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3 Overview of available Spatial Data and respective Sources

b) Sentinel 2 images - Possibilities and Limitations

Julius-Maximilians-UNIVERSITÄT WÜRZBURG

DLR

MARTIN-LUTHER-UNIVERSITÄT HALLE-WITTENBERG

UNIVERSITY OF BOTSWANA

INES Ruhengeri Institute of Applied Sciences

EARTH OBSERVATION RESEARCH

Learning objectives

Identify the main strengths and applications of Sentinel-2 data

Understand the limitations of Sentinel-2 and how to address them

Make informed choices when selecting Sentinel-2 for remote sensing projects

What makes Sentinel-2 great?

Global land monitoring at high resolution

- 10m, 20m, and 60m spatial resolution allows detailed environmental and land use analysis.

Frequent revisit times

- 5-day temporal resolution (with Sentinel-2A and 2B working together)
- Ideal for tracking seasonal changes, deforestation, and agricultural cycles

Rich spectral information

- 13 bands covering Visible, Near-Infrared (NIR), and Shortwave Infrared (SWIR)
- Enables advanced analysis like NDVI (vegetation health) and water turbidity monitoring

What makes Sentinel-2 great?

Sentinel-2 Data is publicly available and free

Copernicus Data Space Ecosystem (ESA Official Source)

- https://dataspace.copernicus.eu/
- Direct download of raw Sentinel-2 imagery (Level-1C and Level-2A)

Google Earth Engine (Cloud Processing & Analysis)

- https://earthengine.google.com/
- Provides pre-processed Sentinel-2 data for easy analysis

Sentinel Hub EO Browser (Quick Visualization & Download)

- https://www.sentinel-hub.com/explore/eobrowser/
- View and analyze Sentinel-2 imagery without downloading large files.

And many more …

Strength and uses of Sentinel-2

For each of Sentinel-2s strength, think of why it matters and what potential use cases could be!

Feature	Why It's Useful	Example Use Case
High-resolution (10m for visible bands)	Allows detection of small-scale land changes	
Frequent revisit times (5 days)	Enables time-series analysis	
Multi-spectral bands (13 bands)	Allows vegetation, water, and land use analysis	
Cloud-free composites possible	Data from multiple dates can be merged to remove clouds	
Free and open-source data	Accessible to researchers, governments, and NGOs	

- Within the next 15 - 20 min, find at least one scientific paper for each feature and put the reference in the table and present your results to the class

Strength and uses of Sentinel-2

Your solution could look like this:

Feature	Why It's Useful	Example Use Case
High-resolution (10m for visible bands)	Allows detection of small-scale land changes	Mapping farmland boundaries, urban expansion
Frequent revisit times (5 days)	Enables time-series analysis	Monitoring crop growth, seasonal vegetation cycles
Multi-spectral bands (13 bands)	Allows vegetation, water, and land use analysis	NDVI for plant health, SWIR for soil moisture
Cloud-free composites possible	Data from multiple dates can be merged to remove clouds	Generating annual cloud-free mosaics
Free and open-source data	Accessible to researchers, governments, and NGOs	Environmental monitoring, conservation efforts

Limitations of Sentinel-2

Sentinel-2 cannot see through clouds

- Sentinel-2 is an optical sensor

→ Cannot capture data during heavy cloud cover, study site is not fully visible

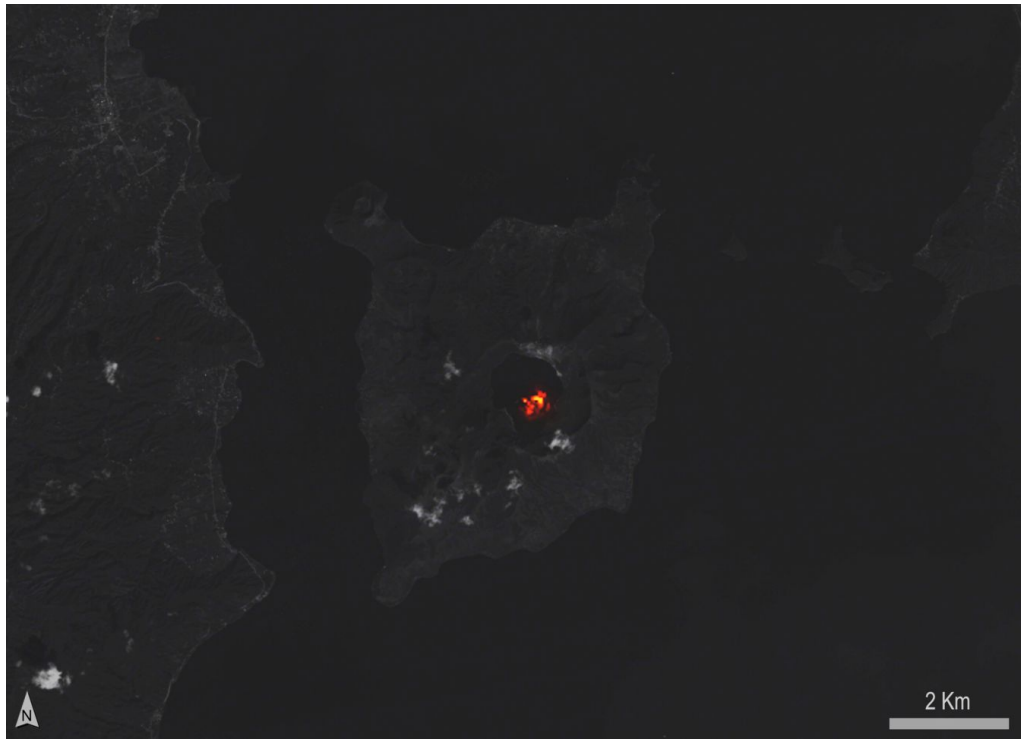
- Workaround: Use multi-date composites or combine with Sentinel-1 (SAR-based)

(Fjord 2022)

Limitations of Sentinel-2

Limited nighttime or low-light data

- Sentinel-2 does not have thermal sensors and is not a radar satellite
  → Cannot be used for nighttime monitoring
- Workaround: Use Landsat 8 (thermal bands) or
- MODIS for continuous global coverage

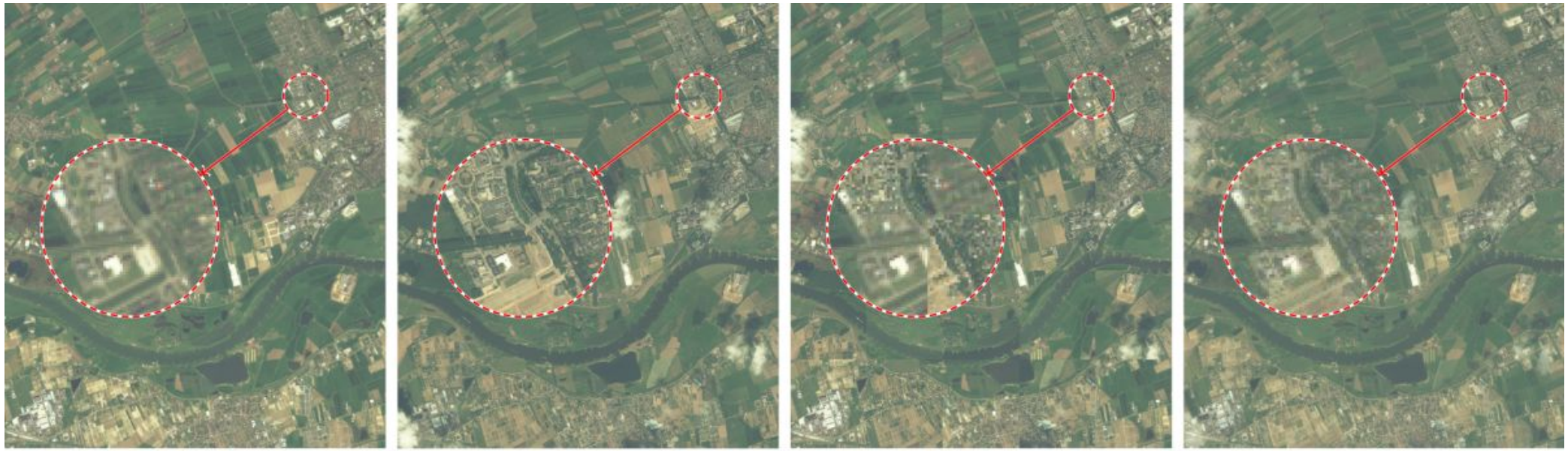


(Landsat Missions 2022)

Limitations of Sentinel-2

Moderate spatial resolution

- 10m resolution is good, but not as high as commercial satellites
- e.g., PlanetScope at 3m, Pleiades 1A/B satellites at 0.5m, WorldView at 0.3m



(a) S-2 color image (b) WV-2 color image (c) S-2 combined with WV-2 (d) Multiple S-2 images

(Kowaleczko et al. 2013)

Limitations of Sentinel-2

Data storage and processing requirements

- Large file sizes (especially raw Level-1 products)
- Workaround: Use cloud-based processing (Google Earth Engine, Sentinel Hub)

Limited to land monitoring

- Cannot capture deep-sea ocean data (e.g., bathymetry, deepwater studies)
- Workaround: Use Sentinel-3 for oceanographic applications

Sentinel-2 vs. other satellites

When to use which satellite?

Satellite	Best For	Why?
Sentinel-2	General land cover, agriculture, vegetation, water monitoring	High spectral & spatial resolution, free access
Sentinel-1	Cloudy areas, radar applications	Uses SAR (Synthetic Aperture Radar) to penetrate clouds
Landsat 4 - 9	Long-term land cover change, urban studies	30m resolution but with decades of historical data
MODIS	Large-scale monitoring, global vegetation trends	Daily images but lower spatial resolution
Commercial satellites (PlanetScope, WorldView)	High-resolution urban mapping, small-scale change detection	3m–0.3m resolution but expensive

Hands-On: Sentinel-2 bands

Getting data

Let's get started:

- https://browser.dataspace.copernicus.eu/
- Follow the link above to register and login to Copernicus Data Space
- Download any area of your interest

Hint: Simply select the "Search" tab in the GUI, enter your search terms, choose the location and time, and from the list of data products, you can download your selection by clicking on the "download" icon.

Optional hands-on task

Let's get started with Landsat:

- https://glovis.usgs.gov/app or https://earthexplorer.usgs.gov/
- Follow the link above to register and login to USGS website
- Explore and download any area of your interest

Hint: Use this tutorial link to assist you in downloading Landsat and DEM data https://www.youtube.com/watch?v=42YTGa_k9ys

Other Resources:
https://www.earthdatascience.org/courses/use-data-open-source-python/multispectral-remote-sensing/modis-data-in-python/download-modis-hdf4-data/ (MODIS data access

Summary & key takeaways

Sentinel-2 is powerful for **land monitoring,** with **great spectral, spatial,** and **temporal resolution**

It has limitations in **cloud cover, resolution,** and **thermal/nighttime imaging**

Understanding when and how to use Sentinel-2 improves analysis accuracy

Combining Sentinel-2 with **other satellite data** helps overcome its weaknesses

Different resolutions **serve different applications**, from **agriculture to disaster management**

Sources

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Thank you for your attention!

Dr. Insa Otte, Hanna Schulten
(on behalf of the EOCap4Africa Team)
and colleagues

insa.otte@uni-wuerzburg.de