The Ecological Context Built from Satellites

Summer course on Movement and Population data management and analysis

Duccio Rocchini

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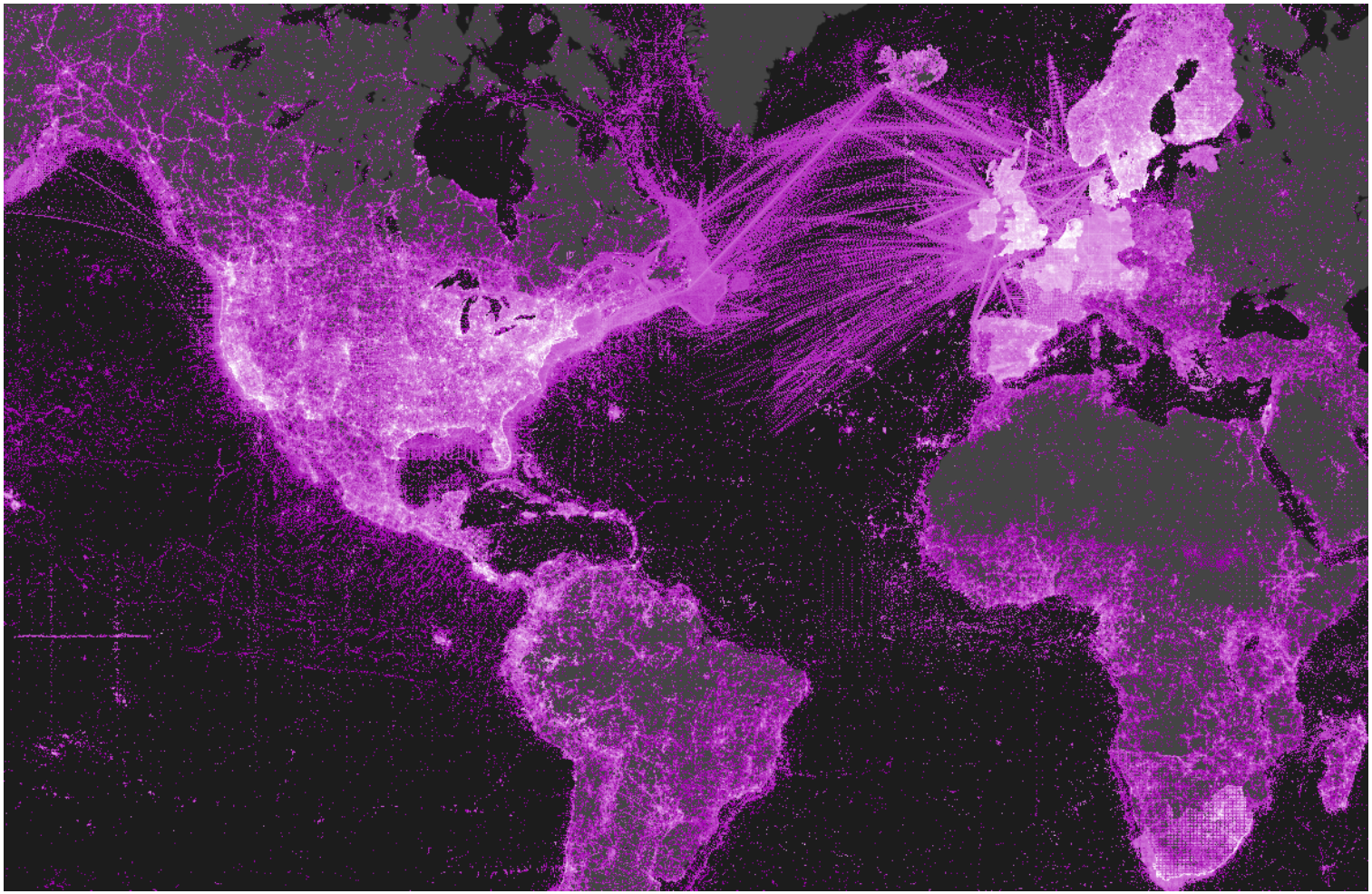
Center Agriculture Food Environment
Centre for Integrative Biology
Fondazione Edmund Mach

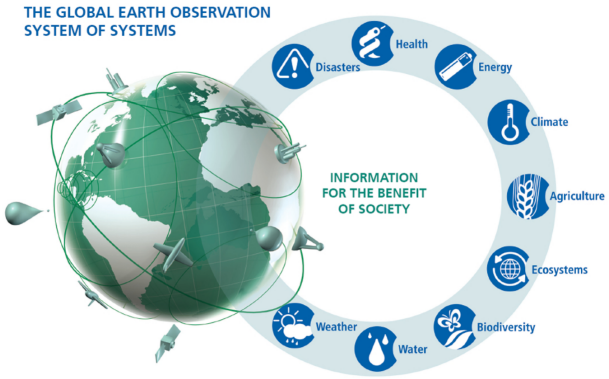
Outline

The Global Biodiversity Information Facility [GBIF]



http://www.gbif.org/

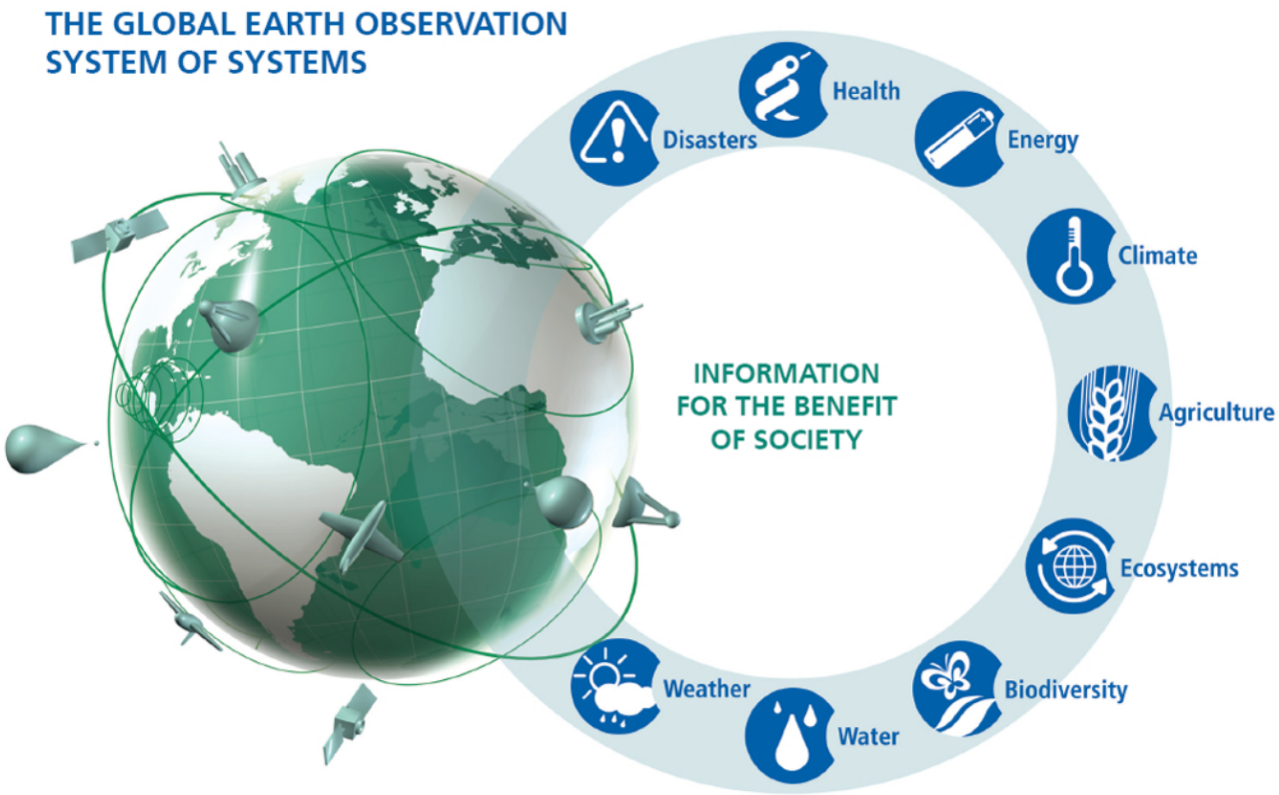
GEOSS - Global Earth Observation System of Systems



GEO GROUP ON EARTH OBSERVATIONS

- The Commission is committed to implement GEOSS
- GEO Strategic Plan 2016-2025
- Increasing capacity to observe the planet at different scales

GEOSS - Global Earth Observation System of Systems



Ecological Informatics for robust and reproducible analysis

Trends in Ecology & Evolution

Letter

Cell PRESS

Let the four freedoms paradigm apply to ecology

Duccio Rocchini and Markus Neteler

Fondazione Edmund Mach, Research and Innovation Centre, Department of Biodiversity and Molecular Ecology, Via E. Mach 1, 38010 S. Michele all'Adige (TN), Italy

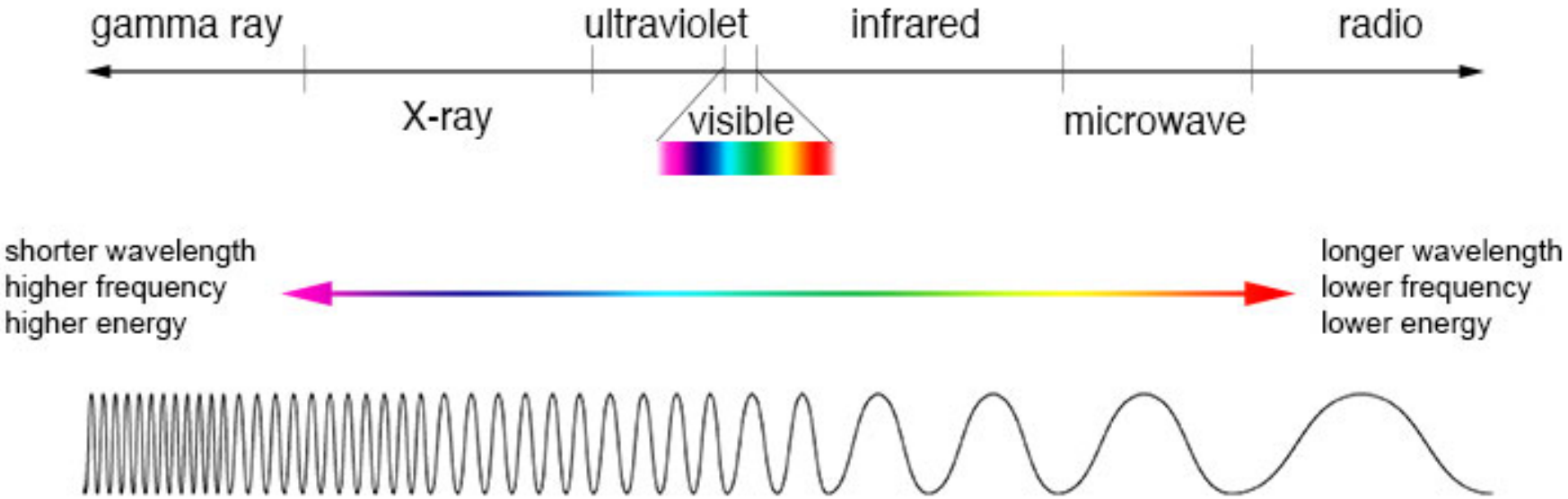
In our view, the explicit use of Free and Open Source Software (FOSS) with **availability of the code** is essential for **completely open science**: 'scientific communication relies on evidence that cannot be entirely included in publications', but '**anything less than the release of source programs is intolerable for results that depend on computation**' [3].

My aim

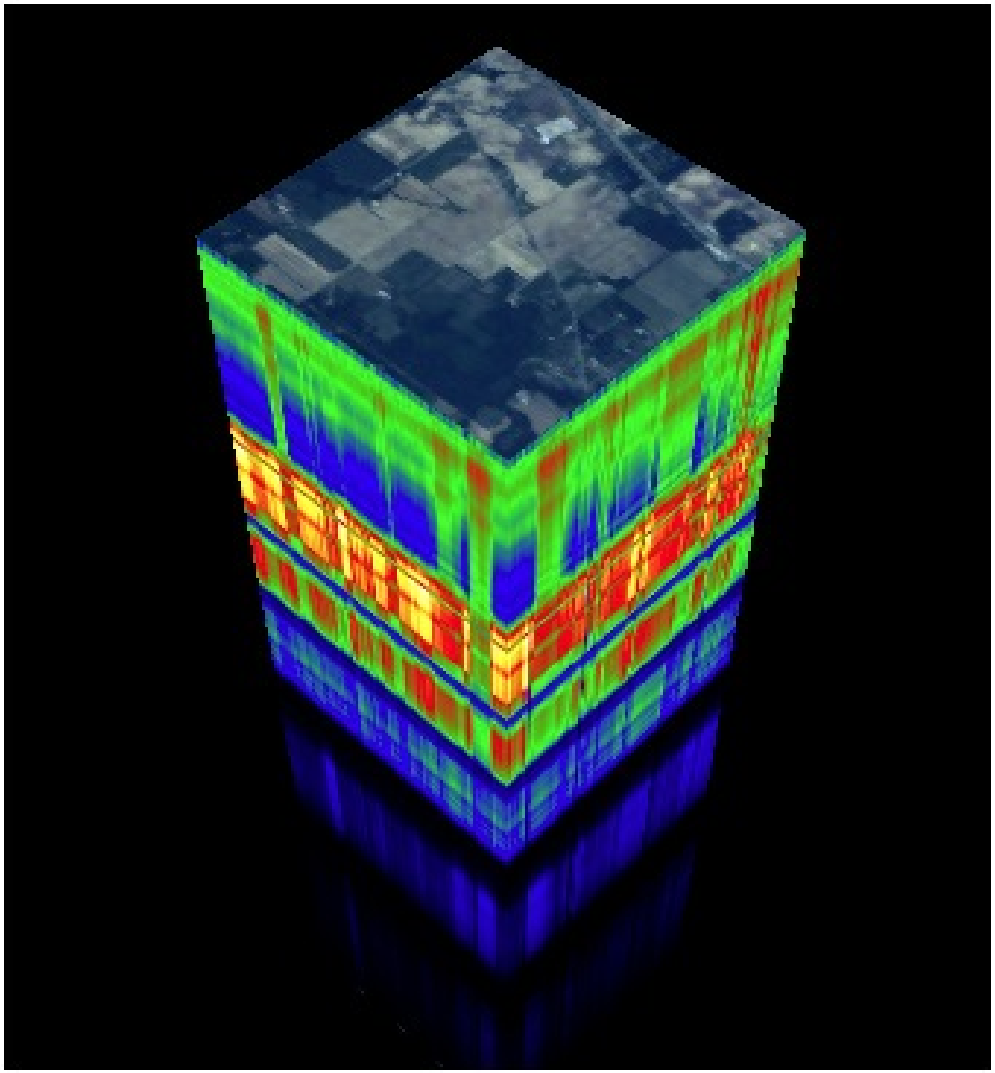
"Once a map is drawn people tend to accept it as reality" (Bert Friesen)

Outline

Satellite images - electromagnetic spectrum

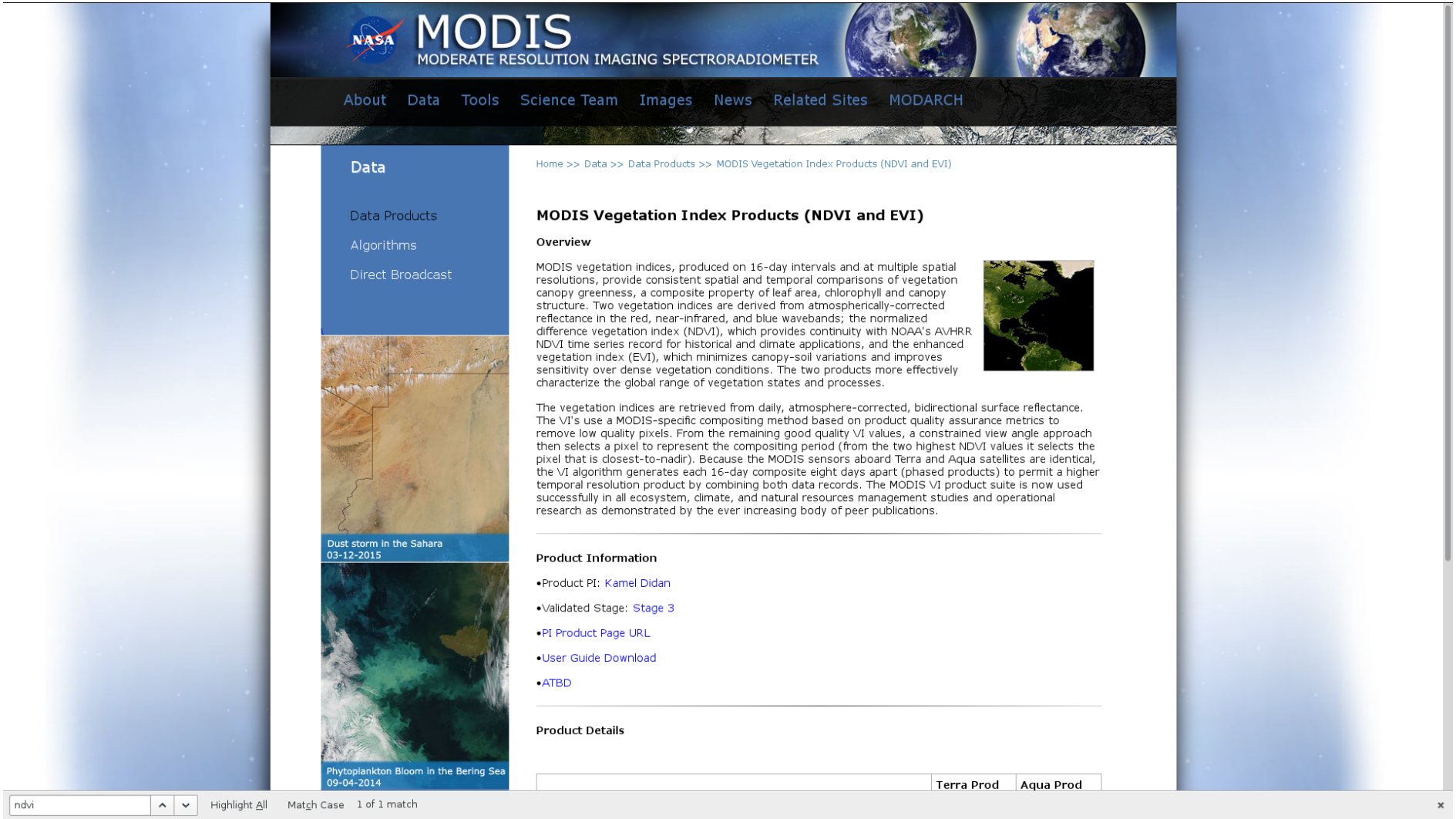


Satellite images - Multi- or Hyper-cubes



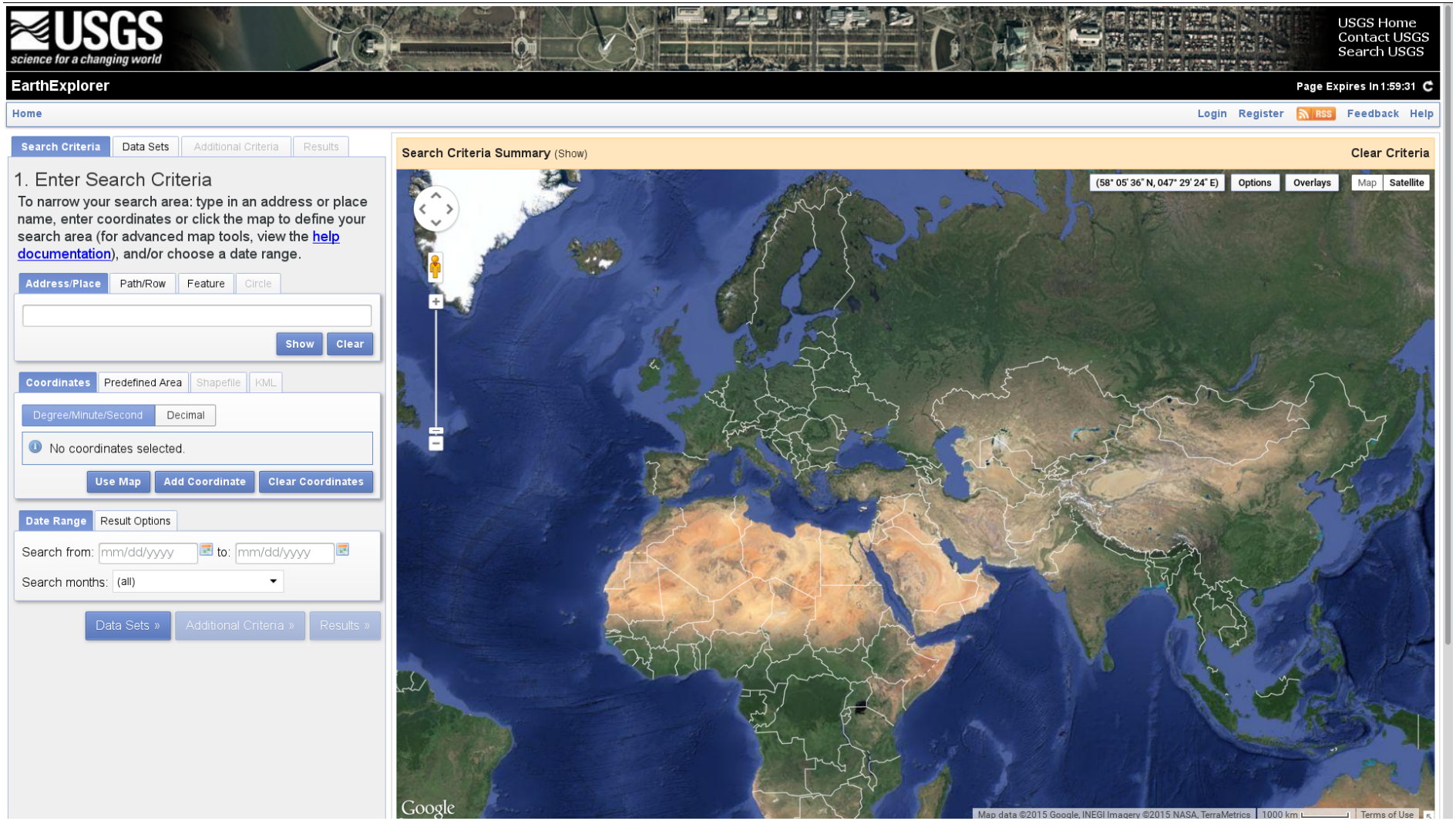
Satellite images as matrices of numbers

NASA site



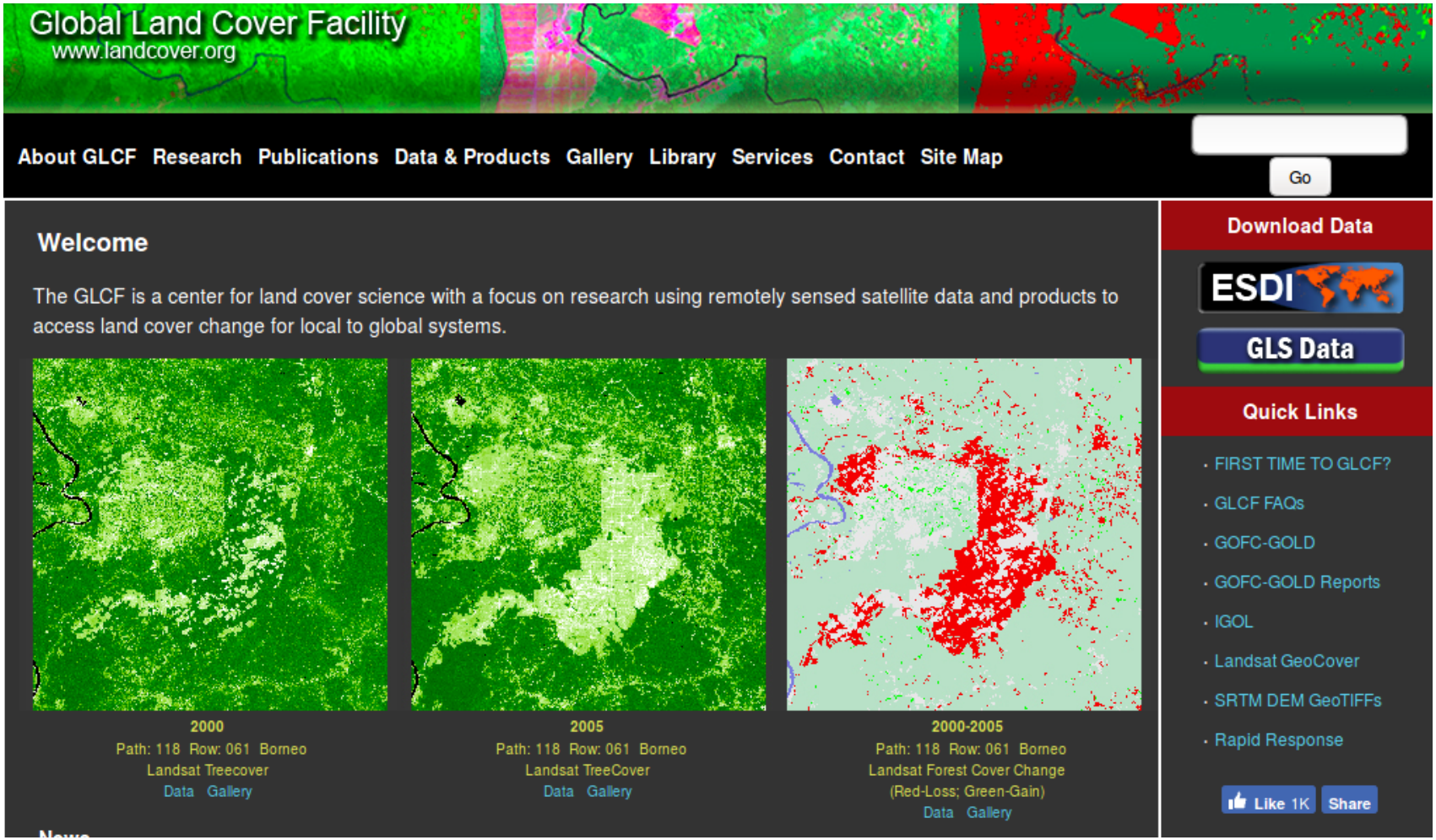
https://earthdata.nasa.gov/ - NASA [National Aeronautics and Space Administration] MODerate resolution Imaging Spectroradiometer

The USGS site



http://earthexplorer.usgs.gov/

The Global Land Cover Facility

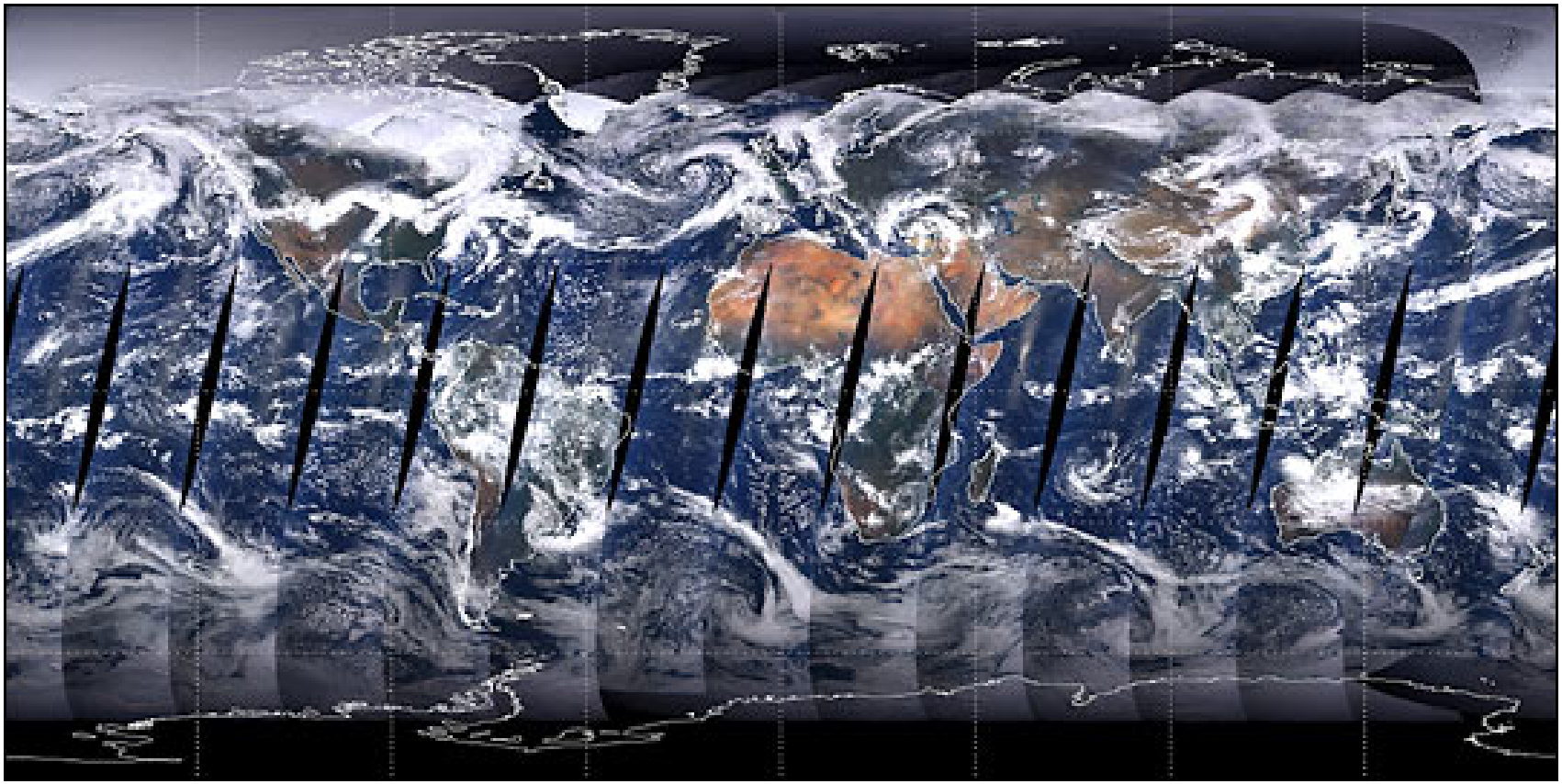


http://glcf.umd.edu/

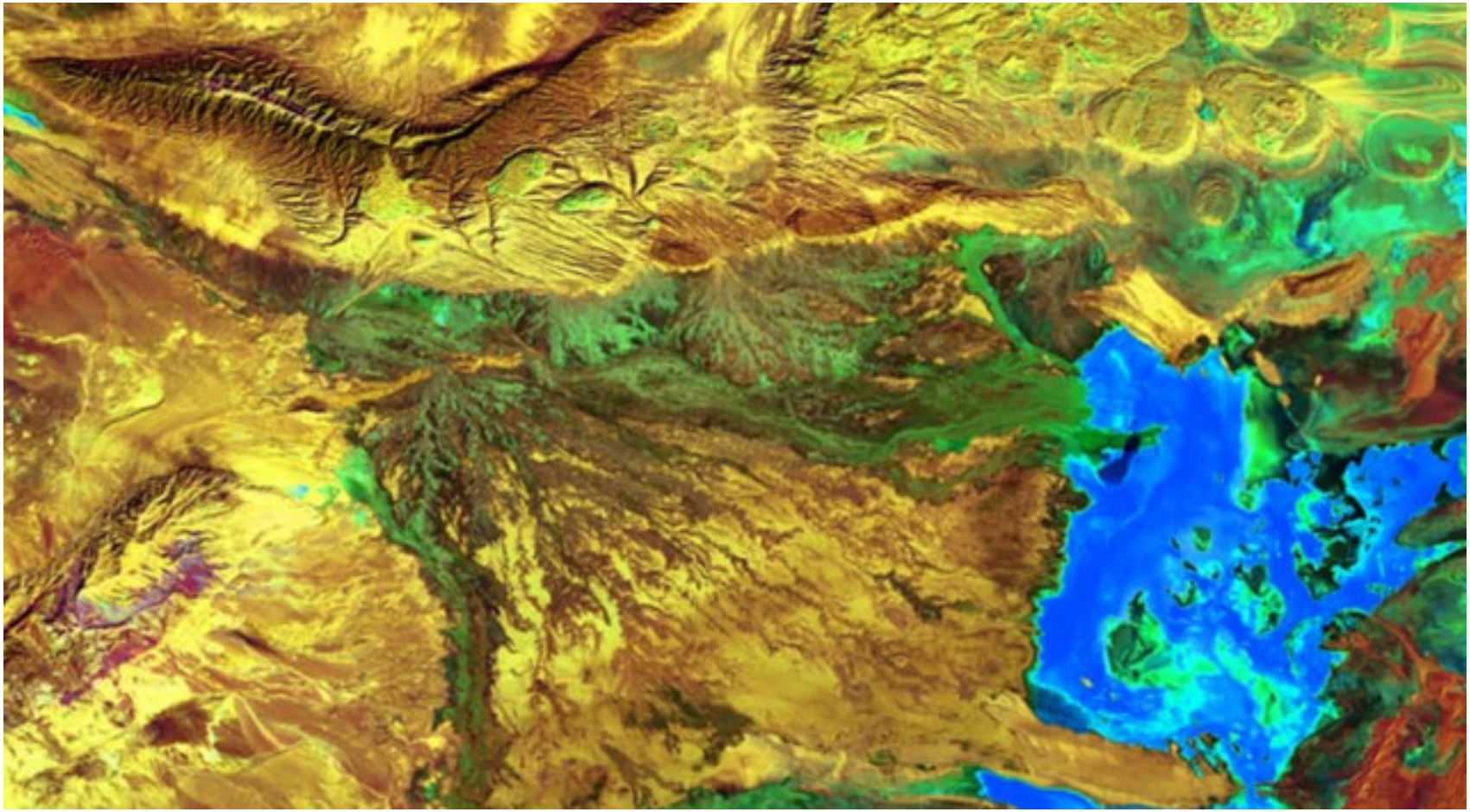
The Global Land Cover Facility

http://glcf.umd.edu/

Different types of sensors....the MODIS program

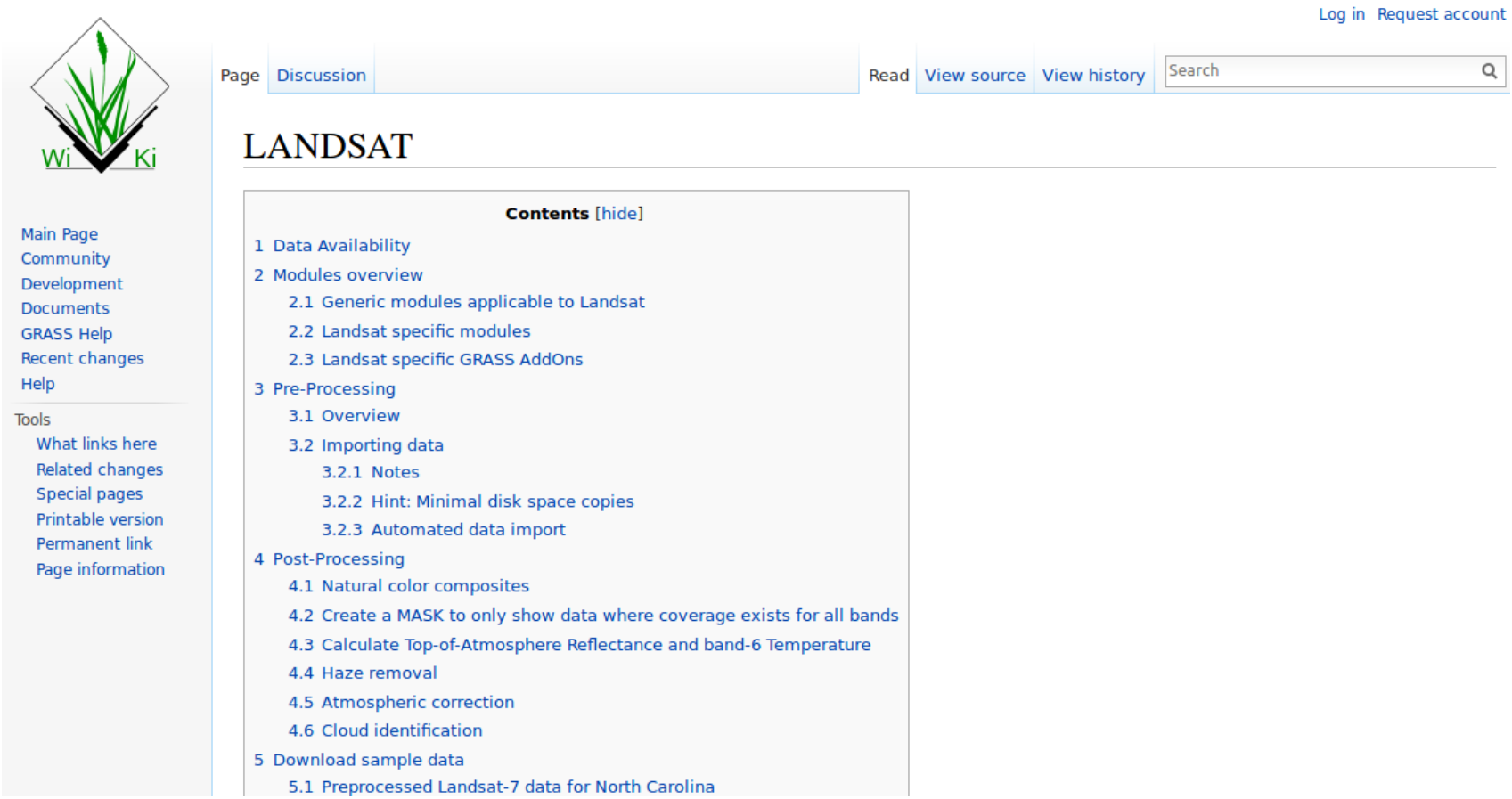


Different types of sensors....the Landsat program



Different types of sensors....the Landsat program

Different types of sensors....the Landsat program



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LANDSAT

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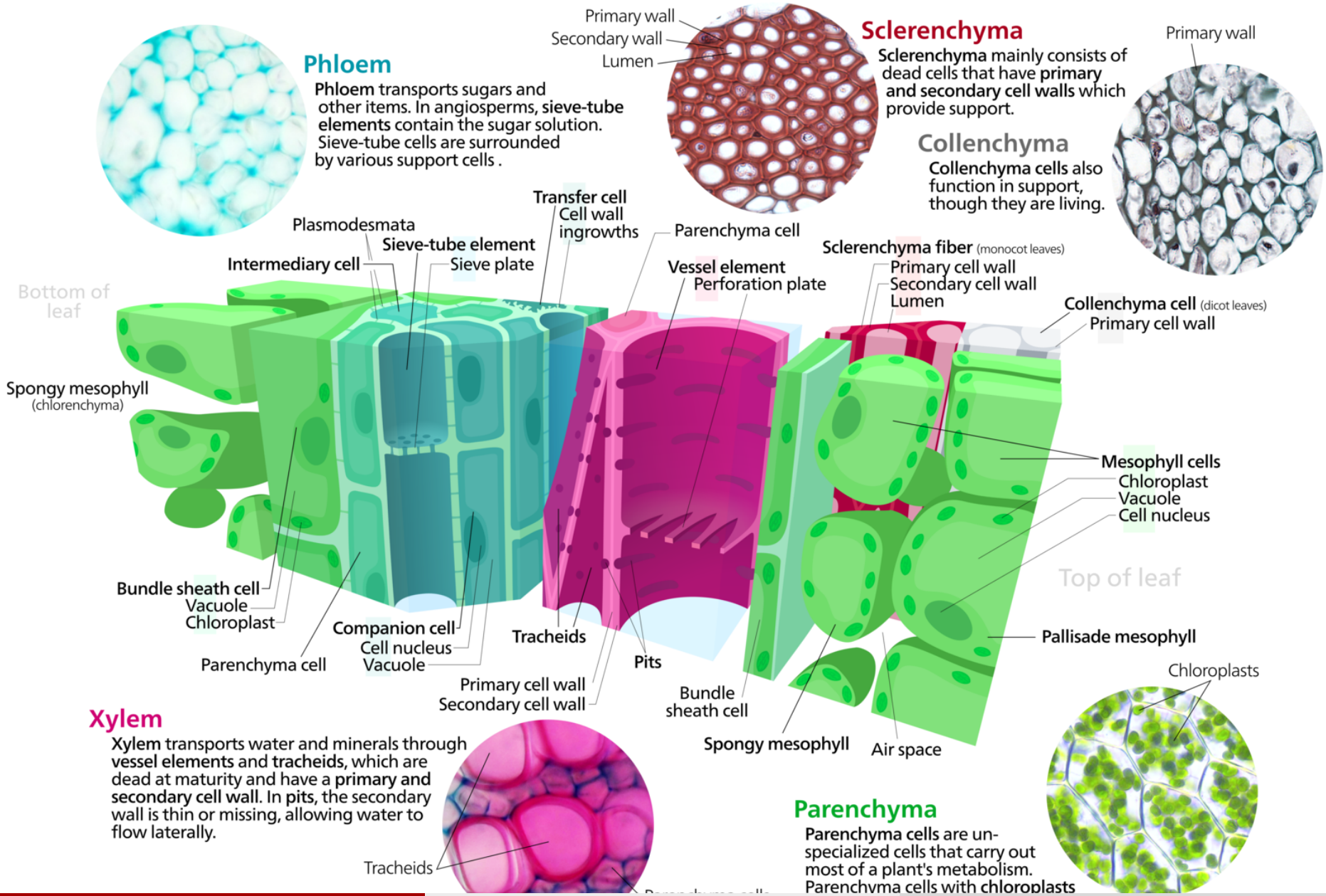
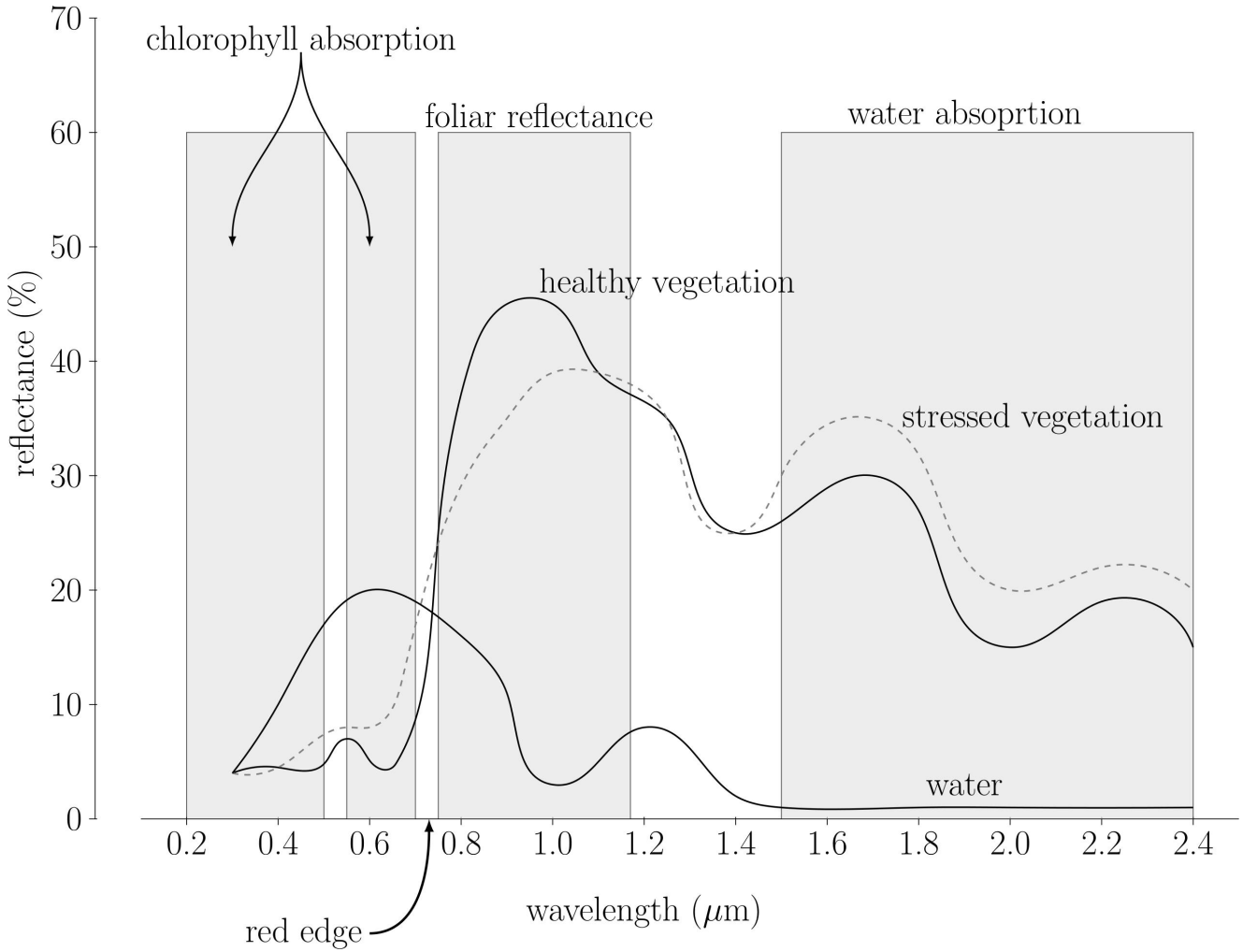
Different types of sensors....Quickbird

Outline

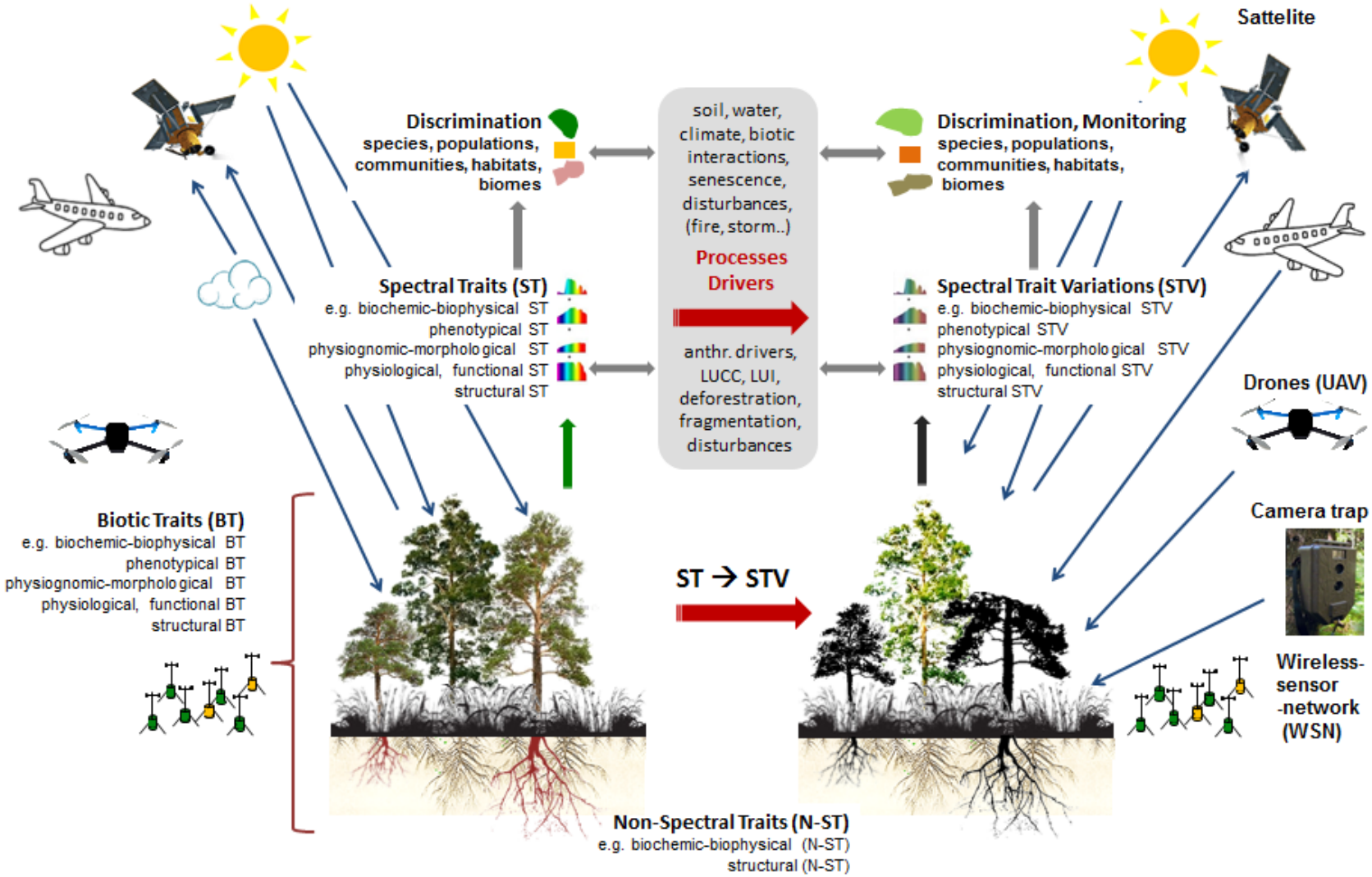
Ecosystem structure



Spectral signatures

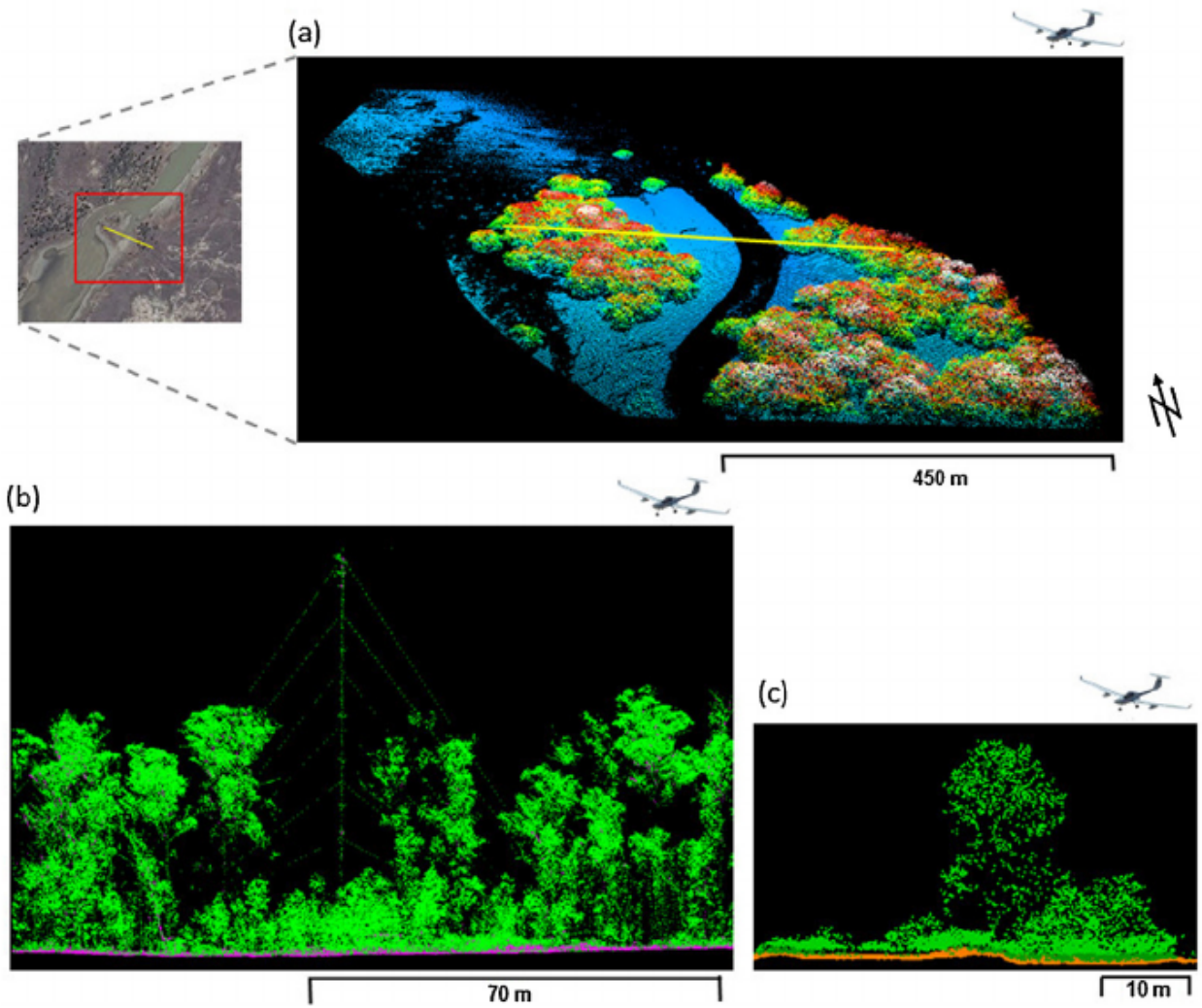


Ecosystem structure



Lausch et al. (Ecol. Indic., 2016)

Ecosystem structure

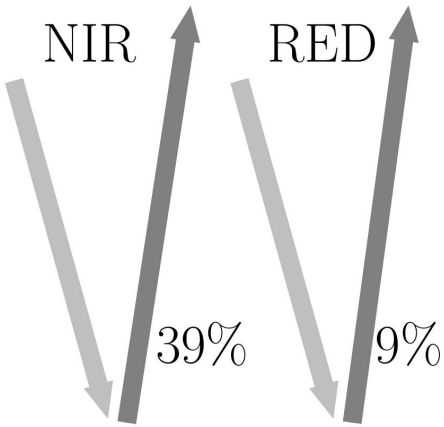


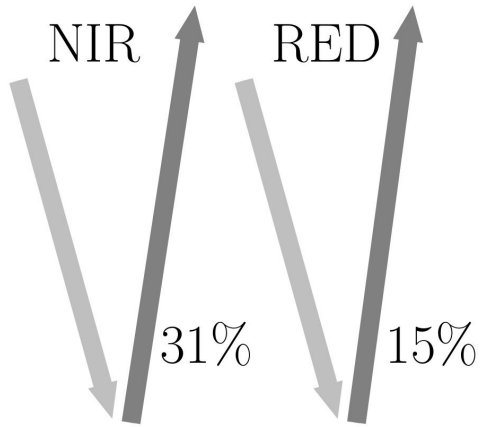
Lausch et al. (Ecol. Indic., 2016)

Vegetation indices

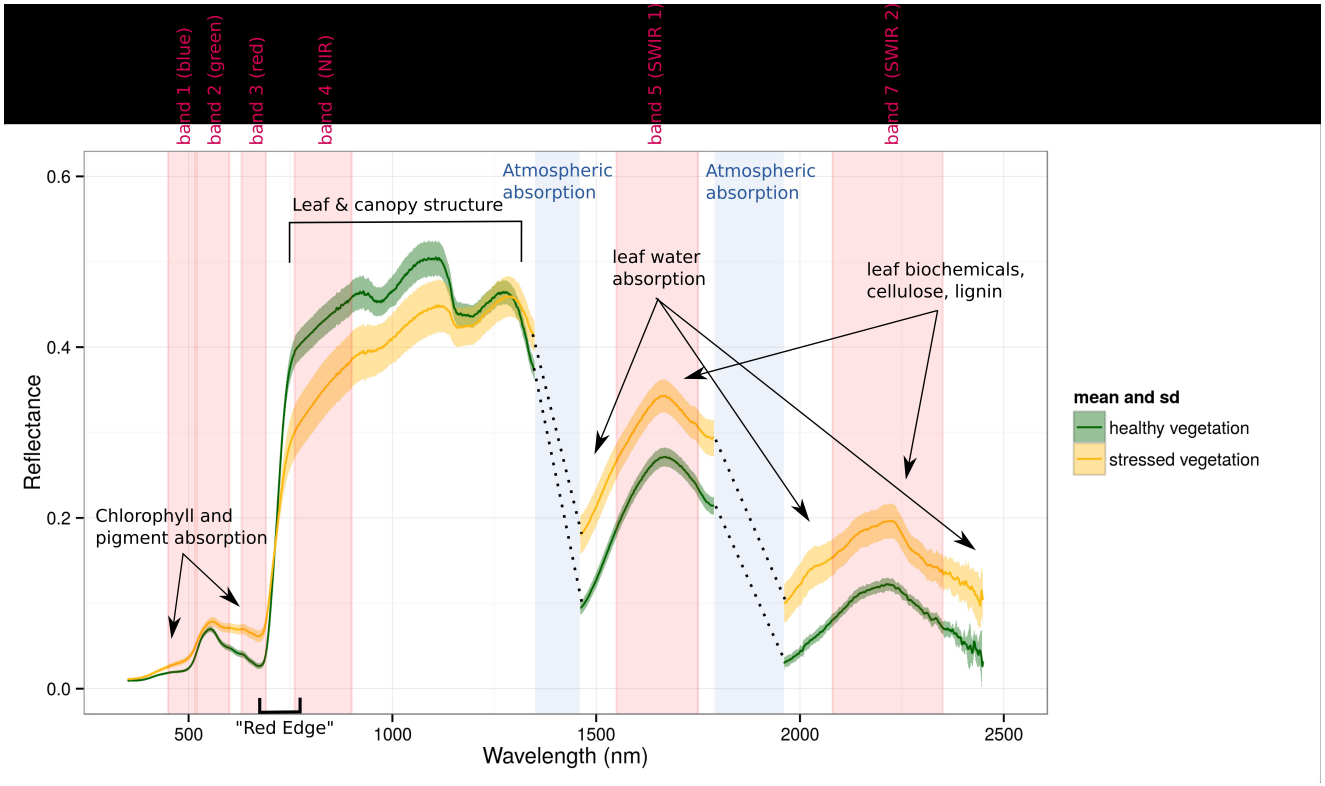
$$\frac{NIR - RED}{NIR + RED} = \mathbf{NDVI}$$

$$\frac{0.39 - 0.09}{0.39 + 0.09} = \mathbf{0.63} \qquad \frac{0.31 - 0.15}{0.31 + 0.15} = \mathbf{0.35}$$

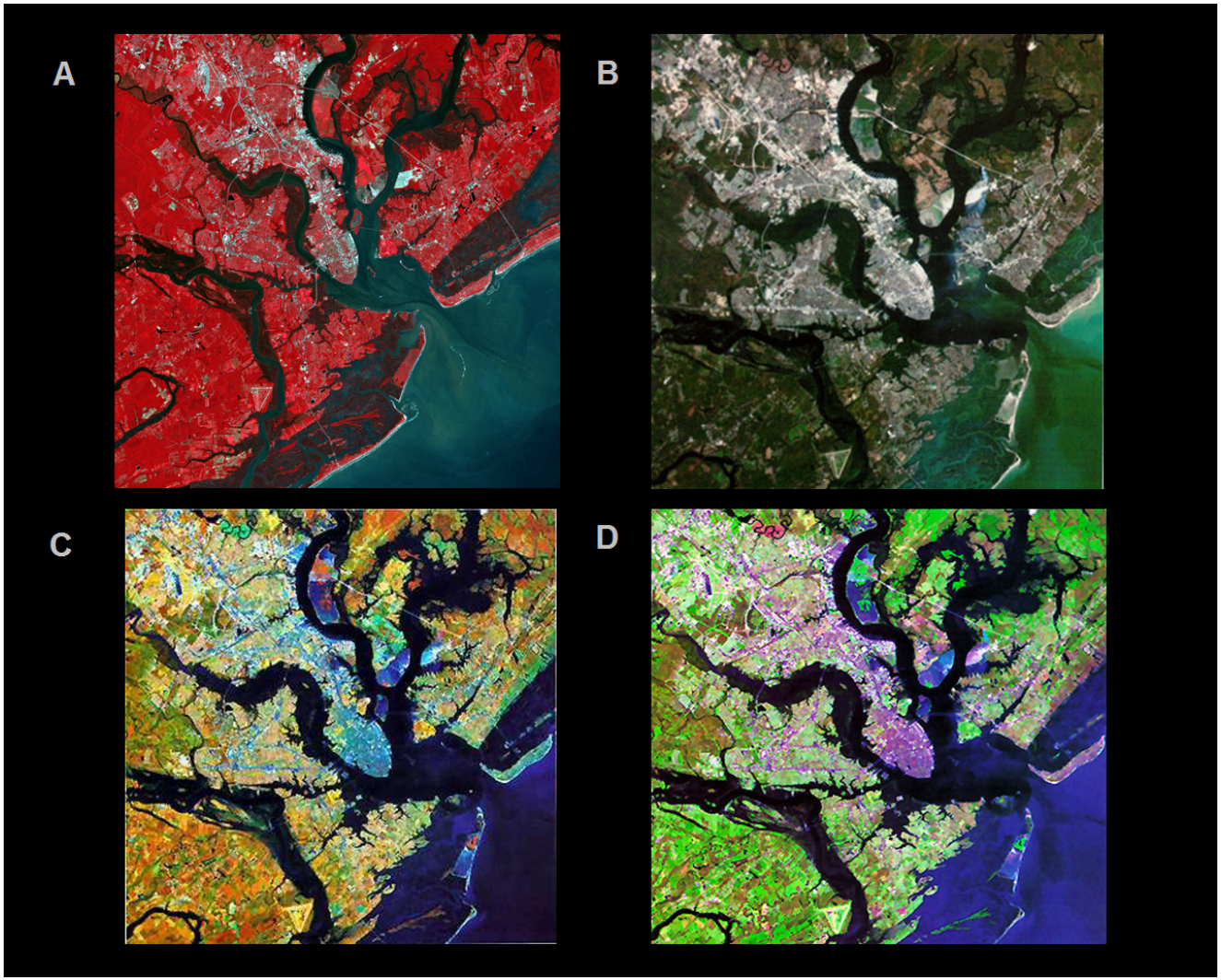




Monitoring changes in ecosystem structure in time

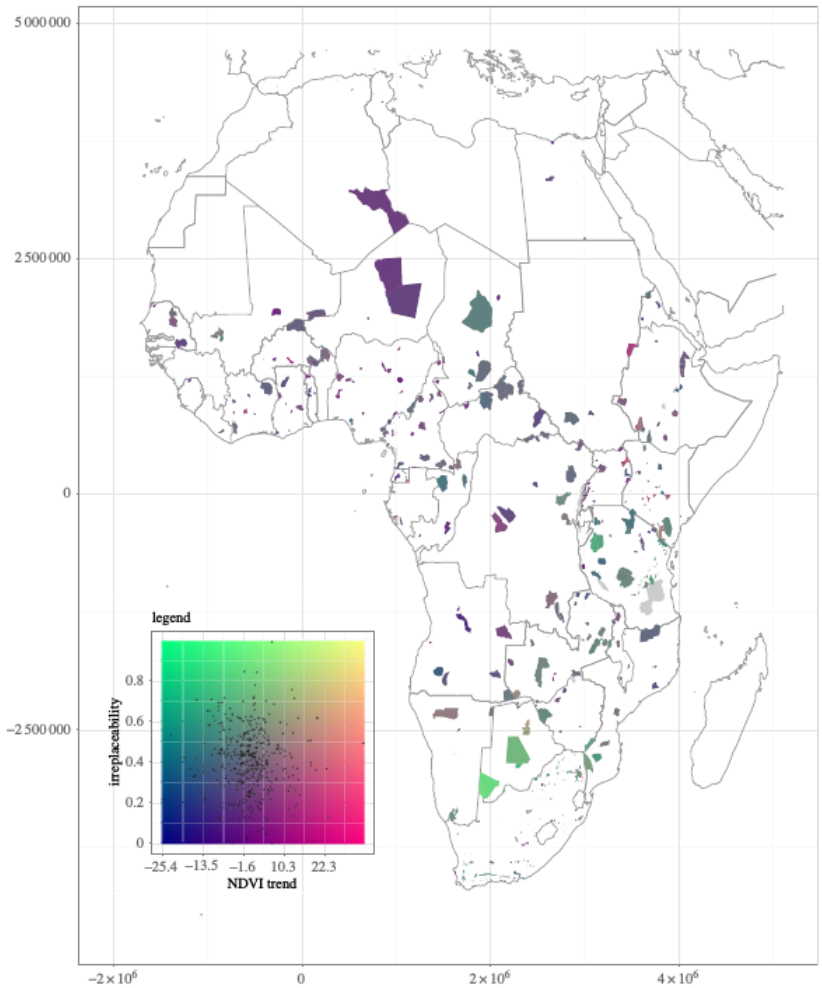


Colour composites



Outline

Indirect RS: ancillary data



Wegmann, M., Santini, L., Leutner, B., Safi, K., Rocchini, D., Bevanda, M., Latifi, H., Dech, S., Rondinini, C. (2014). Role of African protected areas in maintaining connectivity for large mammals. **Philosophical Transactions of the Royal Society B-Biological Sciences**, 369: 20130193.

Tiger mosquito spread

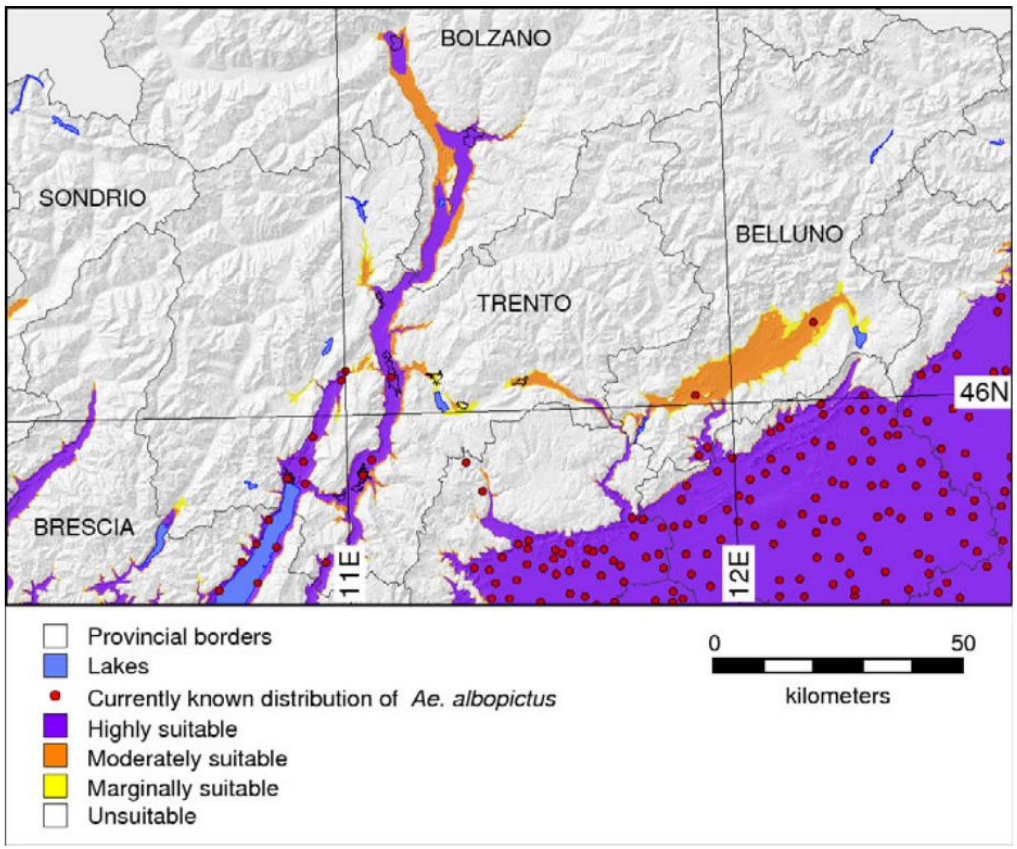
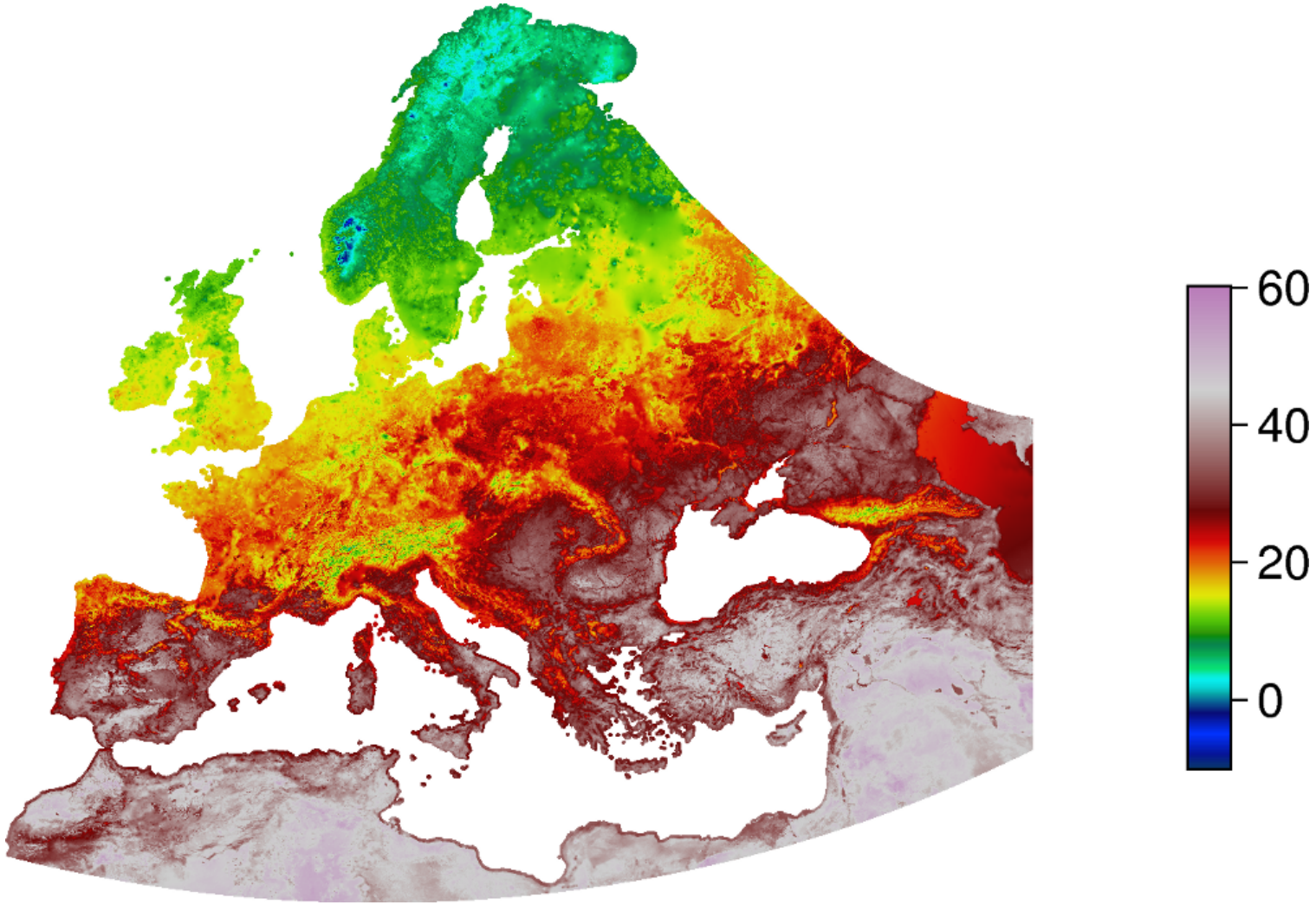


Figure 3 Habitat suitability map of *Ae. albopictus* in north-eastern Italy. The map is based on classified summary of egg winter survival, annual adult survival, and the areas of successful life cycle completion (see also explanations for Figure 2).

(Neteler et al., Int. J. Health Geogr., 2011)

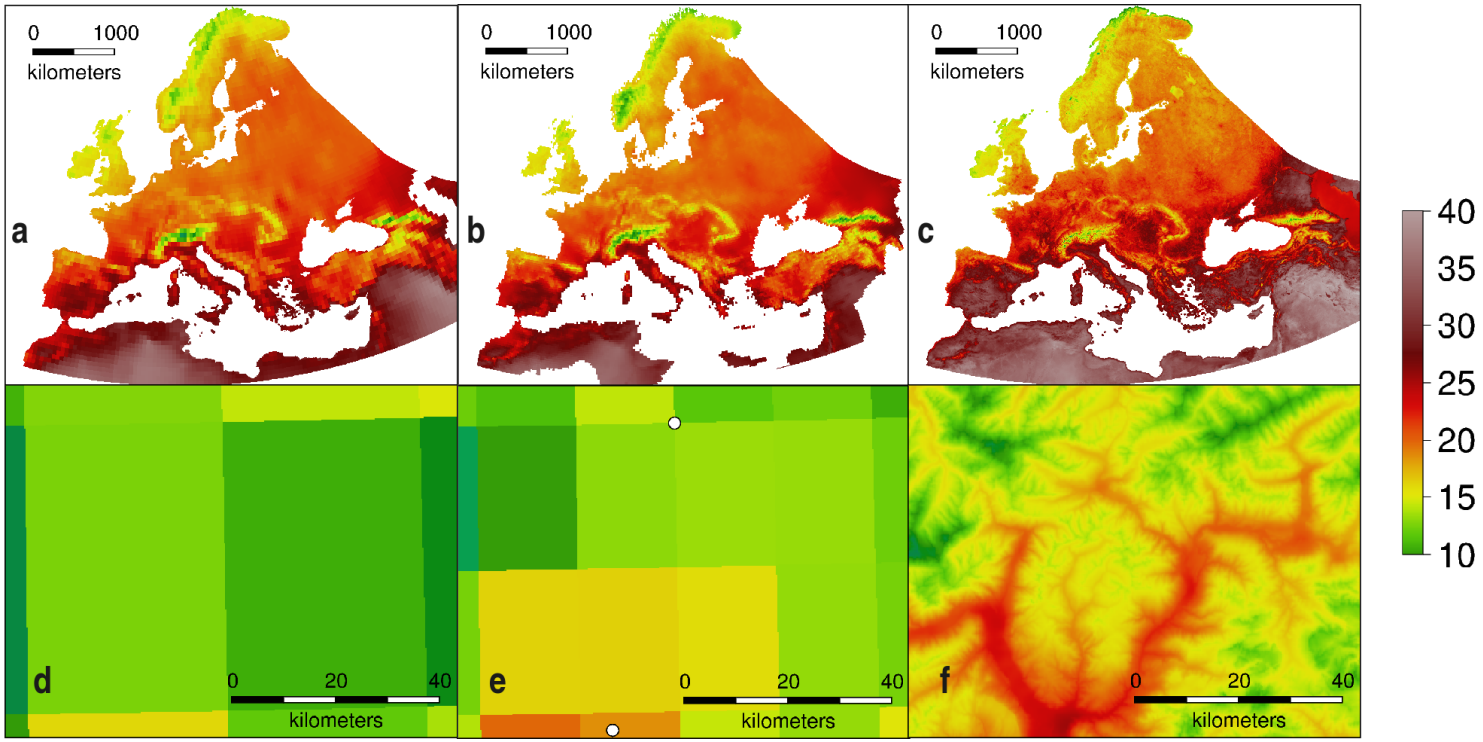
MODIS daily temperatures



Metz, M., Rocchini, D., Neteler, M. (2014). Surface Temperatures at the Continental Scale: Tracking Changes with Remote Sensing at Unprecedented Detail. Remote Sensing, 6: 3822-3840.

MODIS daily temperatures

http://gis.cri.fmach.it/eurolst-bioclim/



CRU TS 3.1 ECA&D 5.0 MODIS v005

Metz, M., Rocchini, D., Neteler, M. (2014). Surface Temperatures at the Continental Scale: Tracking Changes with Remote Sensing at Unprecedented Detail. Remote Sensing, 6: 3822-3840.

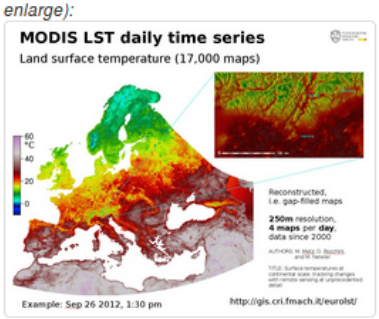
LST site

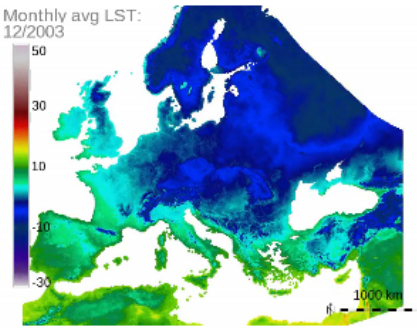
EuroLST

a seamless and gap-free daily European maps of temperatures

The new EuroLST dataset is **seamless and gap-free with a temporal resolution of four records per day and enhanced spatial resolution of 250 m**. This newly developed reconstruction method has been applied to Europe and neighbours countries, resulting in complete daily coverage from 2001 on. To our knowledge, this new reconstructed LST time series exceeds the level of detail of comparable reconstructed LST datasets by several orders of magnitude. Studies on emerging diseases, parasite risk assessment and temperature anomalies can now be performed on the continental scale, maintaining high spatial and temporal detail. In their paper, the authors provide examples for implications and applications of the new LST dataset, such as disease risk assessment, epidemiology, environmental monitoring, and temperature anomalies.

Reconstructed MODIS Land Surface Temperature Dataset, at 250m pixel resolution (click figure to enlarge):





Article and data citation:

EuroLST product of FEM-DBEM based on gap-free daily MODIS LST (Product of NASA) maps.

http://www.geodati.fmach.it/eurolst.html

Land use data and their potential in ecology

Biodiversity and Conservation **13:** 2599–2621, 2004.

Mapping the spatial distribution of plant diversity indices in a tropical forest using multi-spectral satellite image classification and field measurements

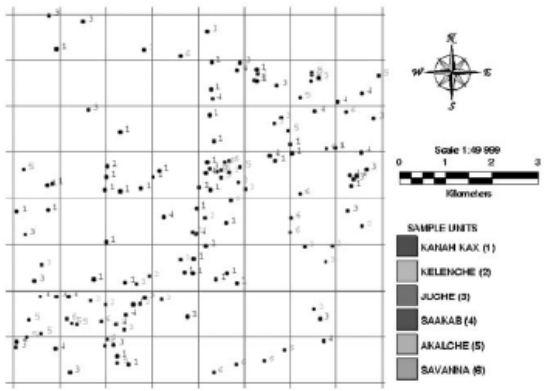
J. LUIS HERNANDEZ-STEFANONI[1] and RAUL PONCE-HERNANDEZ[1,2,*]

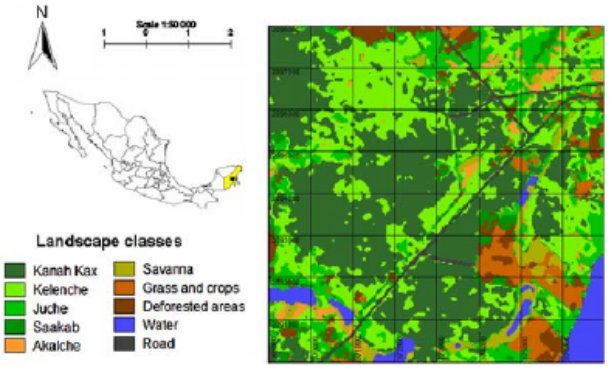
Biodivers Conserv (2007) 16:3817–3833
DOI 10.1007/s10531-007-9182-6

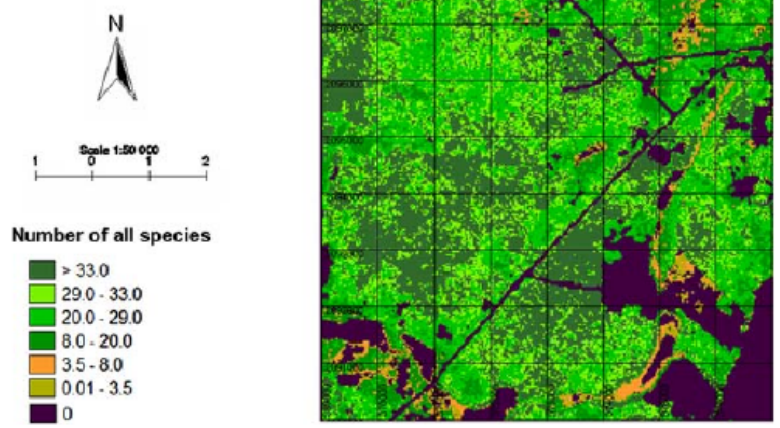
ORIGINAL PAPER

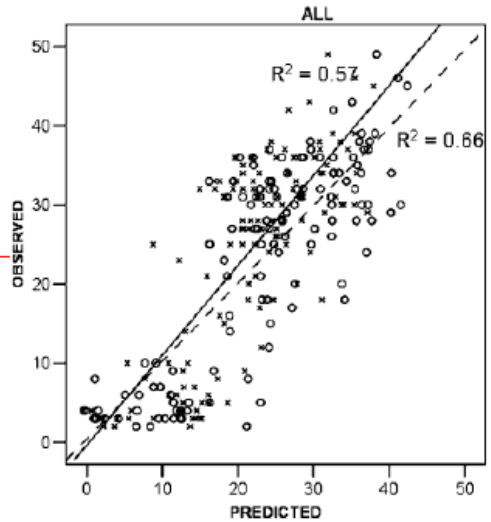
Mapping species density of trees, shrubs and vines in a tropical forest, using field measurements, satellite multiespectral imagery and spatial interpolation

J. Luis Hernández-Stefanoni · Juan Manuel Dupuy

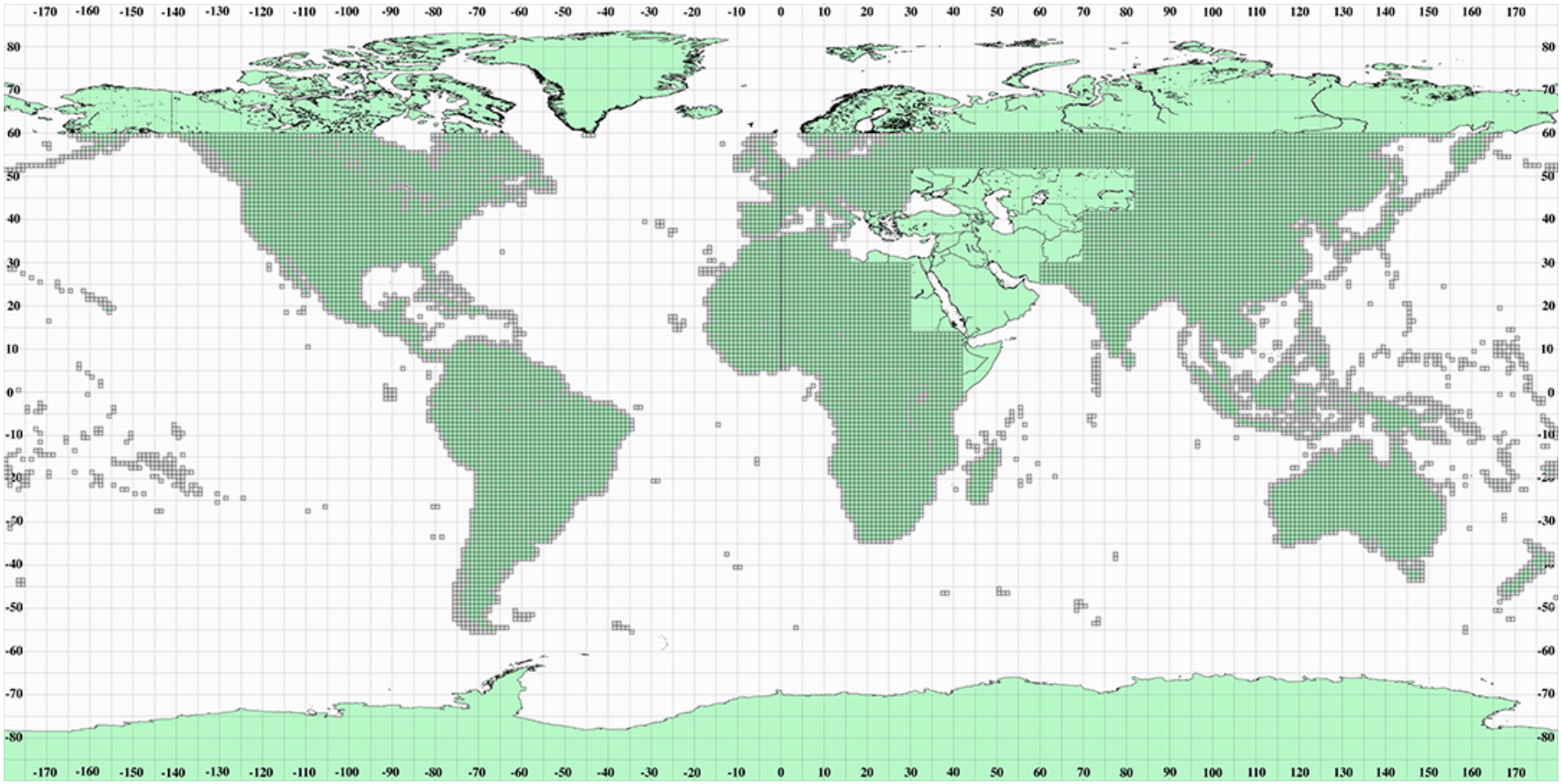








Deriving elevation from RS data: the Shuttle Radar Topography Mission (SRTM)



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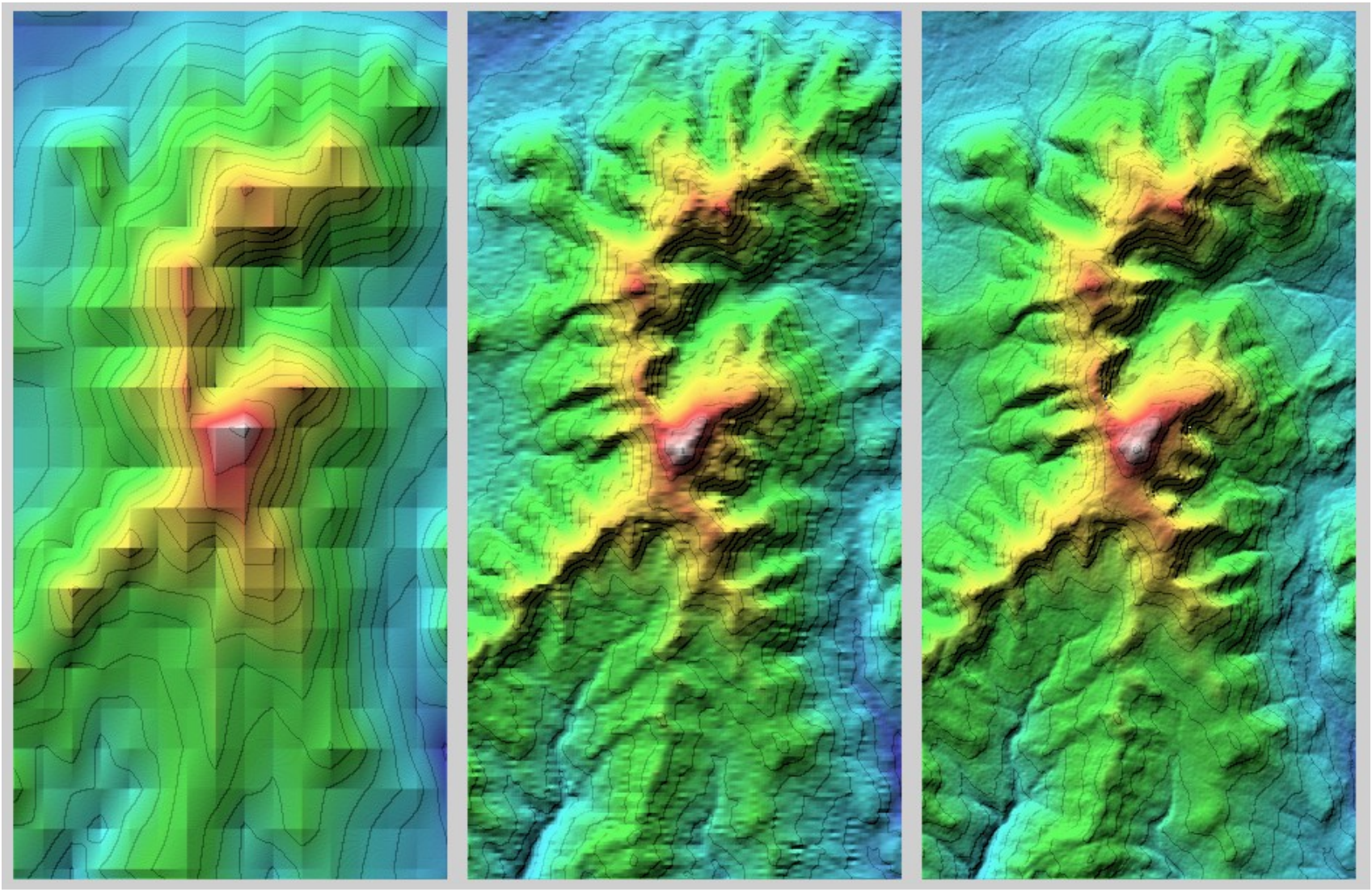


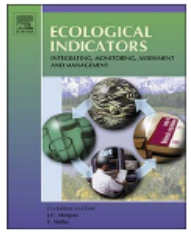
RS heterogeneity

Ecological Indicators 85 (2018) 983–990

Contents lists available at ScienceDirect

Ecological Indicators

journal homepage: www.elsevier.com/locate/ecolind



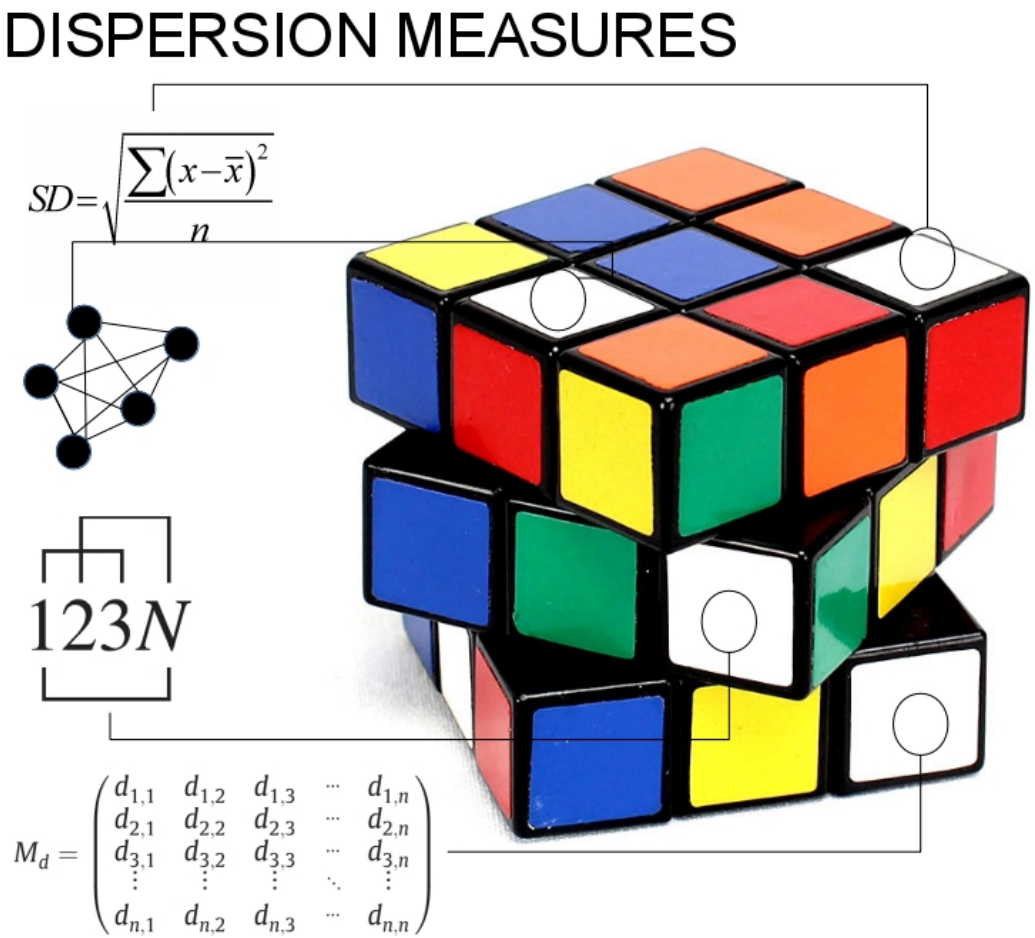
Brief article

Remotely sensed spatial heterogeneity as an exploratory tool for taxonomic and functional diversity study

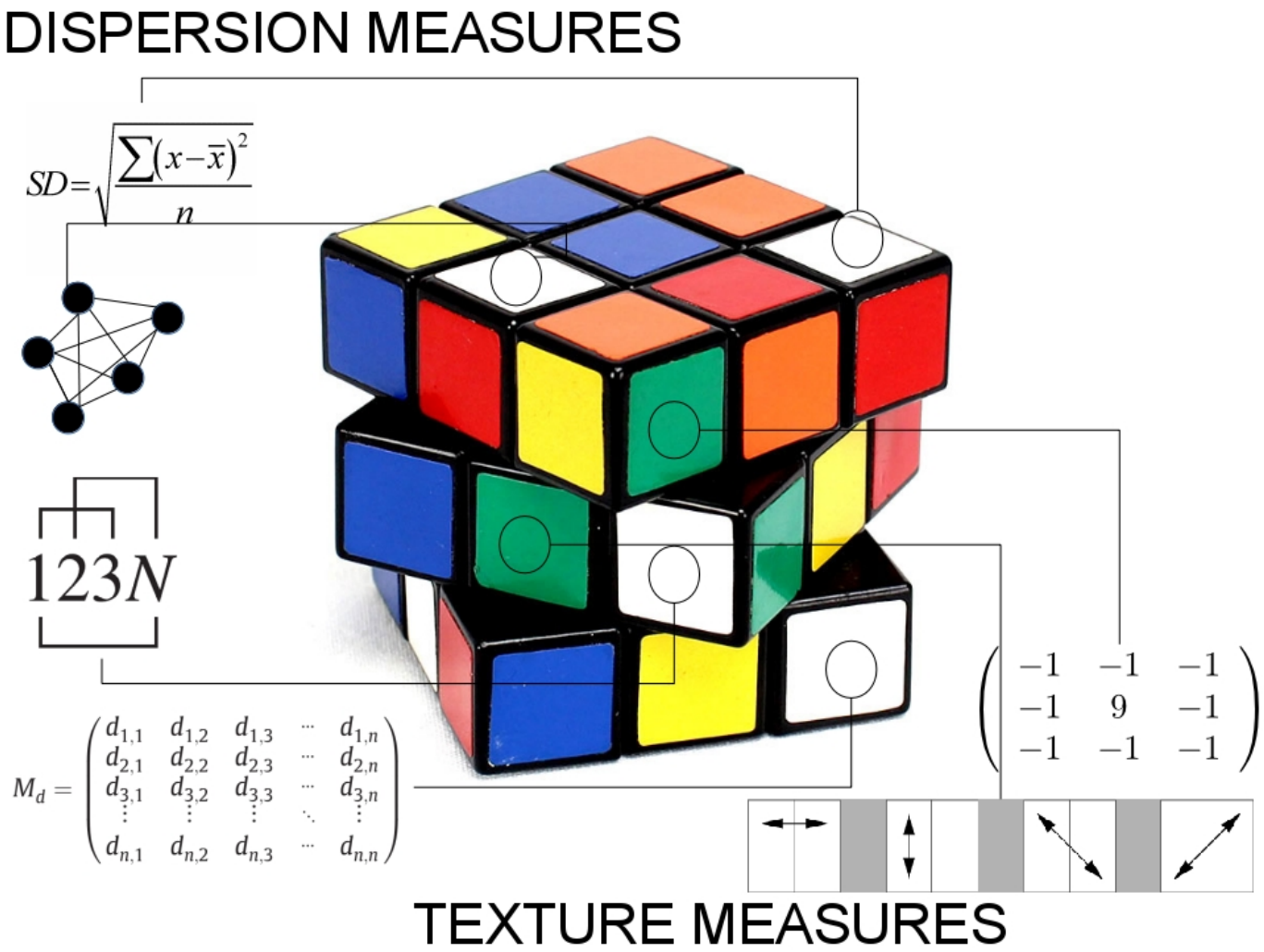
Duccio Rocchini[a,b,c,*], Giovanni Bacaro[d], Gherardo Chirici[e], Daniele Da Re[d], Hannes Feilhauer[f], Giles M. Foody[g], Marta Galluzzi[e], Carol X. Garzon-Lopez[h], Thomas W. Gillespie[i], Kate S. He[j], Jonathan Lenoir[k], Matteo Marcantonio[l], Harini Nagendra[m], Carlo Ricotta[n], Edvinas Rommel[o], Sebastian Schmidtlein[p], Andrew K. Skidmore[q,r], Ruben Van De Kerchove[s], Martin Wegmann[t], Benedetto Rugani[u]

RS heterogeneity

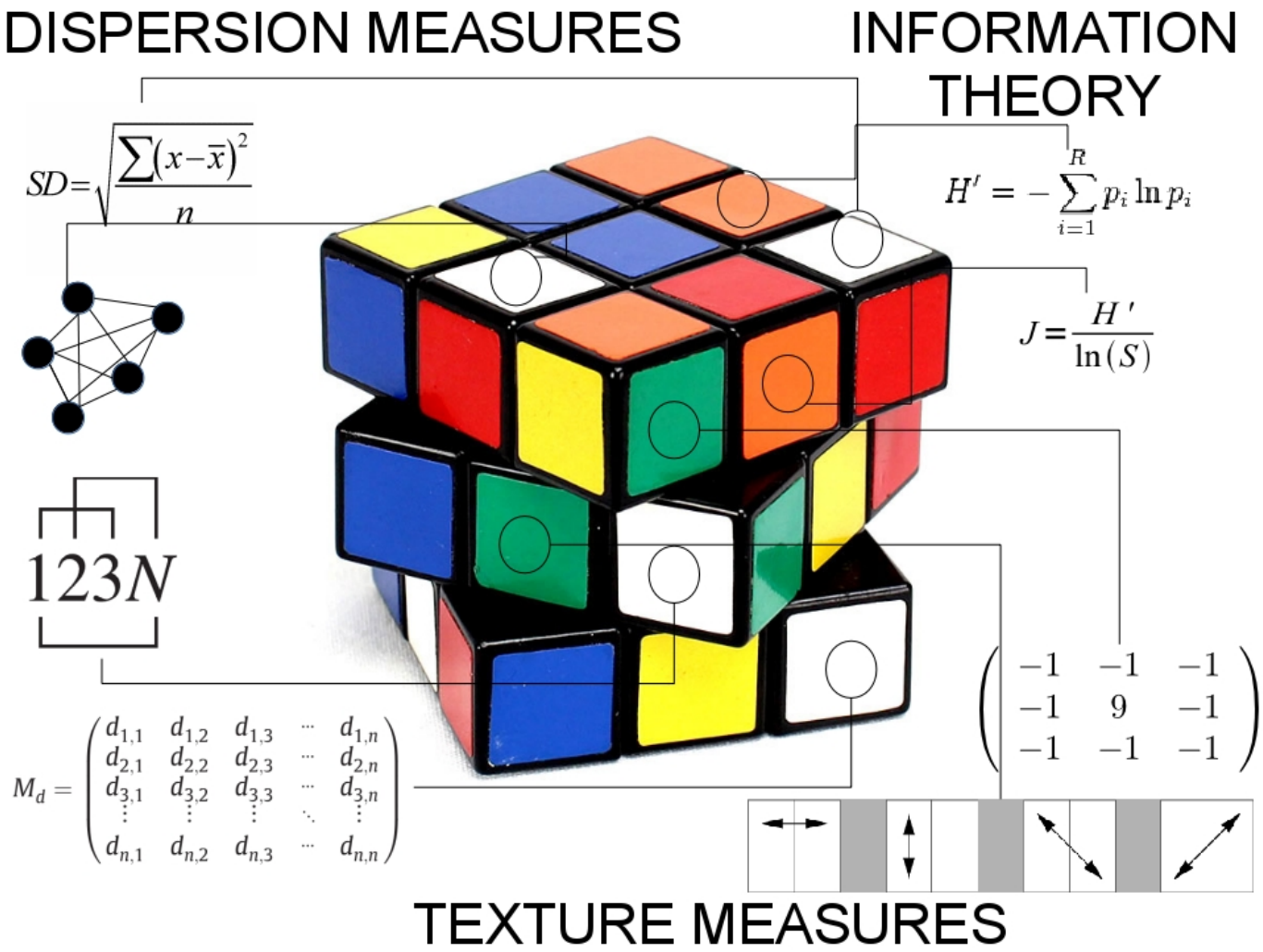
RS heterogeneity



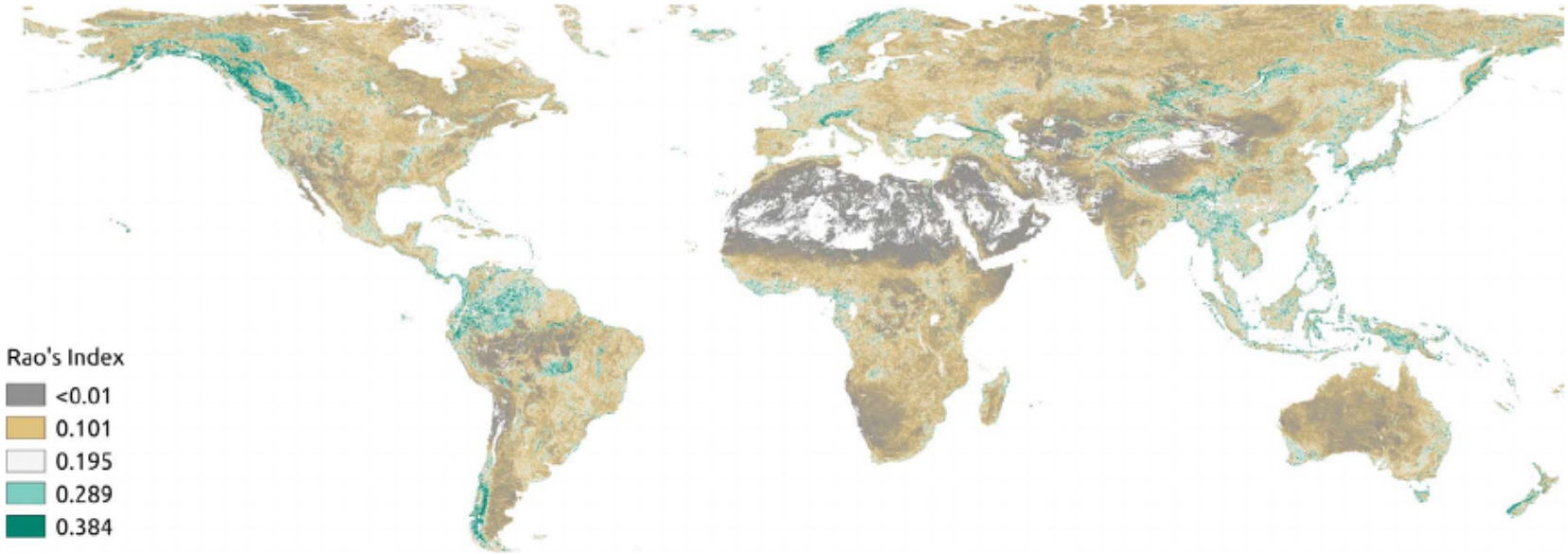
RS heterogeneity



RS heterogeneity



RS heterogeneity



Coding

R code
Introduction to remote sensing and GIS for ecological applications

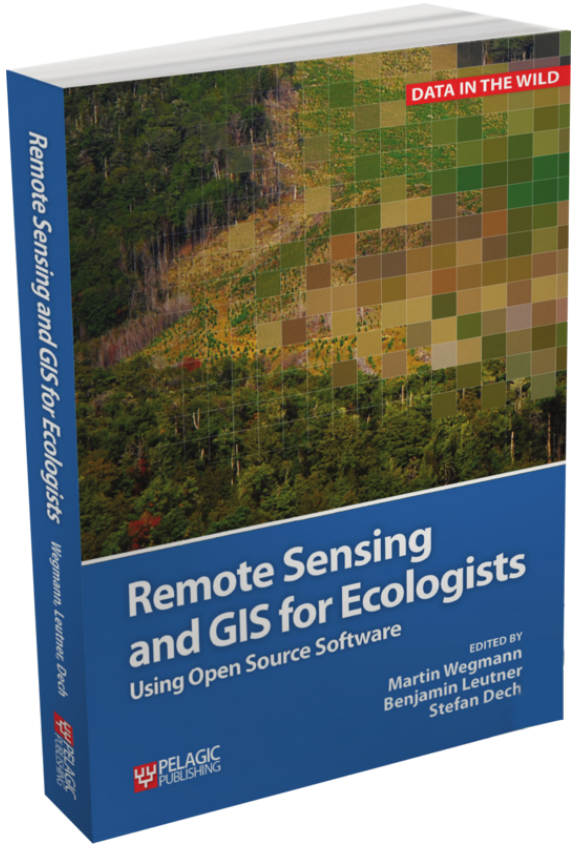
Duccio Rocchini

May 21, 2018

Coding

```
###- Functions:
https://github.com/bleutner/RStoolbox/tree/master/R

###- Data:
http://book.ecosens.org/software/rstoolbox/

###- Landsat bands
https://landsat.usgs.gov/what-are-band-designations-landsat-satellites

###- Code

install.packages("raster") #------ do the same for all packages to be recalled later on by library()

library(raster)
library(rgdal)
#  Geospatial Data Abstraction Library
library(RStoolbox)
library(ggplot2)
library(hexbin)

# 2011 image
p224r063_2011m <- brick("~/grassdata/data_book/raster_data/final/p224r63_2011_masked.grd")
```

Coding


DATA IN THE WILD
Remote Sensing and GIS for Ecologists
Using Open Source Software
EDITED BY
Martin Wegmann
Benjamin Leutner
Stefan Dech
PELAGIC PUBLISHING
Remote Sensing and GIS for Ecologists
Wegmann Leutner Dech
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