AOMSUC-15 FYSUC-2025

FIFTEENTH ASIA-OCEANIA METEOROLOGICAL SATELLITE USERS' CONFERENCE

THE JOINT 2025 FENGYUN SATELLITE USER CONFERENCE

Quantifying the Contribution of FengYun-3D-Derived Seasonal NDVI Dynamics and Climatic Variables for Rice Yield Variability in Bangladesh

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Collaborators: Abdur Rahim Mozomdar , Omada Friday Ojoungwa, Dr. Xijia Zhou

Outline

- Introduction of Team
- Study Area
- Data Used
- Method
- Result
- Potential Future Applications of Feng Yun Satellites in Bangladesh.
- Conclusion

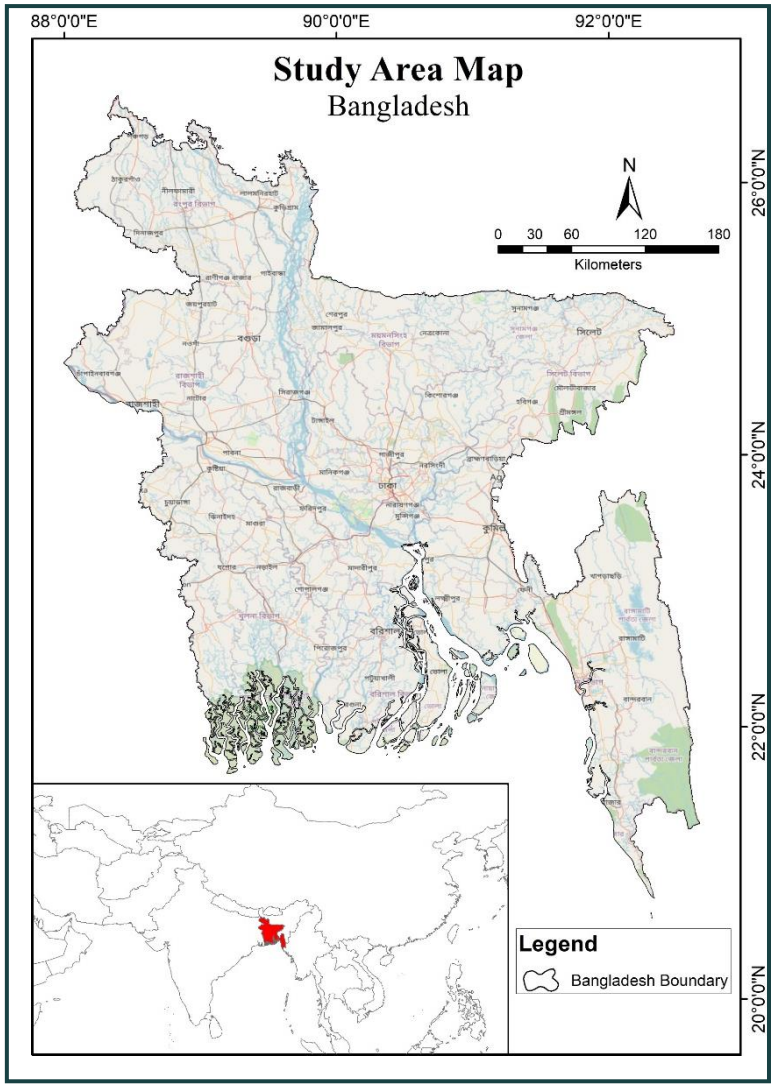
Introduction of Team

- **Team Name:** Beihang Feng
- **Track:** Agriculture Application
- **Team Members:**

Abdur Rahim Mozomdar **From:** Bangladesh	Regional Centre for Space Science and Technology Education in Asia and the Pacific (RCSSTEAP), Beihang University, Hangzhou
Omada Friday Ojonugwa **From:** Nigeria	
Seemab Khalid **From:** Pakistan	
Dr Xijia Zhou **From:** China	National Satellite Meteorological Center (National Center for Space Weather), China Meteorological Administration, Beijing

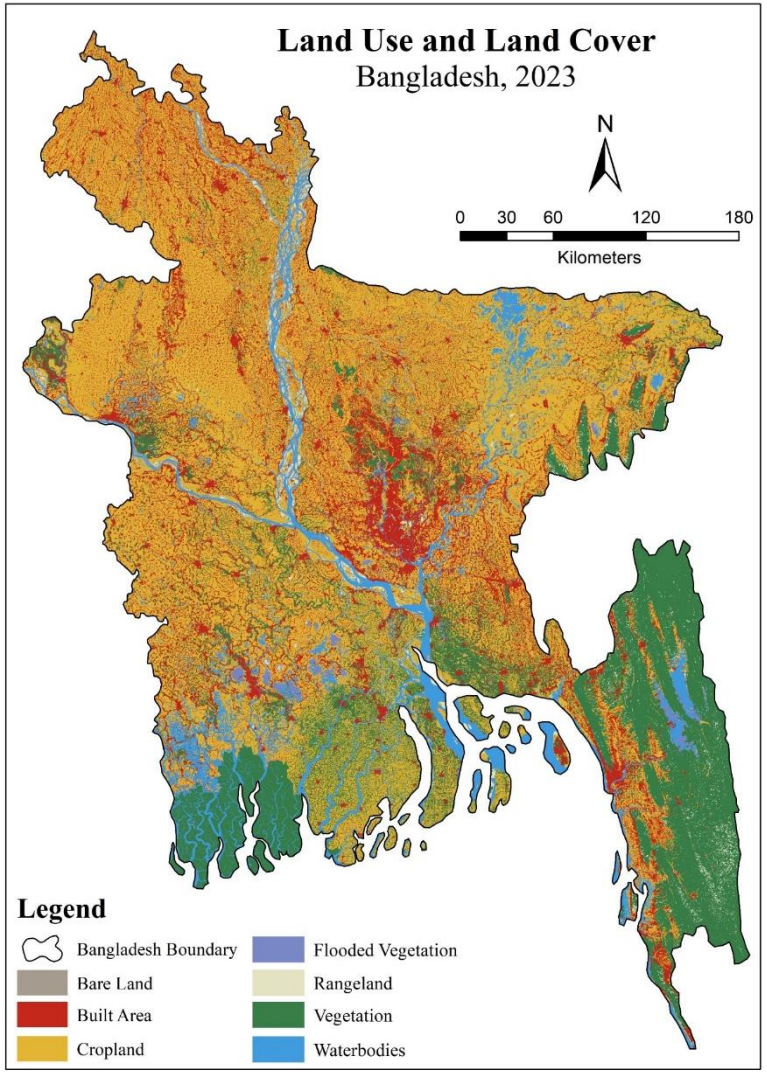
Study Area

- Bangladesh is a South Asian country.
- Absolute location is between 20°34' to 26°38' north latitude and 88°01' to 92°41' east longitude.
- On the west, north, and east, India surrounds the nation for 4,096 kilometers. It connects to Myanmar in the southeast and has a coastline along Bay of Bengal in the south.
- The agriculture of Bangladesh contributing about 11-12% to the GDP and employing nearly 40% of the population.
- Smallholder farmers mostly cultivate rice, wheat, jute, vegetables, and fruits.
- Rice is the staple crop, with production increasingly shifting towards Boro rice grown during the dry season.



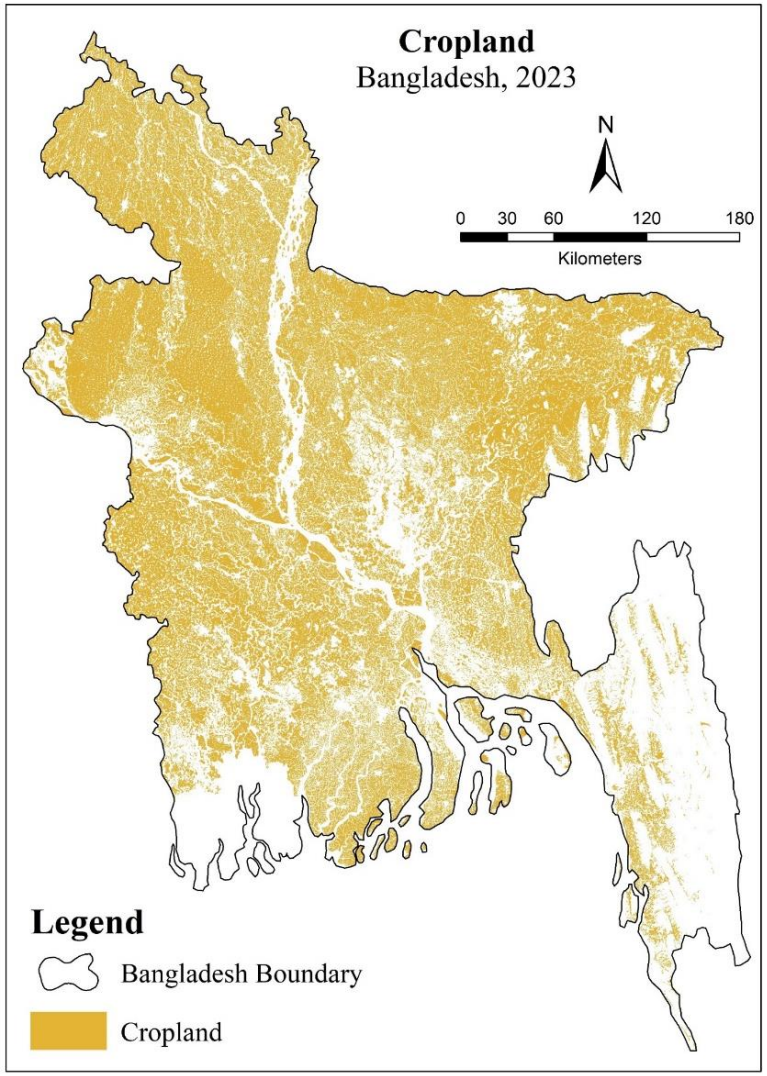
Study Area (LULC)

- The 2023 land use and land cover map of Bangladesh delineates seven main land types: cropland (yellow), built area (red), vegetation (green), waterbodies (blue), flooded vegetation (purple), rangeland (light beige), and bare land (brown).
- Cropland predominates throughout the entire country.
- Significant rivers and lakes are classified as water bodies.
- Forests are categorized under the vegetation class, mostly located in the southwestern, northeastern, and southeastern regions of Bangladesh



Study Area (LULC)

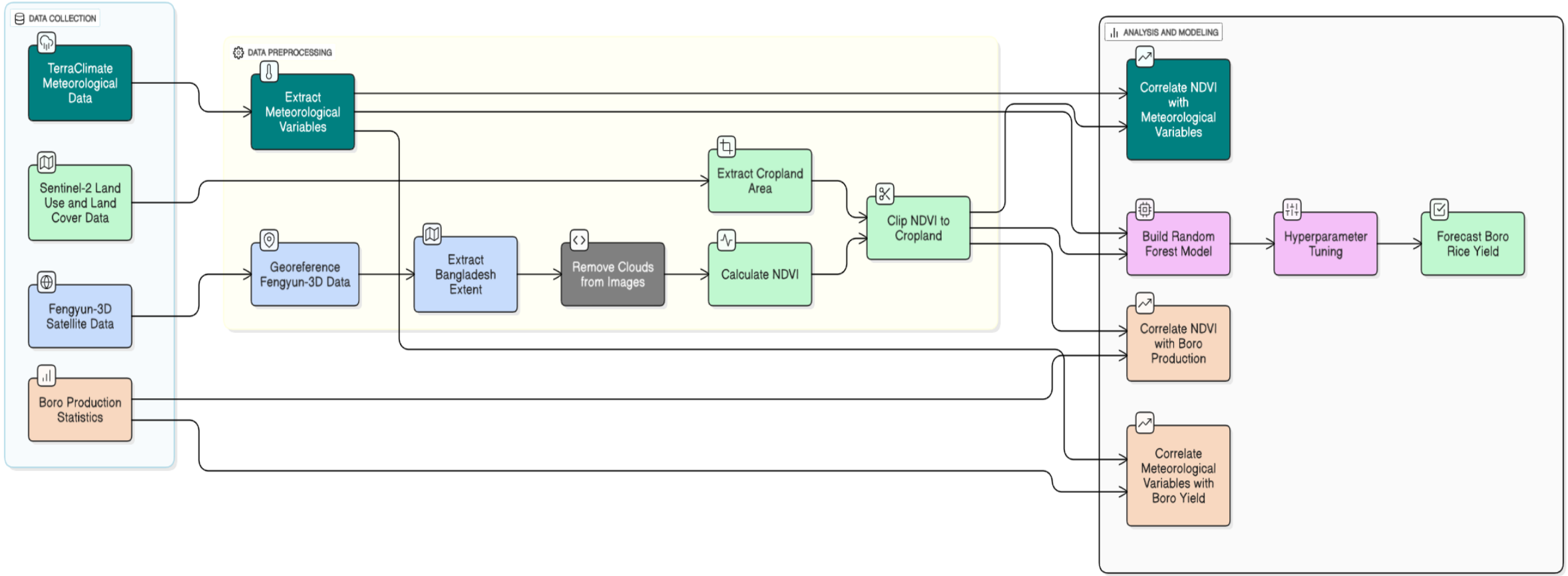
- Cropland is prevalent throughout Bangladesh.
- Significantly concentrated in the northwestern and northeastern regions, indicating the prominence of agriculture in these zones.
- The agricultural layout follows the level alluvial plains formed by the Brahmaputra, Ganges, and Meghna river systems, which provide fertile soil and water for crops.
- The eastern hilly regions have less agricultural coverage, suggesting the presence of forest and less arable land.
- The southern coastal regions have a modest presence of agricultural land, perhaps affected by tidal and saline conditions.



Data Used

- **Fengyun-3D Satellite Data (1000 m resolution)**
  - Obtained from competition data server
  - Provided by National Satellite Meteorological Center (NSMC) of China
  - From January to June of 2023
  - For generating NDVI
- **Climatic data**
  - Monthly temperature, rainfall, and potential evapotranspiration
  - Extracted from TerraClimate (~4 km resolution)
- **Land use and land cover data (LULC)-2023**
  - Gathered from ESRI Sentinel-2 Land Cover Explorer (10 m resolution)
  - Used to mask cropland areas for targeted NDVI analysis
- **Crop statistics data**
  - Collected from "45 years Agriculture Statistics of Major Crops“ report
  - Provided by Bangladesh Bureau of statistics (BBS)

Method


DATA COLLECTION
TerraClimate Meteorological Data
Sentinel-2 Land Use and Land Cover Data
Fengyun-3D Satellite Data
Boro Production Statistics
DATA PREPROCESSING
Extract Meteorological Variables
Georeference Fengyun-3D Data
Extract Bangladesh Extent
Remove Clouds from Images
Extract Cropland Area
Calculate NDVI
Clip NDVI to Cropland
ANALYSIS AND MODELING
Correlate NDVI with Meteorological Variables
Build Random Forest Model
Hyperparameter Tuning
Forecast Boro Rice Yield
Correlate NDVI with Boro Production
Correlate Meteorological Variables with Boro Yield

Method

Data Preprocessing

- **Extract Meteorological Variables:** Extracts relevant meteorological data from the collected sources.
- **Georeference Fengyun-3D Data**: Aligns the Fengyun-3D satellite data to geographic coordinates for further analysis.
- **Extract Bangladesh Extent**: Focuses on the geographic extent of Bangladesh for the analysis.
- **Remove Clouds from Images**: Processes the images to remove cloud cover, ensuring clearer data for analysis.
- **Calculate NDVI**: Computes the Normalized Difference Vegetation Index (NDVI) from the satellite imagery, a measure of vegetation health.
- **Extract Cropland Area**: Extracts and isolates the cropland areas from the larger dataset.
- **Clip NDVI to Cropland**: Focuses the NDVI data on the extracted cropland areas for more precise analysis.

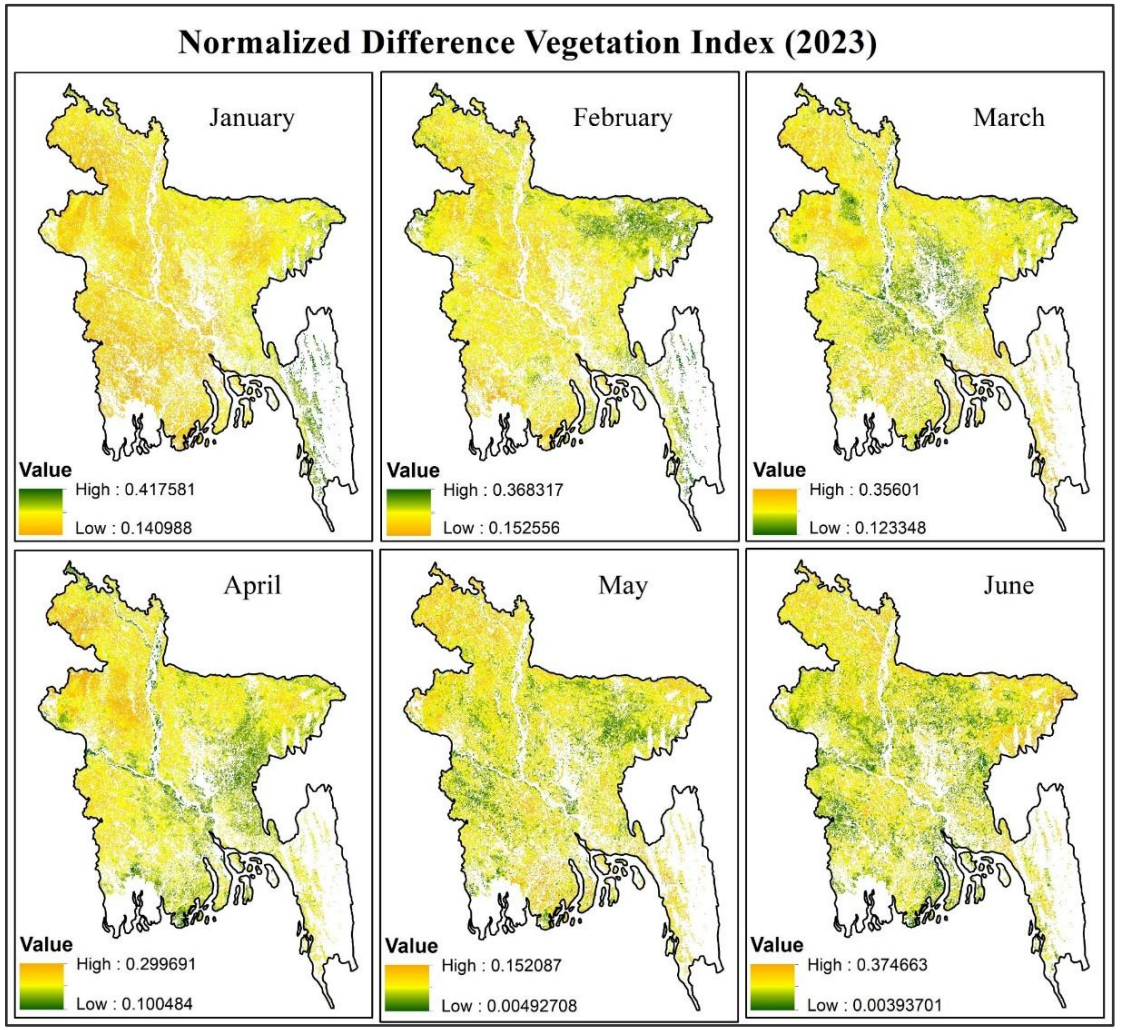
Method

Analysis and Modeling

- **Correlate NDVI with Meteorological Variables:** Analyzes the relationship between vegetation health (NDVI) and various meteorological factors.
- **Build Random Forest Model:** Constructs a random forest machine learning model to analyze the data and predict outcomes.
- **Hyperparameter Tuning:** Fine-tunes the random forest model's parameters to optimize its performance.
- **Correlate NDVI with Boro Production:** Examines the correlation between vegetation health (NDVI) and Boro rice production levels.
- **Correlate Meteorological Variables with Boro Yield:** Analyzes how meteorological variables affect Boro rice yield.
- **Forecast Boro Rice Yield:** Uses the tuned random forest model to predict future Boro rice yield based on the correlations found in the previous steps.

Result (NDVI)

- **January:**
  - High: 0.417581
  - Low: 0.140988
- **February:**
  - High: 0.368317
  - Low: 0.152556
- **March:**
  - High: 0.35601
  - Low: 0.123348
- **April:**
  - High: 0.299691
  - Low: 0.100484
- **May:**
  - High: 0.152087
  - Low: 0.00492708
- **June:**
  - High: 0.374663
  - Low: 0.00393701



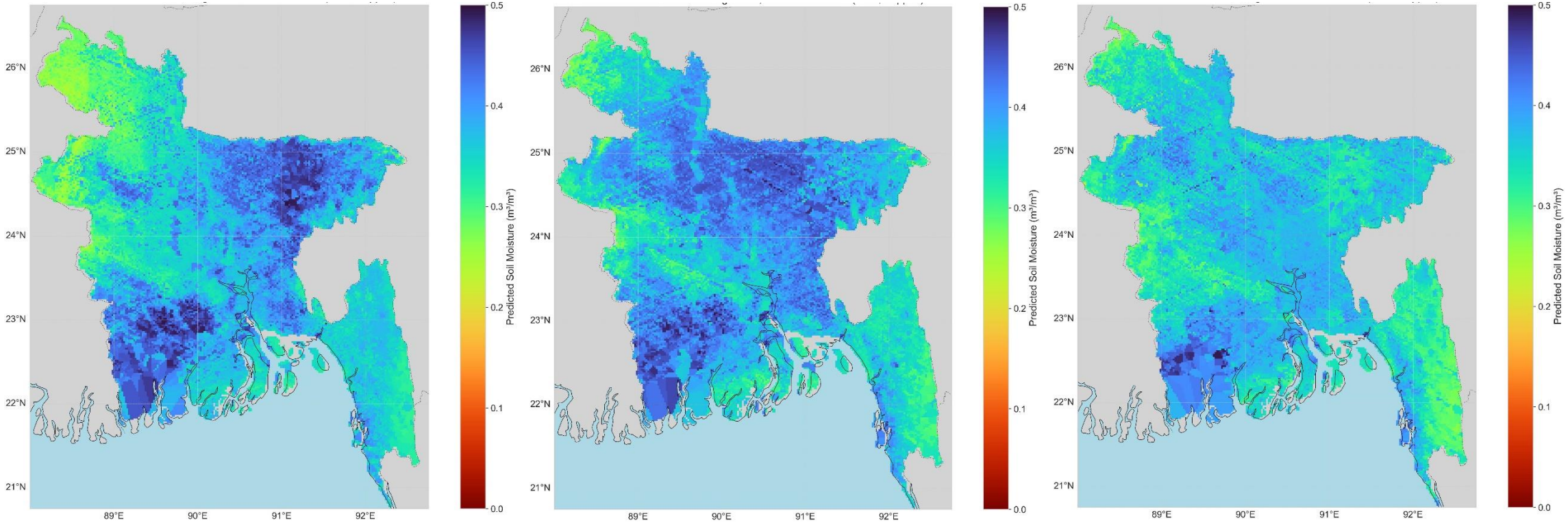
Result (Meteorological Variables)

- **Potential Evapotranspiration**
  - January: 78.11
  - February: 88.47
  - March: 118.90
  - April: 156.34
  - May: 165.75
  - June: 131.71
- **Rainfall**
  - January: 0.55
  - February: 1.90
  - March: 63.41
  - April: 38.02
  - May: 129.85
  - June: 303.59
- **Temperature**
  - January: 18.47
  - February: 21.98
  - March: 25.47
  - April: 29.04
  - May: 29.33
  - June: 29.58

Result (Meteorological Variables)

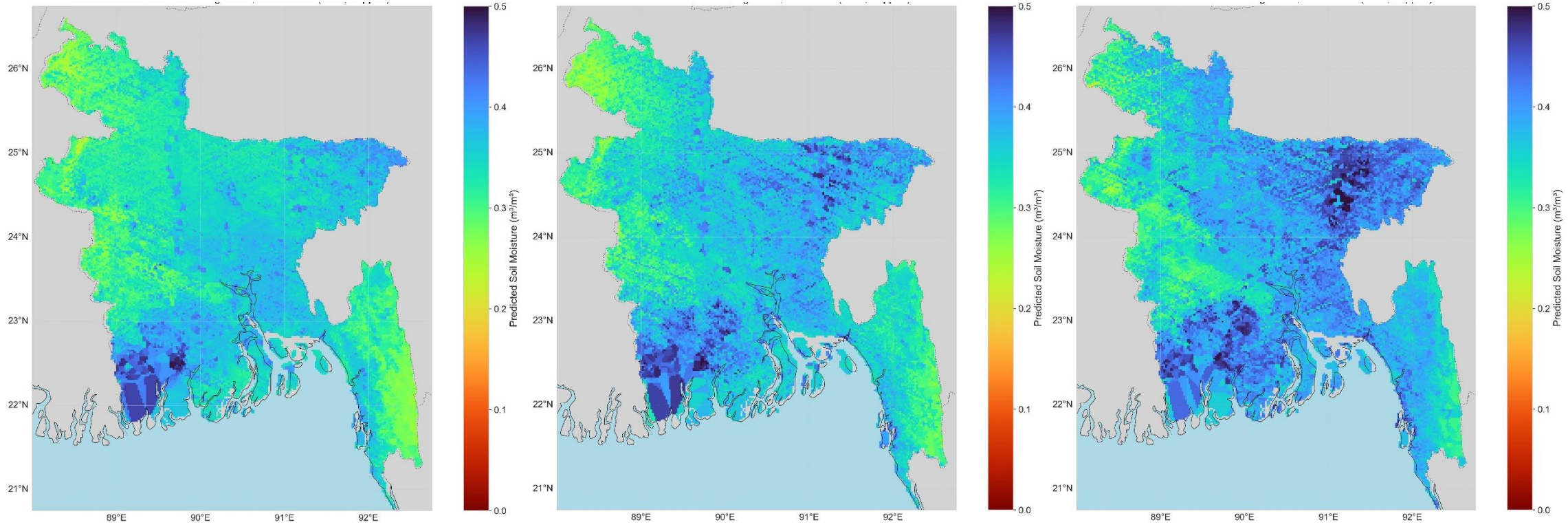
- The data reflect Bangladesh's transition from dry winter to wet summer monsoon.
- PET starts at 78.11 mm in January, gradually increases, peaking in May at 165.75 mm, and then slightly decreases in June to 131.71 mm.
- PET's rise before June aligns with higher heat and solar radiation in pre-monsoon months.
- Rainfall is very low in January (0.55 mm) and February (1.90 mm), then jumps sharply from March (63.41 mm) to June (303.59 mm).
- Rainfall's dramatic jump from May to June indicates the onset of the monsoon season.
- Temperature begins at 18.47°C in January and rises steadily through the months.
- By March, the temperature reaches 25.47°C and continues increasing.
- From April (29.04°C) onward, the temperature stays around 29°C, indicating the hot season.

Result (Soil Moisture)



January February March

Result (Soil Moisture)



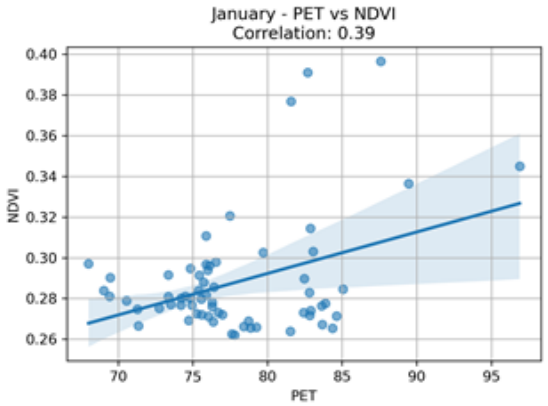
April May June

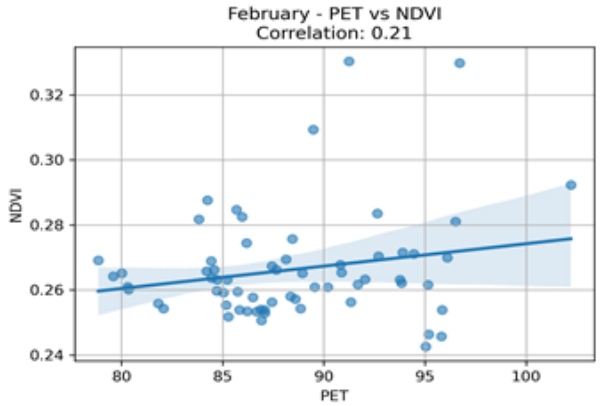
Result (Correlation)

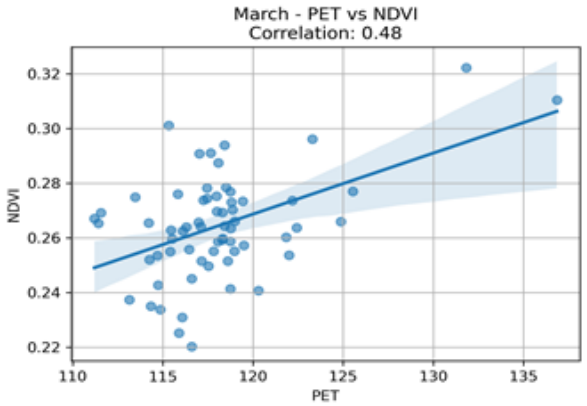
Months	NDVI & PET	NDVI & Rain	NDVI & Temperature	NDVI & Crop	Crop & Rain	Crop & Temperature	Crop & PET
January	0.3856	-0.0496	0.3831	-0.1077	0.2439	-0.4175	-0.0713
February	0.2065	0.0222	0.0783				
March	0.4828	-0.1862	0.248				
April	0.5991	-0.2399	-0.26				
May	-0.1971	-0.0503	-0.1752				
June	0.2347	0.339	-0.0193				

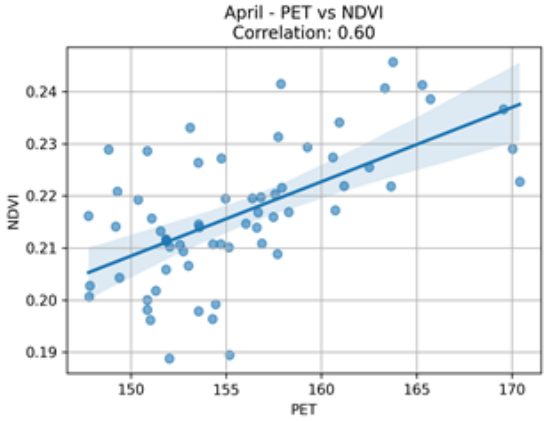
- Highest positive correlations of NDVI with PET and temperature occur in April.
- Rain shows varying weak to moderate correlations with NDVI.
- The relationship between crop and climate variables generally shows weak

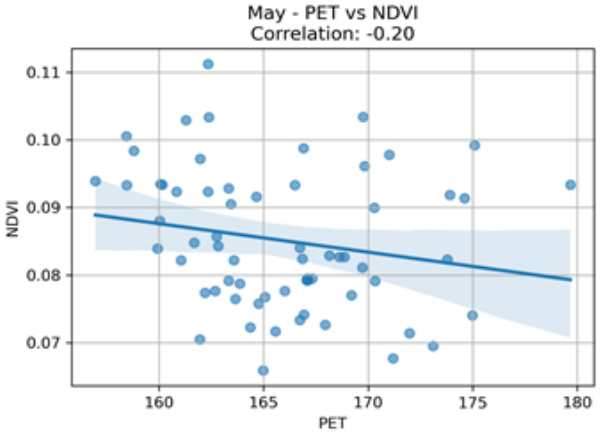
Result (Correlation: PET vs NDVI)

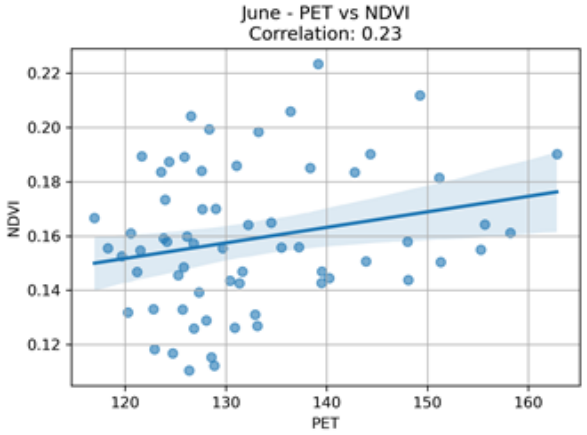




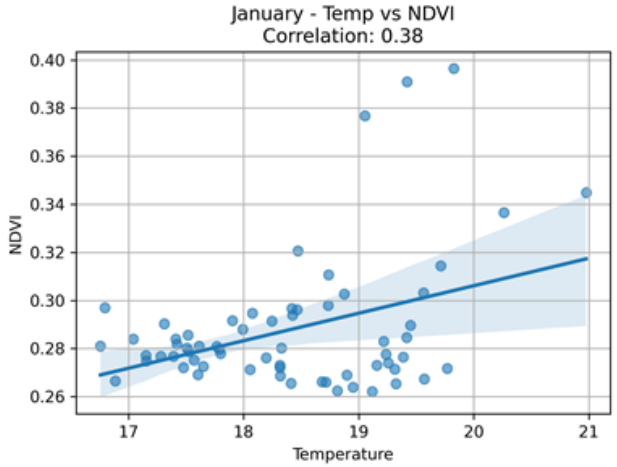


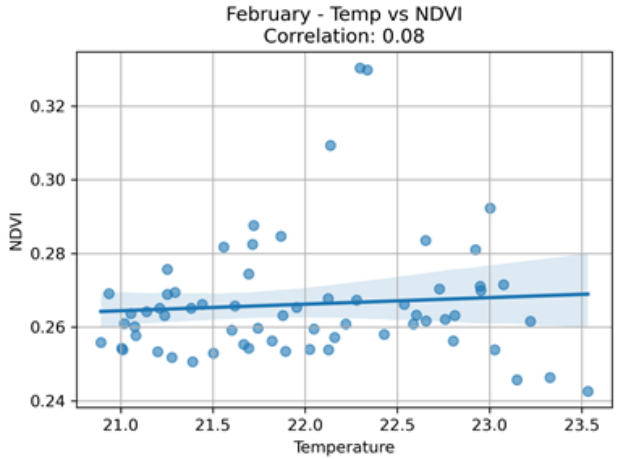


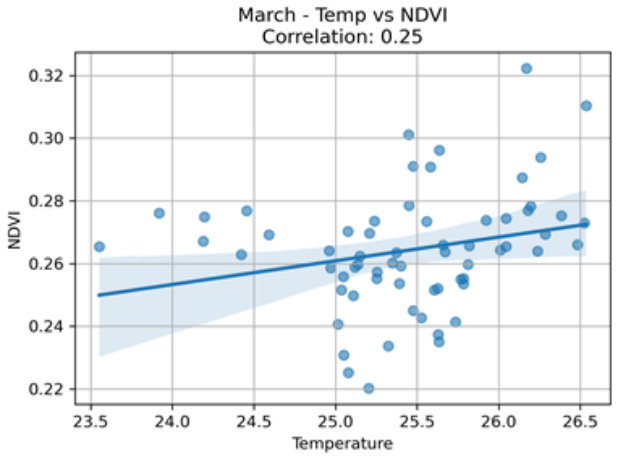


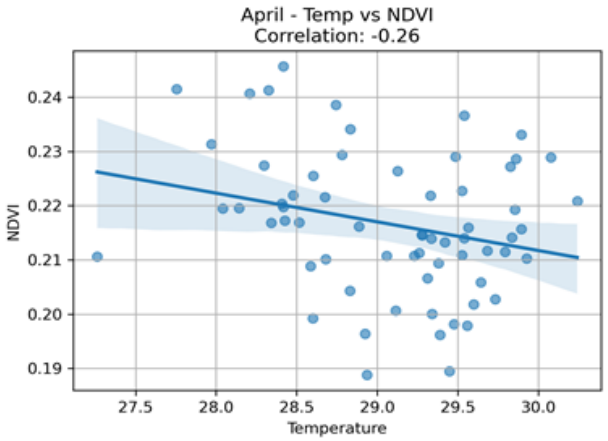


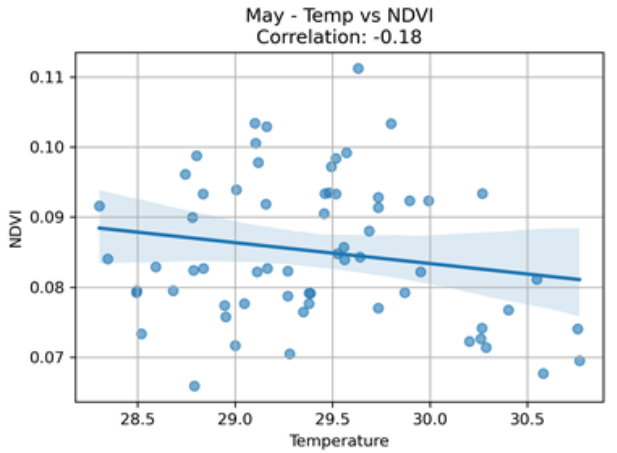
Result (Correlation: Temperature vs NDVI)

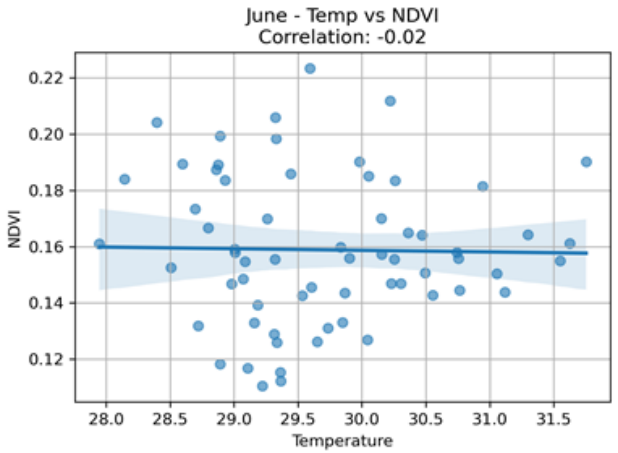




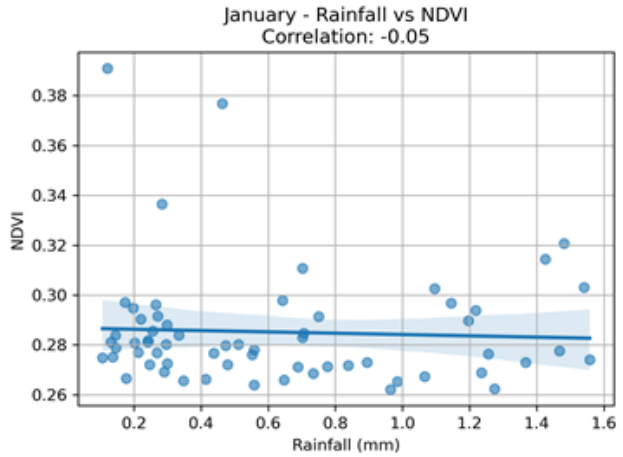


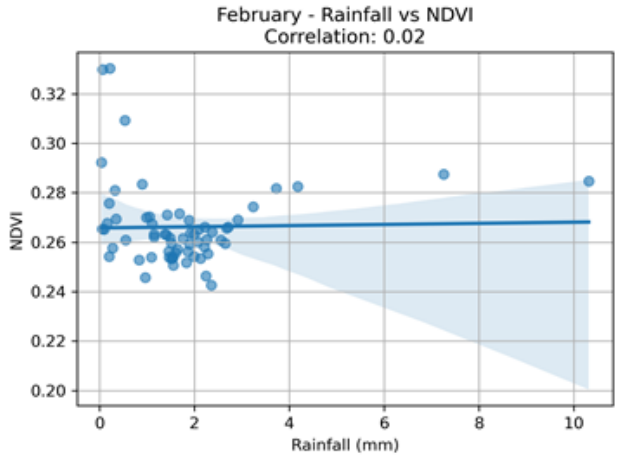


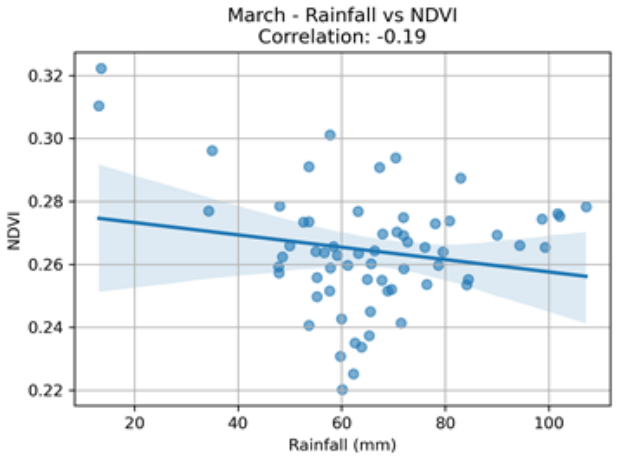


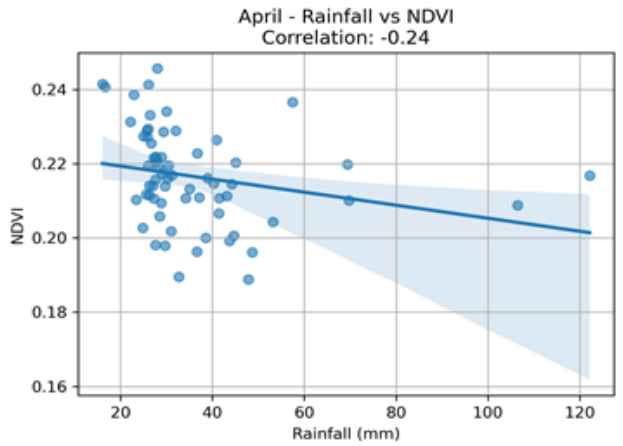


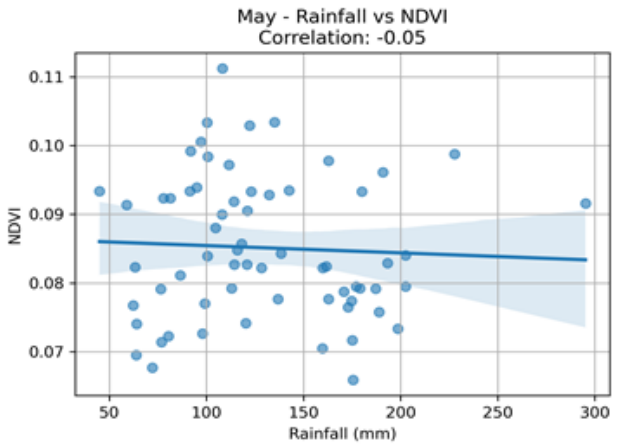
Result (Correlation: Rainfall vs NDVI)

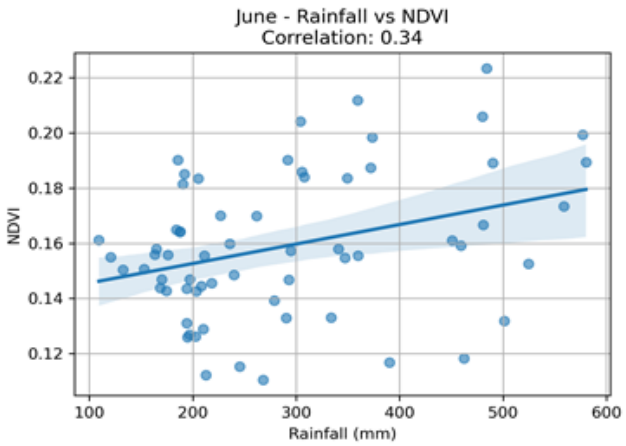




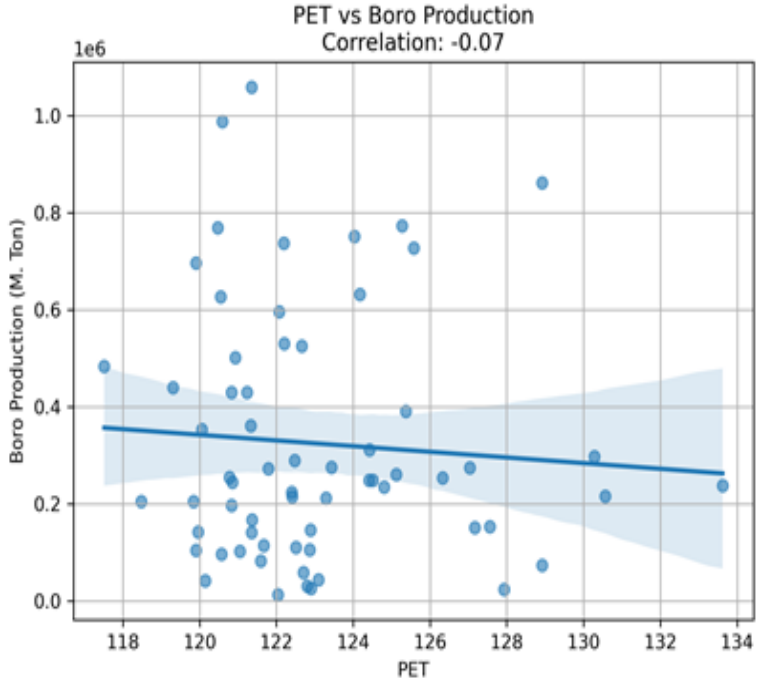


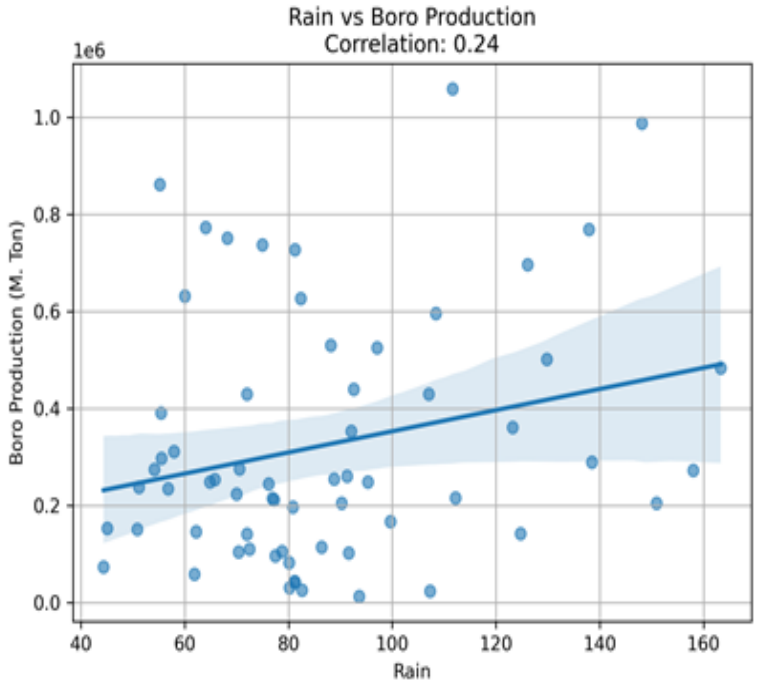


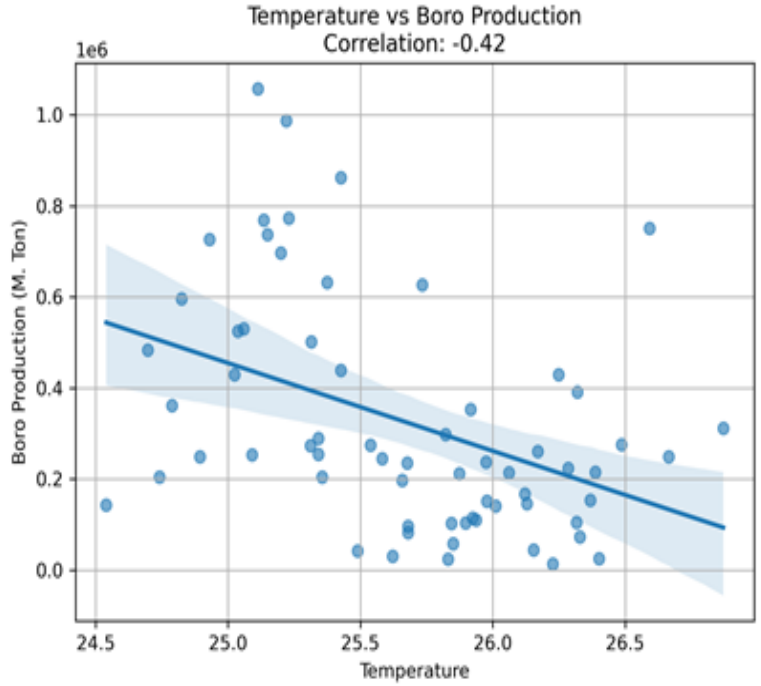




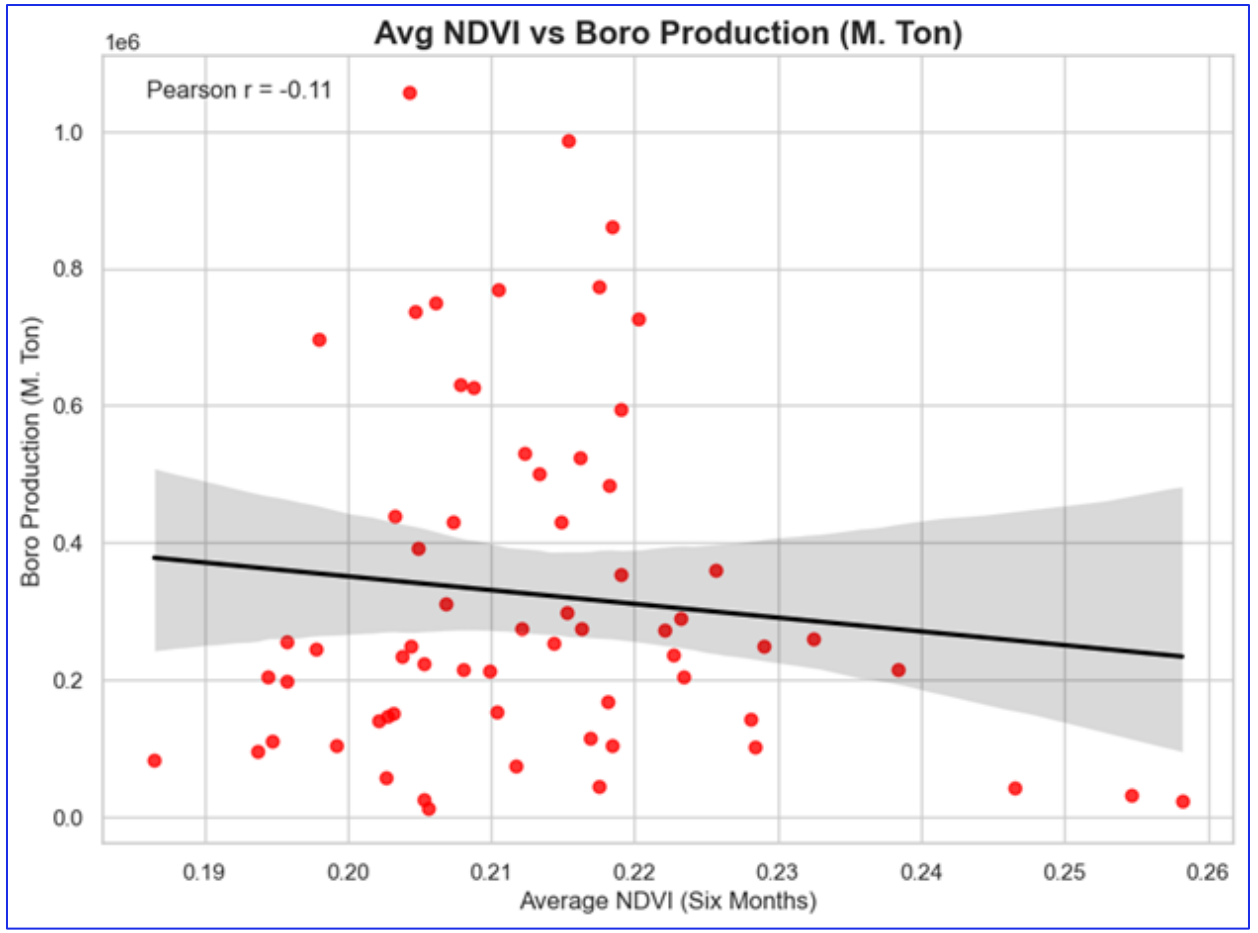
Result (Correlation: Variables vs Boro Production)







Result (Correlation: NDVI vs Boro Production)



Result (Regression: RF)

Random Forest	
R^2 Score	0.421
RMSE	149642.4657
NDVI	0.2184
Rain	0.1171
Temperature	0.5332
PET	0.1313

- RF model explains about 42.1% of the variation in rice yield. This is a moderate performance, meaning other factors not in the model also influence yield.
- Temperature has the highest influence on yield prediction, indicating that rice growth in the Bangladesh is highly sensitive to temperature changes.
- The modest R^2 suggests important factors like irrigation, soil properties, fertilizer application, planting dates, or management practices needs to be included for better yield prediction

Result (Regression: RF Hyperparameter Tuning

Random Forest Hyperparameter Tuning	
n_estimators	200
min_samples_split	5
min_samples_leaf	2
max_features	0.5
max_depth	30
CV R^2	0.399184812
R^2	0.8052
RMSE	111578.7986

- Hyperparameter tuning improved model accuracy from $R^2 = 0.421$ to $R^2 = 0.8052$.
- The tuned model explains about 80.5% of yield variability in Boro rice.
- Prediction error decreased significantly compared to the untuned model.
- Temperature remained the most influential predictor, followed by NDVI, PET, and rainfall

Potential Future Applications

- **Agricultural Monitoring**
  - Near-real-time NDVI monitoring for rice and other crops
  - Multi-season crop assessments
  - NDVI time series can help identify crop growth anomalies
- **Food Security and Policy Support**
  - Integration of Feng Yun NDVI with climate and yield models enables early warning systems for crop yield shortfalls.
  - Policymakers can use this data to plan food imports, manage grain reserves, and stabilize markets.
  - District-level monitoring could guide resource allocation for irrigation, fertilizers, or flood recovery.

Potential Future Applications

❑ Climate Adaptation

- Bangladesh is highly vulnerable to heat stress, drought, and irregular monsoon rainfall.
- climate extremes impact crop cycles, supporting long-term adaptation strategies.
- Data-driven insights could help in breeding heat- or drought-tolerant rice varieties

Conclusion

- Fengyun-3D-derived NDVI data combined with climatic variables and other factors can effectively monitor Boro rice growth and yield variations.
- Temperature emerged as the most influential climatic factor affecting Boro rice yield predictions.
- Rainfall and potential evapotranspiration also showed significant correlations but were less influential than temperature.
- Machine learning model can predict the rice yield based on vegetations indices and other factors that influence crop growth and development

Acknowledgment

We thank the National Satellite Meteorological Centre (NSMC China) for providing data and the FYSUC 2025 Organizing Committee for giving us the chance to present our work.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Thank You for Your Attention!