Institute for advanced architecture of Catalonia | BARCELONA

MASTER IN CITY & TECHNOLOGY
DIGITAL TOOLS AND BIG DATA
2020/2021

FACULTY DIEGO PAJARITO

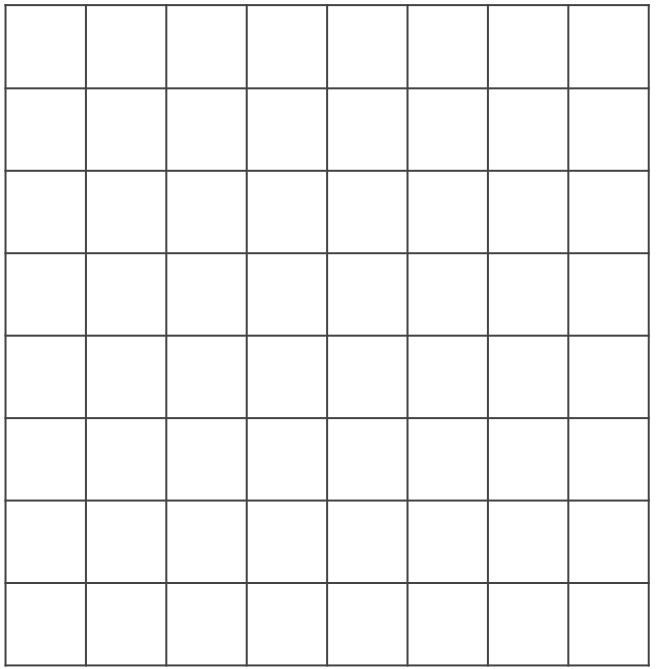
Continuous fields

When sharp boundaries are difficult to meet

A surface represents “ values for a continuous single-valued variable, z(x,y), as the spatial attributes (coordinates) x and y vary”

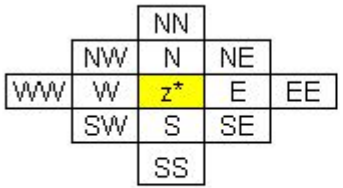
Surfaces are typically:

- **Very smooth changes over large areas, or exhibit smooth wave-like variations (e.g. air pressure at a given altitude)**
- **Extremely jagged with sharp variations over small regions.**

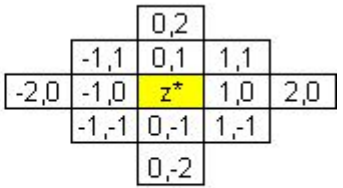


Source: https://www.spatialanalysisonline.com/HTML/index.html?modeling_surfaces.htm

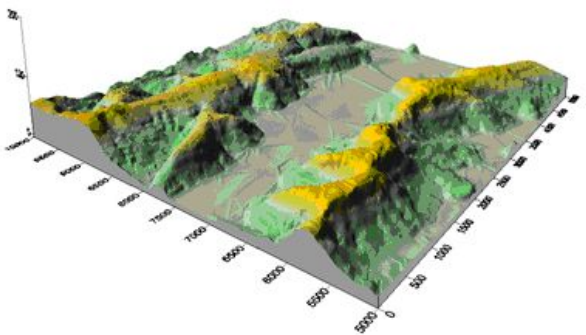
Digital elevation model (DEM) and raster

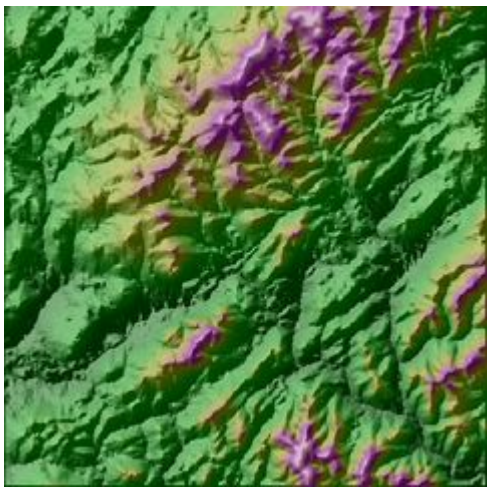


A. NSEW



B. OFFSET





Source: https://www.spatialanalysisonline.com/HTML/index.html?test_datasets.htm

Digital elevation model (DEM) and ASCII data files

met15v20as0f0420Amr1r100.txt

```
NCOLS                1878
NROWS                1261
XLLCENTER       400590.000000000
YLLCENTER       4576080.00000000
CELLSIZE        15.0000000000000
NODATA_VALUE         -9999
278.88 273.54 270.11 266.21 264.61 262.93 260.84 259.13 257.95 256.77 255.59
255.04 251.70 250.84 249.99 249.12 248.50 247.88 247.96 247.82 247.82 247.85
247.91 248.11 248.26 248.13 248.54 250.42 250.96 251.48 252.37 253.58 254.58
255.45 256.74 256.83 257.93 258.56 259.03 260.23 261.46 262.45 263.34 264.64
265.94 266.93 267.66 270.05 271.96 272.50 273.54 274.96 277.68 280.44 280.89
284.87 289.85 292.73 294.43 291.82 286.98 283.97 282.31 282.82 284.47 286.11
288.28 291.08 292.91 294.15 291.24 287.31 285.89 281.26 274.43 274.01 273.55
273.79 274.04 273.86 273.55 276.70 282.54 284.88 287.22 290.99 296.22 296.34
296.26 296.15 296.11 296.17 295.79 295.55 293.04 285.06 280.66 279.62 279.63
284.62 285.17 287.90 292.83 292.93 293.31 293.72 292.99 292.20 292.09 292.68
292.59 292.71 293.01 293.73 294.28 294.65 294.66 294.55 294.18 293.48 292.81
293.12 292.92 291.99 291.61 291.25 291.23 291.21 291.23 291.26 291.93 291.17
290.99 287.27 285.24 286.57 287.01 285.18 283.94 280.61 278.98 277.73 277.46
275.93 275.65 274.09 272.48 270.26 267.59 264.17 258.34 256.61 255.06 252.41
252.65 259.67 262.58 263.65 264.80 265.62 264.73 264.75 265.35 266.92 268.71
269.95 273.22 274.62 276.20 275.74 275.28 273.18 270.49 267.94 265.49 262.38
260.66 260.94 261.49 260.58 258.23 256.16 254.69 252.34 249.28 247.05 245.24
245.81 245.42 244.89 244.01 242.42 235.81 234.27 235.11 233.25 232.49 232.51
```

Source: https://www.icgc.cat/es/Descargas/Elevaciones

Institut Cartogràfic i Geològic de Catalunya disposes elevation data:

Digital elevation model (DEM) with multiple pixel sizes:

- 15x15m
- 5x5m
- 2x2m

Slopes higher than 20%

Source: https://www.icgc.cat/es/Descargas/Elevaciones

Download and integrate the individual files for Barcelona and and Catalunya

Organise all files and visualise them into QGIS

Try to get a common visual representation of elevation values

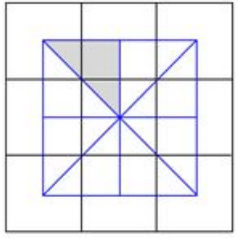
Generate an integrated for Catalunya

Source: https://www.icgc.cat/es/Descargas/Elevaciones

Gradient: Slope and Aspect

$$S = \sqrt{\left(\frac{z_E - z_W}{2\Delta x}\right)^2 + \left(\frac{z_N - z_S}{2\Delta y}\right)^2}$$

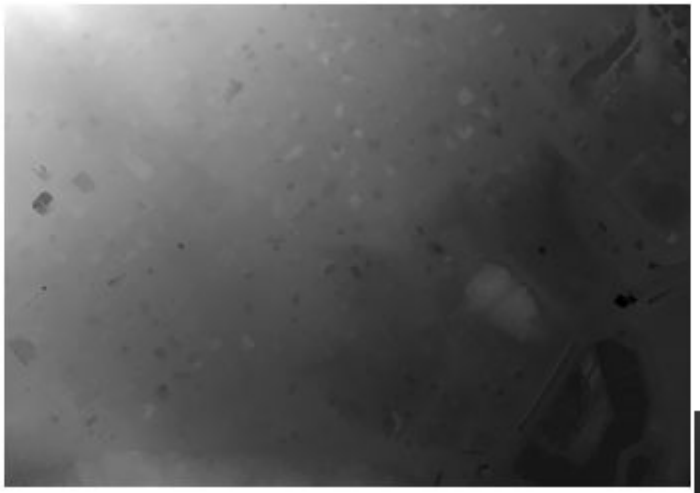
N	N	N
W		W
S	S	S

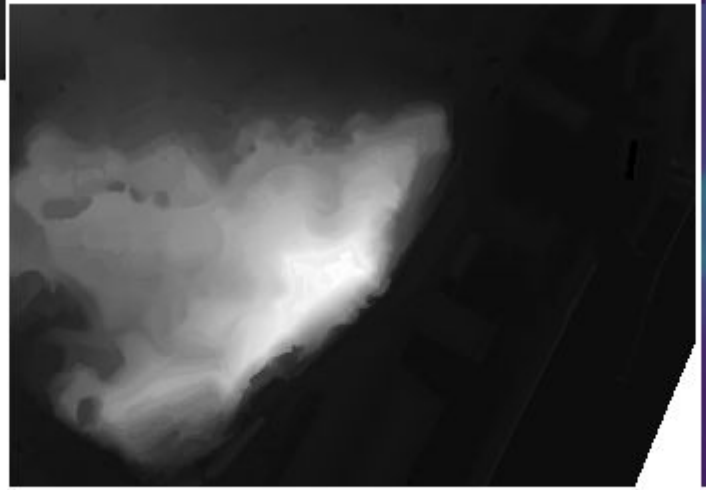


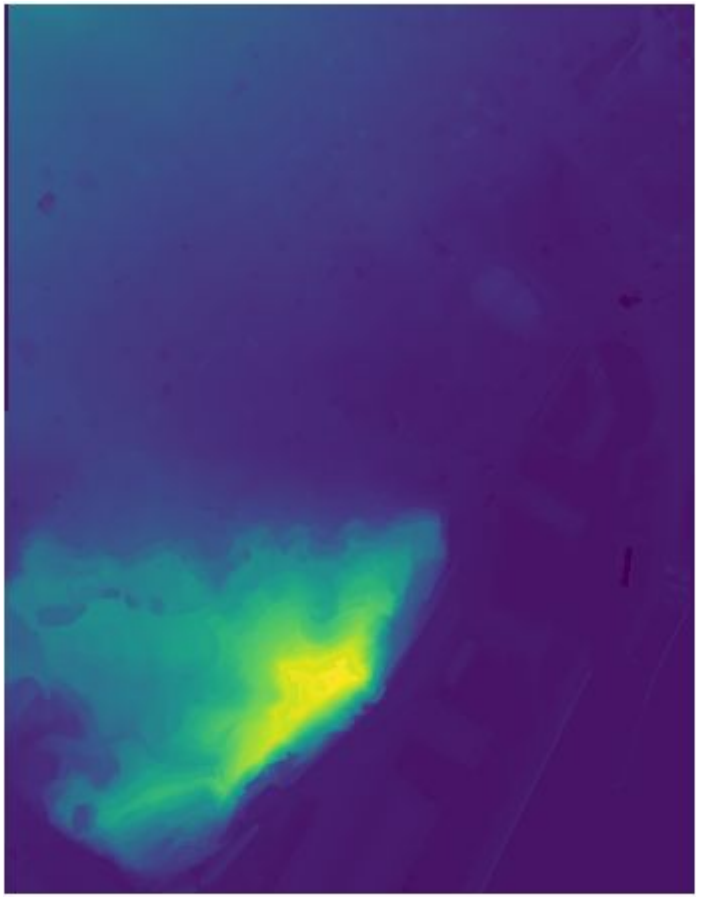
A. Source terrain map	B. Aspect — classified
C. Aspect — graduated colors	D. Aspect — NSEW classification

Source: https://www.spatialanalysisonline.com/HTML/index.html?gradient__slope_and_aspect.htm

Source: https://lpdaac.usgs.gov/products/astgtmv003/

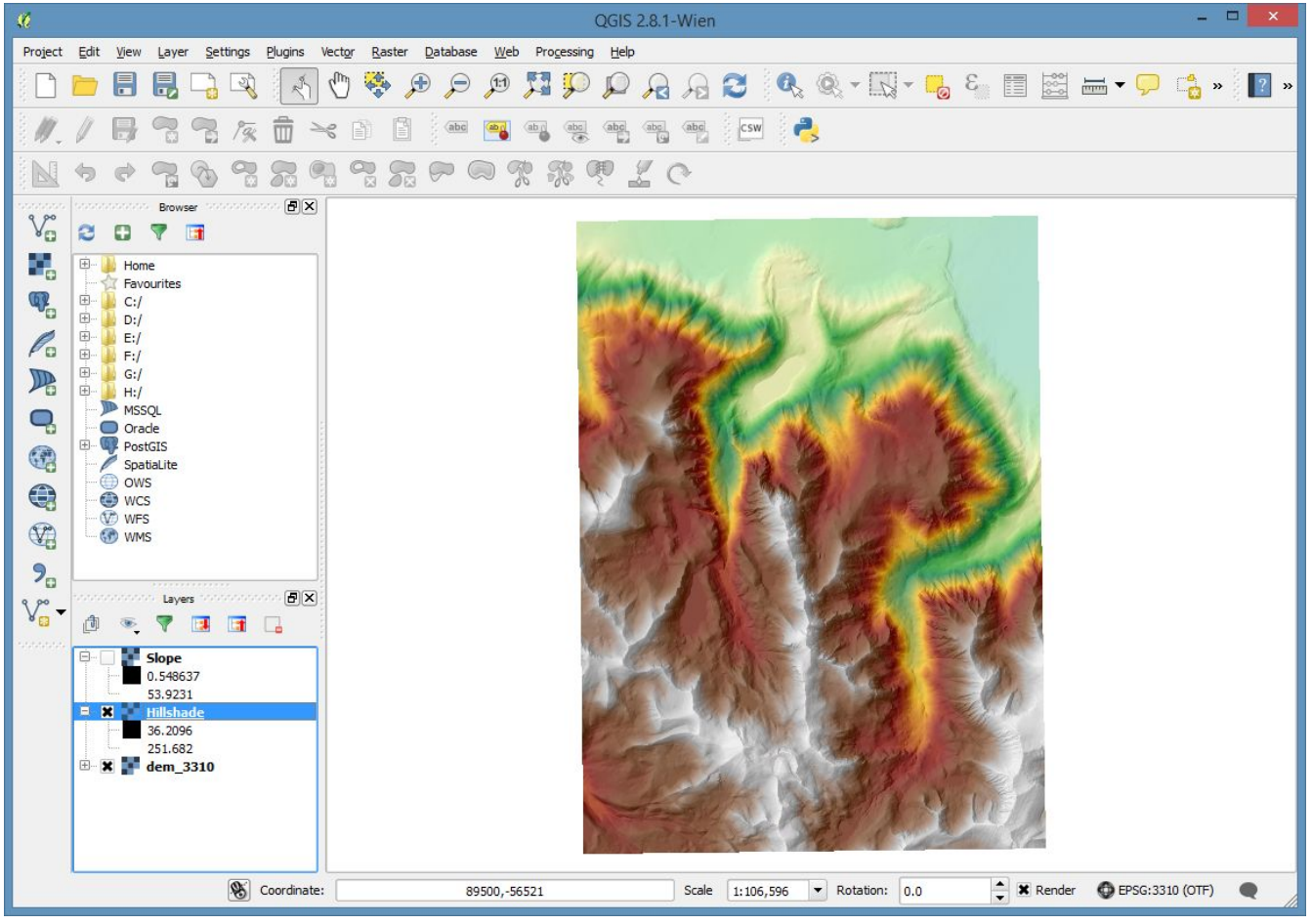






Based on a shared geospatial reference system multiple images can turn into a single one

Source: https://support.dronesmadeeasy.com/hc/en-us/articles/115003641246-QGIS-Raster-Merging



Min	*Max*	***Value***
-999	0	**0**
0	10	**1**
...	...	**...**
190	200	**20**

Source: https://nates-intro-to-qgis.readthedocs.io/en/latest/rasters.html

Satellite Imagery

Earth observation from the space

“Aerial photography was first practiced by the French photographer and balloonist **Gaspard-Félix Tournachon**, known as "Nadar", in **1858** over Paris, France. However, the photographs he produced no longer exist and therefore the earliest surviving aerial photograph is titled '***Boston, as the Eagle and the Wild Goose See It.***' Taken by James Wallace Black and Samuel Archer King on October 13, **1860**, it depicts Boston from a height of **630m**.”

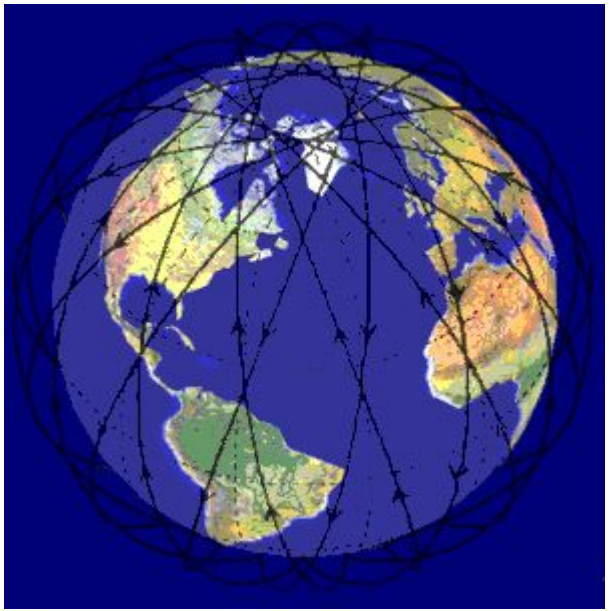
Short History: https://en.wikipedia.org/wiki/Aerial_photography

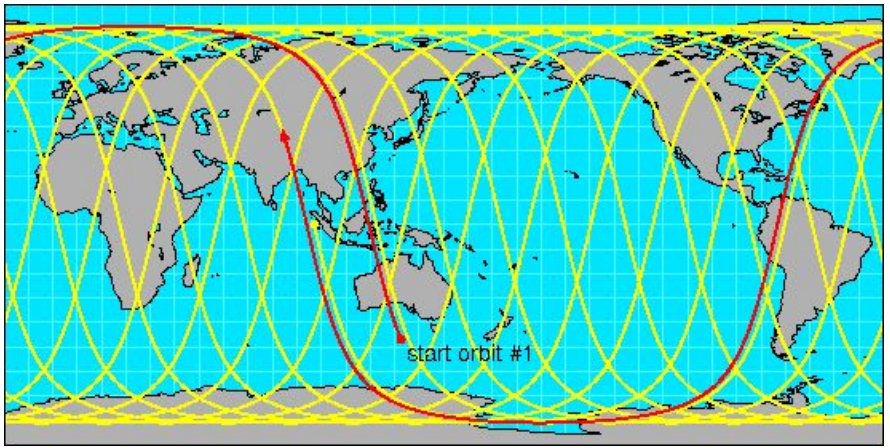
“Since the first **Landsat satellite** launched in 1972, the mission has **collected data** on the forests, farms, urban areas and freshwater of our home planet, generating the longest continuous record of its kind. Decision makers from across the globe use **freely available** Landsat data to better **understand** environmental change, manage agricultural practices, allocate scarce water resources, respond to natural disasters and more.”

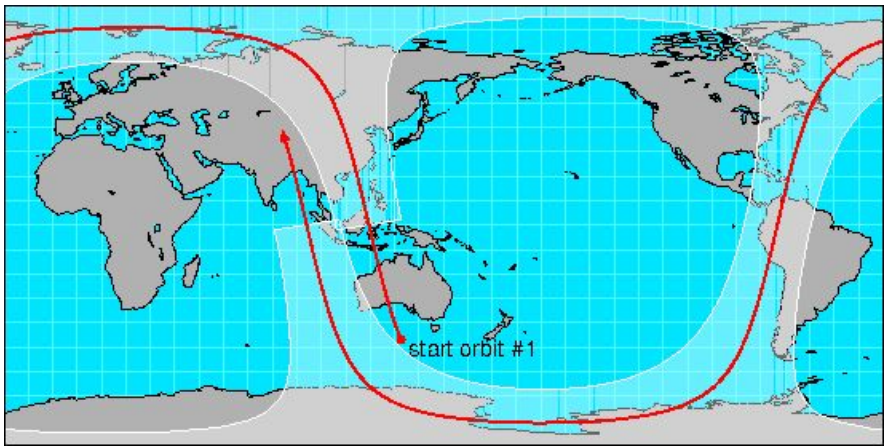
Source: https://www.nasa.gov/mission_pages/landsat/overview/

“Sentinel-2 is providing **high-resolution** optical imagery of agriculture, forests, land-use change and land-cover **change**. It is mapping biophysical variables such as leaf chlorophyll content, leaf water content and leaf area index. It is also monitoring coastal and inland waters and **helping with risk and disaster mapping**. The Sentinel-2 mission is providing **global coverage** of Earth's land surface every 10 days with the first spacecraft, reducing to **every 5 days** once both are in orbit.”

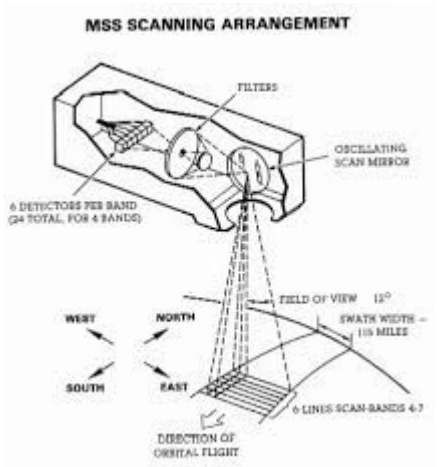
Source: https://www.esa.int/Enabling_Support/Operations/Sentinel-2_operations



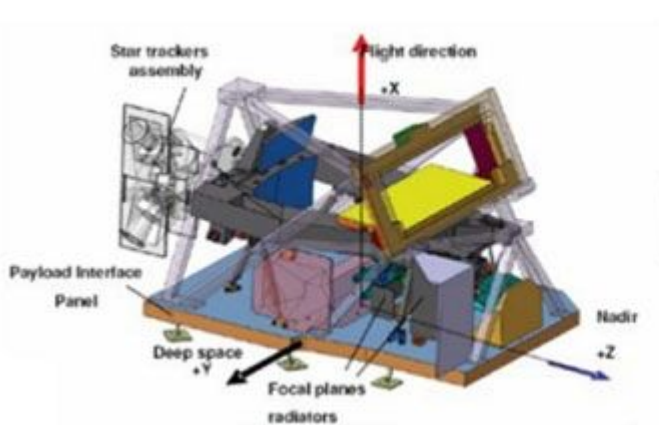


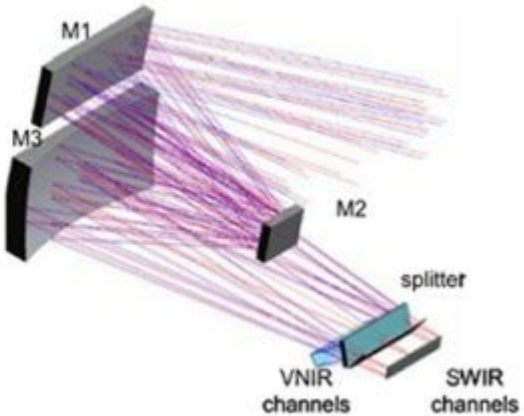


Source: http://tornado.sfsu.edu/geosciences/classes/m415_715/Monteverdi/Satellite/PolarOrbiter/Polar_Orbits.html



Source: http://uregina.ca/piwowarj/Satellites/Landsat.html

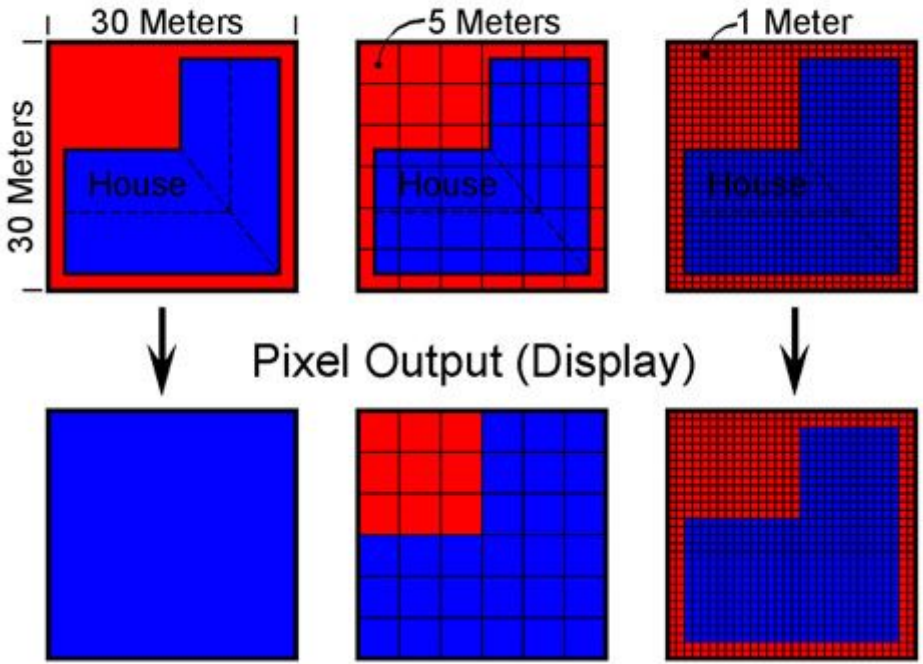




Source: https://earth.esa.int/web/sentinel/technical-guides/sentinel-2-msi/msi-instrument

Spatial resolution refers to the size of one pixel on the ground. Naturally linked to the raster format. For regular-pixel raster models, it measures the length of a pixel side.

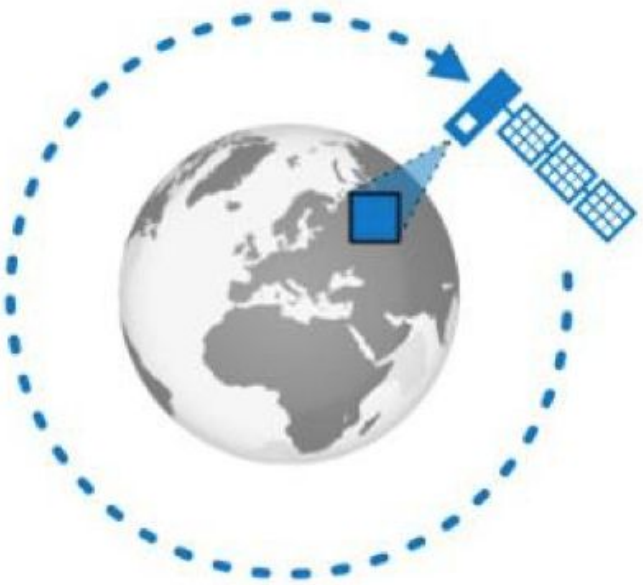
No object / surface smaller than the pixel size can be recognised. Theoretically, all values falling into the pixel area are used to calculate an average digital value

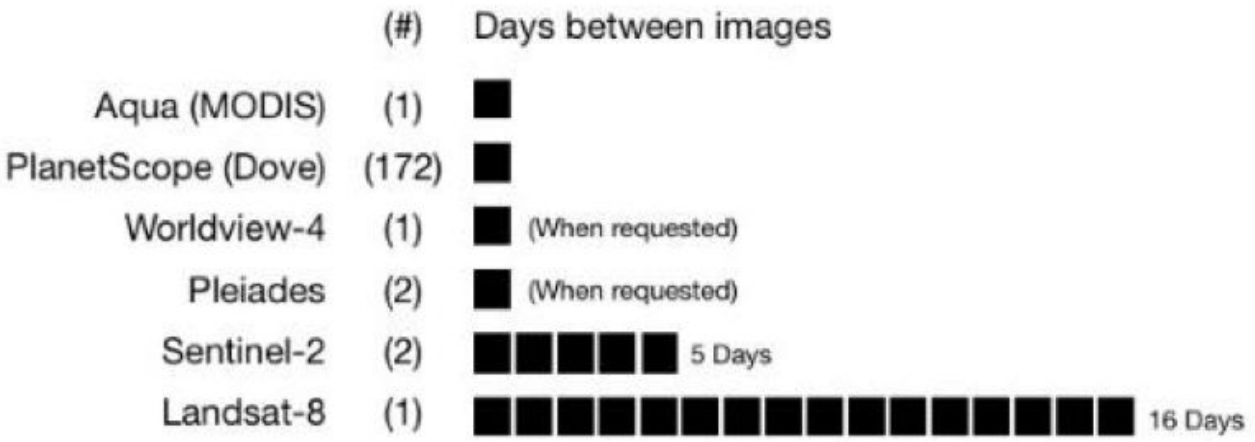


Example from: https://www.satimagingcorp.com/services/resources/characterization-of-satellite-remote-sensing-systems/

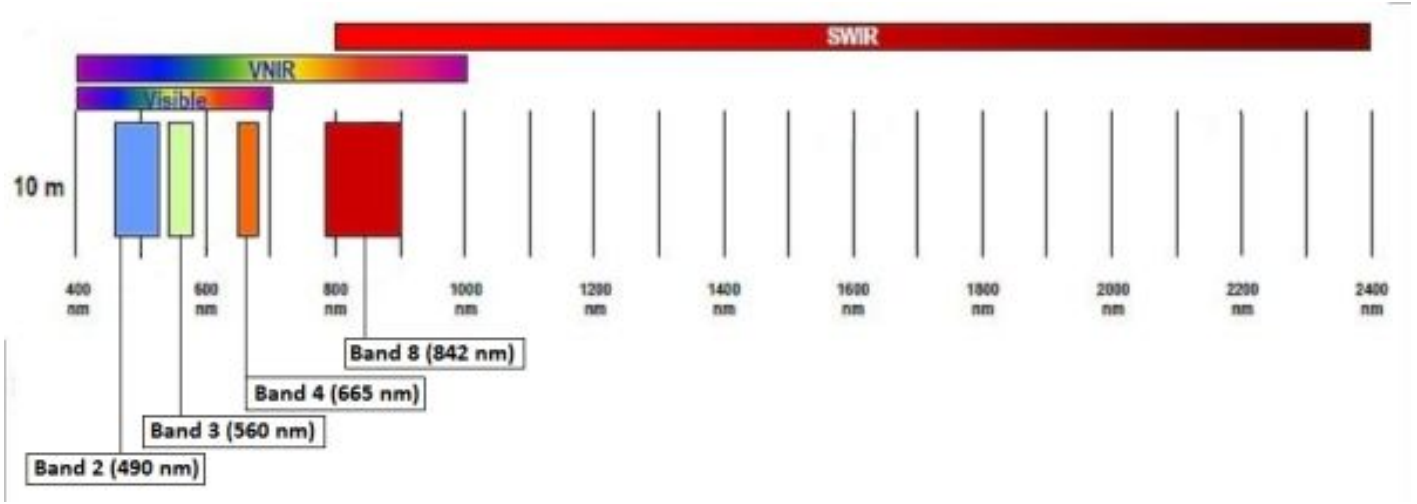
Temporal Resolution

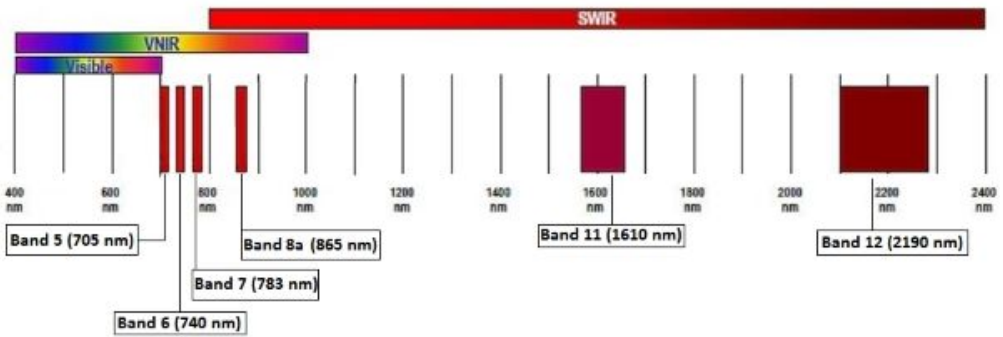
Temporal resolution varies by satellite and describes the time it takes for an individual satellite to orbit and revisit a specific area. Some satellites operate as a constellation with multiple satellites working together to increase their global coverage daily.

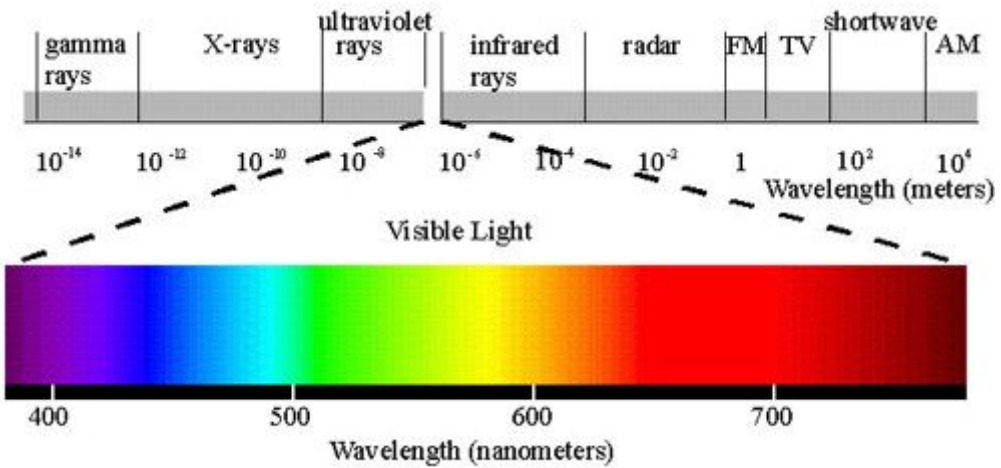




Example from: https://towardsdatascience.com/how-to-use-open-source-satellite-data-for-your-investigative-reporting-d662cb1f9f90?gi=c541862bd36a







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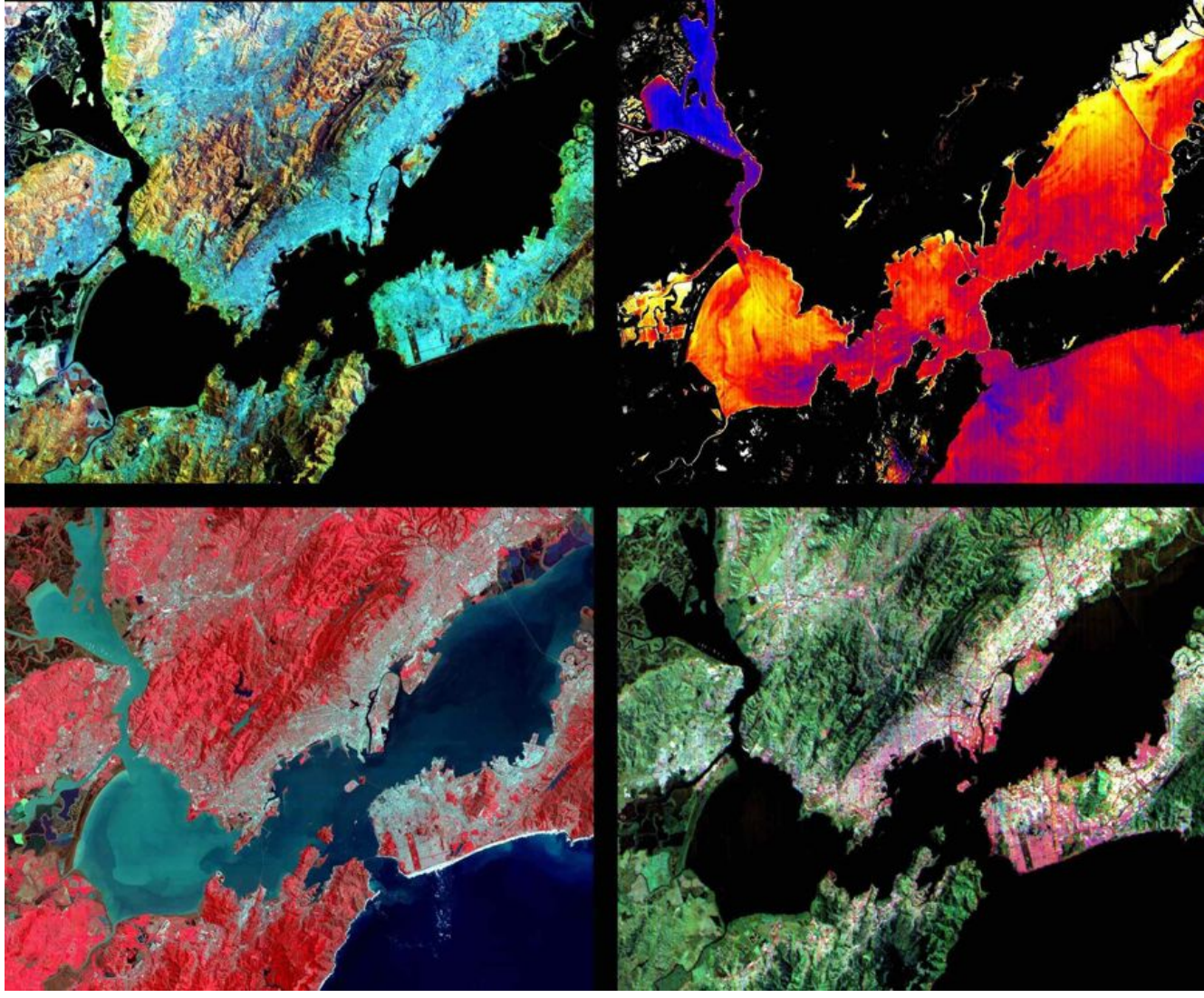
Resolution - spectral

Spatial resolution Sentinel 2: https://sentinel.esa.int/web/sentinel/user-guides/sentinel-2-msi/resolutions/spatial
Remote Sensing Basics USAID: https://geocenterusaid.org/remotesensing/basics.html

Spectral features



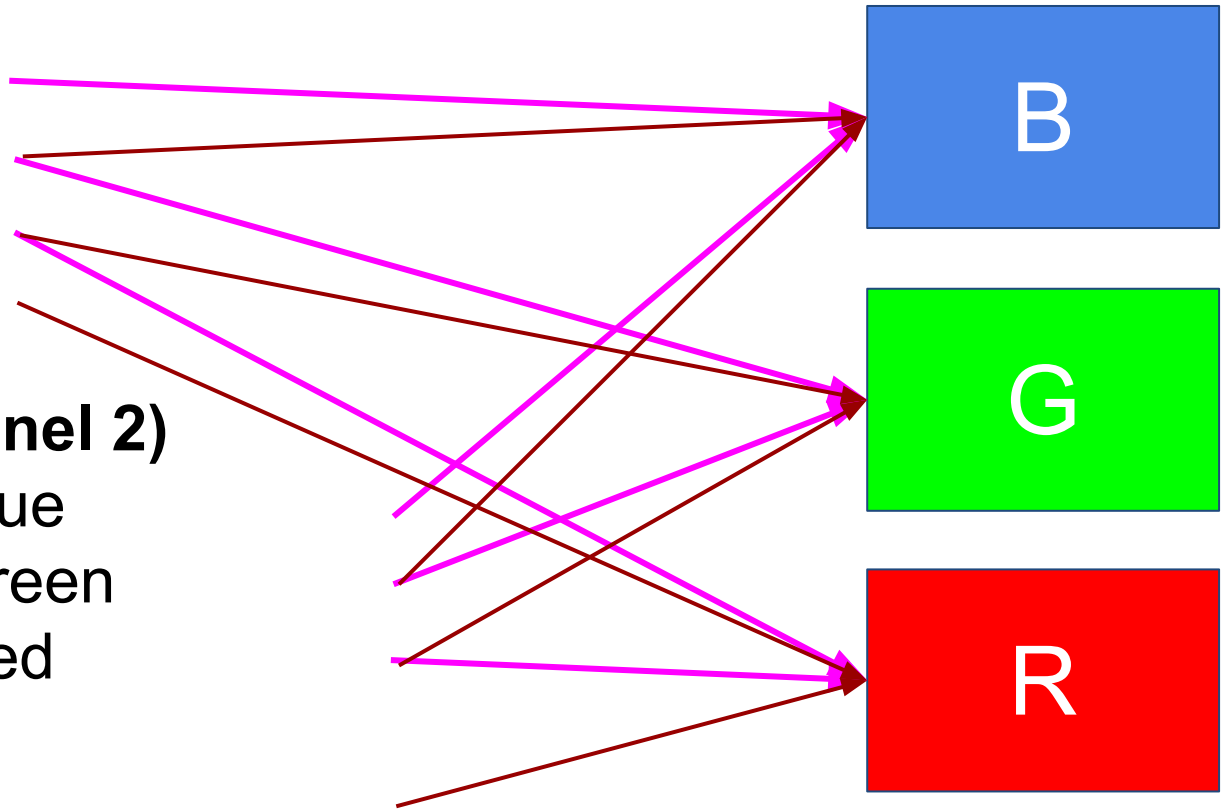
Sources: https://possibility.teledyneimaging.com/hunting-new-mining-deposits-hyperspectral-imaging/

Bands (Image)

Channels (Screen)

(Landsat)
B1: Blue
B2: Green
B3: Red
B4: Close IR

(Sentinel 2)
B2: Blue
B3: Green
B4: Red
...
B8: IR

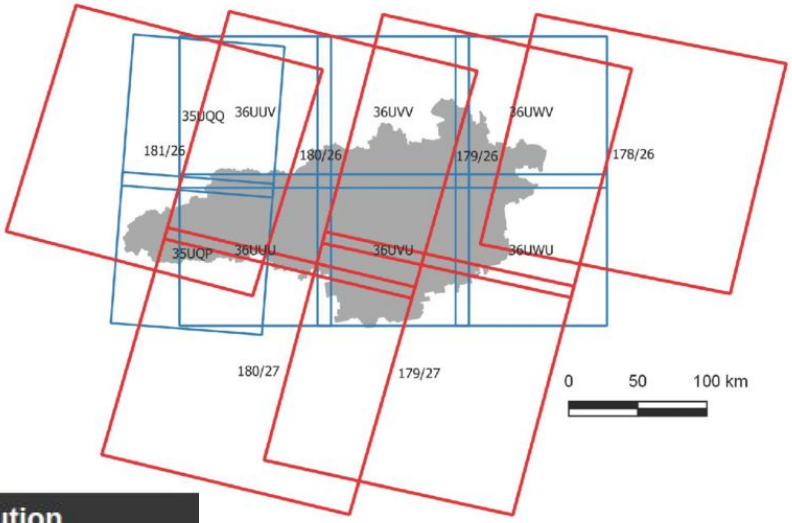


True Color

False Color

Spatial coverage

Pixel size versus image footprint



Coverage of Landsat-8 scenes and Sentinel-2A tiles. Example from a particular study.

Sources:
https://www.researchgate.net/figure/Coverage-of-Landsat-8-scenes-and-Sentinel-2A-tiles-over-the-study-area_fig3_317095580
http://gsp.humboldt.edu/OLM/Courses/GSP_216_Online/lesson3-1/resolution.html

1 USGS Earth Explorer
2 Sentinel Open Access Hub
3 NASA Earthdata Search
4 NOAA Data Access Viewer
5 DigitalGlobe Open Data Program
6 Geo-Airbus Defense
7 NASA Worldview
8 NOAA CLASS
9 National Institute for Space Research (INPE)
10 Bhuvan Indian Geo-Platform of ISRO
11 JAXA's Global ALOS 3D World
12 VITO Vision
13 NOAA Digital Coast
14 Satellite Land Cover
15 UNAVCO

Source: https://gisgeography.com/free-satellite-imagery-data-list/

1. Set your area of study (e.g., polygon, bounding box)
2. Get the right DEM files (e.g., NASA, National SDI, Open Data)
3. Perform basic terrain analysis
4. Find Imagery data (e.g., Data files or web services)
5. Explore image processing tools and methods

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