Internship Report

Name: Most Sanjida Anjum Suchi

Internship Duration: April – June 2024 (12 weeks)

Project Title: Remote Sensing-Based Mapping and Analysis of Landslides to Support Humanitarian Aid.

Host organization

Department of Geoinformatics – Z_GIS, Paris Lodron University Salzburg (PLUS)

Schillerstrasse 30, 5020 Salzburg, AUSTRIA

Internship supervisor(s)

Dr. Daniel Hölbling, Senior Scientist & Research Group Leader

Elena Nafieva, Researcher

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1. Introduction

This report summarizes the work I carried out during my 12-week internship, which officially ended on 22 June 2024. The internship was part of the broader landslide mapping and disaster risk reduction project, with a special focus on Malawi (Mulanje region), Madagascar (Mananjary region) and Mozambique.

Cyclone Freddy (2023) triggered widespread flooding and slope failures across southeastern Africa. Accurate mapping of landslide-affected areas is critical for both emergency response and long-term risk management. The aim of the internship was to evaluate, collect, and process Earth Observation (EO) and GIS datasets to support landslide detection and analysis, using a combination of manual mapping, satellite data interpretation, and geospatial tools such as Google Earth Engine (GEE) and the ESA Charter Mapper platform.

2. Objectives

The main objectives of my internship tasks included:

- Evaluation of existing EO-based landslide services and catalogues.
- Compilation of a landslide events table for Malawi.

- Collection and documentation of GIS datasets (e.g., DEMs, LULC, meteorological data).
- Manual digitization of landslides in Malawi and potentially other study areas.
- Mapping landslides using Sentinel-1/2 data in Google Earth Engine.
- Testing the Charter Mapper platform for landslide detection and analysis.
- Accuracy assessment of detection results in cyclone-affected regions.
- Contribution to dissemination activities (poster/StoryMap for AGIT conference).

3. Organizational Context

The internship was hosted by Z_GIS, University of Salzburg, a leading European institute in the field of geoinformatics. Within Z_GIS, the work was carried out in the EO and Natural Hazards research group, led by Dr. Daniel Hölbling, which focuses on applying remote sensing and geospatial analysis to natural hazard monitoring, risk assessment, and climate resilience.

4. Tasks and Methodology

4.1 Evaluation of Existing EO-Based Landslide Services

- Reviewed landslide catalogues, including UGLC (Understanding and Generating Landslide Catalogs).
- Summarized strengths, gaps, and relevance for southern Africa.

4.2 Collection and Documentation of GIS Datasets (Malawi)

- Compiled key datasets: DEM, LULC, rainfall, and forest cover change.
- Verified dataset characteristics: spatial resolution, temporal coverage, licensing.
- Supported by contextual studies such as the *Mulanje Land Cover Study* and *Malawi Forest Change Analysis*.

4.3 Manual Landslide Mapping (Malawi)

- Digitized polygons of suspected landslides in the Mulanje region.
- Used high-resolution imagery and cross-validation with Sentinel-2.

4.4 Google Earth Engine Workflow (Sentinel-1/2)

- Analyzed NDVI-based vegetation loss mapping.
- Evaluated backscatter changes from Sentinel-1 for slope instability signals.
- Documented limitations for automated detection in tropical contexts.

4.5 Charter Mapper Testing

- Participated in ESA Charter Mapper training.

- Explored AOI selection, mission filtering, and automated workflows.
- Performed a case study of NDVI change detection on Sentinel-2.
- Documented Charter Mapper's strengths (rapid analysis) and weaknesses (limited customization).

4.6 Landslide Accuracy Checks in Madagascar

- Since UGLC contained no landslide points for Madagascar, I manually identified suspected events.
- Focused on Mananjary, severely impacted by Cyclone Freddy.
- Used Sentinel-2 pre-event (30.11.2022) and post-event (20.05.2023) imagery.
- Cross-checked with Google Earth Pro.
- Main challenges: cloud cover, rapid vegetation regrowth, and optical resolution limits.
- Produced a preliminary reference dataset for potential cyclone-triggered landslides.

5. Results and Outputs

- Dataset library for Malawi (DEM, LULC, rainfall, forest change).
- Table of landslide events in Malawi.
- Digitized landslide polygons for validation.
- Charter Mapper workflow documentation.
- NDVI-based change detection maps (Sentinel-2).
- Preliminary Madagascar landslide reference points for validation studies.
- Draft contribution to poster/StoryMap for AGIT conference.

6. Challenges and Limitations

- Absence of UGLC points in Madagascar hindered validation.
- Optical imagery limitations: cloud cover and vegetation recovery reduced visibility.
- Automated detection approaches (NDVI, backscatter) were not always reliable for small or subtle slope failures.
- Balancing manual and automated mapping approaches required methodological compromises.

7. Reflection on Learning Outcomes

This internship allowed me to:

- Develop technical skills in remote sensing, Google Earth Engine, and Charter Mapper.
- Gain experience in dataset evaluation, manual digitization, and accuracy assessment.
- Understand challenges of hazard mapping in data-poor, tropical regions.
- Strengthen reporting, documentation, and research communication skills through weekly updates and final report writing.

8. Conclusion and Future Perspectives

The internship provided valuable insights into the role of remote sensing for landslide detection and analysis in humanitarian contexts. While limitations exist—especially in terms of cloud cover, resolution, and validation data—the combination of manual interpretation, automated workflows, and platform-based tools offers a strong foundation for rapid disaster mapping.

Future work should focus on:

- Incorporating high-resolution optical and SAR data (PlanetScope, commercial VHR, Sentinel-1).
- Expanding validation with field surveys or citizen science contributions.
- Further integration of EO-derived products into disaster response workflows.

9. Annexes

Figure 1. Training session with Mauro Arcorace from Terradue

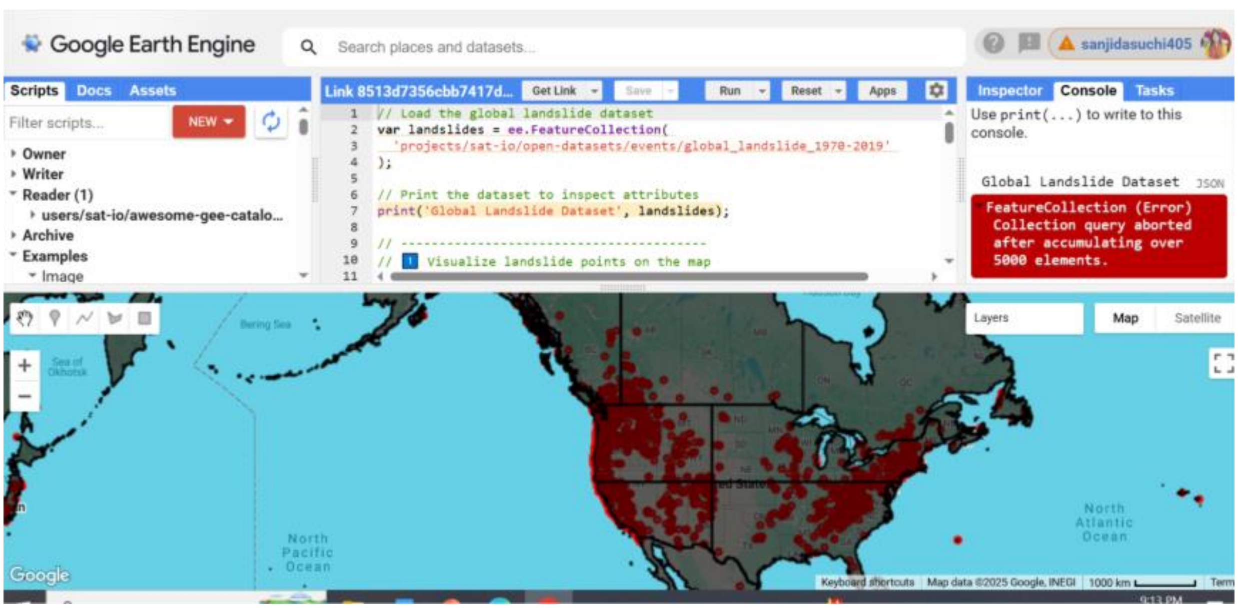
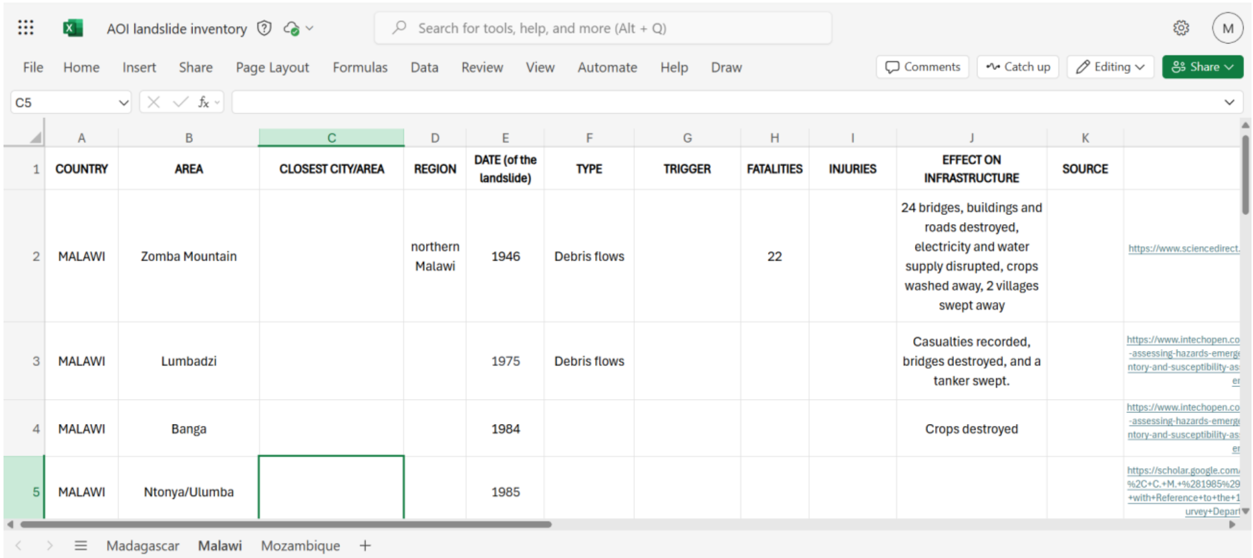


Figure 2. Visualizing Landslide Events through Google Earth Engine



COUNTRY	AREA	CLOSEST CITY/AREA	REGION	DATE (of the landslide)	TYPE	TRIGGER	FATALITIES	INJURIES	EFFECT ON INFRASTRUCTURE	SOURCE	
MALAWI	Zomba Mountain		northern Malawi	1946	Debris flows		22		24 bridges, buildings and roads destroyed, electricity and water supply disrupted, crops washed away, 2 villages swept away		https://www.sciencedirect.
MALAWI	Lumbadzi			1975	Debris flows				Casualties recorded, bridges destroyed, and a tanker swept.		https://www.intechopen.co -assessing-hazards-emerge ntory-and-susceptibility-as er
MALAWI	Banga			1984					Crops destroyed		https://www.intechopen.co -assessing-hazards-emerge ntory-and-susceptibility-as er
MALAWI	Ntonya/Ulumba			1985							https://scholar.google.com/ %2C+C.+M.+%281985%29 +with+Reference+to+the+1 urvey+Depart

Figure 3. Landslides inventory Excel table, Malawi

Figure 4. Several points taken from Mananjary area for detecting landslides