Abstract theme: Land Applications

Presentation request: Poster

Lava flow mapping and change detection in the Mt. Etna Volcano between 2009-2012 using Hyperion hyperspectral imagery.

Catherine Karagiannopoulou[1], Olga Sykioti[2], Issaak Parcharidis[3], Pierre Briole[4]

1. Harokopio University of Athens, Department of Geography, Athens, Greece, gp215305@hua.gr
2. Institute for Astronomy, Astrophysics, Space Applications and Remote Sensing, National Observatory of Athens, Athens, Greece, sykioti@noa.gr
3. Harokopio University of Athens, Department of Geography, Athens, Greece, parchar@hua.gr
4. Centre National de la Recherche Scientifique Ecole Normale Superieure, Paris, France, briole@ens.fr

Abstract

Mt. Etna (Italy) is a composite strato-volcano and one of the most active volcanoes in the world. Eruptions occur almost every year and there is a persistent degassing activity at the summit craters. In the last 100 years it produced in average $10^7 m^3$ of new lava per year.

The main goal of our work is to discriminate different lava flows as well as detect land cover changes over the volcano that occurred between 2009 and 2012.

For this purpose, we analyze two Hyperion L1T scenes acquired on 8/10/2009 and 14/7/2012. The time span of the two scenes encompasses several eruptions, especially at the summit "New Southeast" crater. Both images have near nadir acquisition angles and low cloud coverage. Level 1T products are already geometrically corrected. However, additional co-registration is performed in order to ensure that both datasets are superimposed with accuracy at sub-pixel scale. Preprocessing also includes atmospheric corrections and noise reduction. For the latter, the 67 noisiest bands are removed from further processing. For additional noise reduction in the retained bands, two transforms are tested: inverse Principal Component Analysis (PCA) and inverse Minimum Noise Fraction (MNF) rotation.

The NDVI map is then calculated in order to delineate and differentiate vegetated and non-vegetated areas for both dates. An unsupervised classification map using the ISODATA method is produced using four datasets for each date. These datasets are (i) the atmospherically corrected image, (ii) the first seven PC components composite image, (iii) noise-reduced image after inverse PCA and (iv) the corresponding one after inverse MNF rotation. The assessment of the classification results is performed through comparison with geological maps and previous published work, including field spectral measurements in specific parts of the volcano. For this purpose, five different sites are selected for the interest of their particular spectral features in the general land cover classes: vegetation, urban areas, bare soil and lava flows.

The examination of these areas shows that the most realistic classification results are provided by the classified image issued from the inverse PCA rotation. The specific classification maps are retained for further analysis.
The comparison between the two classified images shows that the spectral and spatial differentiation of the older than 2009 lavas, located at the slopes and near the center of the volcano, is difficult. The most significant lava changes after 2009 are detected in the southern part of the volcano, where several lava flows that occurred during the 3-year time period.

Concerning the vegetated areas, including vegetation installed on older lavas, a significant difference in the spatial extent is observed between the two dates. This is probably due to both (i) the vegetation seasonal behavior combined with the different acquisition dates and (ii) the vegetation growth between the three-year time span in some areas and new lava depositions in others. Older lavas under vegetated areas cannot be distinguished. On the other hand, no spectral changes are observed in urban areas. However, slight differences in their spatial extent are observed between the two dates.

The first results of this study show that Hyperion can be useful for lava flow mapping and change detection in a complex environment such as the Etna volcano. The results are promising considering the relatively coarse pixel size, the number of noisy bands, the scarcity of lava field spectral measurements and the limited published work for this study period. Future investigations include field work, testing of clustering techniques such as SAM and the complementarity of Hyperion to other satellite data.

Key words: Volcanoes, Geology and Geomorphology, Mapping, Classification, land cover and land use. Satellite data: Other

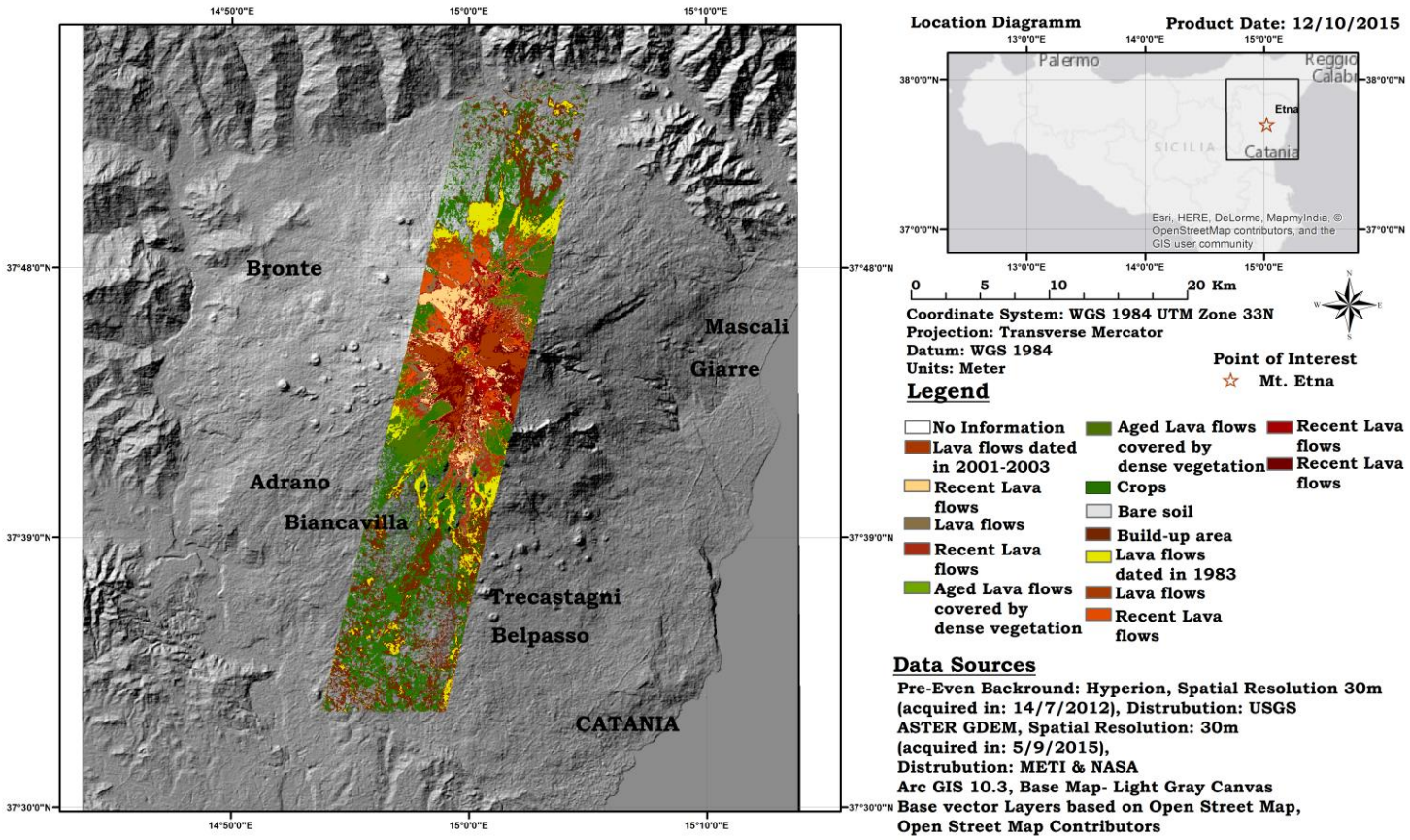

Figure 1: ISODATA classification of Hyperion 2012 dataset with 15 classes after "Inverse PCA" transform. Cartographic overlay of the classified image on the hillshade of Mt. Etna.