German Remote Sensing Data Center (DFD)
Land Surface Dynamics

The Transition towards a Sustainable Intensification of Agriculture: The Potential of Remote Sensing to Support Smallholder Farmers in West Africa

Jonas Meier[1], Frank Thonfeld[1], Niklas Heiss[1], Pierre C. Sibiry Traore[2], Celeste Tchapmi Nono Nghotchouang [2], Janet Mumo Mutuku[2], Sidy Tounkara[3], Laure Tall[3], Ursula Gessner[1]

[1] German Remote Sensing Data Center, German Aerospace Center
[2]Manobi Africa
[3]Initiative Prospective Agricole et Rurale (IPAR)

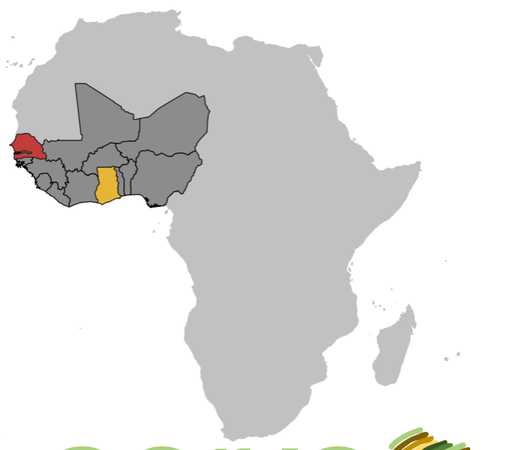
BACKGROUND

The COINS project

… 1 of 4 regional project within the call "Sustainable land management in Sub-Saharan Africa: Improving livelihood through local research within the FONA framework of the BMBF

Objectives

… The **implementation** of **sustainable intensification (SI) practices, "**where agricultural **yields** are **increased** without adverse environmental impact and without the conversion of additional nonagricultural land" (Pretty & Bharucha, 2014)



Challenges in Sub-Saharan Africa

… Sub-Saharan Africa faces **multiple risks (climatic, social, economic, ecological)** with partly uncertain future developments

… **Limiting yields** and thus the acceptance of certain measures by farmers

… This generally leads to **agricultural expansion** to satisfy increased demands and compensate degradation

… **Rising population** as driver for **increase in cropland** and in **livestock**

… Consequences are **loss in carbon** and **loss in biodiversity**

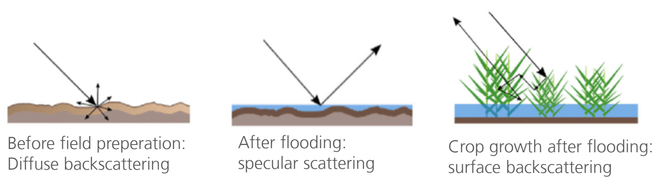
METHOD

Deliniation of Field Boundaries using a CNN

- **Input:** Planet data (NICFI) 2016-07 - 2023-07 (5 bands: R, G, B, NIR, maxNDVI)
- Use of maxNDVI to map all active fields
- **Training data** creation:
  - 4 sample regions representing different agricultural systems
  - Polygons were drawn across all agricultural fields
  - Rasterized to Planet resolution
- **Preprocess data**:
  - Stretch the dataset using augmentation techniques like flipping, rotating and scaling and image generators
- **Train the U-Net model (Ronneber et al., 2015)**:
  - Tune hyperparameters and monitor learning curves to reach minimum loss
  - fully convolutional neural network (CNN)
  - Only convolutional layer

Identification of Agricultural Management Events using SAR-based change detection

- **Evaluation** of the potential using Sentinel-1 data to identify agricultural management
  - Tilling, Sowing, Flooding, Harvesting
- Management on field level
- Change detection as an indicator for management actions
- Based on the *Sequential Omnibus Algorithm* (Canty, M. et al., 2019)
- Validation of the management measures actually applied in progress



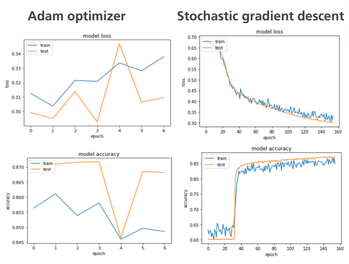
Modified after Ottinger & Künzer (2020)

RESULTS

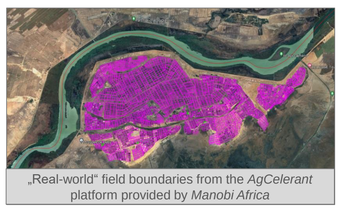
Comparison of field boundaries delineated from Planet (NICFI) data:
- RGB high resolution image and ESA *WorldCover*
- Field data provided to local partner to plan with exact field sizes

Identification of management practices based on Sentinel-1 data:
- Can bridge the gap between farmers and credit/insurance institution
- reduces insurers' costs as crop failure checks can be automated
- Automation and cost-effective monitoring

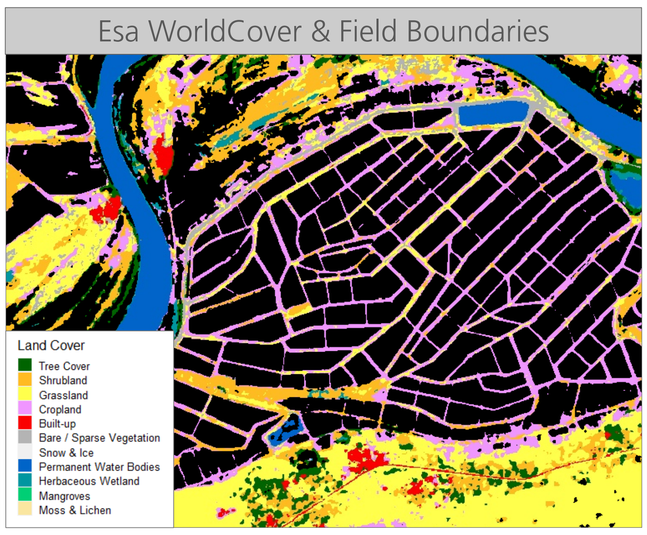
Comparison of optimizer functions

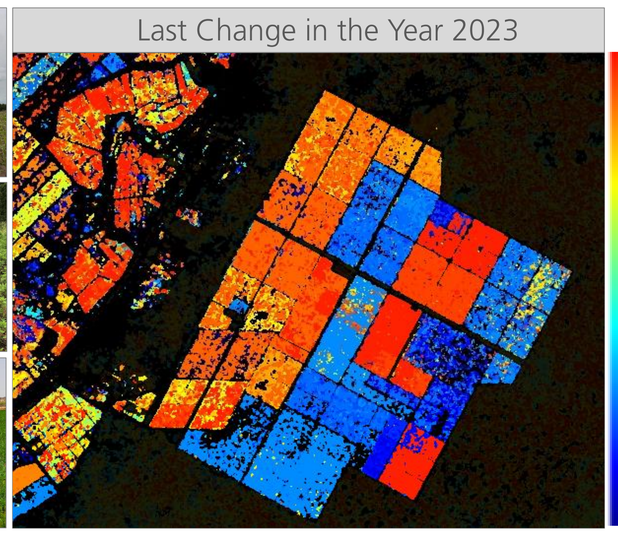


To improve the model in-situ field boundaries are provided by local partners



„Real-world" field boundaries from the *AgCelerant* platform provided by *Manobi Africa*





SPONSORED BY THE

Federal Ministry of Education and Research

This work is part of the COINS project funded by the German Federal Ministry of Research and Education (Förderkennzeichen 01LL2204A-F)

Canty, M.J.; Nielsen, A.A.; Conradsen, K.; Skriver, H. (2019): Statistical Analysis of Changes in Sentinel-1 Time Series on the Google Earth Engine. *Remote Sensing* 12, 46.
Ottinger, M. and Kuenzer, C. (2020): Spaceborne L-Band Synthetic Aperture Radar Data for Geoscientific Analyses in Coastal Land Applications: A Review. *Remote Sensing* 12, 2228.
Pretty, J. and Z. P. Bharucha (2014): Sustainable intensification in agricultural systems. *Annals of Botany* 114(8): 1571-1596.
Ronneberer, O., Fischer, P., Brox, T. (2015): Medical Image Computing and Computer-Assisted Intervention (MICCAI). *Springer*, LNCS, Vol. 9351: 234-241.

Deutsches Zentrum für Luft- und Raumfahrt
German Aerospace Center

Contact: **Dr. Jonas Meier**
German Aerospace Center (DLR)
Earth Observation Center (EOC)
German Remote Sensing Data Center (DFD)

Oberpfaffenhofen
82234 Weßling
Tel.: +49 8153 28-3946
jonas.meier@dlr.de