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Remotely Sensed Yield Modelling of Household Fields to Monitor Child Undernutrition and Climate Change Impacts

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Abstract

Climate change has a large impact on agricultural fields, resulting in food instability, particularly among rural smallholder farmers in sub-Saharan Africa. Based on satellite remote sensing and extensive field observations from 2018, we conducted an interdisciplinary study to monitor and predict crop yields of household fields (median 1.4 ha) to support research and policies on food security and child undernutrition. The study was conducted in the Nouna Health and Demographic Surveillance (HDSS) area, in the Sudano-Sahelian region of North-Western Burkina Faso. The area is dominated by subsistence agriculture, which is characterised by manual labour and rainfall dependent farming practices. This makes the farmers extremely vulnerable to weather unpredictability from climate change. Seasonal food insecurity is high in the Nouna HDSS, where, as of September 2018, stunting and wasting of children below five years of age reached 26 % and 7 %, respectively.

We established a crop yield estimation and prediction regression model based on monthly metrics of vegetation indices derived from multi-temporal Sent-inel^{-2} data. In-situ harvest measurements taken from five crops typical for the region (maize, beans, sorghum, millet, peanuts) served as model inputs. The models produced adjusted R^2 between 0.32 and 0.5 and, e.g. enabled maize yield predictions up to two months before harvest. The spatial application resulted in yield maps, in which each field can be associated and spatially linked to an individual household. These quantitative yield estimates can then be translated to crucial socio-economic information, such as crop-specific calorie intake per household. The quantitative yield estimation is, therefore, a predictor and direct determinant for potential food insecurity.

Our findings provide a scientifically and politically relevant earth observation approach since it allows monitoring and predicting yields of individual households at 10 m spatial resolution. These results can consequently be used to identify local yield losses, which is crucial for implementing early-onset prevention measures aimed at minimising food insecurity and subsequently, child undernutrition. Moreover, they can serve as a basis to evaluate the impact of climatic factors, agricultural interventions or management on households' economic and child nutritional status.

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