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Towards Improving Land Use and Land Cover Change(LULCC)

University of Pretoria – MSc Geoinformatics

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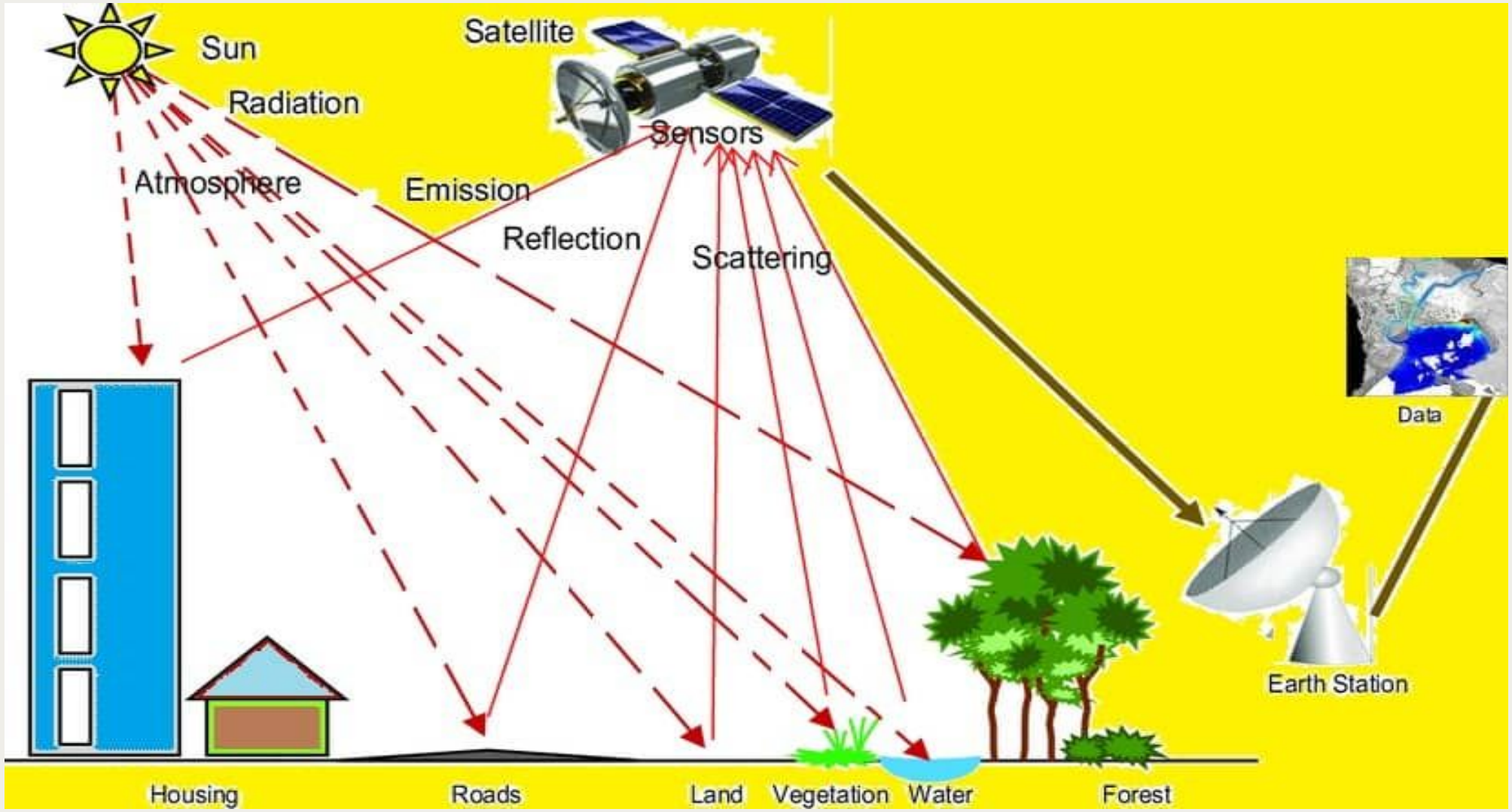
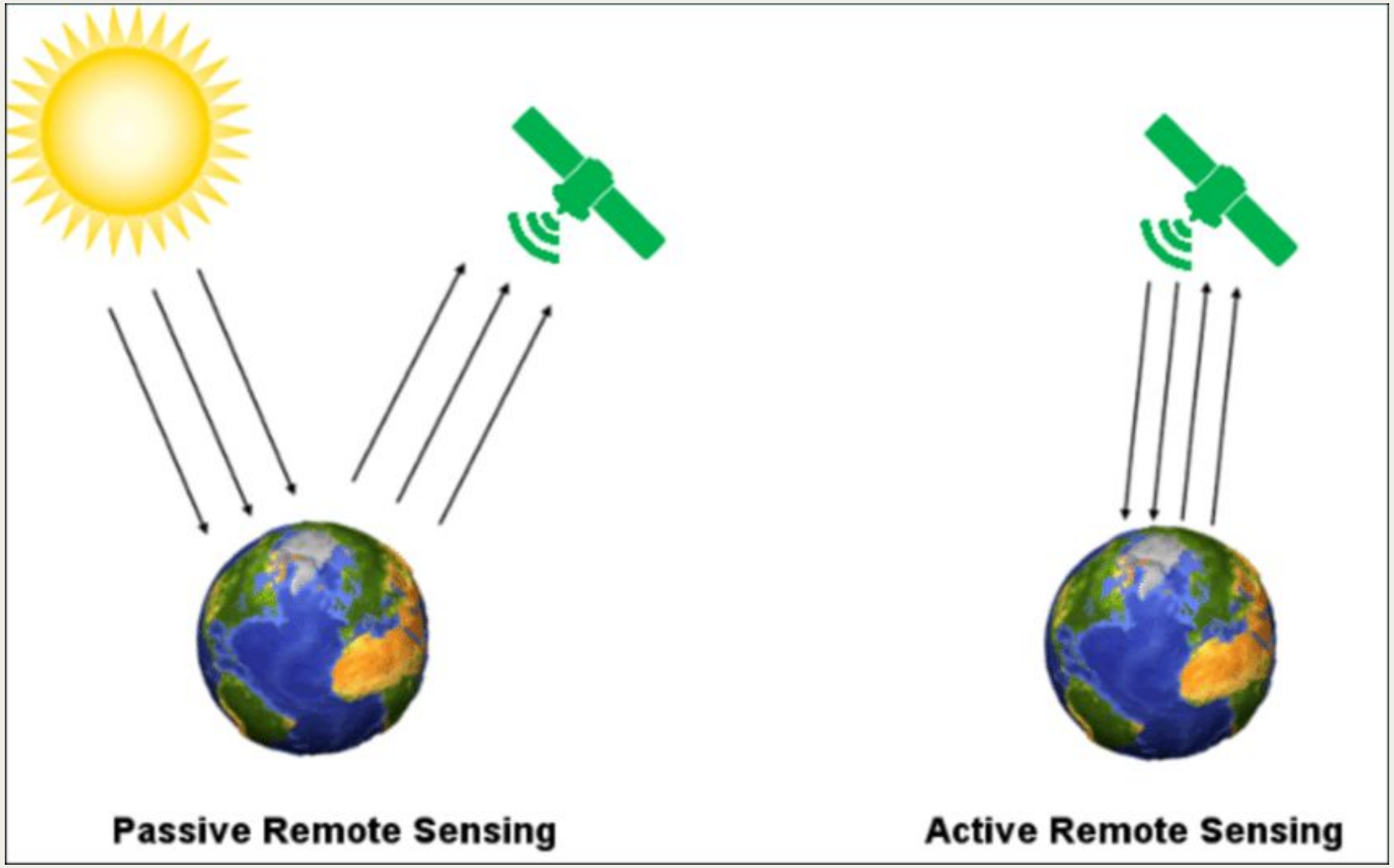
Remote Sensing Introduction



Remote Sensing Introduction

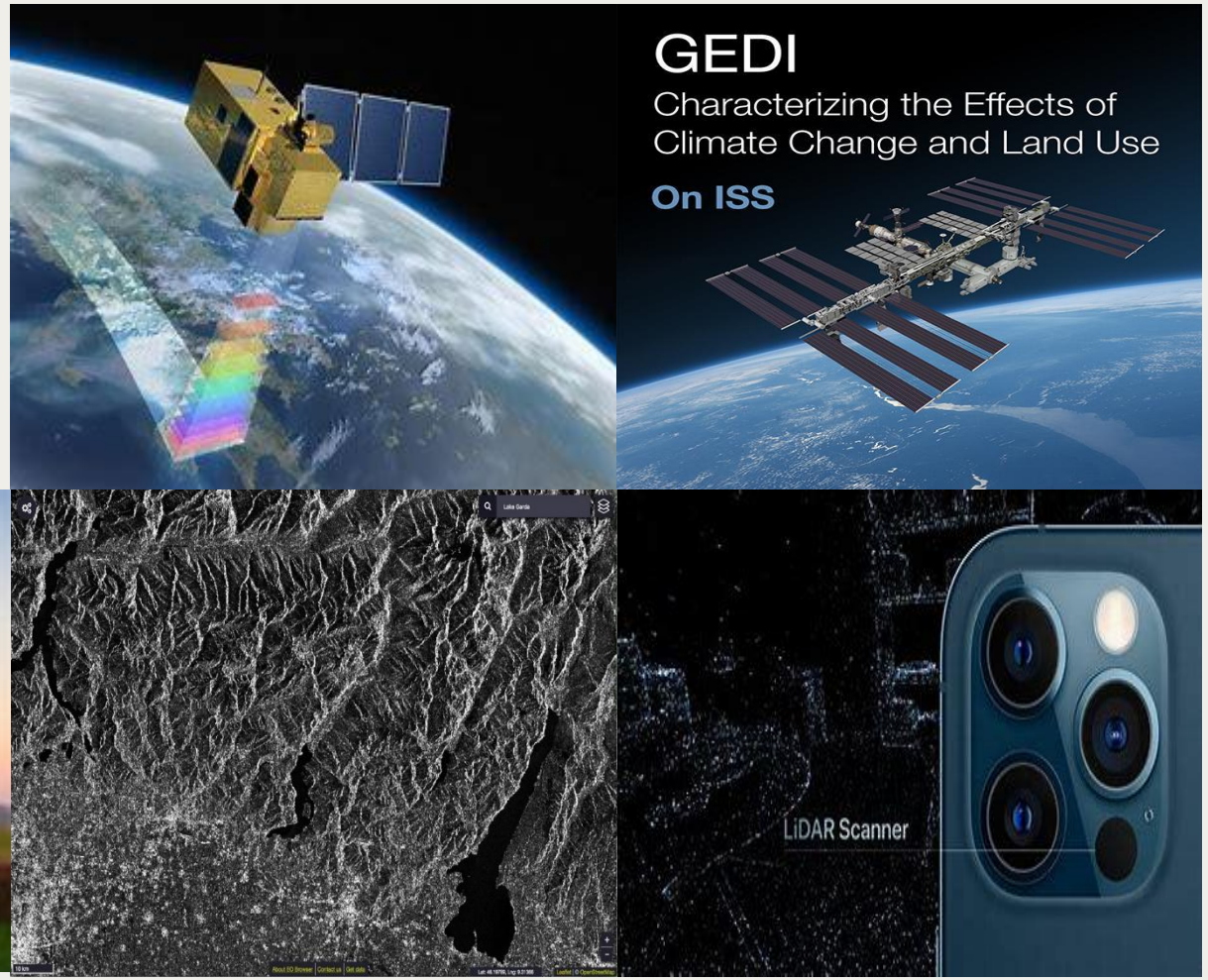


Advantages of Satellite- Based Remote Sensing

1. Large Area Coverage
2. Improved data accuracy
3. Efficiency in projects turnaround
4. Repeatability
5. Cost-Effective
6. Multi-Disciplinary (environmental monitoring, agriculture, water, forestry, mineral exploration, and disaster management etc)
7. Advancements in Technology

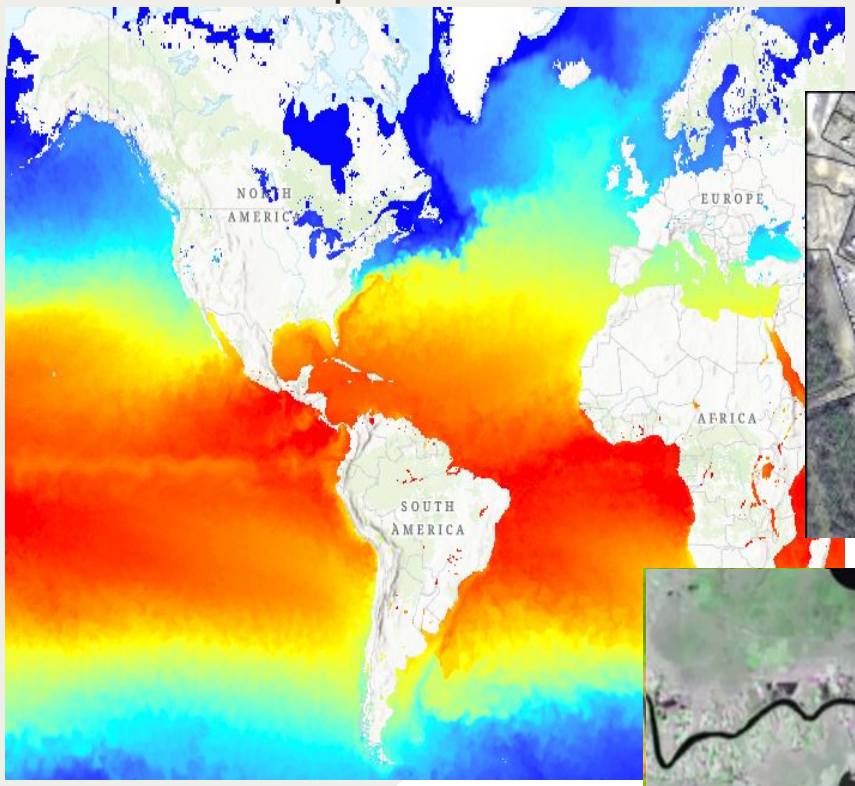
Available Technology

1. Optical Imagery (Landsat, Sentinel 2, commercial etc)
2. Drones
3. SAR (Synthetic Aperture Radar) Satellites
4. Aerial Imagery
5. Lidar
6. Radar



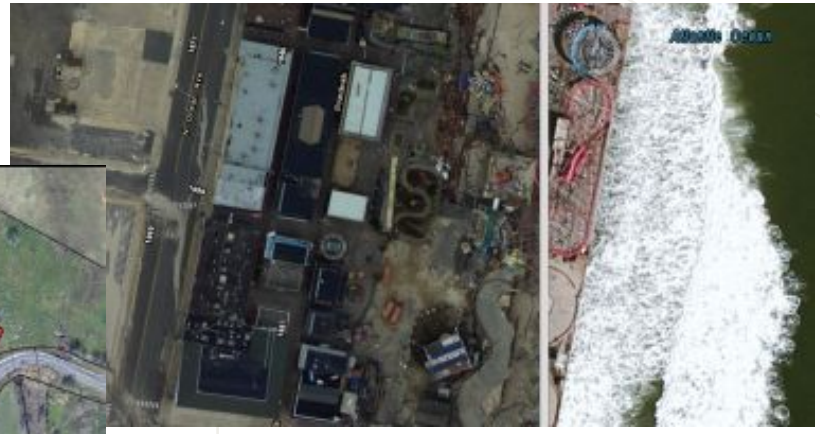
Applications

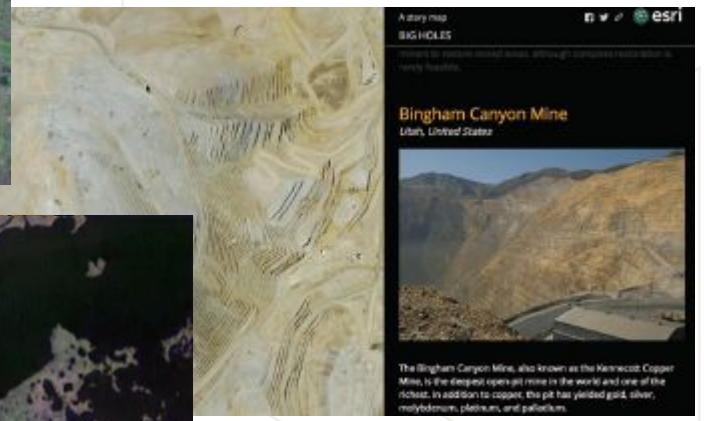
Sea surface temperature products



Developme nt

Natural disaster





Minin g

Change detection in land over time

MSc Geoinformatics (UP) Dissertation: Improving Land Use Land Cover Monitoring By Integrating Optical Imagery And Synthetic Aperture Radar (SAR) In Fragmented Rural Landscapes Around Nandoni Dam, Limpopo Province.

Standard ESRI Workflow

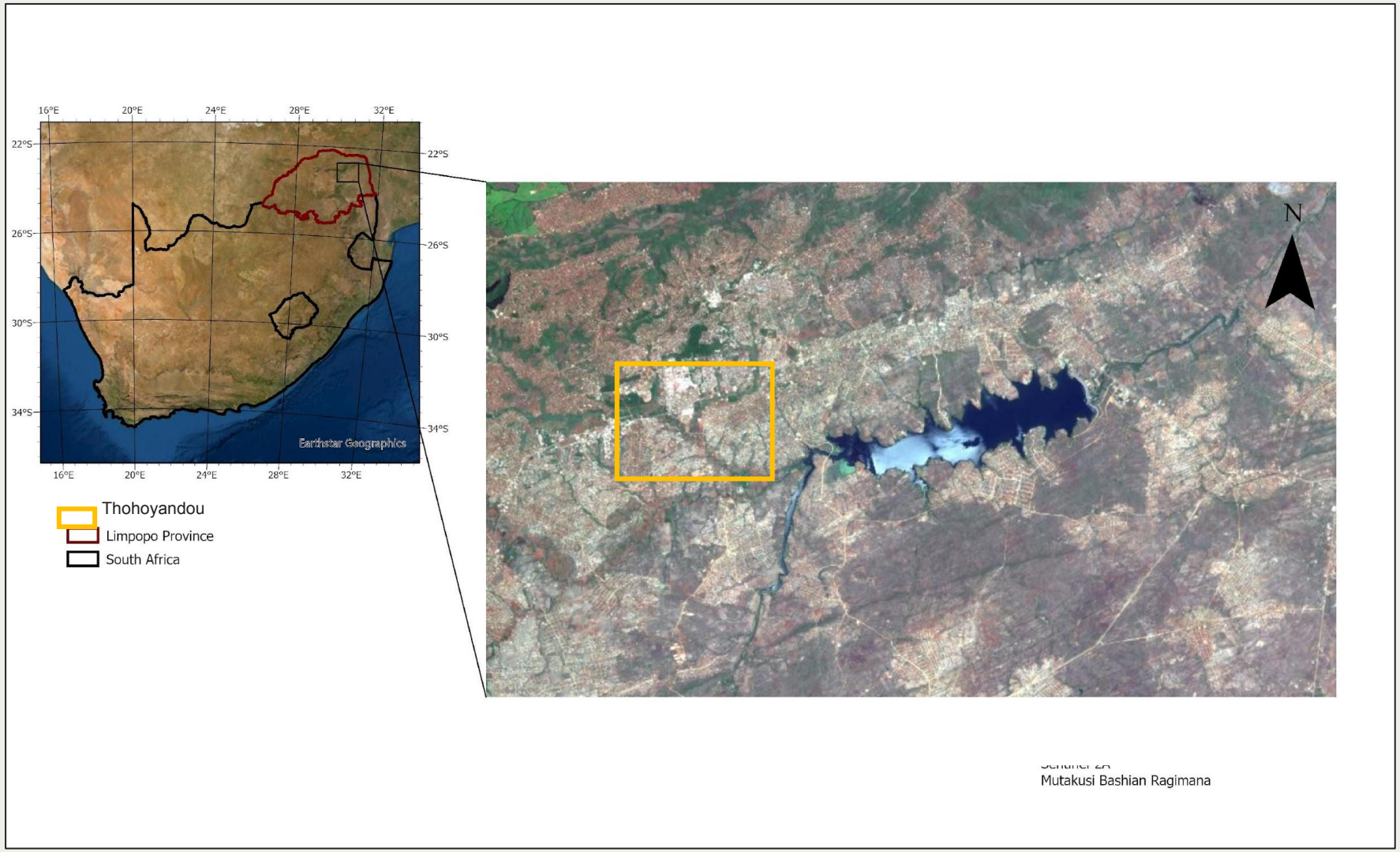
Research Background and Rationale

- **Limited LULC studies in the region (Before/After Dam construction).**
- **Frequent community unrests.**
- **No clear future land use policy framework (SPUMLA Act 16 of 2013).**
- **Convergence between Remote Sensing and Data Sciences (Collecting more data than ever before).**
- **Emerging Remote Sensing application using Synthetic Aperture Radar (can we fuse data?)**

Aims and objectives

- **Aim: To monitor LULC change over a 20-year period (Before and after dam construction) and improve LULC classification in fragmented rural landscapes around Nandoni Dam by integrating optical imagery and SAR data.**
- **Objectives:**
  I. **To quantify and monitor land cover class change over a 20-year period from 2001 through the application of an optimized Random Forest algorithm on Landsat optical imagery.**
  II. **To assess the potential of integrating Sentinel 2A optical imagery and Sentinel 1 SAR remote sensing data in improving LULC in rural interspersed landscapes.**

Study Area (Nandoni Dam, Sentinel 2A view)



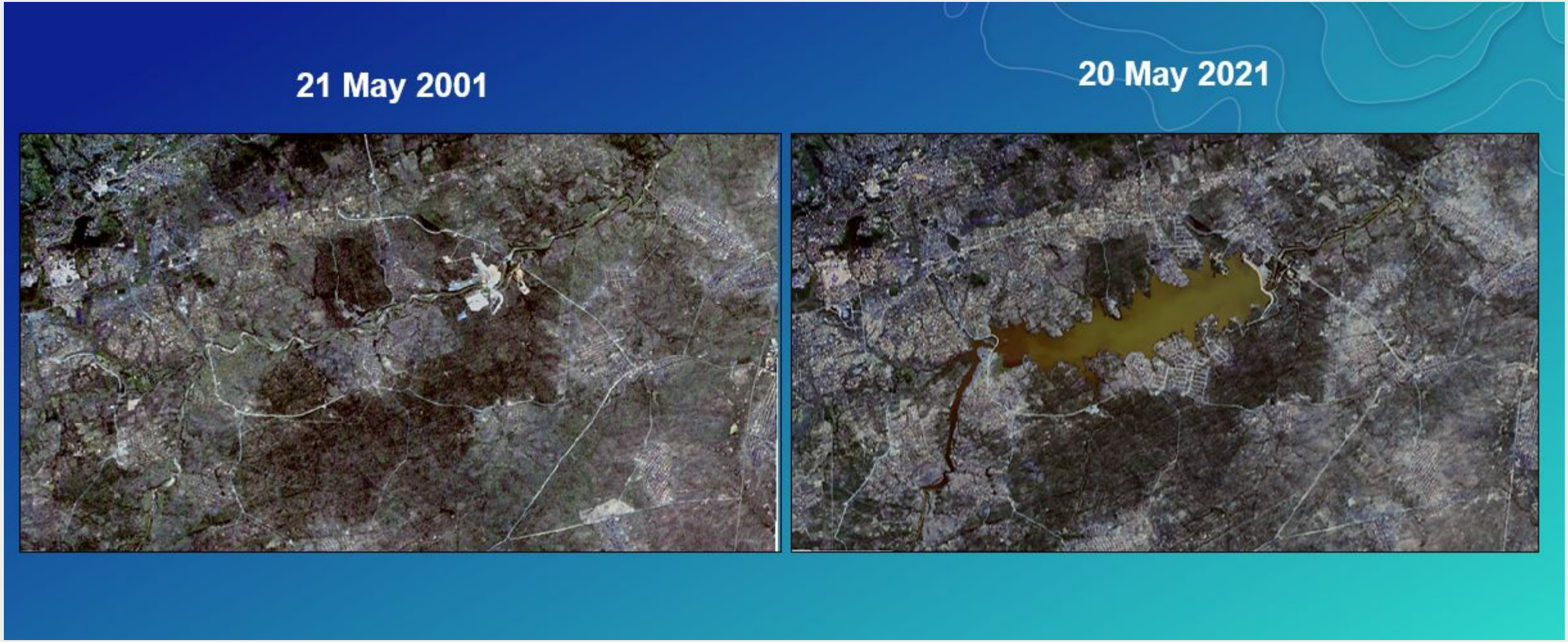
Explore and Prepare Data

- ArcGIS Online Living Atlas (Landsat Explorer App).

- USGS Earth Explorer (Orthorectified- anomalies/distortions removal).
- Dates (May 2001 and May 2021, Best window for landscape interpretation).
- Separate Satellites (Landsat 7 and Landsat 8).

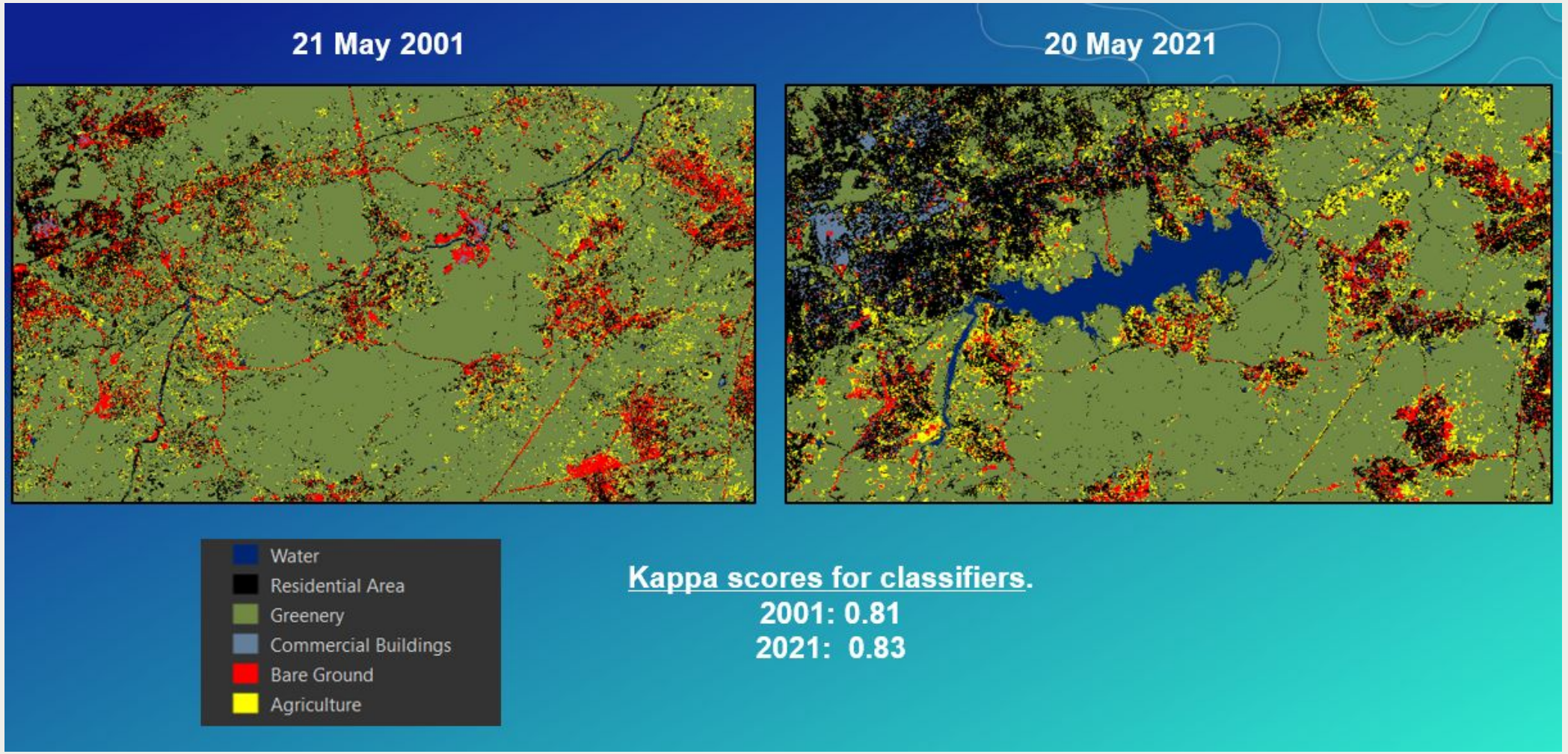
- Band Combinations.
- Texas Sharpshooter fallacy.

Study Area: Nandoni Dam Before and After



Model and Analyse

Results Classified 2001 and 2021

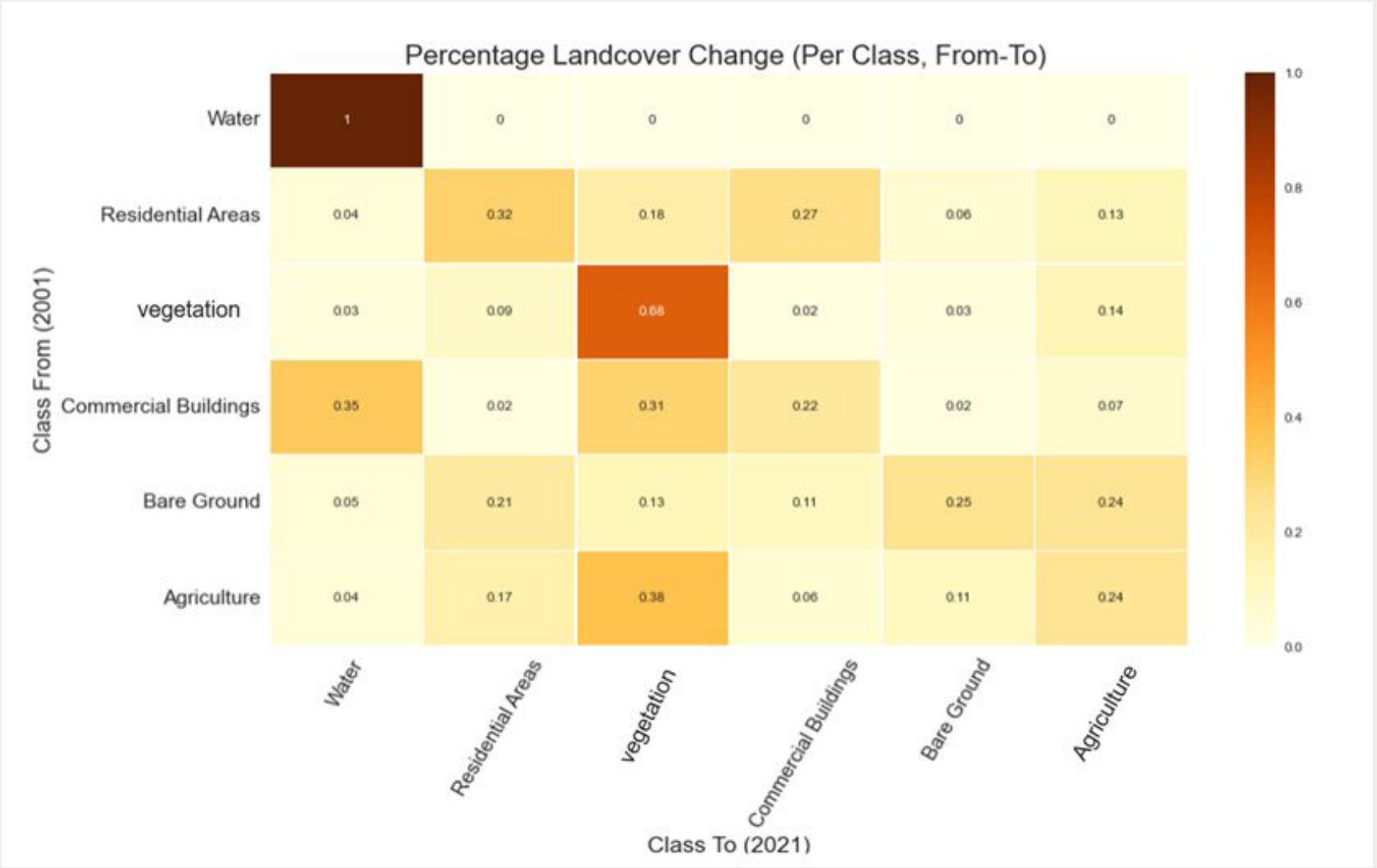


F1 Scores.

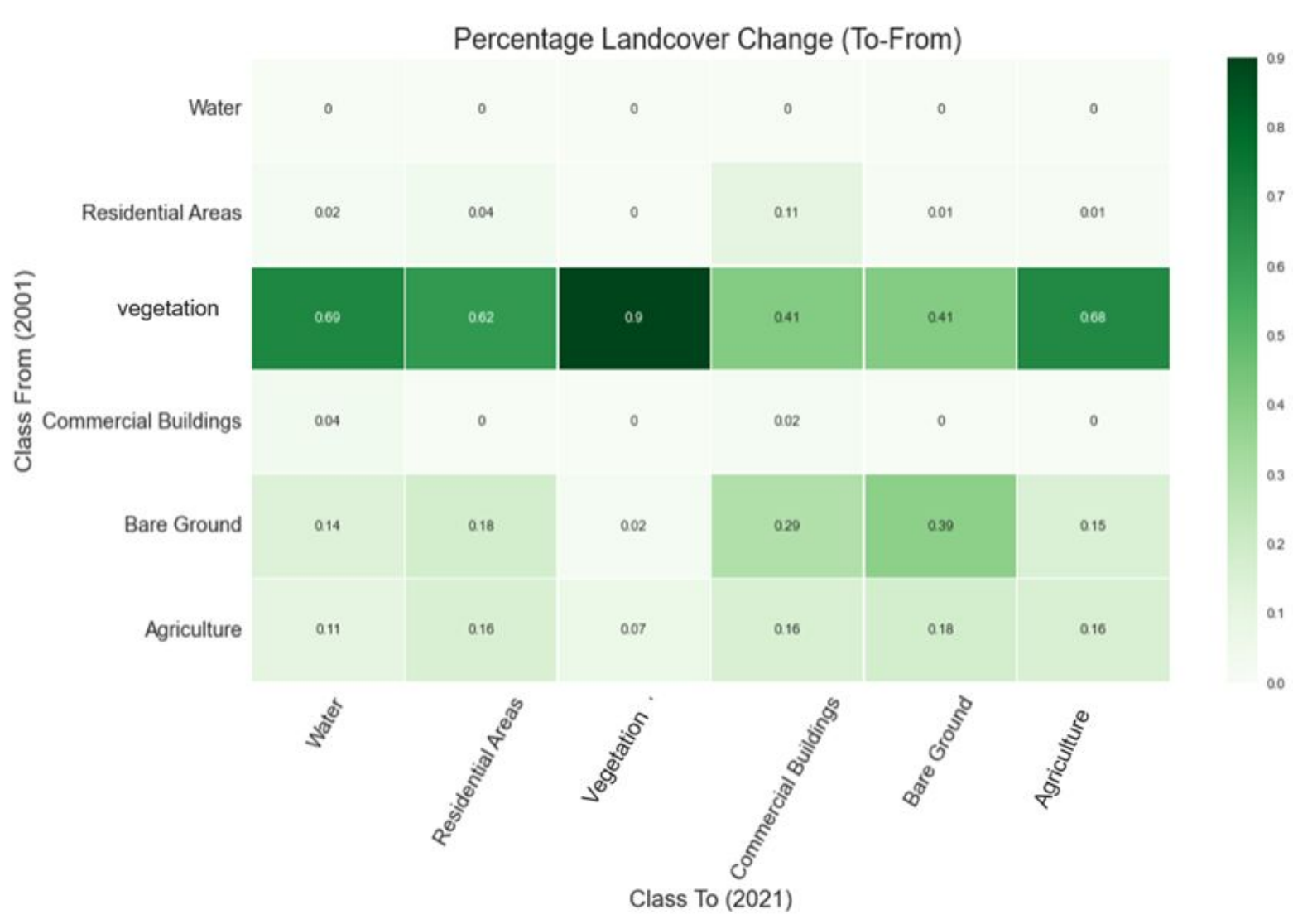
Statistical Measure to Rate Performance

Land Cover Class	2001	2021
Water	1	1
Residential Buildings	0.76	0.87
Commercial Buildings	0.74	0.88
Bare Ground	0.73	0.86
Vegetation	0.78	0.94
Agriculture	0.39	0.4

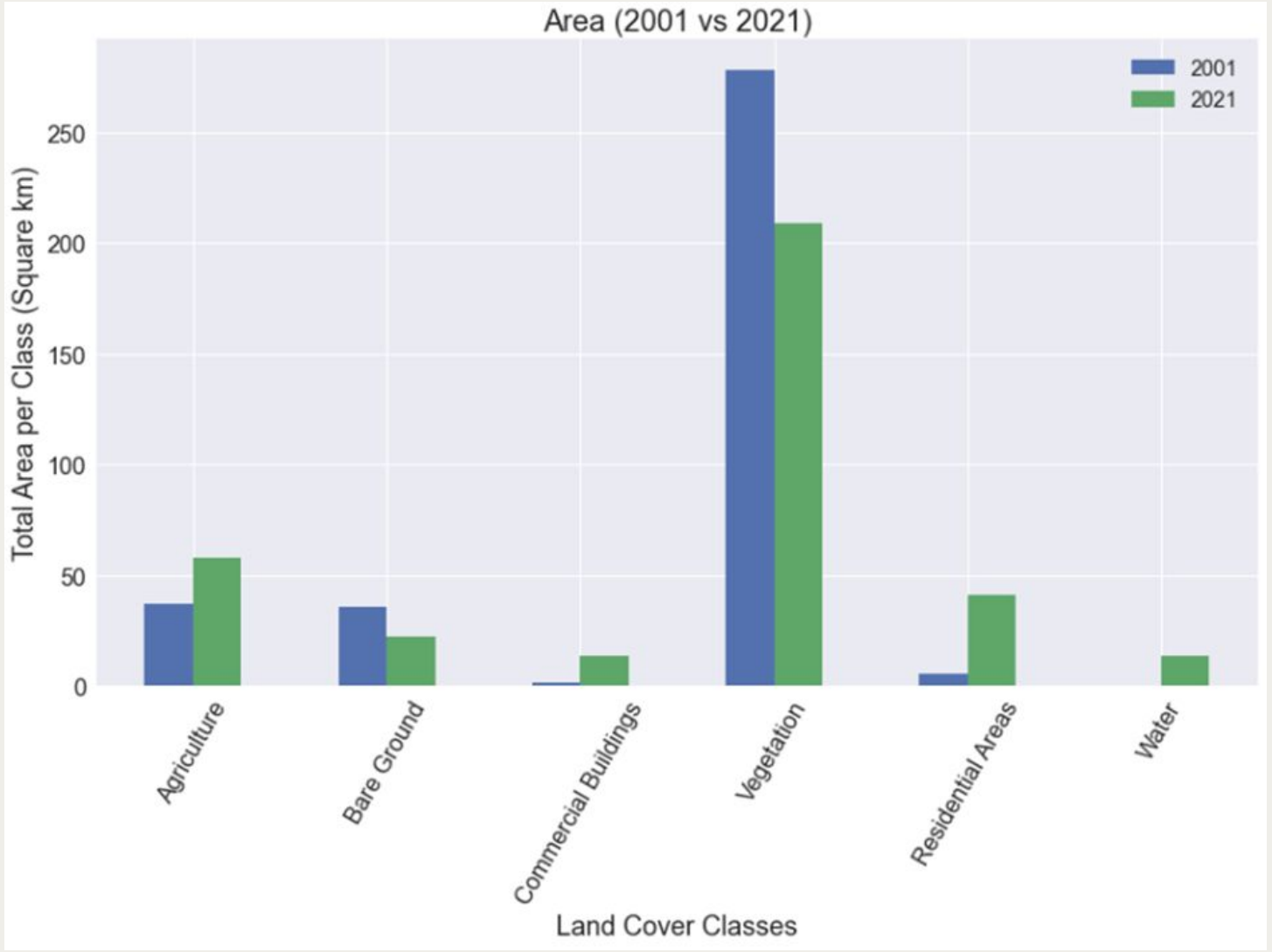
Heat Maps (% From- To)



Heat Maps (% TO- From)

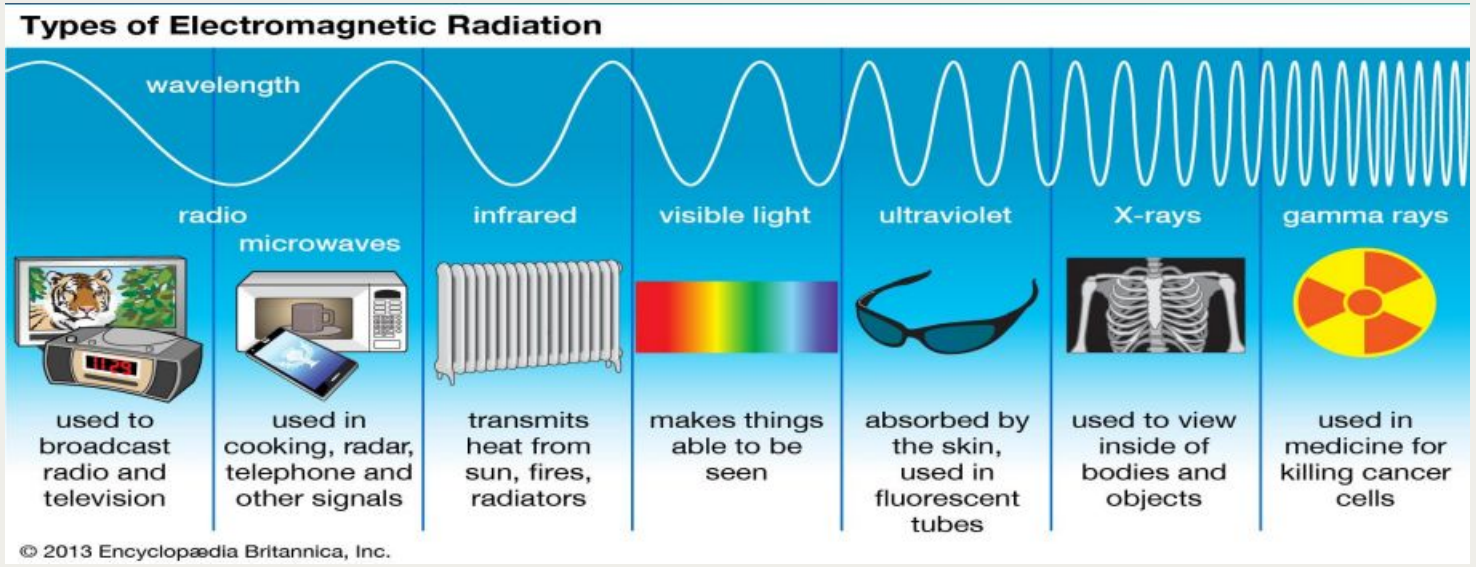


Area Difference (2001 vs 2021), per Class



Radar

- Radio Detection and Ranging.
- Radar uses Radio waves (mm – m scale)
- Radio waves are sensitive to everyday objects (Plants, waves, buildings, rocks, (water) soil etc)



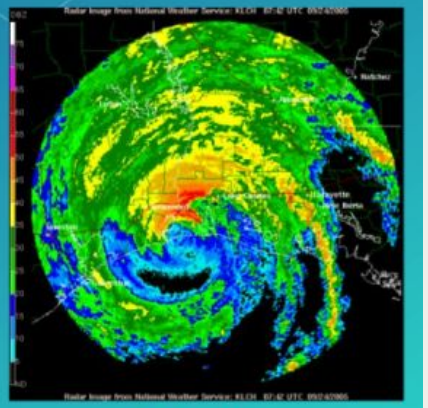
Typical Radar applications

Radio **D**etection and **R**anging
Widely used for military and civilian applications

Threat detection and identification

Vehicle speed monitoring

Air traffic control

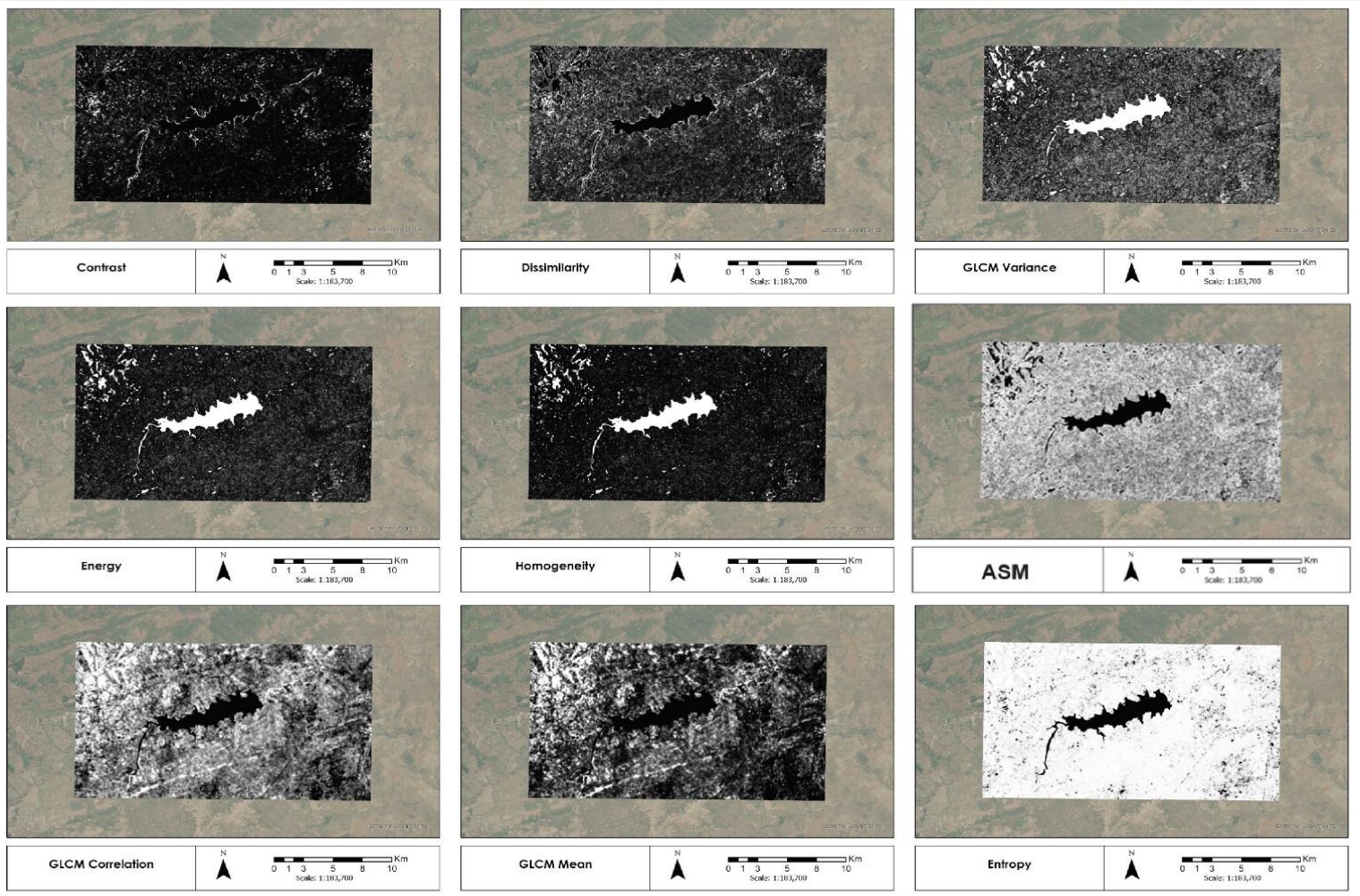


Weather

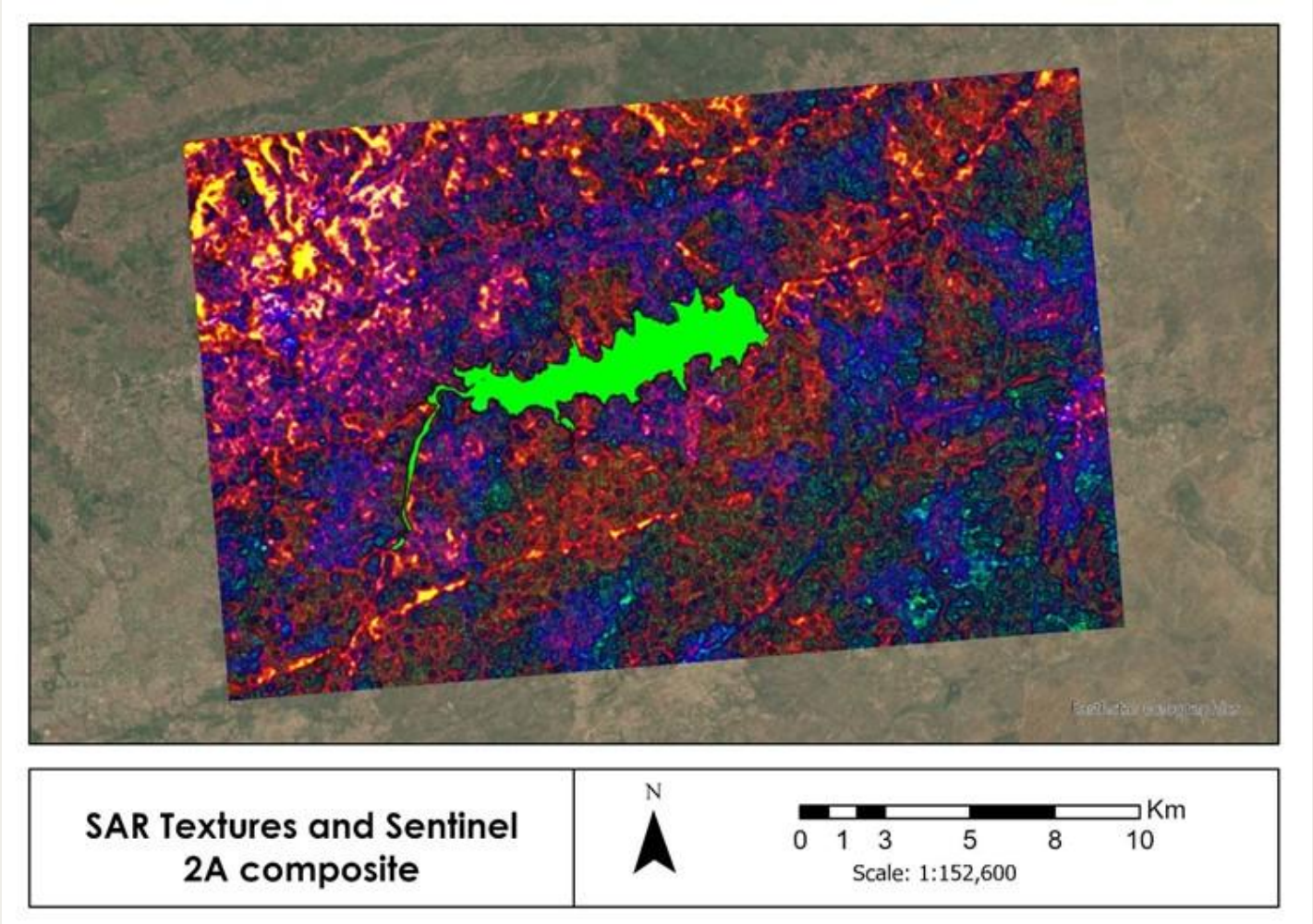
Synthetic Aperture Radar – Sentinel 1

- Active system
- Any weather condition (Vital in flood mapping)

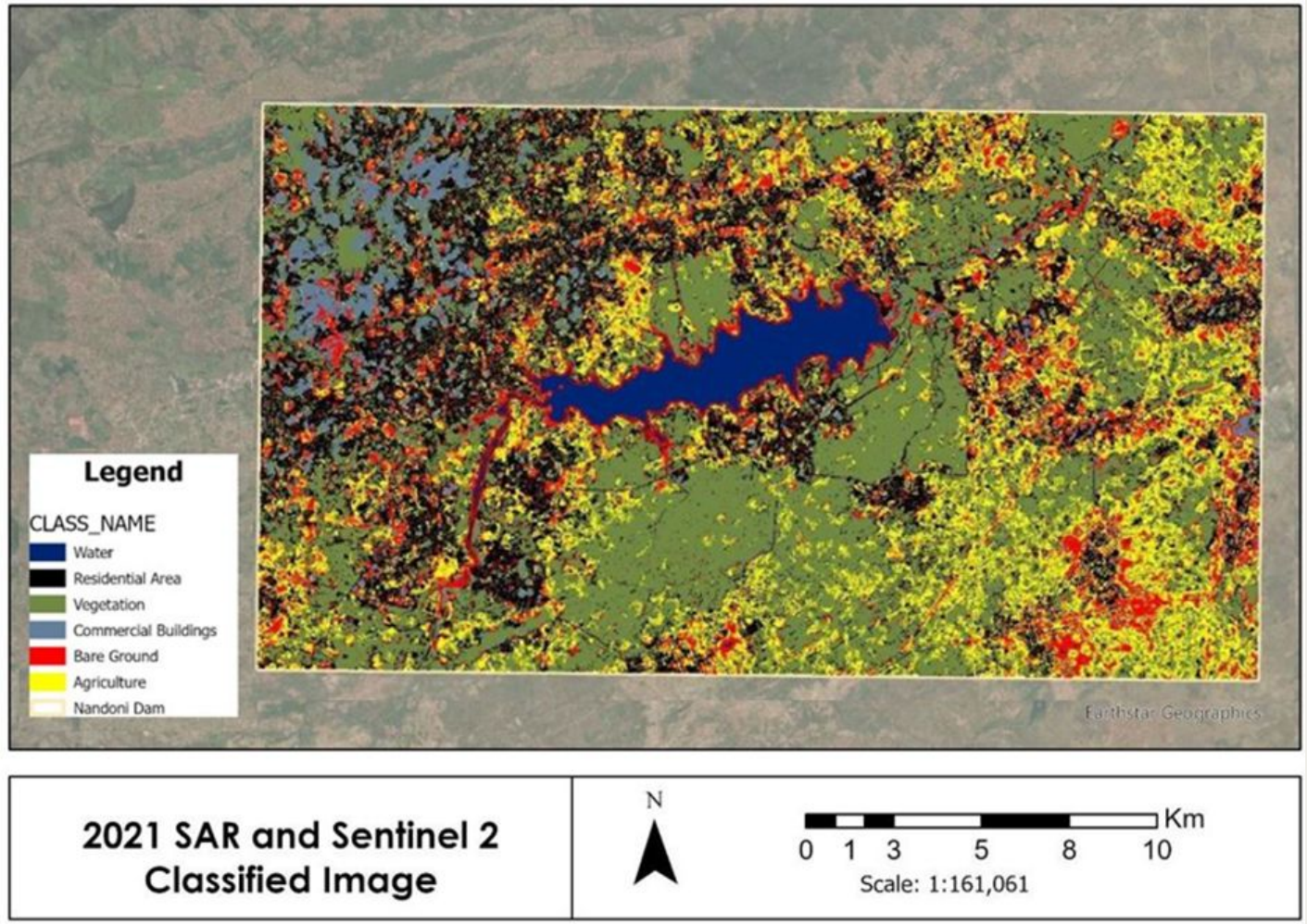
SAR Statistical Textures



SAR Sentinel 1 A Statistical Textures + Sentinel 2 A Composite



SAR (Sentinel (1 A) Statistical Textures + Sentinel 2 A Classified Image



Research Main Findings and Conclusions

1. **Kappa scores above 80% (2001: 0.81 and 2021: 0.83) Using Landsat.**
2. **SAR plus Optical achieved a 0.89 kappa Score.**
3. **No statistical significance between Optical and, SAR plus Optical (p value ≈ 0.9023)**
4. **Absence of evidence is not evidence of absence (Altman and Bland, 1995; Alderson, 2004)**
5. **Vegetation is the most changing class (decline).**
6. **Notable increase in residential and commercial classes.**
7. **The Land use trade off (ecosystem services vs economic gains).**

“Complex is better than complicated.” - Zen of Python.

Questions and Comments

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