Crop type mapping in Central and South Asia using Sentinel-1 and Sentinel-2 remote sensing data

Sharing not permitted

Christoph Raab[1,2*], Viet Duc Nguyen[1]

[1]Eberswalde University for Sustainable Development (HNEE), Schwappachweg 3, 16225 Eberswalde, Germany; [2]University of Hildesheim, Institute of Geography, Universitätsplatz 1, 31141 Hildesheim, Germany

*christoph.raab@uni-hildesheim.de

1. Introduction

Crop type information derived from satellite remote sensing are of pivotal importance for quantifying **crop growth** and **health status**. However, such spatial information are not readily available for countries in **Central and South Asia**, where **smallholder farmers** play a dominant role in agricultural practice. These, however, are regions, particularly vulnerable to **climate change** related **food insecurities**.

Thus, the aim of this study was to investigate **possibilities** and **limitations** of a combined use of multi-spectral **Sentinel-2** and radar **Sentinel-1** data for **crop type** mapping.

2. Study site

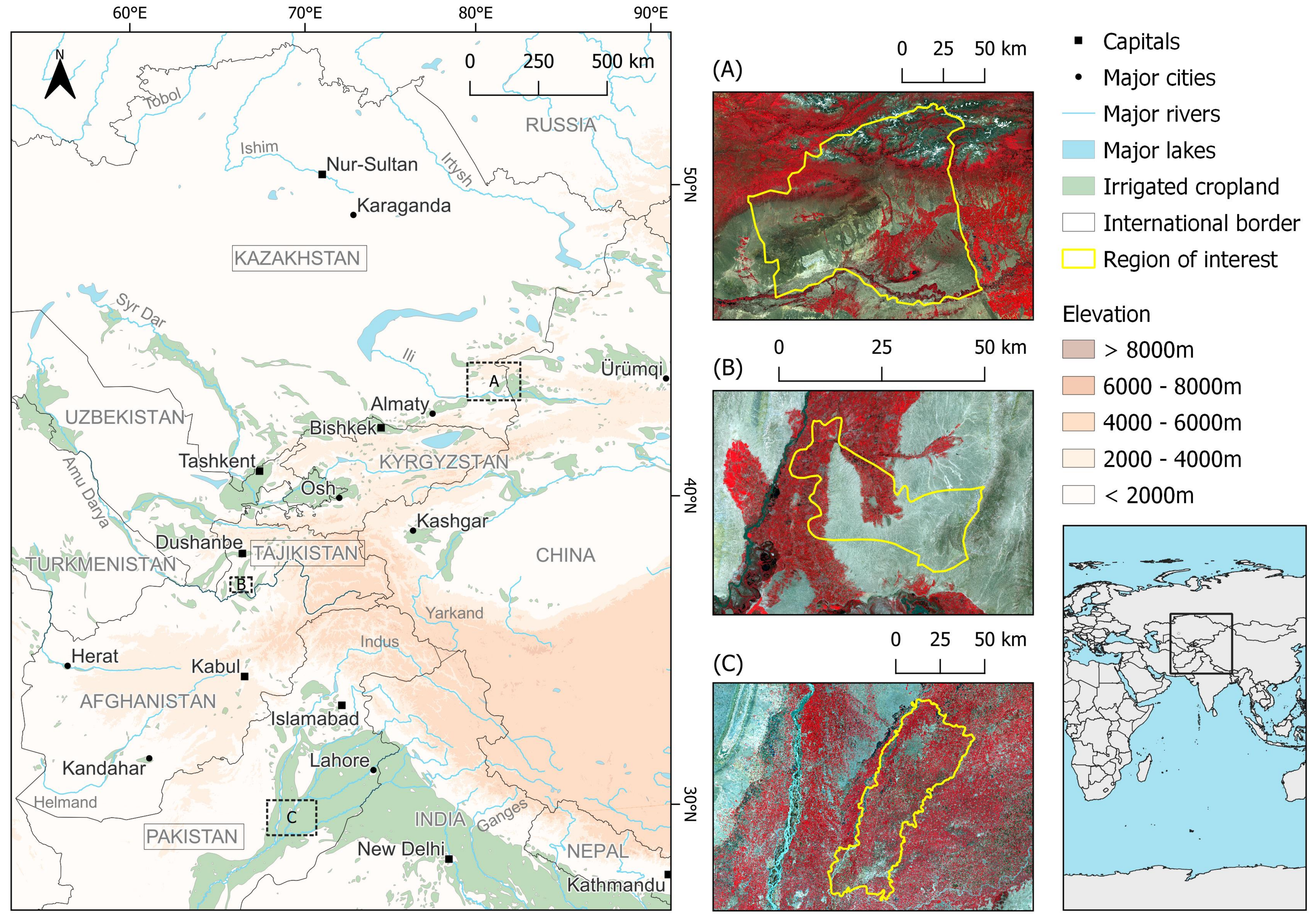

Figure 1: Overview of the study regions.

As study areas, two regions in **Central Asia** – A) Panfilov District in **Kazakhstan**, B) Jaloliddin Balkhi District in **Tajikistan** – and one in South Asia – C) Multan District in Pakistan – were selected (Figure 1). All three case studies are dominated by smallholder farmers, whereas **cotton** plays an important role as a cash crop in the studied regions of **Pakistan** and Tajikistan.

3. Materials & Methods

- **Field data** were collected in Jaloliddin Balkhi District in Mai 2022, in Panfilov District in June 2022 and Multan District in October 2022.
- Based on **roadside collection** approach for training data (Waldner et al., 2019).
- The **WorldCover 2020 v100** (Zanaga et al., 2021) product was used to limit the randomised sampling.
- A collection of Sentinel-2 and Sentinel-1 satellite data was used along with the **random forest classification** algorithm in the **Google Earth Engine** (Gorelick et al., 2017).
- Three different **temporal aggregation intervals** (Rufin et al., 2019).
- We evaluated the performance of **single Sentinel-2 and Sentinel-1** along with a **combined multi-spectral** and **radar dataset**.
- We used **cross-validation** and **area adjusted accuracy assessment** (Olofsson et al., 2014) implemented in R, respectively.

4. Results

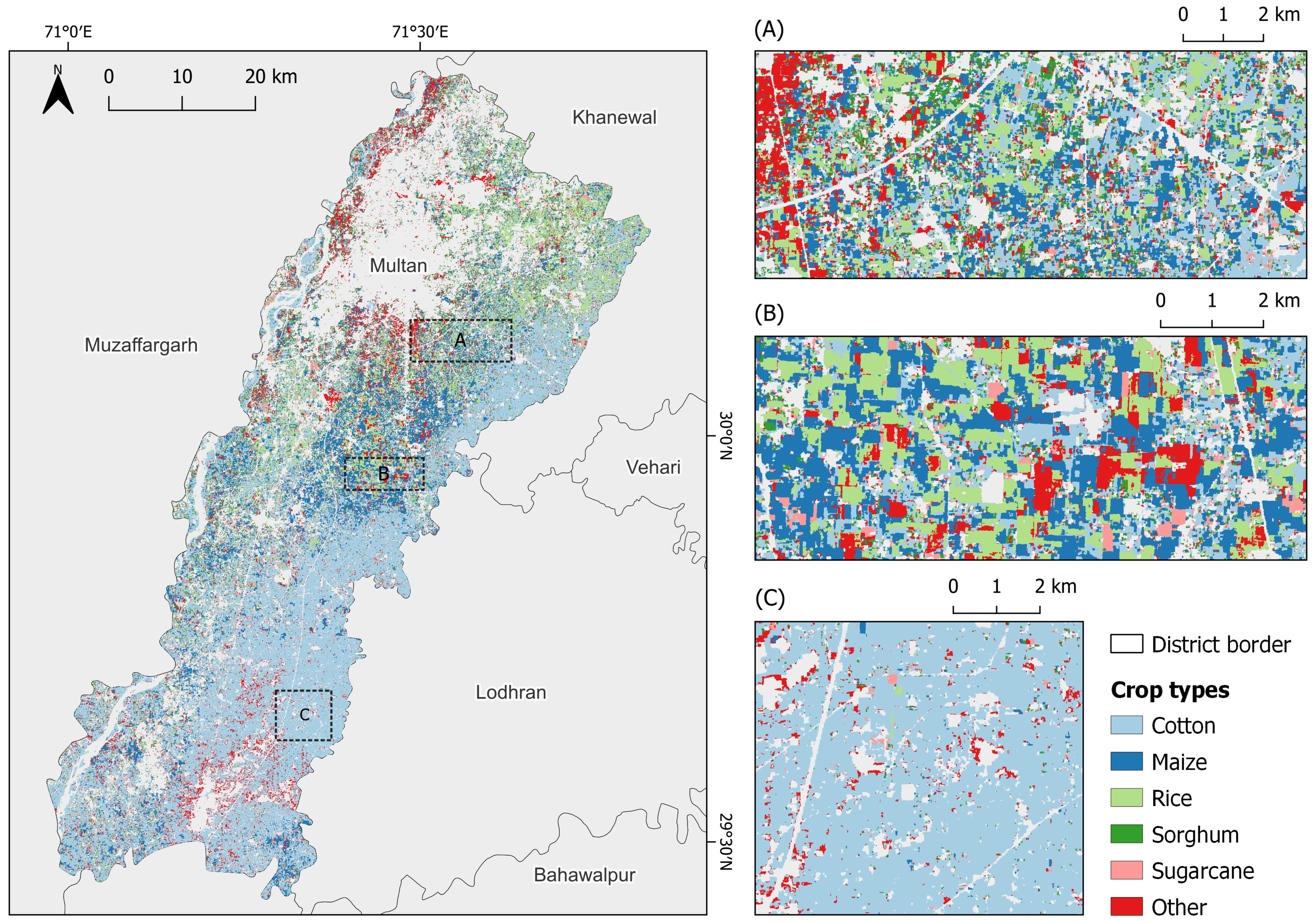

Figure 1: Preliminary results for Multan District in Pakistan.

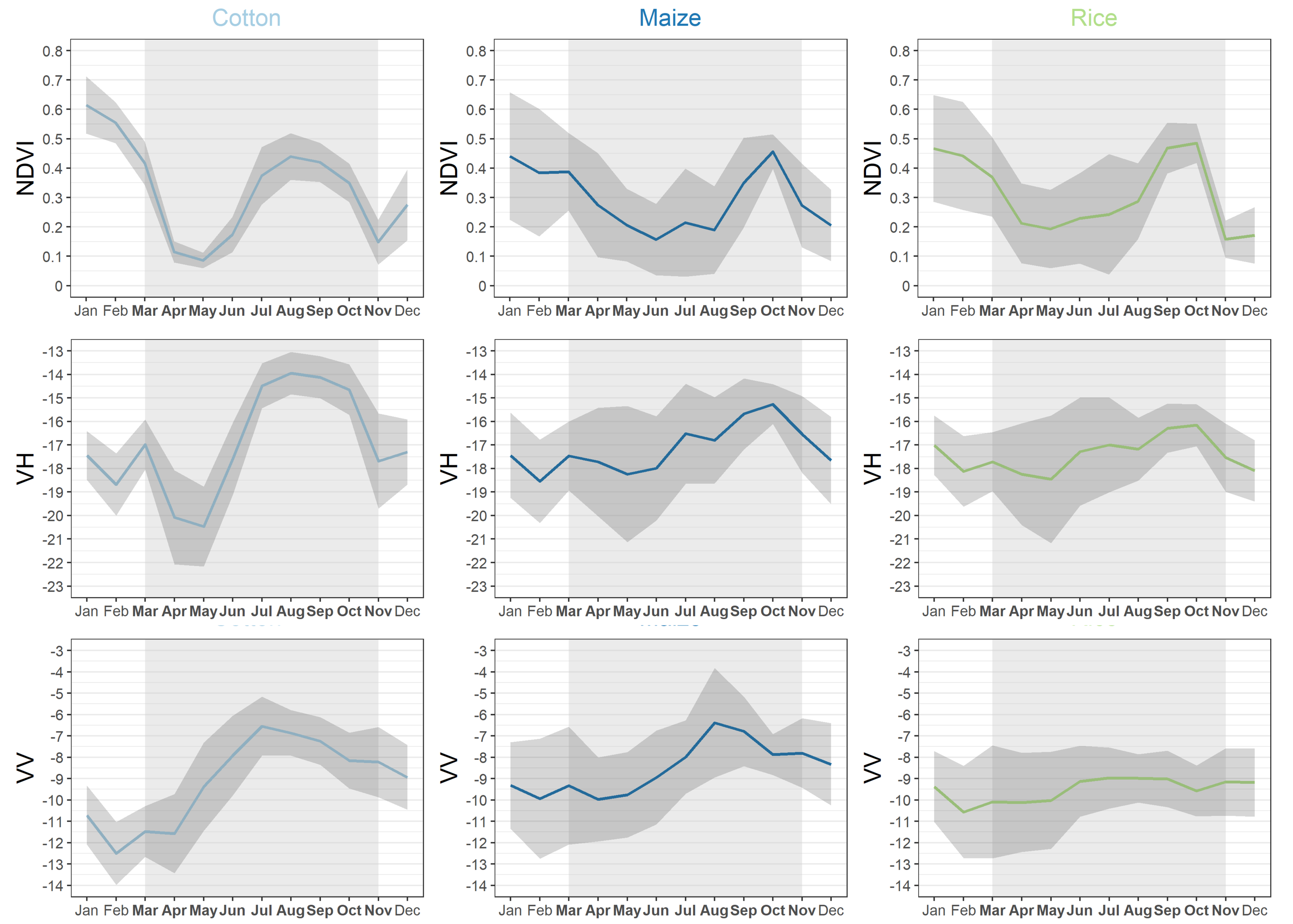

Figure 1: Temporal curves for selected crops in Pakistan. Kharif season is shaded in grey.

Sentinel-2 + Sentinel-1:
80 % Overall Accuracy, monthly aggregation — 80 % OA — **S-2 + S-1**

Sentinel-2 only:
79 % Overall Accuracy, monthly aggregation — 79 % OA — **S-2**

Sentinel-1 only:
72 % Overall Accuracy, monthly aggregation — 72 % OA — **S-1**

Table 1: Result of the area adjusted accuracy assessment for Multan District in Pakistan, using combined Sentinel-2 and Sentinel-1 data with monthly aggregation.

	km²	km²±	PA	PA±	UA	UA±
Cotton	1206.28	106.16	100.00	0.00	93.94	8.27
Maize	306.74	97.81	87.31	21.86	72.41	16.56
Rice	220.42	25.00	94.21	10.68	100.00	0.00
Sorghum	183.99	128.68	65.34	28.81	66.67	65.33
Sugarcane	132.71	49.16	100.00	0.00	77.78	28.81
Other	391.13	152.71	58.47	22.83	100.00	0.00

5. Discussion & Conclusion

Preliminary results for Pakistan showed the **high potential for a combined Sentinel-2 and Sentinel-1 crop type mapping** in the context of **smallholder farming** systems. Following research activities will expand the analysis to the case studies in Tajikistan and Kazakhstan.

Project background and funding

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Sources

Gorelick, N., Hancher, M., Dixon, M., Ilyushchenko, S., Thau, D., & Moore, R. (2017). Google Earth Engine: Planetary-scale geospatial analysis for everyone. *Remote Sensing of Environment*, *202*, 18–27. https://doi.org/10.1016/j.rse.2017.06.031

Olofsson, P., Foody, G. M., Herold, M., Stehman, S. V., Woodcock, C. E., & Wulder, M. A. (2014). Good practices for estimating area and assessing accuracy of land change. *Remote Sensing of Environment*, *148*, 42–57.

OpenStreetMap contributors and available from https://www.openstreetmap.org

Rufin, P., Frantz, D., Ernst, S., Rabe, A., Griffiths, P., Özdoğan, M., & Hostert, P. (2019). Mapping cropping practices on a national scale using intra-annual landsat time series binning. *Remote Sensing*, *11*(3), 232.

Waldner, F., Bellemans, N., Hochman, Z., Newby, T., de Abelleyra, D., Verón, S. R., Bartalev, S., Lavreniuk, M., Kussul, N., & Le Maire, G. (2019). Roadside collection of training data for cropland mapping is viable when environmental and management gradients are surveyed. *International Journal of Applied Earth Observation and Geoinformation*, *80*, 82–93.

Zanaga, D., Van De Kerchove, R., De Keersmaecker, W., Souverijns, N., Brockmann, C., Quast, R., Wevers, J., Grosu, A., Paccini, A., & Vergnaud, S. (2021). *ESA WorldCover 10 m 2020 v100 (Version v100)[Data set]. Zenodo.*

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