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Analysis of Landslide in Chosica Using Satellite Images

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Abstract

Early in the year, Peru suffered from heavy rains mainly due to the El Niño and La Niña phenomena. As a result of these heavy rains, several cities were affected by floods and landslides. One of the most affected cities was Chosica. On the other hand, the satellite images have many applications, one of them is the aid for a better management of the natural disasters (post-disaster management). In this sense, in the present work, one proposes the use of radar satellite images to make an analysis of the most-affected areas by landslides in the city of Chosica. The results show a significant number of places flooded according to satellite images of March 2017. The satellite images used were from the Sentinel 1 satellite belonging to the European Union.

Keywords: Floods, landslide, satellite images, Peru, image processing, Sentinel 1

1. Introduction

In the months of January, February, and March 2017, there is an intensification of rains in some districts of Lima - Peru. This intensification of rains produces the soaking of lands and the increase of the river level. This increase in the level of the rivers causes overflows, and the overexposure of land to the rains produces landslide called ‘Huaycos’ in Peru. Due to these effects, we can indicate that the intense rains have damaged urban areas in different districts as Chosica, Chaclacayo, Santa Eulalia, Cañete, Huaral and Huaura in Lima. Several families, from these communities mentioned above, have lost their belongings, their homes, their businesses, and we also can talk about human losses.

![Fig. 1 Image of the overflow in Chosica - Peru](image)

Among the consequences of this nature fury, we can mention: Huaycoloro Bridge collapsed due to an overflow of the river, Central Highway blocked by a landslide, More than 170 houses and medical centers affected by landslides, Kilometer 66 of Cañete-Yauyos road obstructed by landslides, Fall of public lighting posts and power outages by landslides in Lunahuaná, Damaged crops in Quilmaná due to flooding. Among others.

Due to these disasters, immediate decision-making is needed to define where to take help, the type of support to make, and where to bring it. For this purpose, the use of satellite imagery can be a great help.

A satellite image shows a broader picture of the areas to be analyzed. In this work, we propose to develop satellite image processing algorithms to analyze the areas most affected by landslides. For this purpose, we plan to use both optical and radar satellite imagery because when the area under analysis is covered by clouds, optical images will not help us much, and hence the importance of having radar images whose products are not affected by the climatic conditions. Then it is proposed to apply segmentation algorithms and identify those areas covered by water and sludge.

The continuation of this work is organized as follow: Section 2 shows the applied methodology; in Section 3 one can see the obtained results; finally, one present de discussion.

2. Methodology

For the present work, it is necessary to apply some physical principles of microwave and remote sensing concepts. The methodology that we used for the analysis of landslides produced by the rains is composed of three main components:

1. Collection of satellite images
2. Image processing
3. Mapping the results

In Figure 2, one can observe a flow diagram for the methodology.
Fig. 2 Methodology used to analyze landslides

1.1 Collection of satellite images
Data collection is the first step in the flow to be follow. Considering that we want to analyze territories that have been affected by landslides caused by rainfall, it is very probable that these areas are covered by clouds, so the use of optical images will not give us much information. In that sense, the best option is the use of radar images. For this work, we have used radar images from the Sentinel 1A and Sentinel 1B satellites. Both satellites are part of the European constellation. To download the pictures that we need, we can access to the Copernicus Open Access Hub (https://scihub.copernicus.eu).

Sentinel-1 is a part of space mission by the European Union and carried out by the ESA (European Space Agency) within the Copernicus Programme. The payload of Sentinel-1 is a Synthetic Aperture Radar (SAR) in C band. Sentinel-1A was launched on 3 April 2014 and Sentinel-1B on 25 April 2016.

1.2 Image processing
After data collection, one applies different image processing techniques, which were applied in this work, consists of 5 stages:
1. Radiometric calibration
2. Speckle filtering
3. Terrain correction
4. Histogram Analysis
5. Identification of flooded areas.

In Figure 3, one can observe a block diagram for the image processing step.
The image processing step is the most critical phase of this work. The idea is to extract a much information as is possible from the satellite images, and to achieve a good classification of the image.

1.2.1 Radiometric calibration
The radiometric calibration is significant in order to make a quantitative interpretation rather than a qualitative interpretation. For this step, one uses the VV polarization.

1.2.2 Speckle filtering
It is necessary to filter the common speckle in the SAR image. For our cases, one use a Gamma Map Filter and apply it to a moving window which across the image. The size of the filter as 5 for both X and Y.

1.2.3 Terrain correction
Another important step is to apply a geometric correction, in this work one apply a terrain correction.

For terrain correction one use SRTM 3secc. For DEM and image, one set the resampling methods as bilinear interpolation. The pixel spacing in metres should be set to 10 m. In this case, one used “WGS84 (DD)” geographical coordinates.

1.2.4 Histogram Analysis
The flood detection methodology chosen to be used in this work relies on the unique backscattering properties of water surfaces. Water surfaces appear dark in SAR images. The retrieval methodology that was used in this work was apply a threshold in order to classify an image into flooded and non-flooded portions.

Fig. 3 Image processing steps
The threshold value can be determined manually or automatically by histogram analyzing.

1.2.5 Identification of flooded areas.
To identify flooded areas we apply a mask based on the threshold identified in the previous step. For a better visualization, one set the mask with the red color.

1.3 Mapping the results

For the results mapping we must analyze a before-disaster, and after-disaster image, then one can show the difference between both results and identify the affected areas.

3. Results

Our area of analysis is Chosica. Chosica is the capital city of the Lurigancho-Chosica district of the Lima region. In Figure 3 one can observe a map where it is possible to identify the Lurigancho-Chosica district.

The datasets that we used for this work were:
- SENTINEL-1 SAR scene acquired on October 12th 2016 in image Mode Medium precision (IMM) with pixel size 10m. The image was acquired in vertical send-vertical received (VV) polarization configuration.
- SENTINEL-1 SAR scene acquired on March 27th 2017 in image Mode Medium precision (IMM) with pixel size 10m. The image was acquired in vertical send-vertical received (VV) polarization configuration.

After applying the methodology explained before, we have the following results that can be seen in Figure 5 and Figure 6. Figure 5 shows how was identified the threshold using the histogram analysis, after choosing the threshold, one create a mask. In Figure 6 one can observe two images that show the difference between and image before overflows and landslide, and image after overflows and landslides.
Fig. 6 Comparing result images (October 2016 and March 2017)
4. Discussion

When the optical images cannot help when the analysis area is covered by clouds, the radar images are the ones that can provide information about the affected areas.

The use of satellite images to analyze affected areas is critical and allows us to do better post-disaster management, helping us to make better decisions. Identify the most-affected areas, determine the contribution to taking, what kind of help to manage and where to get it to the victims.

The shaded areas in red show areas affected by water, you can see a greater covered area in the image of 2017 compared to the picture of 2016.

References