

## Introduction

Satellite synthetic aperture radar (SAR) data provides the best opportunity to quickly detect landslides for hazard response because SAR can image the ground regardless of weather or daylight conditions. The recent failure of the Sentinel-1B satellite has significantly reduced our ability to generate landslide maps in a timely manner across certain parts of the world leaving a gap in rapid response support. The ICEYE constellation may fill this gap because it can acquire repeat imagery over the same area every 24 hours and can be tasked to acquire data in specific areas. In addition, ICEYE acquires data with a higher spatial resolution, which is better suited for detecting smaller landslides. The high revisit time and high resolution of ICEYE significantly increases the capability to rapidly detect landslides and can provide key information to first responders.

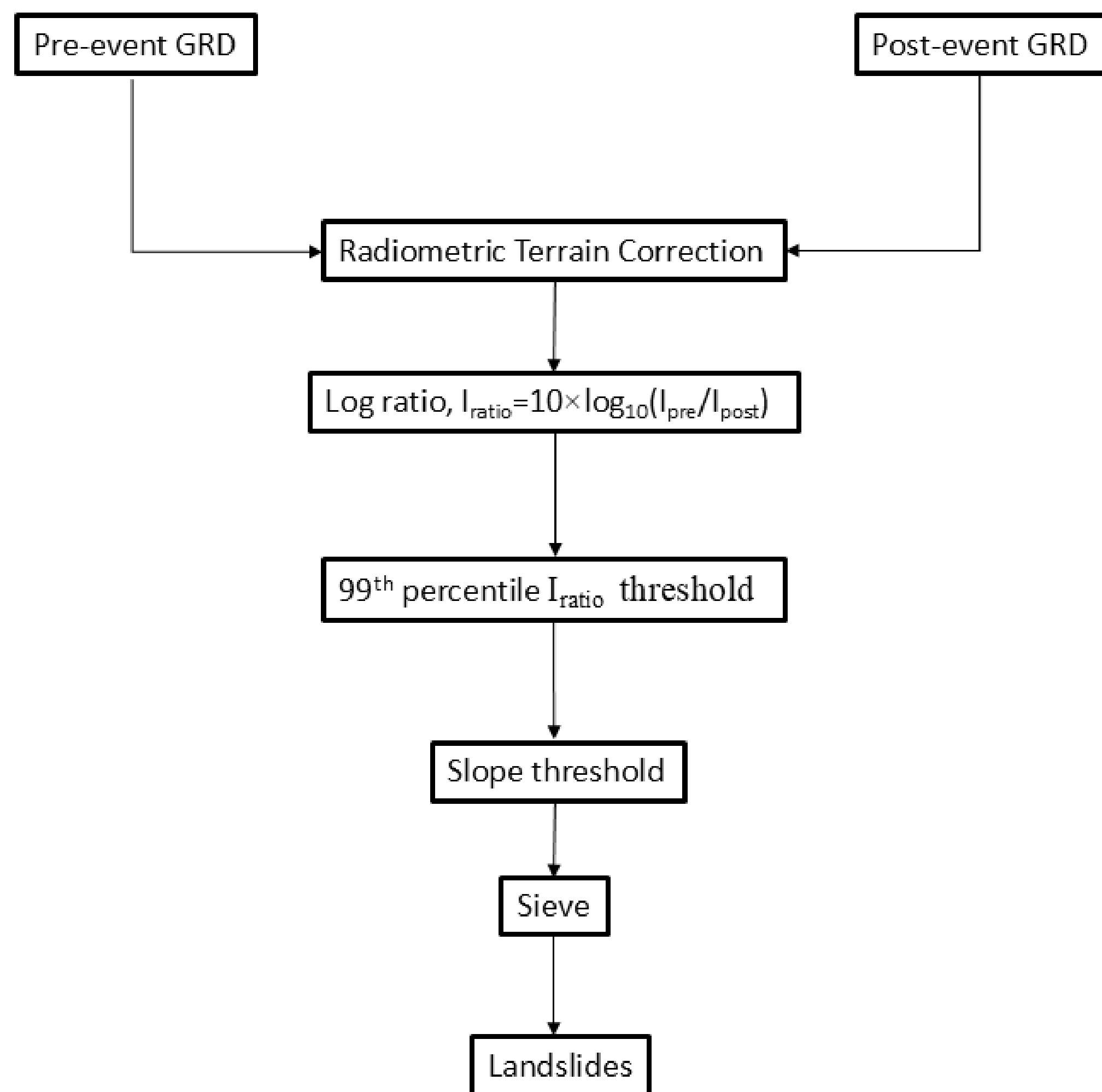
The main goal of this work was to test applicability/suitability of SAR imagery from ICEYE to generate rapid response landslide products.

## Study Area

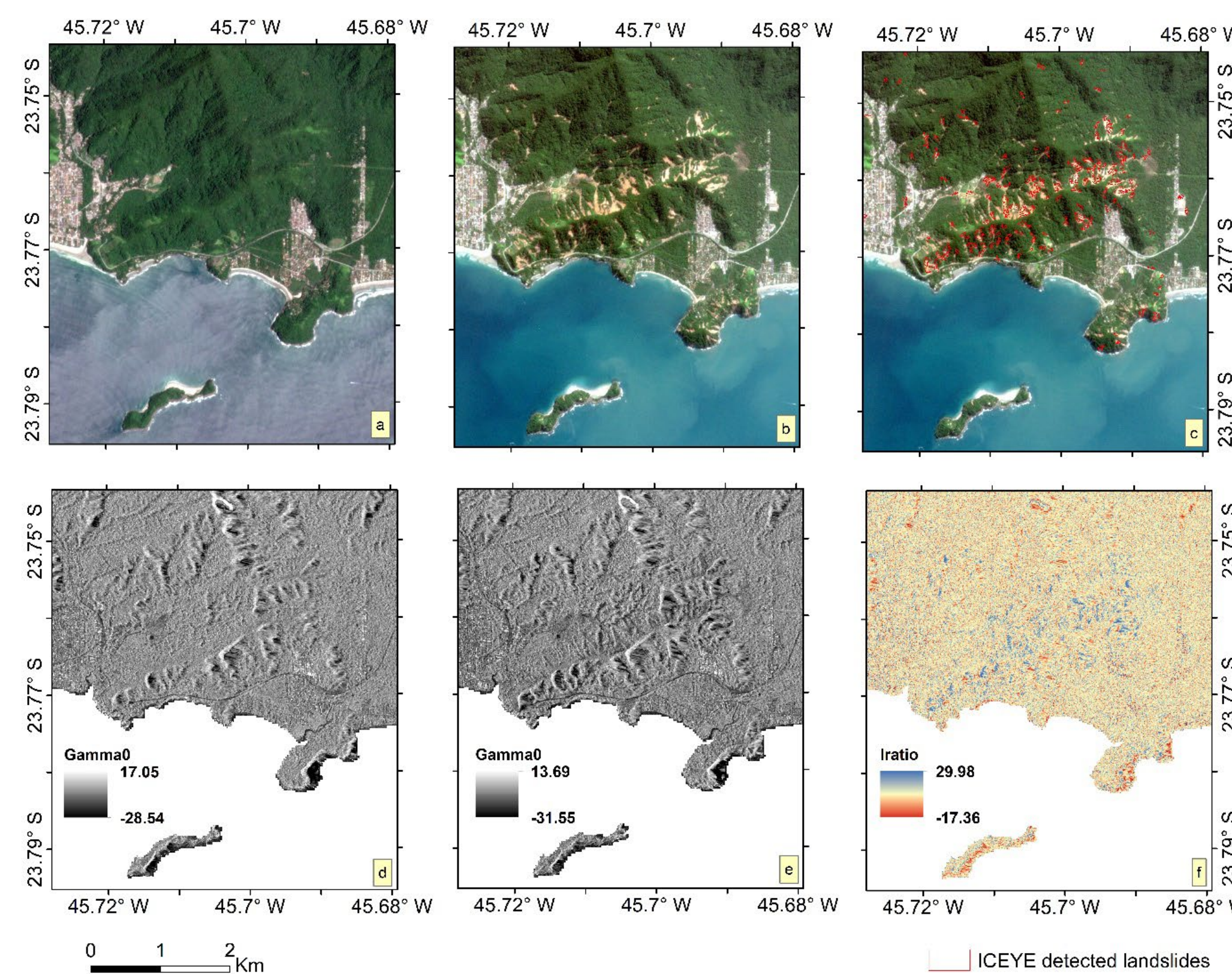
Landslide detection tests were carried out in various parts of the world with documented past landslide activity and had availability of a pre-event ICEYE imagery. For these events we obtained post-event imagery for change detection by tasking ICEYE satellites to acquire imagery with similar geometry to the pre-event imagery.

For the second test utilizing post-event imagery only, we tasked ICEYE satellites to acquire multiple images over landslide sites.

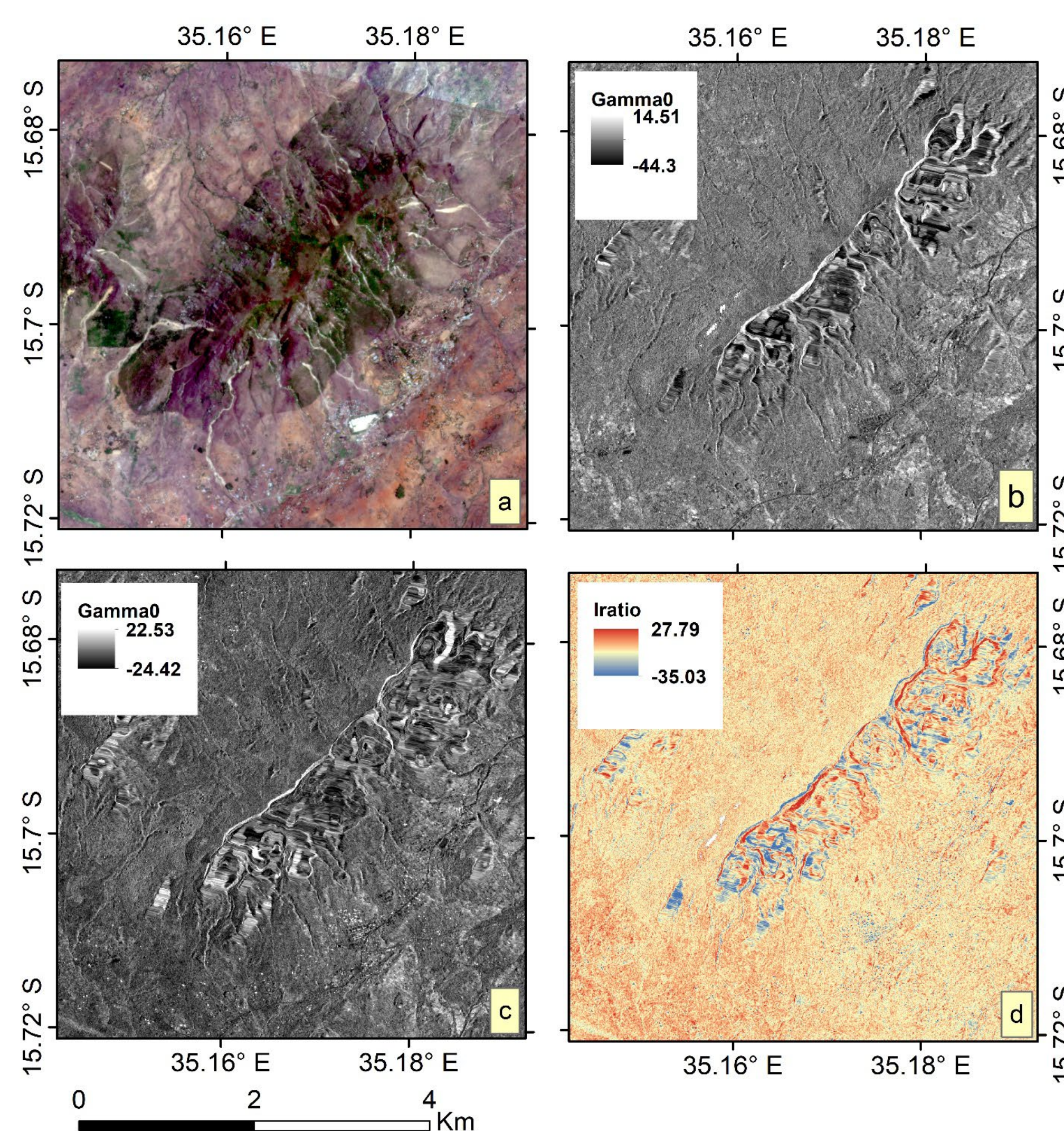
## Change detection methodology



## Change detection results

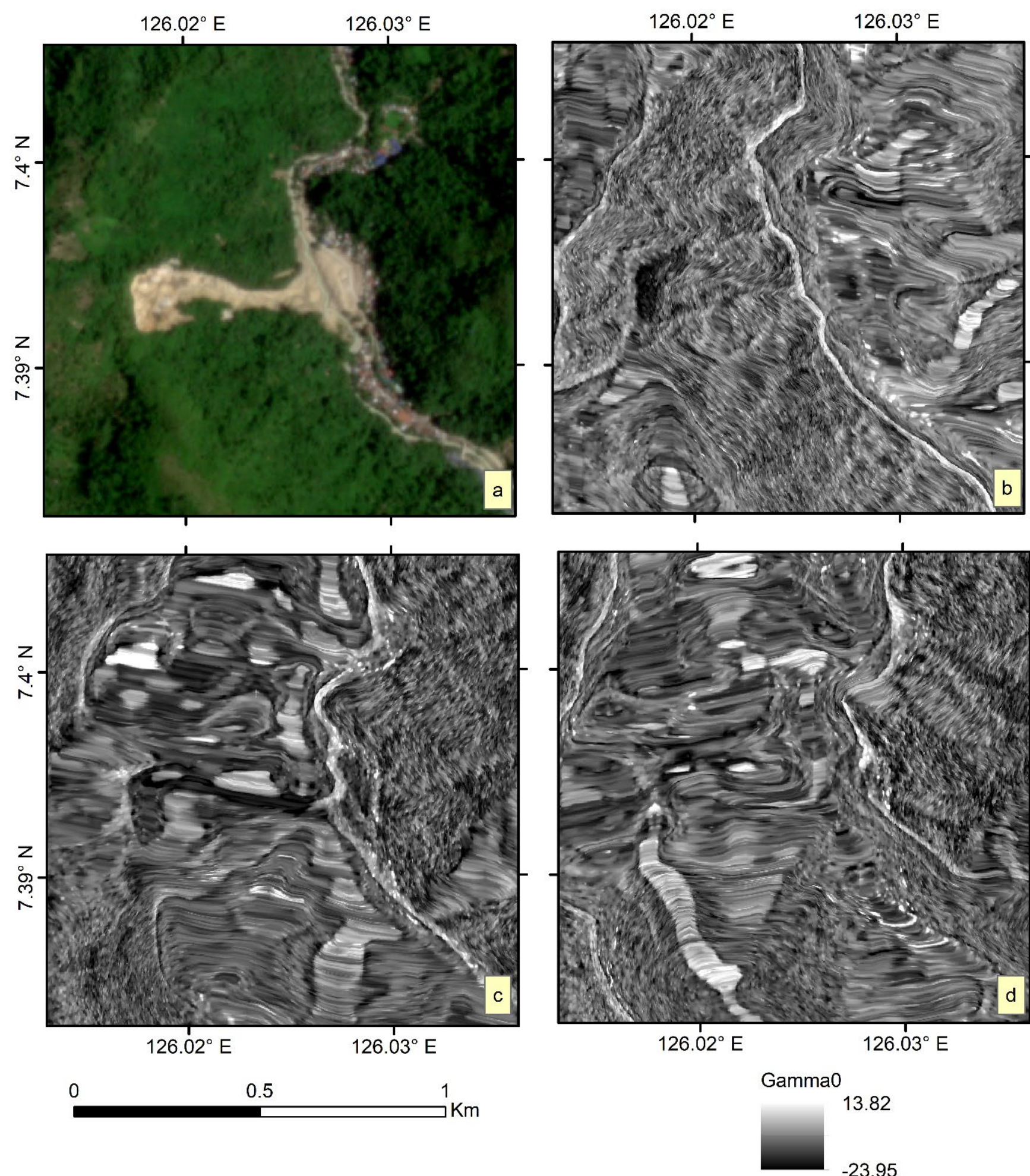


Landslides detected in Sao Paulo, Brazil: a) pre-event Planet image; b) post-event Planet image; c) ICEYE change map showing landslides (red colors) draped on post-event Planet; d) pre-event RTC ICEYE image; e) post-event RTC ICEYE image and f) I\_ratio ICEYE image.



An unsuccessful attempt to detect landslides at Chiradzulu, Malawi due to terrain artifacts: a) post-event Planet image; b) pre-event RTC ICEYE image; c) Post-event RTC ICEYE image and d) I\_ratio ICEYE image.

## Post-event only



A landslide in Maco, Philippines: a) post-event Planet image; b) descending left looking ICEYE image; c) descending right looking ICEYE image and d) ascending left looking ICEYE image. An image with ascending right orientation was not delivered due to failed quality control at ICEYE. Landslide is only visible in descending left orientation highlighting the importance of acquiring imagery with the proper imaging geometry.

## Findings

- The ability to match geometry of pre-event imagery during acquisition is key for detecting landslides using change detection.
- Currently, pre-event imagery is not available for most parts of the world, nor do we expect it to be for a tasking-based company. In the future, as we do not really know where landslides will occur in advance, the process of getting ideal imagery will be a major challenge.
- With proper planning as we know of impending storm or hurricane events tasking landslide susceptible areas pre- and post-event with proper investigation of satellite pass vs mountain slope visibility might help the response efforts.

## References:

Handwerger, A. L., Huang, M., Jones, S. Y., Amatya, P., H., Kerner, H. R., Kirschbaum, D. B. (2022). Generating landslide density heatmaps for rapid detection using open-access satellite radar data in Google Earth Engine. *Natural Hazards and Earth System Sciences*. <https://doi.org/10.5194/nhess-22-753-2022>.