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Smallholder Maize Farm Mapping With Multi-Temporal Sentinel-1 Data in Support of the Sustainable Development Goals

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Abstract:

Maize (*Zea mays L.*) is an important cereal crop worldwide for different purposes such as food consumption, animal feed, and the production of industrial products (Ranum et. al., 2014). Smallholder maize farmers are the main producers of maize and are central to combating food insecurity in developing countries. However, there is a lack of high quality spatial information on smallholder farmers from local planning agencies and governments. Improving food security is one of the critical targets of the Sustainable Development Goals (SDGs) (SDG, 2019). Hence, a collection of Sentinel-1 multitemporal data was used in this study to develop a framework for mapping smallholder maize farms and estimating maize production area. The Principal Component Analysis (PCA) method was used to fuse the multi-temporal data at a pixel level to obtain three components for each polarization (vertical transmit and vertical receive (VV), vertical transmit and horizontal receive (VH), and VV/VH), which explained more than 70% of the information. Both the Support Vector Machine (SVM) and Extreme Gradient Boosting (Xgboost) algorithms were used at model-level feature fusion to classify the data. Results from this study demonstrate that two-stage image fusion is superior in mapping the distribution and estimated production areas for smallholder farms. The overall accuracy of both SVM and Xgboost algorithms was more than 90%. There was a 3% difference in production area estimation observed between the two algorithms. This framework can be used to generate spatial agricultural information in areas where agricultural survey data are limited and for areas that are affected by cloud coverage.

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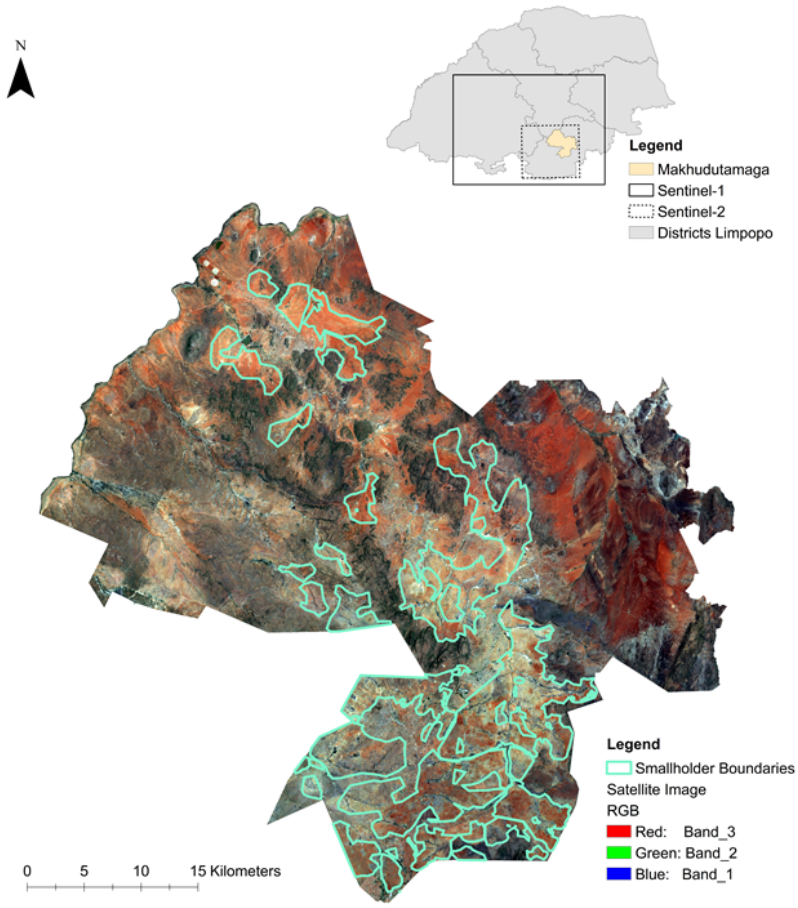

Figure 1. Study area location map for Makhuduthamaga in Limpopo, South Africa (Mashaba-Munghemezulu et al., 2021).

The use of Sentinel-1 multi-temporal data in conjunction with machine learning algorithms is recommended to map smallholder maize farms in support of the SDGs. Smallholder cropland maps can help farmers identify areas that are suitable for agricultural production and support the development of sustainable agricultural practices, leading to increased food production and improved food security for rural communities. This can help reduce hunger and malnutrition, which are key components of the Zero Hunger sustainable development goal. Additionally, cropland maps can help the government monitor changes in land use and crop production over time, allowing for more effective policies and programs to ensure food security for the rural population.

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