Investigating the impact of introducing submergence-tolerant Aman rice in Bangladesh

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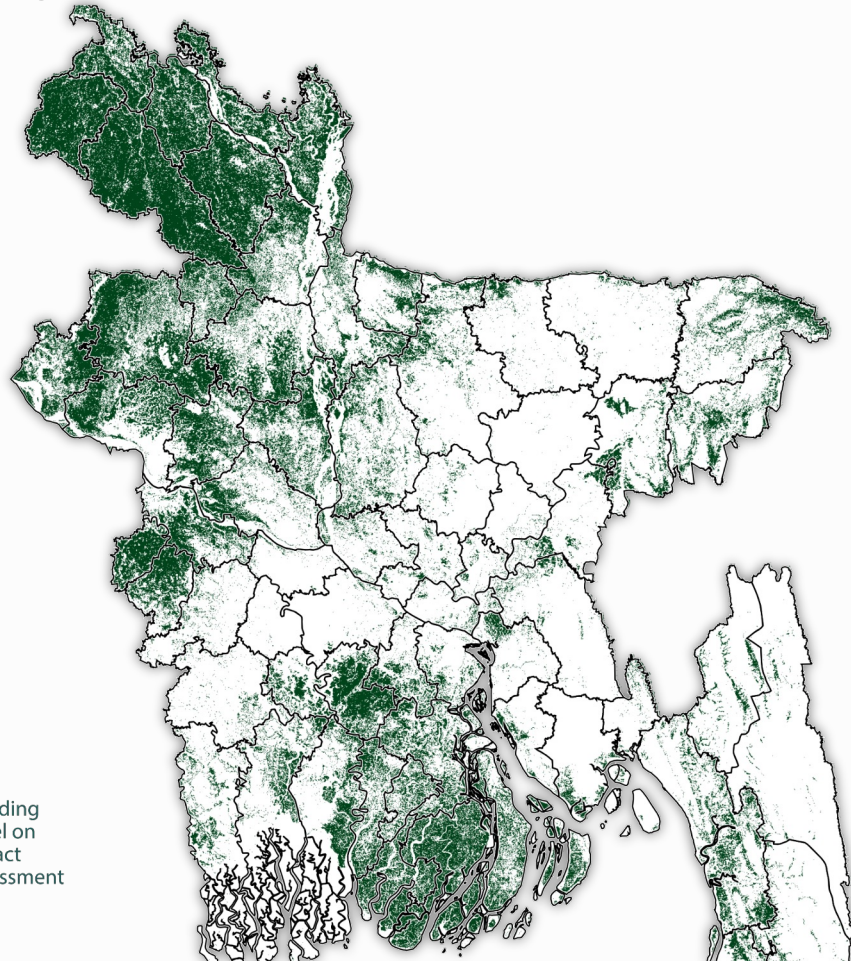

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Floods affect rice crops

15% of flood losses absorbed by the agricultural sector (FAO 2015)

Asia lost 48 billion USD in agricultural production from 1980-2013 (60% due to floods) (FAO 2015)

Submergence Tolerant Rice Varieties (STRVs), introduced in India in 2011, and in Bangladesh since 2013, can help mitigate flood effects

Can we measure the **effectiveness** of the **Aman** STRV introduced in Bangladesh?

If so, has its introduction been **positive** for **flood damage mitigation**?

Interpress News Service: Mintu Deshwara/ Sheikh Nasir

Two-way fixed-effects regressions to analyse the effect of the introduction of Aman rice

Enhanced Vegetation Index (EVI): Proxy for rice yield

Floods: Investigate the impact of floods

$$EVI = f\left(Seed, Flood, \ldots\right)$$

Aman Rice Seeds: Cumulative rice seeds distributed in each district

Other effects (rice area, flood duration,...)

Only select pixels where **rice** is **detected**

Aggregate data per **district**

Consider years 2001 to 2018

Data

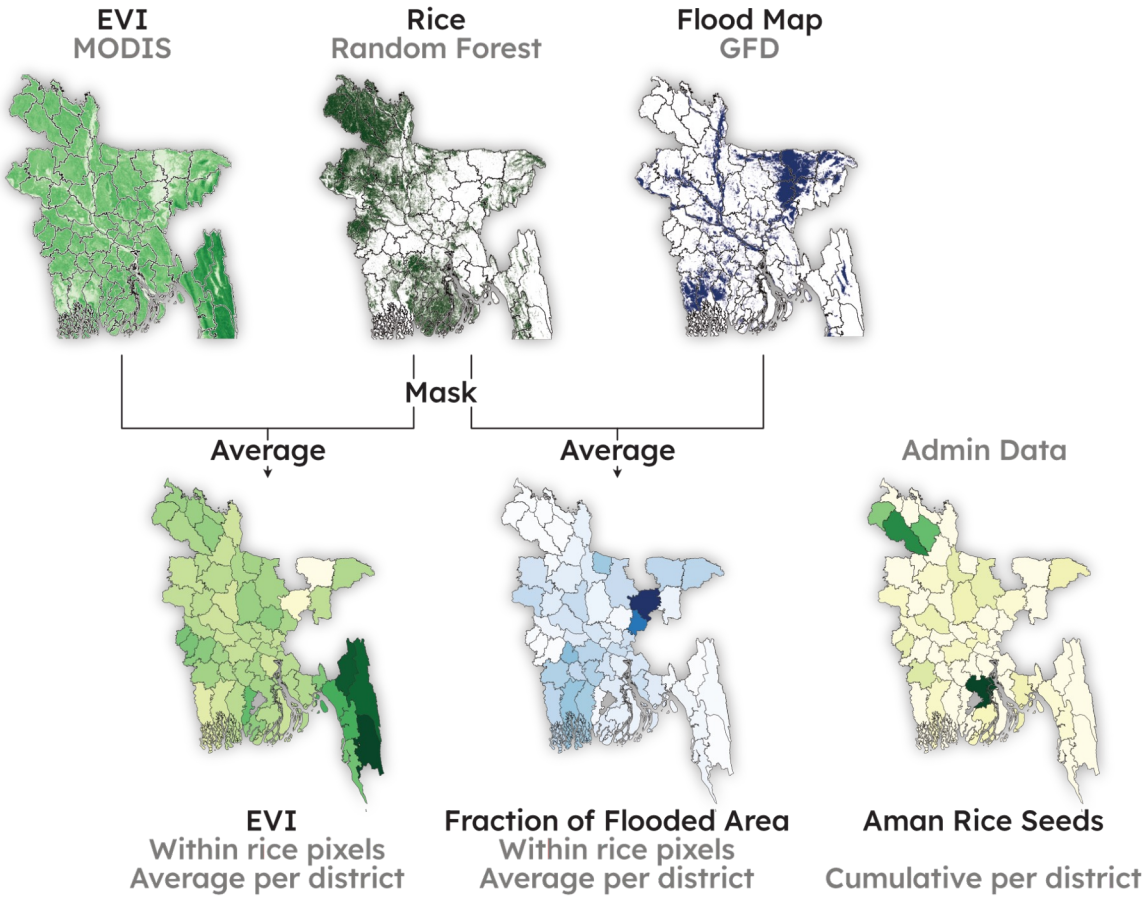
1 map / year / district

EVI: MODIS median from June to December

Rice Presence: Random Forest Algorithm based on MODIS (details later)

Flood Map: Global Flood Database Algorithm (GFD) based on MODIS

Aman Rice Seeds: Administrative data from government offices in each district



Rice Map Details:
Ground Truth

Baseline Rice/NoRice (**RNR**) area map derived from MODIS

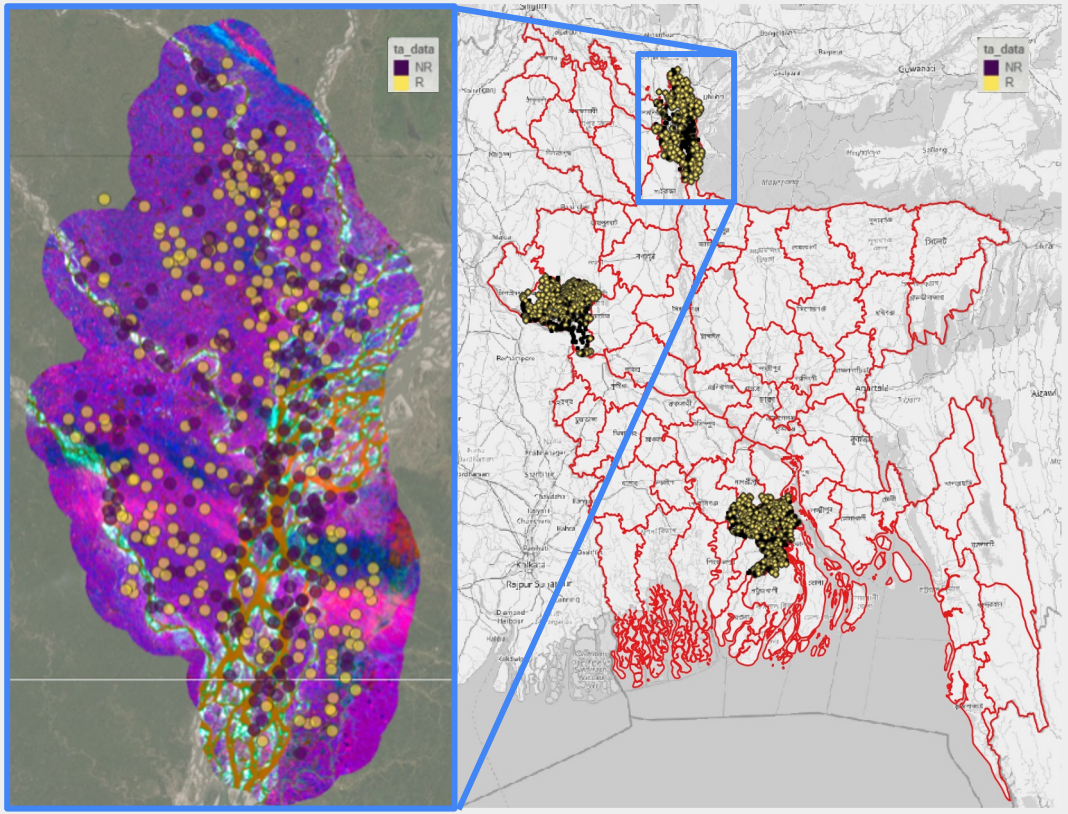
↓

Random Sampling of RNR → 'Ground Truth'

↓

RNR 'Ground Truth' interpreted and confirmed using high resolution Google Earth data

Sampled years: 2002, 2004, 2006, 2009, 2015, 2016, 2018 - 2020
Sampled districts: Barisal, Kurigam, Rajshahi



450 total number of samples

Rice Map Details:

Random Forest generated maps

Data and model processed in Google Earth Engine

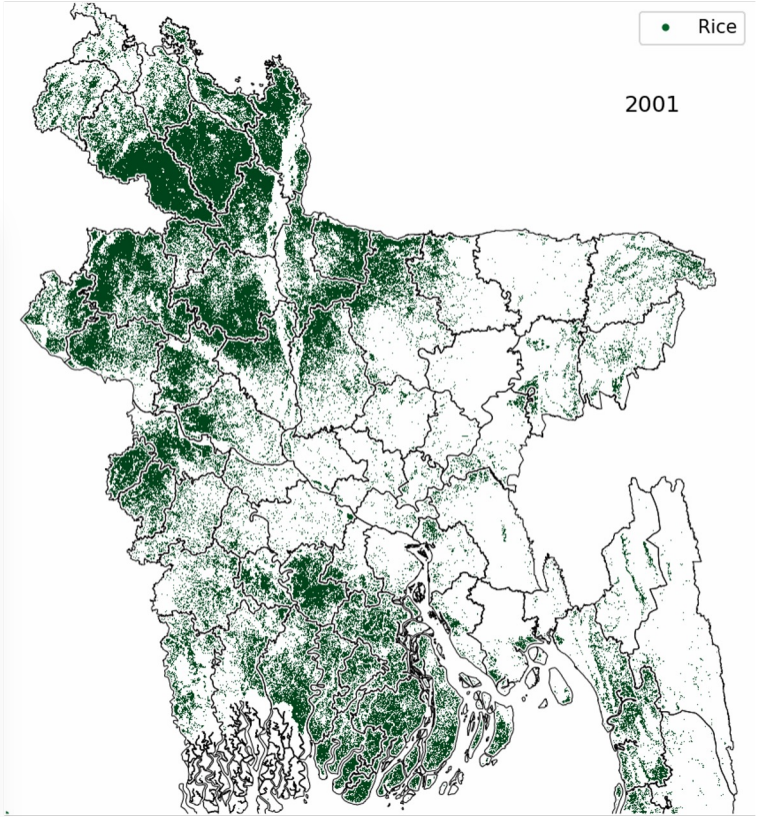
Data:

- MODIS Terra 8-days Composite Median value for the rice grow season (±June to December, may vary depending on the district)
- FABDEM Elevation

Random Forest:

- 70% of data for training, 30% for testing
- .77 accuracy

Inference Run on data form 2001 to 2018



Google Earth Engine

Linear model with multiple group fixed effects

Response:

Model *EVI*, proxy for yield, for district *i* and year *t* [$\mathbf{EVI_{i,t}}$]

Fixed Group Effect:

One intercept per district (i) and one per time step (t) [$\mathbf{a_i a_t}$]

$$EVI_{i,t} = a_i + a_t + b \cdot \ln Seed_{it} + c \cdot \ln Flood_{i,t} + d \cdot (\ln Seed_{i,t} \times \ln Flood_{i,t}) + e_{i,t}$$

Explanatory Variables:

Understand effect of **seed**, **flood**, and **combined** effect

Clustered Error:

One clustered error term per district / year (i,t) [$\mathbf{e_{i,t}}$]

Results

Explanatory Variable	Model 1	2	3	4	5
Seed	↘	↘	↘	↘	↘
Flood		*** ↘	*** ↘	*** ↘	*** ↘
Seed x Flood				↗	↗
Rice			** ↗		** ↗
Adjusted R^2	-.075	.023	.042	.023	.042

Coefficient: Positive ↗, Negative ↘ | p-value: * ** ***

Number of seeds negatively influences EVI values

As expected, flood negatively influences EVI values

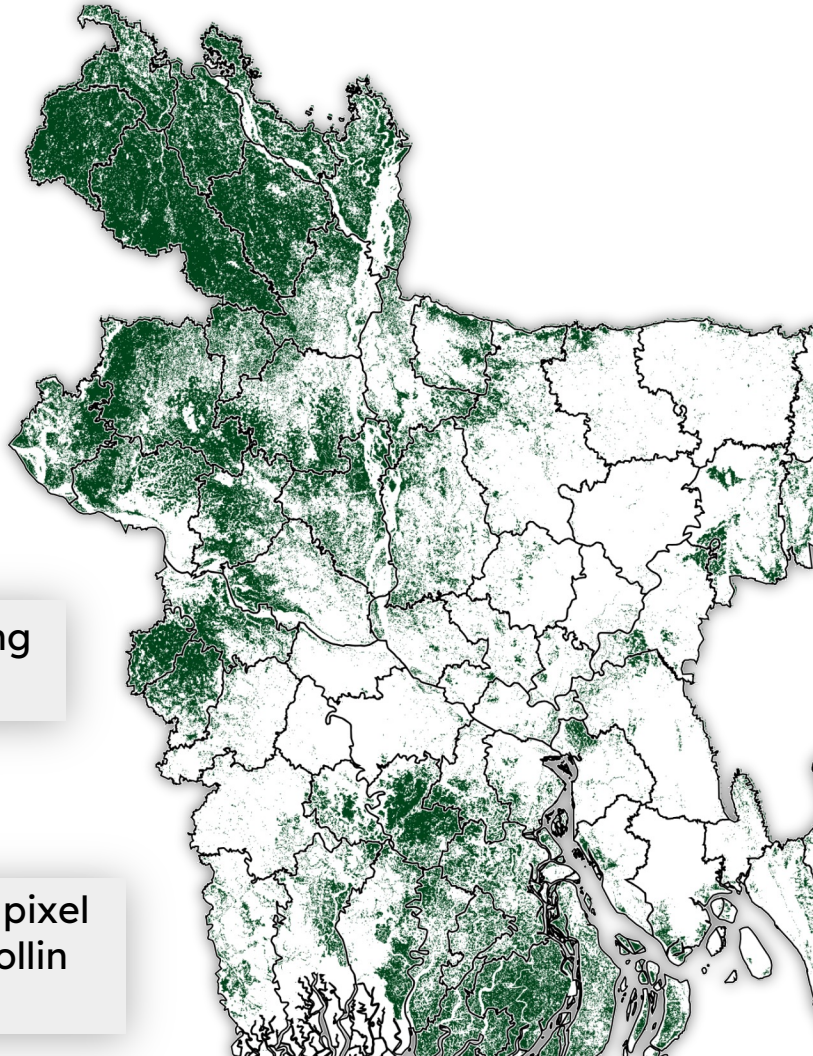
(Seed x Flood) increases EVI

As expected, fraction of district covered in rice is positive with EVI

Conclusion

Initial assessment seems to suggest positive impact of introduction of STRV, but not large or significant

Most of the EVI variance is explained by the increase in rice cropped area



Next Steps

Per district analysis and modeling is necessary

Improve Rice maps classification, possibly with Landsat

Explore additional outcomes of Rice yields

Two way fixed effects at the pixel level or finer spatial scale (Gollin et al., 2021)

Thank you for your attention!

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