SMITHSONIAN'S NATIONAL ZOO & CONSERVATION BIOLOGY INSTITUTE

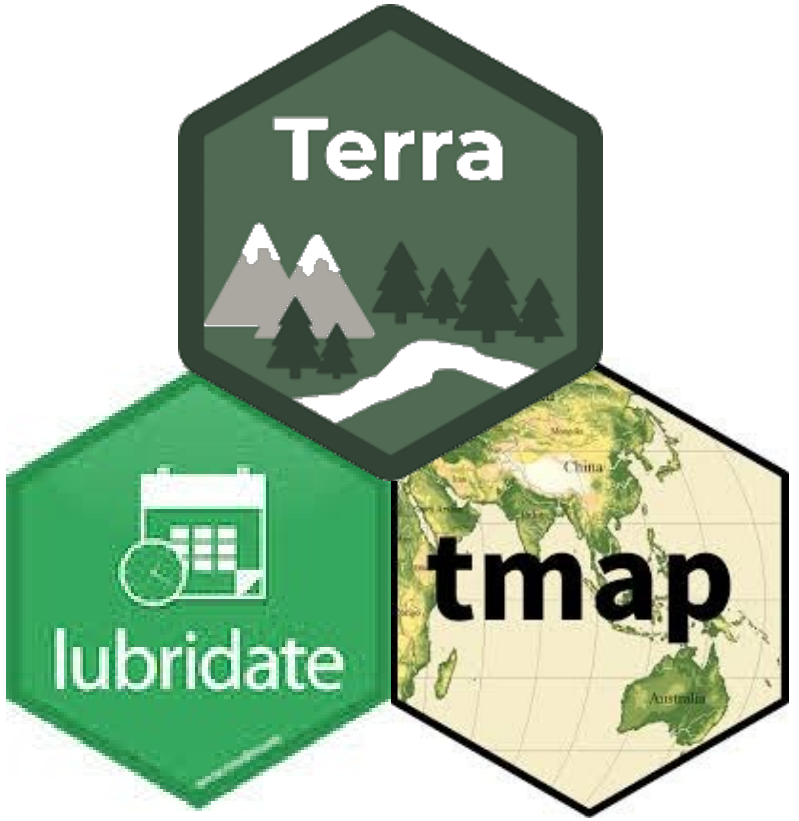
Introduction to GIS in R

Wildlife Tourism College
Pardamat Conservation Area
17 September 2024

EARTH SCIENCE APPLIED SCIENCES
Award: 80NSSC23K1537

Learning Objectives

- Create and import spatial data into R
- Basic vector and raster analysis
- Introduction to remote sensing
- Raster data extraction
- Simple spatial analysis
- Making maps in R



Geographic Information Systems

A computer-based system to create, manage, analyze, and display geographical data

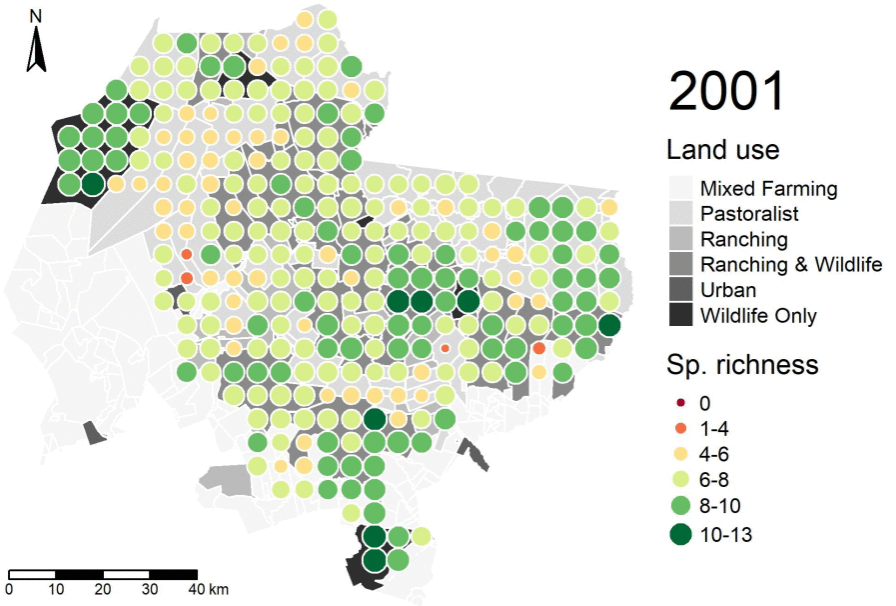
GIS DATABASE

GEOGRAPHIC ANALYSIS

Spatial Data (x,y)

Attribute Data

STATISTICAL ANALYSIS

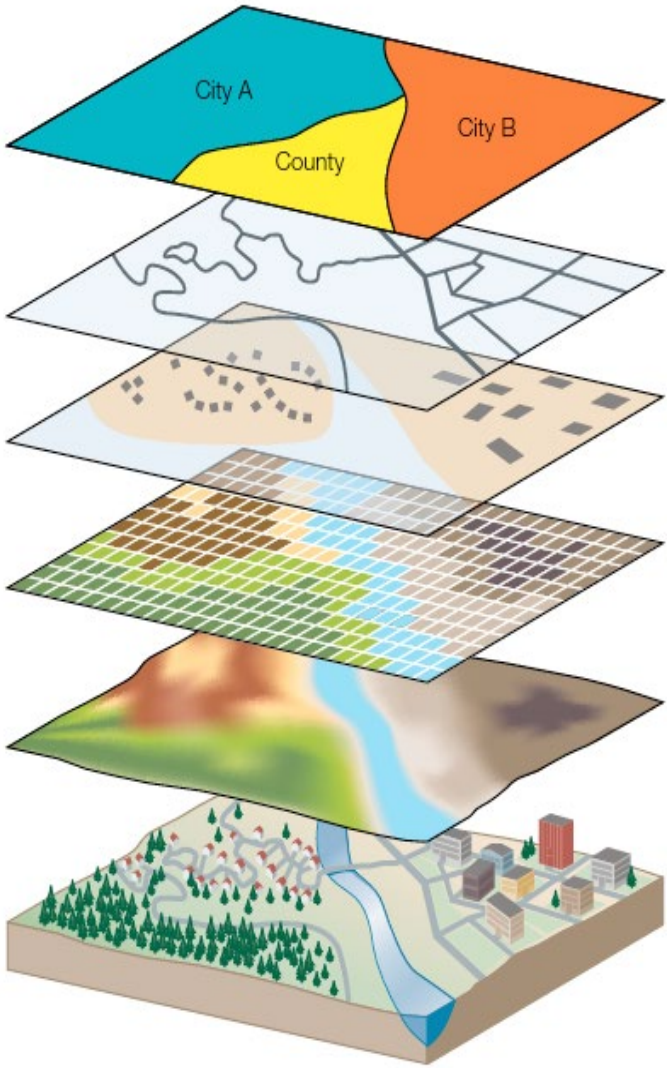


TYPES of SPATIAL DATA:

VECTOR

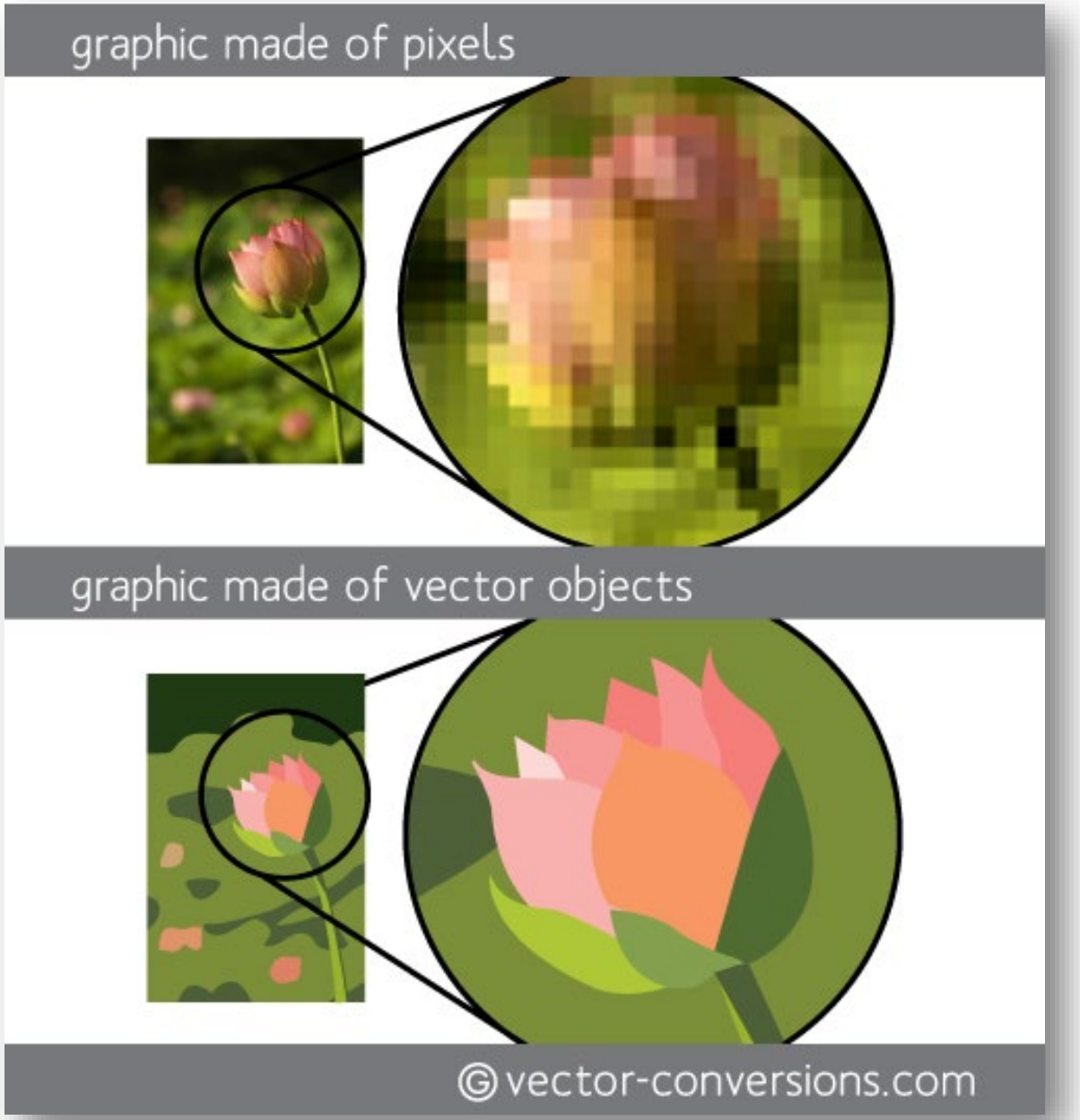
vs

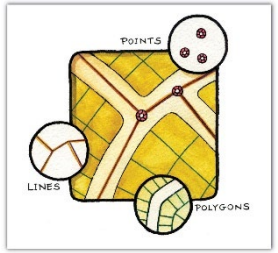
RASTER



RASTER

VECTOR

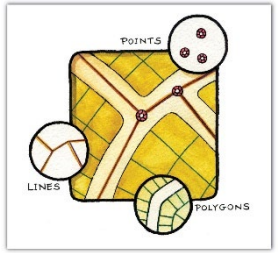




Points (Vector)

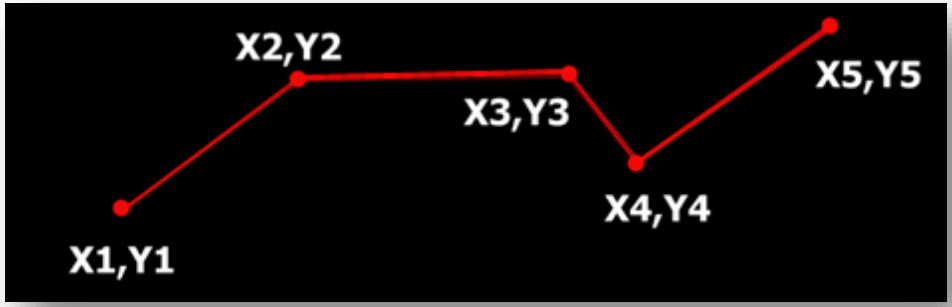
Single point (no area)

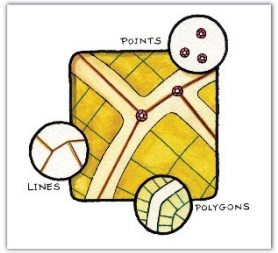
- Examples: GPS points, animal locations



Lines (Vector)

- Series of points connected together in order
- Has **length,** but not area
  - Examples: roads, boundaries, streams, route traveled

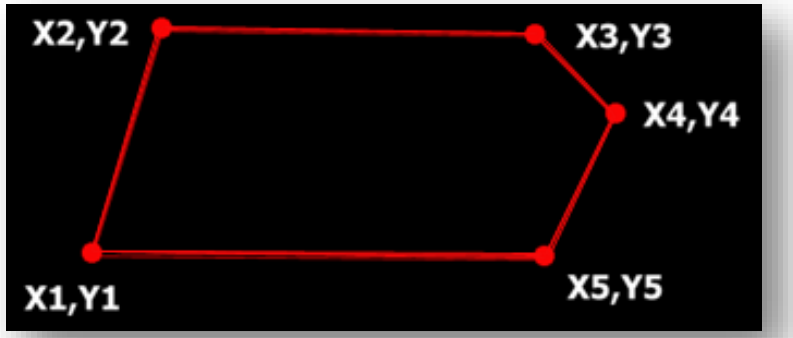


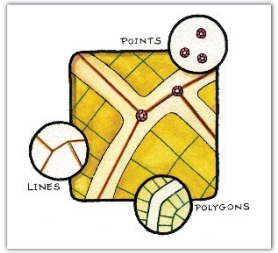


Polygons (Vector)

Series of points connected

- Has length, width, and area
  - Examples: buildings, administrative boundaries, protected areas





Vector data

Attributes are attached to each object:

- Examples: species, date, depth, age, habitat

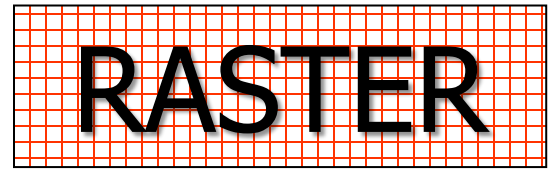
	OBJECTID	AREA	PERIMETER	COUNTY3_	COUNTY3_ID	COUNTY
1	36	0.20600000000	2.53700000000	37.00000000000	36.00000000000	Murang'a
2	35	0.10600000000	1.67700000000	36.00000000000	35.00000000000	Kisii
3	34	1.45400000000	6.86200000000	35.00000000000	34.00000000000	Narok
4	33	0.07200000000	1.50500000000	34.00000000000	33.00000000000	Nyamira
5	40	1.77400000000	7.28000000000	41.00000000000	40.00000000000	Kajiado

Vector data Queries based on attributes

- Exact matching: ==
  - `Name == "Naboisho Conservancy"`
- Logical operator : >, <, >=, <=
  - `Area > 3000`

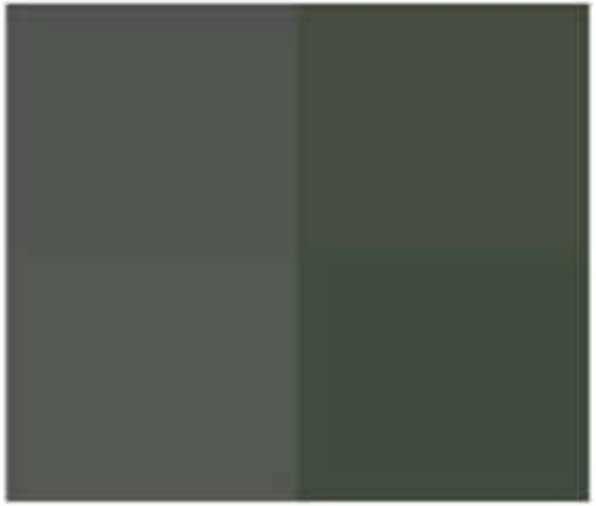
- Combination of multiple conditions
  - `Area > 3000 AND COUNTY == “Narok”`

Raster data



- Numbers or values in each pixel (cell)
- Good for mapping things that change continuously (like elevation)

Spatial Resolution: the level of detail of your data (e.g., pixel size)



Aqua (MODIS)
250m Resolution

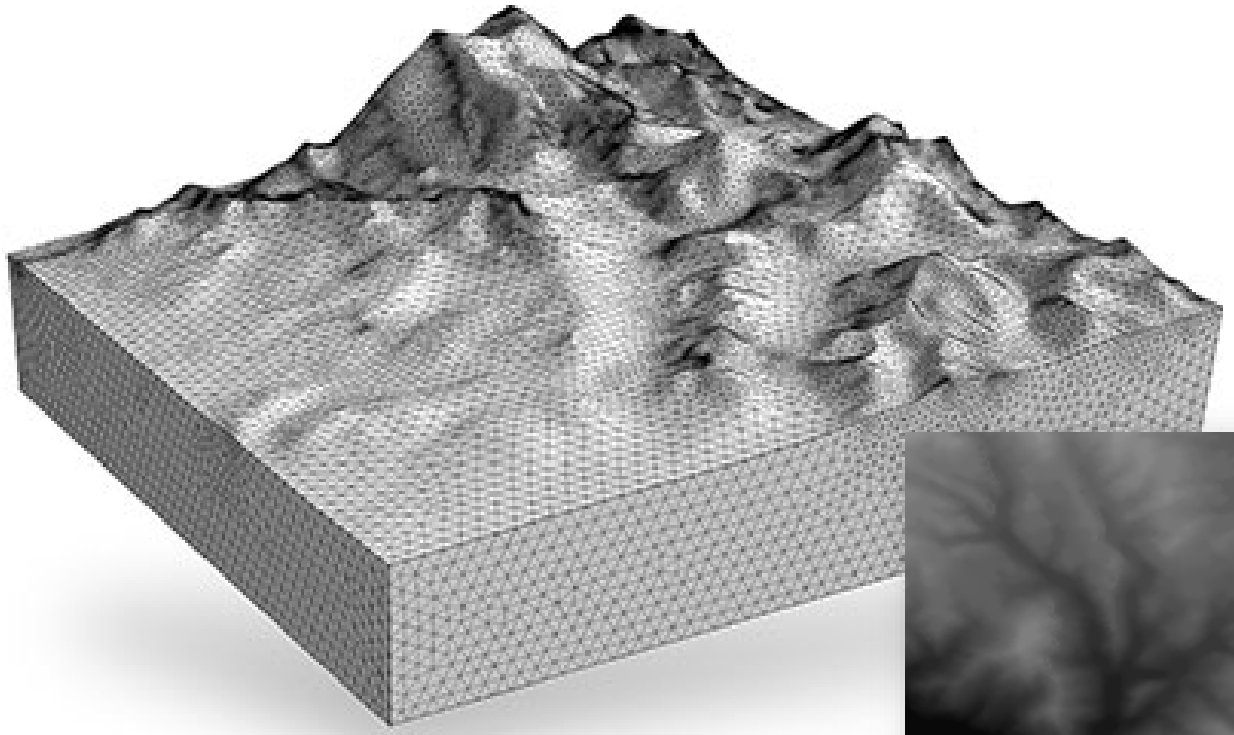
Landsat-8
30m Resolution

Sentinel-2
10m Resolution

PlanetScope (Dove)
3m Resolution

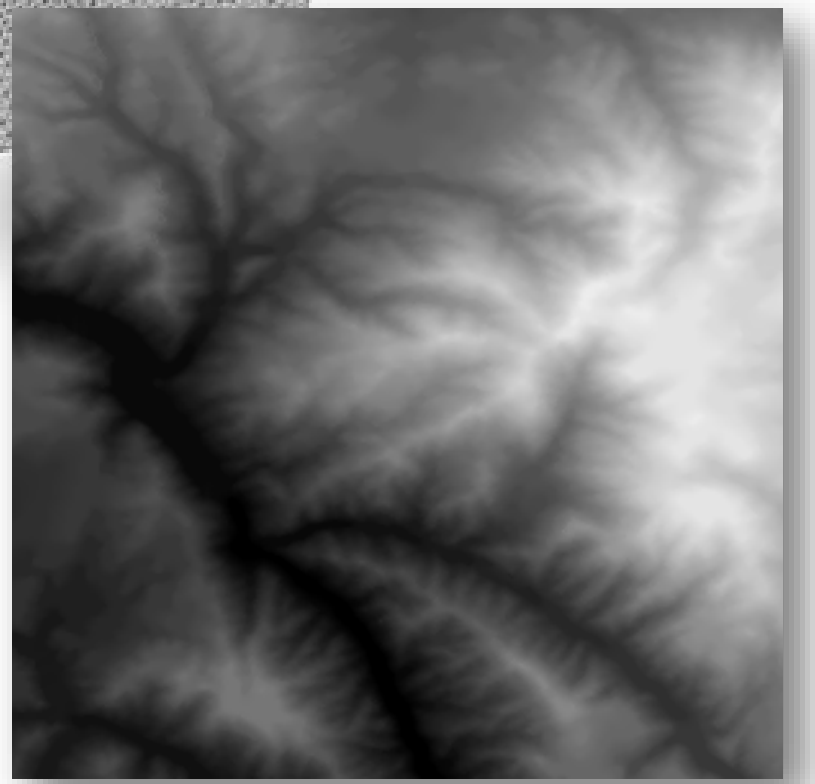
Pleiades
0.5m Resolution

Worldview-4
0.3m Resolution

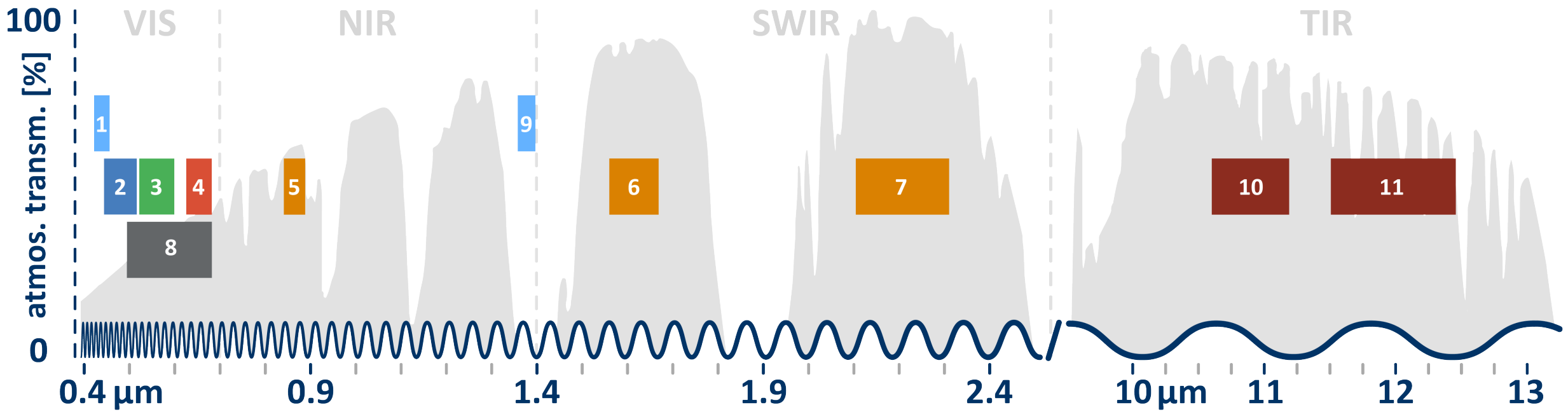


RASTER

Digital Elevation Model (DEM)

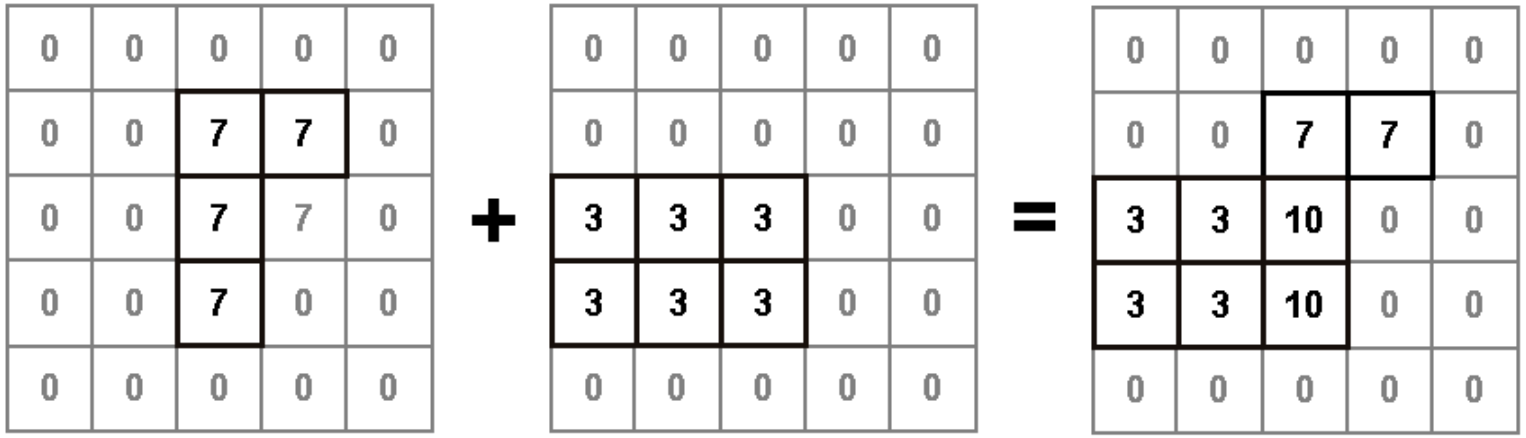


Spectral Bands of Digital Imagery



Landsat-8 Spectral bands

Band Math and Vegetation Indices



+, -, *, /, max, min, mean etc.

Examples:

- Surface elevation, maximum precipitation, average temperature, vegetation indices

Vegetation Indices & NDVI

Reflectance of healthy vegetation

50% NIR

8% Red

NDVI = 0.72

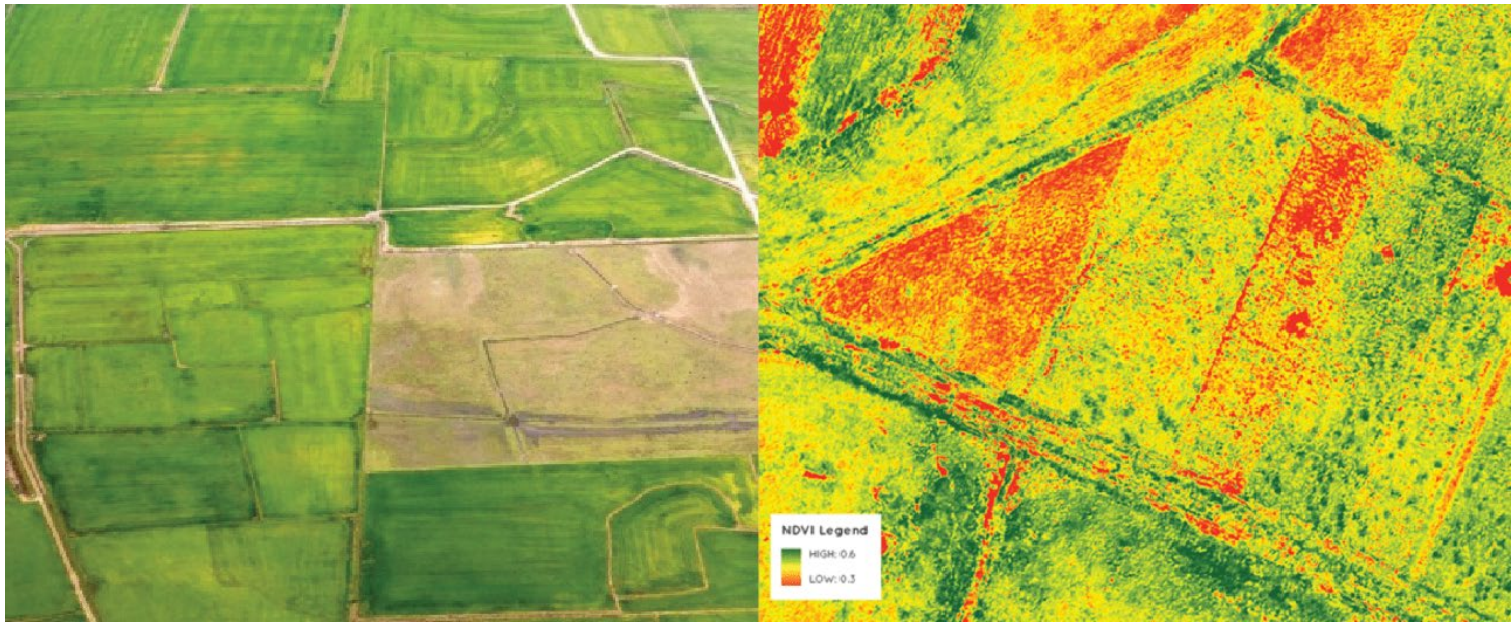
Reflectance of stressed vegetation

40% NIR

30% Red

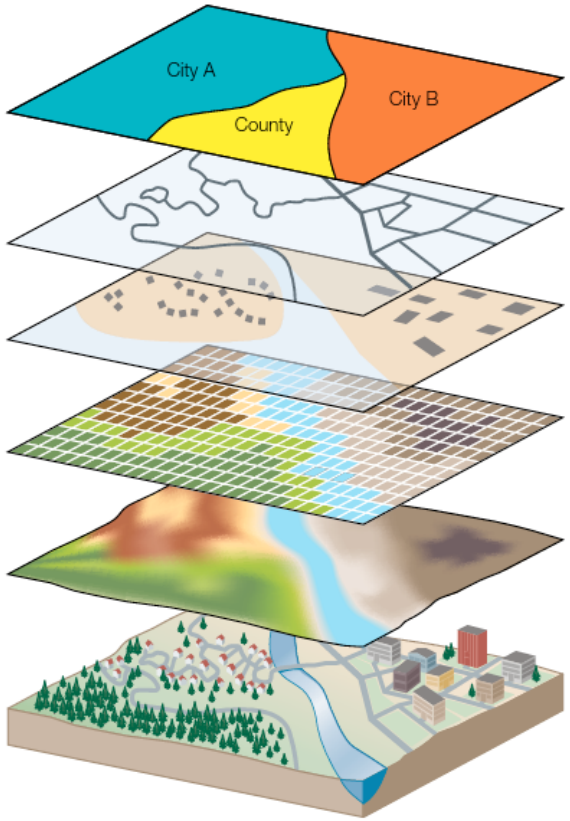
NDVI = 0.14

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



Vegetation index	Calculation formula
NDVI	$$NDVI = \frac{B_{NIR} - B_{RED}}{B_{NIR} + B_{RED}}$$
DVI	$DVI = B_{NIR} - B_{RED}$
RVI	$RVI = B_{NIR} / B_{RED}$
SAVI	$$SAVI = \frac{(B_{NIR} - B_{RED})(1 + L)}{B_{NIR} + B_{RED} + L}$$
MSAVI	$$MSAVI = B_{NIR} + \frac{1 - \sqrt{(2B_{NIR} + 1)^2 - 8(B_{NIR} - B_{RED})}}{2}$$
EVI	$$EVI = [(B_{NIR} - B_{RED}) / (B_{NIR} + 6B_{RED} - 7.5B_{BLUE} + 1)] \times 2.5$$
ARVI	$$ARVI = \frac{B_{NIR} - (2B_{RED} - B_{BLUE})}{B_{NIR} + (2B_{RED} - B_{BLUE})}$$

Summary



Vector data	
Political/ administrative boundaries	Polygons
Roads	Lines
Land parcels/ buildings	Points/lines/ polygons

Raster data	
Land use/ land cover	Cells (nominal data)
Elevation	Cells (interval data)

Real world