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"Competing pathways for equitable food systems transformation: Trade-offs and synergies"

Mapping crop types and cropping systems in Nigeria with sentinel-2 imagery

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Abstract

Reliable crop-type maps from satellite data are an essential prerequisite for quantifying crop growth, health, and yields. However, such maps do not exist for most parts of Africa, where smallholder farming dominates. Prevalent cloud cover, small farm sizes, and mixed cropping systems pose substantial challenges when creating crop-type maps for sub-Saharan Africa (SSA). There is accordingly the need to explore remote sensing data more rigorously and to develop methodologies for detecting and mapping crops. We here suggest a mapping scheme based on freely available Sentinel-2 A/B (S2) time series and very high-resolution SkySat data to map the main crops, maize and potato, and intercropping systems including these two crops for the main crop production region of Nigeria, Jos Plateau. We analysed the spectral-temporal behaviour of mixed crop classes to improve our understanding of inter-class spectral mixing. Building on the Framework for Operational Radiometric Correction for Environmental Monitoring (FORCE), we preprocessed S2 time series and derived spectral-temporal metrics (STM) from S2 spectral bands for the main temporal cropping windows. These STMs were used as input features in a hierarchical random forest classification. Our crop type mapping resulted in the first wall-to-wall crop type map for this key agricultural region of Nigeria and achieved an overall accuracy of 84 % for crop/non-crop discrimination, and 72 % for the five most relevant crop classes. Maize is the dominant crop, followed by mixed cropping systems, including maize–cereals and potato–maize cropping; potato was found to be the least prevalent class. About 48 % of the mapped classes of interest are intercropped, further revealing the implication of intercropping in smallholder regions. Plot analyses based on a sample of 1,166 individual fields revealed largely homogeneous mapping patterns, demonstrating the effectiveness of our classification system also for intercropped classes, which are temporally and spatially heterogeneous. Moreover, we found that small field sizes (75 % of fields smaller than 1 ha) were dominant in all crop types, regardless of whether or not intercropping was used. Our study offers guidance for creating crop-type maps for smallholder-dominated systems where intercropping is prominent, which are previously lacking. Mapping intercropped classes will provide better yield estimates for smallholder regions.

Keywords: Spectral-temporal metrics, classification, intercropping, maize, potato, random forest, SkySat, smallholder agriculture, sub-Saharan Africa, time series

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