Handling raster data

Lab_06: Urban Terrain Analysis & Land Cover in NYC

402.467 / Applied GIS Fundamentals

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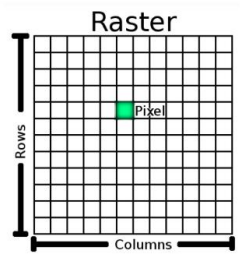
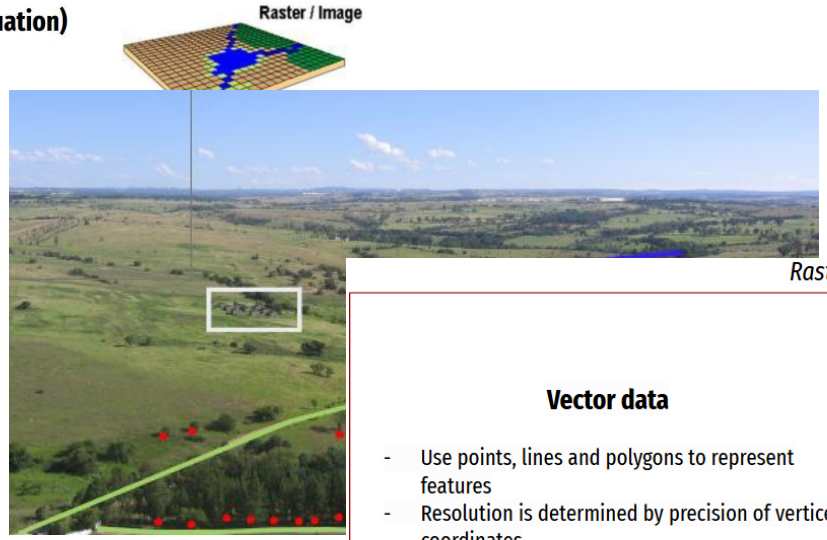
26 November 2025

Refresh our memories

Layer cake's components (continuation)

Raster data





Raster is vaster, vector is corrector

Vector data

- Use points, lines and polygons to represent features
- Resolution is determined by precision of vertices coordinates
- Efficiently represents discrete data
- Spatial relationships exist

Raster data

- Represented as 2D array of brightness values for pixels
- Resolution is determined by pixel size
- Efficiently represents continuous data
- Spatial relationships do not exist

Abubahia, Ahmed & Haig, Ella. (2017). Advancements in GIS map copyright protection schemes - a critical review. Multimedia Tools and Applications. 76. 10.1007/s11042-016-3441-z.

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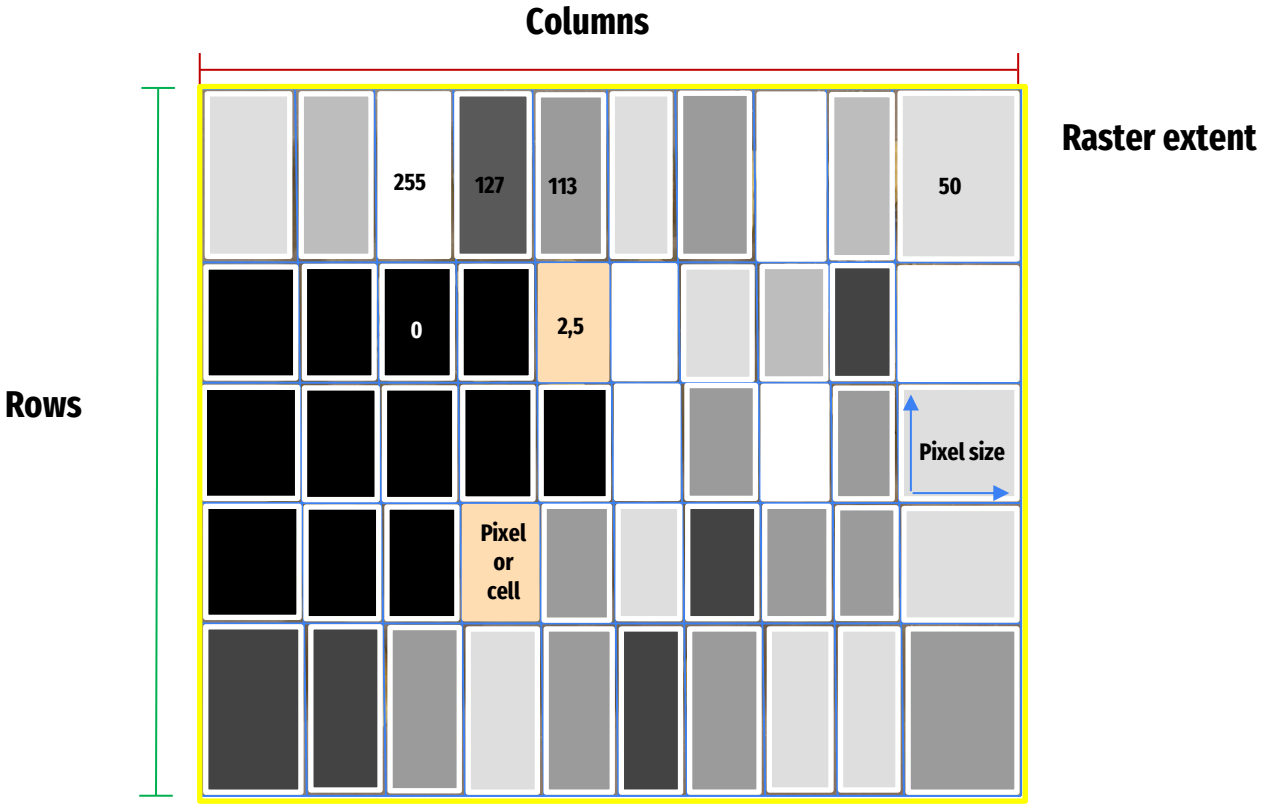
Everyday example



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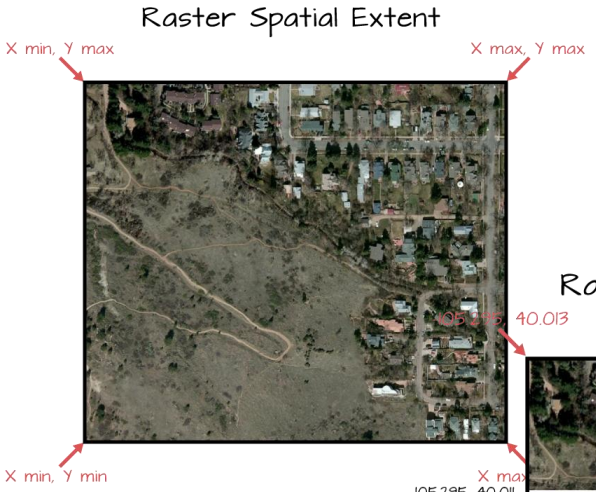
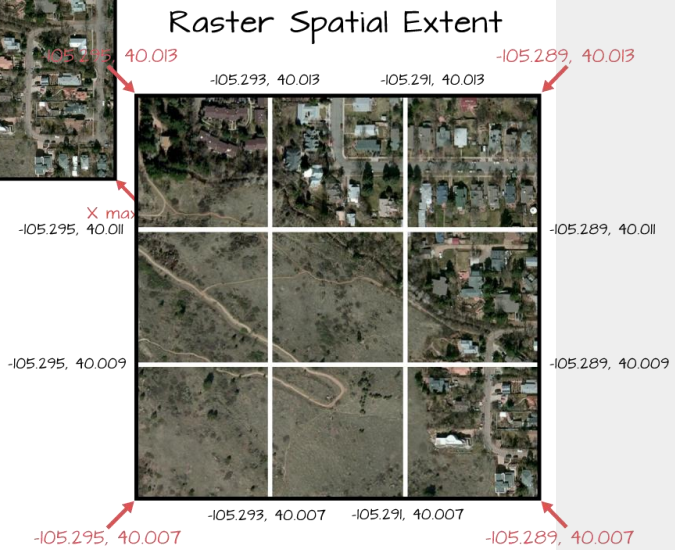
Spatial extent





A raster consists of:

1. Extent
2. Resolution
3. CRS

Information from provider

Extent	972620.3000000000465661,146772.6749999999301508 : 1030453.3000000000465661,208563.6749999999883585
Width	9639
Height	10299
Data type	UInt16 - Sixteen bit unsigned integer
GDAL Driver Description	
GDAL Driver Metadata	
Dataset Description	
Compression	
Band 1	• STATISTICS_APPROXIMATE=YES • STATISTICS_MAXIMUM=140 • STATISTICS_MEAN=23.632288998141 • STATISTICS_MINIMUM=0 • STATISTICS_STDDEV=34.998253222294 • STATISTICS_VALID_PERCENT=100 • Scale: 1 • Offset: 0
More information	• ZOOM_LEVEL=6 • AREA_OR_POINT=Point • IDENTIFIER=dem_brooklyn_6ft
Dimensions	X: 9639 Y: 10299 Bands: 1
Origin	972620.3000000000465661,208563.6749999999883585
Pixel Size	5.999896254798220419,-5.999708709583459587

Coordinate Reference System (CRS)

Name	EPSG:2263 - NAD83 / New York Long Island (ftUS)
Units	feet (US survey)
Type	Projected
Method	Lambert Conformal Conic
Celestial Body	Earth
Reference	Static (relies on a datum which is plate-fixed)

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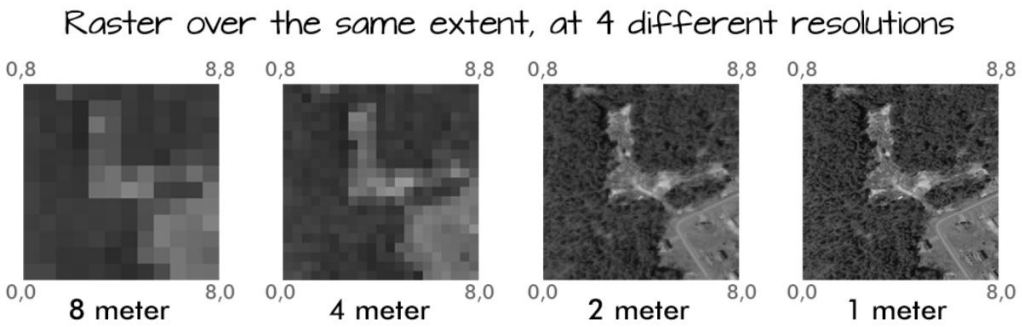
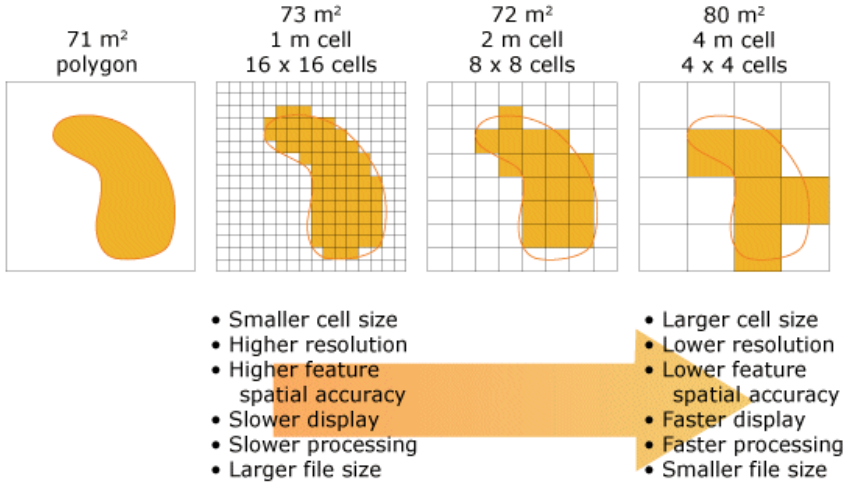
https://www.neonscience.org/resources/learning-hub/tutorials/raster-res-extent-pixels-r

Spatial resolution

bigger pixels mean less detail and smaller pixels mean more detail





Small pixel sizes are compared to large pixel sizes.

- The size of pixels in a raster determines its spatial resolution
- Each pixel represents an area on the Earth's surface
- The value of each pixel can be continuous (e.g., elevation) or categorical (e.g., land cover)

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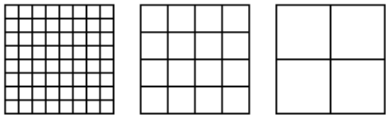
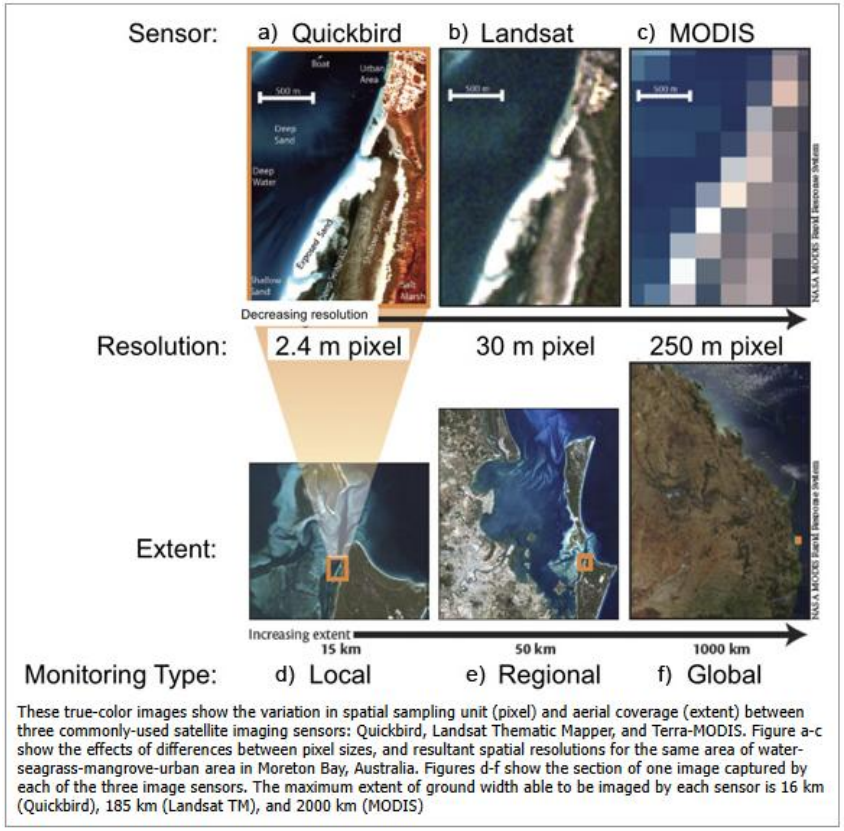
https://docs.qgis.org/3.40/en/docs/gentle_gis_introduction/raster_data.html

Spatial resolution



1. High < 5m
2. Medium 5 m - 100 m
3. Low >100 m

High, medium, low spatial resolution



These true-color images show the variation in spatial sampling unit (pixel) and aerial coverage (extent) between three commonly-used satellite imaging sensors: Quickbird, Landsat Thematic Mapper, and Terra-MODIS. Figure a-c show the effects of differences between pixel sizes, and resultant spatial resolutions for the same area of water-seagrass-mangrove-urban area in Moreton Bay, Australia. Figures d-f show the section of one image captured by each of the three image sensors. The maximum extent of ground width able to be imaged by each sensor is 16 km (Quickbird), 185 km (Landsat TM), and 2000 km (MODIS)

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https://sees-rsrc.science.uq.edu.au/rstoolkit/en/html/atmospheric/help/spatial-dimensions.html

Spatial resolution Vs scale

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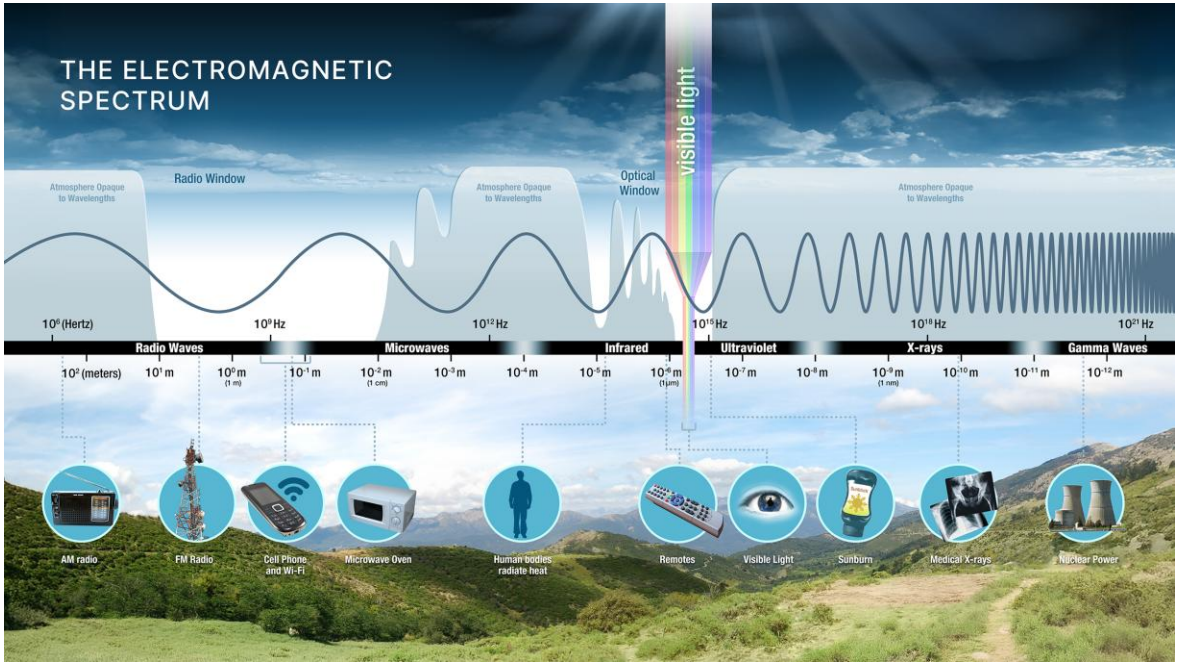
https://pro.arcgis.com/en/pro-app/3.5/help/data/imagery/pixel-size-of-image-and-raster-data-pro-.htm

Spectral resolution

- What is spectral resolution?

- How precisely a sensor can 'see' different wavelengths (colours) of light

- If an image consists of only one band, it is called a **grayscale** image (e.g. DEM)
- When raster data contains bands from different parts of the electromagnetic spectrum, they are called **multi-spectral images**
- Three of the bands of a multi-spectral image can be shown in the colours Red, Green and Blue



https://www.earthdata.nasa.gov/learn/earth-observation-data-basics/remote-sensing

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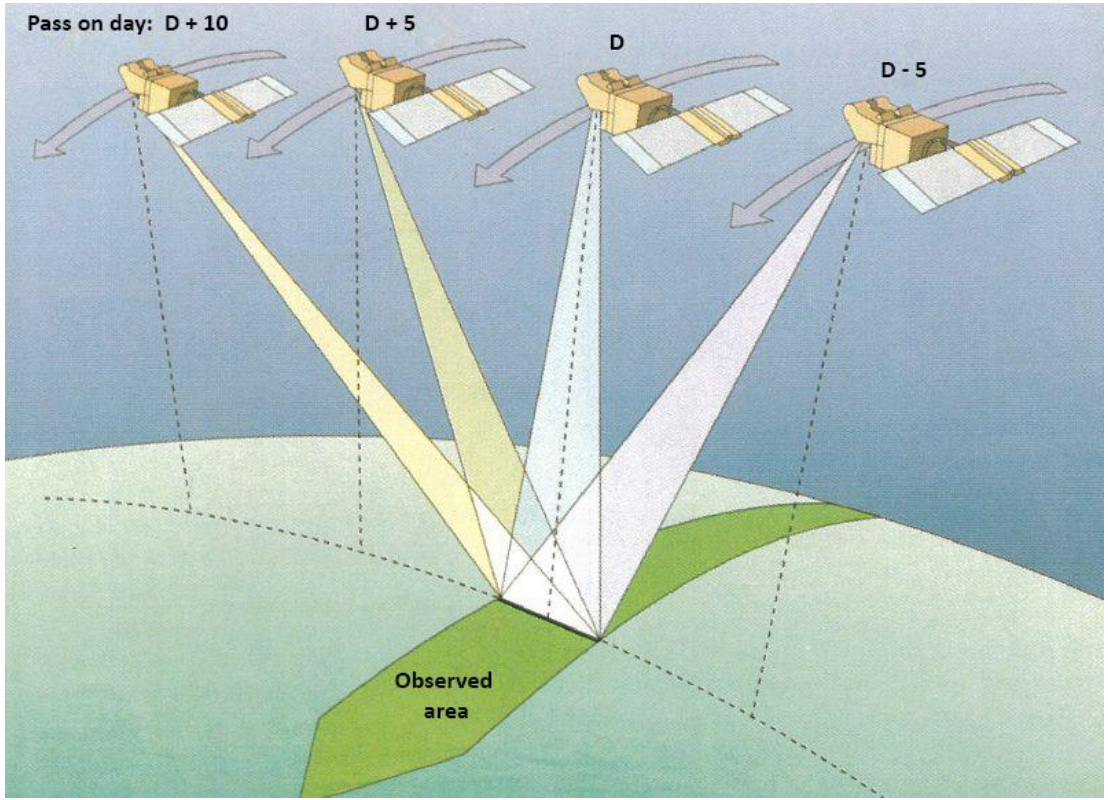
Temporal resolution

Temporal resolution refers to how often a sensor obtains imagery of a particular area

High temporal resolution, means a sensor revisits a location frequently (daily or multiple times per day)
Low temporal resolution, means longer intervals between visits (weeks or months)

Why it matters?



https://eo.belspo.be/en/iii23-temporal-resolution

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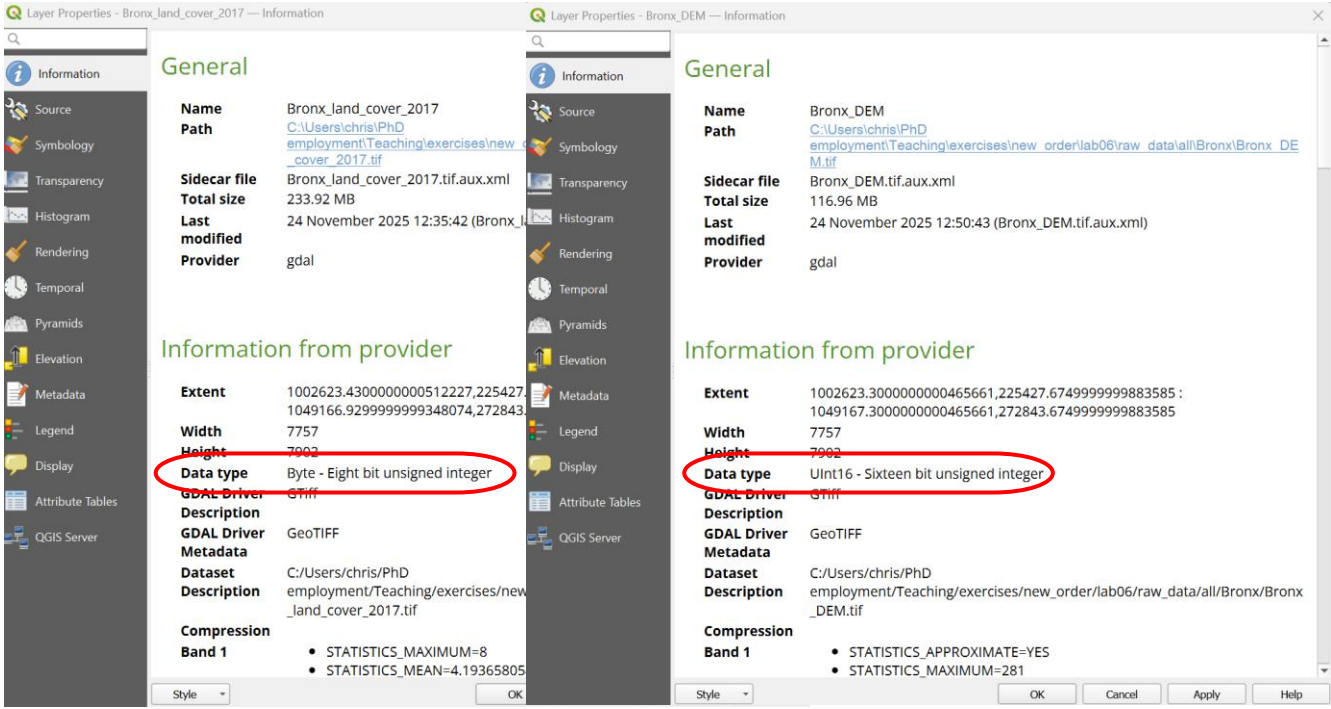
Radiometric resolution

Radiometric resolution is how many brightness levels a sensor can detect

Bit depth examples:

- 8-bit → 2^8 = 256 possible values
- 16 -bit → 2^{16} =65,536 possible values



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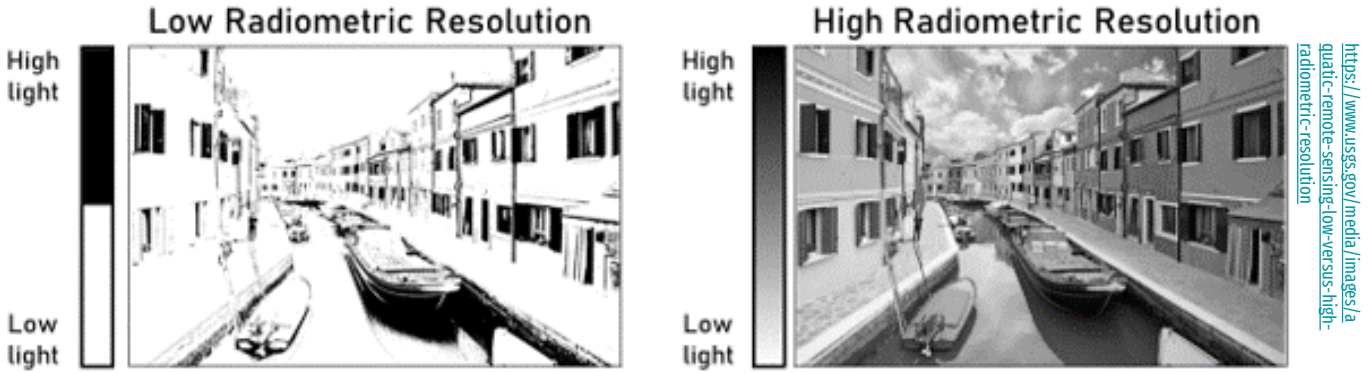
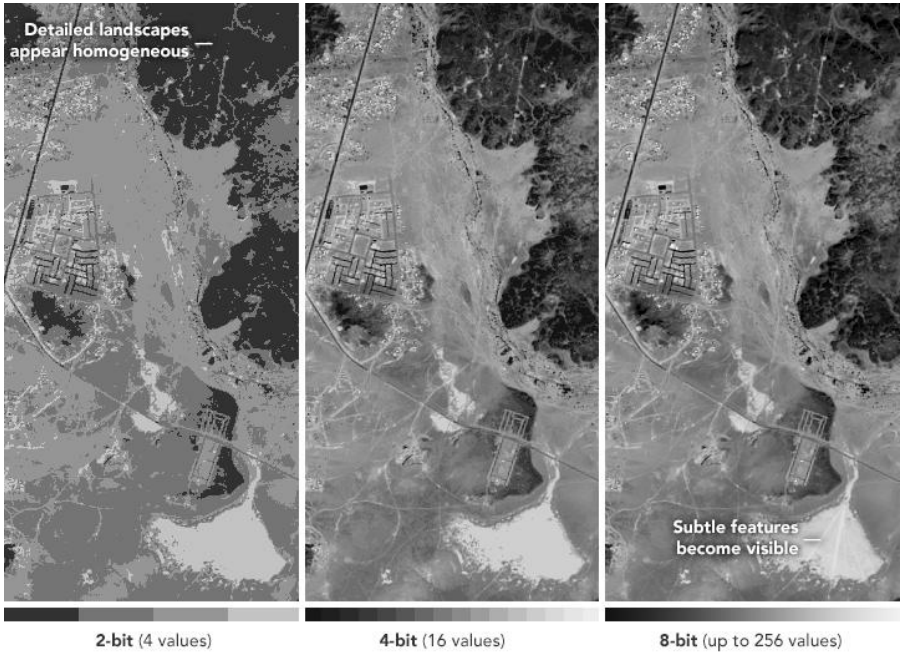


https://www.usgs.gov/media/images/aquatic-remote-sensing-low-versus-high-radiometric-resolution

Examples

More levels=more tonal variation visible



https://www.earthdata.nasa.gov/learn/earth-observation-data-basics/remote-sensing

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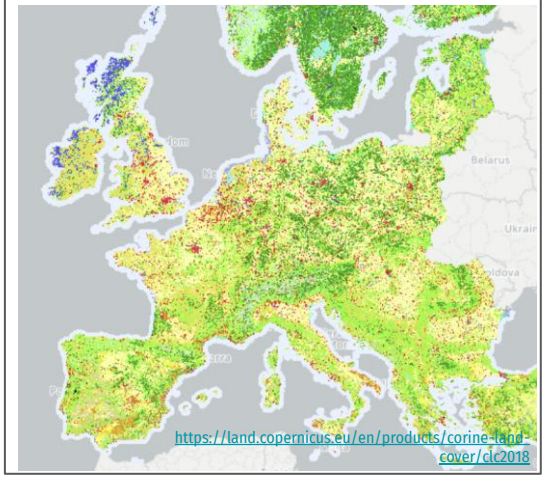
Sources of raster data

Satellite Remote Sensing

CORINE Land Cover (Copernicus) raster 100 m



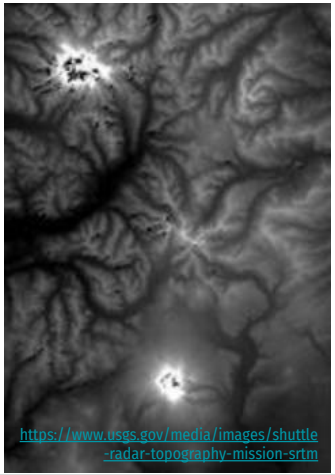
https://land.copernicus.eu/en/products/corine-land-cover/clc2018

Aerial photography

Aerial image of Jakominiplatz

Digital Elevation Models

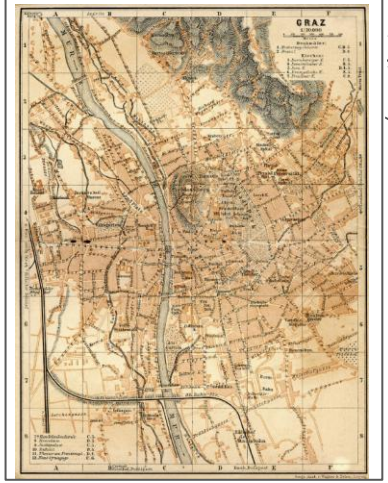
SRTM Mt. Rainier and Mt. Adams USA



https://www.usgs.gov/media/images/shuttle-radar-topography-mission-srtm

Scanned maps

Historical map of Graz



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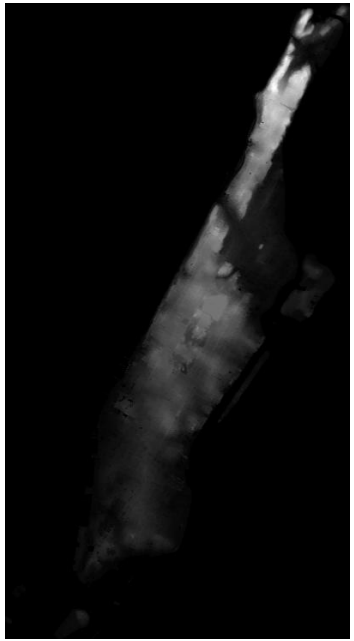
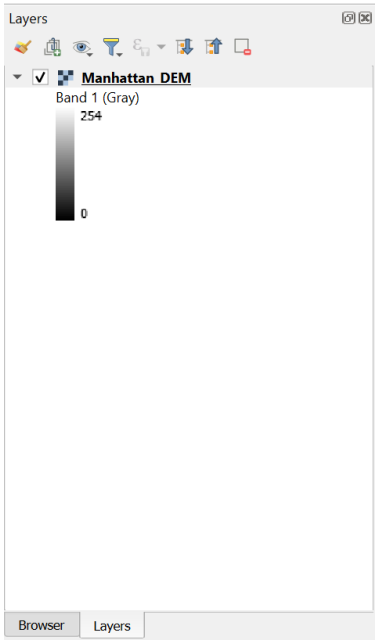
Continuous rasters

Measurement data that are continuous integers and can take any value within a range; typically, elevation and temperature data





Discrete rasters

Spatially discrete and categorized data; typically, land cover types or land use categories