APPLICATION OF AIRSAR DATA SET AS A TOOL FOR VOLCANIC HAZARDS MAPPING -SUMMARY OF PROCESSING DONE TO CANLAON AIRSAR IMAGE USING ENVI

ROWENA B. QUIAMBAO
Philippine Institute of Volcanology & Seismology (PHIVOLCS)
Manila, Philippines

ABSTRACT

Volcanic hazards are one of the incessant disasters plaguing the Philippines. Being located in a seismic- and volcanic-belt, the Philippines has its more than enough share of related disasters. This paper is a preliminary report on the hazard mapping of Canlaon Volcano, a project handled by the Philippine Institute of Volcanology and Seismology (PHIVOLCS) under the Philippines-NASA AIRSAR Program. In particular, this report is the initial one made on the image processing aspect of the project using the software ENVI. This paper discusses a background on the study area, the processing done so far with the AIRSAR image strips of Canlaon Volcano, the initial results obtained, and the future work for the immediate completion of the project. It is emphasized that the processing done to a part of the entire set of images covering the Canlaon area will be towards the development of a procedure to be implemented later. It is envisioned that the utilization of the AIRSAR data sets will be maximized as applied to volcanic hazards mapping.

I. Brief Background On The Study Area

Canlaon Volcano, a strato-volcano, is situated in the north central portion of Negros Island, Philippines, with the geographic location of 10° 24.7'N and 123° 7.9' E and peak elevation from sea level of 2465 meters. The Philippine Institute of Volcanology and Seismology (PHIVOLCS) maintains three Volcano Observatory Stations around and within the vicinity of Canlaon Volcano.

Despite its being listed as one of six most active volcanoes in the Philippines, Canlaon Volcano has had no violent eruption ever recorded yet. Normal ash explosions and steam blast as in its first known eruption in 1866 characterized majority of its eruptions. It has similar phreatic eruption in 1893, 1894, and in 1898. In 1906, Canlaon Volcano is said to have erupted again characterized by lava outpouring. The 1969 eruption of Canlaon Volcano saw tephra falls with blocks hurling to a distance of around 3 kilometers from the crater. The same type of volcanic debris was seen in the 1978 eruption as well as some more ash ejection. Earthquake swarms occurred in the volcano area in 1973 and in 1980 but for both instances, these did not culminate into an eruption. In 1987 and 1988, small ash and steam ejection were again observed. The most recent eruptive activity of Canlaon Volcano was in 1996 generally characterized by ash ejection as well. Referring to the Canlaon Volcano Profile, a publication of PHIVOLCS, here is a summary of the physical characteristics of the volcano:

> "The volcano rises...above a rejuvenated highland made up of intercalated volcanic deposits and metamorphosed sediments. Its basal diameter of 30 kilometers encompasses the towns of La Carlota, La Castellana, Murcia and Bago City on the

west, and Canlaon City and San Carlos City in the east. The topography is rugged characterized by abrupt changes in slope resulting in a step-like profile at the upper and medial portions of the volcano.

From 500 to 1000 meters the slope assumes a more gentle topography. The volcano has major gullies and rivers radiating from the summit resulting in a typical radial drainage pattern...The summit of the volcano is dotted with numerous cones and depressions, with the most recent ones bare and the older ones thickly vegetated."

A semi-detailed mapping and hazard risk assessment was done on Canlaon Volcano in 1987 by PHIVOLCS. Geological survey was made in the vicinity of the volcano gathering data for the mapping activity. Topographic maps and aerial photos of the area were initially analyzed to produce geologic map of Canlaon Volcano. These maps were subsequently verified in the survey conducted. Aside from field verification of the initial geologic map, the survey included documentation of stratigraphy and collection of volcanic product deposits around the volcano. The samples were taken for petrographic and/or petro-chemical analysis. The output geologic map was supposed to become the basis for PHIVOLCS in delineating and/or updating the existing hazard maps of Canlaon Volcano.

As part of the umbrella program called "Philippine-NASA AIRSAR Project-Phase II," PHIVOLCS is undertaking the project entitled "The Application of AIRSAR Data Sets on Volcanic Hazards Mapping of Canlaon Volcano." This report discusses the results and progress on the image processing applied to the AIRSAR images using the software ENVI. The image processing activities are geared towards the application of the AIRSAR images as a tool for hazard mapping of Canlaon Volcano.

II. Brief Background On Image Strip Currently Being Processed

The entire geographic coverage of the study area covers the following latitude-longitude extent based on 1:50,000 topographic base map:

Latitude extent
10°10' - 10°40'N
Longitude extent
122°39' - 123°24'E

There are three AIRSAR image strips taken in 1996 that comprise the aerial flight in the Canlaon area (Kanlaon_102-1A, Kanlaon_202-1A, and Kanlaon _102-2A). Within the study area for Canlaon Volcano, the three strips comprise the following latitude-longitude extent based on the header files of the images:

Latitude extent
10°10' - 10°40'N
Longitude extent
122°22' - 123°43'E

The L- and P-band files of the three image strips have been synthesized, and together with the C-VV file for each, has been inspected visually. Hard copies of these raw files were printed. A virtual mosaic of the three image strips was made and a print out was brought to the field work done last February-March 1999.

Actual processing of the images then began starting with the uppermost/northernmost strip. After the initial slant-to-ground range correction, geo-referencing was made using the four latitude-longitude values for the start and end scenes in the header file of the image. Image

enhancements were also done to the 102-1A files, such as Lee and Local Sigma filtering. Owing to the hardware difficulty in the Institute, image processing could only be done on a per image strip and per band file basis. Hence, continuous image processing was shifted to the middle strip, the 202-1A strip, where the crater area is located. Major image processing is being done to this strip until a valid procedure can be established and be used for the other two strips as well. Composed of processes geared towards hazard mapping of Canlaon Volcano, the procedure being developed will be applied to the mosaic image out of the three image strips. In the meantime, image processing is applied to the middle strip in trial and error basis due to one, in the middle strip lies the crater of the volcano where major activity(ies) is(are) located; and two, there is some limitation of hardware being experienced.

III. Processing Done

Two sets of files were established for the image strip under consideration. One set is the C-VV file and the other set is composed of the L- and P-bands. An enhancement of the C-VV file as suggested and recommended by Dr. Ian Tapley through an e-mail communication was used. For both the enhanced C-VV file and the synthesized L- and P-bands, slant-to-ground range correction was made. Warping of the two sets was made using the header information for each. The C-VV file was warped using the latitude-longitude values for the start and end scenes contained in the C-VV header file; while the L- and P-band file was warped using the latitude-longitude values contained in their header files. The L- and P-bands have the same latitude-longitude values in the header information file, which is different from the values contained in the C-VV header file. The RMS errors for the C-VV and the L&P sets (using RST warp method and nearest neighbor resampling method) were 0.5592 and 0.3645, respectively.

In an attempt to merge into one file the CVV and the L- and P-band file, the area covered by the CVV file had to be made the same as that of the L- and P-band file. The CVV file covers a bigger area in the east and west sides of the image than the L- and P-band file.

In a paper entitled "Side Looking Radar, A Tool for Geological Surveys " (Koopmans, ITC, The Netherlands), it has been noted that a number of lava-alluvium contacts were better enhanced in the cross-polarized bands than in the co-polarized bands for radar images. Furthermore, it was noted that cross-polarized imagery gave a better lithologic differentiation. This generalization has been observed in results of preliminary image processing applied to the middle strip. In all of the resultant files, the L-HV band gives the better grayscale image as well as with the P-HV band. Furthermore, combination of the L-** bands (L-HH, L-VV, and L-HV) gives a better RGB image.

An interesting result was noticed in the enhancement processing. The L- and P-band file was processed using the MNF Transform of ENVI. A Lee Filter procedure was applied to the resulting file before returning back the file into the original data space via the Inverse MNF Transform. Visual comparison of the resultant file after these processes indicates that there was no significant change in the surface detail of the image. These entire forward and inverse transformation processes was applied to a cropped middle portion of the L- and P-band image, a 10-minute-long strip centered at the main crater area.

Apart from the MNF procedure, the rectified and enhanced image strip was attempted to be classified. Using as a source/guide for creating the training areas was the photo-geologic map of Canlaon Volcano. This map was made from aerial photo and topologic map interpretation. Geo-referencing of the rectified image strip with the photo-geologic map proved to be difficult and resulted into quite large of an error. This is brought about by the fact that location points in the rectified image is offset in the topographic map (which is the

base map used for the photo-geologic map) by as much as 1.9 km in the x-direction and 7.5 km in the y-direction. For the purpose of classification, the discrepancy on the location values between the rectified image and the topographic map will be resolved by allowing instead the manual selection of features (volcanic products) through visual interpretation of image print out. Hence, hard copy of the different band-files for the middle image strip is being prepared and subjected to image interpretation. Once enough training sites are located in the image print out, supervised maximum likelihood classification procedure will be done to each band-file. The results of the classification will be analyzed, assessed, and categorically compared with the photo-geologic map of Canlaon Volcano.

IV. Summary of Activities Done

Image processing for the middle image strip of Canlaon Volcano was done separately - for the C-VV and for the L-&P-band files. Image enhancements for the C-VV file involved the sigma zero-band math-and-lee filter procedures. Geometric correction applied to all the files was the slant-to-ground range correction. The corrected and enhanced image files were then rectified using the latitude-longitude values for the start and end scenes in their respective header files. The rectified L- and P-band image was then subjected to Forward MNF Transform, Lee-filtering, and Inverse MNF Transform. The resultant file after the transformations did not produce a significant change in the surface detail of the image strip.

V. Future Work

Supervised classification of the middle image strip will be done using the photo-geologic map as source of training areas. Maximum likelihood classification will be done to the C-VV and the L- and P-band files once the selection of training areas from print outs of the rectified image is done. Comparison and analysis of the classification results with the photo-geologic map will then be made.