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4 Potential and challenges of Spatial Data Analysis

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EARTH OBSERVATION RESEARCH

Learning Objectives

1) Understand the key benefits of Spatial Data Analysis

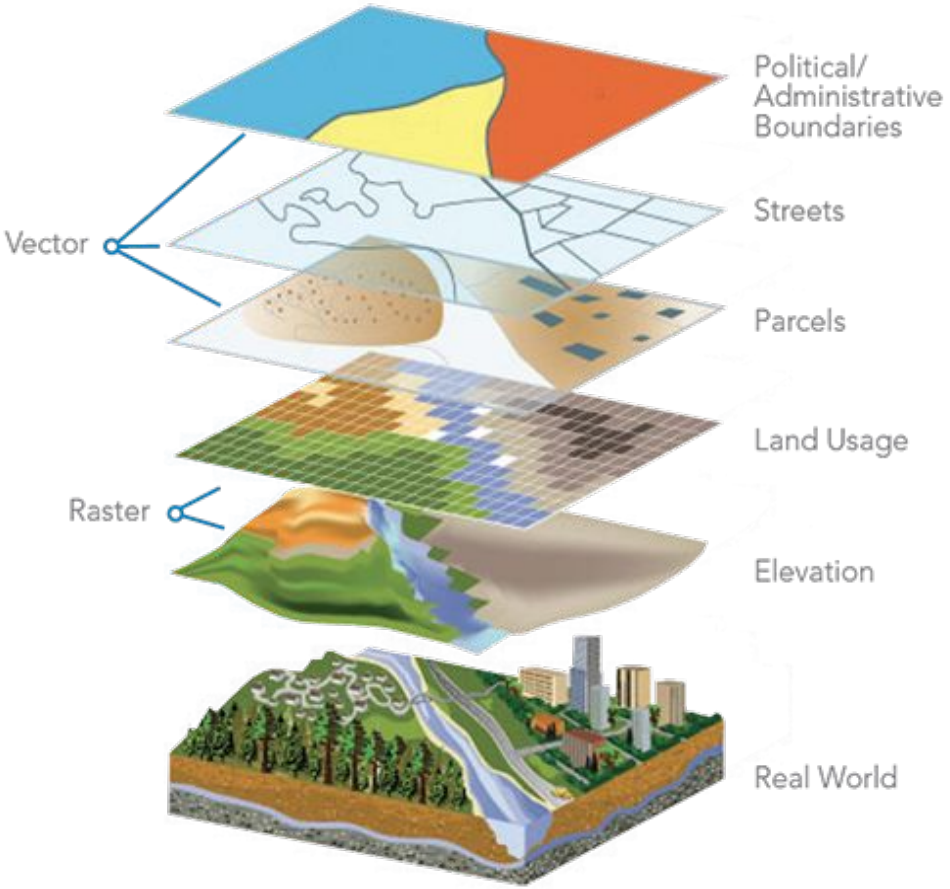
2) Recognize common challenges when working with Spatial Data

3) Explore solutions for overcoming limitations

What is Spatial Data Analysis

Spatial analysis is a set of techniques for deriving new information and knowledge from spatial data. These techniques include all of the samplings, visualization, manipulation, and analytical methods that can be applied to spatial data.

What is Spatial Data Analysis



(Velotio Technologies n.d.)

Key Concepts

- Uses **location-based** data to solve problems.
- Combines **spatial (where)** and **non-spatial (what, when, why)** attributes.
- Often visualized through **maps, models, or statistical methods**.

Why is spatial data important?

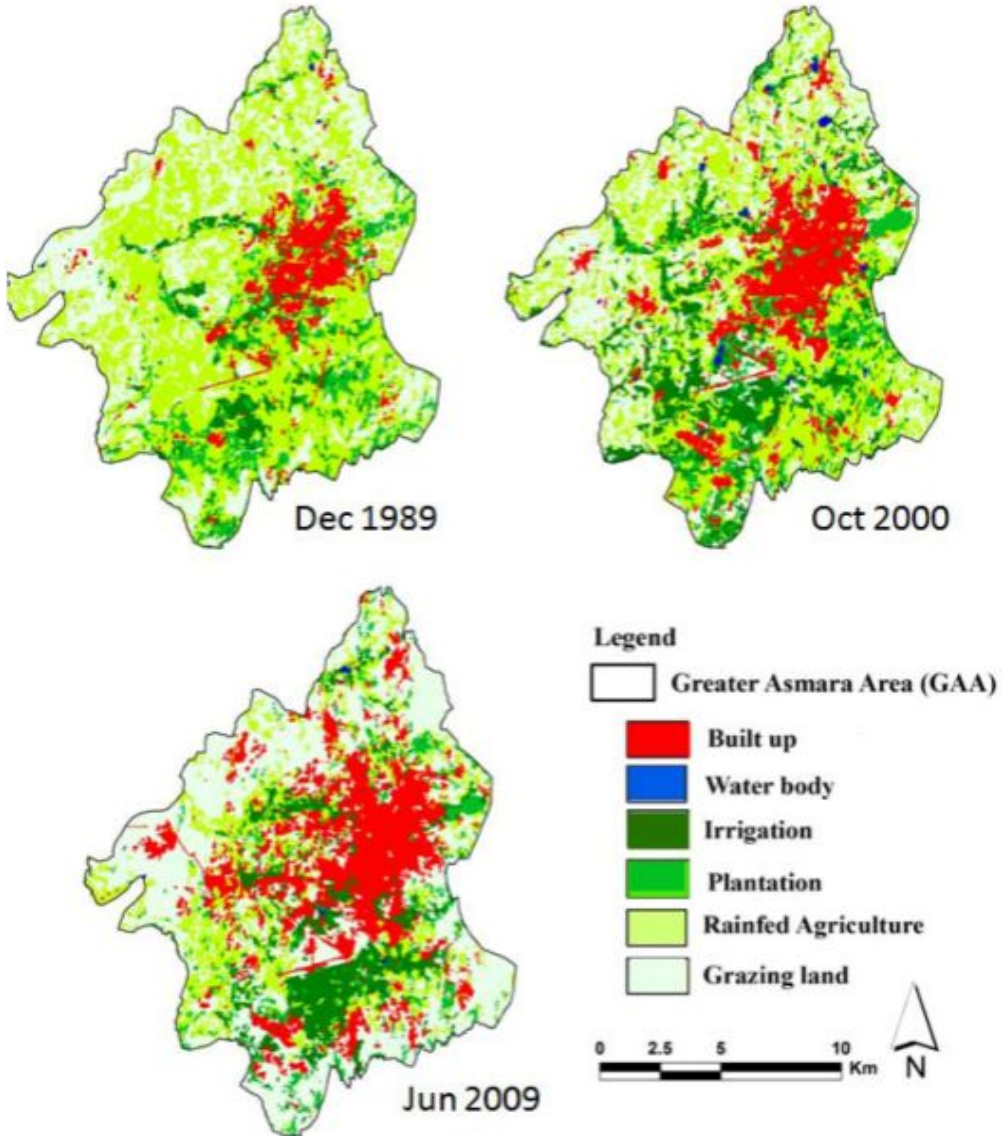
Allows us to uncover patterns, relationships and trends in geographical data

For example:

- Monitoring deforestation using satellite images
- Urban planning and infrastructure mapping
- Disease outbreak tracking (e.g., malaria risk zones)

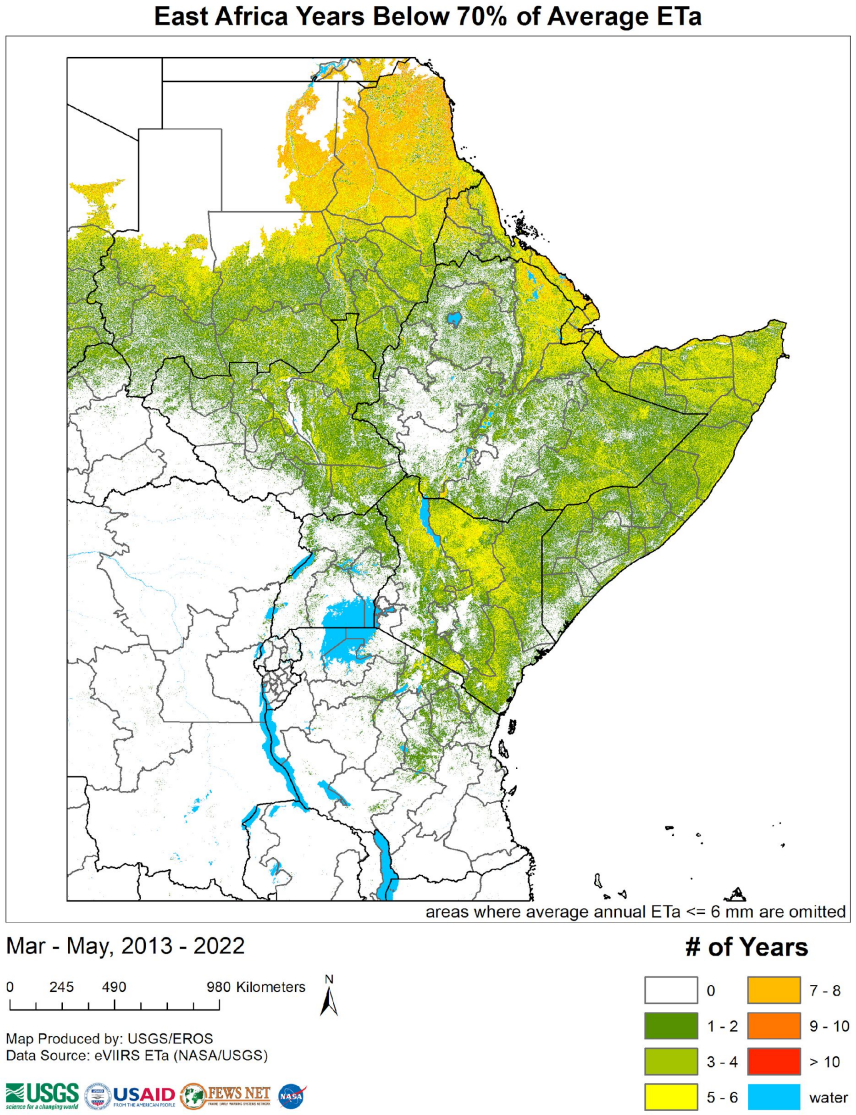
Why is spatial data analysis important?

Urban Sprawl analysis in Asmara, Eritrea can be used to inform government officials and urban planners (Tweolde & Cabral 2011)



Why is spatial data analysis important?

Evapotranspiration data of East Africa can help inform agricultural decision makers (U.S Geological Survey n.d.)



Why is spatial data analysis important?

Importance of spatial analysis on Wetland monitoring

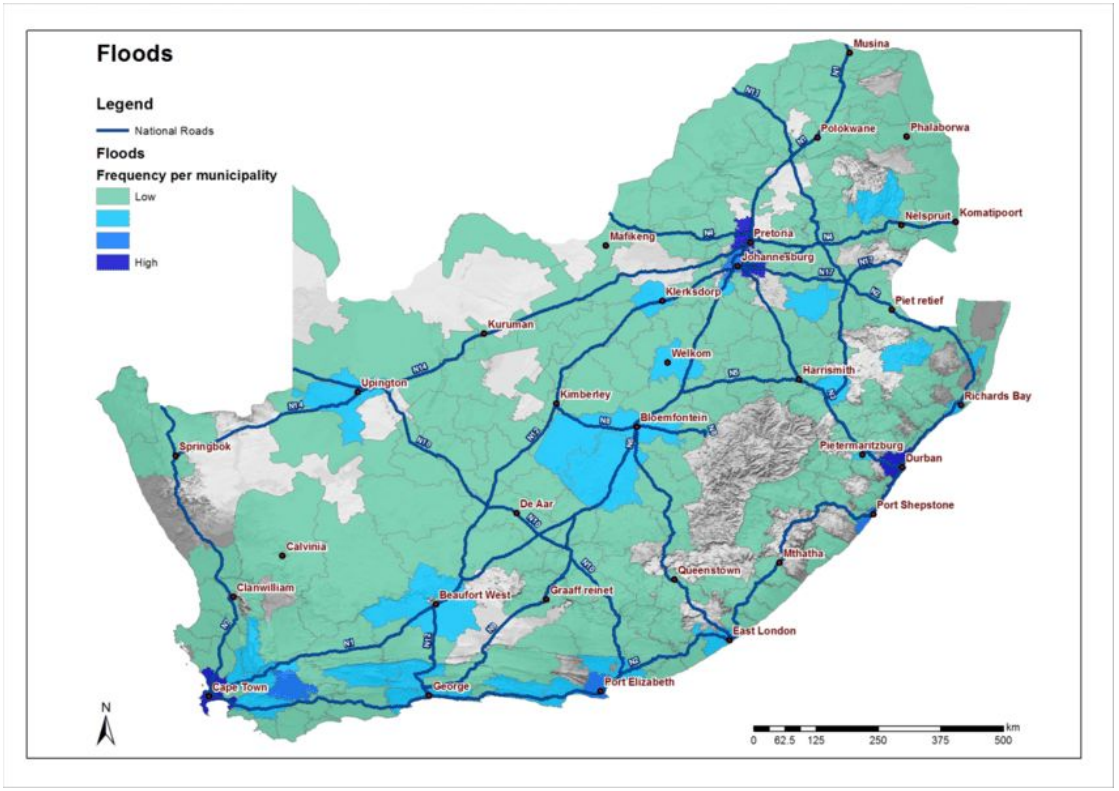
- Use of remote sensing and GIS to identify and classify wetland type
- Identifying potential sources of pollution or excessive sedimentation affecting wetlands
- Using NDVI (Normalized Difference Vegetation Index) and other indices to assess vegetation health.
- Mapping species distribution and critical habitats for conservation planning
- Assessing wetland vulnerability to droughts.

Why is Geodata so powerful?

1) Provides insights beyond traditional Data

Geospatial data allows for pattern recognition in a way that tabular data alone cannot

-> Predicting flood-prone areas based on elevation models (Coetzee et al. 2013)

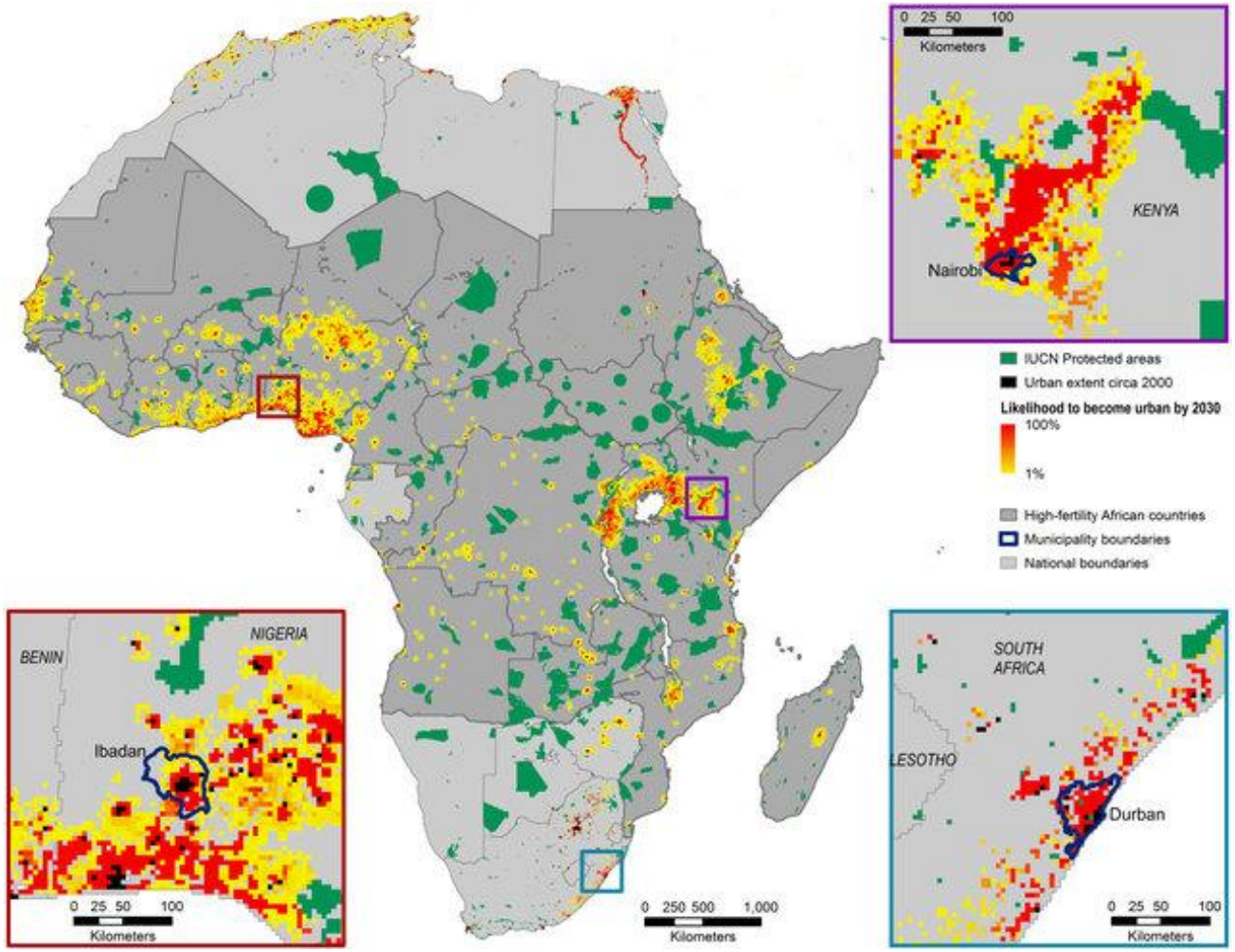


Why is Geodata so powerful?

2) Informs Decision Makers

Used in urban planning, agriculture, transportation, disaster management, etc.

-> Understand Urban spread over the African continent
(Güneralp et al. 2017)



Why is Geodata so powerful?

3) Enables Real-Time-Monitoring

Satellite and GPS data allow continuous monitoring of environmental changes

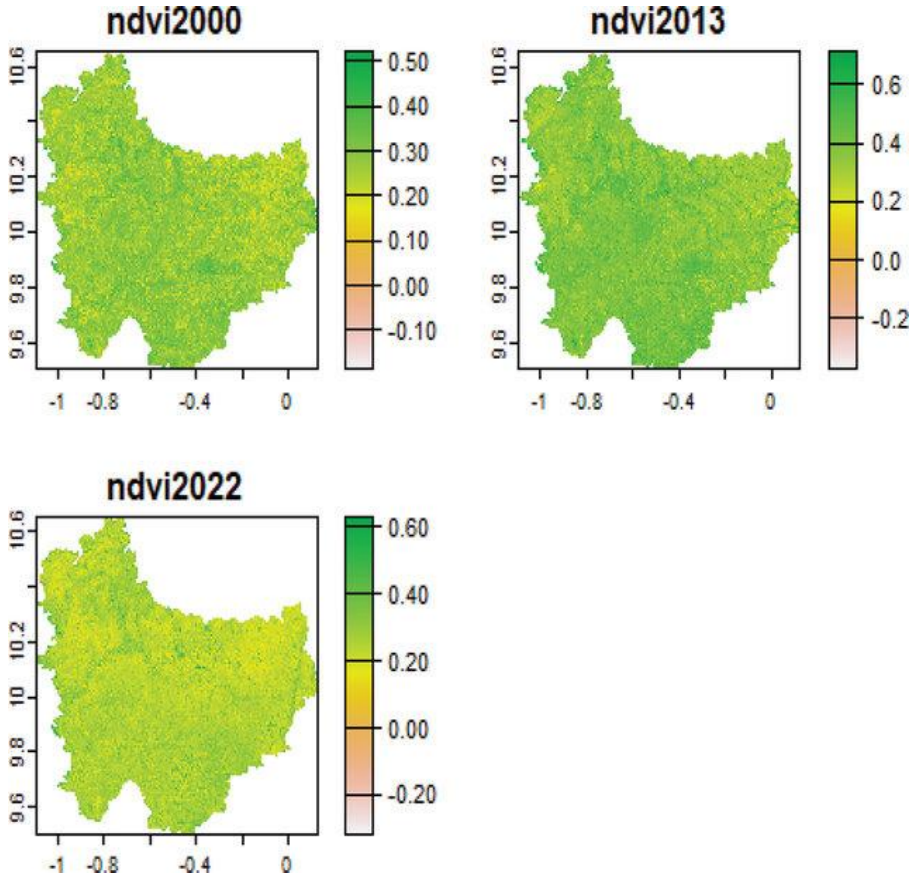
-> Tracking forest fires or drought impact over time as they happen (Max Planck Society 2024)

Why is Geodata so powerful?

4) Improves efficiency in Resource Management

Helps in monitoring water availability, land use changes, and infrastructure planning

-> Farmers can benefit from NDVI Data (Nanii et al. 2024)



Common Geodata Challenges and Solutions

1) Data Quality Issues

- Incomplete or outdated data
- Spatial resolution too low for analysis

Solution 1) Improving Data Quality

- Use cloud-free composite images
- Combine different data sources (Sentinel-2 + field data)

Common Geodata Challenges and Solutions

2) Limited Access to High-Quality Data

- Some datasets require expensive licenses (usually very high-resolution data)

Some examples:

- WorldView-3: Resolution: Up to 31 cm (panchromatic), 1.24 m (multispectral)
- IKONOS: Resolution: 82 cm (panchromatic), 3.2 m (multispectral)
- Quickbird: **Resolution: 65 cm** (panchromatic), **2.62 m** (multispectral)

Solution 2) Accessing Open-Source Data

- Use free and open datasets (Sentinel, Landsat, OpenStreetMap)

Common Geodata Challenges and Solutions

3) Technical Barriers

- Processing large datasets requires computational resources
- Need for GIS knowledge and programming skills

Solution 3) Overcoming Technical Barriers

- Cloud computing (Google Earth Engine) for large-scale analysis
- Learn GIS tools for efficient data handling using free resources online (Youtube, StackExchange, Reddit, Blogs)

Common Geodata Challenges and Solutions

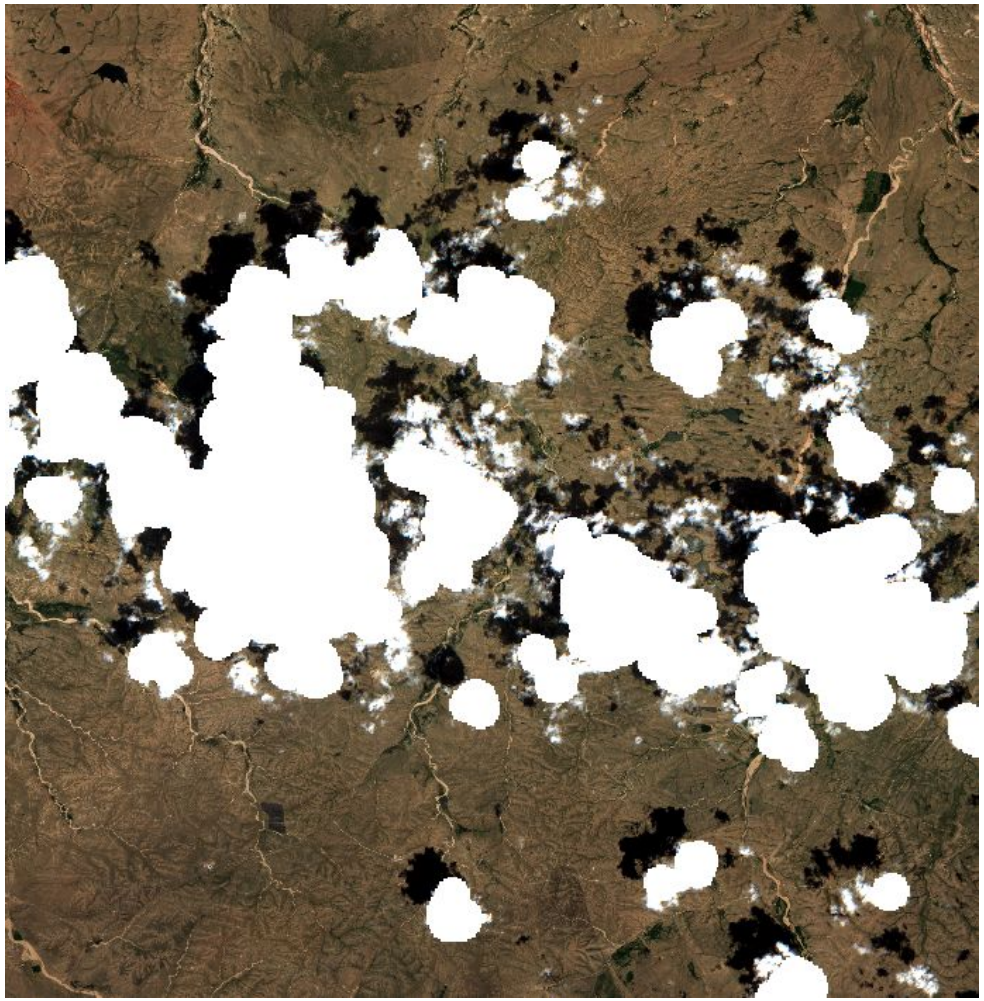
4) Ethical & Privacy Concerns

- Who owns the data?
- Is location-based data being misused?

Solution 4) Ethical Handling of Data

- Follow FAIR principles (Findable, Accessible, Interoperable, Reusable)

Identifying Challenges in Real-World Data



What potential challenges could this dataset have?

- Cloud Coverage

Depending on the type of Analysis

- Temporal Resolution of Satellite (Repetition Rate)
- Image Resolution

Summary & Key Takeaways

Spatial data analysis involves examining geographic data to understand spatial relationships and patterns

Geospatial data is powerful because it provides unique insights, supports decision-making, enables real-time monitoring, and improves resource management

Common challenges include data quality, access issues, technical limitations, and ethical concerns

Solutions involve using open data, cloud computing, and learning GIS skills. Understanding **limitations** is key to making **better-informed decisions.**

Sources

Coetzee, C., Van Niekerk, D., Murphree, M., Shapiro, M. D., & Others. (2013). *Feasibility study on the decentralisation and institutional capacity development for the Directorate Agricultural Disaster Risk Management*. DAFF.

Güneralp, B., Lwasa, S., Masundire, H., Seto, K. C., & Others. (2017). *Urbanization in Africa: Challenges and opportunities for conservation*. *Environmental Research Letters, 13*(1), 015002. https://doi.org/10.1088/1748-9326/aa94fe

Max Planck Society. (2024, July 31). *The Global Fire Monitoring Center (GFMC)*. Retrieved February 10, 2025, from https://www.mpg.de/22341037/global-fire-monitoring-center

Nanii, Y., Abubakari, A., Amikuzuno, J., & Blay, J. K. (2024). *Impacts of farming and herding activities on land use and land cover changes in the north eastern corridor of Ghana: A comprehensive analysis. Sustainable Environment, 10*(1), 2307229. https://doi.org/10.1080/27658511.2024.2307229

Tewolde, M. G., & Cabral, P. (2011). *Urban sprawl analysis and modeling in Asmara, Eritrea*. *Remote Sensing, 3*(10), 2148–2165. https://doi.org/10.3390/rs3102148

U.S. Geological Survey. (n.d.). *USGS FEWS NET Data Portal*. Retrieved February 10, 2025, from https://earlywarning.usgs.gov/fews/product/865

Velotio Technologies. (n.d.). *Spatial data analytics: The what, why, and how*. Retrieved February 10, 2025, from https://www.velotio.com/engineering-blog/spatial-data-analytics-the-what-why-and-how

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Thank you for your attention!

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