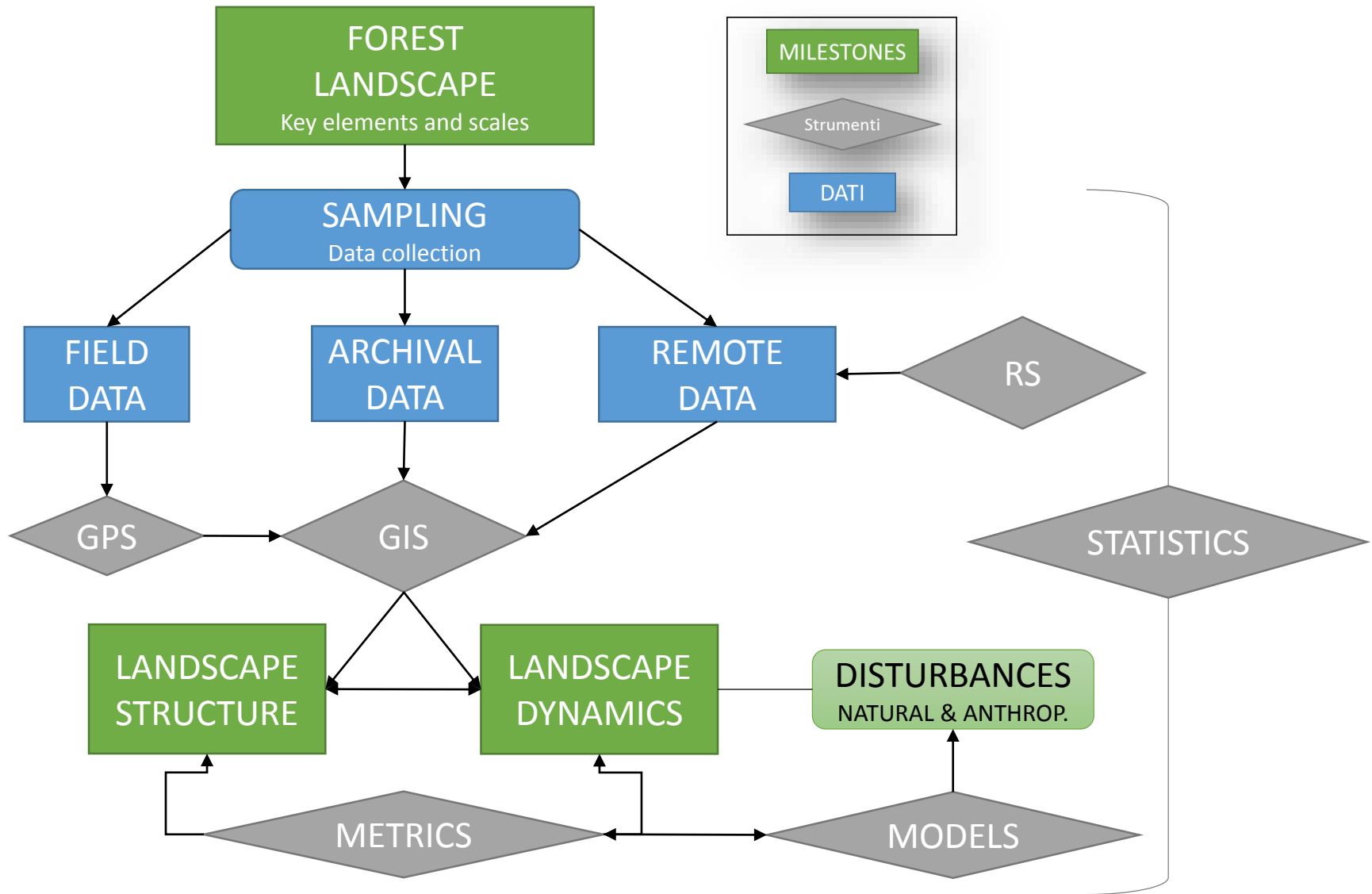


Tools, methods, data ...



Remote Sensing

FIRST METHODS



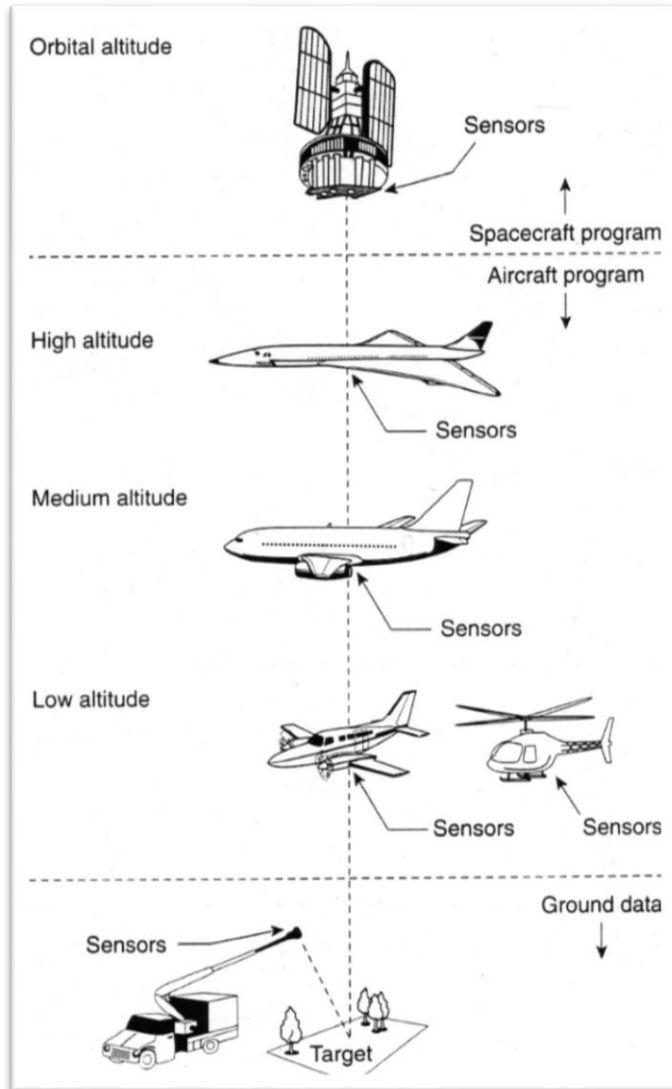
<http://employees.oneonta.edu/baumanpr/geosat2/RSHistory/HistoryRSPart1.htm>

1860-1910

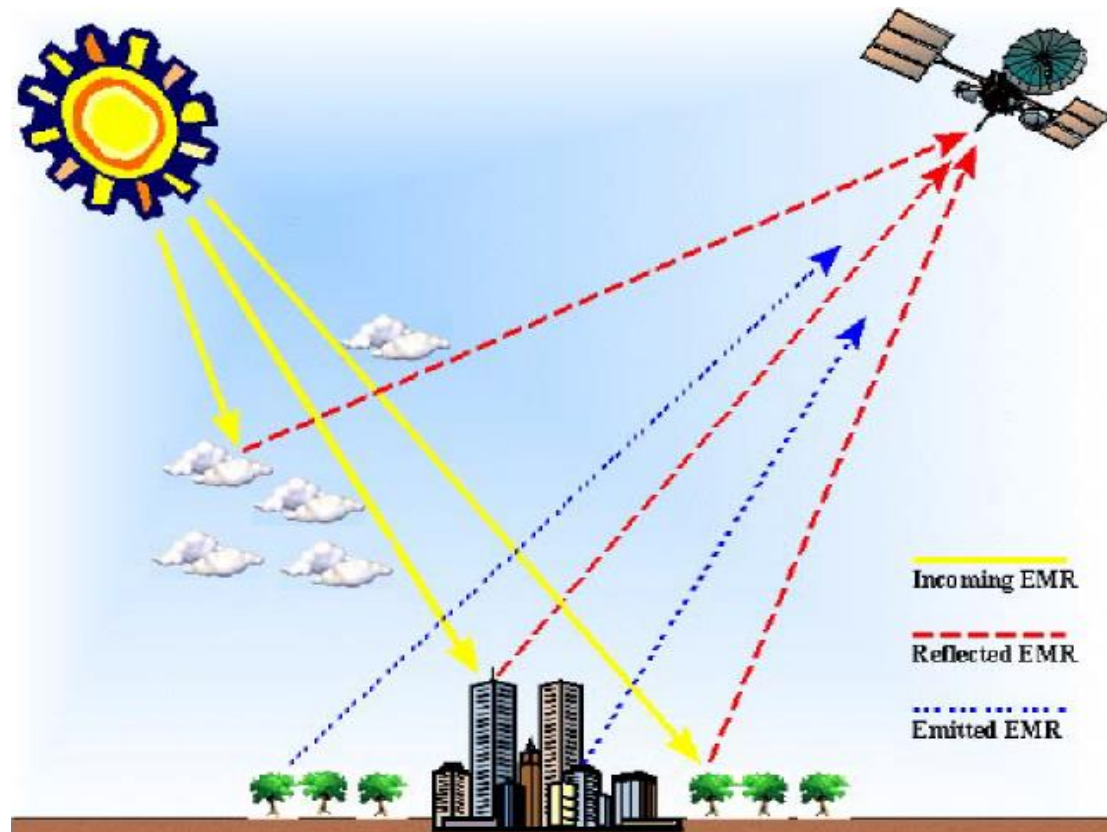


Remote Sensing

SENSORS & PLATFORMS

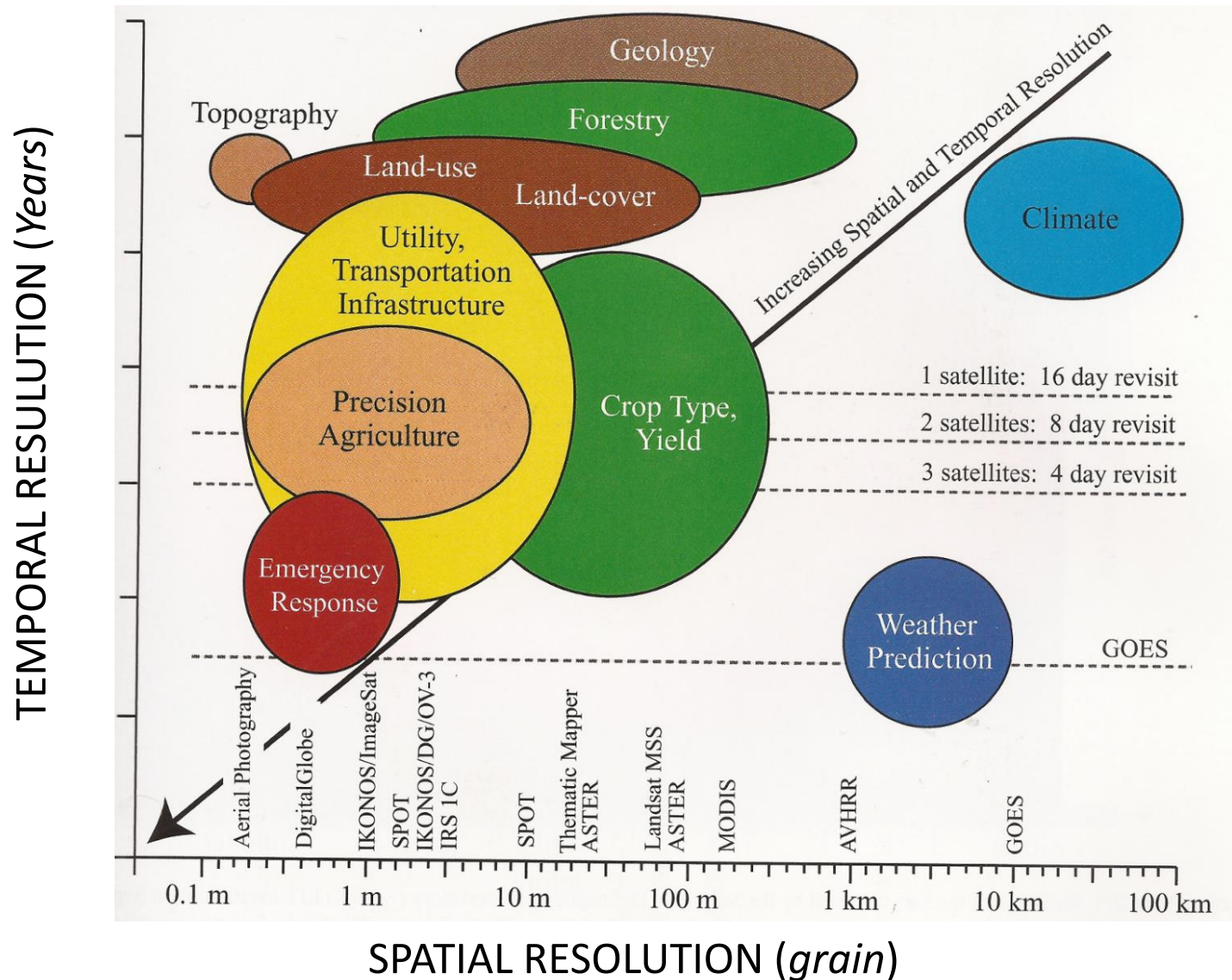


PASSIVE/ACTIVE SENSORS



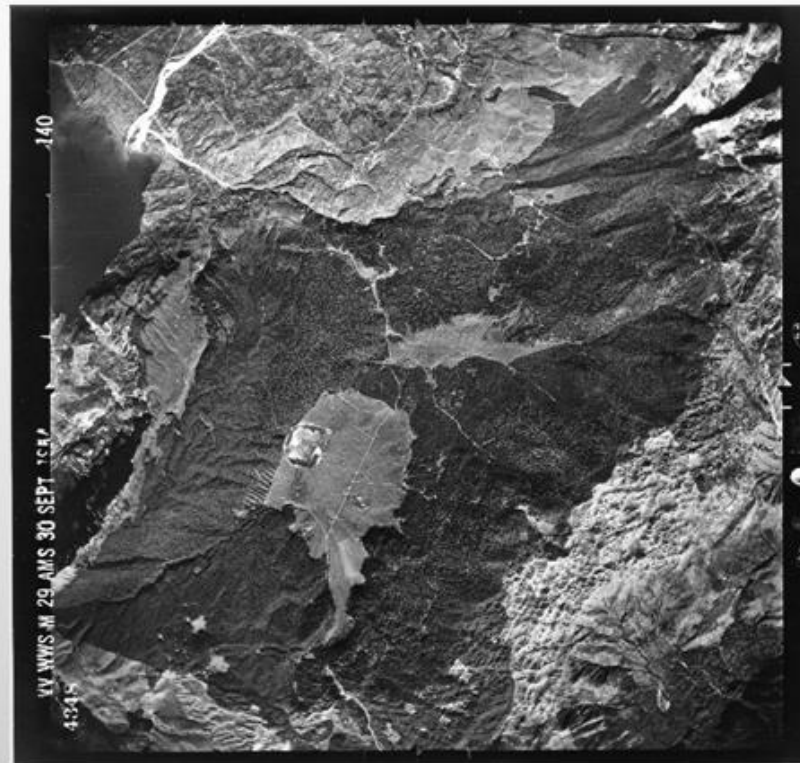
Remote Sensing

DATA SOURCES & RESOLUTIONS (Space/Time)

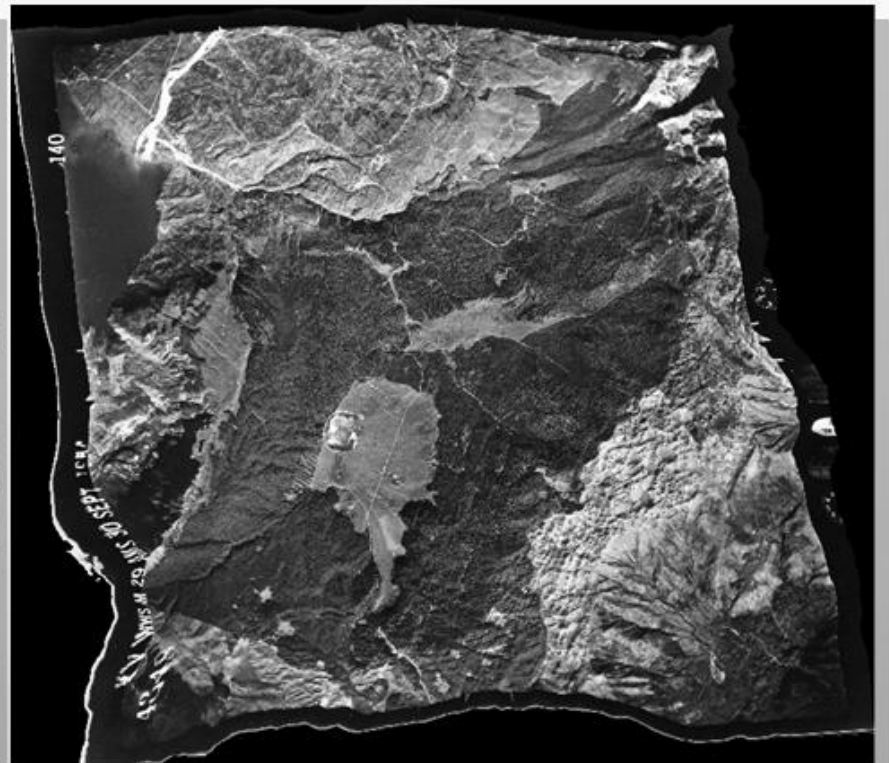


RS: Aerial Imagery

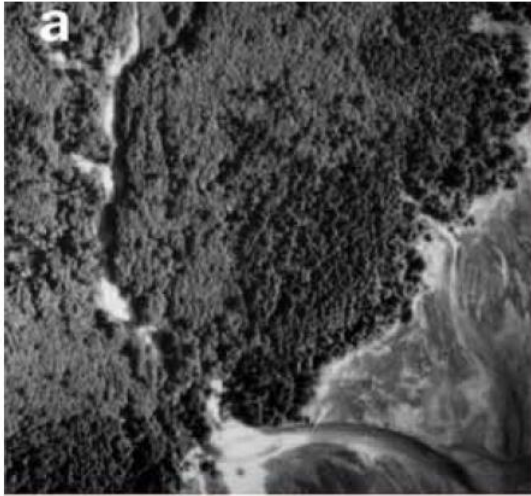
RAW IMAGE



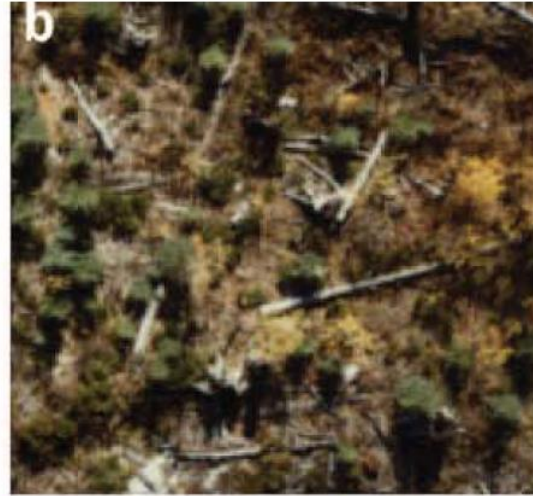
ORTHOIMAGE



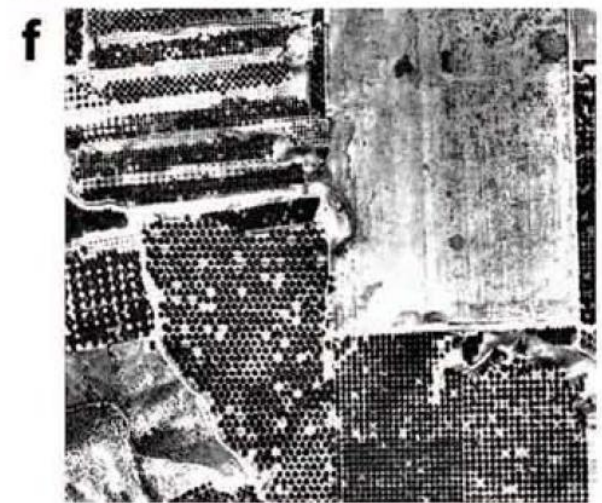
RS: Aerial Imagery



Tone



Color



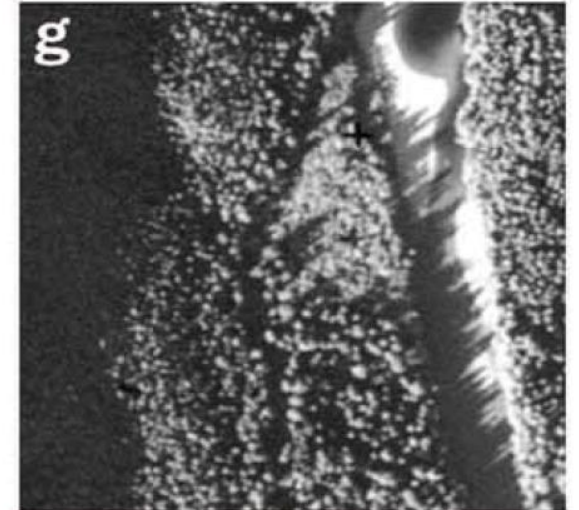
Pattern



Size



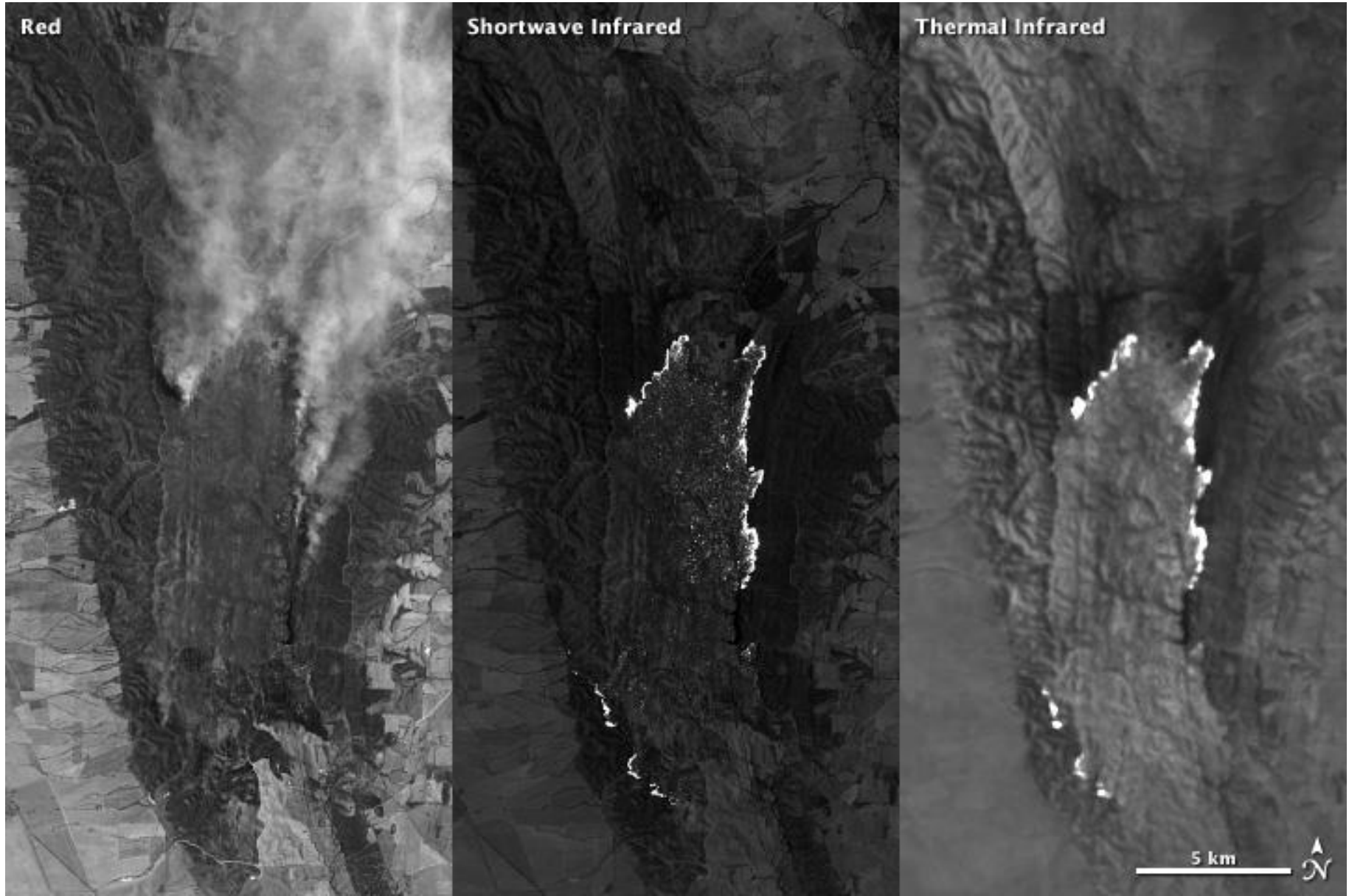
Shape



Shadow

RS: Satellite Imagery

MULTISPECTRAL APPROACH



R - G - B

fields

wetlands

city

10 km



NIR - R - G

fields

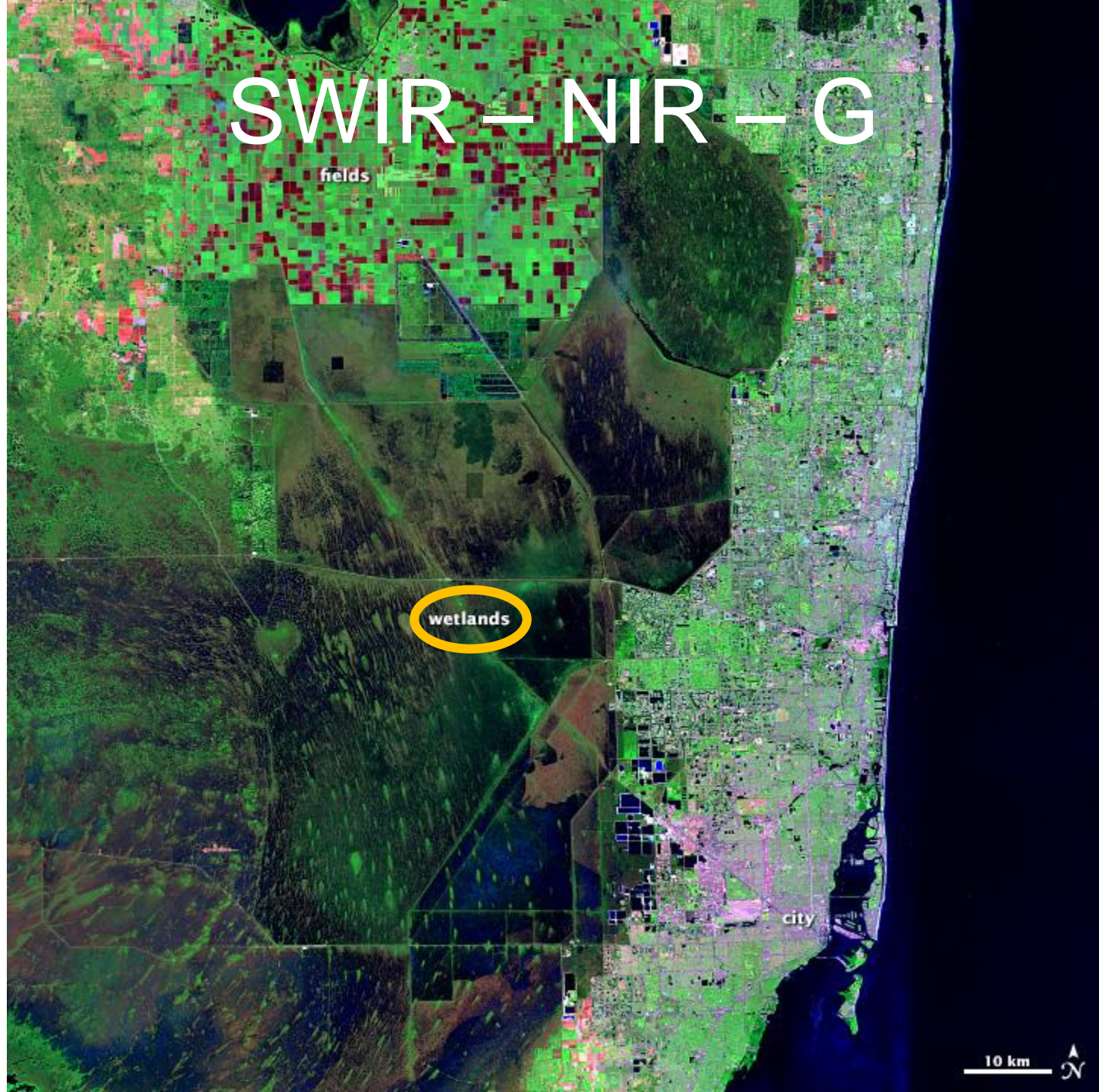
wetlands

city

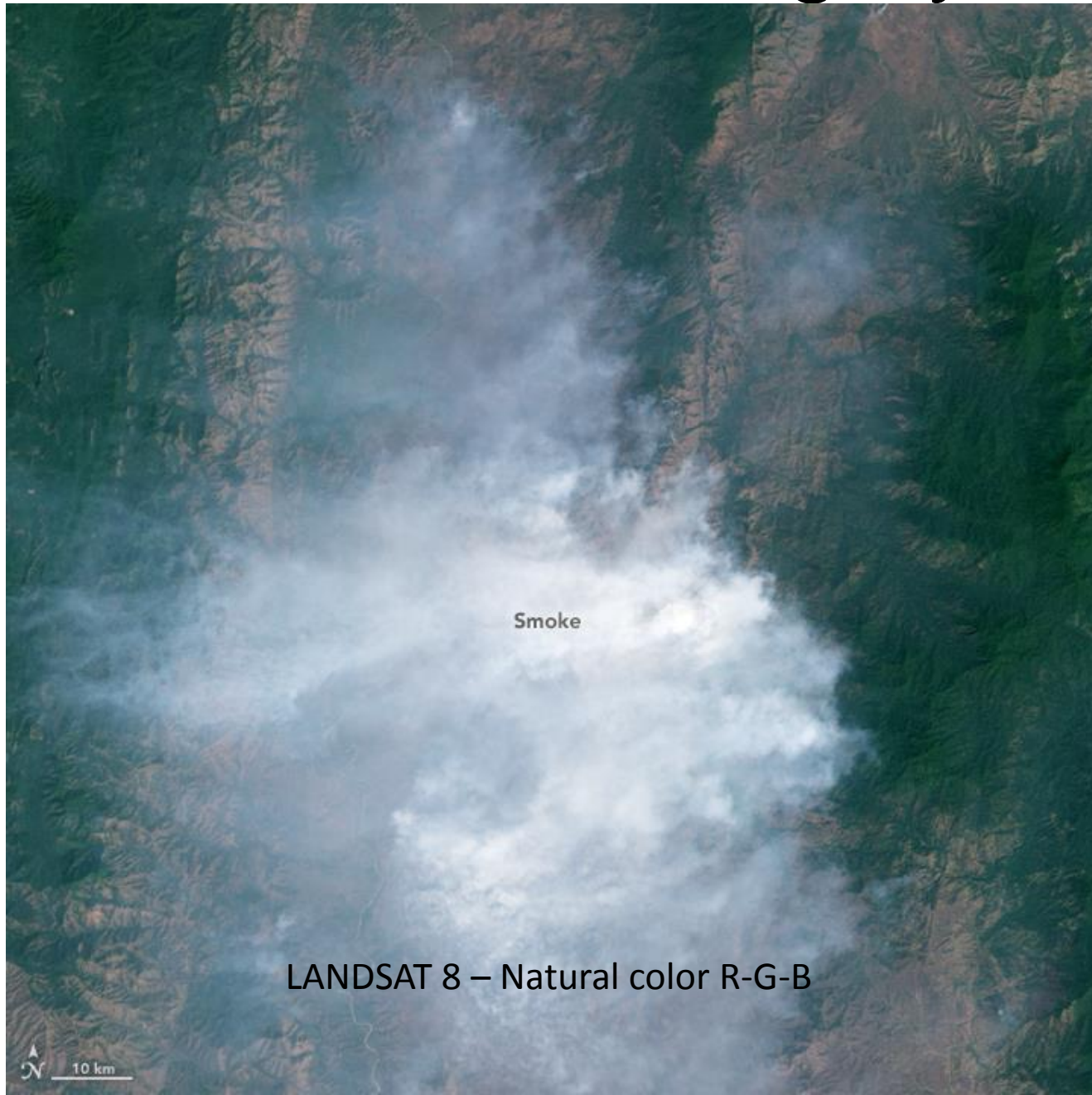
10 km



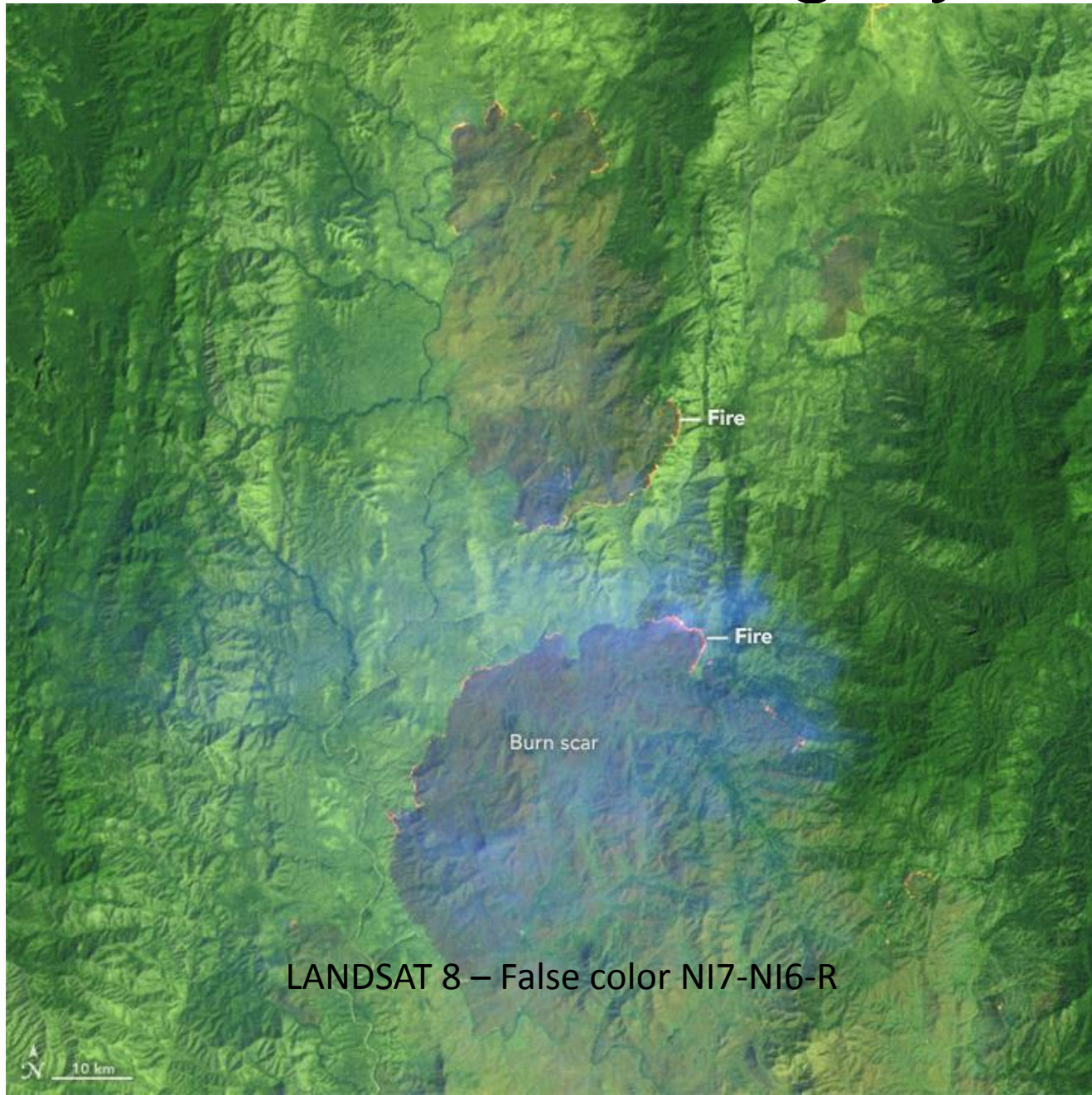
SWIR – NIR – G



RS: Satellite Imagery



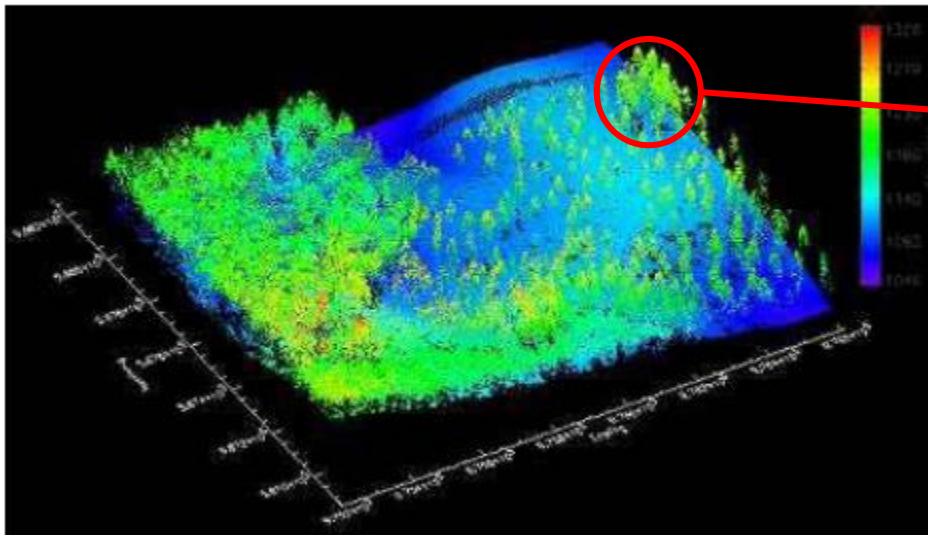
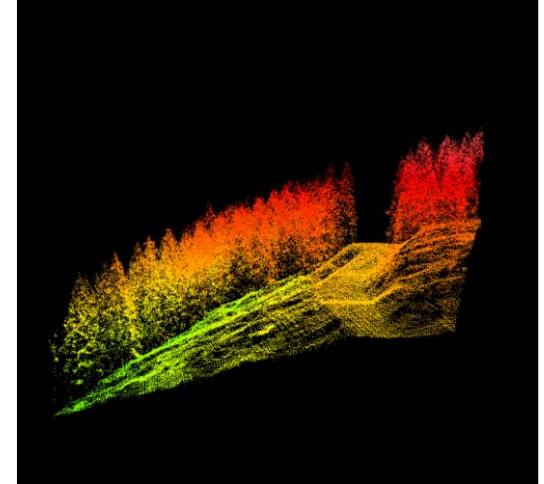
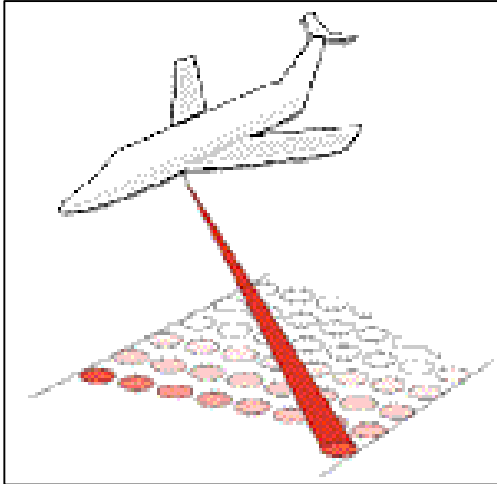
RS: Satellite Imagery



LANDSAT 8 – False color NI7-NI6-R

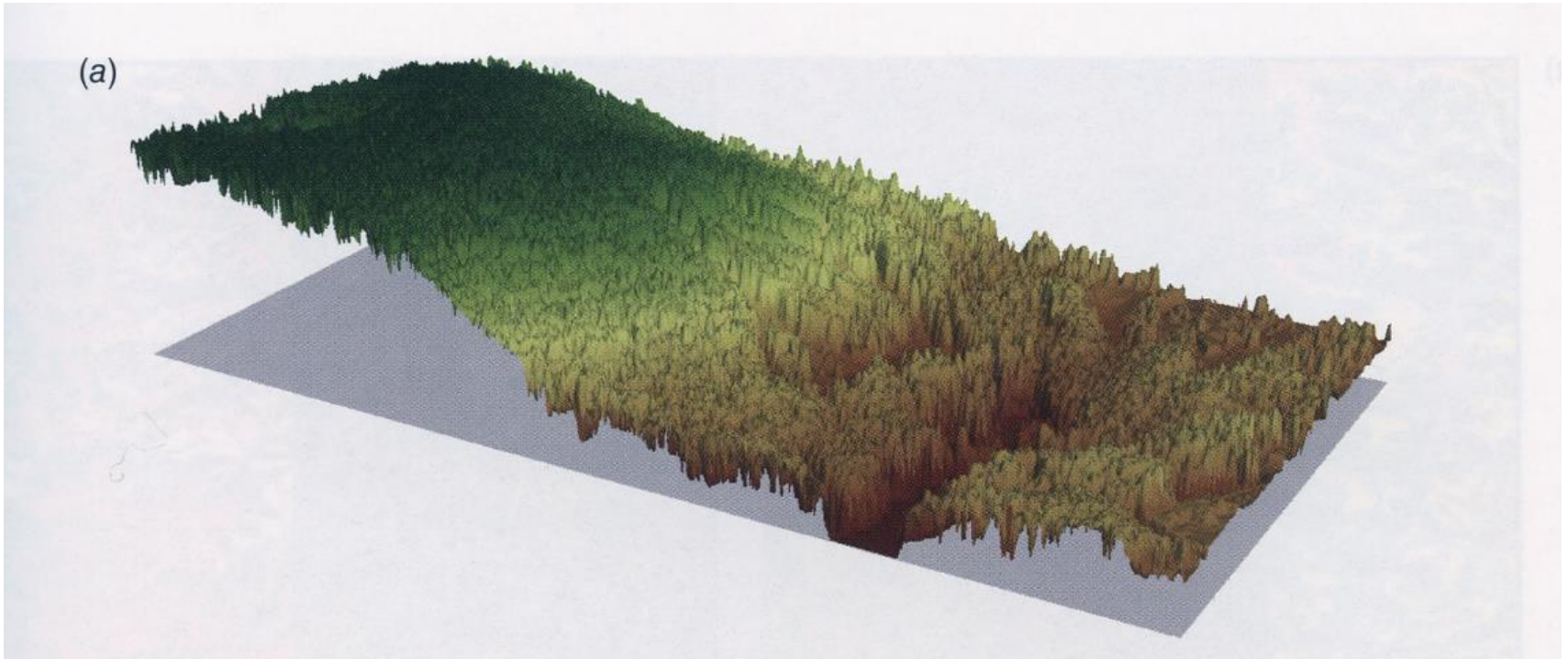
RS: LiDAR

LASER ACTIVE SENSOR → 3D DATA → POINTS CLOUD → DTM with OBJECTS





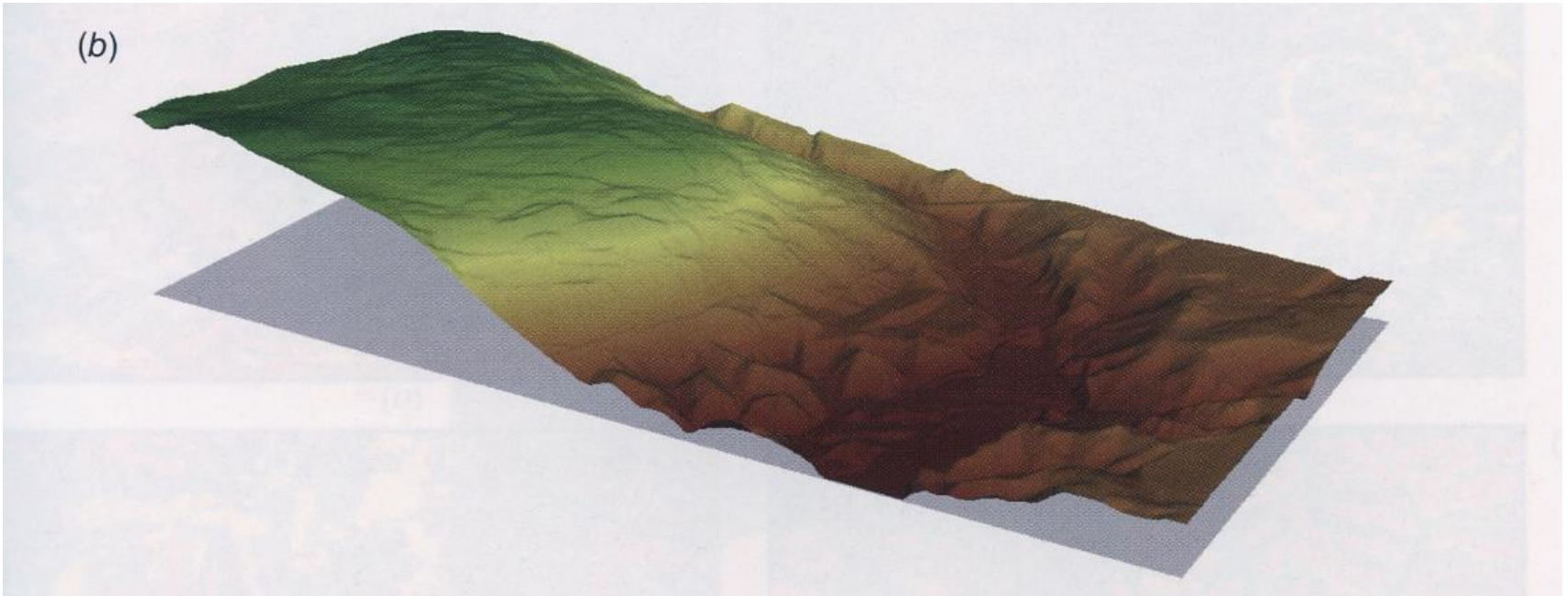
RS: LiDAR



DSM – Digital Surface Model

Lillesand & Kiefer 2015

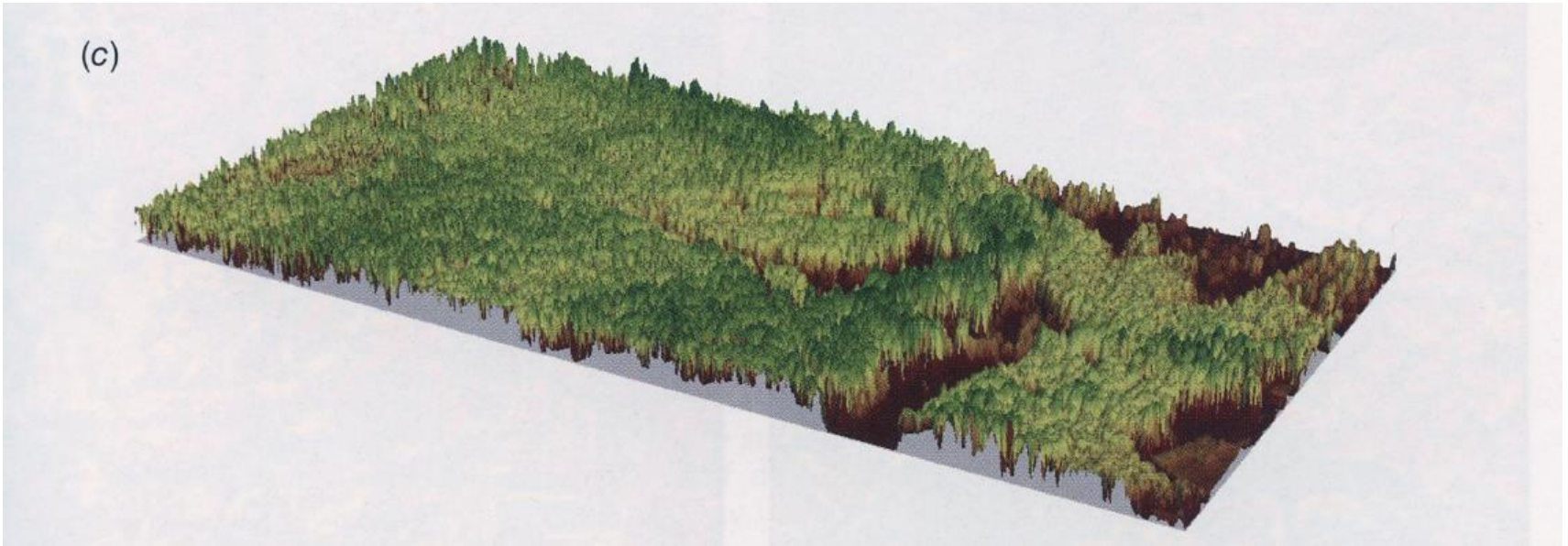
RS: LiDAR



DTM – Digital Terrain Model

Lillesand & Kiefer 2015

RS: LiDAR

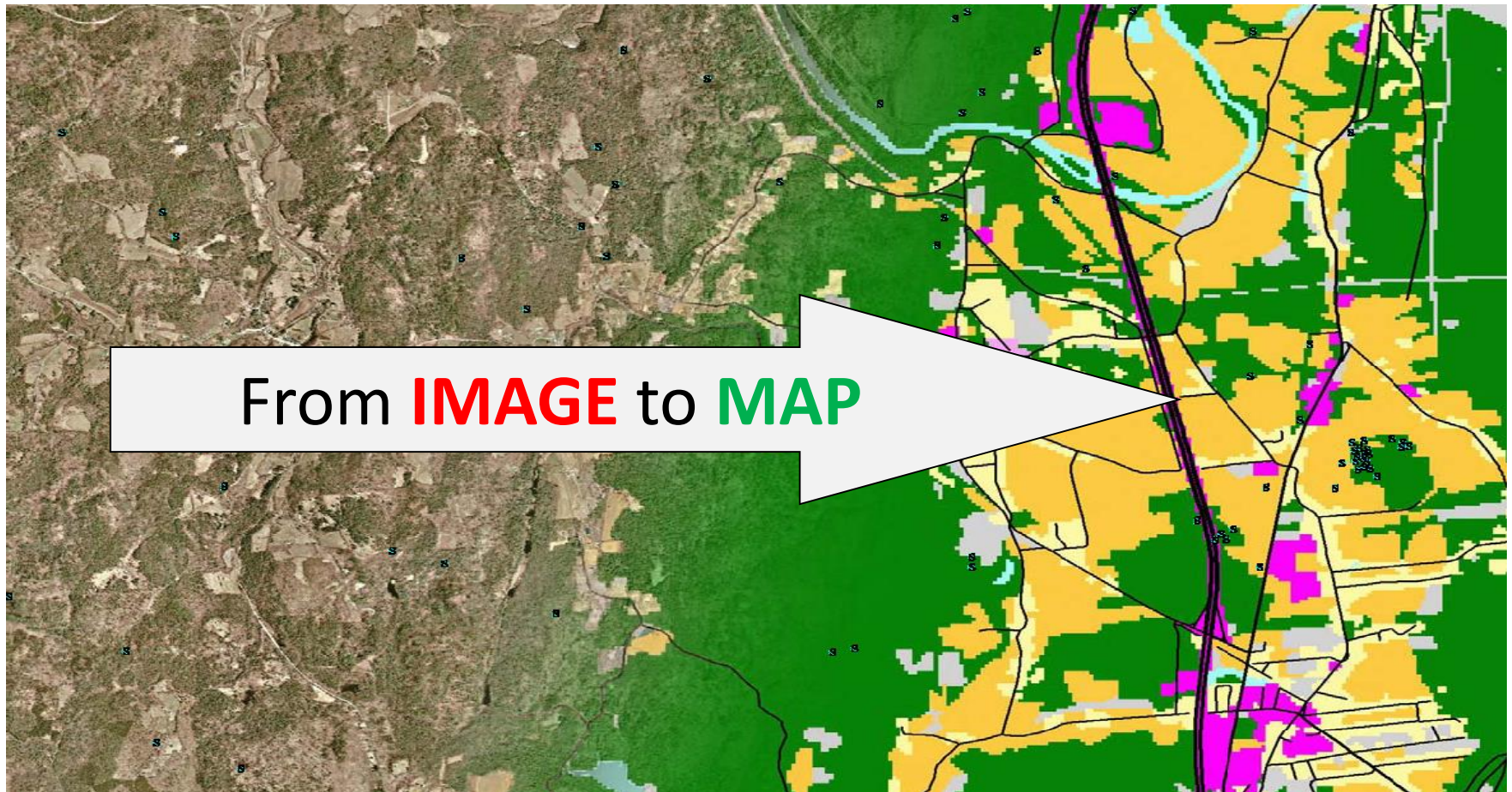


CHM – Canopy Height Model

Lillesand & Kiefer 2015

RS: Image/Data Classification

Continuous Data → Categorical variable



Input off

Level 2



Class Hierarchy

- water
- fuel type 1
- fuel types 2,3,4
- fuel types 5,6,7
- bare soil
- house
- concrete

Inheritance Groups Structure

Sample Editor

Active class: [Level 1] Compare class: [none]

0.0 244.1 488.3 732.4 976.5 1220.6 1464.8

0.0 238.5 477.0 715.5 954.0 1192.5 1431.0

0.0 245.9 491.8 737.6 983.5 1229.4 1475.3

View Settings

Mode	Layer
Layer	Image Data
Image Data	Pixel
Outlines	(off)

Equalizing

focus:Reprojectto\UTM32D0

focus:Reprojectto\UTM32D0

focus:Reprojectto\UTM32D0

Feature View

- Object features
- Class-related features

Image Object Information

Feature

No image object selected

Features Classification Clas:



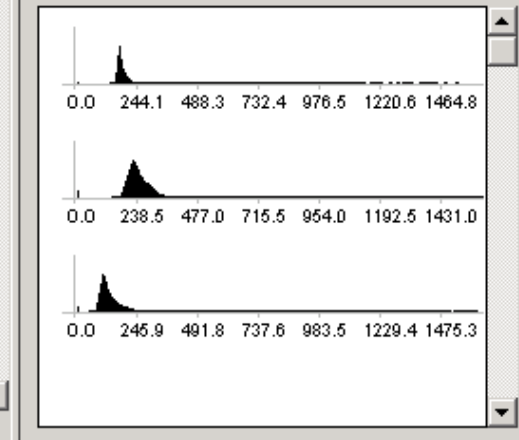
Class Hierarchy

- water
- fuel type 1
- fuel types 2,3,4
- fuel types 5,6,7
- bare soil
- house
- concrete

Inheritance Groups Structure

Sample Editor

Active class: [Level 1] Compare class: [none]



Mode Layer

Layer Image Data

Image Data Pixel

Outlines raster

Equalizing

focus:Reprojectto\UTM32D0

focus:Reprojectto\UTM32D0

focus:Reprojectto\UTM32D0

Object features

Class-related features

Feature

No image object selected



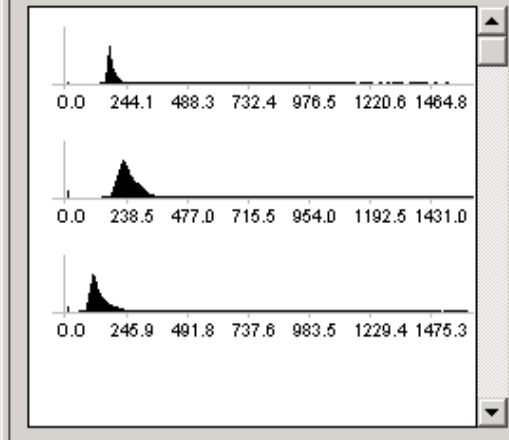
Class Hierarchy

- water
- fuel type 1
- fuel types 2,3,4
- fuel types 5,6,7
- bare soil
- house
- concrete

Inheritance Groups Structure

Sample Editor

Active class: [Level 1] Compare class: [none]



View Settings

Mode	Layer
Layer	Image Data
Image Data	Object mean
Outlines	raster

Equalizing

focus:Reprojectto\UTM32D0

focus:Reprojectto\UTM32D0

focus:Reprojectto\UTM32D0

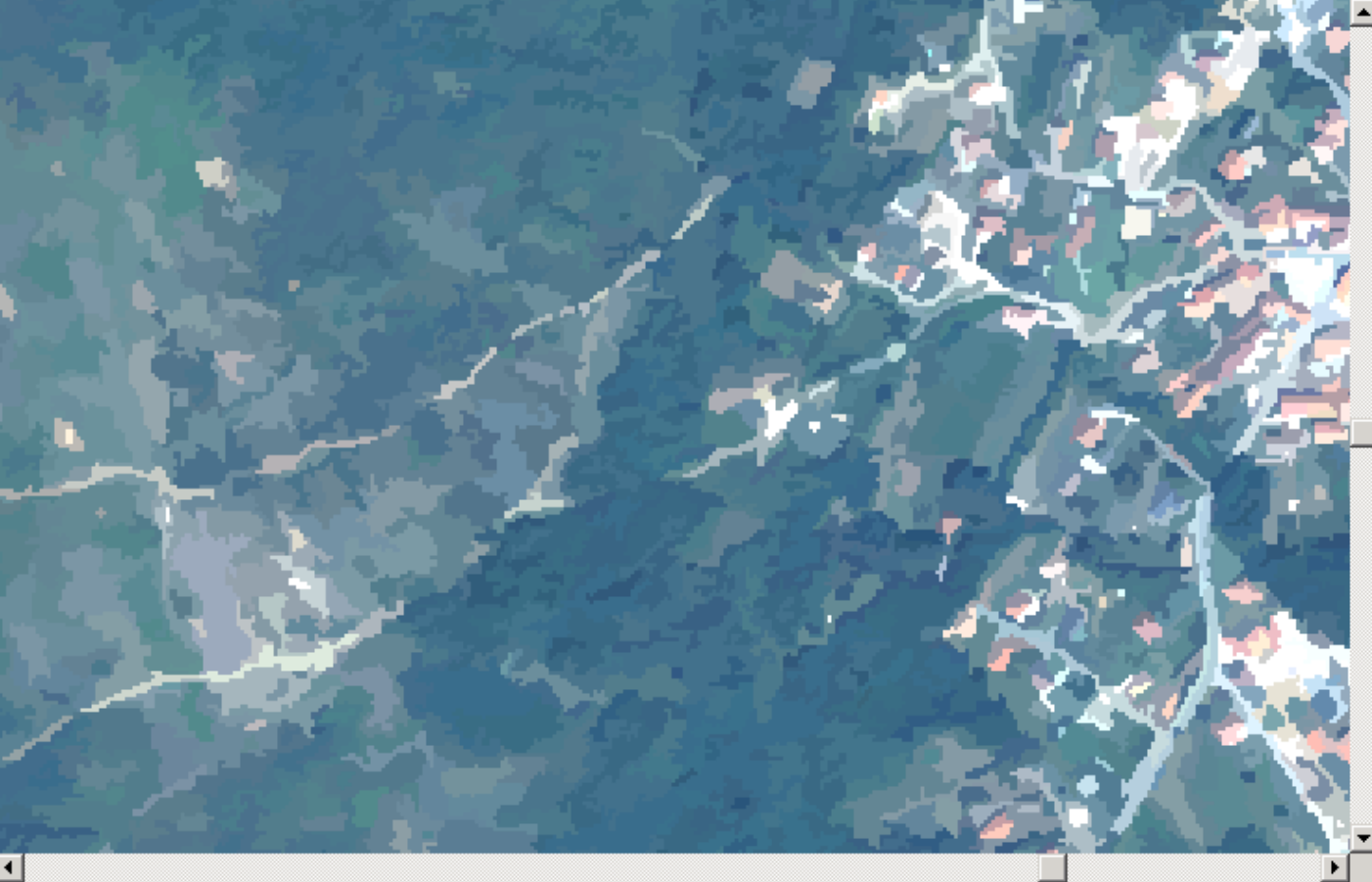
Feature View

- Object features
- Class-related features

Image Object Information

Feature

No image object selected



Class Hierarchy

- water
- fuel type 1
- fuel types 2,3,4
- fuel types 5,6,7
- bare soil
- house
- concrete

Inheritance Groups Structure

Sample Editor

Active class: [Level 1] Compare class: [none]

0.0 244.1 488.3 732.4 976.5 1220.6 1464.8

0.0 238.5 477.0 715.5 954.0 1192.5 1431.0

0.0 245.9 491.8 737.6 983.5 1229.4 1475.3

View Settings

Mode	Layer
Layer	Image Data
Image Data	Object mean
Outlines	(off)

Equalizing

focus:Reprojecto\UTM32D0

focus:Reprojecto\UTM32D0

focus:Reprojecto\UTM32D0

Feature View

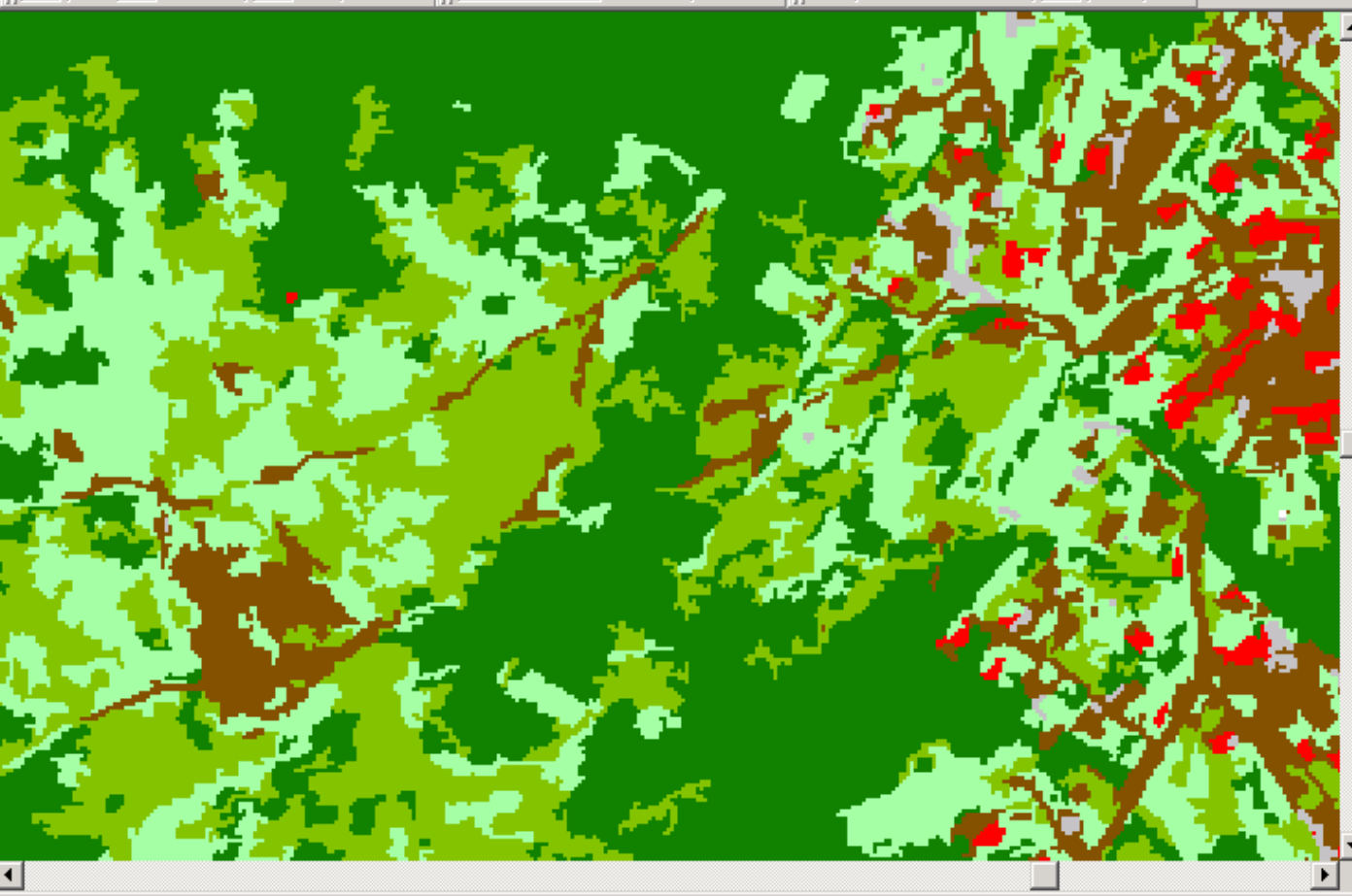
- Object features
- Class-related features

Image Object Information

Feature

No image object selected

Features Classification Clas:



Class Hierarchy

- water
- fuel type 1
- fuel types 2,3,4
- fuel types 5,6,7
- bare soil
- house
- concrete

Inheritance Groups Structure

Sample Editor

Active class: [Level 1] Compare class: [none]

0.0 244.1 488.3 732.4 976.5 1220.6 1464.8

0.0 238.5 477.0 715.5 954.0 1192.5 1431.0

0.0 245.9 491.8 737.6 983.5 1229.4 1475.3

View Settings

Mode: Layer Image Data Outlines

Classification: Image Data Pixel (off)

Feature View

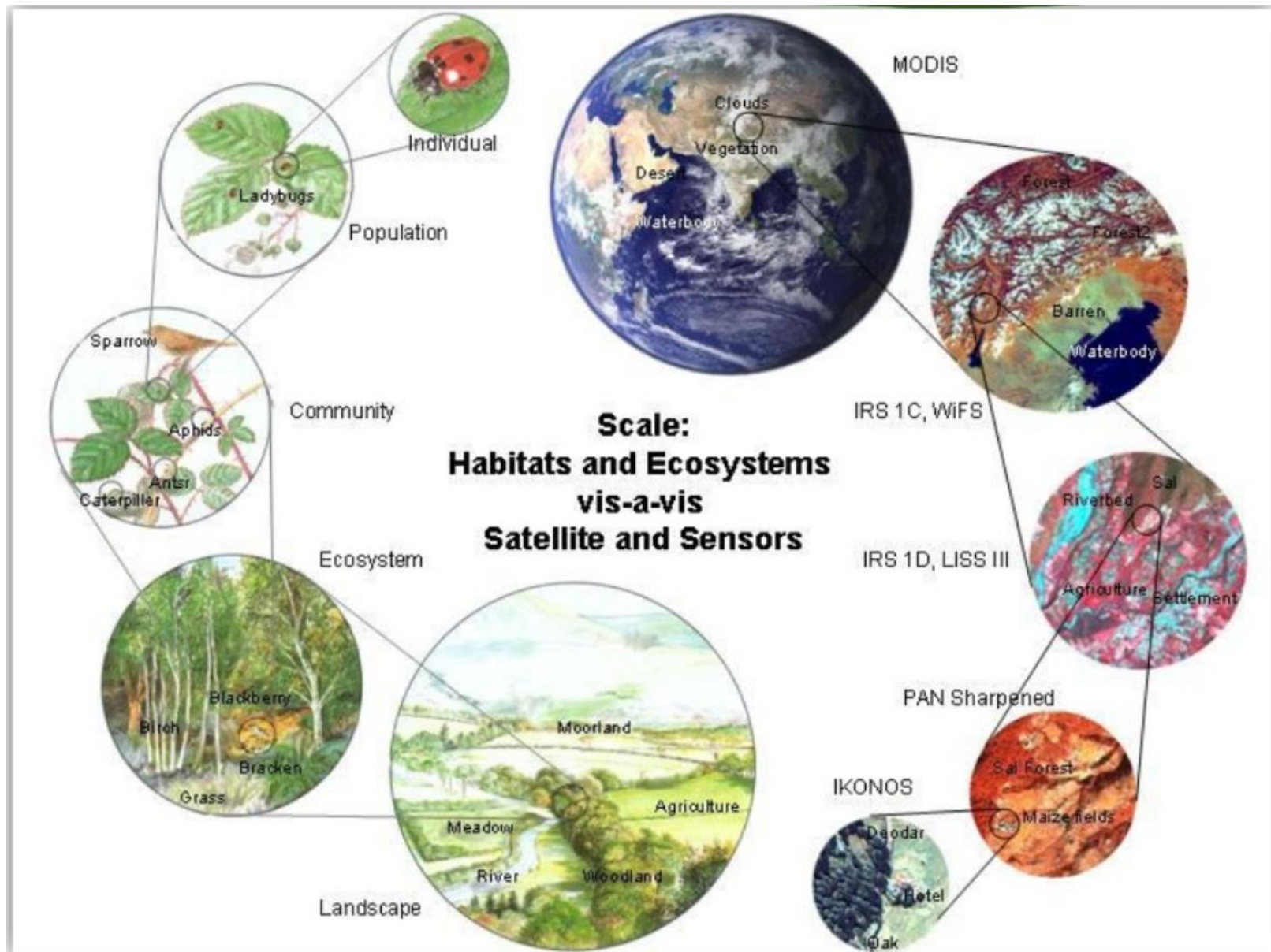
- Object features
- Class-related features

Image Object Information

Feature: No image object selected

Features Classification Class

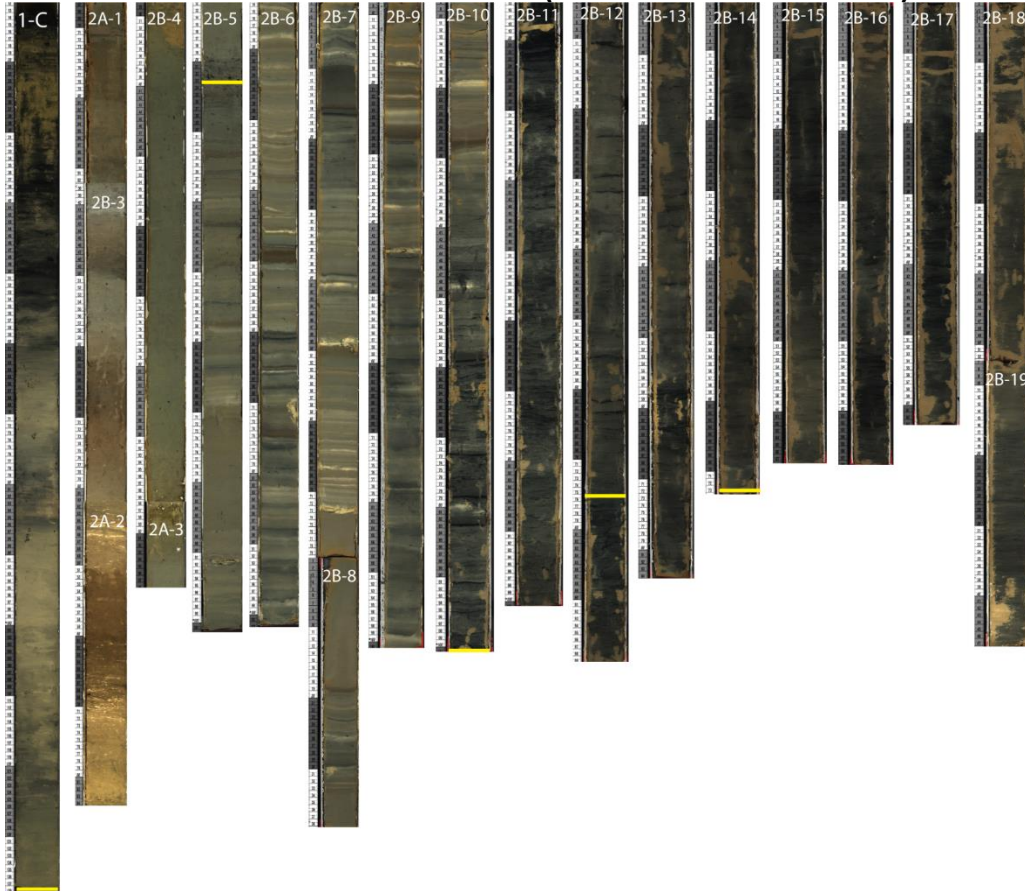
Remote Data \leftrightarrow Scale



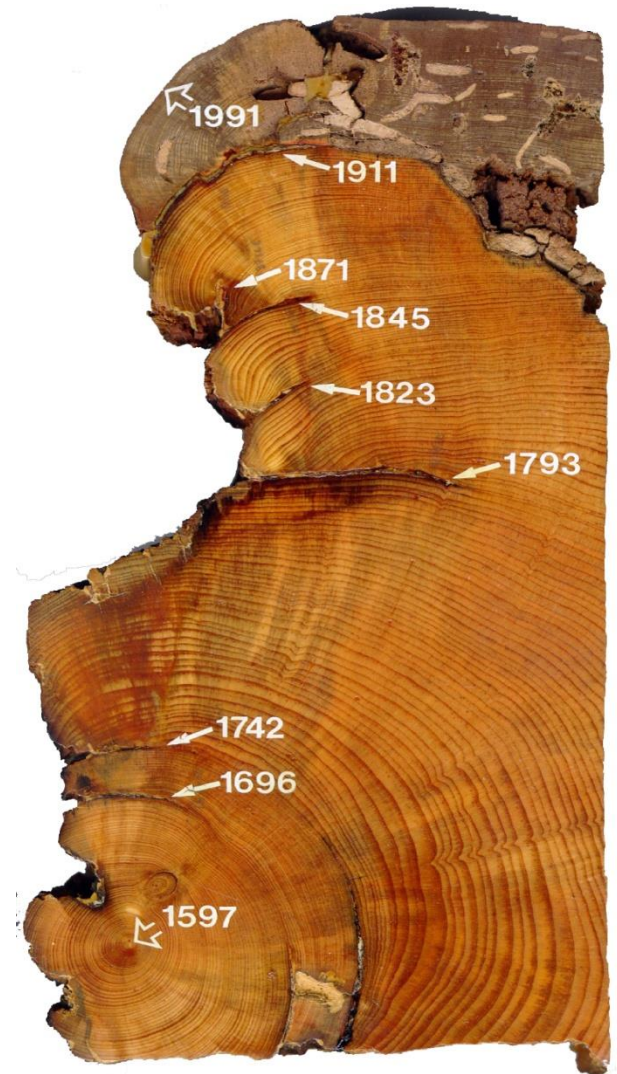


Archival Data (Biological)

POLLEN ANALYSIS (SEDIMENT CORES)

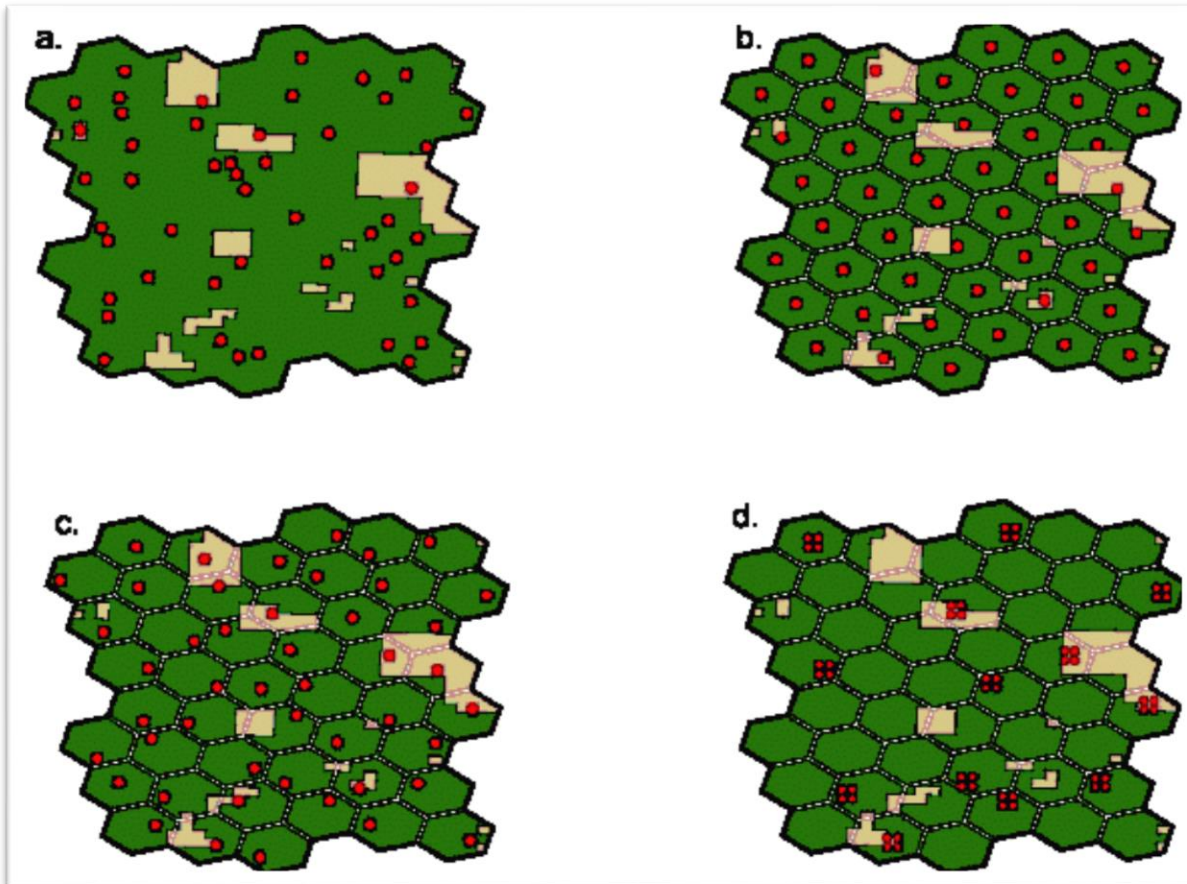


DENDROECOLOGY (WOODEN SECTIONS)



Field Data: sampling design

Sampling Design (examples)



- a) Random
- b) Systematic
- c) Systematic non-aligned
- d) Systematic non-aligned and nested

*FAO-IUFRO National
Forest Assessments
2004*

Field Data: GPS

Many different data, but all MAPPED with a GPS → Spatial Component of DATA

What is your GPS application?

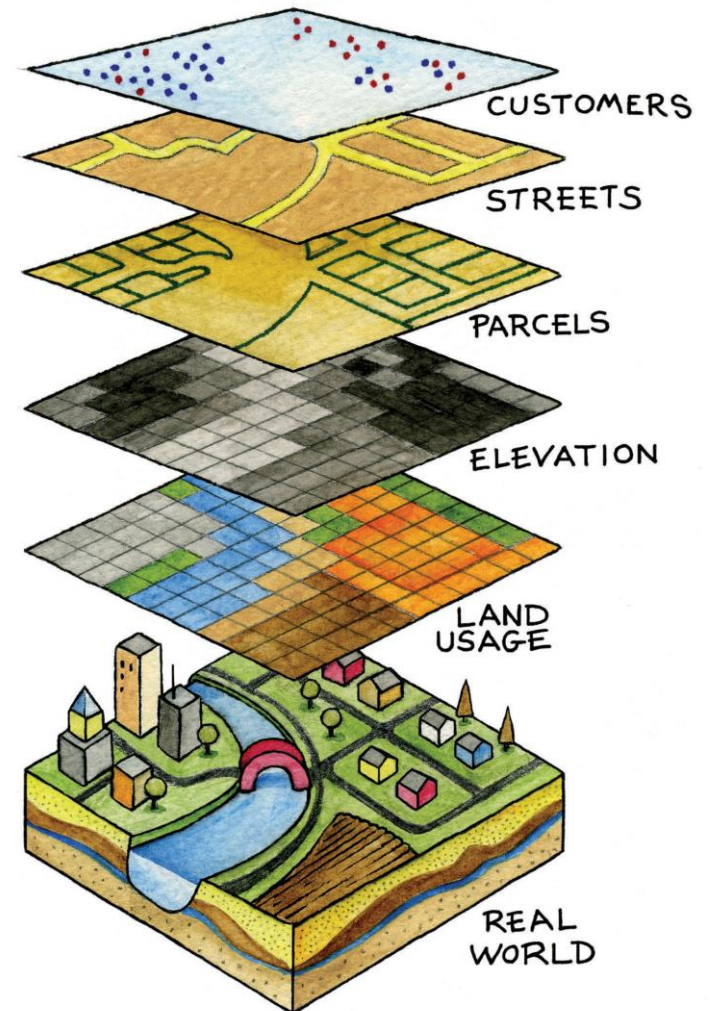


GIS

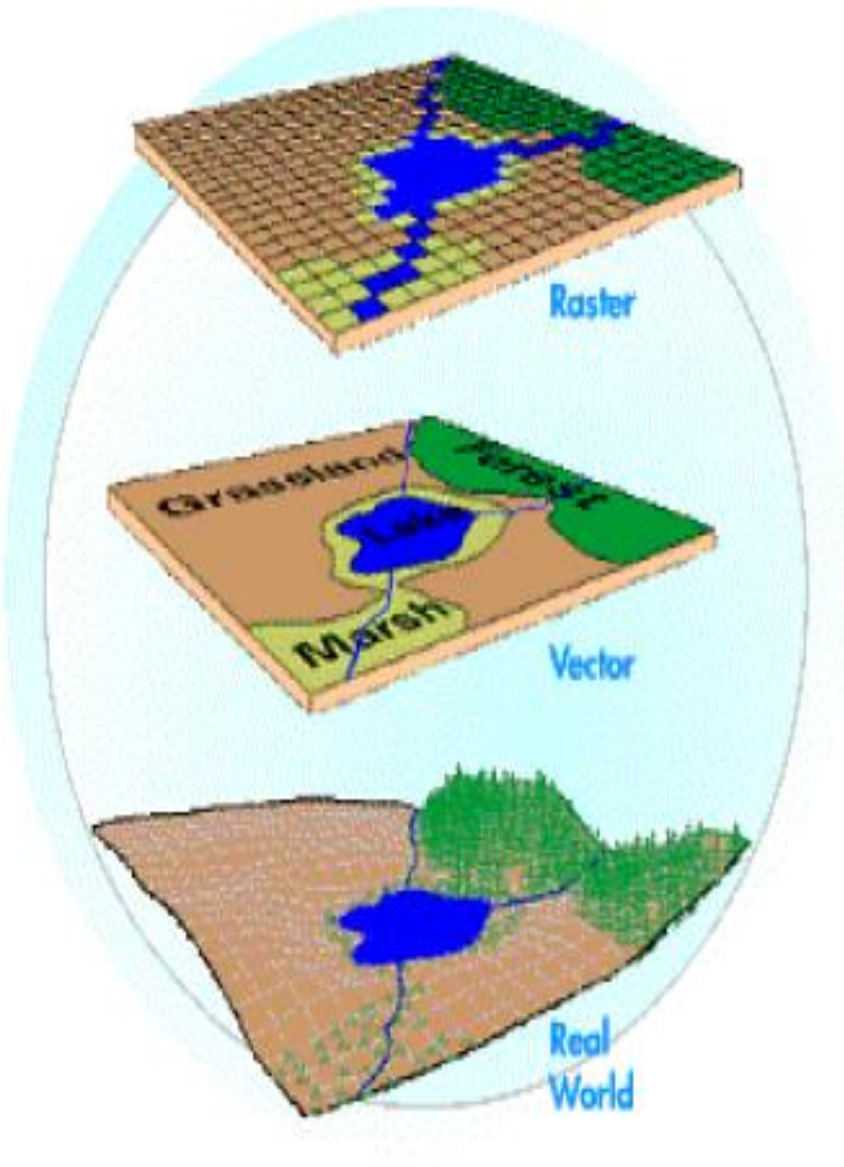
An interface for many different data sources (absolute coordinates)



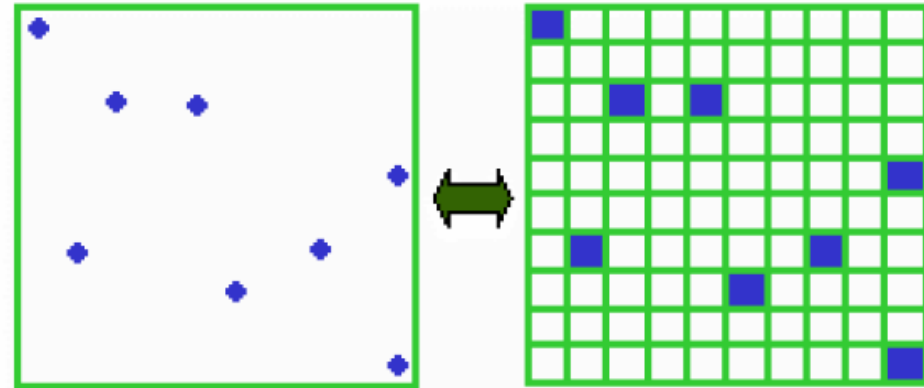
Sistemi Informativi Territoriali - D.G. Preatoni



GIS (Vector - Raster)



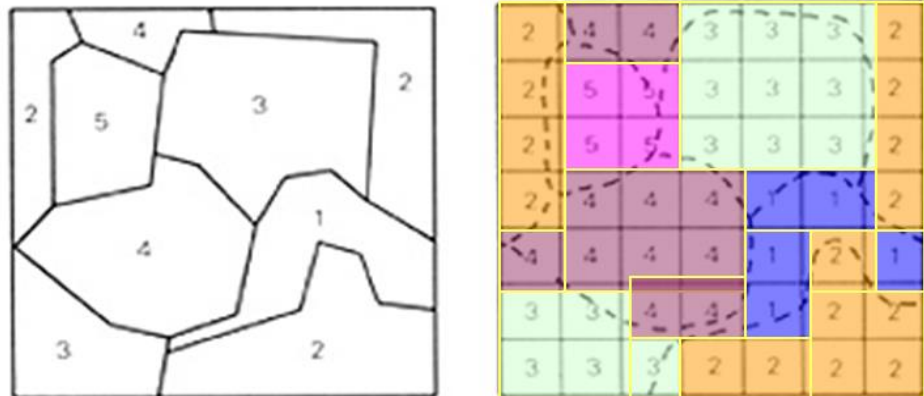
POINTS



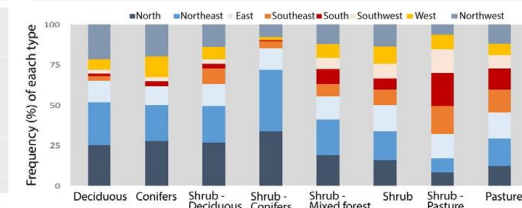
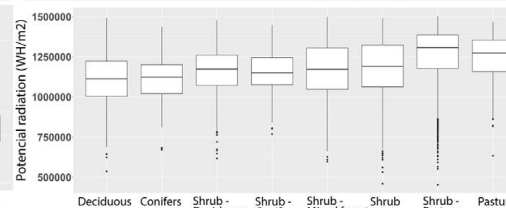
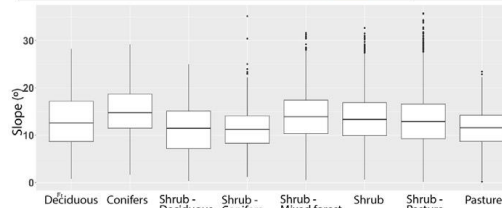
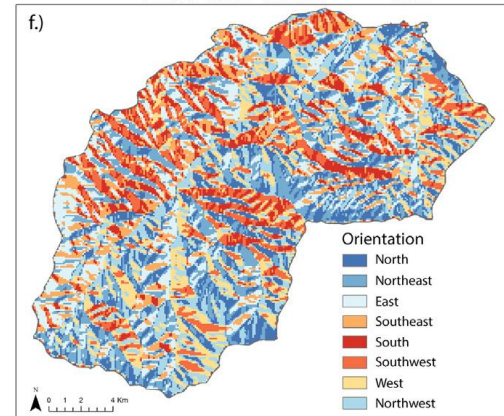
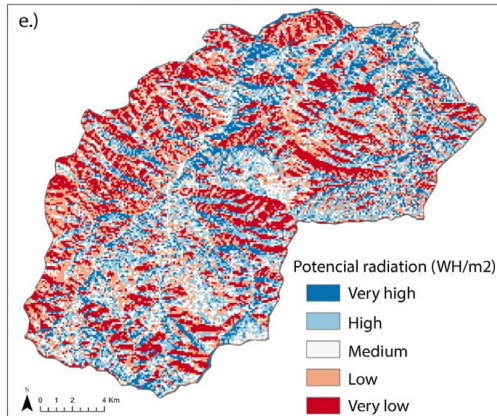
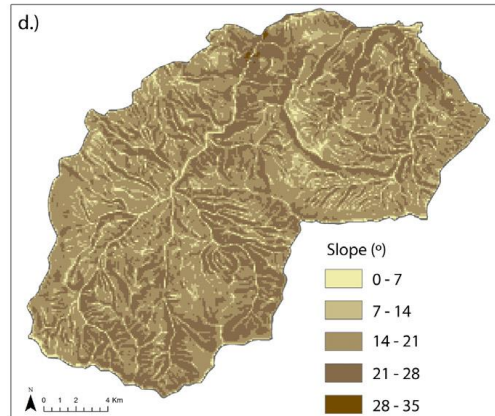
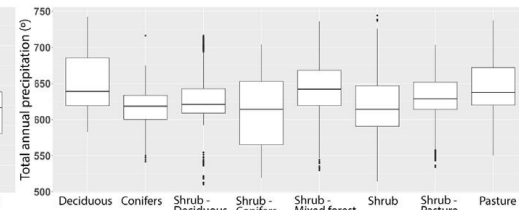
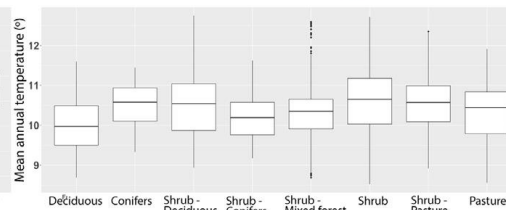
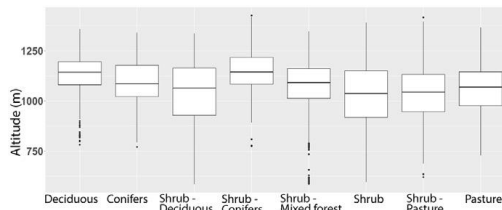
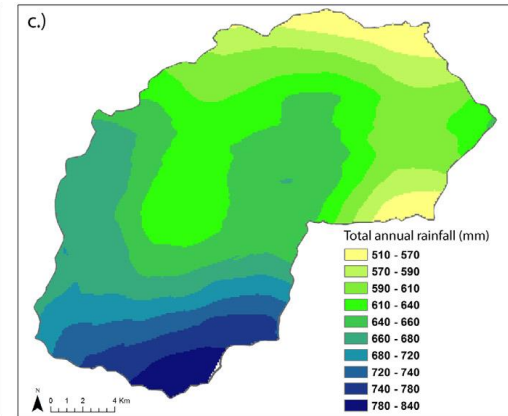
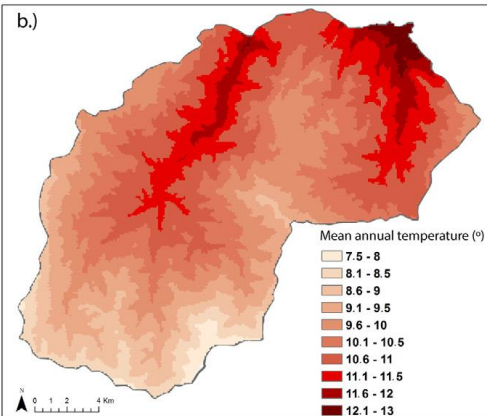
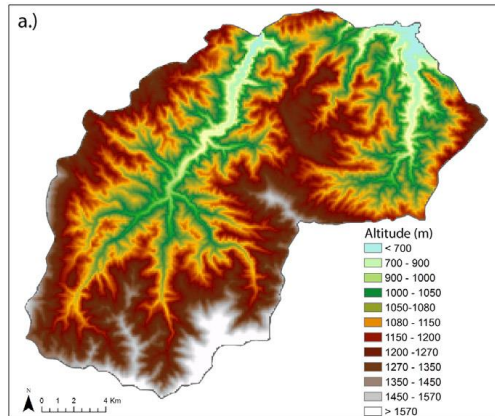
LINES



POLYGONS

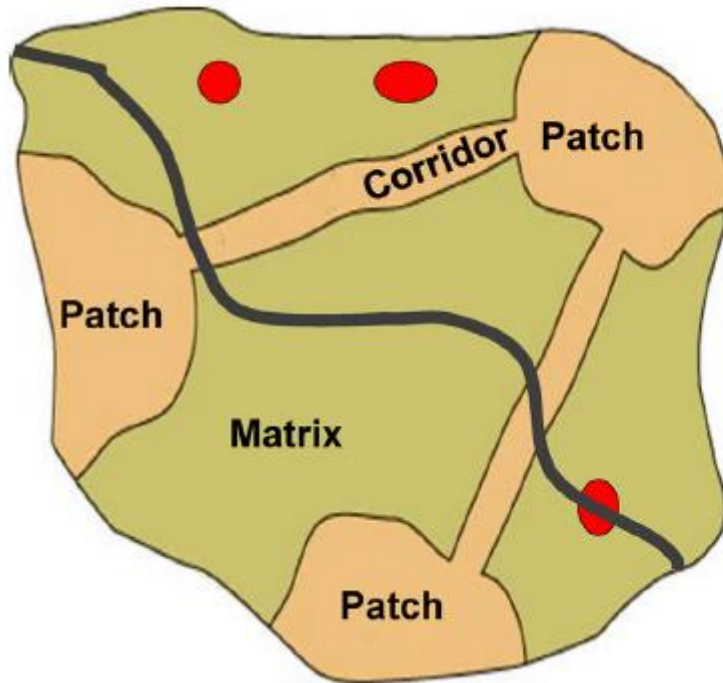


GIS → MAPS

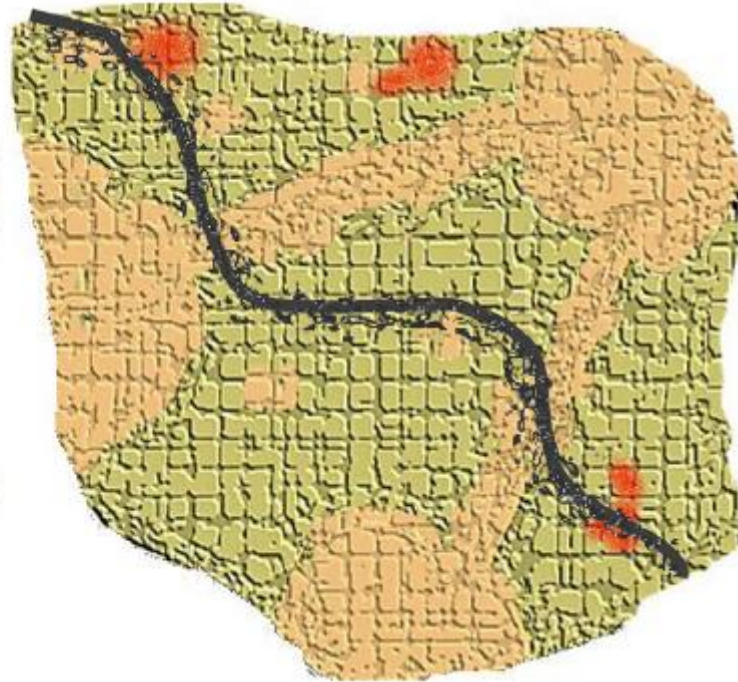


MAPS → LANDSCAPE STRUCTURE

PMM: Patch Matrix Model



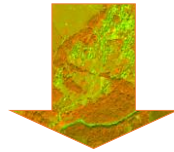
GM: Gradient Model



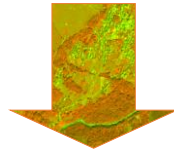
Representation of landscape structure with 2 different models (Lausch et al. 2015).

LANDSCAPE METRICS

- ✓ 1 Select the study area (*landscape*)
- ✓ 2 Identify and classify the objects (*patches*)
- ✓ 3 Raster or vector map (*land cover map*)



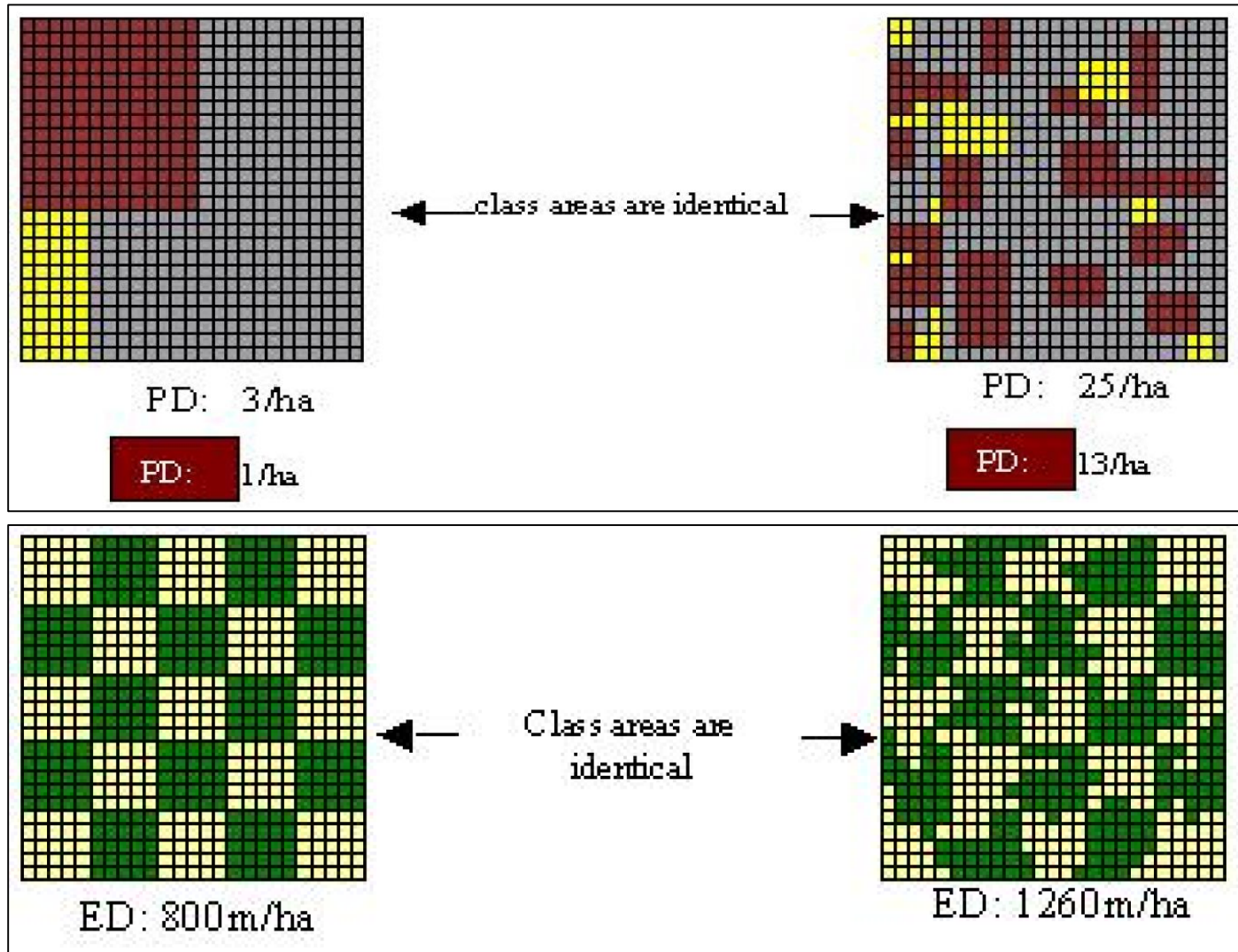
LANDSCAPE PATTERN ANALYSIS



LANDSCAPE METRICS

LANDSCAPE METRICS

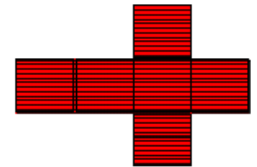
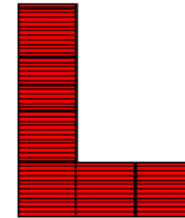
Densities Patch and Edge



LANDSCAPE METRICS

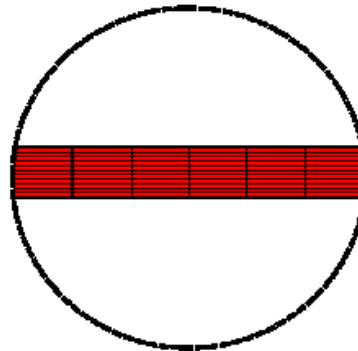
Measures of Shape

**Geometric
complexity versus
morphology**



Shape index = 1.43

**Complexity
versus
compaction**



LANDSCAPE METRICS

FRAGSTATS

<https://www.umass.edu/landeco/research/fragstats/fragstats.html>

r.le Programs

<http://eratos.erin.utoronto.ca/res/vbr/web/rle/rle.htm>

Patch Analyst

<http://flash.lakeheadu.ca/~rrempel/patch/>

LEAP II

http://www.ai-geostats.org/software/Geostats_software/LEAP.htm

LANDISVIEW

http://kelab.tamu.edu/standard/restoration/restoration_tools.htm

LecoS for QGIS

landscapemetrics on R

<https://cran.r-project.org/web/packages/landscapemetrics/index.html>

MEASURES OF FRAGMENTATION

Everyone talks about fragmentation but how can we **measure** it objectively?

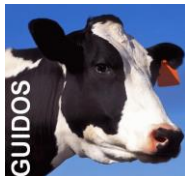
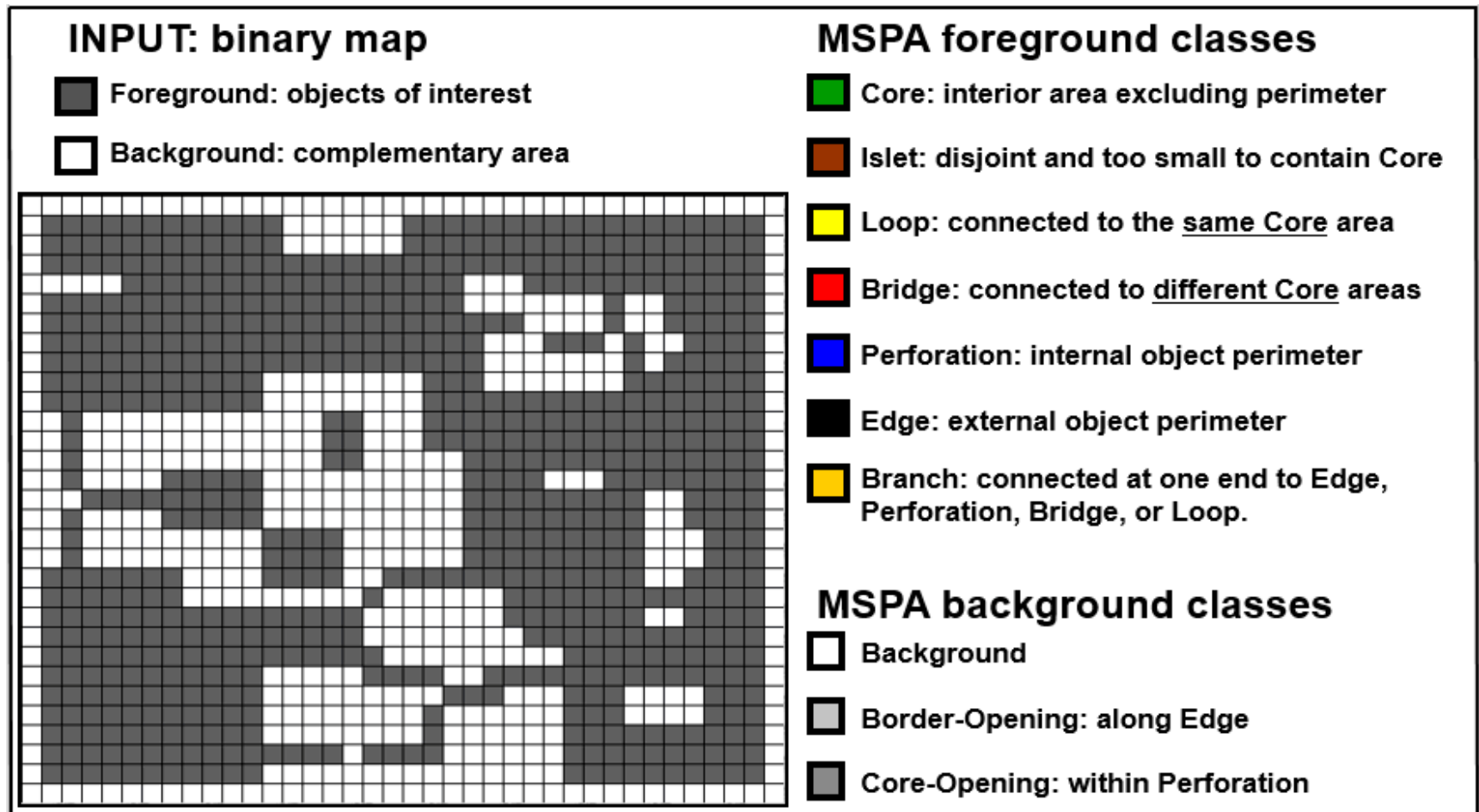


GUIDOS – JRC – P. Vogt

<https://forest.jrc.ec.europa.eu/en/activities/lpa/gtb/>



MEASURES OF FRAGMENTATION



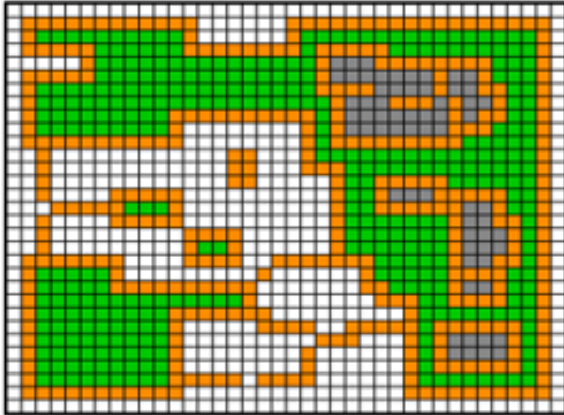
GUIDOS – JRC – P. Vogt

<https://forest.jrc.ec.europa.eu/en/activities/lpa/gtb/>



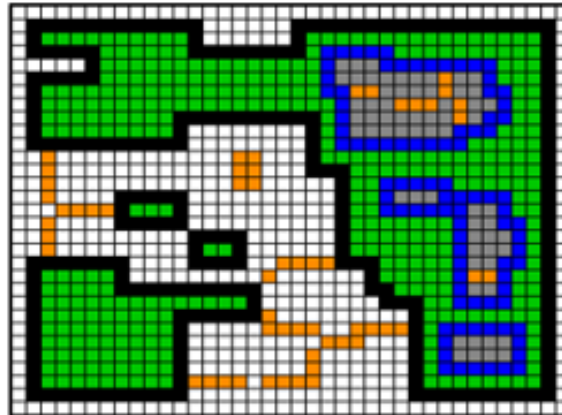
MEASURES OF FRAGMENTATION

SPA3: Core + Holes



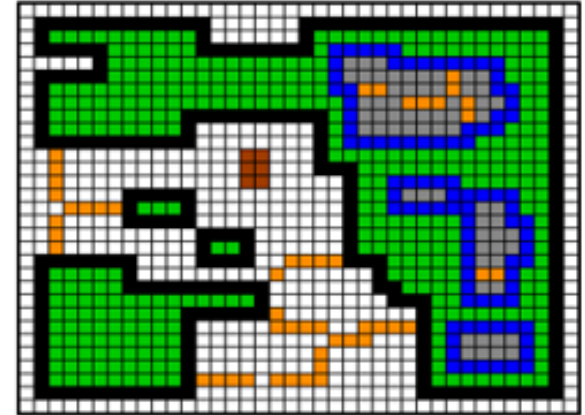
- Core: Interior Foreground
- Core-Opening: Background in Core
- Margin: Other Foreground

SPA5: SPA3 + Core-borders



- Core: Interior Foreground
- Core-Opening: Background in Core
- Edge: Outside Core border
- Perforation: Inside Core border
- Margin: Other Foreground

SPA6: SPA5 + Islets



- Core: Interior Foreground
- Core-Opening: Background in Core
- Edge: Outside Core border
- Perforation: Inside Core border
- Islet (isolated non-Core fragment)
- Margin: Other Foreground



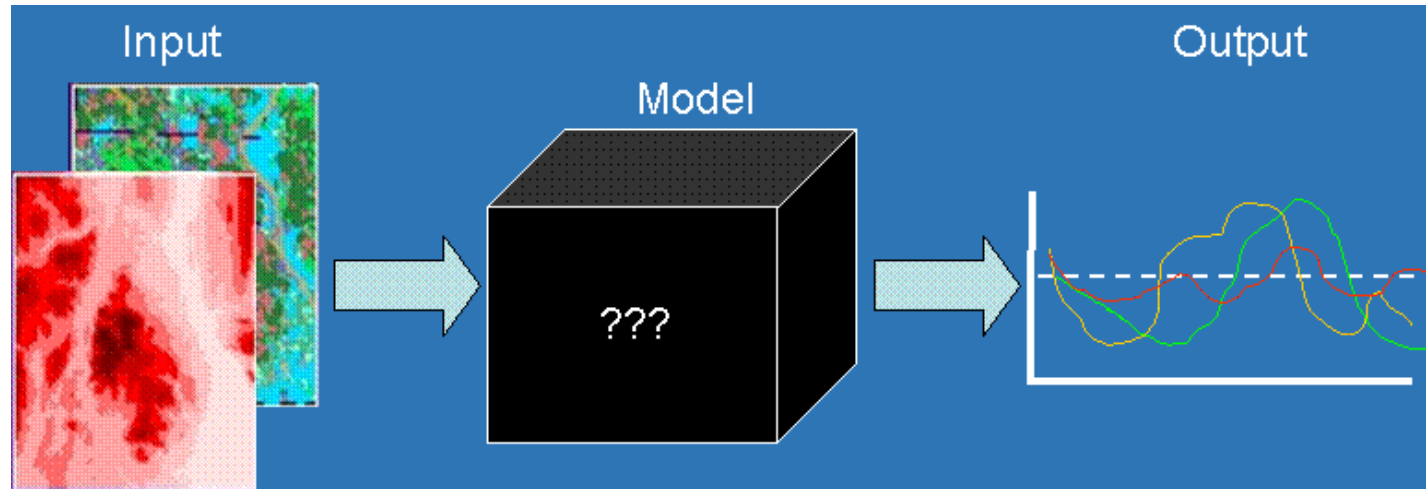
GUIDOS – JRC – P. Vogt

<https://forest.jrc.ec.europa.eu/en/activities/lpa/gtb/>

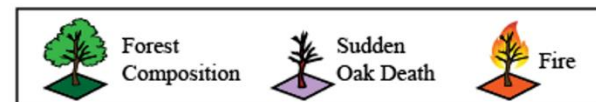
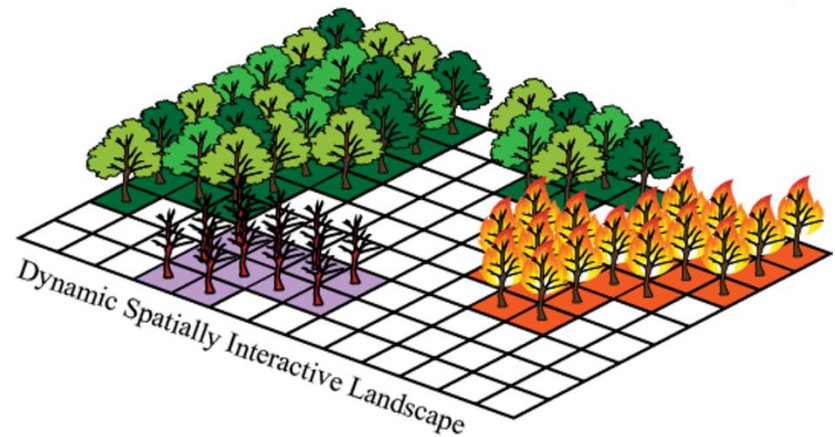


LANDSCAPE MODELS

Why use models?



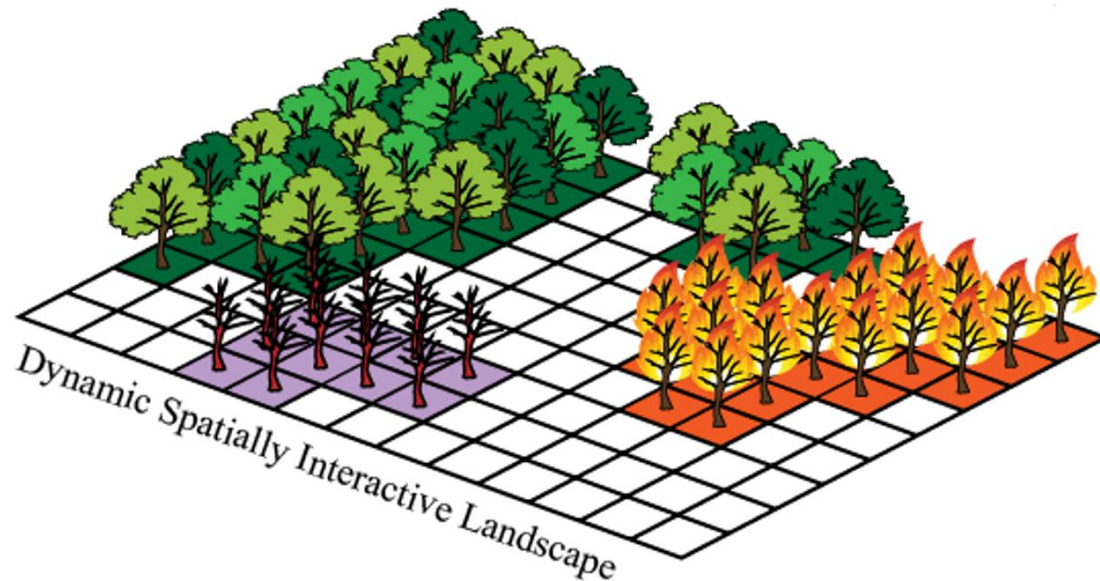
1. Make Predictions
2. Heuristic Value
3. Experimentation



LANDSCAPE MODELS

MANY DIFFERENT TYPES

Landis II (LANdscape DISturbances) <http://www.landis-ii.org/> is a spatially explicit model that simulate landscape changes due to climate change, land-use change and disturbance occurrence.



LANDSCAPE MODELS

LANDIS-II: Forest Landscape Simulator

