Optimisation of regional scale woody vegetation cover mapping with optical, thermal and radar data

Elias Symeonakis, Kyriaki Petroulaki, Thomas Higginbottom, Ángel Marqués-Mateu

School of Science and the Environment, Manchester Metropolitan University, Manchester M15GD, UK

School of Engineering in Geodesy, Cartography and Surveying, Universitat Politècnica de València, Valencia 46022, Spain

Abstract

Woody perennial vegetation is an integral part of savannah ecosystems and plays an important role in carbon cycling and ecosystem service provision. Accurately mapping its presence and its characteristics can provide useful input to global carbon emissions models as well regional policy decision making efforts regarding bush control or the overexploitation of fuelwood. Recent attempts to map the extent of savannah woody cover over the regional scale have employed Earth observation data either from optical or radar sensors, and most commonly from the dry season when the spectral difference from the 'background' grasses is maximised. By far the most common practice has been the use of Landsat optical bands, but some studies have also used vegetation indices or L-band or C-band SAR data. However, conflicting reports with regards to the effectiveness of the different approaches have emerged leaving the respective land cover mapping community with unclear methodological pathways to follow. We address this issue by employing Landsat and ALOS PALSAR data, together with colour aerial photography for training and validation of random forest regressions, to assess the accuracy of mapping woody vegetation when: (a) data from either or both seasons are considered; (b) annual PALSAR mosaics or the actual PALSAR data are used on their own or together with the optical data; (c) vegetation indices are calculated and are used either on their own or together with the Landsat bands; and (iv) thermal infrared information is not discarded but included in the parameterisation. We test our approach in an area of the Northwest Province of South Africa which spans over 6 Landsat scenes, covering an area of approximately 53,000 km^2. Our hard classification results (woody vegetation, non-woody vegetation and no-vegetation) show that the most accurate estimates are produced from the model that incorporates all 23 parameters: Landsat optical and thermal bands and three vegetation indices (NDVI, MSAVI and TNDVI) and HH polarised PALSAR data for the dry and wet seasons (overall accuracy: 89%; woody cover balanced accuracy: 91%, producer's accuracy: 83% and user's accuracy: 90%). The combination of either dry season Landsat bands with the HV polarised radar data, appears to be sufficient for achieving woody cover balanced accuracies of 89%. Dry season optical bands alone are able to map woody cover with more than 81% balanced accuracy and the accuracy increases by the inclusion of either the vegetation indices or the TIR band (to 83% and 84%, respectively). Our findings can provide much needed assistance to woody vegetation monitoring efforts in southern African savannahs where the process is partly related with bush encroachment and land degradation brought about by recent climatic changes and overgrazing.

Keywords: Woody vegetation cover, Landsat, ALOS PALSAR, aerial photos, vegetation index, Random Forests