

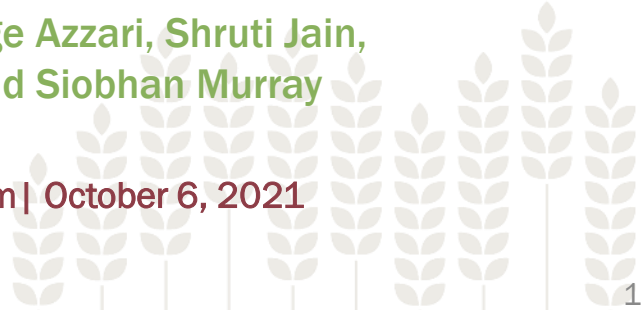


Understanding the Requirements for Surveys to Support Satellite- Based Crop Type Mapping: Evidence from Sub-Saharan Africa

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Joint work with George Azzari, Shruti Jain,
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UN World Data Forum | October 6, 2021



Background

- Role of agriculture in rural livelihoods
- Need for accurate, crop-specific measures of area under cultivation, production and yields – not only at the national-level but with enhanced within-country disaggregation
- Surge in high-resolution satellite imagery and research on remotely sensing outcomes in smallholder farming systems
 - Still need data to train and validate the underlying models

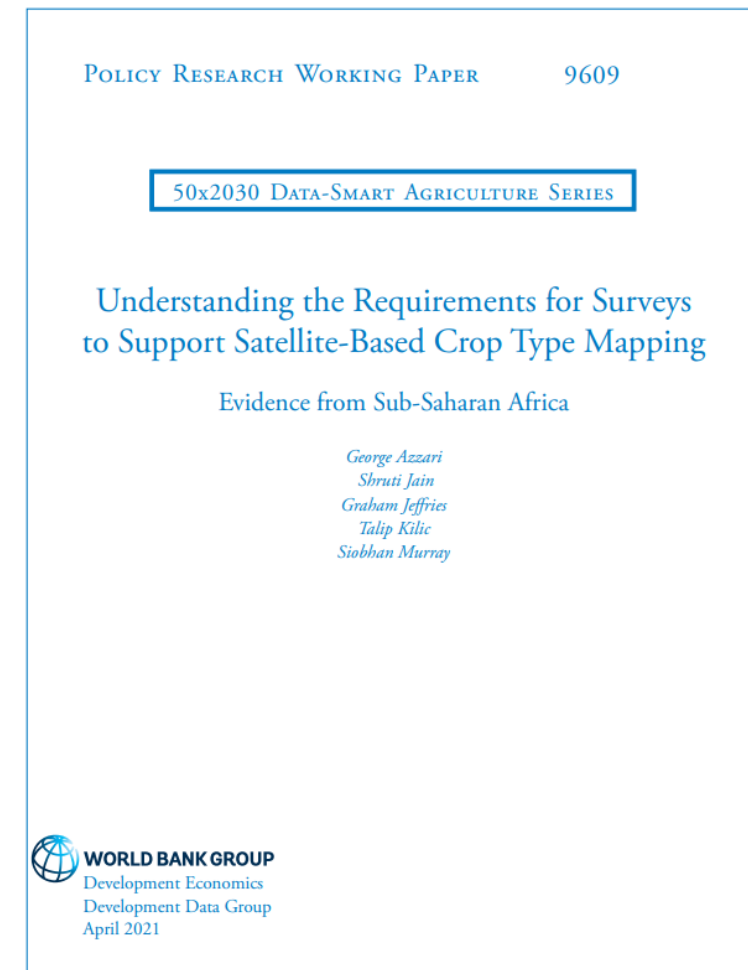


Key takeaways from the literature

- Training data have a bearing on the quality and spatial resolution of satellite-based estimates ([Lobell et al. 2019](#), [2020](#))
- Research has largely been at sub-national levels, with heterogeneity in the type of and approach to training data collection
- Large-scale surveys *can* address training data needs of earth observation applications on crop area mapping and crop yield estimation in lower-income countries, but...
 - There are no clear recommendations on survey methods and fieldwork protocols to generate the right training data

What we do

- Address operational and inter-related research questions in the context of maize area mapping in Malawi and Ethiopia
 - How much training data do we need to reach an acceptable level of accuracy of a crop classification algorithm?
 - How does the approach to georeferencing plot locations in surveys impact algorithmic accuracy?
 - How do the type of satellite data and exclusion of plots under specific area thresholds affect algorithmic accuracy?
- Leverage ML, georeferenced national survey data collected by NSOs, and Sentinel-2 imagery + ancillary geovariables
- Inform the guidelines being developed by [50x2030 Initiative](#) for georeferenced survey data collection for training and validating EO models for high-resolution crop type mapping and crop yield estimation in smallholder farming systems



<https://bit.ly/wps9610>

What we find

- Collecting a **complete plot boundary** is preferable to competing approaches to georeferencing plot locations in large-scale household surveys. This is particularly true if collection capacity is limited to fewer locations.
- Seemingly-small erosion in maize classification accuracy under less preferable approaches to georeferencing plot locations **consistently results in total area under maize cultivation to be overestimated** - in the range of **0.16 to 0.47 million hectares** (8 to 24 percent).
- **Georeferencing the complete set of plot corners is a second-best strategy**, can approximate full plot boundaries and can in turn train models with comparable performance.
- Classification performance peaks with **~60% of the training data** under preferred and second-best approaches to georeferencing plot locations.
- **If only a single GPS point** can be collected, that location should be **near the plot centroid** rather than at the plot corner. With large datasets, the performance could be comparable to that of complete plot boundaries.
- **No plot observations should be excluded** from model training based on a minimum plot area threshold.
- **Optical features alone** can provide sufficient signal to maximize prediction quality.

Open access data assets

10-m resolution crop area and maize area maps for Malawi and Ethiopia for each agricultural season from 2016 to 2019 on World Bank Development Data Hub

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High-Resolution Crop And Maize Area Mapping For Ethiopia

Metadata last updated on - Jul 21, 2021

Linked to the research conducted under the Methods and Tools Component of the 50x2030 Initiative (<https://www.50x2030.org/>), this data deposit includes 10-meter spatial resolution maps for (i) areas cultivated with any crops, and (ii) areas cultivated with maize across Ethiopia for each rainy season during the period of 2016-2019. The maps are a product of the analyses conducted by Azzari...

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[Overview](#)

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 HTML • Classification: Public

Basic Information Document for crop and maize area mapping
 PDF • Last Updated: Apr 13, 2021 • Classification: Public • Size: 349.1 KB

Ethiopia maize mask for 2017
 TIF • Last Updated: Apr 13, 2021 • Classification: Public • Size: 335.6 MB

METADATA	
Description	Pixels with probability of crop cultivation greater than or equal to 40 percent and probability of maize cultivation greater than or equal to 50 percent.
Classification	Public

Ethiopia maize mask for 2016
 TIF • Last Updated: Apr 13, 2021 • Classification: Public • Size: 244.9 MB

Ethiopia maize mask for 2018
 TIF • Last Updated: Apr 13, 2021 • Classification: Public • Size: 390.6 MB

Ethiopia maize mask for 2019
 TIF • Last Updated: Apr 13, 2021 • Classification: Public • Size: 375.2 MB

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Topics

- Agriculture and Food Security

Related Links

Azzari, G., Jain, S., Jeffries, G., Kilic, T., and Murray, S. (2021). "Understanding the Requirements for Surveys to Support Satellite-Based Crop Type Mapping: Evidence from Sub-Saharan Africa." World Bank Policy Research Working Paper No. 9609. LSMS Washington, DC: World Bank.

Tags

Africa , agriculture , crop type , earth observation , Ethiopia , household survey , maize , remote sensing , satellite imagery , sentinel-2

<http://bit.ly/ethiopiamaps>

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High-Resolution Crop And Maize Area Mapping For Malawi

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Malawi maize mask for 2018
 TIF • Last Updated: Apr 13, 2021 • Classification: Public • Size: 162.5 MB

METADATA	
Description	Pixels with probability of crop cultivation greater than or equal to 40 percent and probability of maize cultivation greater than or equal to 60 percent.
Classification	Public

Malawi maize mask for 2016
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Malawi maize mask for 2017
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Malawi maize mask for 2019
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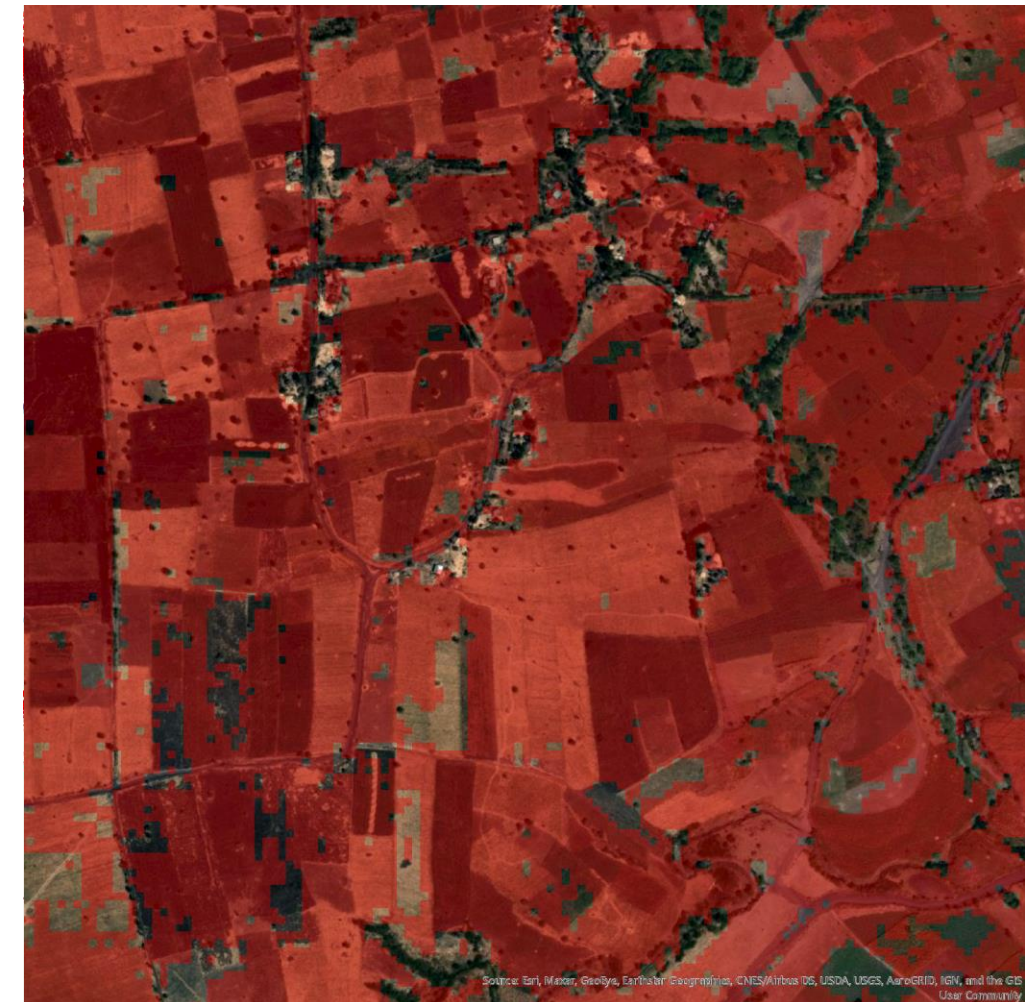
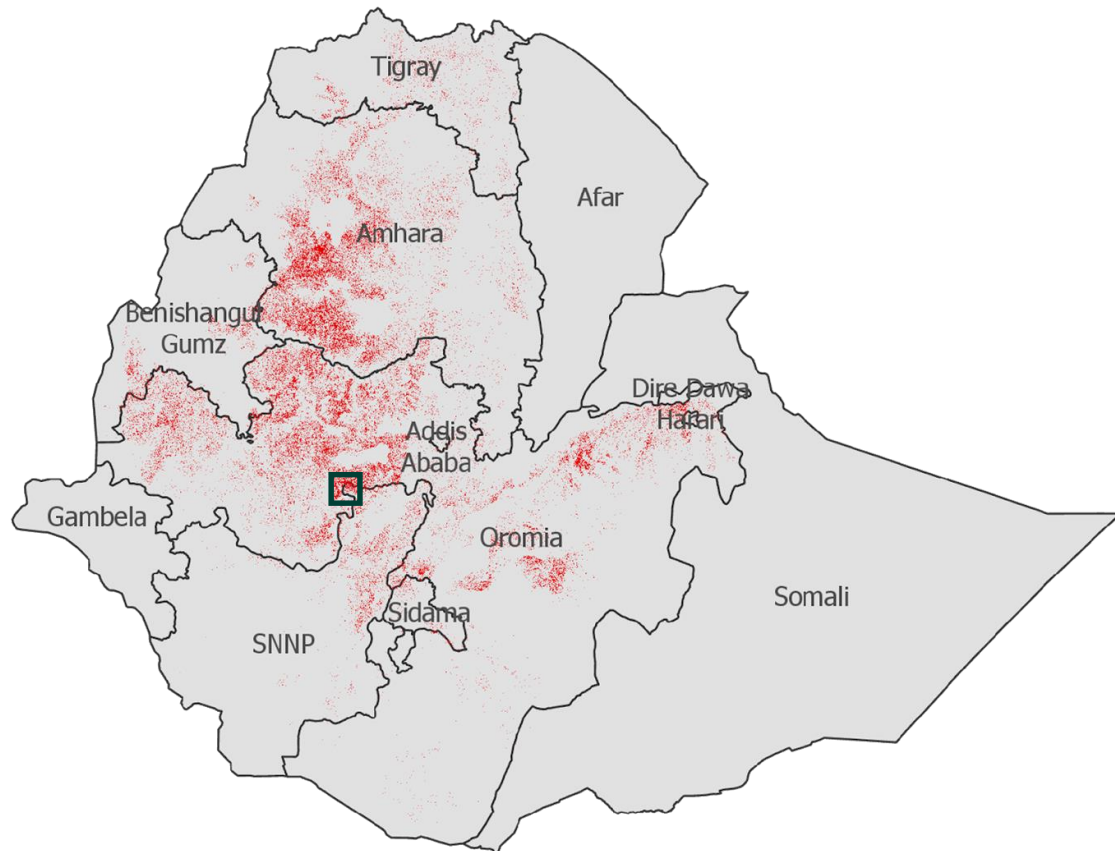
Tags

Africa , agriculture , crop type , earth observation , household survey , maize , Malawi , remote sensing , satellite imagery , sentinel-2

<http://bit.ly/malawimaps>

Open access data assets

Ethiopia 2019: high-density production area



Source: Earth, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GE User Community

Looking forward

- Continuing 50x2030-supported research to formulate the guidelines for large-scale surveys to fulfill training data needs of satellite-based crop area mapping and yield estimation in smallholder farming systems
 - Leverage additional existing large-scale survey data from Mali, Malawi and Uganda – with georeferenced plot outlines and objectives measures of yields based on crop cutting – to:
 - Expand crop classification to new countries & new cereals: barley, millet, rice, sorghum & wheat
 - Identify training data requirements for high-resolution yield estimation for maize & new cereals
 - Gauge sensitivity of recommendations to the choice of model (e.g., RF vs. CNN) & geospatial covariates
 - Document accuracy of out-of-season predictions & inter-temporal decay in model accuracy
 - Conduct research on object-based classification and automated detection of plot boundaries
 - If the COVID-19 pandemic allows, conduct additional survey experiments in 2022 in non-African settings



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