SERVIR-Southeast Asia

Methodology for Crop Mapping in Myanmar

December 7, 2023

Outline

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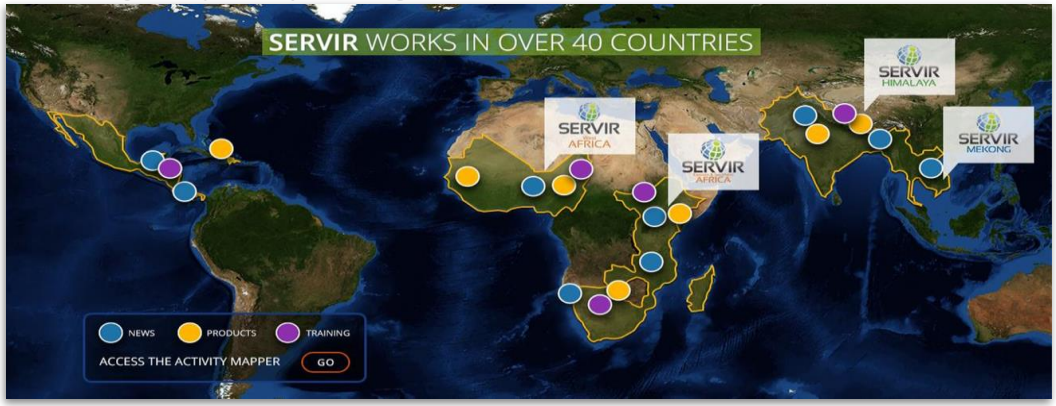
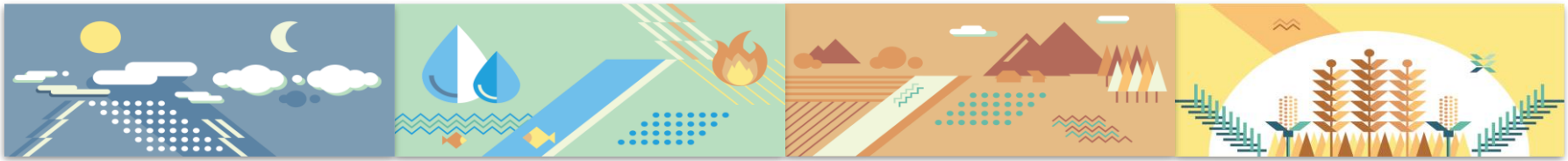
- ❑ Background
- ❑ Methodology Overview
- ❑ Data Processing and Model
- ❑ Results and Feedback
- ❑ Preliminary Results
- ❑ Validation and Confidence
- ❑ Conclusions and Future Work

Introduction

THE SERVIR NETWORK





WEATHER AND CLIMATE

WATER RESOURCES AND DISASTERS

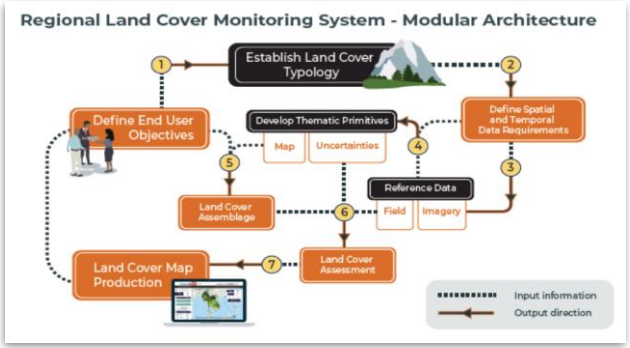
LAND COVER / LAND USE AND ECOSYSTEMS

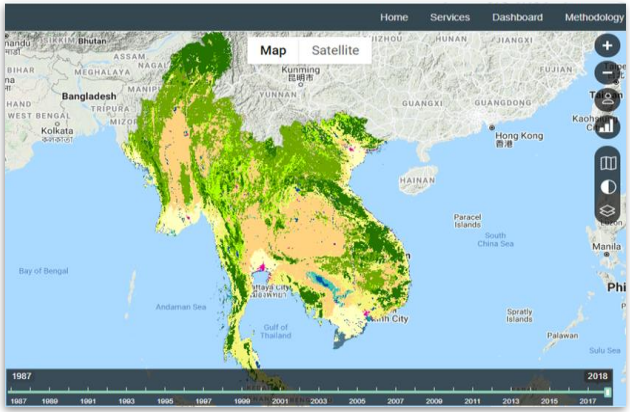
FOOD SECURITY

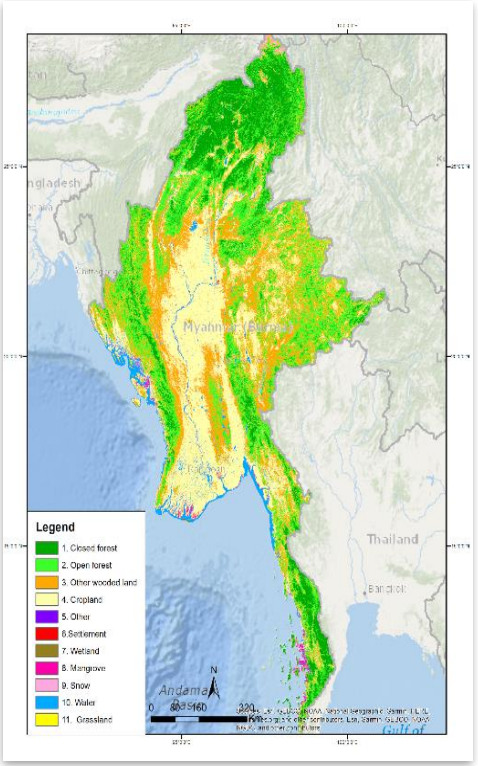
SERVIR SEA Technologies

REGIONAL LAND COVER MONITORING SYSTEM

- ❑ Developed **collaboratively**
- ❑ Produces **consistent** products at regular intervals
- ❑ Serves the expressed **needs** of multiple users
- ❑ Uses transparent, well documented **open source** approach
- ❑ Includes **quality control** / assurance methodology







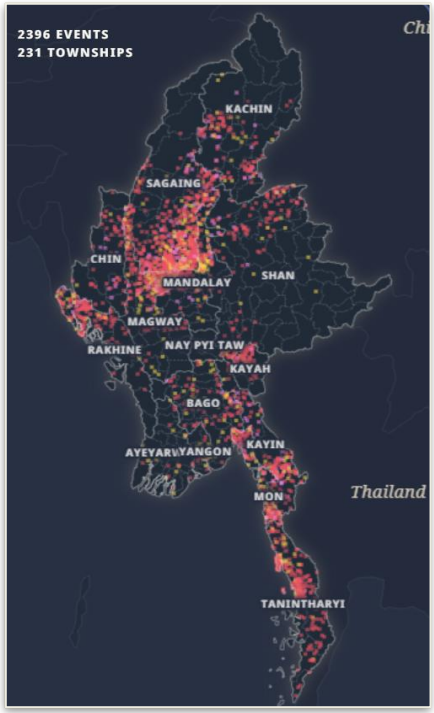
Services

Rice

Maize

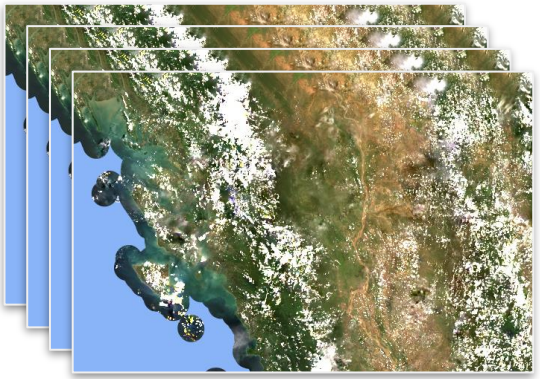
Beans and Pulses

Challenges



Source: IISS Analysis, ACLED

- ❑ **Cloudy conditions** during the Monsoon season significantly impair the effectiveness of optical imagery.
- ❑ **Limited access** to the information on ground
- ❑ **Ground truth data**
- ❑ Lack of **historical data**
- ❑ **Data Volume**
- ❑ Different **cultivation approaches**

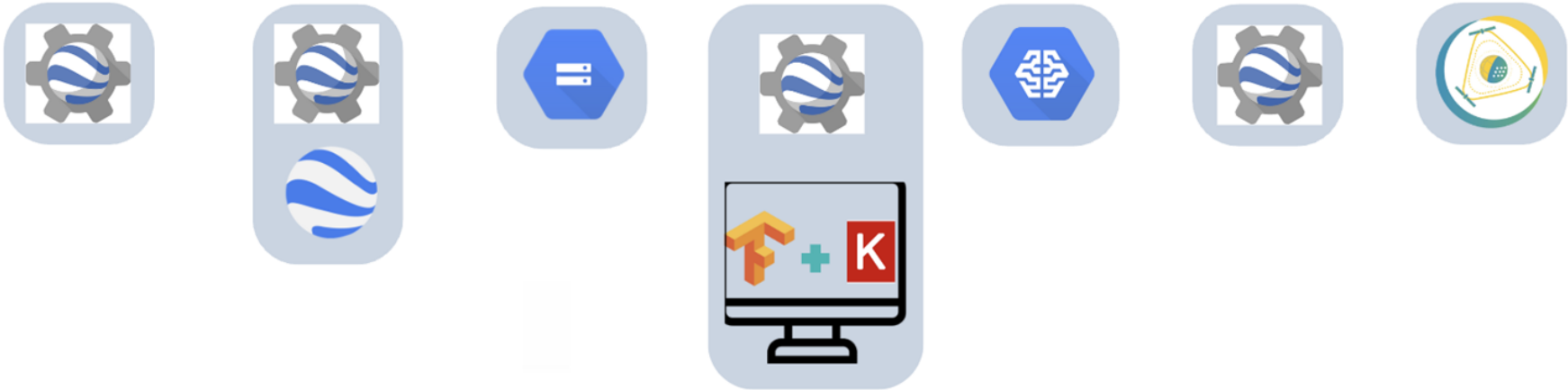


Source: Frontier Myanmar

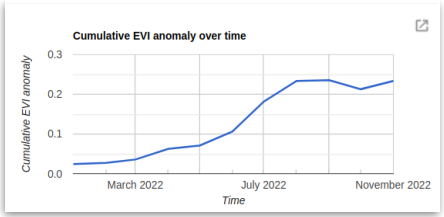
Background

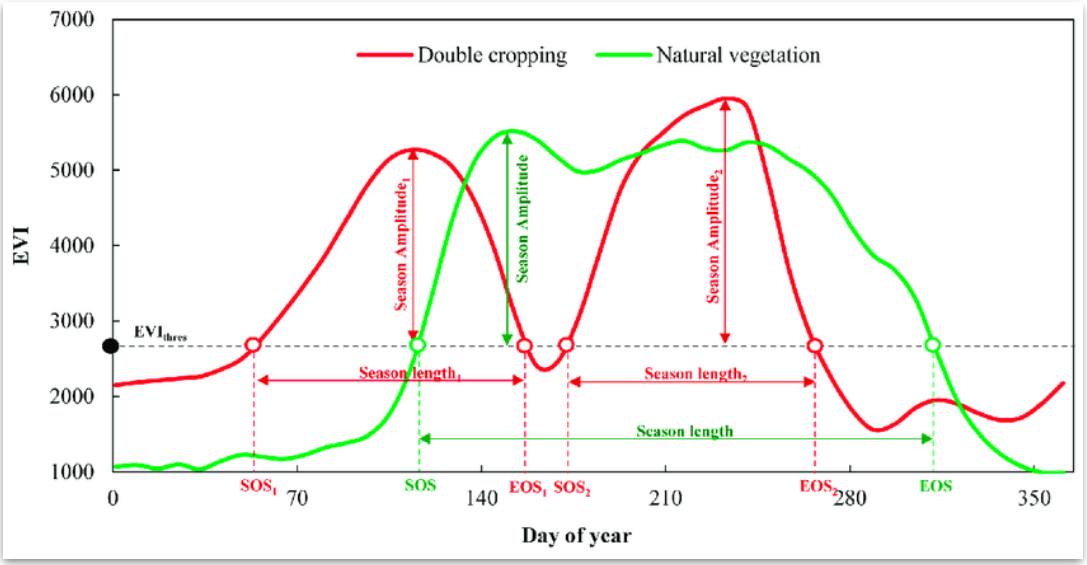
- ADPC Rice Mapping initiative
  - Rice producing states/regions
  - Monsoon
  - Post-monsoon (Summer)
  - https://servir.adpc.net/publications
- Historical Monsoon rice work
- Need for continual mapping and data updates

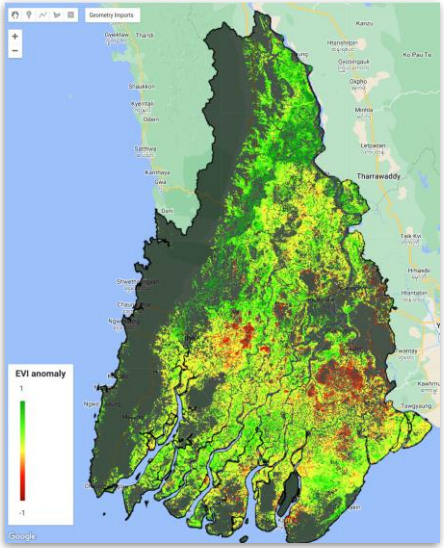
1. Satellite Image Composites
2. Reference Data collection and Generate training data/ patch (tfRecord)
3. Export Patch
4. ML/DL Model Training and Parameter Tuning
5. Model Hosting
6. Running Prediction
7. Model Validation



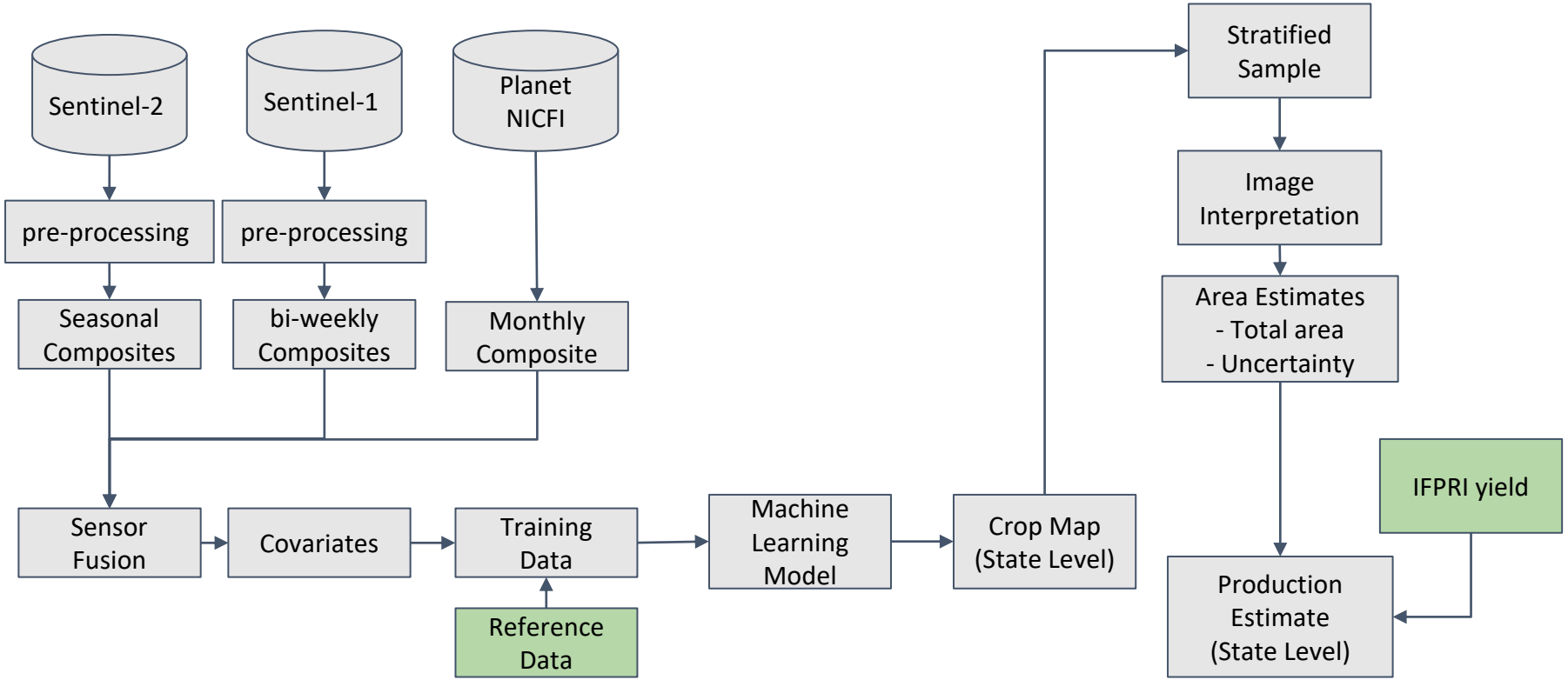
Sr	Title	April				May				June				July				August				September				October				November				December				January				February				March			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1	Monsoon Paddy																																															
	Plant																																															
	Growing																																															
	Harvest																																															
2	Summer Paddy																																															
	Plant																																															
	Growing																																															



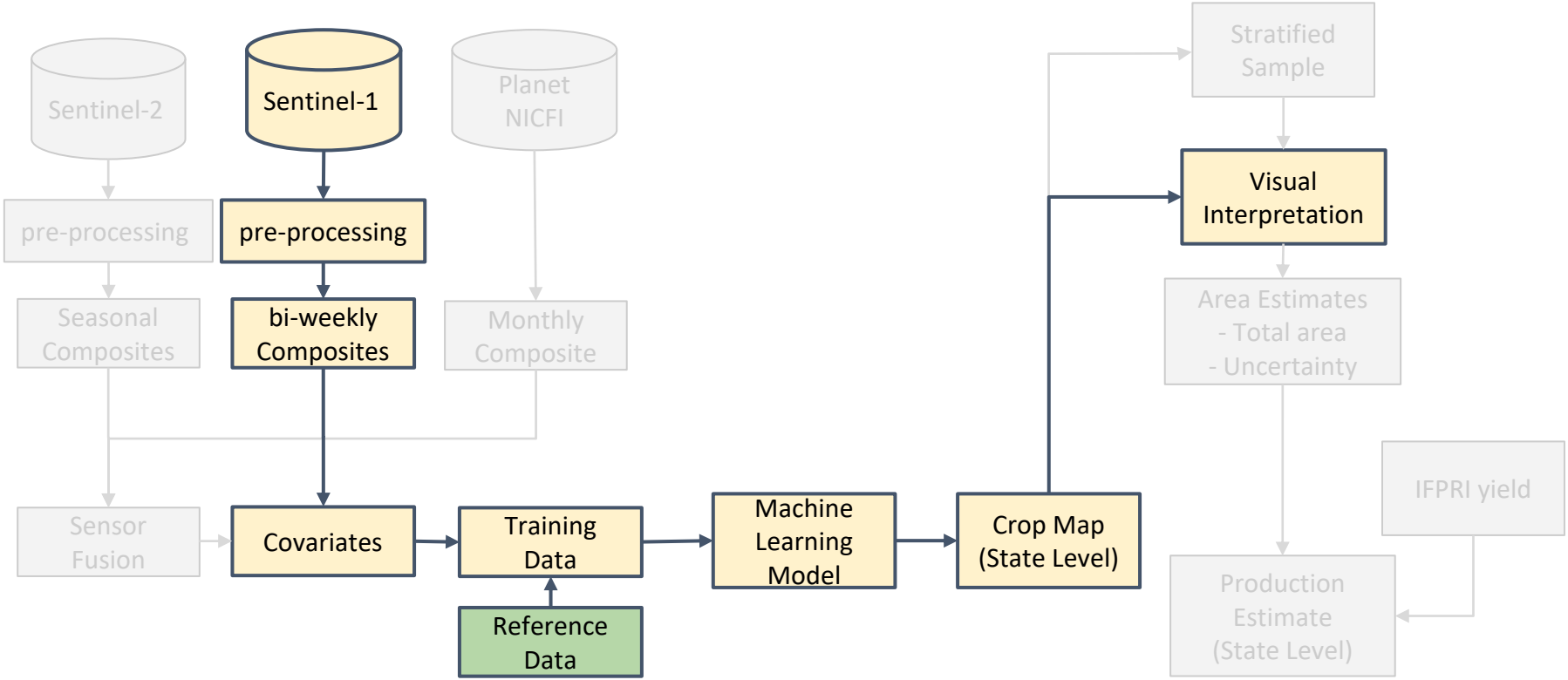




Methodology Overview (2021-2022)



Methodology Overview (2017-2020)



Methodology Overview

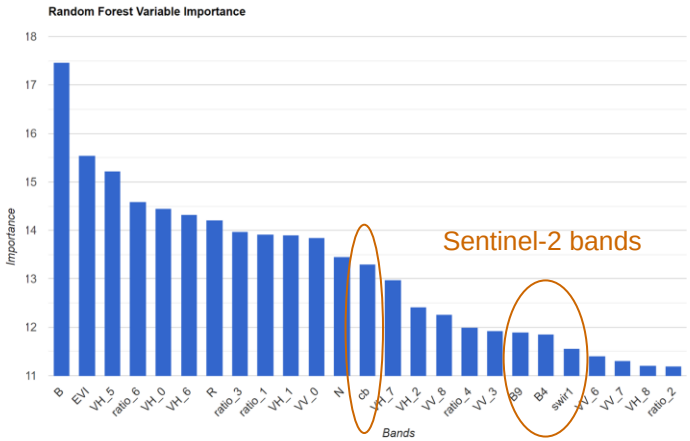
- ❑ Consistent methodology across years as much as possible
- ❑ Imagery used

2021-2022: Sentinel-1 (10m)
Sentinel-2 (10m)
Planet (5m)

2017-2020: Sentinel-1 (10m)

- ➔ Model's feature importance chart highly ranks Sentinel-1 VV, VH, and VH/VV ratio bands due to inundation patterns
- ➔ Sentinel-2 and biannual Planet imagery used for visual inspection only

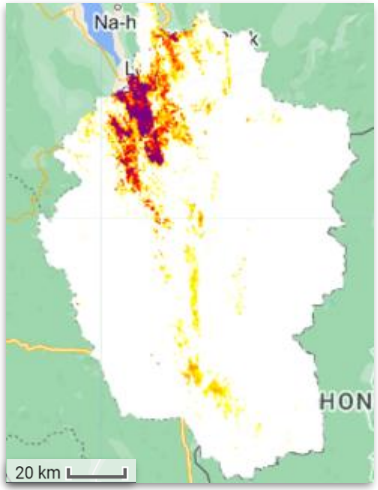
Yangon 2022 top 25 features



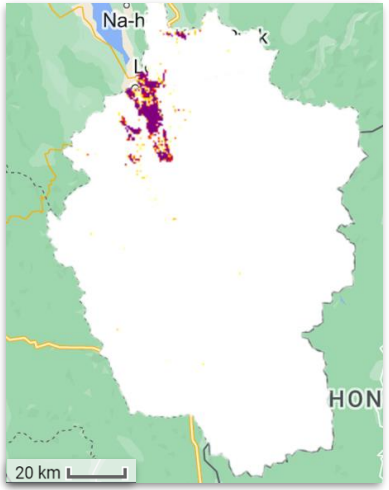
Data Processing and Model

- Training data
  - 2021 reference points in GEE to sample imagery in 2022 and 2017-2020
- Machine learning model
  - Random Forest for binary rice/other pixel classification
  - Output: probability maps
- Improving the model performance
  - Studying model output of **each year's** probability maps and adding/removing training data points

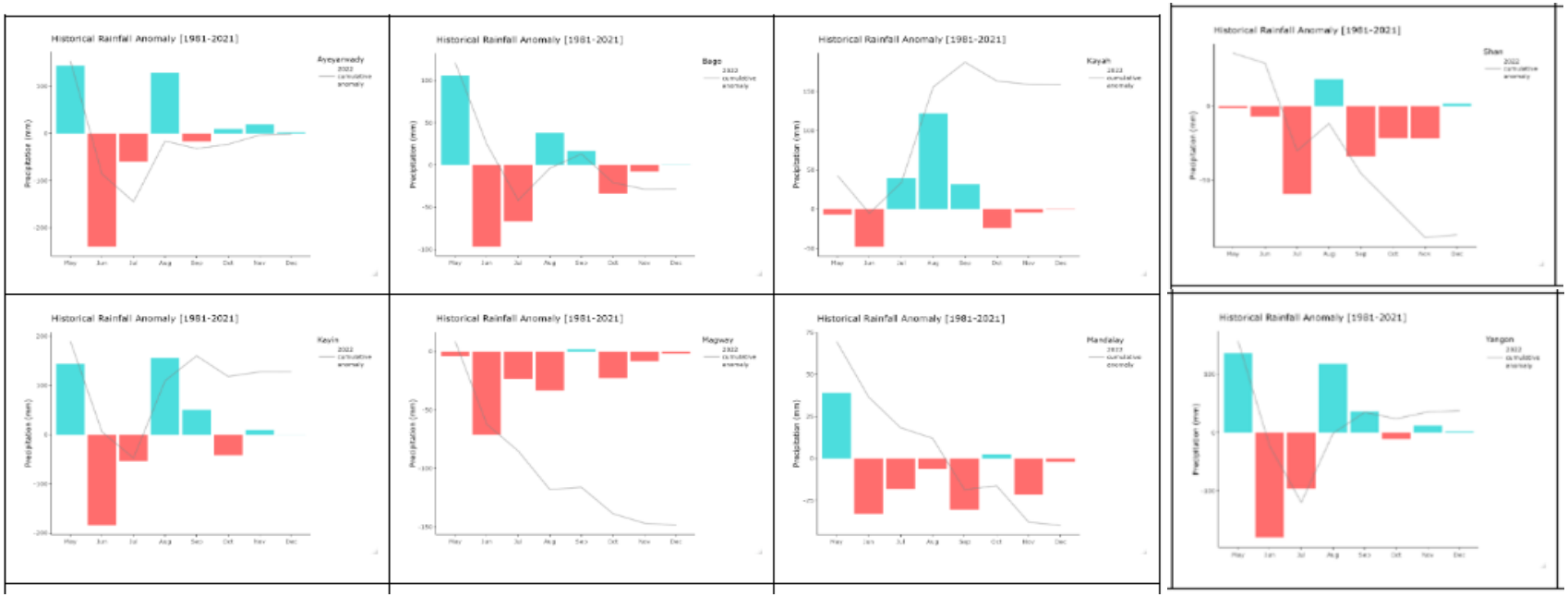
Kayah 2020 **before**



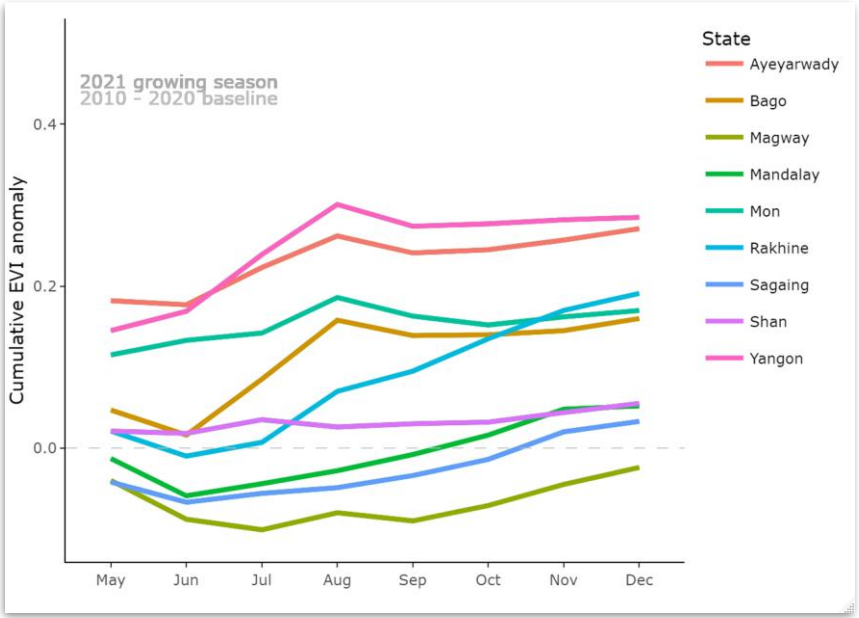
Kayah 2020 **after**

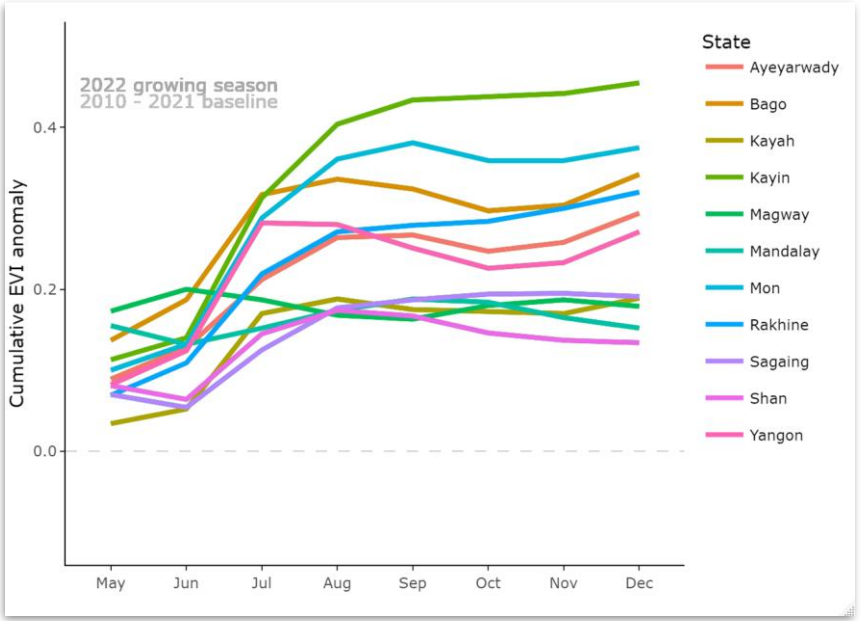


The cumulative rainfall anomaly for rice-producing states in Burma



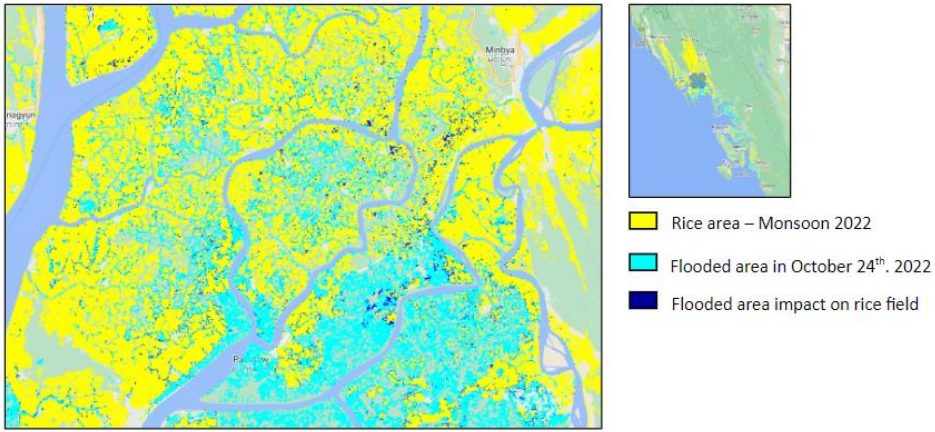
The cumulative EVI anomalies during the monsoon season for cultivated rice area in 2021 and 2022 for each state.



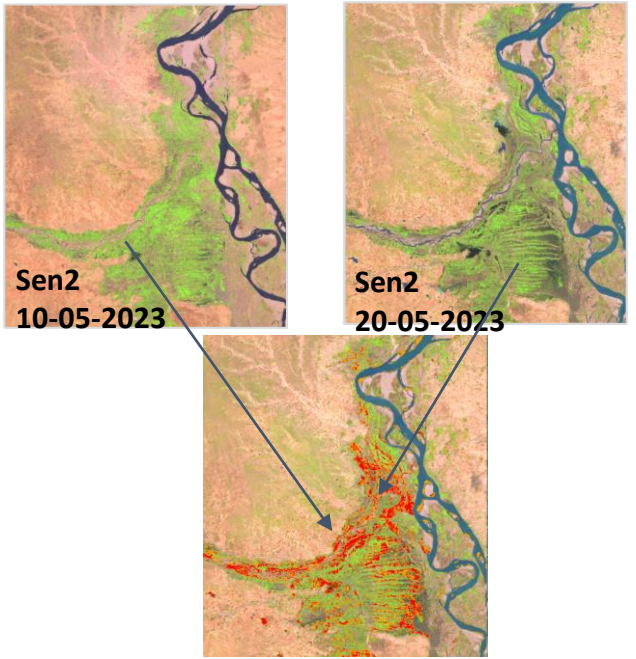


Climate Impact

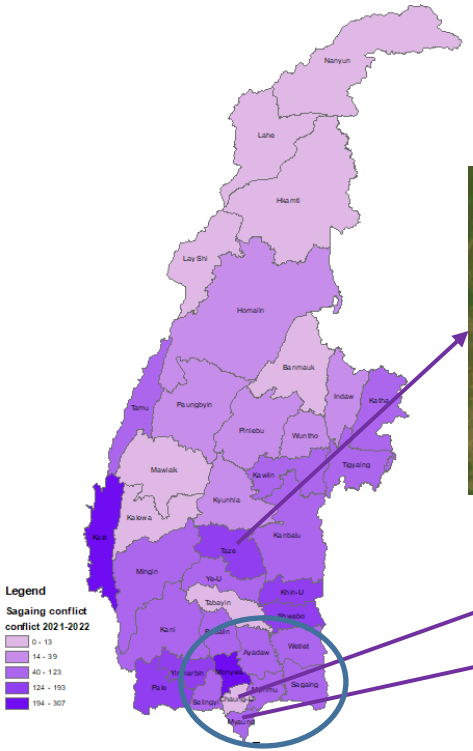
Floods in Rakhine caused by Sitrang Cyclone



Crop damage areas in Magway caused by MOCHA Cyclone

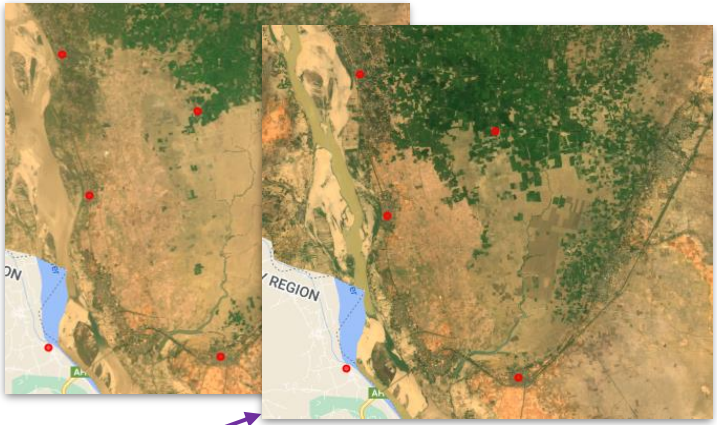


Conflicts Impact



April 2021 vs. April 2022

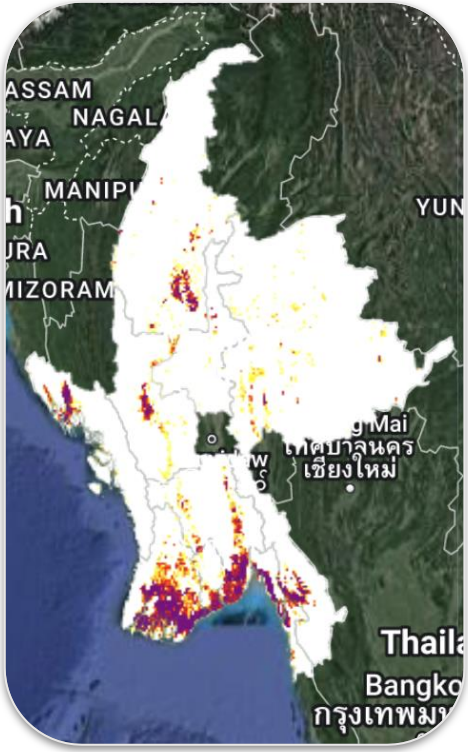
Taze



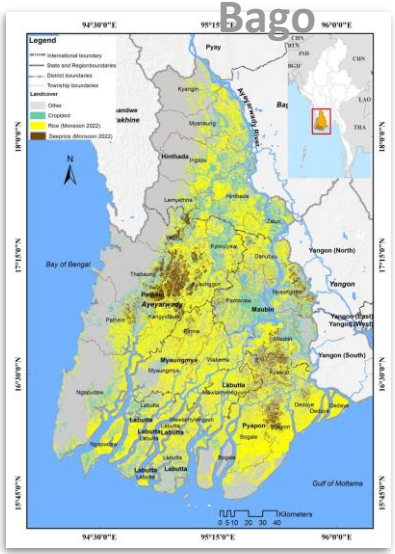
ChangU

Myaung

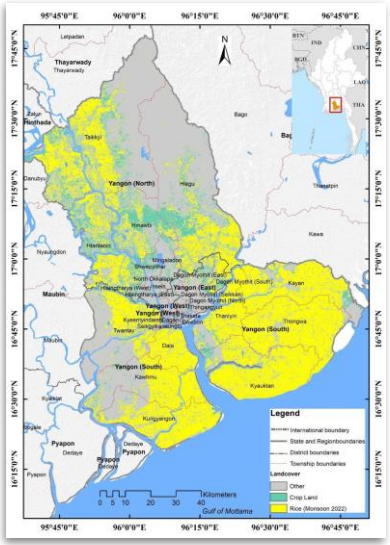
Results

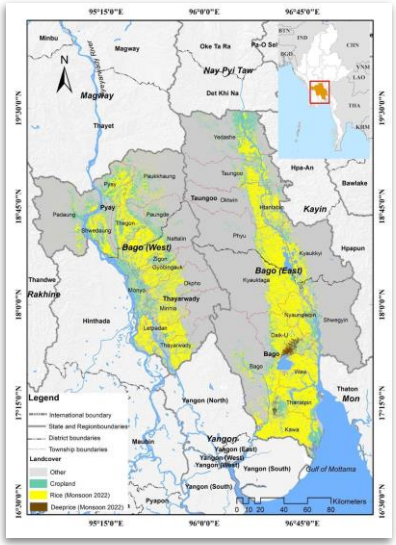


Ayeyarwady
Bago



Yangon





https://code.earthengine.google.com/6508de6222b9e95d66a38377868341ff

We appreciate your input and feedback!

Validation and Confidence

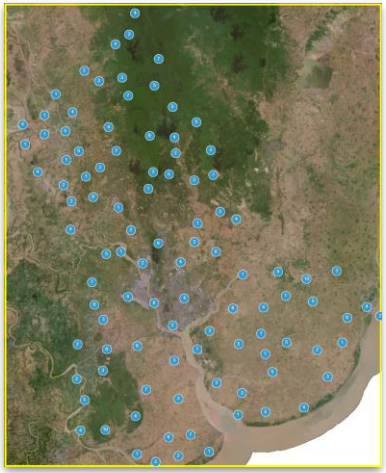
- Validation process for 2021-2022
  - *Pontus* method to estimate area and assess uncertainty (Olofsson et al., 2014)
  - Stratified random sample of **n points** from the model output

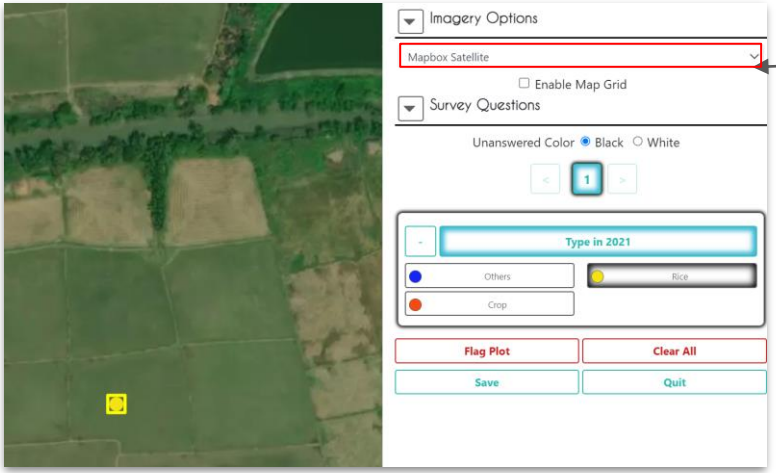
	Rice	Crop	Other	Total
Area in pixels	36,394,419	22,937,031	38,297,873	97,629,322
Wi (Mapped proportion)	0.37	0.23	0.39	
Ui (Expected user's accuracy)	0.90	0.80	0.70	
Si (Standard deviation)	0.30	0.40	0.46	
Wi*Si	0.11	0.09	0.18	0.39
SE overall accuracy				0.02
total points				**372**
size per stratum	**Rice**	**Crop**	**Other**	**Total**
equal	93	93	93	372
proportional	139	87	146	372
minimim strata = 50	139	87	146	372
minimim strata = 70	147	70	155	372
minimim strata = 100	132	100	139	372

$$n \approx \left(\frac{\Sigma W_i S_i}{S(\bar{O})}\right)^2$$

Validation and Confidence

- Validation process for 2021-2022
  - *Pontus* method to estimate area of uncertainty (Olofsson et al., 2014)
  - Stratified random sample of **n points** from the model output
  - Sample interpretation using Collect Earth Online (CEO)





0.2m resolution

Validation and Confidence

- Validation process for 2021-2022
  - *Pontus* method to estimate area of uncertainty (Olofsson et al., 2014)
  - Stratified random sample of **n points** from the model output
  - Sample interpretation using Collect Earth Online (CEO)
  - Error-adjusting the area estimates according to accuracy matrix

Accuracy Matrix

	other	rice	crop	total	map area (ha)	Wi
other	151	0	4	155	382,978.73	0.39
rice	5	133	9	147	363,944.19	0.37
crop	45	10	15	70	229,370.31	0.23
total	201	143	28	372	976,293.22	1.00

	other	rice	crop	total	map area (ha)	adjusted area
other	0.38	0.00	0.01	0.39	382,978.73	532,926.80
rice	0.01	0.34	0.02	0.37	363,944.19	362,050.03
crop	0.15	0.03	0.05	0.23	229,370.31	81,316.40
total	0.55	0.37	0.08	1.00	976,293.22	976,293.22

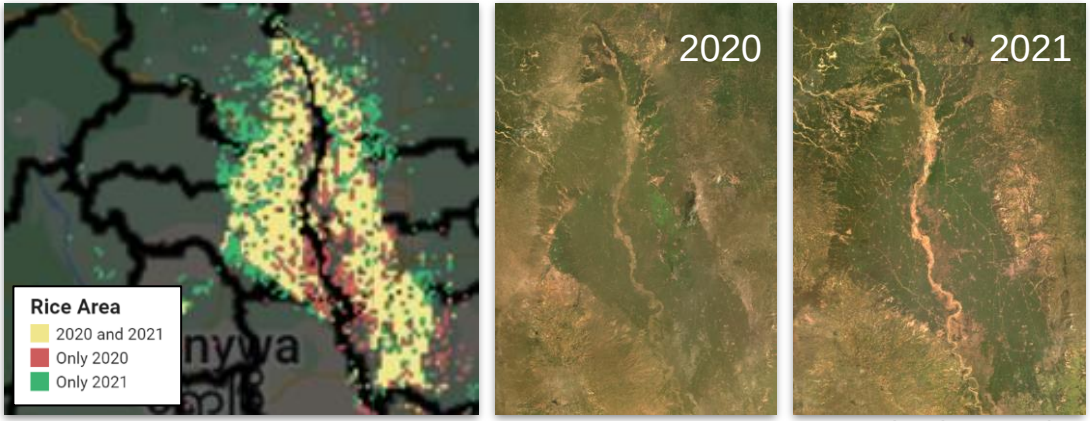
	sd1	sd2	sd2	SE	SE
	0.00003	0.00003	0.00018	0.01549	15126.49
	0.00000	0.00008	0.00010	0.01342	13097.26
	0.00003	0.00005	0.00013	0.01465	14299.09

	pixel area	Area, ha	SE, ha	Conf90%, ha	% conf of est
other	382,978.73	532,926.80	15,126.49	24,883.08	4.67
rice	363,944.19	362,050.03	13,097.26	21,544.99	5.95

Validation on a state/region level

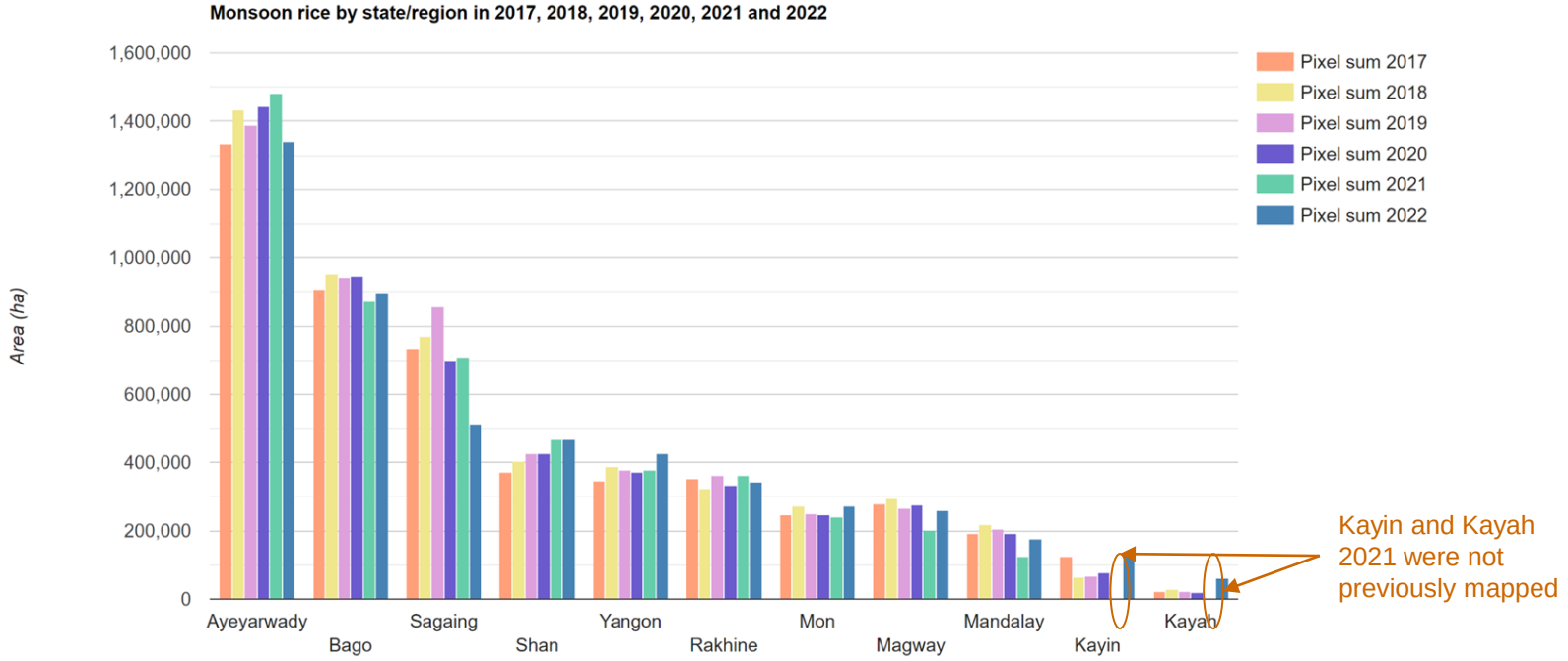
Validation and Confidence

- Validation process for 2017-2020
  - Comparing maps with 2021-2022 maps and **visually inspecting** suspect areas



Shwebo, Sagaing

Results


Monsoon rice by state/region in 2017, 2018, 2019, 2020, 2021 and 2022
Area (ha)
1,600,000
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
Pixel sum 2017
Pixel sum 2018
Pixel sum 2019
Pixel sum 2020
Pixel sum 2021
Pixel sum 2022
Ayeyarwady
Bago
Sagaing
Shan
Yangon
Rakhine
Mon
Magway
Mandalay
Kayin
Kayah
Kayin and Kayah 2021 were not previously mapped

Preliminary 2017-2020 Results

Monsoon Rice Binary Maps

Monsoon Rice Area Estimates Compared to GAD Data

Conclusions and Future Work

- Preliminary **2017-2020 monsoon rice estimates are comparable to GAD data** despite differences in data and methodology
- Continuous rice mapping allows for a better understanding of the factors influencing food security in Myanmar
- Future work includes
  - **Finalizing the historical model** with further training data cleaning and visual validation
  - Repeating the process for rice in the **2017-2020 summer seasons**
  - Mapping and rigorously validating **Kayah and Kayin in 2021**
  - Mapping and rigorously validating **Monsoon season of 2023**
  - **Revise model** with information learned from historical mapping

Thank You

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2021 Monsoon Rice Maps and Area Estimation

2022 Summer Rice Maps and Area Estimation

2022 Monsoon Rice Maps and Area Estimation