

Automated high resolution mapping of coffee in Rwanda using an expert Bayesian Network

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Abstract

African highland agro-ecosystems are dominated by small-scale agricultural fields that often contain a mix of annual and perennial crops. This makes such systems difficult to map by remote sensing. We developed an expert Bayesian network model to extract the small-scale coffee fields of Rwanda from very high resolution data. The model was subsequently applied to aerial orthophotos covering more than 99% of Rwanda and on one QuickBird image for the remaining part. The method consists of a stepwise adjustment of pixel probabilities, which incorporates expert knowledge on size of coffee trees and fields, and on their location. The initial naive Bayesian network, which is a spectral-based classification, yielded a coffee map with an overall accuracy of around 50%. This confirms that standard spectral variables alone cannot accurately identify coffee fields from high resolution images. The combination of spectral and spatial variables allowed mapping of coffee fields and associated uncertainties with an overall accuracy of 87%. Aggregated to district units, the mapped coffee areas demonstrated a high correlation with the coffee areas reported in the detailed national coffee census of 2009 ($R^2 = 0.92$). Unlike the census data our map provides high spatial resolution of coffee area patterns of Rwanda. The proposed method has potential for mapping other perennial small scale cropping systems in the East African Highlands.

Keywords: Coffee, mapping, expert knowledge, Bayesian Network, orthophotos, Rwanda

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