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Rice area mapping in Bangladesh: Harnessing the power of time-series of Sentinel data and Google Earth Engine

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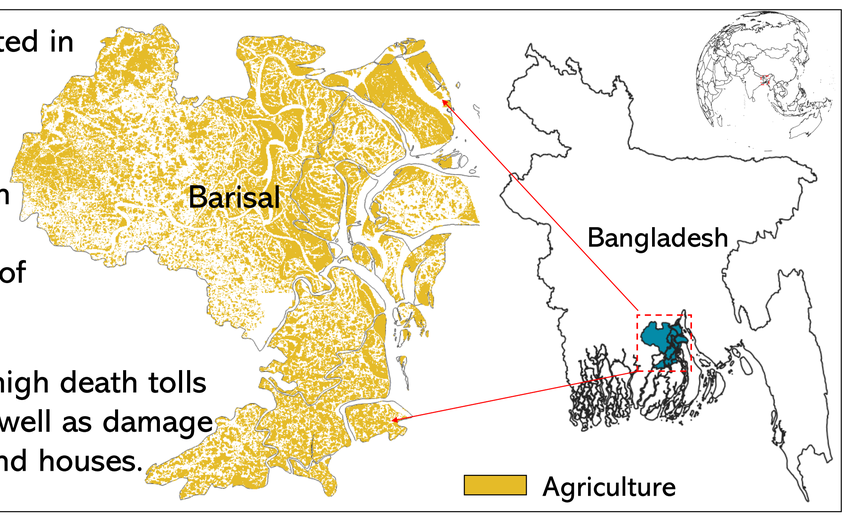
INTRODUCTION

- Rice is the main food source in Bangladesh, which provides livelihood, nutrition, and food security for 160 million people.
- Rice is cultivated in the majority (75%) of the agricultural land in Bangladesh.
- Nearly 17% of Bangladesh's national income and 70% of the agricultural Gross Domestic Production depends upon rice cultivation.
- In recent years climate change has caused increased flooding events which pose a threat to rice cultivation in the pre-harvest season.
- Bangladesh ranked seventh on the Global Climate Risk Index in 2021.
- Therefore, there is a strong need for an in-season assessment of rice crop area for food security management in Bangladesh.

STUDY AREA

- Barisal is a district located in the southern region of Bangladesh.
- Cyclones are common in the Barisal region, with and average frequency of 3 per year.
- Cyclones have caused high death tolls in the communities, as well as damage to crops (mainly rice) and houses.

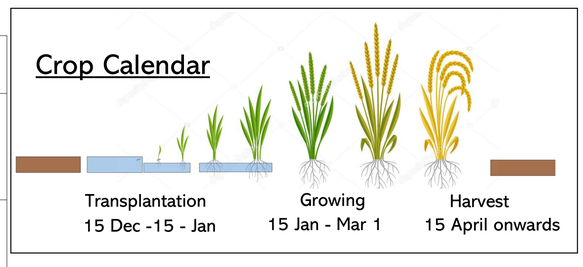


DATASETS USED

Satellite Datasets

Characteristics	Sentinel - 1	Sentinel - 2
Acquisition dates	Nov - Jan (2018 - 2019)	Nov - May (2018 - 2019)
Bands	VV	Red (Band 4), NIR (Band 8)
Spatial resolution (m)	10 m	10 m
Wavelength	5.5 cm	443 - 2190 nm
Swath	250 km	290 km
Temporal resolution	12 days	5.5 days

Other Datasets



- Ground sample points collected by the International Maize and Wheat Improvement Center for rice and non-rice crops.
- Crop calendar developed by the Bangladesh Bureau of Statistics.
- Land cover map developed by International Centre for Integrated Mountain Development.

RESEARCH GAPS AND LIMITATIONS

Research gap

- Currently there is no spatially explicit, in-season rice area map for Barisal district of Bangladesh.

Limitations of Machine Learning Methods:

- Machine learning (ML) approaches require extensive training data collected either from the field or from high-resolution satellite images, which not only requires huge manpower and skilled image interpretation, but also has cost and time constraints.

Limitations of Manual Thresholding:

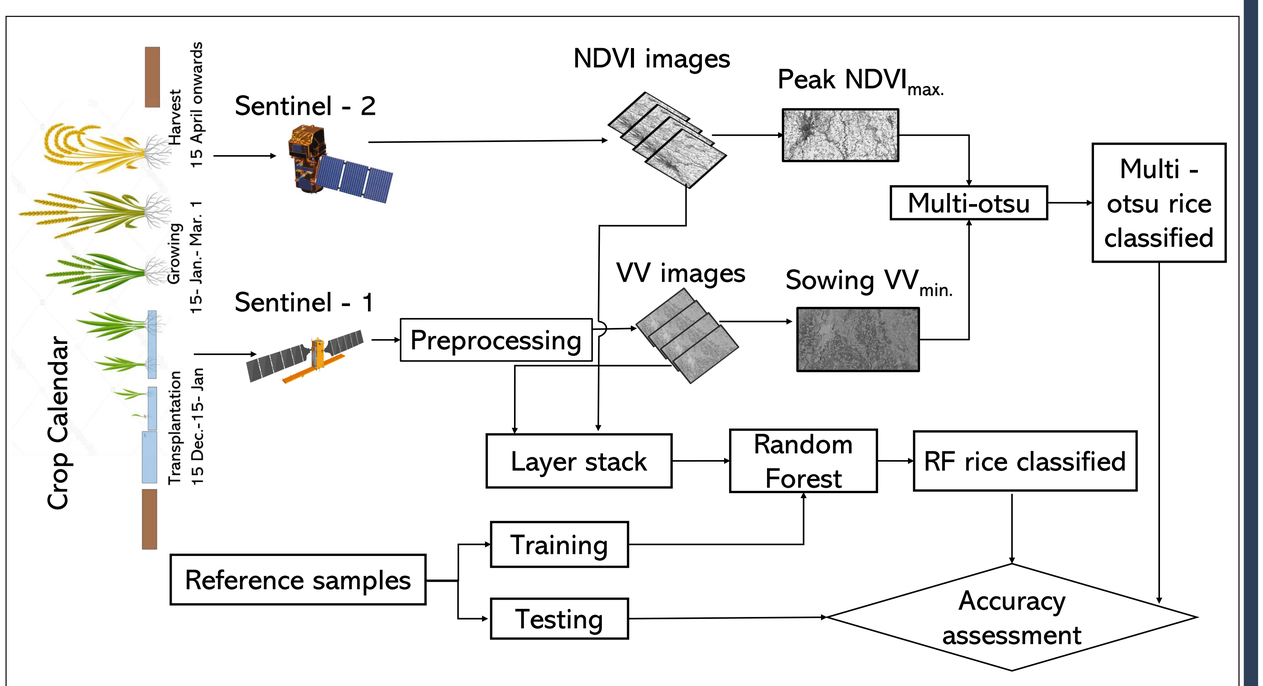
- Phenology-based thresholding (manual thresholding) approaches for rice mapping requires calibration data, high temporal revisits of satellite images, and extensive knowledge of the crop calendar on a micro-scale (i.e., rice fields).
- Determining a threshold manually can be challenging in time series data due to variability in the threshold values.

OBJECTIVES

The objective of this study is to develop an operational in-season rice area mapping framework using a multi-otsu automatic classification approach to support food security management in Bangladesh.

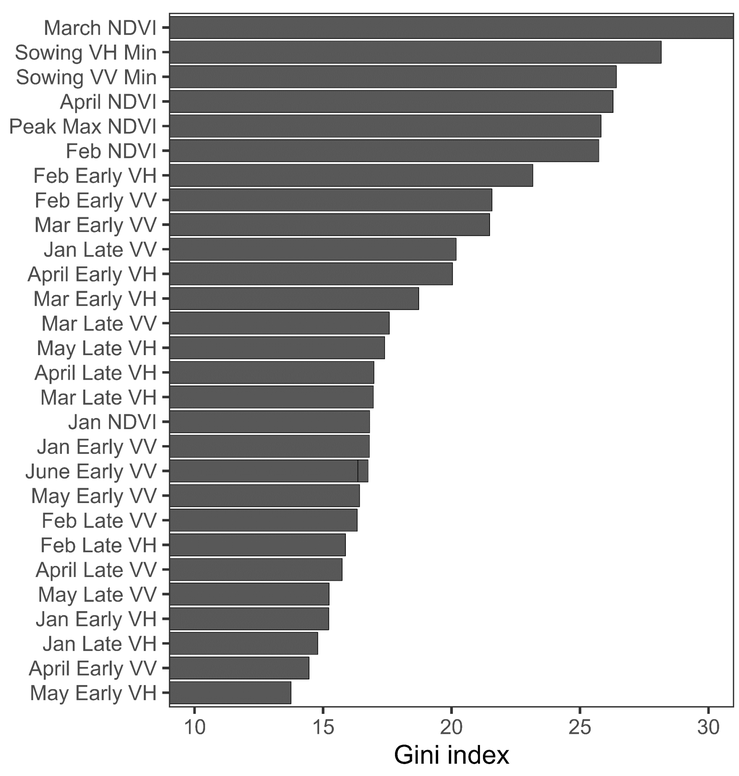
1. How is the multilevel thresholding approach useful for mapping rice areas without using training data?
2. How do multilevel thresholding and random forest (RF) classification algorithms perform in classifying rice areas in Bangladesh?

METHODOLOGY

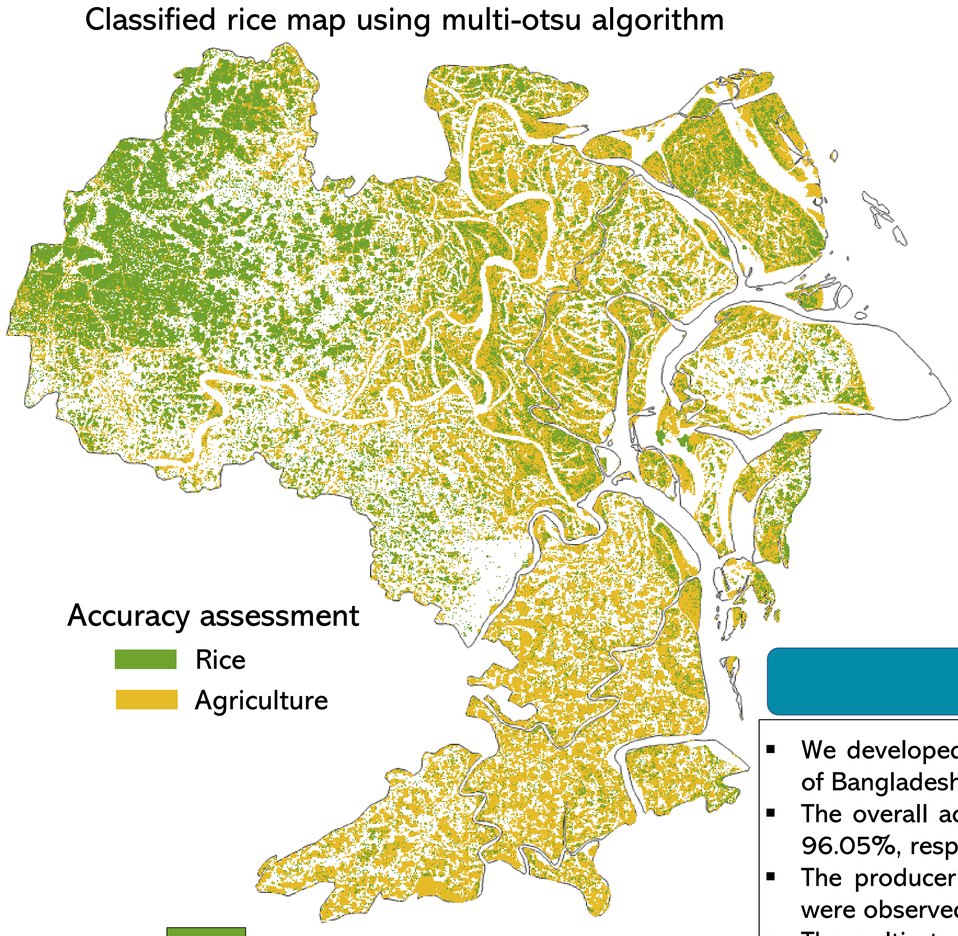


RESULTS & ANALYSIS

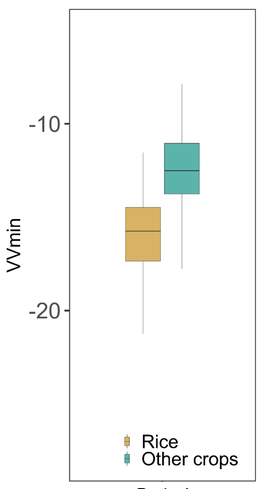
Random forest variable importance



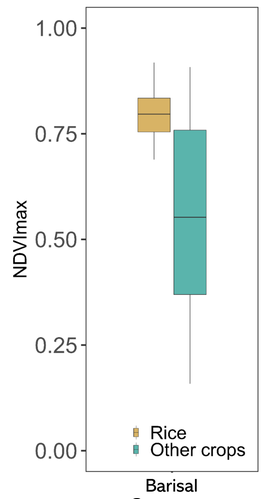
Classified rice map using multi-otsu algorithm



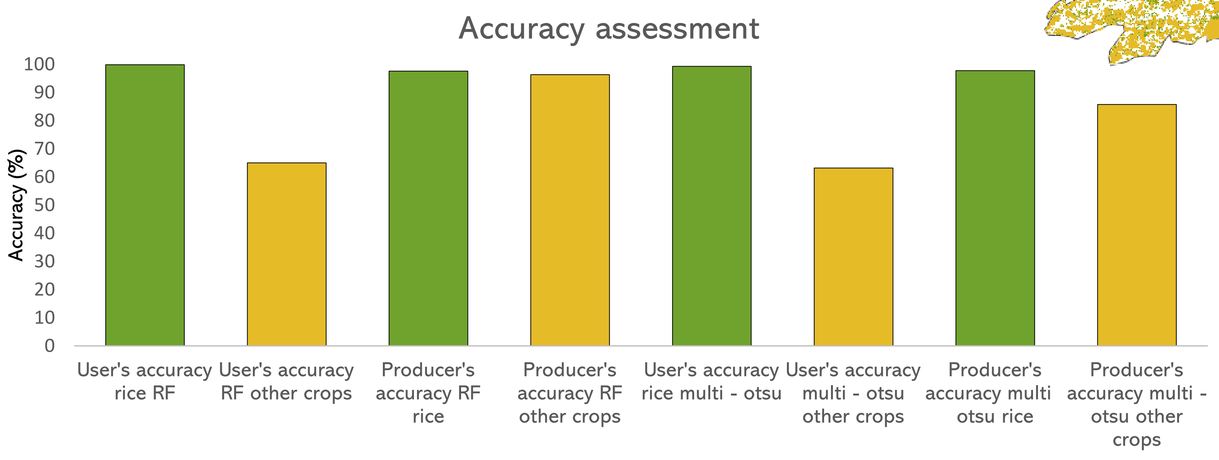
Backscatter response of rice (during sowing) using Sentinel - 1 SAR data



NDVI response of rice (during peak) using Sentinel - 2 optical data



Accuracy assessment



CONCLUSION

- We developed a spatially explicit, in-season rice map for the Barisal district of Bangladesh at a spatial resolution of 10 meters.
- The overall accuracies of RF and multi-otsu were observed as 97.51% and 96.05%, respectively.
- The producer's and user's accuracy of rice classified by RF and multi-otsu were observed as 97.57% & 99.82% and 97.75% & 99.28%, respectively.
- The multi-otsu algorithm is useful for operational rice area mapping in a data scarce country like Bangladesh, as the algorithm does not require reference data for performing rice classification and is scalable across space and time.
- Rice has a unique flood like response during transplantation time. Therefore, Sentinel-1 is useful for detecting rice fields during transplantation time.

REFERENCES

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