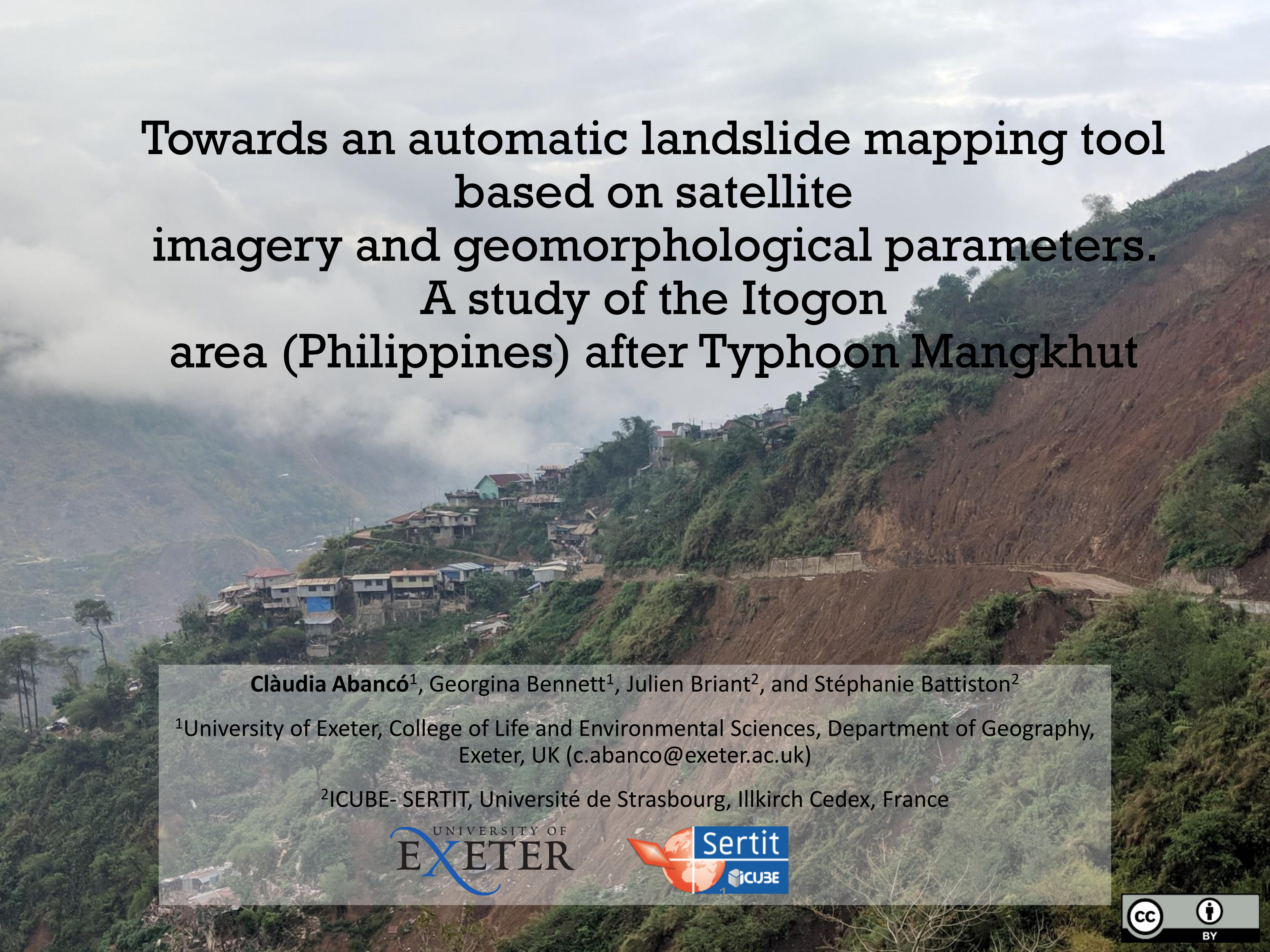

Towards an automatic landslide mapping tool based on satellite imagery and geomorphological parameters. A study of the Itogon area (Philippines) after Typhoon Mangkhut

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Introduction

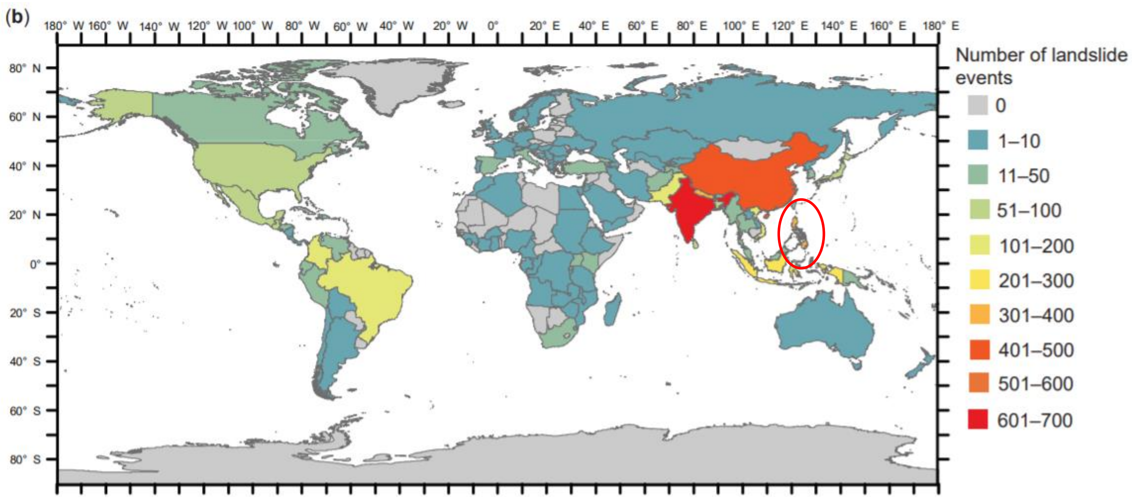


Figure 1- Number of non-seismically triggered fatal landslides by country (2004 to 2016). From (Froude and Petley, 2018)

The Philippines accounts for **46%** of rainfall-triggered landslides in SE Asia, although it represents only **6% of the land area** (Petley, 2012) (Fig.1).

In 2018, the devastating Typhoon Mangkhut triggered **thousands of landslides**.
One of them, with specially long runout, killed **70 miners** near Itogon (NW Luzon island) (Fig.2).

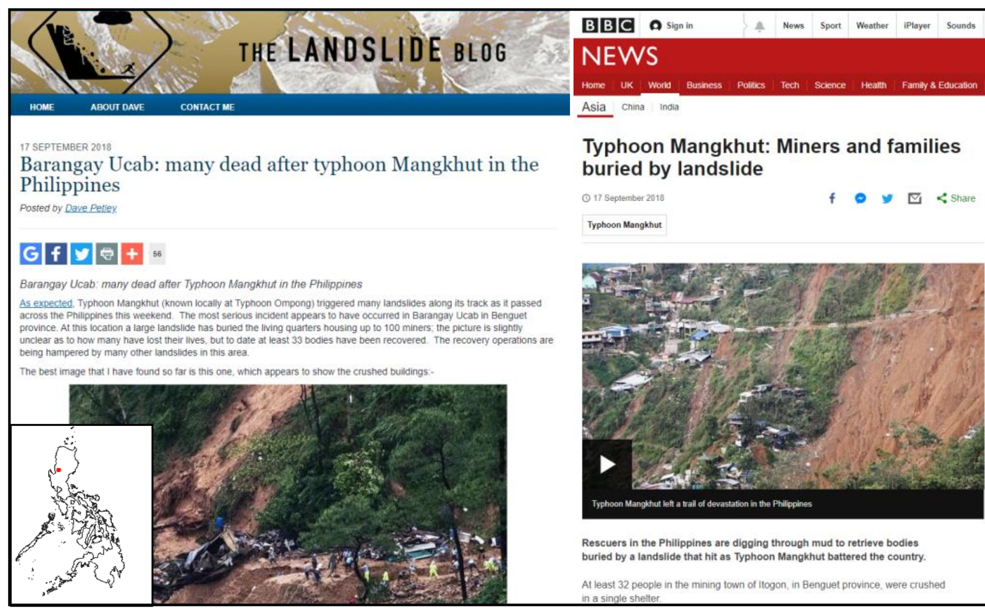


Figure 2- Snapshots of news reporting the fatal landslide in Itogon. Inset (lower left), the location of Itogon within the Philippines (red dot).

Aim of this work

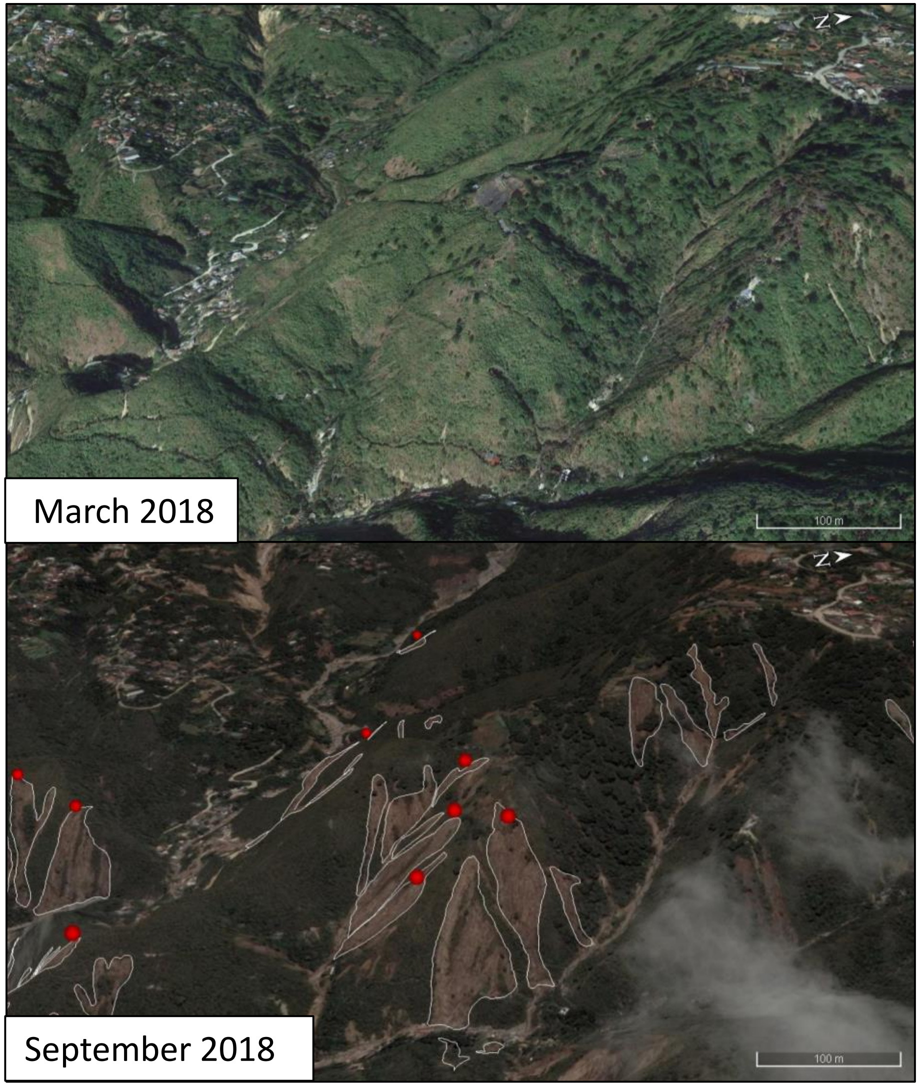


Figure 3- Pre and post satellite imagery (in Google Earth) of the landslides occurred in the area of Itogon due to the passage of Typhoon Mangkhut. Point-based inventories in red and polygon inventories in white.

Landslide inventories are very scarce in the Philippines. Most of them are point-based inventories (lacking landslide **magnitude**) (Fig.3).

however…

Magnitude-frequency relationships are essential for landslide hazard assessment

Volume of sediment delivered by slopes is important to study channel morphodynamics (flood risk, reservoir management, …)

For this reason, our objectives were:

Study area: **Itogon- Typhoon Mangkhut**

1) Map and characterize the geomorphological features of the landslides

2) Analyse the potential of automatic tools to map landslides from satellite imagery

Methods- Geomorphologic analysis

We mapped landslides in a study area of **570 km²** in the surroundings of of Itogon city (Fig.4). We used:

- Different sources of **satellite imagery** (pre- and post- Typhoon) (Fig.5):
  - Planet Labs (3 m resolution)
  - Sentinel-2 (10 m resolution)
  - Google Earth imagery (Worldview, Pleiades, very high resolution)

- Layers including **geomorphological parameters**:
  - DEM (5x5) (NAMRIA, 2013)
  - Geology (USGS, 1999)
  - Soil type (Bato and Nicopior, 2010)
  - Land cover (NAMRIA, 2010)

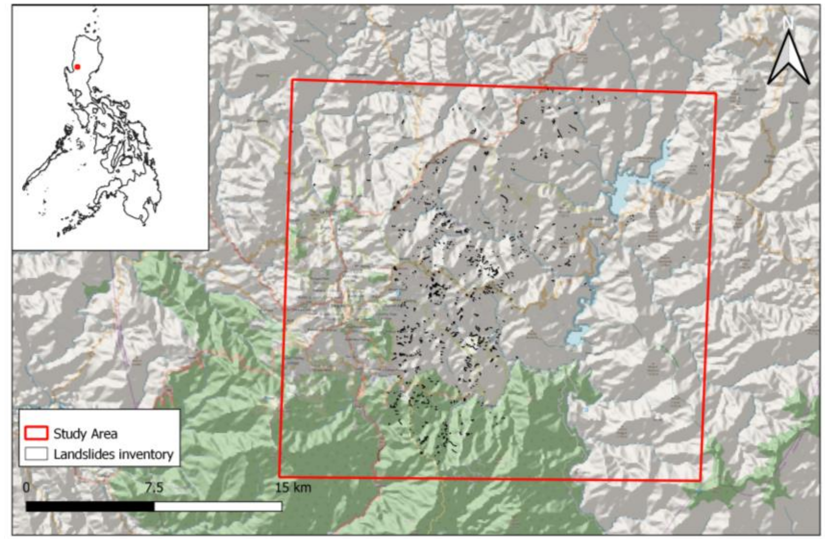
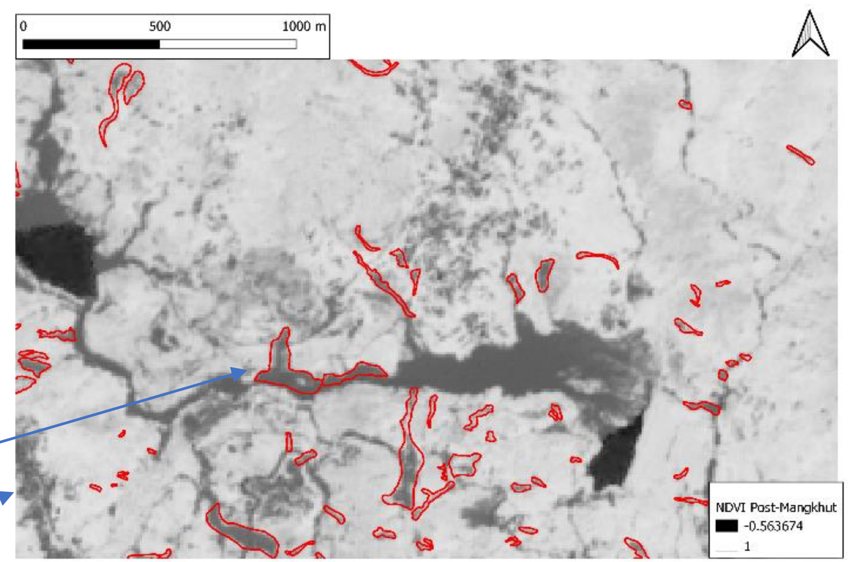


Figure 4- Landslide inventory over the study area, near Itogon



Landslide inventory

NDVI after Typhoon Mangkhut

Figure 5- Detail of the inventory, overlaying NDVI extracted from Sentinel-2

Methods- Automatic rapid mapping

SLIDEX is a **pixel-based approach**, that has been chosen as a first approach. Change detection is made based on the disappearance of vegetation due to landslides.
A threshold is applied on the result on **NDVI difference** computation. An additional process allows the reduction of false alarms by thresholding **slopes** using a DEM (Fig. 6) (HEIMDALL, 2018).

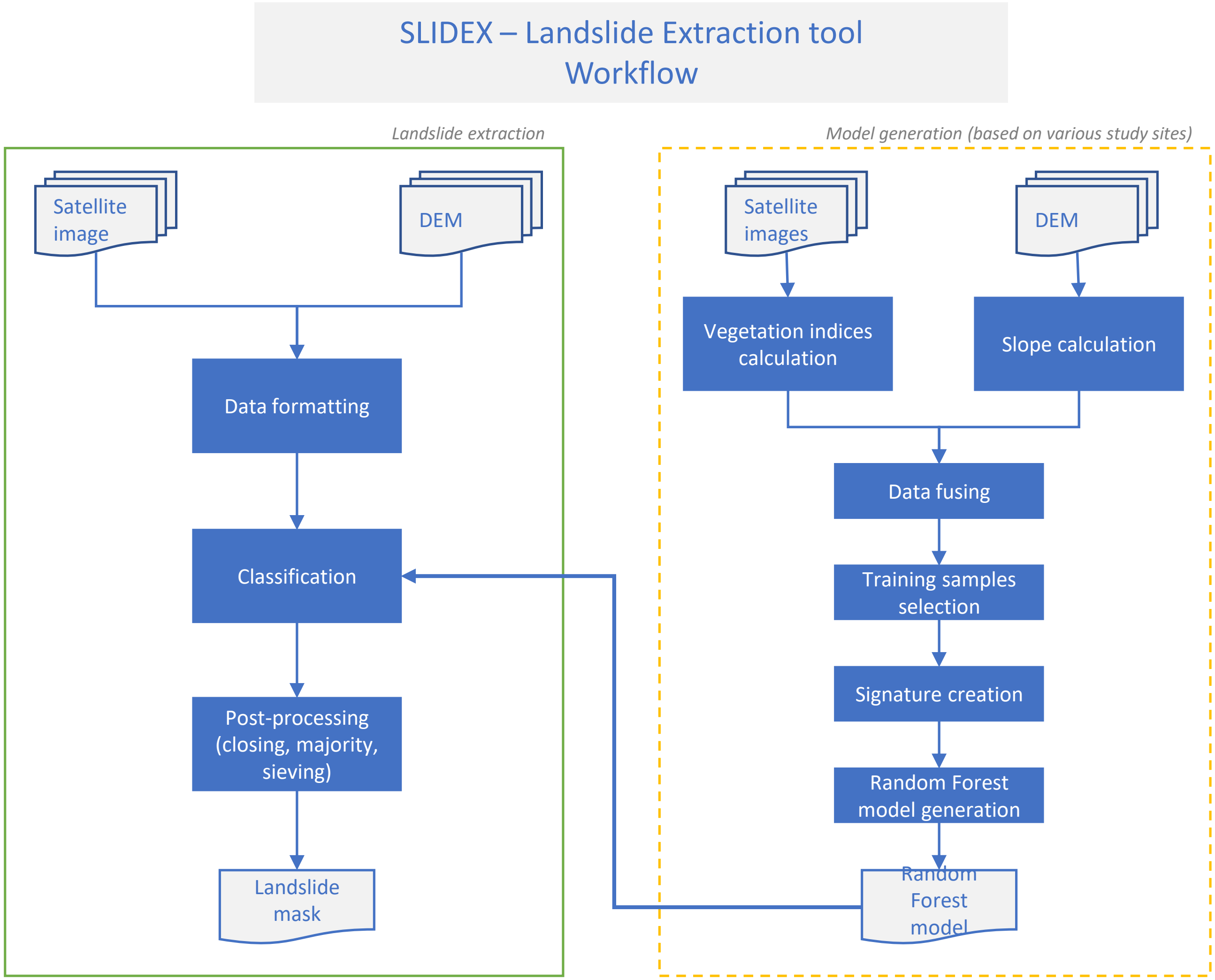


Figure 6- Scheme of the SLIDEX algorithm.

Results

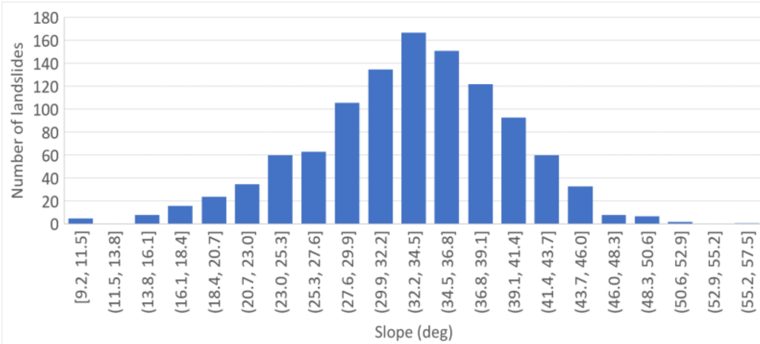


Figure 7- Histogram of the distribution of mean slope of landslides of the inventory

We mapped **1096 landslides** in the study area, spanning 1.21% of the area (Fig.4). Landslides in the area occur at altitudes mainly between 975 and 1230 m.a.s.l., within slopes typically around 30 degrees (Fig.7).

Landslides predominantly occurred in slopes facing **E and SE** (Fig.8), with 63% of them facing these two orientations, while it was less common to have landslides facing NW.

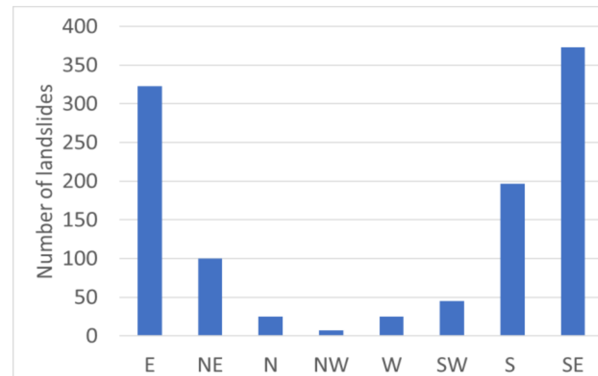
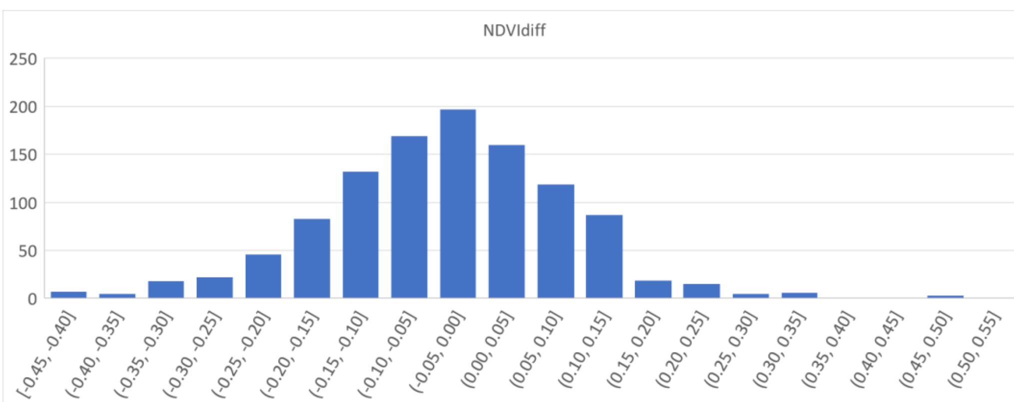


Figure 8- Histogram of the distribution of mean aspect of landslides of the inventory



The differences in NDVI at the areas affected by landslides is predominantly about **-0.05** (Fig.9), but it may depend on the sub-area.

Figure 9- Histogram of the distribution of the difference in NDVI (NDVI post-NDVI pre) in the area of landslides of the inventory

Results

Figure 10- Landslide inventory over the study area, near Itogon

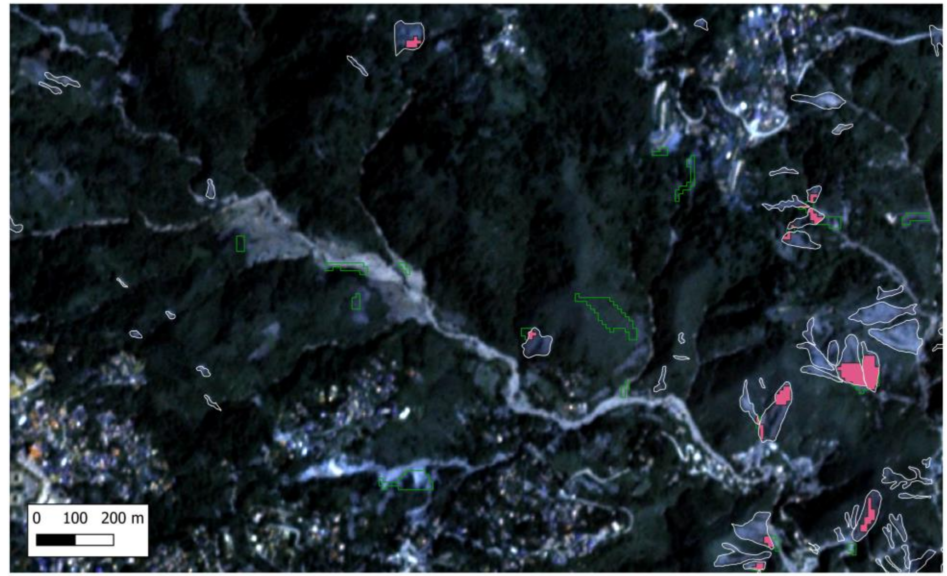


Figure 11- Landslide inventory over the study area, near Itogon

SLIDEX was applied to Sentinel-2 images and was able to automatically detect **118 (>800 m2; ~50%)** of the bigger landslides of the inventory (Fig.10).

However, the delineation of the polygons was often challenging.

The detection of the smaller landslides **(<800 m2; ~50%)** was **not possible** in the vast majority of the cases (Fig.11).

Concluding remarks and next steps

Why are landslides mostly facing E-SE?

1) Typhoon trajectory and winds: Typhoon Mangkhut had a direction SE to NW above the study area. The atmorspheric conditions may have favoured landsliding in slopes with a certain aspect (Fig.12).
2) Different environmental conditions: soil moisture could be different in slopes receiving different insulation

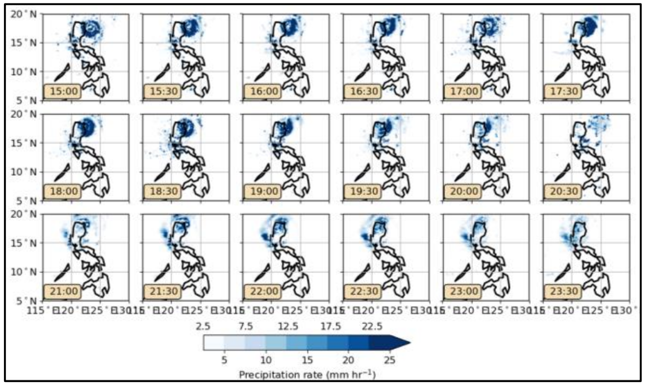


Figure 12- Landslide inventory over the study area, near Itogon

Which challenges have been faced on the use of an automatic tool to quickly map landslides in Itogon?

1) Half of the landslides in the study area were too small to be detected using Sentinel-2 imagery
2) Delineation of the landslide polygons couldn't be done properly due to the low resolution of the imagery
3) Effort should be put on the use of higher resolution imagery
4) The performance may increase by establishing different thresholds in different units of terrain of the study area

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Chat time:
Wed, 06 May, 08:30–10:15 (CEST)

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https://georgielbennett.wordpress.com/scarp-project/

- This project runs in parallel with a partner project in the Philippines, leaded by **Mapua University (Manila)** and financed by **PCIEERD-DOST**.
- This project has been integrated into a collaboration with **Glasgow University** project *"Catchment susceptibility to hydrometeorological events: sediment flux and geomorphic change as drivers of flood risk in the Philippines"*

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