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A medium-sized rainfall-induced landslide detection using L- and C-band SAR images: A comparative study in agricultural lands

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ABSTRACT

Because of landslides, rapid volume of materials fall or move along the steep slopes. This research consists of a comparative study for creating landslide inventory maps (LIM) in agricultural lands of Gilan province, Iran using the ALOS-2 PALSAR-2 and Sentinel-1 (both ascending and descending directions). A pixel-based RGB band combination model and interferometric synthetic aperture radar (InSAR) technique were used to detect the occurred landslides. The landslide was detected using ALOS-2 PALSAR-2, while, it was not detected using Sentinel-1. The google earth and GPS were employed to validate the study. The results showed the potential of L-band ALOS-2 PALSAR-2 compared to C-band Sentinel-1.

1. INTRODUCTION

Landslide is one of the geo-hazards in terms of damage (Schlögel et al., 2015). Landslides are almost happen everywhere on the Earth (Adriano et al., 2020; Bui et al., 2016). In Gilan province, landslide cause many damages to the agricultural lands (Moroor, 2020). Remote sensing technologies present the best methods for detecting post-disaster damage, including landslides (Adriano et al., 2020). SAR data have widely been used for landslide monitoring (Catani et al., 2005; García-Davalillo et al., 2014; Jebur et al., 2015; Strozzi et al., 2018). InSAR is a valuable technique for landslide inventory (Calabro et al., 2010; Zhao et al., 2012). The accurate identifying of landslides is vital for disaster response management (Adriano et al., 2020). Pixel-based RGB band combination method detects Landslides directly from the satellite data. The current study can be significant, because it compares either ascending or descending directions of Sentinel-1 (C-band) with ALOS-2 PALSAR-2 (L-band) for detecting an occurred landslide. Many researches have conducted landslide through different models and techniques such as convolutional network, hot-spot analysis, differential interferometric synthetic aperture radar (DInSAR), NDVI, random forest, InSAR (Chen et al., 2014; Furuta and Tomiyama, 2008; García-Davalillo et al., 2014; Jebur et al., 2015; Lv et al., 2020; Schlögel et al., 2015). The main objective of this study was to compare the suitability of Sentinel-1 and ALOS-2 PALSAR-2 on landslide detection in the agricultural lands of a part of Gilan Province, Iran (Figure 1).

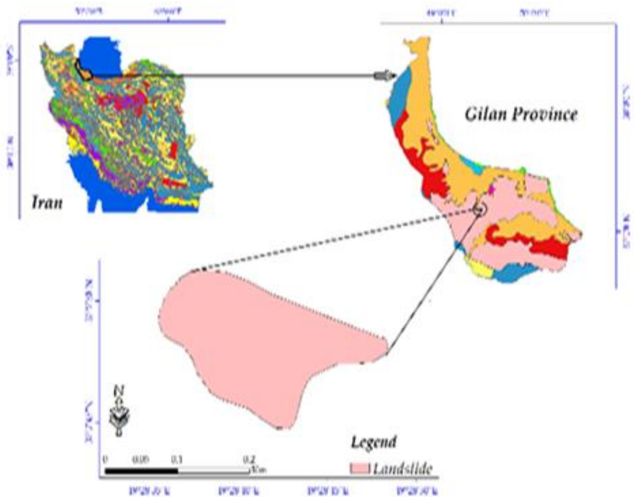

Figure 1. Geographical extent of the study

2. METHOD

2.1. Data Acquisition and Methodology

A pair image of ALOS-2 PALSAR-2 and Sentinel-1 (pre- and post-event) were acquired (date of the event 10 / 4 / 2020). Table 1 shows the attributes of the data used.

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Table 1. Technical characteristics of the data used

Imagery	Orbit Type	Date acquired	Product
Sentinel-1	Ascending	01-04-2020 13-04-2020	SLC
	Descending	27-03-2020 20-04-2020	
ALOS-2 PALSAR-2	Ascending	29-01-2020 22-05-2020	SLC

The RGB methodology used in this study represents a series of pixels to detect the landslides. The processing steps is summarized in Figure 2. This flowchart is managed into three main sections of data used, preprocessing and output. In the pre-processing task, two operators of TOPS split and TOPS deburst (shown in orange color) belong only to Sentinel-1 data, while the other operators are common tasks for both ALOS-2 PALSAR-2 and Sentinel-1. For landslide detection using RGB band combination, intensity band of pre-event image was used for R window and intensity band of post-event for G window. Finally, GPS and the Google Earth images were applied for validation processes.

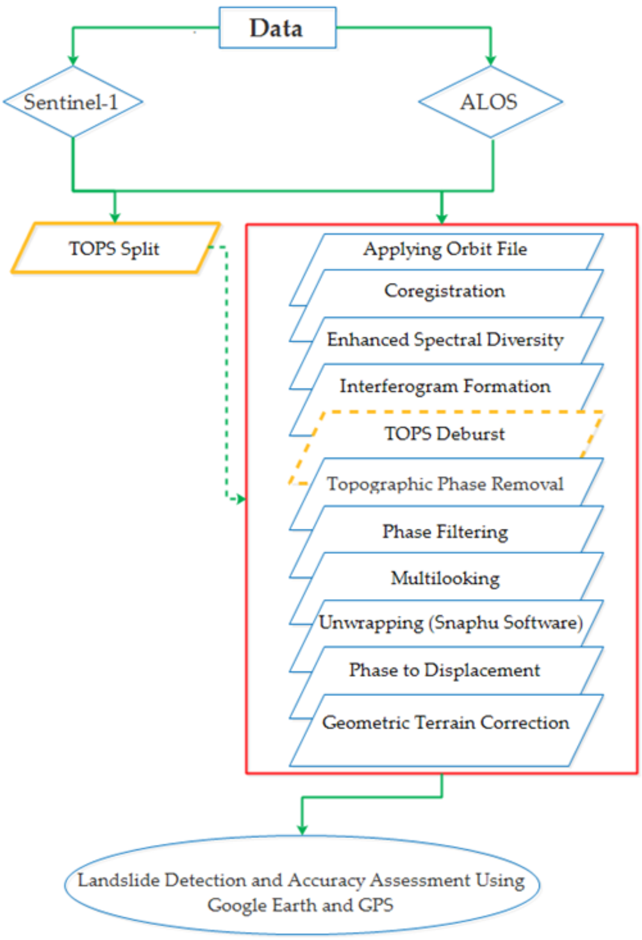

Figure 2. Methodology

3. RESULTS

3.1. Landslide Detection

Figure 3 shows the proposed RGB band combination of ALOS-2 PALSAR-2 data. The green color represents areas where the landslide occurred. It is worth mentioning that the yellow colors show the correctly co-registered pixels in both slave and master data.

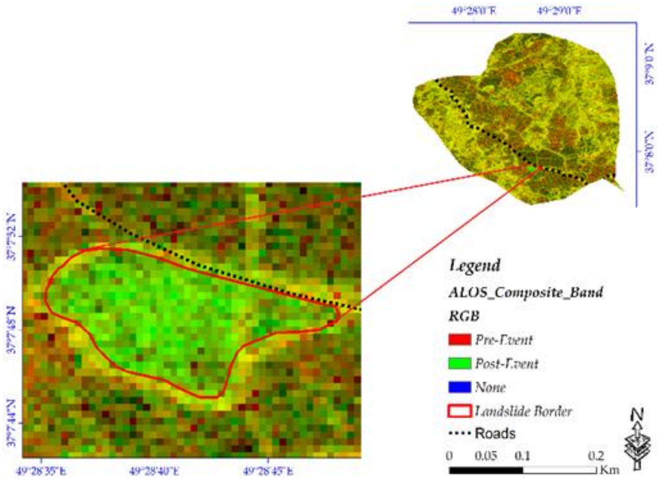

Figure 3. Landslide detection using ALOS-2 PALSAR-2

Figure 4 represents results for ascending and descending directions of Sentinel-1. Firstly, we performed the analysis for ascending direction, but no good finding was obtained. We thought that maybe it is because of the view angle; therefore, the operations were done on the descending direction as well. Unfortunately, it was not also capable of detecting the occurred landslide.

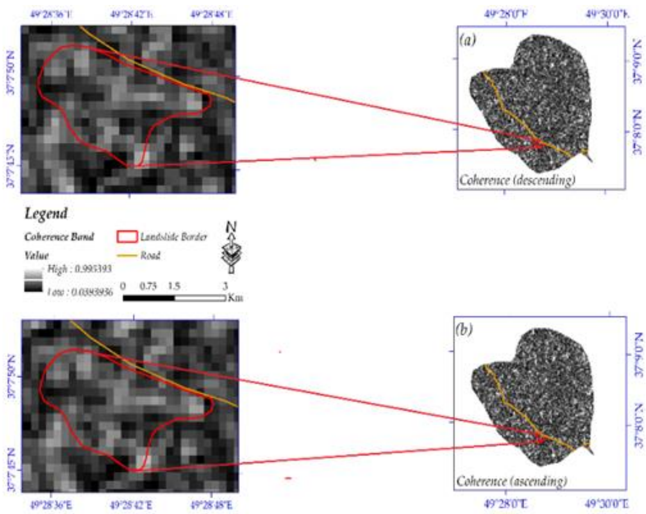

Figure 4. Landslide inventory using Sentinel-1 data; (a) descending and (b) ascending

3.2. Validation

Because, this study was focused only on one rainfall-induced landslide and it was occurred near to the main road; therefore, it was validated by GPS and the Google Earth as well (Figure 5).

4. DISCUSSION

We employed SAR satellite data of L- and C-bands of ALOS-2 PALSAR (wavelength 24 cm) and Sentinel-1 (wavelength 5.7 cm) images, respectively (Hein, 2003; Strozzi et al., 2018). Because of the physical situation of Gilan province, C- band cannot detect the occurred landslide, while L-band was able to detect it. Because of smaller wavelength and penetration power into vegetation coverages, results from Sentinel-1 showed a lower quality than ALOS-2 PALSAR-2. The findings indicate that the technique is suitable for rapid response planning to such disasters using ALOS-2 PALSAR-2. On the other hand, applying C-band satellite data including Sentinel-1 for vegetated areas is a time-consuming effort.

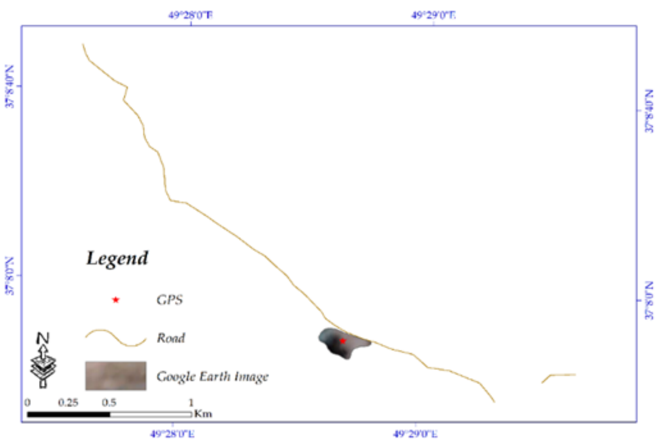

Figure 5. Validation using GPS and the Google Earth

5. CONCLUSION

InSAR and a pixel-based RGB band combination method were applied for detecting a rainfall-induced landslide in vegetated area of Gilan Province, Iran. ALOS-2 PALSAR-2 (L-band) and Sentinel-1 (C-band) were acquired and used to detect an occurred landslide in the study area. From ALOS-2 PALSAR-2 the landslide was identified, while C-band Sentinel-1 was not able to detect it. GPS and the Google Earth were applied to validate the results.

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