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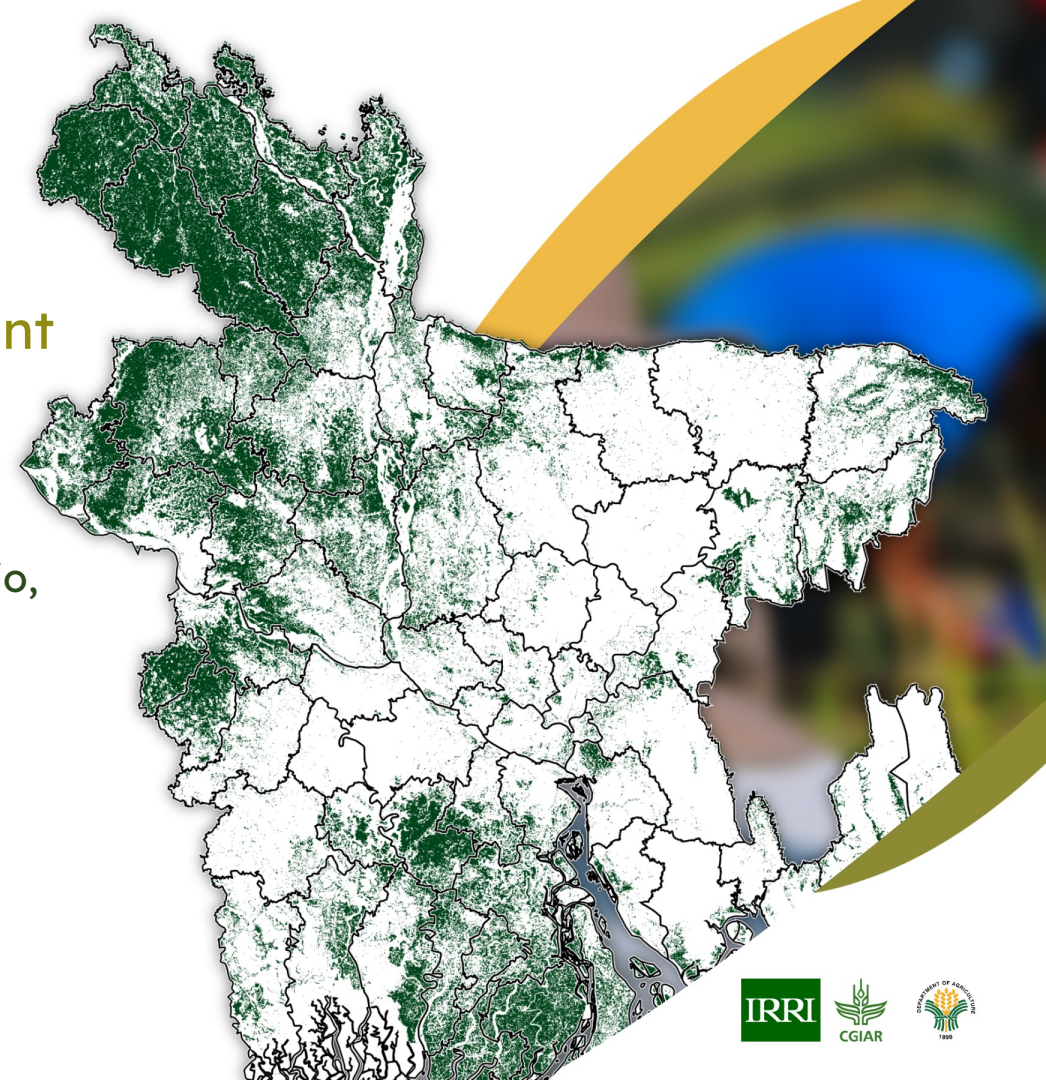
# Investigating the impact of introducing submergence-tolerant Aman rice in Bangladesh

**Jonathan Giezendanner**,
Pavan Kumar Yeggina, Jorrel Khalil Aunario, Aileen Maunahan, Cornelia Garcia, Dewan Abdullah Al Rafi, Valerien Pede, Renaud Mathieu, **Jeffrey Michler**, **Beth Tellman**

jgiezendanner@arizona.edu
jgiezendanner.com
Twitter: @JoGiezi



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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

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**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 2002 to 2021

# Data

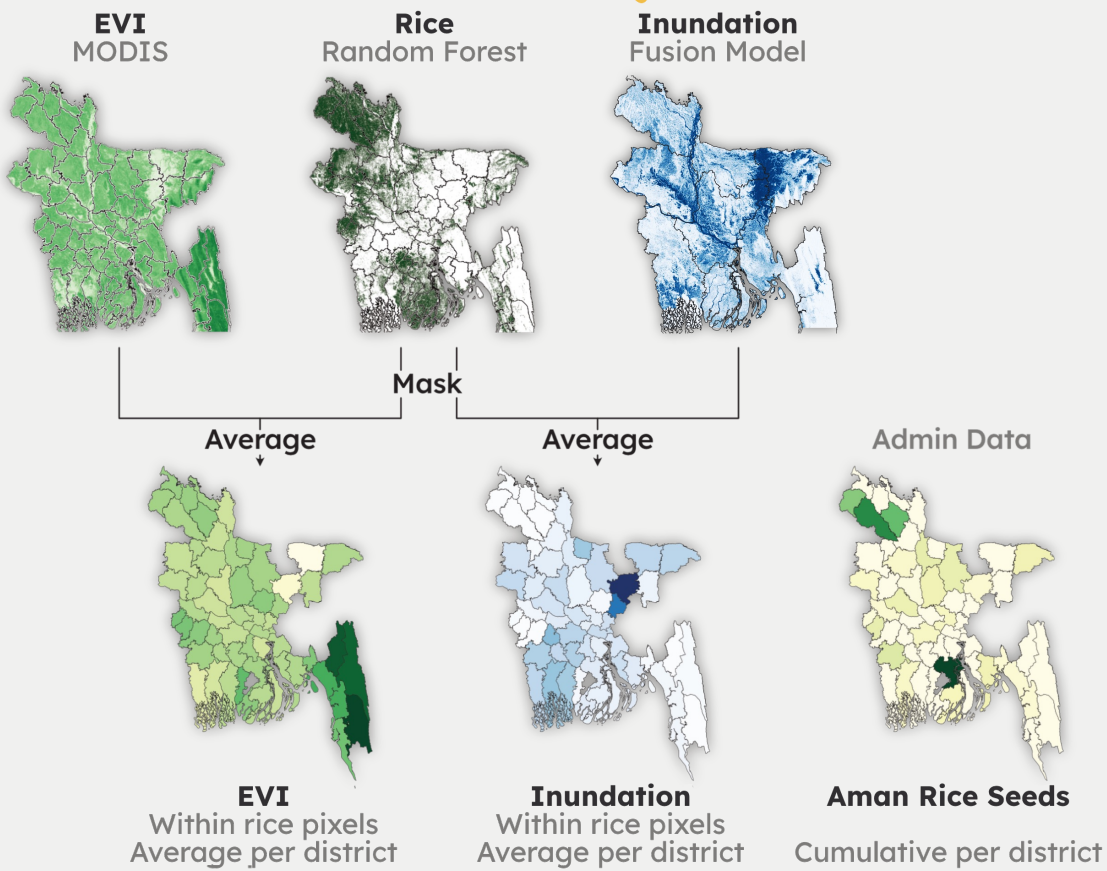
## 1 map / year / district

**EVI:** MODIS median from June to December

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

**Flood Map:** Fractional Inundated Area (Giezendanner et al. 2023)

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



# Inundation Map Details:
## Fusion Model

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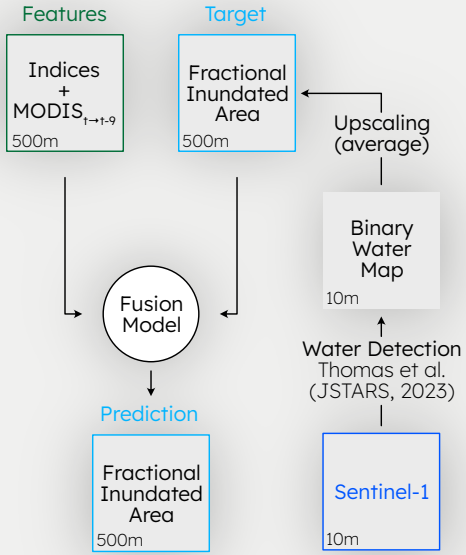
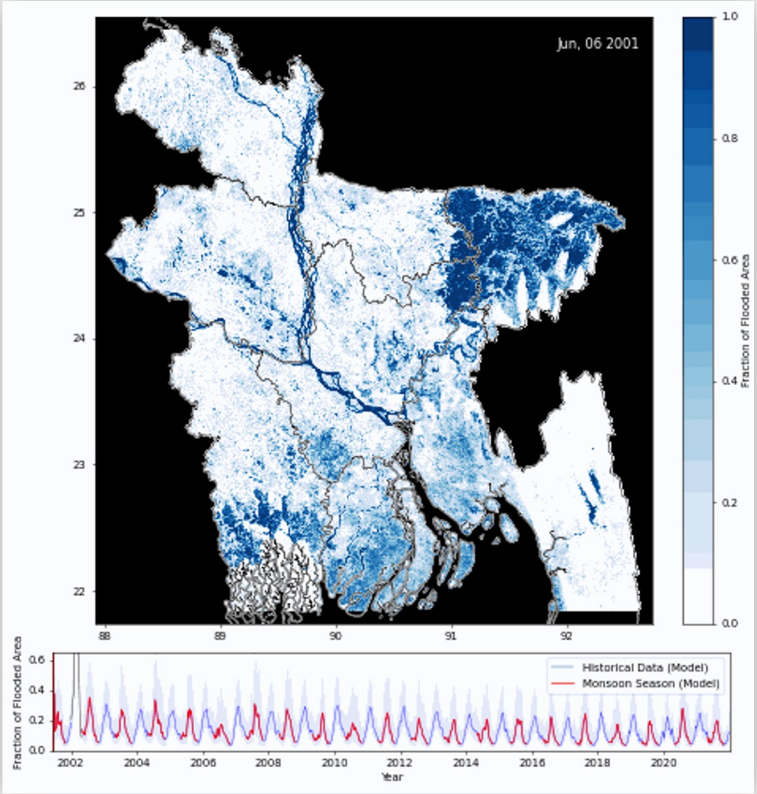



Fusion Model based on recreating Sentinel-1 observed Fractional Inundated Area with MODIS

Shows fraction of 500 x 500 meters pixel covered by water every 8 days, from 2002 to 2022




Paper, Data and Code

**Giezendanner et al** (2023) *Inferring the past: a combined CNN-LSTM deep learning framework to fuse satellites for historical inundation mapping*, CVPR Earthvision Workshop

# Rice Map Details:
## Ground Truth

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

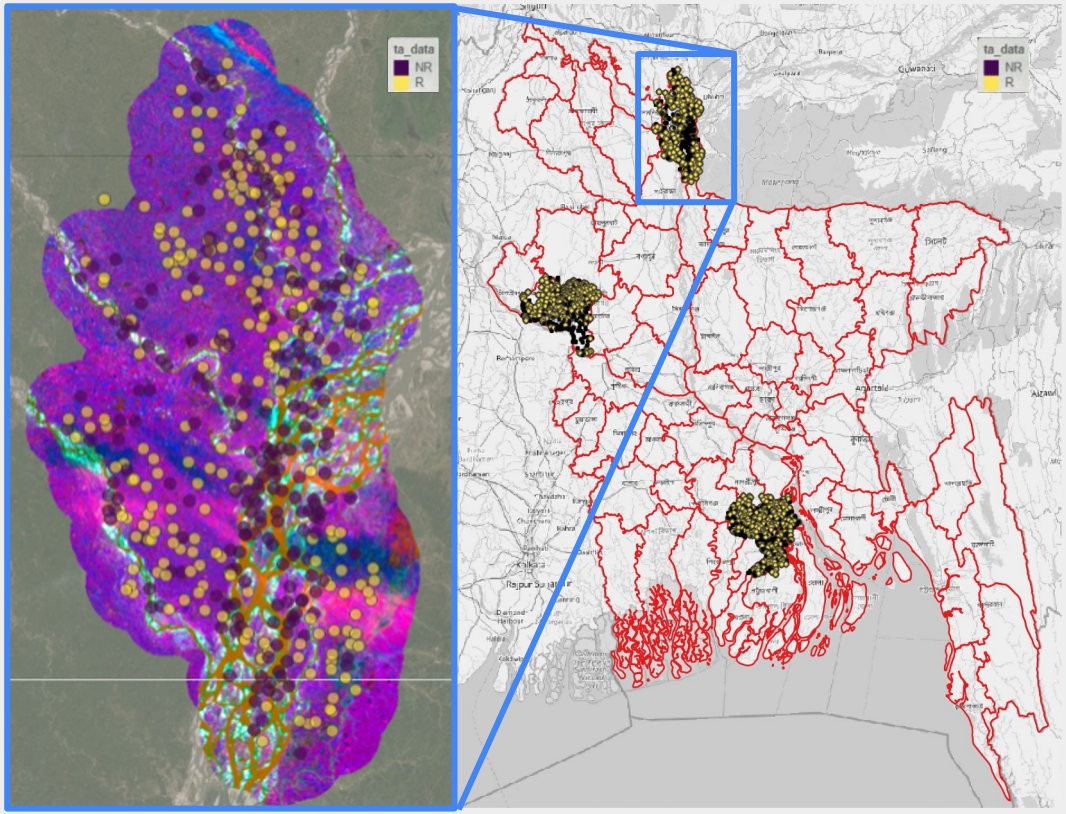
↓

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

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Data and model processed in Google Earth Engine

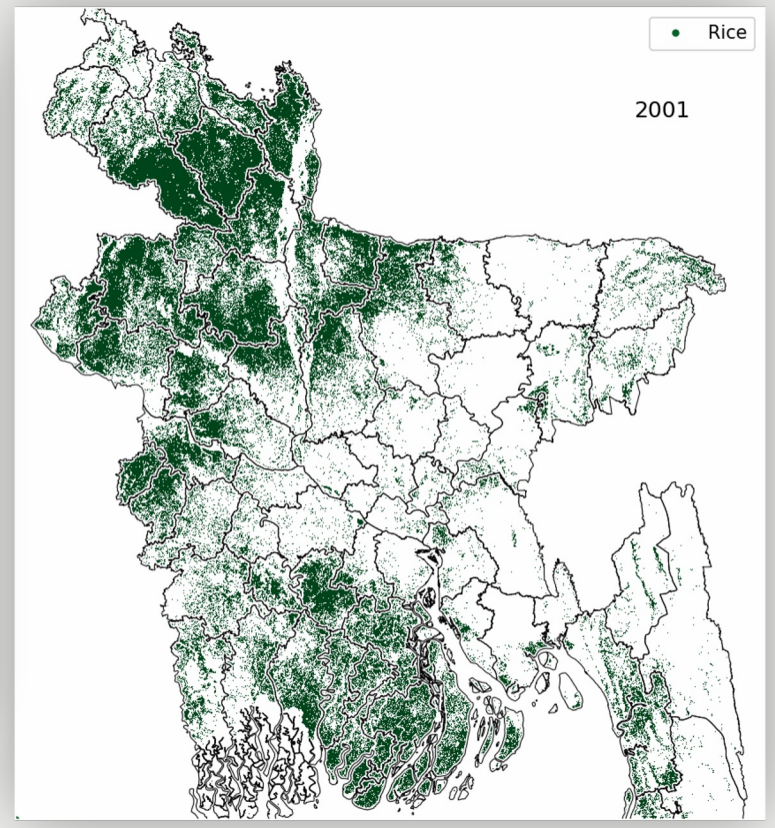
Data:

- MODIS Terra 8-days Composite Median value for the rice grow season (±June to November, 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 2002 to 2021

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# Linear model with multiple group fixed effects

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**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) [$\mathbf{a_i a_t}$]

$$
\begin{aligned}
EVI_{i,t} &= a_i + a_t \\
&+ b_1 \cdot \ln Seed_{it} \\
&+ b_2 \cdot Flood_{i,t} \\
&+ b_3 \cdot (\ln Seed_{i,t} \times Flood_{i,t}) \\
&+ b_4 \cdot Rice_{i,t} \\
&+ e_{i,t}
\end{aligned}
$$

**Explanatory Variables:**

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

**Clustered Error:**

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

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# Results

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| Explanatory Variable | Model 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Seed | ↗ | ↗ | ↗ | ↗ | ↗ |
| Flood | | ** ↘ | ** ↘ | ** ↘ | ** ↘ |
| Seed x Flood | | | | ↘ | ↘ |
| Rice | | | | ** ↗ | ** ↗ |
| Adjusted $R^2$ | -.062 | -.031 | -.002 | -.029 | -.002 |

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

Number of seeds positively influences EVI values

As expected, flood negatively influences EVI values

(Seed x Flood) decreases 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

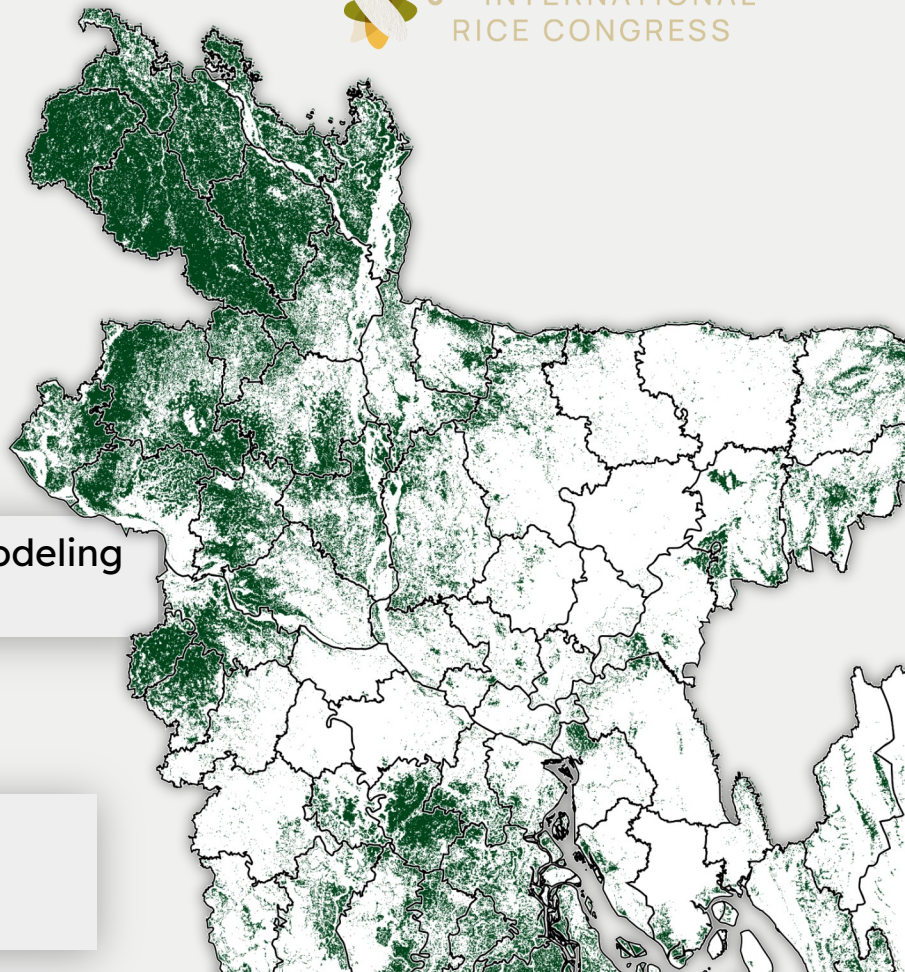
Most of the EVI variance is explained by the increase in rice cropped area

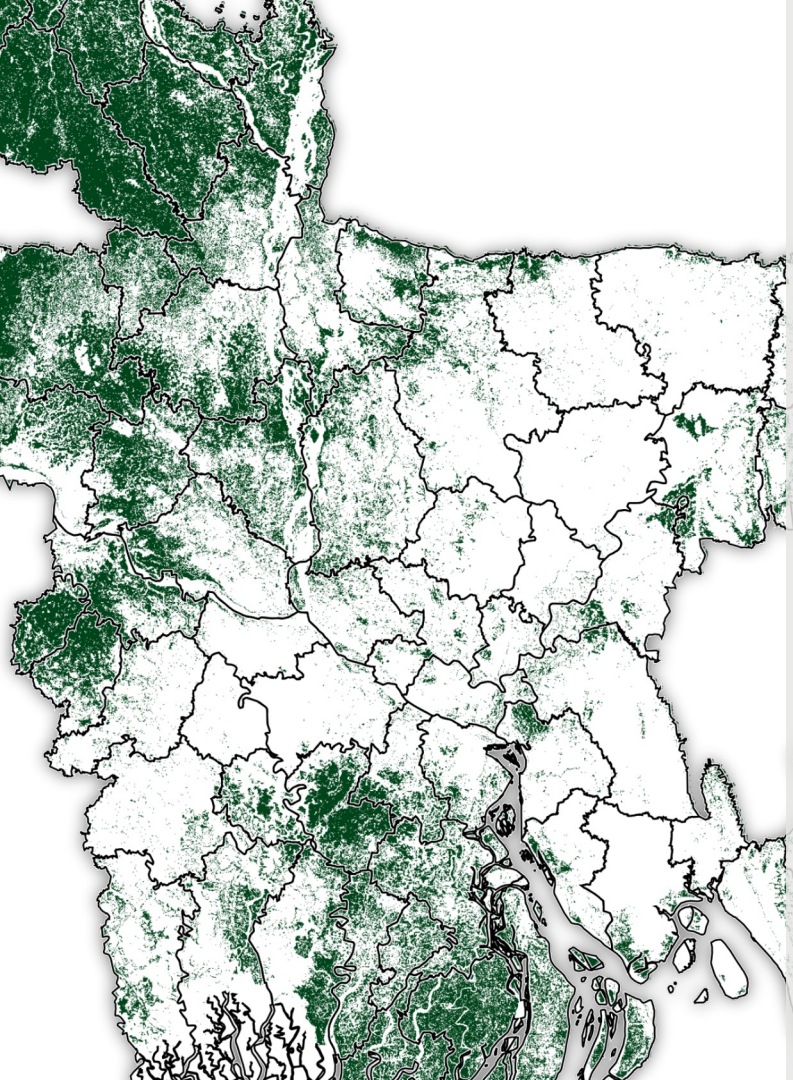
# Next Steps

Per district analysis and modeling is necessary

Improve Rice maps classification, with MODIS and Landsat (WIP)

Explore additional outcomes of Rice yields





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# Thank you!

jgiezendanner@arizona.edu
jgiezendanner.com
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