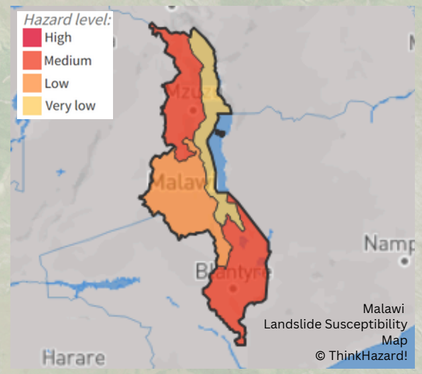
Landslide Data for Action: EO-based Mapping to Support Humanitarian Response

Sarah Forcieri[1,2], Carla Arellano[1], Elena Nafieva[1], Stéphane Henriod[1], Daniel Hölbling[1], Suchi Most Sanjida Anjum[1], Zahra Dabiri[1], Albert Schwingshandl[3], Yann Rebois[4], Leslie Jessen[4]

[1] Department of Geoinformatics – Z_GIS, University of Salzburg, Salzburg, Austria
[2] National School of Geographic Sciences - Geomatics (ENSG - Géomatique), Champs-sur-Marne, France
[3] RIOCOM – Ingenieurbüro für Kulturtechnik und Wasserwirtschaft DI Albert Schwings Händl
[4] Médecins Sans Frontières (MSF) Austria

Problem statement

Tropical Cyclone Freddy hit south-eastern Africa in February and March 2023, causing catastrophic (flash) floods and landslides, resulting in a large number of casualties across Malawi, Mozambique and Madagascar.
Climate change is expected to intensify extreme weather events such as tropical cyclones in future years. To support humanitarian operations on the field, it is crucial to have **fast, effective, reliable, and up-to-date** information as input for **rapid hazard and damage assessments**. Earth observation (EO) data (such as optical and synthetic aperture radar (SAR)) and technologies have demonstrated their value in aiding emergency response and disaster risk management following landslide events.



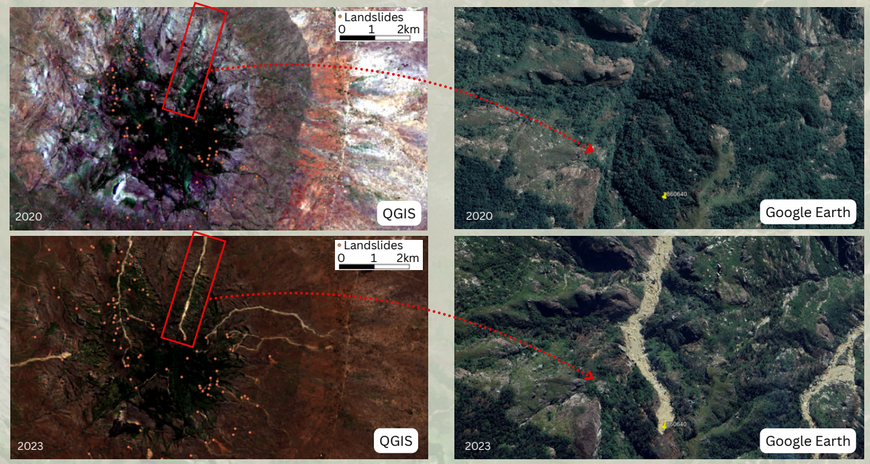
LEONA

Landslide Information from **E**arth **O**bservation to Support Humanitaria**N** **A**id

The project is led by the Risk, Hazard and Climate Lab at Z_GIS and aims to create targeted landslide information from EO data to support humanitarian aid, in collaboration with Médecins Sans Frontières (MSF).
LEONA is supported by the Austrian Research Promotion Agency (FFG) in the Austrian Space Applications Program (ASAP) (contract no. FO999921058).

Landslide inventory

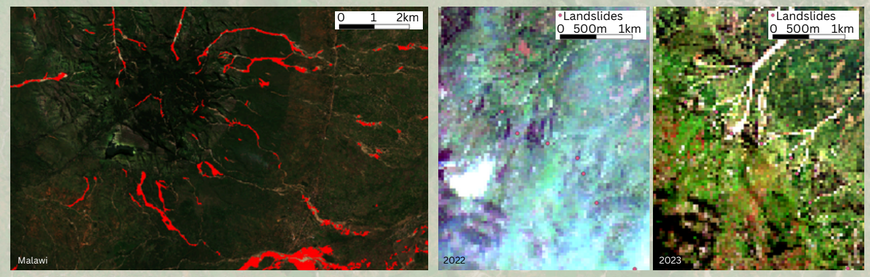
The dataset mainly used for this research is the UGLC landslide point catalogue. It has been sorted into the countries most affected by cyclone Freddy (Mozambique, Malawi and Madagascar) and filtered to include only the events that occurred during the typhoon. Accurate landslide inventories are crucial to understand their distribution and impact, which is why the UGLC inventory's accuracy was verified by comparing pre- and post-cyclone Freddy satellite images. Below is a comparison of Sentinel-2 and Maxar images from the same area in Malawi.



Landslides on Sentinel-2 optical pre- and post-cyclone Freddy images (from Copernicus Browser).

Landslides on Maxar optical pre- and post-cyclone Freddy images (from Google Earth).

EO satellite imagery can also help detect landslides without prior location data, either through image processing (e.g., via Charter Mapper, which is only accessible for authorized users - the NDVI-CD tool flags the loss of vegetation between two images) or by comparing pre- and post-event images of the same area.

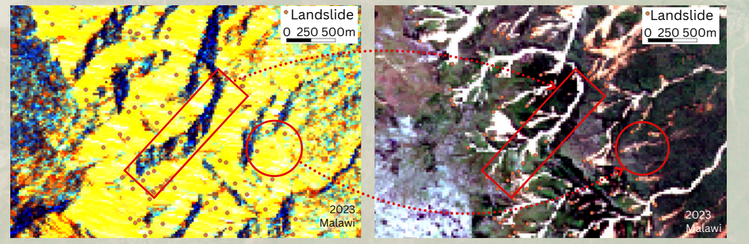


NDVI Change Detection result from Sentinel-2 images dated 05.04.2022 and 25.04.2023.

Landslides on Sentinel-2 optical pre- and post-cyclone Freddy images (from Copernicus Browser) in Mozambique.

Landslide mapping

(Rapid) landslide mapping is important for emergency response to identify riskier areas and anticipate disasters. Since Sentinel-1 and Sentinel-2 images are freely accessible, their ease of use for future landslide detection and mapping has been a focus of this study. This is particularly relevant for MSF which needs a method that can work reliably almost anywhere in the world. Below is a comparison of two Sentinel images (-1 and -2). Smaller landslides do not appear clearly on S-1 images, as shown below in the red circle, and thus the images are not suitable to detect them. The red rectangle shows a clearly visible landslide in both images, which means S-1 images can still give clues about the presence of a landslide.



Comparison of Sentinel-1 and Sentinel-2 images (post-Freddy, 15 days difference between them).

Comparison of the delimitation of a landslide from a Sentinel-2, Sentinel-1 and Maxar image.

Here is a comparison of the result of manual mapping of the same landslide on three different images (S-1, S-2 and Maxar). Even though S-1 images show the bigger landslides, they are not precise enough to map them efficiently. In addition, the lower spatial resolution limits the detection of smaller landslides.

Conclusion

Earth observation data, in particular Sentinel data, provide an effective and accessible tool for mapping landslides in support of humanitarian response. While manual verification with high-resolution imagery enhances accuracy, Sentinel data provides sufficient quality for mapping during disasters like cyclone Freddy. However, the lower spatial resolution of the images limits what can be done.