

Automatic Detection Method of ALOS/PALSAR Shadows

Bruna Patrícia ALENCAR, Ana Lúcia CANDEIAS and João Rodrigues TAVARES JUNIOR, Brazil

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SUMMARY

ALOS/PALSAR images could contain shadow regions due the relief's effect. The direction and the size of the shadow depends on the trajectory of the imaging sensor and the kind of relief. The shadow can be confused with water and some kind of vegetation and It would be appear like dark region in the image. This work shows an ALOS/PALSAR image of a region near of Itaparica reservoir, Pernambuco, Brazil. The terrain near the reservoir has some areas with abrupt slope controlled by shear zones. There is a confusion of ALOS/PALSAR shadow from the relief in the image with water and vegetation present in the area. The methodology for the shadow areas localization is divided into two stages: the first one consists of a simple image binarization using fixed threshold and the second one is to analyse the contours of relief from SRTM images, the aspect, the azimuth and the slope of the area. With these two steps it could be possible to separate shadow due to relief of other targets such as water and vegetation. A simple MATLAB program was developed to binarize image ALOS/PALSAR. With this methodology it could be possible to automate the separation of the shadow effect due the relief of other targets that have a similar response in the image.

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1. INTRODUCTION

The radar image is used as a spatial data for mapping of surface features, especially for its independence of cloud conditions and time of data acquisition. But the Radar images have errors in the geometry acquisition that are caused by the existence and direction of the relief. Such errors are the foreshortening, inversion and shadow. The object of paper is to study how to identify the shadow of the relief. The problem of shadow indicates the presence of the field areas which have not been illuminated by the Radar (Figure 1). As no signal backscatter is received, the areas shaded in the Radar image appear dark. This distortion is most common in steep terrain, imaged with large angles of incidence (BENEDITTI, 2010).

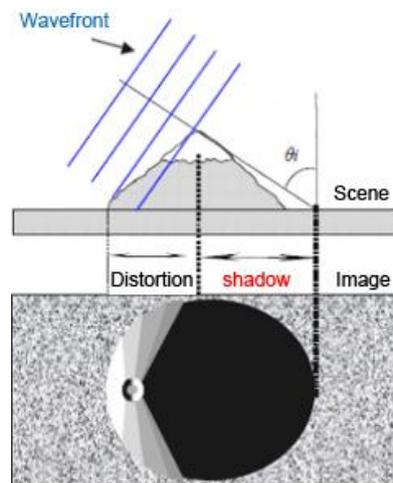


Figure 1. Shadow representation. Source: Beneditti (2010).

Sano et al (2009) examined the potential of images of ALOS/PALSAR for discriminating classes of land cover and use the most representative in the Federal District. The image used was acquired at the end of the rainy season in the region (April 2007). The study identified the physiognomies as agricultural crops, riparian forests, grasslands, reforestation, separate reservoir urbanized areas. However, a higher proportion of shaded Radar images generated with lateral view spectral confusion between indiscriminate forests (Forests and Savanna Dry Forest) with typical Cerrado (small trees, irregular, amid the herbaceous and shrub).

This work shows how to find the shadows in an ALOS/PALSAR image supposing that could

be possible to generate a binary image of the original one with a fix threshold and information of altimetry of the image like: contour of relief, azimuth, aspect and slope.

2. OCCURRENCE OF A PROBLEM IN THE SHADOW OF RADAR IMAGE

The shadow region can occur in radar images on hillsides. The problem is more critical at higher incidence angles. This geometric distortion can also be induced by variation in surface elevation or the change of attitude of the platform (direction, speed and altitude). Thus, a very steep slope can cause shadows in the radar image (region will not record information).

Figure 2 shows the shadows in the radar image caused by raised with the same height, but with increasing line of sight, in other words, with increasing angle of incidence (LIMA, 1995).

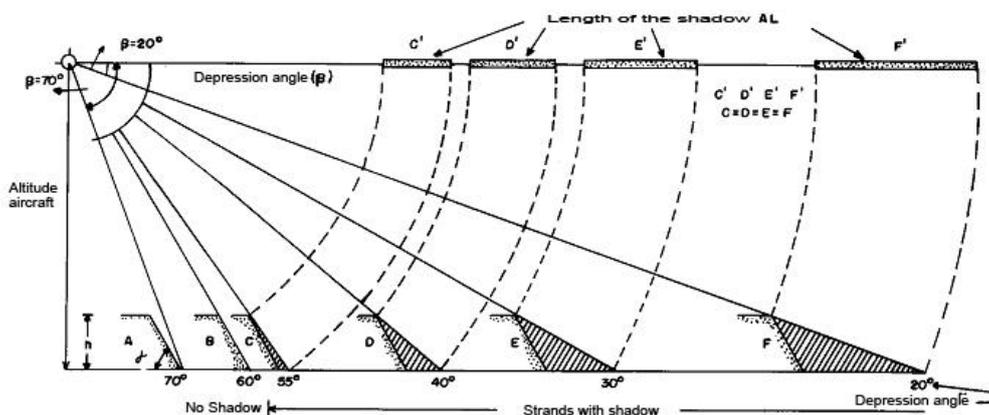


Figure 2. Shadowing effect. Source: Lima (1995).

3. SLOPE AND ASPECT

The azimuth is calculated in the range of angles from 0 ° to 360 °. Figure 3 shows the geometry of the aspect and the azimuth. The categories define aspect of the guidelines are shown in Table 1. In Evans (1972) it could be find more details about azimuth, slope and aspect.

Table 1. Guidelines aspect.

| | |
|--------------------|------------------------|
| North 337.5-22.5° | Northeast 22.5-67.5° |
| East 67.5-112.5° | Southeast 112.5-157.5° |
| South 157.5-202.5° | Southwest 202.5-247.5° |
| West 247.5-292.5° | Northwest 292.5-337.5° |

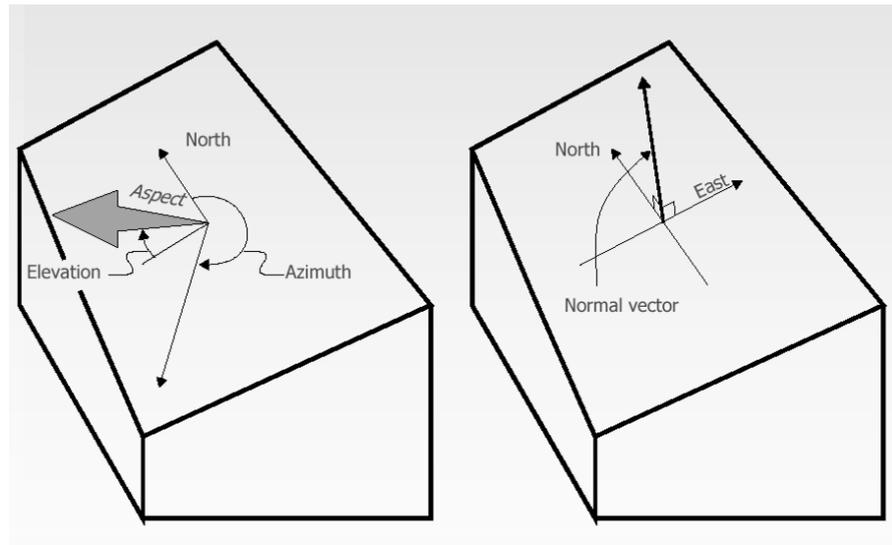


Figure 3. Representation of the aspect and slope. Source: Zhou (2009).

The aspect map is calculated from Equation 1 (ZHOU E LIU, 2004).

$$A = 270^\circ + \arctan\left(\frac{f_y}{f_x}\right) - 90^\circ \frac{f_x}{|f_x|} \quad (1)$$

Where f_x and f_y are the gradients and the direction east-west and north-south respectively.

The slope angle shows the slope of relief in degree (Equation 2). This result can be obtained in percentage (gradient) and can be found in Equation 3. The calculation of the slope is a function of height and distance (ZHOU, 2009).

$$\Theta = \arctan(h/d) \quad (2)$$

$$G = (h/d) * 100 \quad (3)$$

Where h is the height and d the distance.

The calculation of aspect can be obtained from the SRTM data. Furthermore, it is possible to calculate slope and other parameters for understanding the ground. It was used the software ARCGIS spatial analyst for calculation.

In the analysis of the shadows in an image is important to have the Radar aspect (azimuth) and the slopes on the ground, as these parameters provide the direction where the shadow

region is generated.

4. STUDY AREA

The test area is defined between longitude $38^{\circ} 18' W$ latitude $9^{\circ} 4' 30'' S$ and $38^{\circ} 13' 30'' W$ latitude $9^{\circ} 9' S$ with an average elevation of 305 m. This area contains the municipality of Petrolândia which is located in the semiarid region of the state of Pernambuco and near Itaparica reservoir (Figure 4).

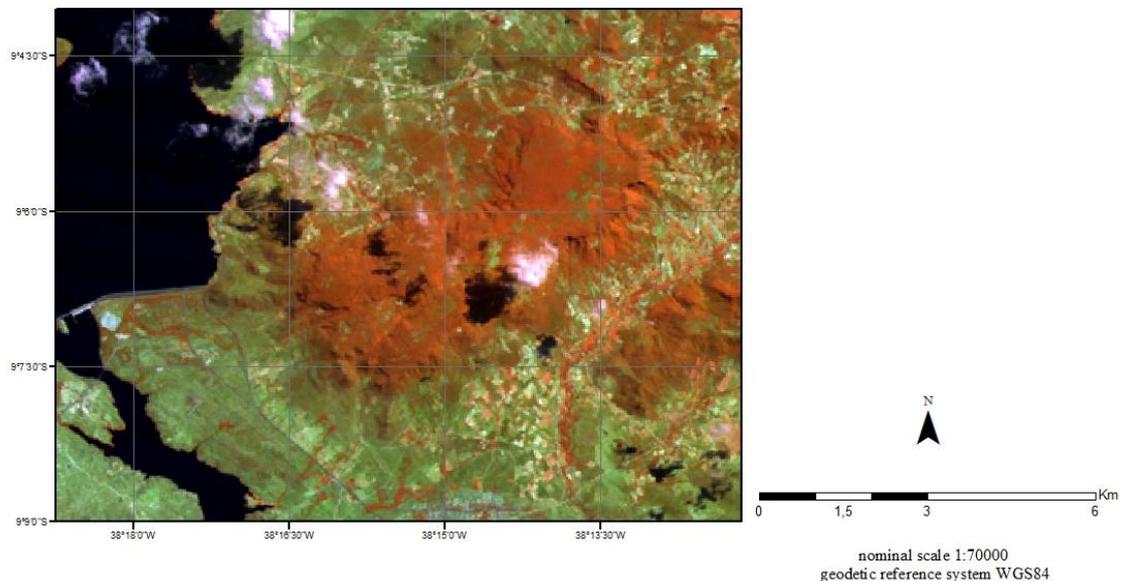


Figure 4. Image Map of the study area.

4.1 Method

The ALOS/PALSAR image acquisition was free and obtained from the site ftp://geofp.ibge.gov.br/imagens_orbitais/alos/ the Brazilian Institute of Geography and Statistics (IBGE), with L band and HH and HV polarization. Currently the scientific cooperation agreement between IBGE and Alaska Satellite Facility ASF has been completed and the site mentioned above is no longer available.

To analyze the behavior of relief and be able to check the direction of the occurrence of shadow region we used the Shuttle Radar Topographic Mission (SRTM), a given altimetry provided free of the website of the Brazilian Agricultural Research Corporation (EMBRAPA).

A simple program that defines a fixed threshold to identify the ALOS/PALSAR image shadow region was developed using MATLAB. A threshold equal to one (1) was used as a parameter, since the shadow region shows that does not exist return signal. Thus, there has been a binary image. Beyond the shadow region, noise and other targets were also classified

too.

With the information provided by altimetry data from SRTM, were generated contour interval of 50 m. The region represents the SC-24-XC map in WGS-84.

We performed an overlap between the contour and the binary image transparency through the tool to compare the steep area where was the shadow region.

5. RESULTS

The developed program in MATLAB to generate the binary image is showed as below:

```
f2=imread('ALOS.tif');
imshow(f2(:,:,1));
f=(f2(:,:,1));
[n,m]= size(f);
f1=zeros(n,m);
for i=1:n
    for j=1:m
        if f(i,j)<=1
            f1(i,j)=255;
        end
    end
end
figure
imshow(uint8(f1));
```

Figure 5 shows the shaded areas due to relief, highlighted by arrows in yellow. On the other hand, In Figure 6 shows the ALOS/PALSAR with HH and HV polarization by overlapped by contours.

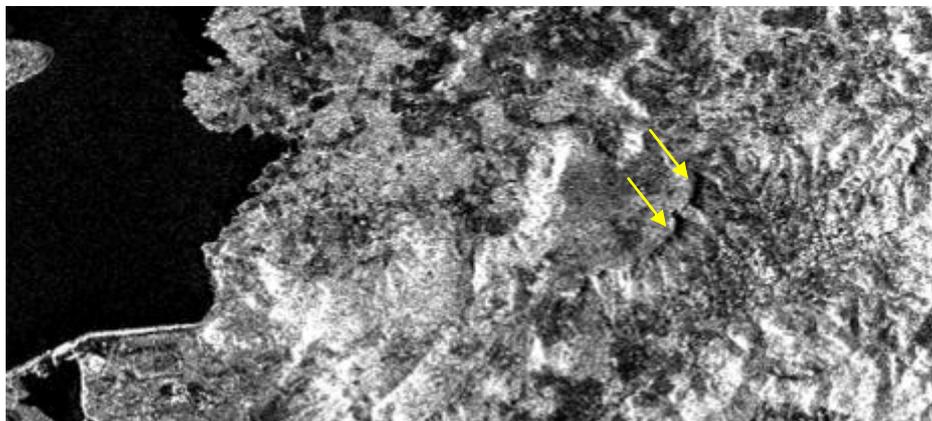
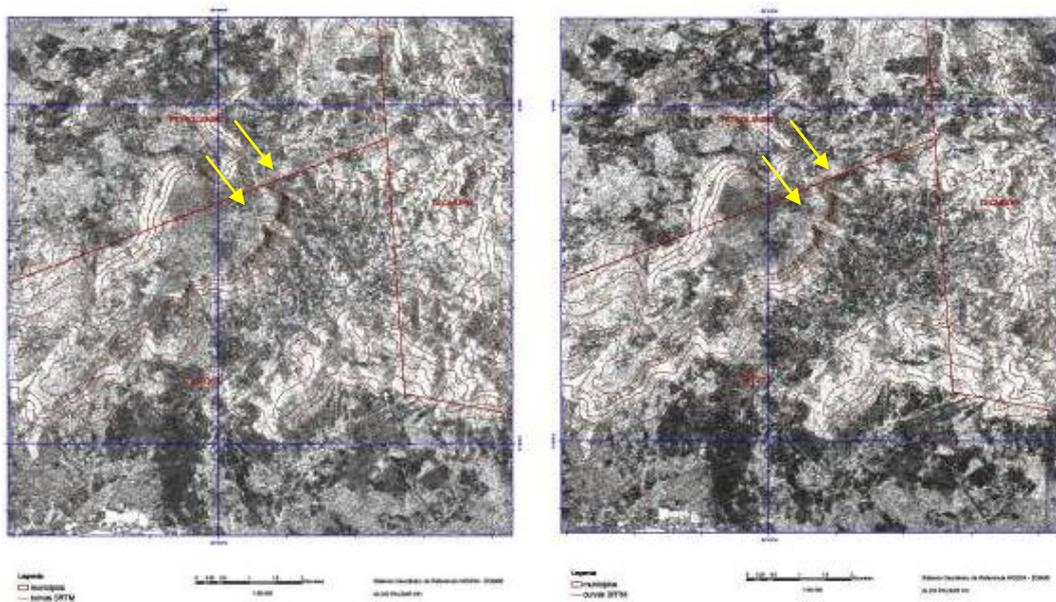


Figure 5. Original image ALOS/PALSAR HH polarization with shadows due to relief.



(a) ALOS PALSAR HH

(b) ALOS PALSAR HV

Figure 6. Localization of the shadow region in the image ALOS/PALSAR.

Figure 7 presents the result of binary image generated by the program in MATLAB. It is possible to identify the shadow region (yellow arrow) and other targets.

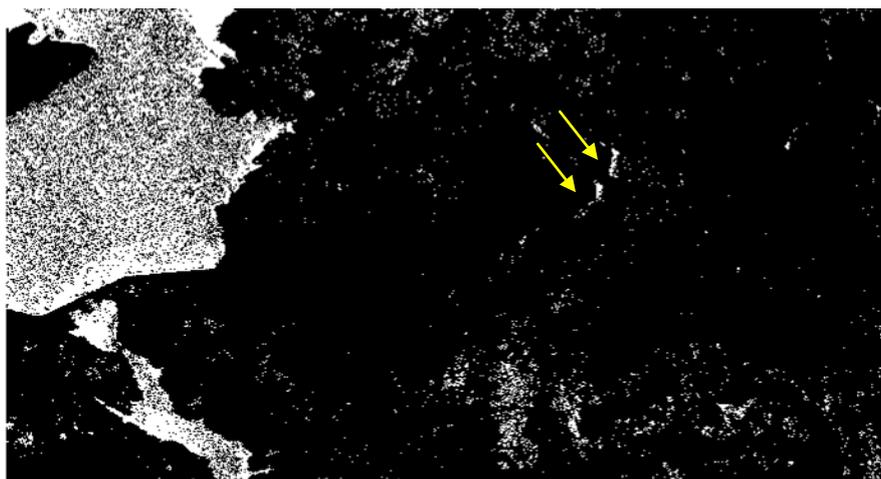


Figure 7. Displaying the location of the shadow region for the binary image.

Figure 8, is the result of superposition of the contour and the binary image. This overlap helped confirm the influence of steep relief in generating the shadow region.

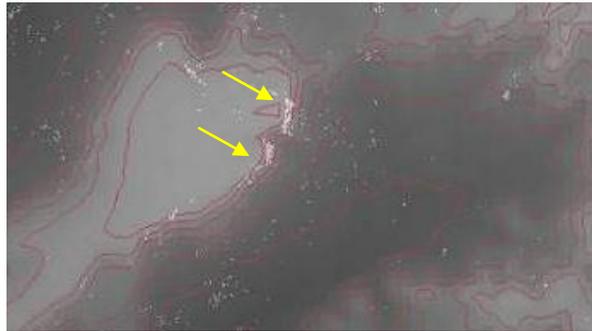


Figure 8. Overlap between contours and binary image.

Figure 9 shows the result of the map aspect. This map considers the direction in which the shadow region was generated due to the acquisition geometry and the characteristic of the relief. As shown in this figure, the shadow region was generated in the south and southeast orientation. Such information is extremely important, because with it can be analyzed and verified that feature was in place and as such the result of a study was influenced by the shadow region.

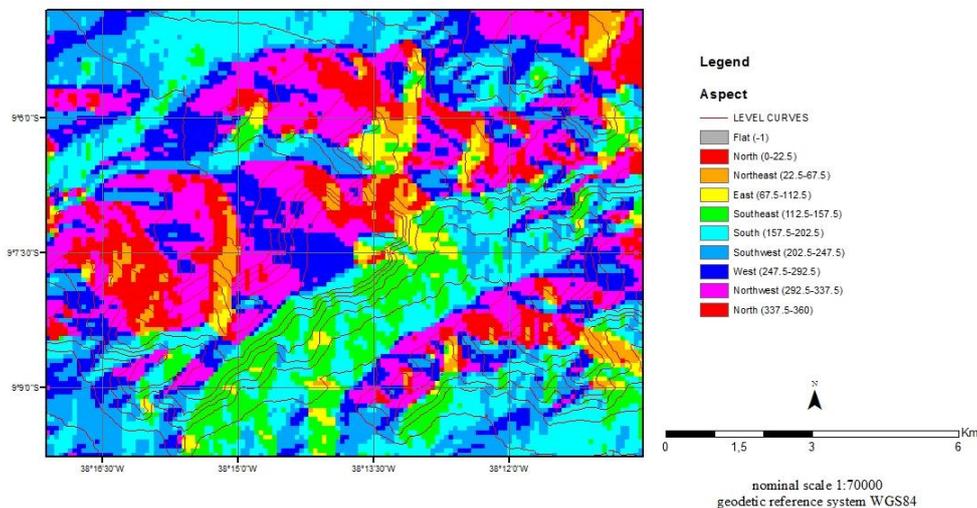


Figure 9. Result of aspect map.

The slope map was generated with six classes (Figure 10), according to EMBRAPA (2006). The classes are as following: flat with slopes less than 3%; soft wavy featuring gentle slopes of 3 to 8%; wavy featuring steep slopes between 8-20%, with strong gradients between 20 and 45%; mountainous presenting unevenness relatively large and strong and very strong gradients of 45 to 75%; steep slopes with very strong valleys, greater than 75%.

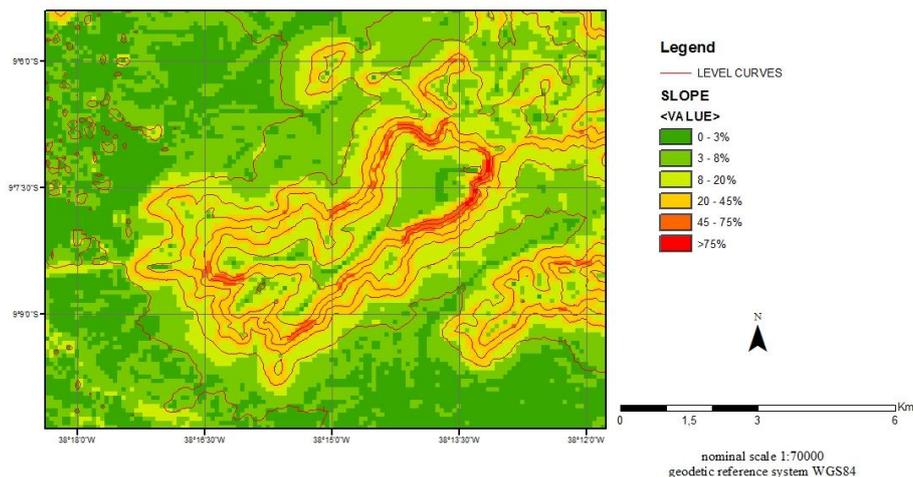


Figure 10. Slope map.

6. CONCLUSION

This paper shows a development of a method for detecting shadows of an ALOS/PALSAR image based on dark regions and altimetry contour lines, slope and aspect of the area studied. It was showed a simple program in MATLAB to do the threshold. The result of the binary image is overlapped to altimetry contour lines and analyzed by the slope and aspect. The method showed here would be useful to ALOS/PALSAR image interpretation, analysis and classification areas.

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TS09D – Posters – 6345

9/10

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CONTACTS

Masters student Bruna Patrícia Alencar
Programa de Pós-Graduação em Ciências Geodésicas
Universidade Federal de Pernambuco
Av. Acadêmico Hélio Ramos, s/n - 2º andar - DECart - Cidade Universitária - 50740-530
Recife – Pernambuco
BRAZIL
Tel. +55 81-21268981
Fax +55 81-21268981
geodesia@ufpe.br
www.ufpe.br/cgtg

Profa. Dra. Ana Lúcia Candeias
Programa de Pós-Graduação em Ciências Geodésicas
Universidade Federal de Pernambuco
Av. Acadêmico Hélio Ramos, s/n - 2º andar - DECart - Cidade Universitária - 50740-530
Recife – Pernambuco
BRAZIL
Tel. +55 81-21268981
Fax +55 81-21268981
geodesia@ufpe.br
www.ufpe.br/cgtg

Prof. Dr. João Rodrigues Tavares Junior
Programa de Pós-Graduação em Ciências Geodésicas
Universidade Federal de Pernambuco
Av. Acadêmico Hélio Ramos, s/n - 2º andar - DECart - Cidade Universitária - 50740-530
Recife – Pernambuco
BRAZIL
Tel. +55 81-21268981
Fax +55 81-21268981
geodesia@ufpe.br
www.ufpe.br/cgtg