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A comparative assessment of supervised pixel–based classification methods in the detection of landslide scars

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On February 20th, 2010 heavy rainfall culminated in violent floods and mudslides in Madeira Island. This extreme event triggered thousands of landslides in both inhabited and uninhabited zones, resulting in extensive personal and material damage. Two main areas were heavily affected: Funchal and Ribeira Brava. Aiming to estimate the volume of sediment displaced during the event, a landslide inventory was an urgent necessity for subsequent mitigation strategies.

The study area includes five hydrographic basins and extends over 100 km2, turning the designed automatic classification methodology of remotely sensed data an inevitability for the identification of landslides. High resolution imagery used for the automatic classifications was acquired by GeoEye-1 satellite soon after the event (February 23rd and 28th, with 2m/pixel for bands R,G,B and NIR and 0.5 m/pixel for the panchromatic band). Most landslides identifiable on the imagery occurred during the 2010 winter, mainly during the 20th February event, but this assumption had to be confirmed through visual comparison with images prior to the event. Two sets of GeoEye-1 images were available: one pre-event (dating from the summer of 2009) and a second post event. Both post- and pre-event imagery was pre-processed with a multi-spectral fusion of the panchromatic band with R-G-B-NIR bands (pan-sharpening), improving spatial resolution from 2 to 0.5 m/pixel, and an orthorectification.

This paper focuses on the procedures used in the cartographic inventory of the landslides, particularly in the assessment tests for the most accurate automatic classification procedure and the applied post-processing methods, in which results were evaluated through the computation of confusion matrices between methodologies.

The classification process was executed in ENVI 4.7®, using the following supervised algorithms: Parallelepiped, Minimum Distance, Maximum Likelihood and Mahalanobis Distance. Several training areas or regions of interest (ROIs) were selected, different sets of ROIs were tested and the best were used to create a total of 11 classes including the “landslide scars” and “landslide tracks”. Preliminary results suggested that the Maximum Likelihood algorithm presents the best accuracy and quality on landslide scar contours. After the classification, the images exhibited isolated and small clusters of spurious pixels, thus a post-classification stage was needed to generalize the classes and smooth the image. Tools as sieving, clump and majority analysis were used and tested with different thresholds to suppress or clump these isolated or small groups of pixels, improving widely the quality of the final landslide scar layout.

The computation of the confusion matrices allowed the comparison of results and the evaluation of the accuracy of landslide scar classification with a ground truth image built from ROIs. However, these matrices did not allow the assessment of any unidentified scars. To obtain the eventually missing scars, high resolution orthophotomaps were used (1:5000 scale with 0.4 m spatial resolution) supporting a more complete ground truth. The final results were very satisfactory, as the methodology produced an overall accuracy over 90% in the detection of landslides for the study area. This enabled an extensive inventory of the scars, with a substantially less time-consuming and less expensive process than the traditional manual delimitation methods.