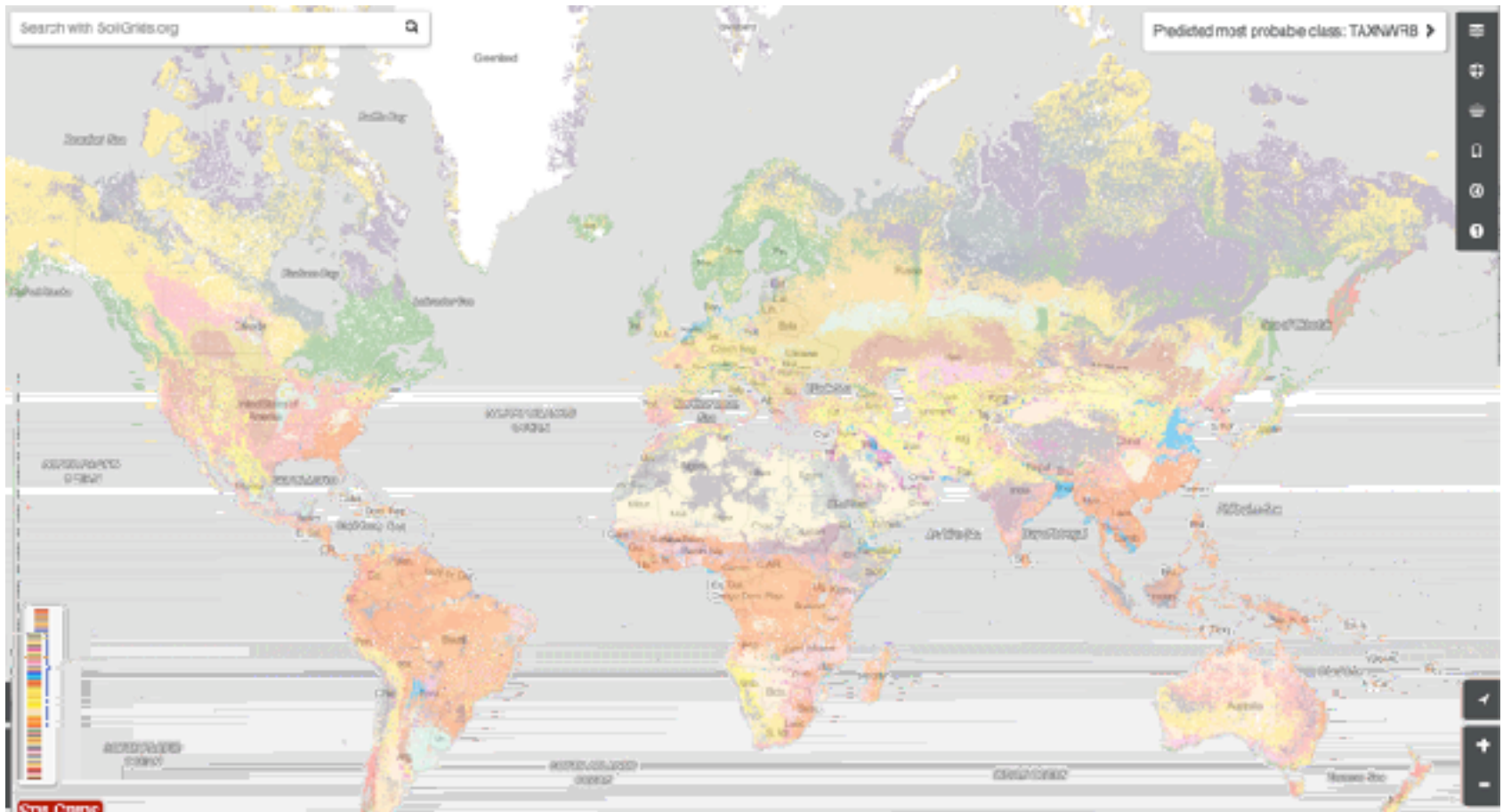


Urban Trees

&

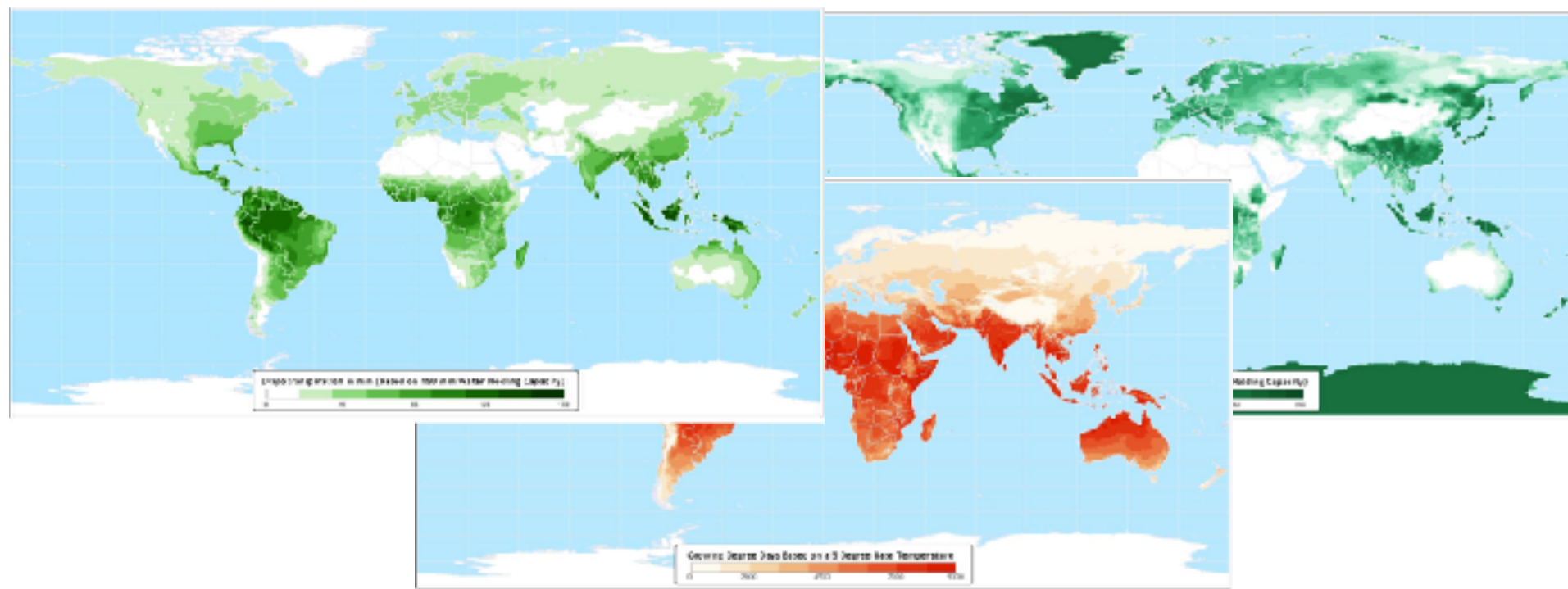


Soil Quality and Type



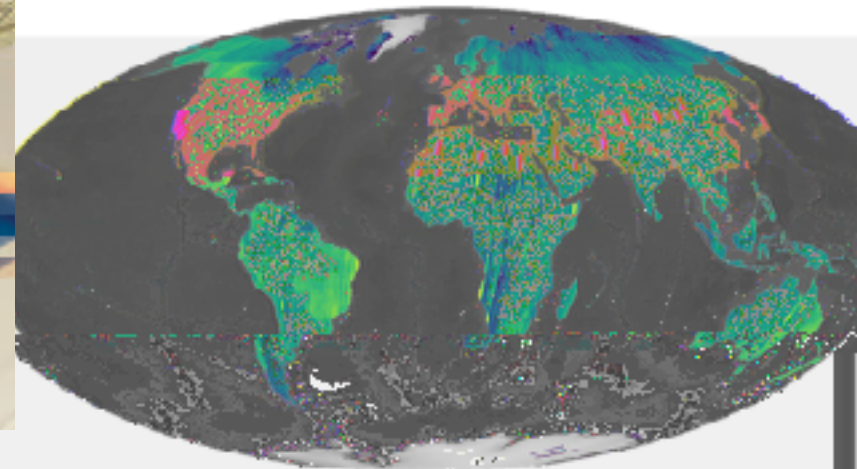
Ecosystems characteristics

- 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



RapidEye images collected: January 2006 - September 2017

1 2 4 8 16 32 64 128 256 512 1024



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/>