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Successive updating of cartographic land cover databases using image segmentation, GIS analysis and visual interpretation

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The elaboration of multidate cartographic databases is a major requirement in order to assess land use/cover changes and update existing databases. This paper presents a hybrid method combining image processing, GIS analysis, and visual interpretation to detect discrepancies between an existing land use/cover map and satellite and ancillary images. It was tested in the elaboration and updating of land use/cover maps for different dates of the State of Michoacan, Mexico using SPOT and Landsat imagery. This study area encompasses nearly 60,000 square kilometers with different types of tropical and temperate forests, undergoing rapid processes of land use/cover change.

The method was first applied to improve the resolution of an existing 1:250,000 land use/cover map using SPOT images. In this map, produced from the visual interpretation of 2007 SPOT images, the representation of objects is constrained with cartographic rules such as the minimum cartographic area and polygon generalization.

A segmentation of the 2007 SPOT images was carried out using a region growing algorithm from SPRING and Barkeley software packages, creating spectrally homogeneous objects with a minimum area of one hectare. After the segmentation, each segment was labeled based on the class from the secondary GIS database covering the largest proportion of its area. This allows tolerating small position differences between the map boundaries and the object edges. The mean and the standard deviation of spectral values of the SPOT image were calculated for each band inside each segment. The same procedure was used to compute the mean and the standard deviation values of biomass inside each segment using a high-resolution (30 m) map of aboveground biomass from the Woods Hole Research Center. Therefore each segment was characterized from the images (spectral indices and biomass estimate) and the map (class label). In order to detect discrepancy a multivariate trimming was applied. Trimming consists in truncating a distribution from its least likely values. In this case, trimming was used to detect the outliers in each population of segments belonging to the same map category using a probability density function. The segments that behave like outliers were detected and labeled as "likely misclassified". In addition, a likely alternative category was determined through a digital classification using the C5 decision tree classification algorithm. Then, the segments were visually inspected in a false color composite in order to assign a final category. The same procedure was applied to update the map to 2014 using Landsat imagery. In this case, it can be reasonably assumed that many discrepancies are effective land use/cover change. Finally, an accuracy assessment was carried out using verification sites selected from a stratified random sampling and visually interpreted using high resolution imagery and ground truth.