Digital Techniques of Images to Support the Analysis of Flood Hazard

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Abstract: - In order to raise awareness of the importance of remote sensing and its application of digital techniques of the images for the extraction of flooded areas in the Colombian territory, during the winter period 2010-2012, as part of semiautomated recognition in the identification of phenomenon of flood was monitored through thematic review with the visual interpretation of the input images from different optical sensors and radar. Products derived from digital imaging processes used for characterization and estimation of flood hazard are used to extract main thematic units such as geomorphology, geology, topography, hydrology and soil units. These products are the results of application of processing techniques such as vegetation indices and segmentation, generation of topographic images of aspect, slope and digital elevation models, application of Adaboost algorithms for change detection, together with application of interferometry to generation of displacement maps and morphometric maps for characterization of areas susceptible to flooding.

Key-Words: Digital Techniques of Images - Remote Sensing – Floods Hazard– Colombia

1 Introduction

Usually flooding are due to extreme weather events related to heavy rainfall accumulated over a short interval of time, or due to instant downloads or sudden thaw processes by increases in temperature. A flood occurs when water covers areas that normally are dry. In most cases, floods are the result of continuous heavy rains or where the absorptive capacity of the soil along with the carrying capacity of rivers and coastal areas is exceeded. The detection quickly during and after such a phenomenon helps identify the state of emergency in a region or country and assess damage also helps to adaptation processes and reconstruction of affected areas, that is why the use remote sensing in the recognition of flooded areas is useful for managing flood risk, therefore, are disclosed below some of the digital processes used for the extraction of flooded areas with different satellite images and in the scenarios of the Colombian territory, also using digital techniques tests for the identification of thematic units as support for threat analysis, which must be pre-determined areas or adequate training of recurrent flooding and is part of the hazard estimation, which must be previously determined in the areas suitable recurrent training or flood events and is part of the estimation of risk.

2 Problem Formulation

The studies current in our country, lack the potential hazard identification and of the causes of the flooding. Are needed the reliability studies to model and understand the mechanisms of phenomena such as flood water levels, volume passing through the plain at the time of a flood, so they data not readily available are in the field and by the extraction of satellite imagery data can provided the evidence in the occurrence of an event like this.
Both passive sensors (optical images) and active (radar images) are potentially very useful for the study of flooded areas. The utility of radar images is due only identify Areas Covered by water and estimate the level of flooding, but also because this capacity is diminished the presence of clouds and vegetation. Rashid and Pramanik (1993) [4] identified the presence of clouds as the main impediment to the study of floods in Bangladesh from images provided by passive sensors (e.g., NOAA-AVHRR). Sano et al. (2007) [5] identified in the Amazon that between 1984 and 2003 on average there was only one Landsat image with less than 10% cloud cover per year, very favorable conditions in the tropical and in the Colombian territory.

For the analysis of the flood hazard in a given area must take into account four (4) major themes such as geomorphology-geology, topography, hydrology and soil characteristics of the area, in addition to elements such as an inventory event to generate a respective map flood hazard. Characterization of the components defining the ground surface and flood scenario models generated with the trigger factor analysis for maximum precipitation and circulation of water in the ground as well as specific applications of digital processes for capturing the difference the water level in examples when you have input when flooding occurs and in its natural state, usually in dry periods. Because of this is shown in Figure 1 digital processes (1) aimed at estimating the flood hazard for their respective thematic mapping (2).

According to the key issues referred to above, must be made improvement processes aimed at satellite images to highlight specific interpretation geomorphological, geological and soil, and digital processes the sensor data resources that can help characterization of the components defining the ground surface and flood scenario models generated with the trigger factor analysis for maximum precipitation and circulation of water in the ground as well as specific applications of digital processes for capturing the difference the water level in examples when you have input when flooding occurs and in its natural state, usually in dry periods. The products resulting from the application of processing techniques for the characterization of geomorphological units, geology structures and soils units are provided in the application of vegetation indices and segmentation. The generation of the topographical characterization of the region is performed with aspect images, slope images, and digital elevation model images. The recognition of flooded areas are performed by applying the algorithm to detect change called Adaboost which, together with the application of interferometric techniques are generated displacement maps and maps for morphometric characterization of flood-prone areas, demonstrating the presence of the event in the present.

Figure 1. Synthesis of the Analysis of the Flood hazard
Below is shown the location of three (3) examples of the sectors to which they apply digital processing techniques to remote sensing images in the Colombian territory.

3 Digital Techniques of Radar Images

A solution to the characterization and visualization of the flooded areas, the occurrence of floods and the behavior of a flooding event is the remote sensing that can help quantify and estimate the flooded areas, characteristics of water levels and other information about the phenomenon from satellite data and images with the use of geospatial technologies provided by different sensors can be studied and reflected in the generation of risk maps for this event. Will be announced some of the remote sensing techniques used and the examples in the Colombian regions.

3.1 Digital Techniques of Optical Images

The digital processing of optical images is performed to identify and differentiate the thematic units of geomorphology and soil. The advantage of using high-resolution optical imaging is the ability to select the precise spatial information of the respective areas (through image fusion), locating and defining the areas flooded or prone to flooding (through classifications). Multitemporal image analysis, combined with land cover allows the identification of the area covered by water (including permanent water bodies), and flooded areas. Some of the digital processing of improvement for visual interpretation and processing automated optical images are raised in the figure 3.

Figure 2. Location of areas of application of digital processing in Colombia

Figure 3. Location of areas of application of digital processing in Colombia

Figure 4. Flood display Sector A (Rio Cauca-Nechi)

a- Image of July 30, 2007 Spot
b- Image of July 30, 2007 Spot panchromatic
c- Image of 2011 Rapideye
3.2 Digital Techniques of Radar Images

Several methods can be found in the literature for the extent of flooding through radar data and the microwave spectrum. A first attempt was made by Lowry et al. (1981) [6.a], which uses X-band radar to map the L-flood in Manitoba in 1979. An incentive to investigate the flood mapping with SAR data was proposed by the availability of data from the C-band radar aboard the ERS-1 (used by Bates and Anderson, 1995 [12th] and, Oberstadler et al, 1997 [2]), was in fact ERS to work the first working meeting of cluster monitoring flooding (ESRIN in 1995), and many researchers had flood maps derived from this instrument as Smith in 1997 [6].

Maps made with data from Landsat and SRTM DEM is known as an efficient and economical method for allocation of a flood so we can resolve the problem as the lack of source data in developing countries (Wang et al. (2002 ) [1a] according to Ho et al (2010). [1]. Examples are presented in figure 3.a y 3.c of mergers RapidEye and spot images with resolution 30 m DEM- SRTM-Colombia.

For automatic flooded area extraction we implemented the Adaboost algorithm, which is a change detection algorithm. This algorithm consists in creating a strong classifier that is built from a small group of weak classifiers. In our approach we use the medium, mean and variance filters. Each of this filters were calculated using three different windows sizes: 3x3, 5x5, and 7x7.

Then we calculate the difference between the filtered after-flood image and the filtered before-flood image. The algorithm consists in two parts: The training and the application. In the first part the algorithm is trained using the two differences-images and a ground truth image.

For the application part we used the differences-images and a model that is generated in the training part. In the figure 5 we show one image before the flood, one after the flood and the result of the algorithm (red zones) overlaid over the image before the flood.

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The digital processing of image enhancement by speckle supression and backscattering (Figure 6) were made for the thematic interpretation of geomorphology, using the recognition of land cover and soil, as well as understand the dynamics and the presence of existing flood events in this study area.

The improved image input helped refine previous interpretations of scales made for more coverage, requiring interpretation on a scale with more detail and with their respective thematic units. Also generated products such as shadow map and the digital model (Figure 7), for geomorphological interpretation of flood plains and terraces system in each region in this case for the field A.

![Figure 5. Application of change detection algorithm in the field B, for the recognition of flooded areas](image-url)
Using a high resolution SAR as CosmoSkymed (Resolution of the order of few meters) for flood mapping with automated classifications increases other issues. Spatial information of the images is generally smaller than the dimensions of the typical goals. Gong et al. (1992) [3a] stated that the best spatial resolution of available data increases the variations within the class, which translates into spectral classes of high confusion. Moreover, in many cases, several pixels represent objects that are not included in the defined classes of land use, so that this problem is intrinsically related to the increase in sensor resolution (Pacifici et al., 2009) [3b].

Blaschke (2010) [5th] noted the importance of taking into account the relationship between spatial resolution and the objects to be classified, noting also that, for all imaginary (optical and SAR) resolution geometric metric or sub-metric (ie, pixels are significantly lower than the objects), the most appropriate approach to consider a relationship is merging pixels into objects. Therefore, the need to segment the images compared to the homogeneous areas.

4 Conclusion

The knowledge and data management of satellite imagery is of great help not only the recognition of flooding, for specific topics important in identifying areas suitable for potential threats and thus generating risk. However, since remote sensing see a different representation of the occurrence of these phenomena, ie an image is captured from a vision of space towards the Earth's surface and in the case of a flood, this is given by increased levels of water above the land surface or ecosystems present, which for the interpretation of these technologies should be used by those familiar with the region as well as take into account the knowledge of the elements visible in the images. An image has many more
elements and physical composition of a region combined with the base mapping and its respective place names, is a complement and advance the management of modern cartography that undoubtedly will become and should increase our understanding of these processing techniques applied to specific topics sensors as mentioned in this article.

In recognition of flooded areas to Colombia from the perspective of remote sensing and the use of data and remote sensing images, we explored the resources to define the methods to identify semi-automated digital processing, with supervision and validation to generate coverage with the appearance of water bodies and air flooded in determining areas of involvement, in some regions during the winter period caused by the La Nina phenomenon, using in most cases with processing visual interpretations made to different images for improved visualization of the phenomenon to be analyzed.

Referencias:


Thanks

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