CROP MAPPING FROM VERY HIGH SPATIAL RESOLUTION SATELLITE IMAGES IN SOUTHERN TENERIFE

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1. INTRODUCTION

Crop maps are an essential tool for land management in Canary Islands. Due to the small size of the islands and their high population density, rural and urban areas usually appear mixed. Thus, to develop land management plans or infrastructures, an accurate and updated crop map is very important.

Nowadays crop maps in Canary Islands are obtained by means of intense field work, where crops are identified plot by plot. This methodology produces very accurate maps, but the costs are very high and thus it cannot be updated as frequently as it should be. An outdated map loses most of its usefulness as a land management tool.

Satellite images have been used for mapping crops in a regular basis for decades in large areas [1], [2]. However in the case of the Canary Islands, where the size of the plots is very small, the use of satellite remote sensing imagery has been limited due to their coarse spatial resolution. The launch of newer satellites that provide very high spatial resolution (VHR) images in the last decade has open the possibility of using these imagery for updating crop maps in the Canarian archipelago.

This study analyzes the potential of using VHR satellite images to map crops in Canary Islands. Pixel- and object-based classification algorithms have been tested. Finally our results were adapted to the cadastral vector layer of the region, which is the usual format of these maps.

2. STUDY AREA AND DATA

The study was carried out in Vilaflor, an agricultural area of the southern hillsides of Tenerife, the largest of the Canary Islands. The size of the study area, which lies between 800 and 1500 m above sea level, is of approximately 50 km^2. The main agricultural land uses in the region are potatoes, vineyard, arable and fallow lands. There is also a small proportion of fruit trees and other minor crops, but these have not been considered in this study.

Figure 1: Natural color GeoEye-1 image .

Figure 2: Potato fields in Vilaflor.

A multispectral GeoEye-1 satellite image (Figure 1) was acquired in October, when potatoes reached its greatest development (Figure 2). The image, completely cloud free, was obtained on the 3rd of October 2010. GeoEye-1 has a multispectral sensor with 4 bands (450-520nm, 520-600 nm, 625-695 nm and 760-900 nm) and 2 m/pixel spatial resolution. The image was radiometric and geometrically corrected and projected to coordinate system UTM-WGS 1984 by the provider, but not orthorectified.

Field work was carried out in order to collect ground truth data to train the classification algorithms and to validate the results. Field data was collected between 3 and 10 days after the image was acquired. A total of 170 plots were randomly selected, where the following information was collected: type of crop, growth level, date and a photo id.

3. METHODOLOGY

3.1. Image corrections

The image was orthorectified using the Rational Polynomial Coefficient (RPC) file and a digital elevation model (DEM) of the study area. The spatial resolution of the DEM was 10 m/pixel. Geoid undulation was calculated with a Geoid Height Calculator for the coordinates of the study area [3]. No ground control points were required for this methodology.

Atmospheric correction was deemed not necessary, since the study was carried out on one single image, and so digital number (DN) values were directly used for classification.

3.2. Classification

For the classification, non agricultural areas were masked out using the last available crop map of Tenerife [4], in vector format. Wastelands, forests and urban areas were not considered for this study.

The maximum likelihood algorithm was used to perform the pixel-based supervised classification. The location of 41 training sites were visually identified in the image and used for running the classification algorithm. The 4 land uses (potatoes, vineyard, fallow and arable land) were identified by considering 9 subclasses that were merged afterwards. This was required due to the high spectral heterogeneity observed within the crops. Thus classification was performed using 9 subclasses: 2 for potatoes, arable and fallow land and 3 subclasses for vineyard.

As an alternative to deal with the high spectral heterogeneity of the VHR imagery, we are currently testing object-based techniques, which have shown good performance when pixel-based classification algorithms were hampered by this limitation [5], [6]. The developed object-based methodology consists of 3 main steps: image segmentation, object refinement and optimization and a decision tree-based classification of the obtained objects [7].

3.3. Adaptation of the classified image into the cadastral vector layer

The current crop maps of the Canary Islands are framed in the cadastral vector layer, which is consistent with other cartographic information of the islands, easier to use and it allows more analysis possibilities. For that reason, the classified raster image was adapted to the cadastral vector map. The cadastral vector layer and the classified raster image were overlaid using ArcMap and the majority class of the classification layer was assigned to each cadastral parcel (polygon). It was assumed that each cadastral parcel had one single land use type.

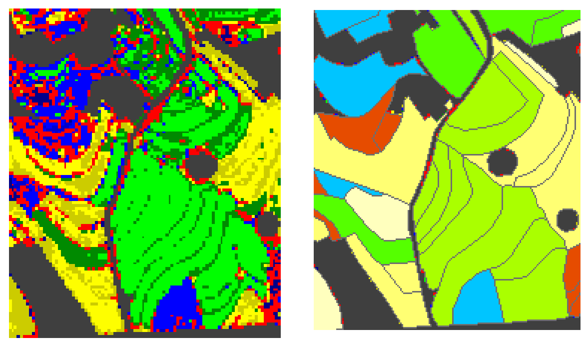

Figure 3: Classified image adapted to the cadastral vector layer

4. PRELIMINARY RESULTS

The classification results were compared against the crops identified for 129 validation sites during the field work. The validation sites corresponded to plots of the cadastral vector layer, and they were use to build an error matrix (Table 1). The surface covered by the training areas accounted for roughly 1% of the whole study area.

Results show an overall good classification. The highest producers' and users' accuracies were obtained for the potatoes and the arable land classes (above 95% and 80% respectively). The other two classes (fallow land and vineyard) showed lower accuracies. Most of the errors are caused by an overestimation of fallow land against vineyard, which was underclassified (Tables 1 and 2).

	Potatoes	Fallow land	Arable land	Vineyard	Total
Potatoes	36	1	0	0	37
Fallow land	2	15	7	13	37
Arable land	0	0	37	2	39
Vineyard	0	0	1	15	16
Total	38	16	45	30	129

Table 1: Error matrix (cadastral plots)

	Producers accuracy	Users accuracy
Potatoes	94,7%	97,3%
Fallow land	93,8%	40,5%
Arable land	82,2%	94,9%
Vineyard	50,00%	93,80%
Overall accuracy		**79,80%**

Table 2: Accuracy report

5. CONCLUSIONS

The methodology developed to update crop maps from VHR satellite images produced accurate results for the study area, with an overall accuracy of 79,8%. The satellite image was easily orthorectified and fitted into the cadastral vector layer. Although the pixel-based classification produced accurate results, they should be further improved, since land managers demand more accurate maps. The preliminary results obtained for the object-based classification are encouraging, and it is expected that this approach will produce more accurate crop maps. In any case, these methodologies should be tested in other areas of the archipelago, and also with different crops. Multitemporal analysis might also help to discriminate more crops and to improve the accuracy of the maps. Further study must be developed to improve the adaptation process of the results into the cadastral vector layer.

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7. REFERENCES

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