Geographic Data Science

Raster Data

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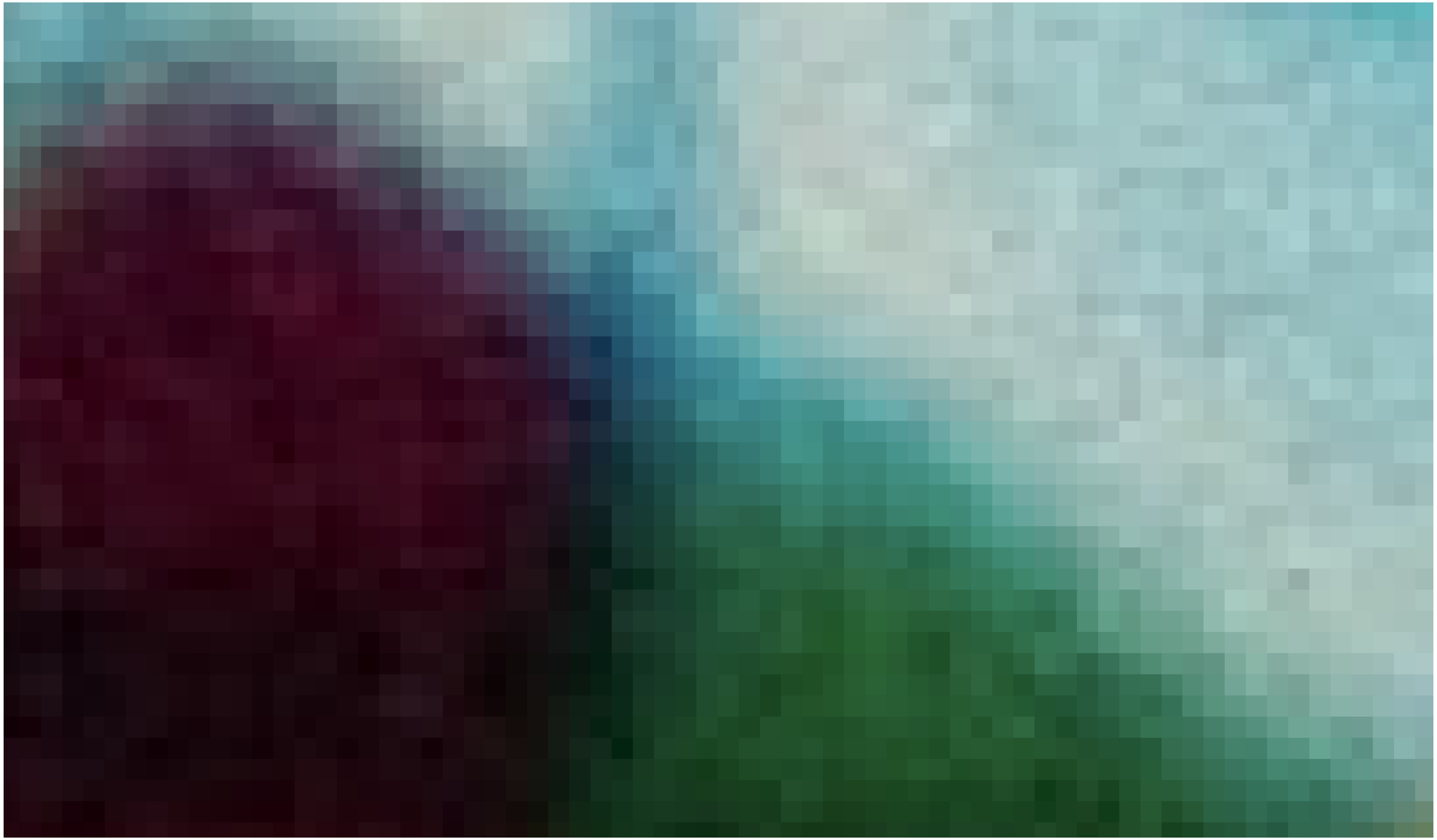
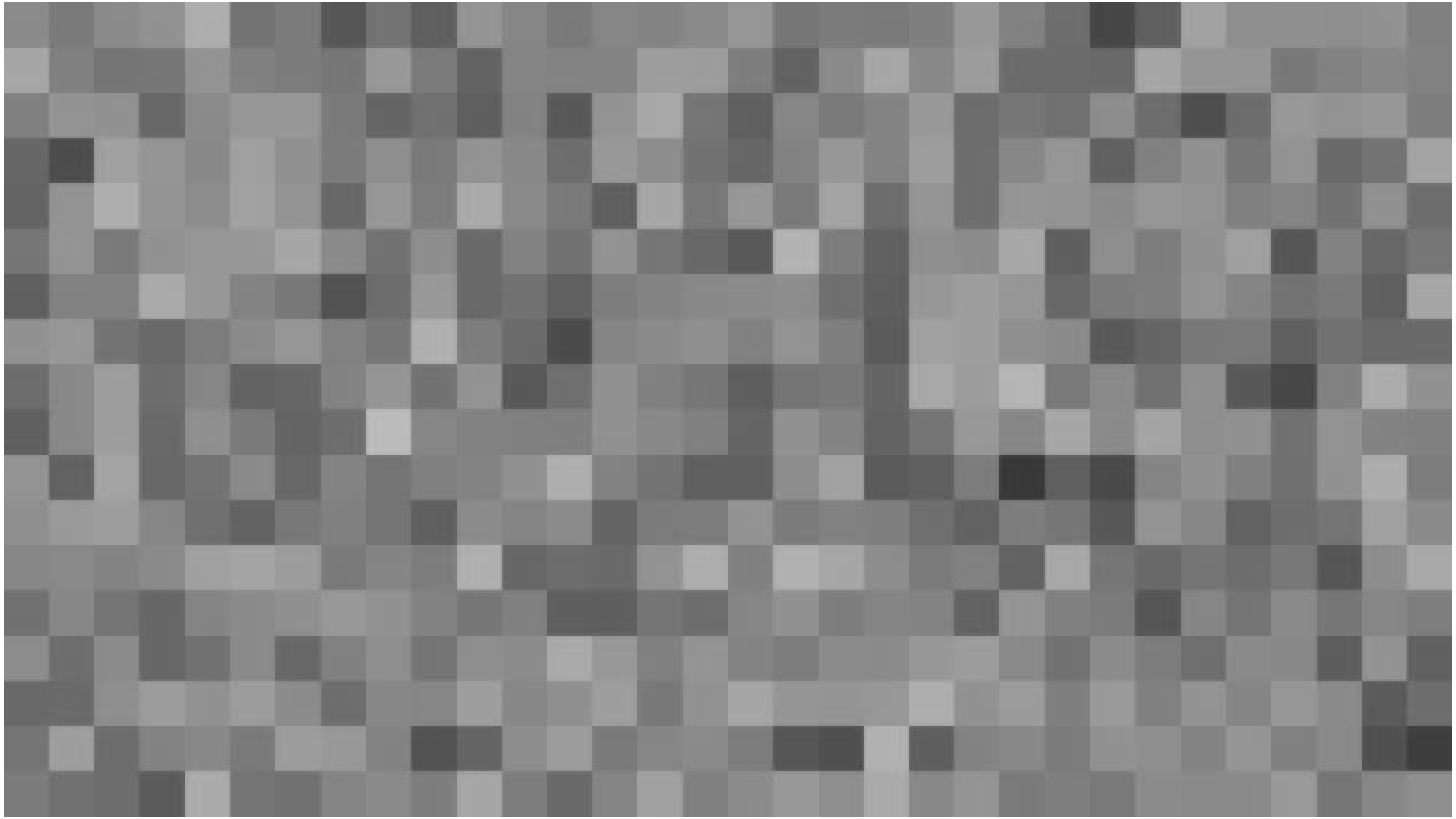
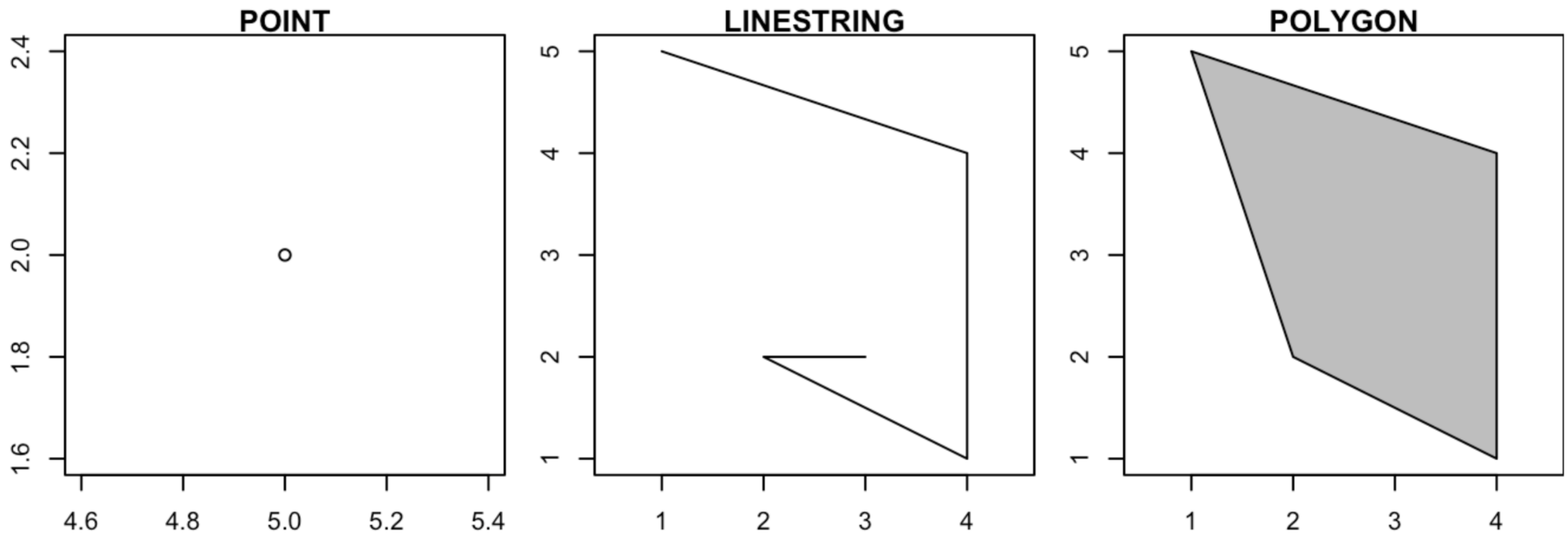
Raster Data


SOUTH AMERICA
BRAZIL



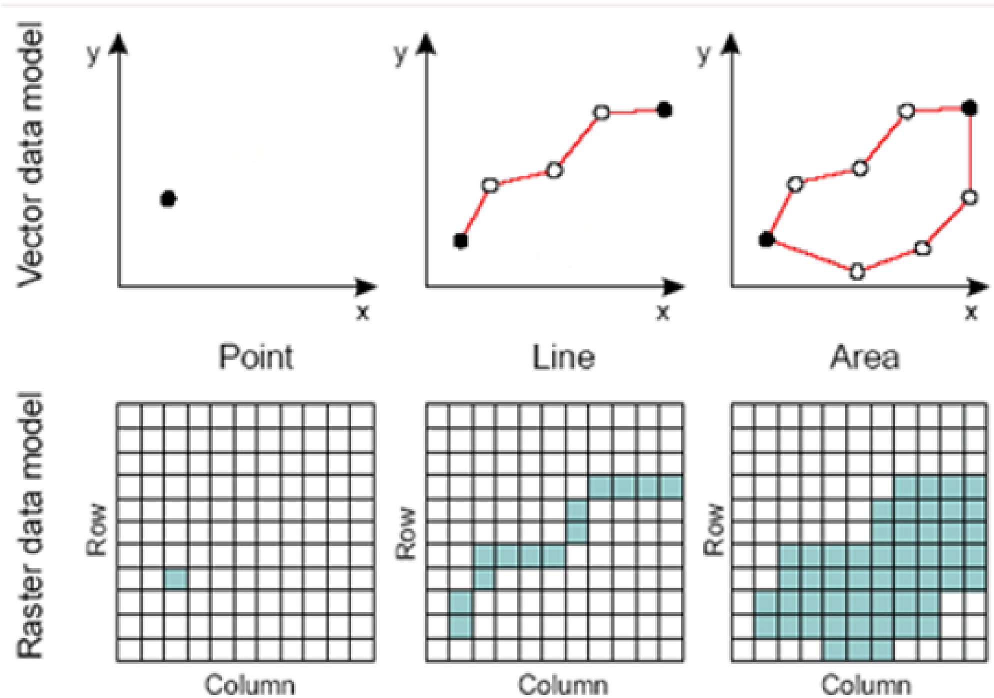


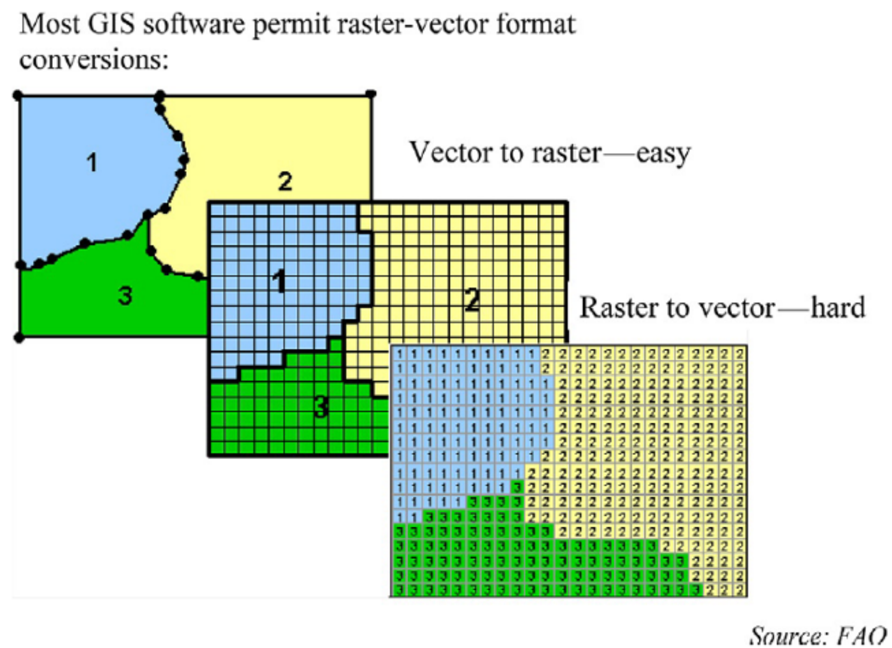
Vector Data



POINT
LINESTRING
POLYGON
2.4
2.2
2.0
1.8
1.6
4.6
4.8
5.0
5.2
5.4
5
4
3
2
1
1
2
3
4
5
4
3
2
1
1
2
3
4

Contrast with Vector Data

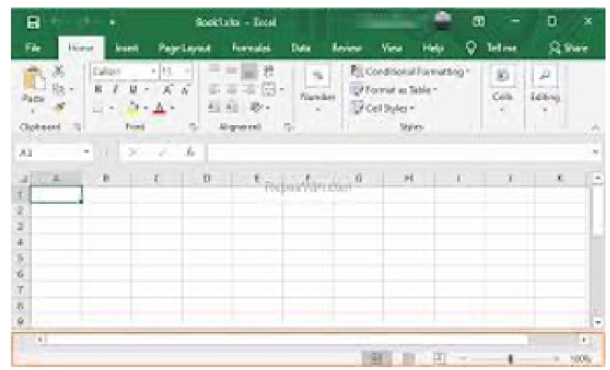


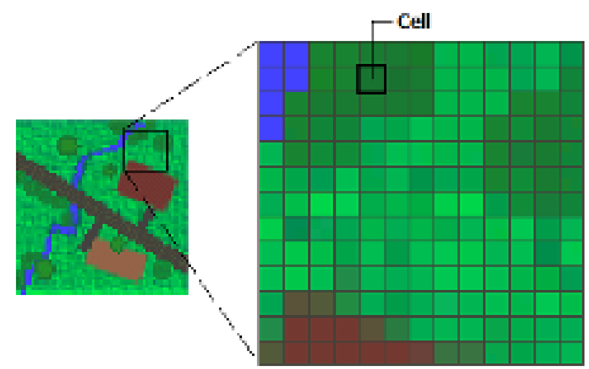


Definition

- Square grid of pixels. Pixel values can represent continuous or categorical variables:
- Divides 2-D space into regular cells - pixels
- Each cell has a single value
- Values assigned according to value at mean, centre point, or some other rule

File Formats





Raster Data Types

Grayscale Rasters

Continuous Data, Single Band

Nightlights data

- Nightlights data can be represented as a grayscale raster, where darker areas indicate lower levels of artificial light, and lighter areas represent higher levels of artificial light.
- The pixel values may represent the radiance or luminance values of nighttime lights.
- Used for monitoring urban development, assessing light pollution, and understanding human activity patterns at night…

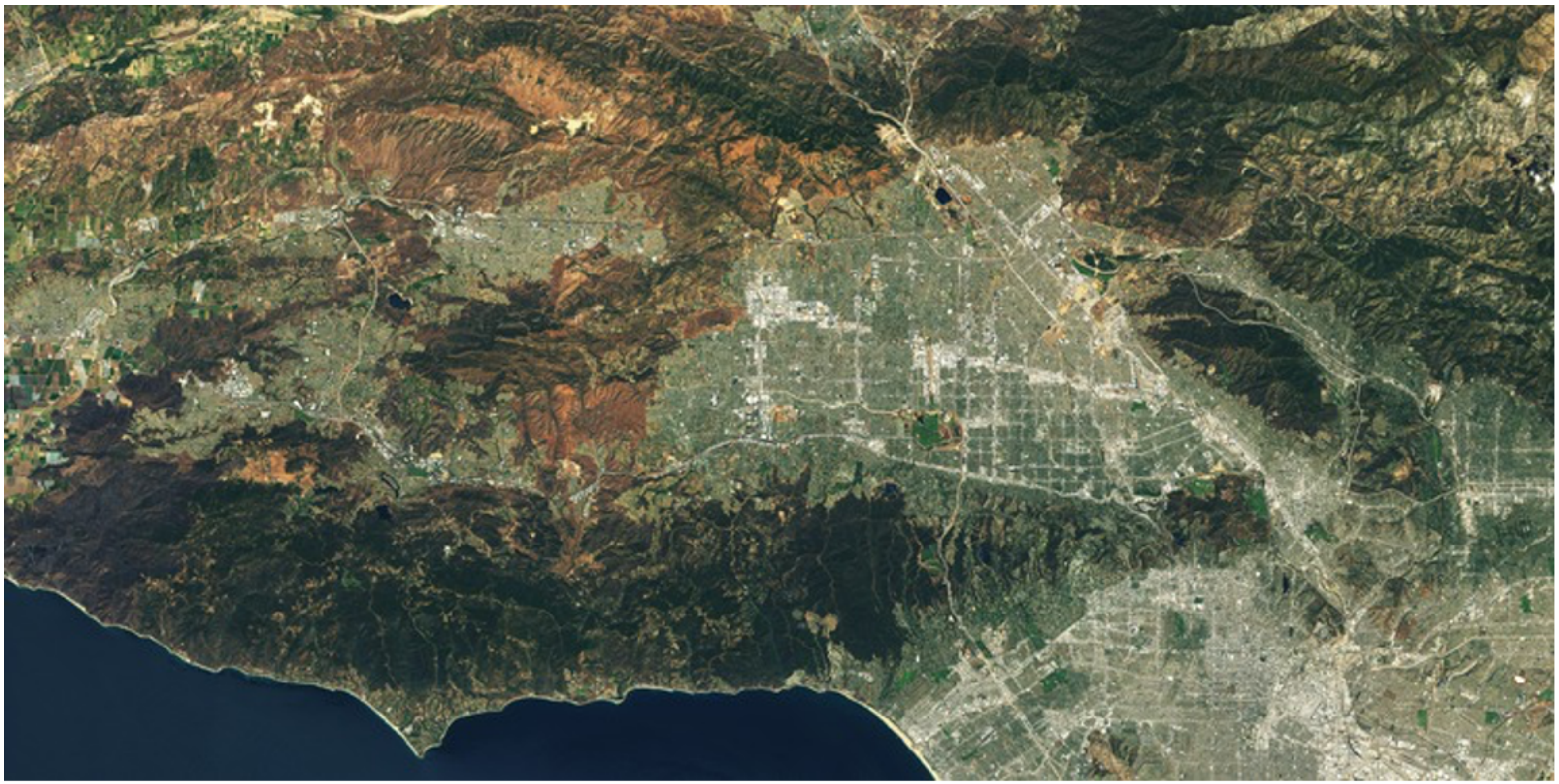
Multispectral Rasters

Multiple Bands

Band Number	µm	Resolution
1	0.433–0.453	30 m
2	0.450–0.515	30 m
3	0.525–0.600	30 m
4	0.630–0.680	30 m
5	0.845–0.885	30 m
6	1.560–1.660	30 m
7	2.100–2.300	30 m
8	0.500–0.680	15 m
9	1.360–1.390	30 m
10	10.6-11.2	100 m
11	11.5-12.5	100 m

Bands 2, 3 and 4

Blue, green, and red for true-color image.



Landsat Satellite Imagery

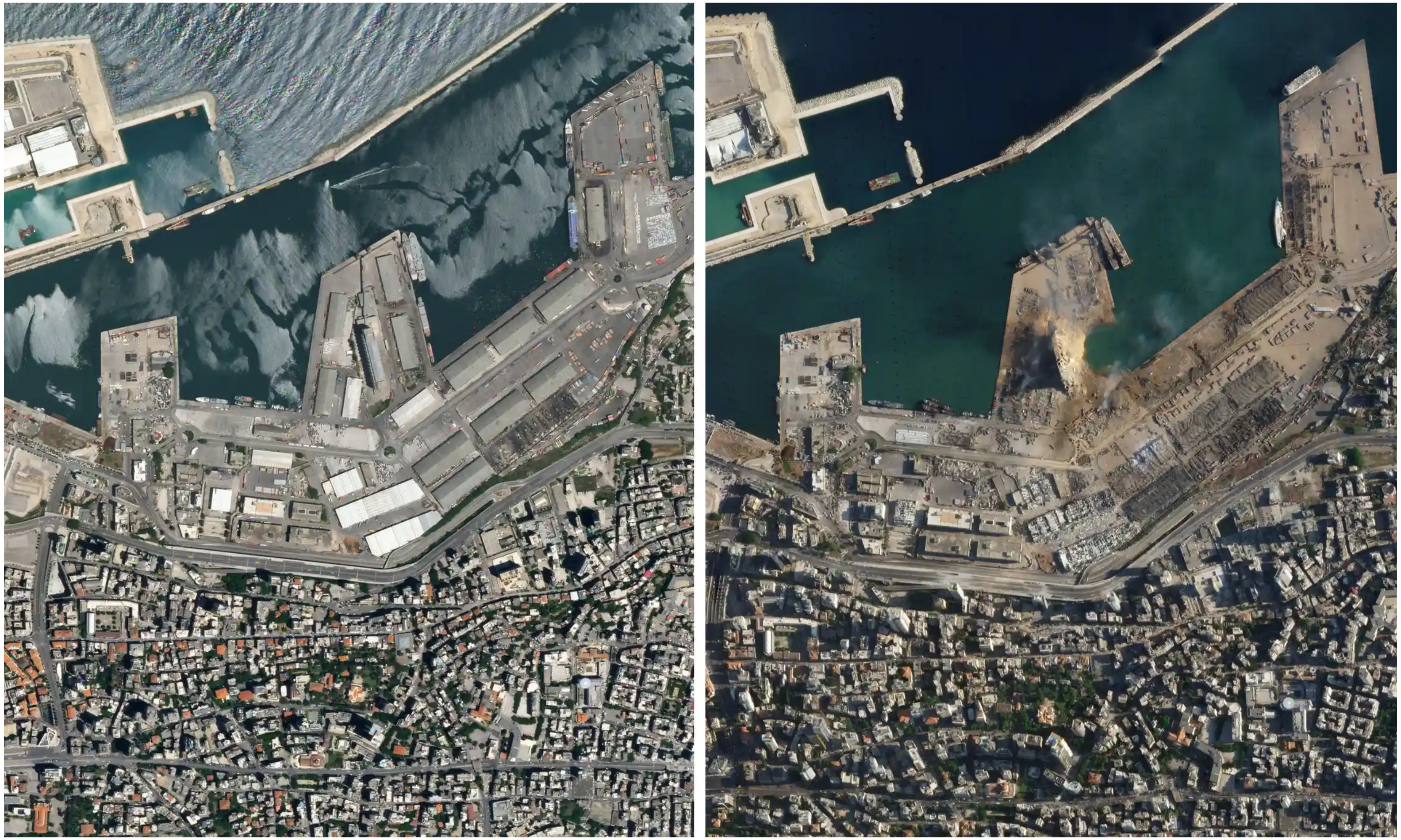
- Landsat satellites capture data in multiple spectral bands, such as visible, near-infrared, and thermal infrared.
- Each band is represented as a separate channel in a multispectral raster, allowing for the analysis of various aspects of the Earth’s surface.
- Different bands capture information related to vegetation, water, and land use.

Sources

- High spatial resolution data - costly commercial products.
- Lower spatial resolution data is free (NASA, ESA, etc).
- Several sources:
  - http://earthexplorer.usgs.gov/
  - https://lpdaacsvc.cr.usgs.gov/appeears/
  - https://search.earthdata.nasa.gov/search
  - https://lpdaac.usgs.gov/data_access/data_pool
  - https://scihub.copernicus.eu/
  - https://aws.amazon.com/public-data-sets/landsat/

Color Rasters

Digital Photography, Optical Satellites

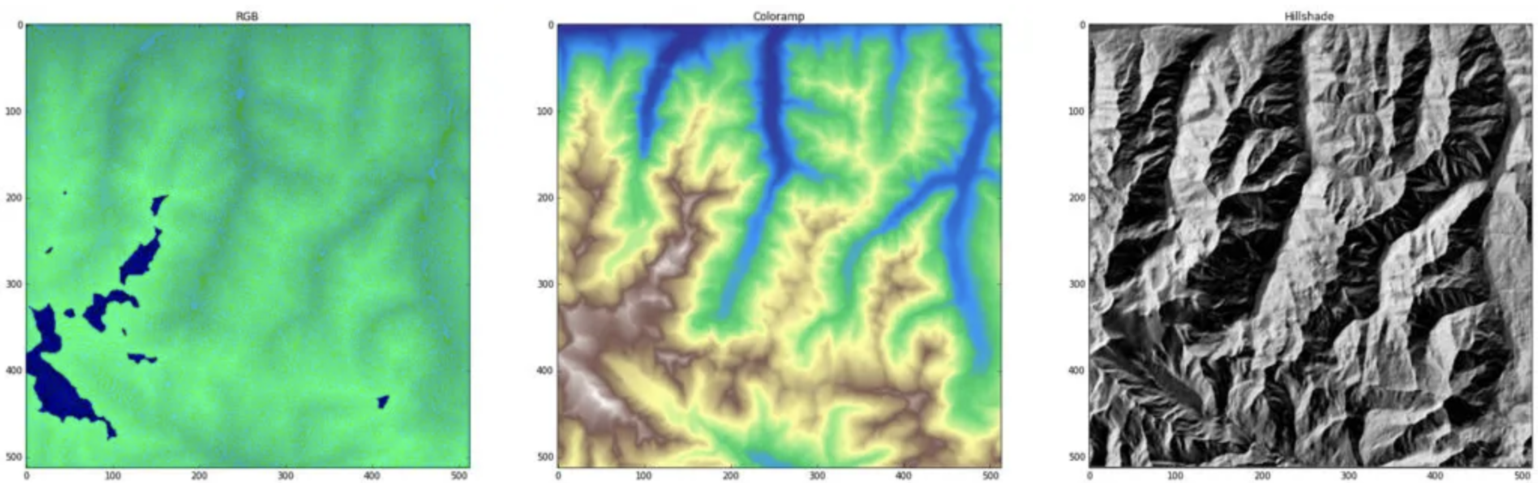


Color Rasters

- Digital photographs are typically stored as color rasters, combining red, green, and blue (RGB) channels to represent a full range of colors.
- Each pixel's RGB values determine the color in the image.
- Digital cameras and most image-editing software work with RGB color rasters.

Elevation Rasters

Representing Terrain Data



Left: *raw RGB*, Center: *decoded to hypsometric tint*, Right: *decoded to hillshades*

Mapbox

Digital Elevation Models (DEMs)

- Digital Elevation Models are used to represent terrain data.
- DEMs are rasters where each pixel’s value represents the elevation (height) of the corresponding location on the Earth’s surface.
- These rasters are widely used in geospatial applications, including topographic mapping and hydrological modeling.

Resolution

Spatial Resolution

- Level of detail or granularity in the spatial domain of data.
- How well an instrument or sensor can distinguish between objects or features in a given space.
- Higher spatial resolution = more detailed data
- Larger file sizes and Increased data processing demands.

Temporal Resolution

- Accuracy and precision of time measurements
- The higher the temporal resolution, the more frequent and precise the time measurements, allowing for the tracking of fast-changing processes or events.

Data Volume and Storage

- Unprecedented rate of collection.
- Fundamental aspects of data management.
- Challenges associated with handling and storing vast amounts of dat
- Traditional hardware-based solutions vs cloud-based storage (right approach?)

Future Trends

Big Data and Raster Information

- Transforming the way we handle geospatial data.
- Sensors and technology become more sophisticated
- The volume of raster information is growing exponentially.

Machine Learning and Raster Data

- Chen Wangyang, Wu, Abraham Noah, Biljecki and Filip, 2021. Classification of Urban Morphology with Deep Learning: Application on Urban Vitality. *Computers, Environment and Urban Systems*

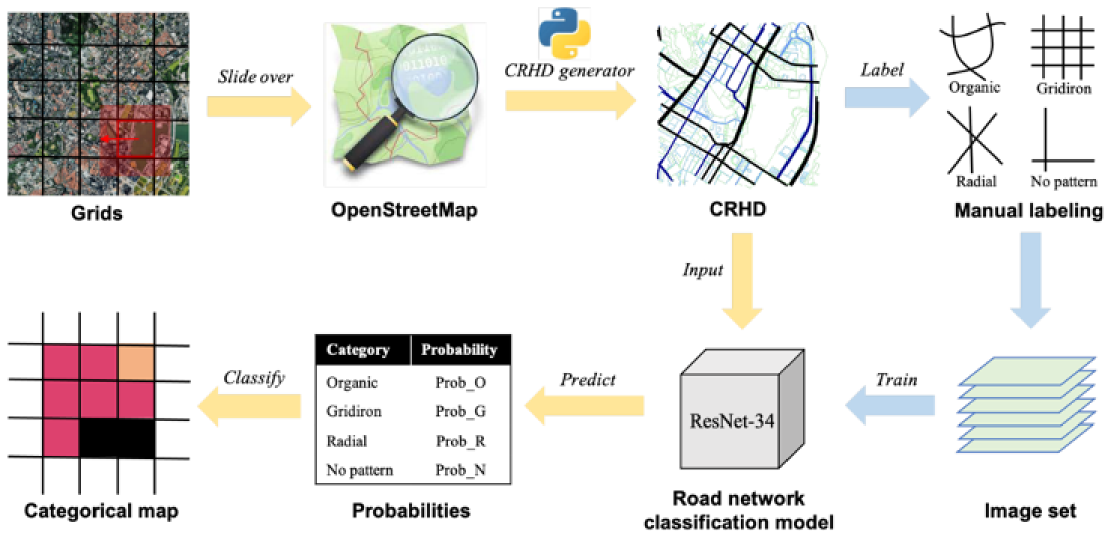


Figure 3: Process of road network classification.

Cloud-Based Raster Data Services

- Redefining how we store, process, and share raster data.
- The cloud offers scalability, accessibility, and cost-efficiency that traditional on-premises systems can't match.

Satellite data for Social Science

Henderson et al 2012.

“Measuring economic growth from outer space”, AER.

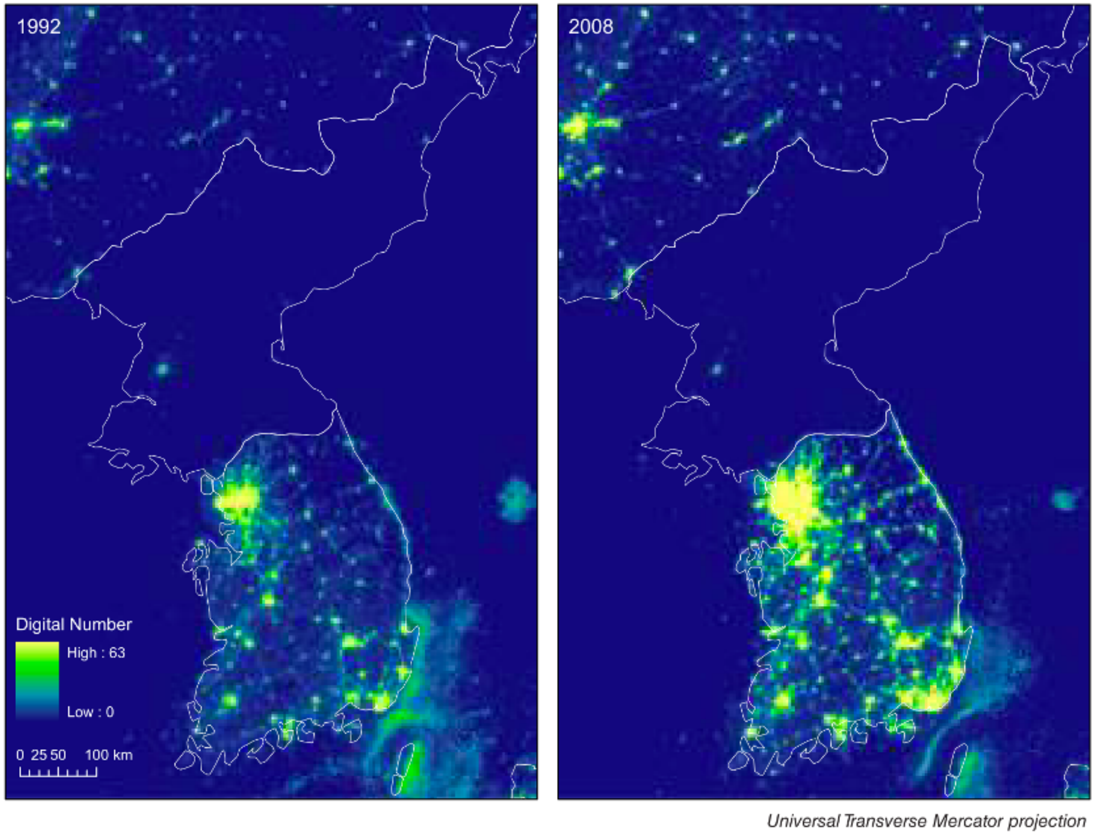
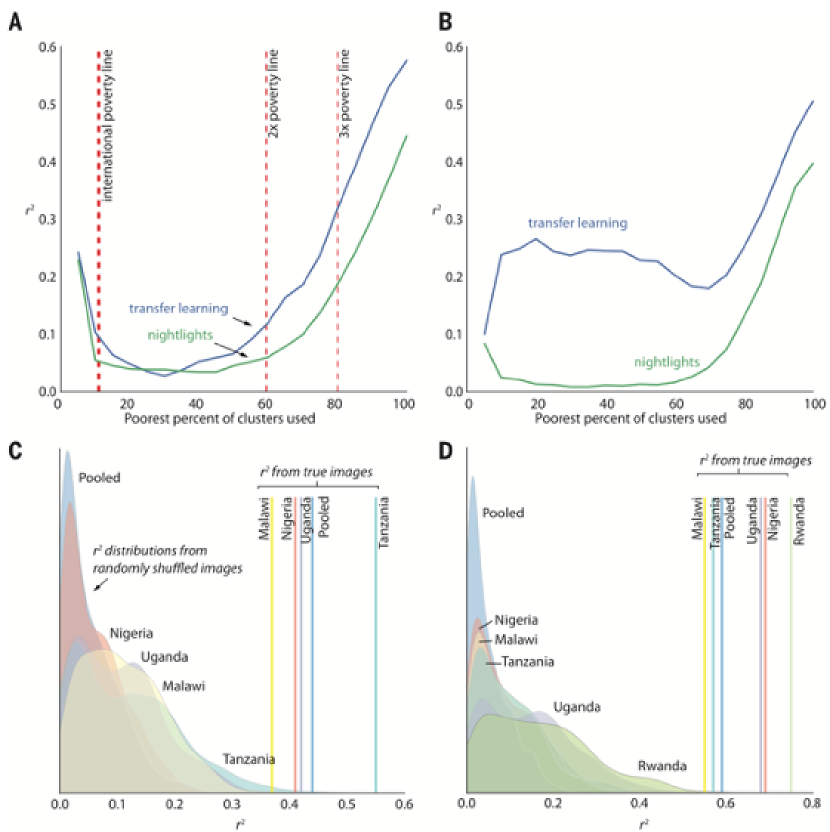


FIGURE 2. LONG-TERM GROWTH: KOREAN PENINSULA

Jean et al. 2016.

“Combining satellite imagery and machine learning to predict poverty.” Science



Questions