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The UP-SRA Yield Estimation System for Sugarcane (YESS) Project

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Department of Agriculture

HOW THE PROJECT STARTED?

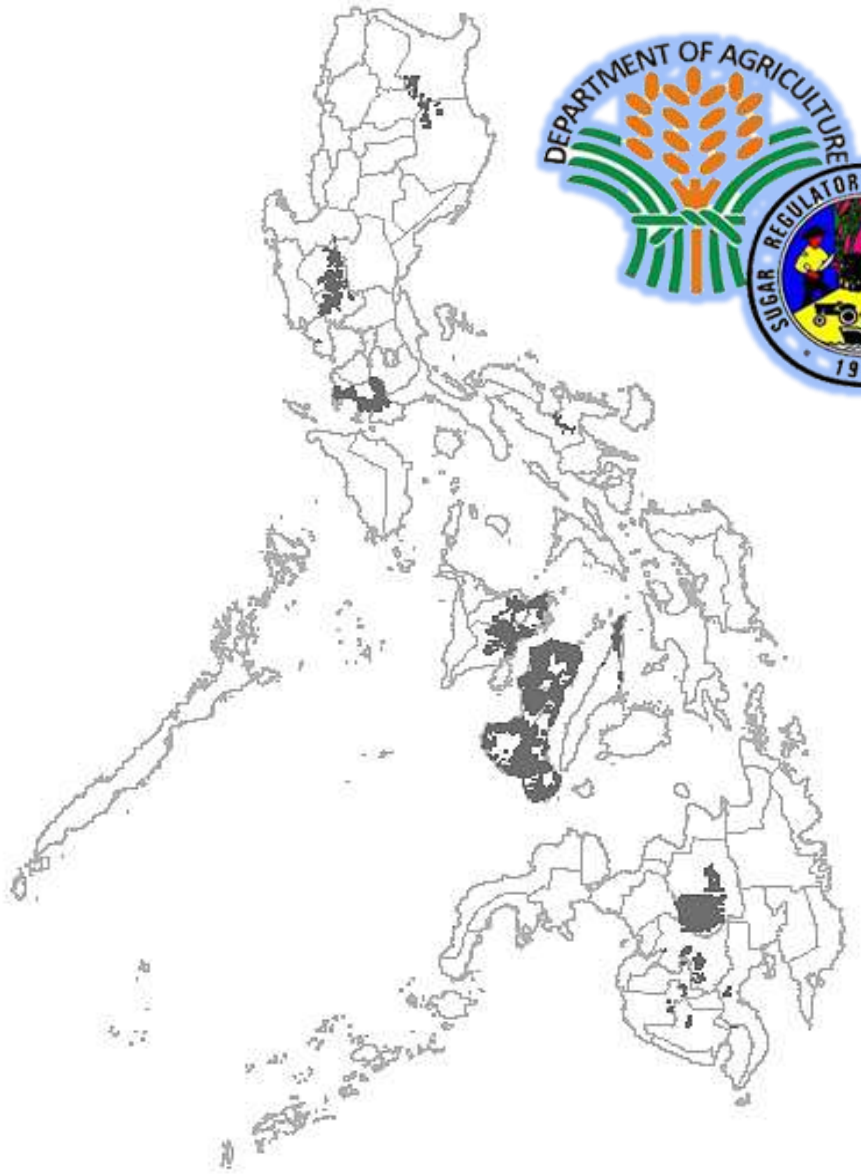
Sugarcane is the primary source of sugar and other products such as ethanol, fiber, and fuel. It **provides livelihood through farming, processing and trading to about 58,996 sugarcane farmers in the Philippines** (Fernandez & Nuthall, 2009).

The Philippines has a booming sugarcane industry **contributing about PHP 87 billion to the local economy** through raw sugar, molasses, and bioethanol production (SRA Roadmap 2016, 2020).

HOW THE PROJECT STARTED?

To ensure profitability and sustainability in the sugar industry, the production and cultivation of sugarcane is being **regulated by the Sugar Regulatory Administration** under the Philippines' Department of Agriculture (DA).

Several programs to increase the efficiency of sugar production: expansion of cultivated areas, development of better cane varieties, farm inventory and baseline farm mapping, establishment of farm-to-mill roads, irrigation and farm mechanization, and establishment of sugarcane economic zones (SRA, 2012; Fernandez & Nuthall, 2009)



HOW THE PROJECT STARTED?

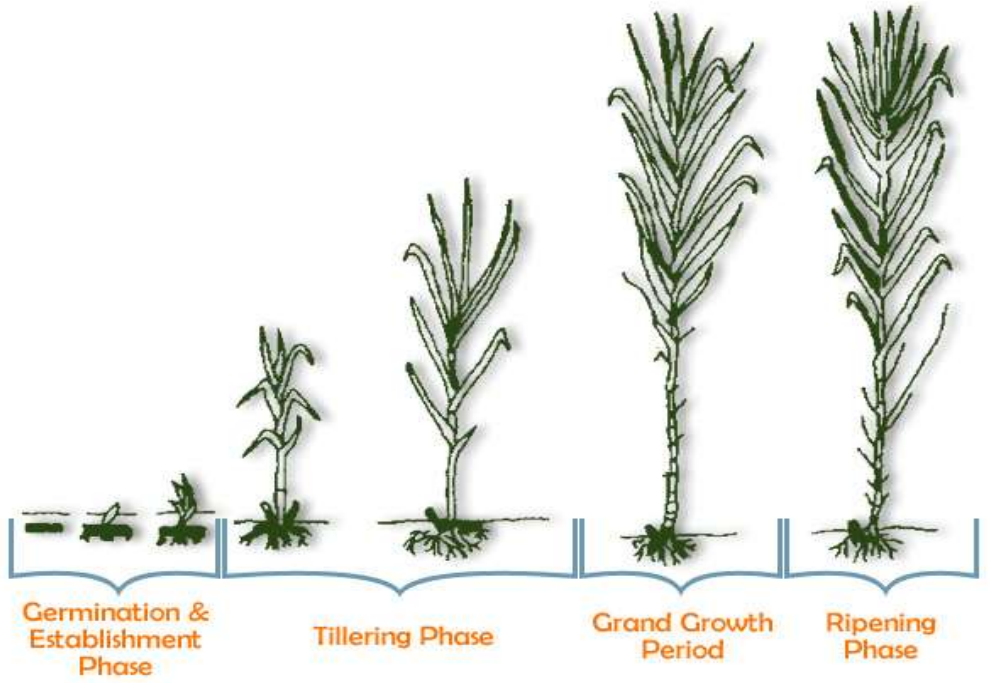
The crop estimate is calculated using the following formula:

Potential Yield = P (100% - CF)

Where

P = (Ave. no of millable stalks/sqm x Ave. wt. of stalk in kg x 10,000 sqm/Ha) / 1,000 kgs/ton

CF = % of rat infestation + % of missing hills + % of lodging of canes.



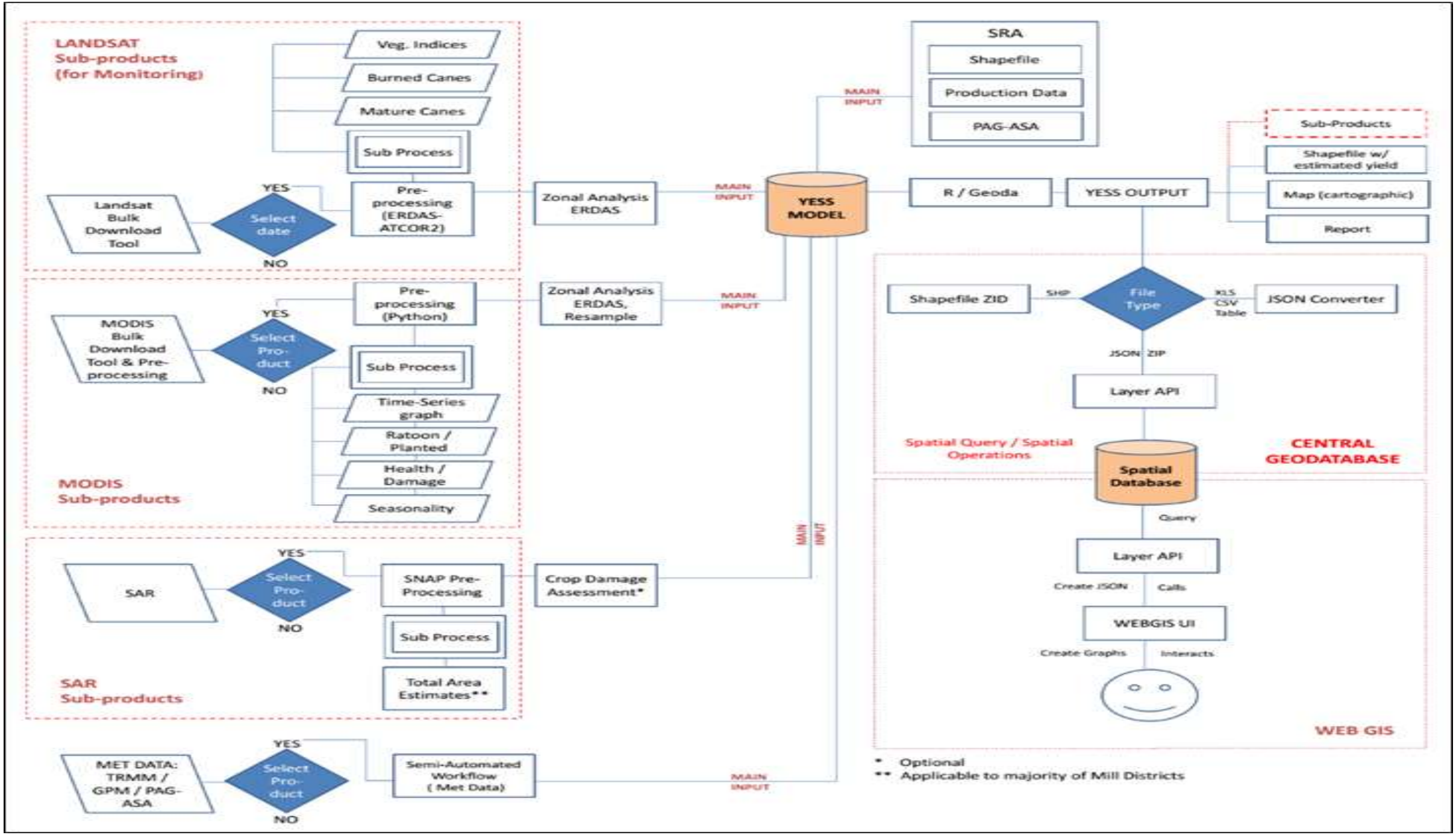
BACKGROUND

Yield Estimation System for Sugarcane (YESS)

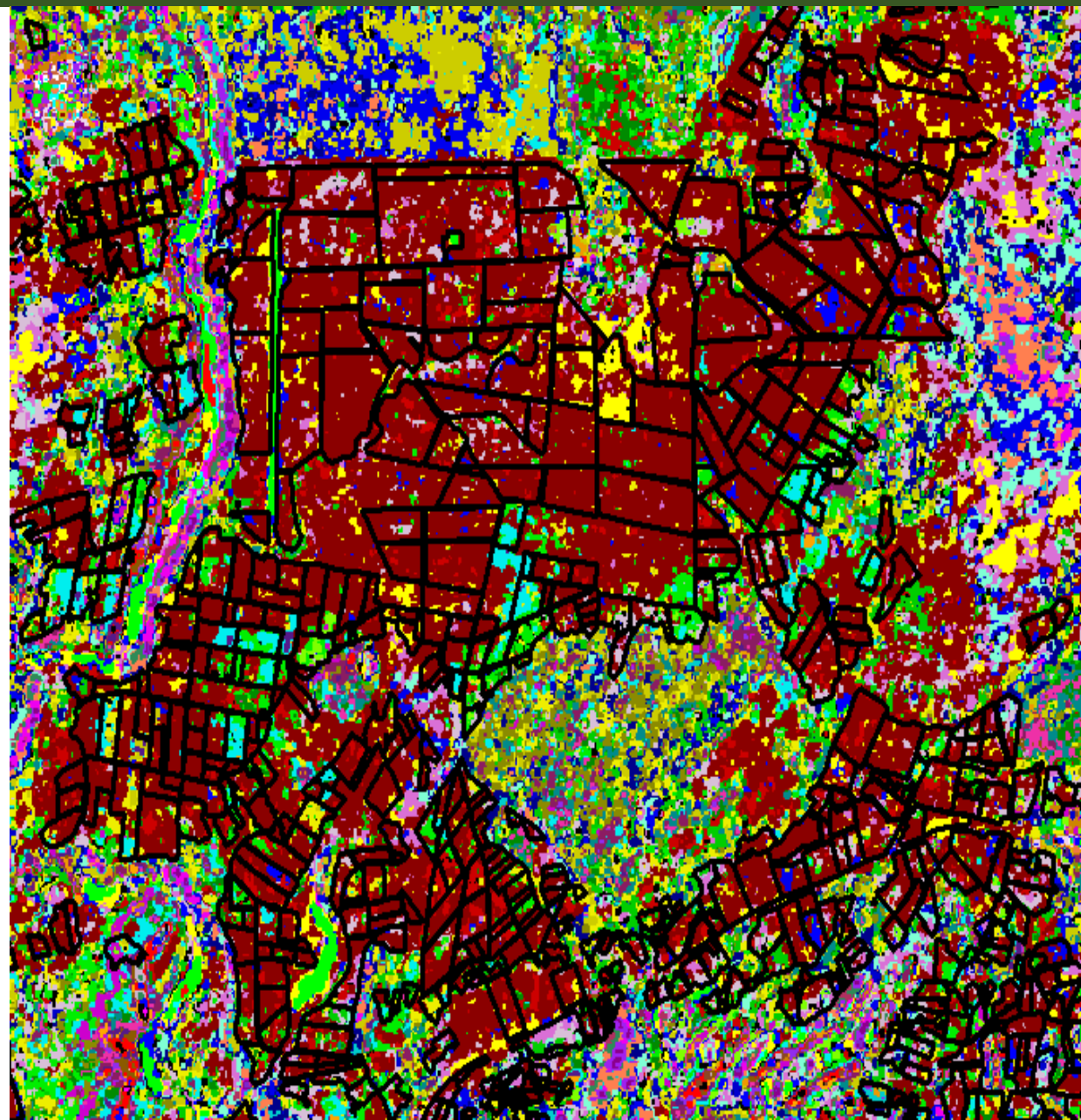
- Launched in January 2016 by the Sugar Regulatory Administration and the University of the Philippines Training Center for Applied Geodesy and Photogrammetry (UP TCAGP)
- Aims to generate rapid, realistic, & science-based estimates on annual yield production; includes satellite-derived products for crop monitoring

BACKGROUND

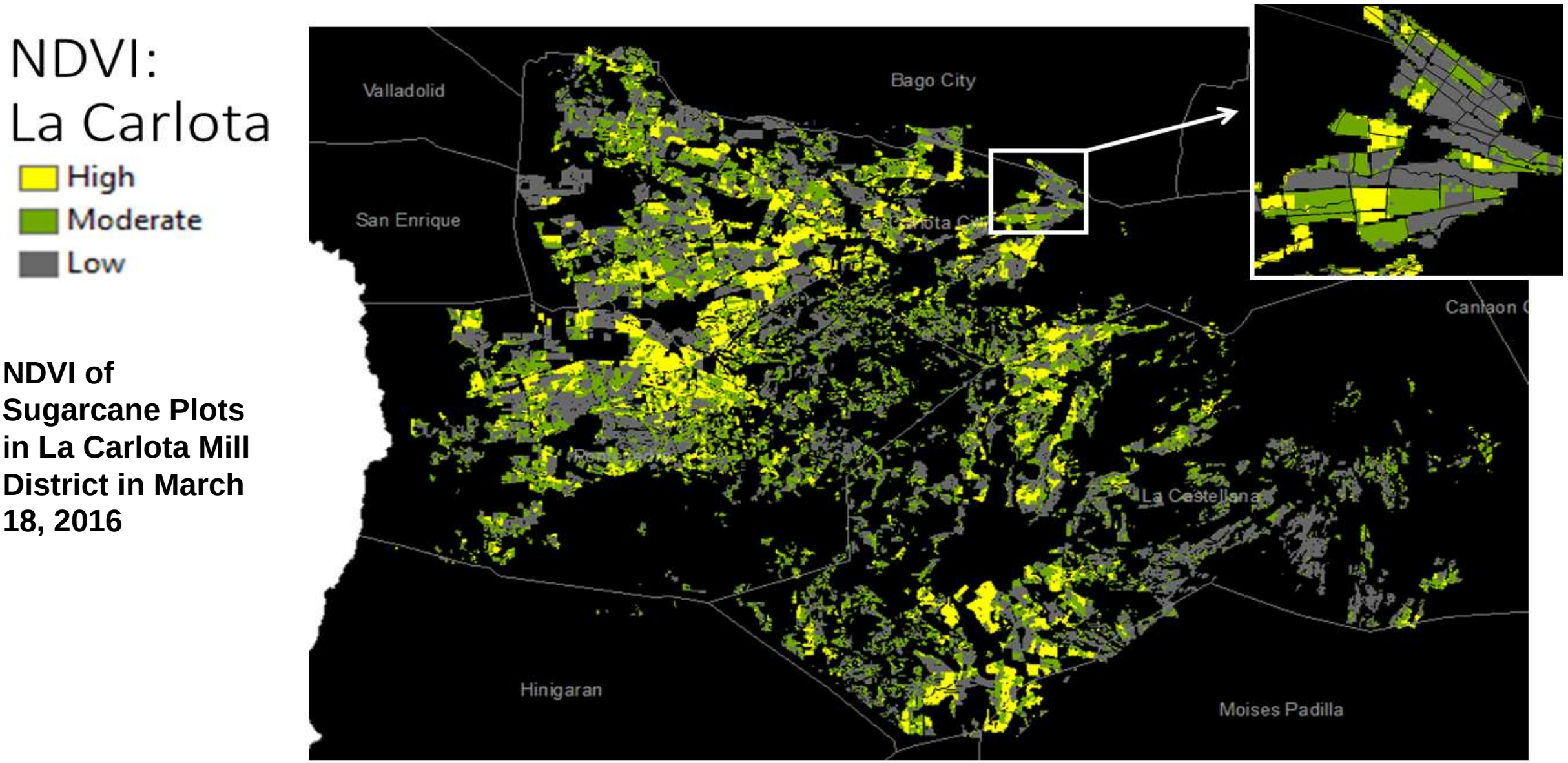
	Conventional		SRA-YESS
Sugarcane growth and health	Regular field monitoring and field inspection	⇢	Generation of vegetation indices from Landsat and MODIS
Total Area Planted	Field Measurement	⇢	Landsat and SAR Areal Estimates
Harvest Schedule	Plot schedule based on start date	⇢	Maturity maps from Landsat
Ratoon vs. Plant Cane	Manual field inspection of cane	⇢	Analysis using MODIS
Yield Estimates	Field-based computations using sample area and sample canes	⇢	YESS-Model estimate from RS, meteorological and statistical data
Crop Damage Assessment	Field inspection and assessment	⇢	Change detection from SAR
Burned Sugarcane Area	On-site assessment of burned area	⇢	Use of Landsat dNBR


LANDSAT
Sub-products
(for Monitoring)
Veg. Indices
Burned Canes
Mature Canes
Sub Process
Pre-processing (ERDAS-ATCOR2)
YES
Select date
NO
Landsat Bulk Download Tool
Zonal Analysis ERDAS
MAIN INPUT
SRA
Shapefile
Production Data
PAG-ASA
MAIN INPUT
YESS MODEL
R / Geoda
YESS OUTPUT
Sub-Products
Shapefile w/ estimated yield
Map (cartographic)
Report
Pre-processing (Python)
YES
Select Pro-duct
NO
MODIS Bulk Download Tool & Pre-processing
Sub Process
Time-Series graph
Ratoon / Planted
Health / Damage
Seasonality
MODIS
Sub-products
Zonal Analysis ERDAS, Resample
MAIN INPUT
Shapefile ZID
SHP
File Type
XLS
CSV
Table
JSON Converter
JSON: ZIP
Layer API
Spatial Query / Spatial Operations
Spatial Database
CENTRAL GEODATABASE
Query
Layer API
Create JSON
Calls
WEBGIS UI
Create Graphs
Interacts
WEB GIS
SAR
YES
Select Pro-duct
NO
SNAP Pre-Processing
Sub Process
Total Area Estimates**
SAR
Sub-products
Crop Damage Assessment*
MAIN INPUT
MET DATA: TRMM / GPM / PAG-ASA
YES
Select Pro-duct
NO
Semi-Automated Workflow (Met Data)
MAIN INPUT
* Optional
** Applicable to majority of Mill Districts

SUGARCANE MAPPING USING SAR

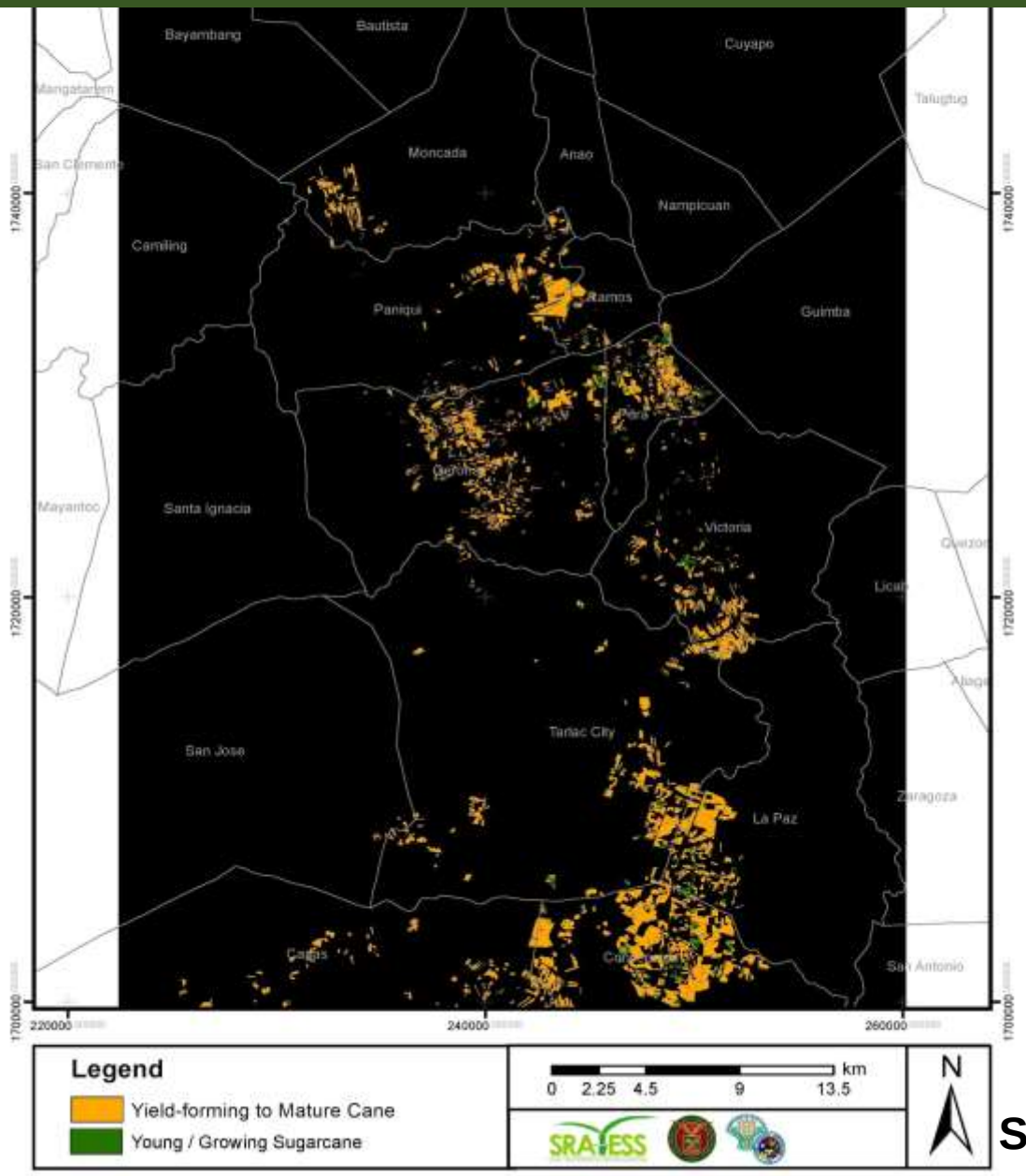


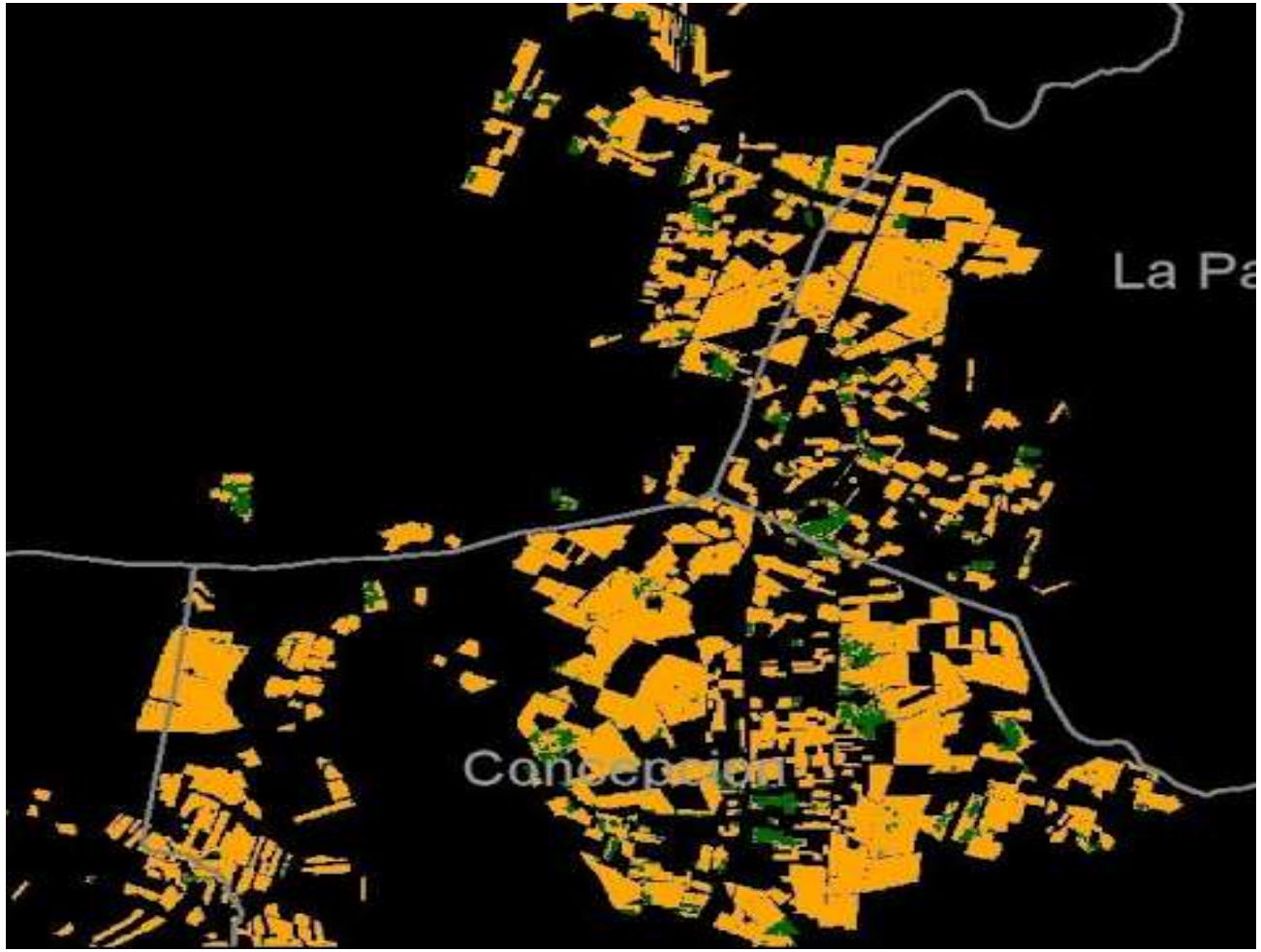
NDVI – Normalized Difference Vegetation Index



NDVI of Sugarcane Plots in La Carlota Mill District in March 18, 2016

Yield-forming to Mature Sugarcane



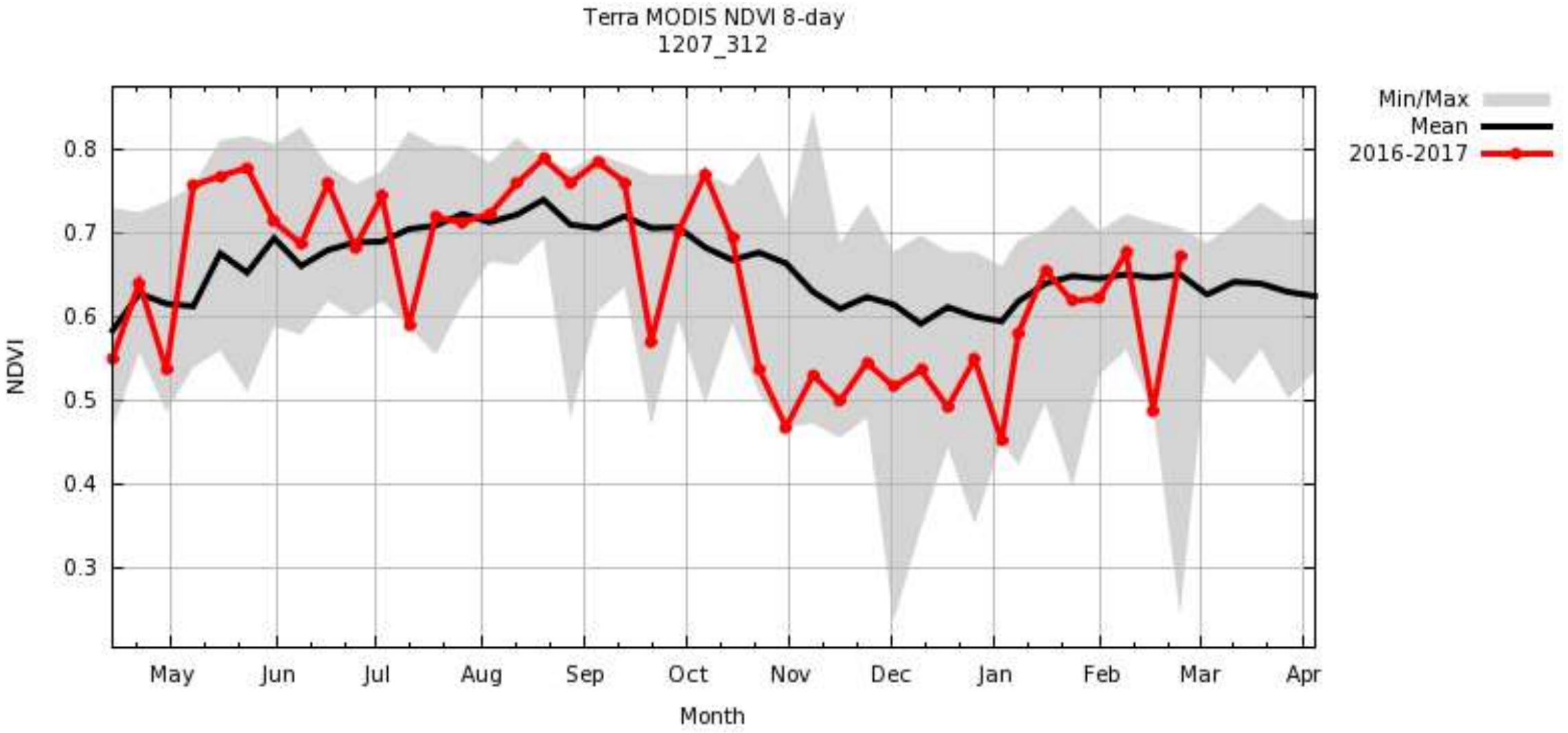


Sample Yield-forming to Mature Cane Maps in Tarlac Mill District

USE OF MODIS DATA

USE OF MODIS DATA

NDVI anomalies can be detected especially when extreme events (e.g., droughts, strong typhoon, and change of crop type) occur within the region/area.



Near Real time MODIS NDVI Anomaly Plot for Cagayan

BURNED SUGARCANE

Sugarcane Burning

- facilitates faster and easier harvest; takes place throughout the harvest period

Burned canes in Batangas, Philippines

Pre-harvest Burning

- Eliminates about 80% of trash: straw, dry tops and leaves

Post-harvest Burning

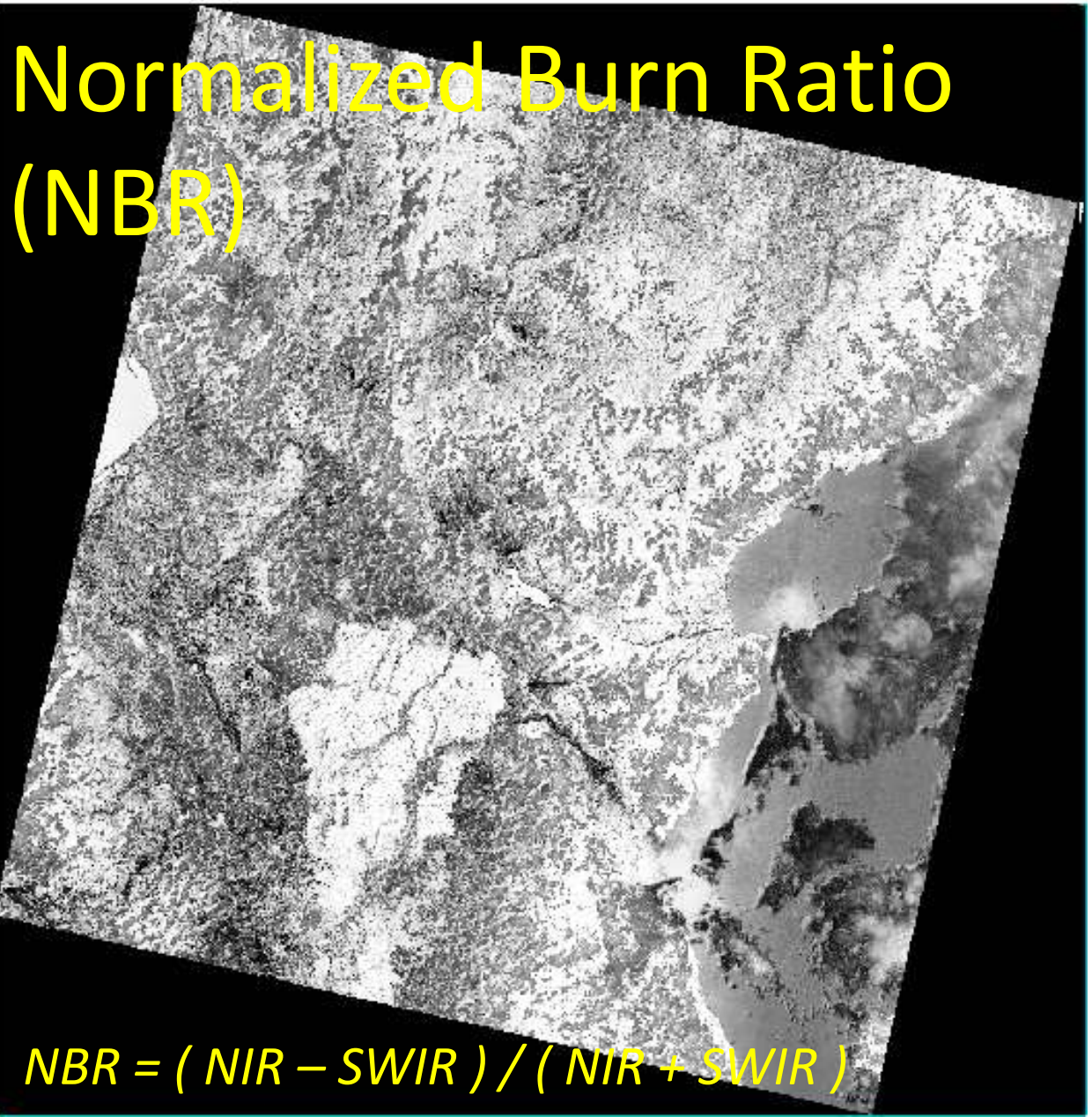
- Done to remove trash after harvest and to prepare land for the next cropping cycle

Impact of Burning

- Lower sugar content of canes

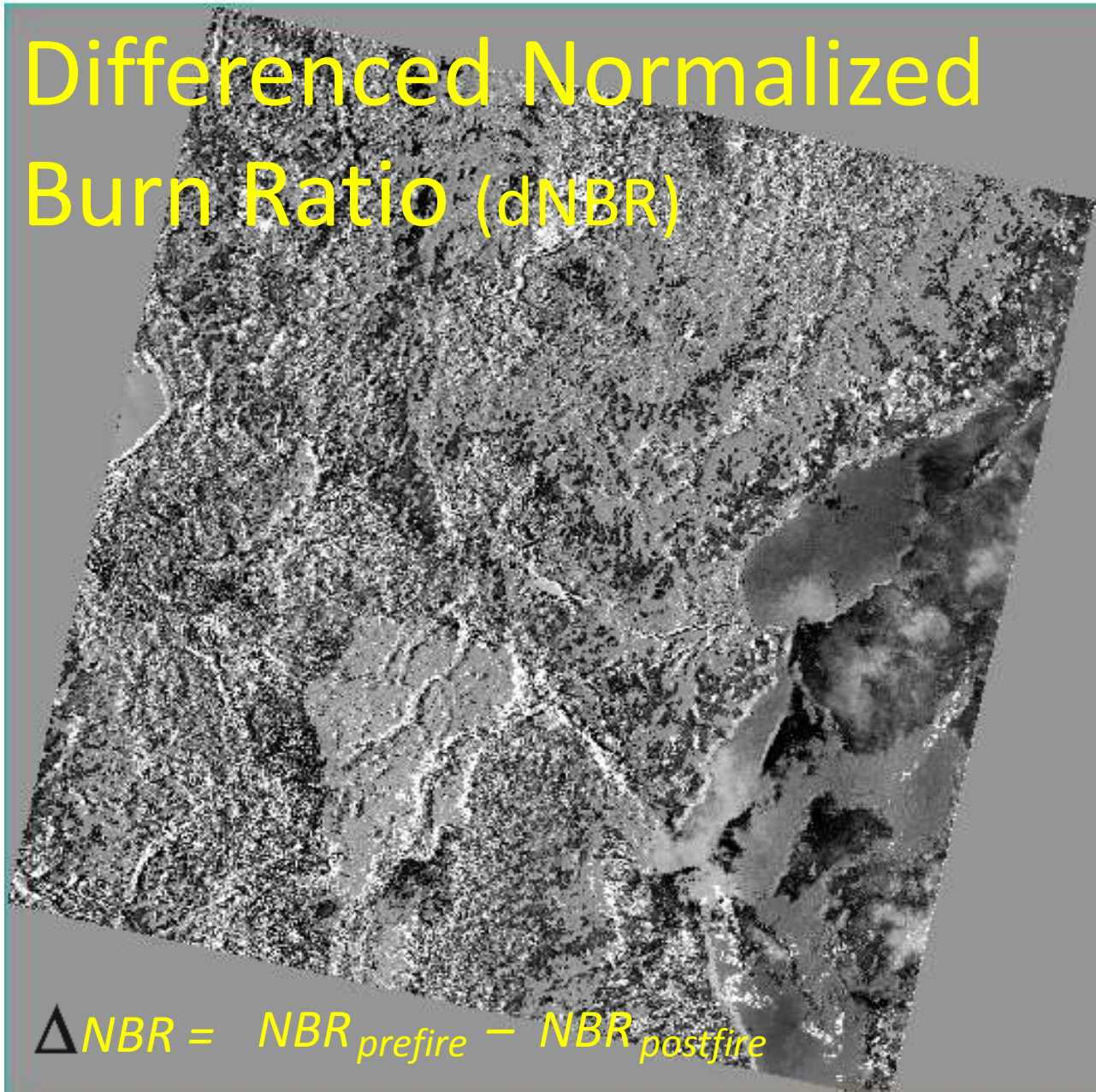
METHODS

Normalized Burn Ratio (NBR)



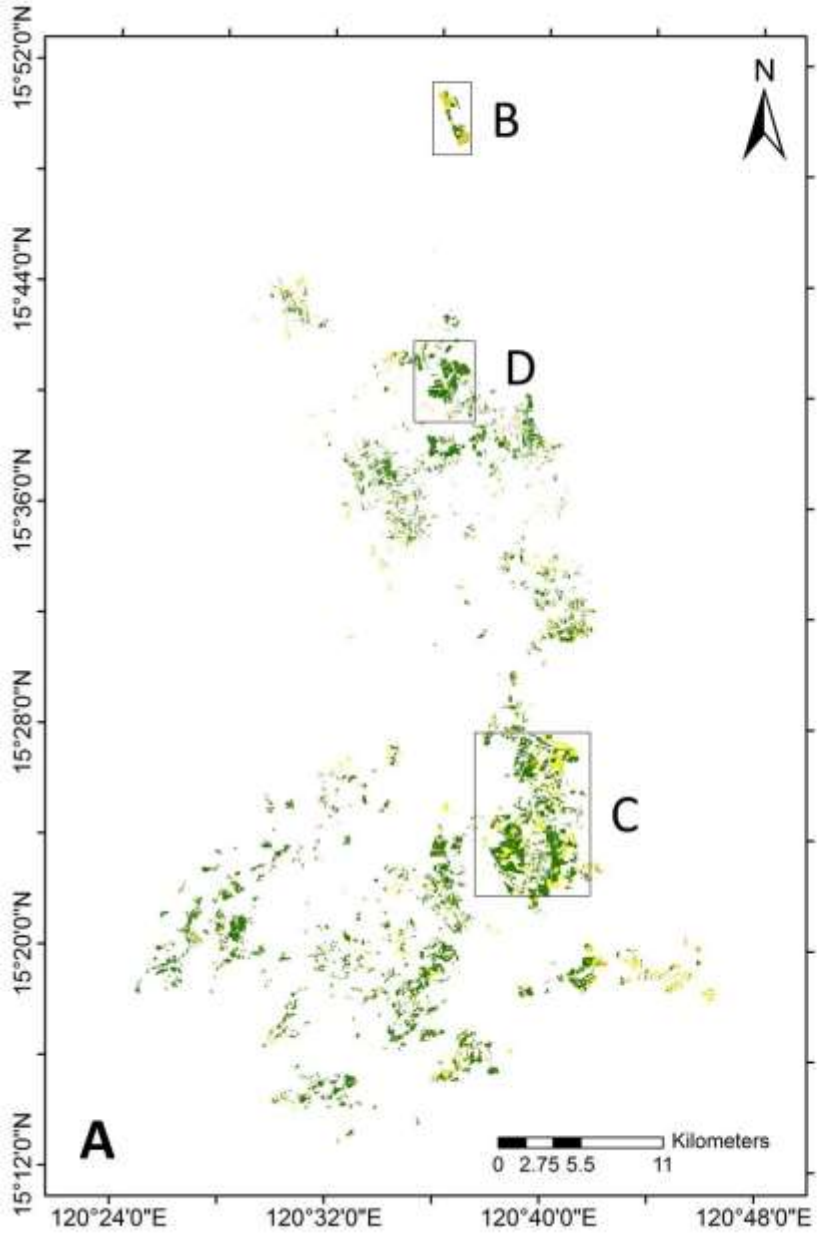
$$NBR = (NIR - SWIR) / (NIR + SWIR)$$

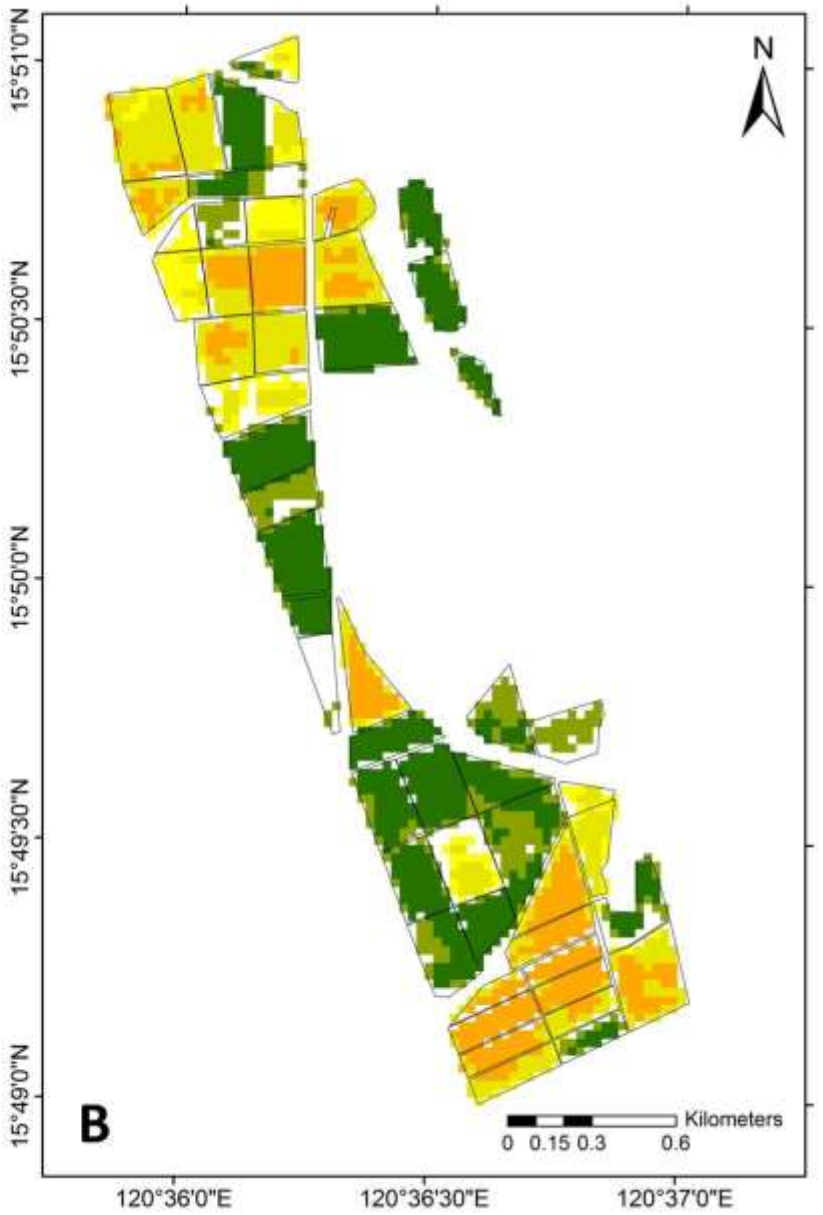
Differenced Normalized Burn Ratio (dNBR)



$$\Delta NBR = NBR_{prefire} - NBR_{postfire}$$

RESULTS: Burn Severity maps of Feb to May dNBR





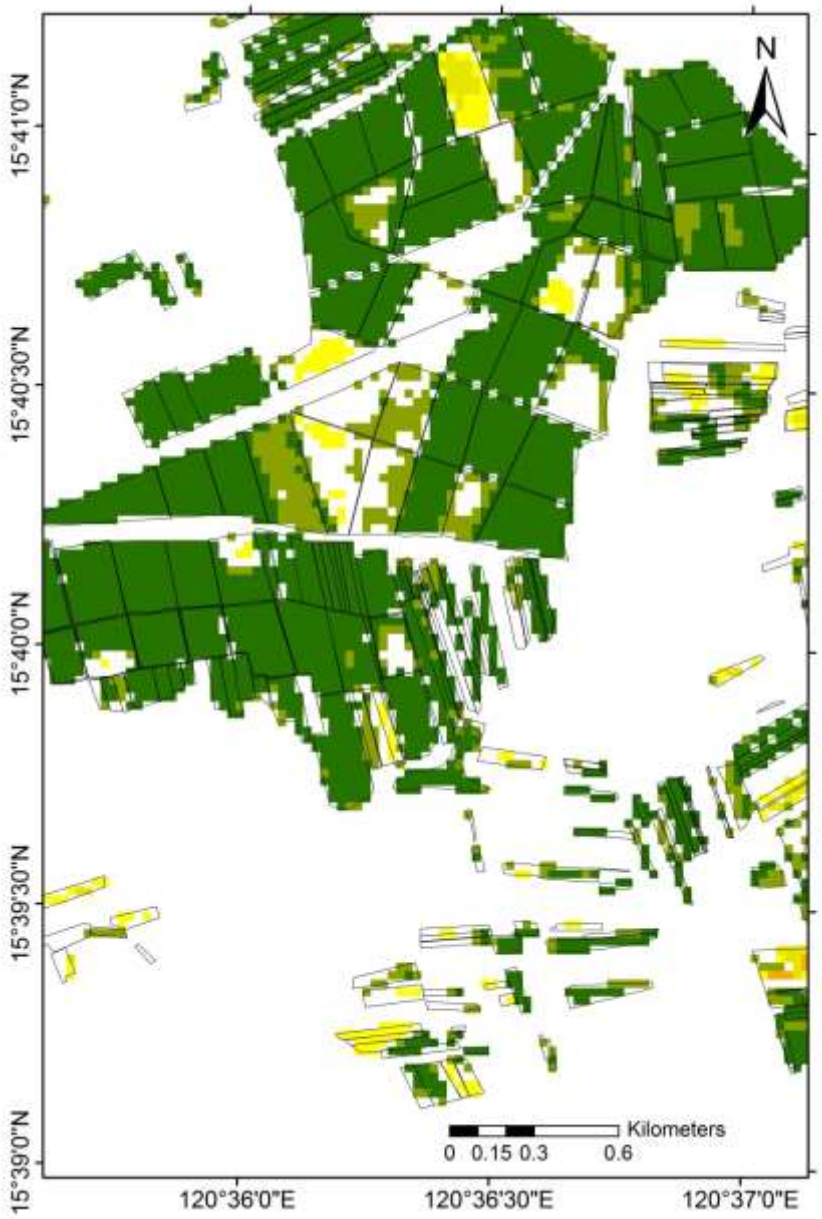
dNBR

- High severity
- Moderate-high severity
- Moderate-low severity
- Low severity
- Unburned
- Low post-fire regrowth
- High post-fire regrowth

(classes from Key and Benson, 2006)

dNBR	Burn Severity Class
< -0.25	High post-fire regrowth
-0.25 to -0.10	Low post-fire regrowth
-0.10 to 0.10	Unburned
0.10 to 0.27	Low severity
0.27 to 0.44	Moderate-low severity
0.44 to 0.66	Moderate-high severity
> 0.66	High severity

RESULTS: Burn Severity maps of Feb to May dNBR



dNBR

- High severity
- Moderate-high severity
- Moderate-low severity
- Low severity
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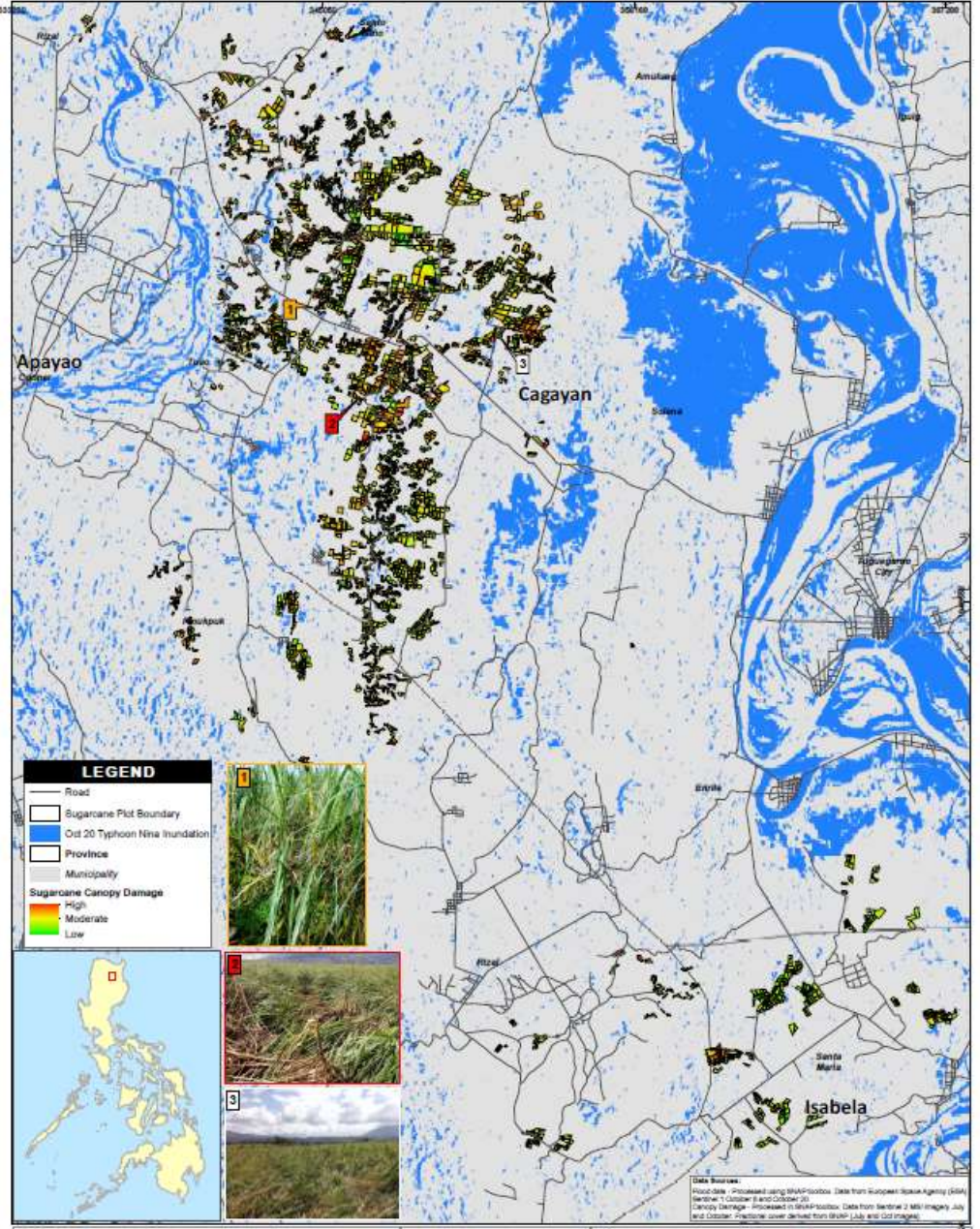
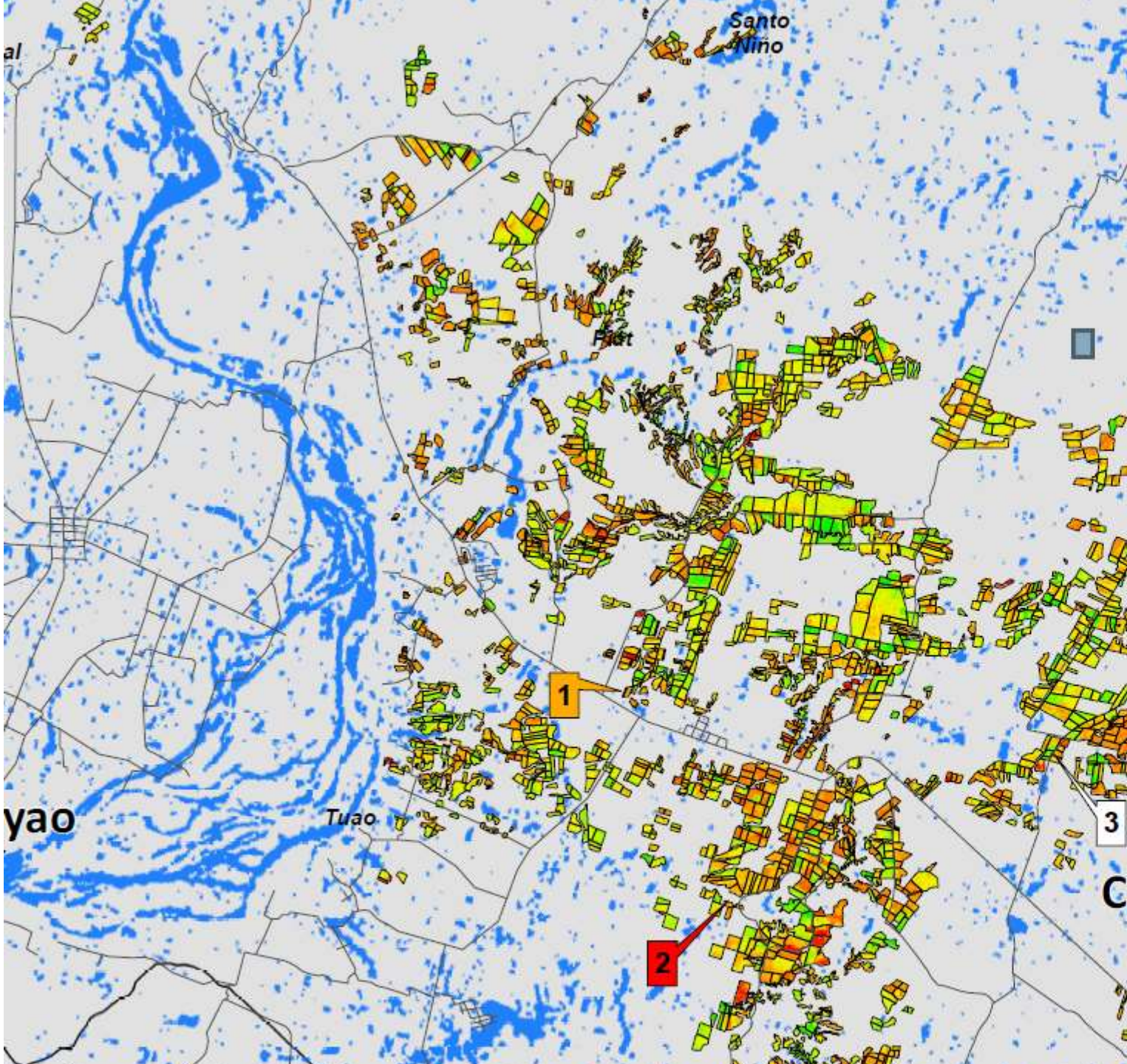

Apayao
Cagayan
Isabela
Santa Maria
Rizal
Amulung
Solana
Enrile
Tuao
LEGEND
Road
Sugarcane Plot Boundary
Oct 20 Typhoon Nina Inundation
Province
Municipality
Sugarcane Canopy Damage
High
Moderate
Low
1
2
3
Crop Damage Assessment
University of the Philippines - Sugar Regulatory Administration
Yield Estimation System for Sugarcane (YESS) Project
N
Map Scale: 1:60,000
Map Datum: WGS 1984
Map Projection: UTM Zone 51 N
Disclaimer:


Santo Niño
Piat
Tuao
1
2
3

Unmanned Aerial System (UAS)

Platforms **Control, Monitor** **Software**

Sensors

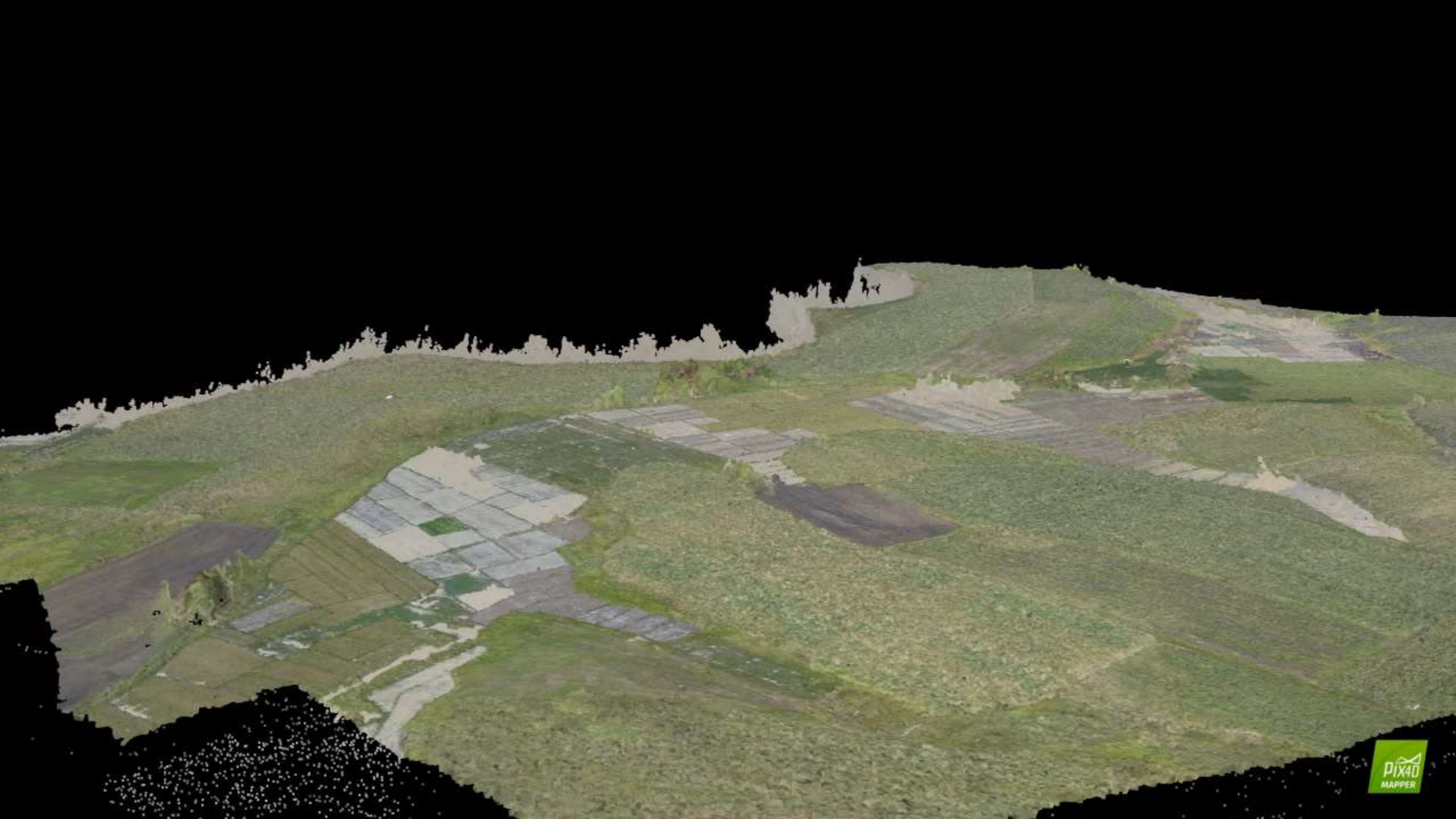
People

Protocol

PIX4D
simply powerful

simactive
CUTTING-EDGE PHOTOGRAMMETRY SOFTWARE

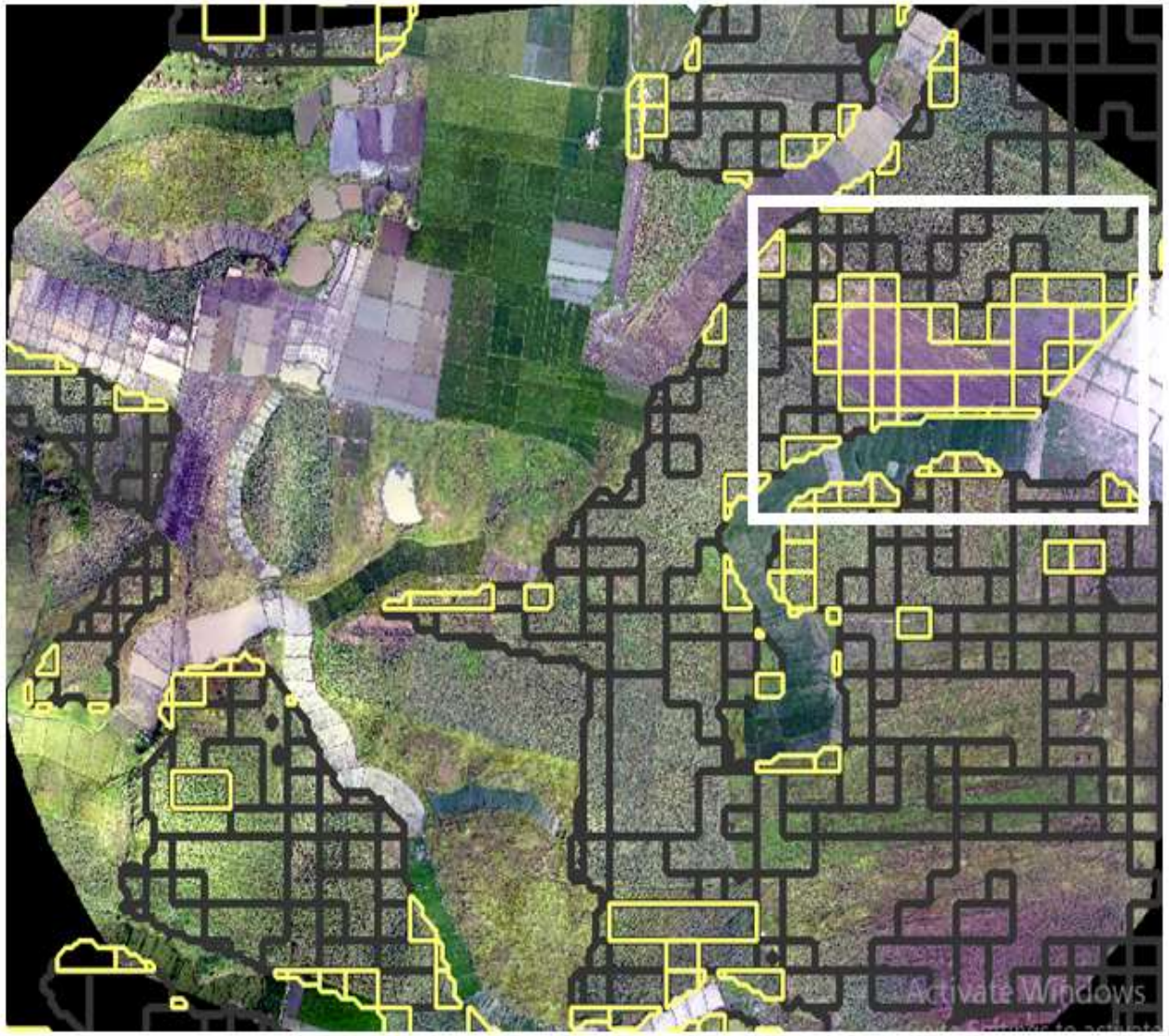
VisualSFM

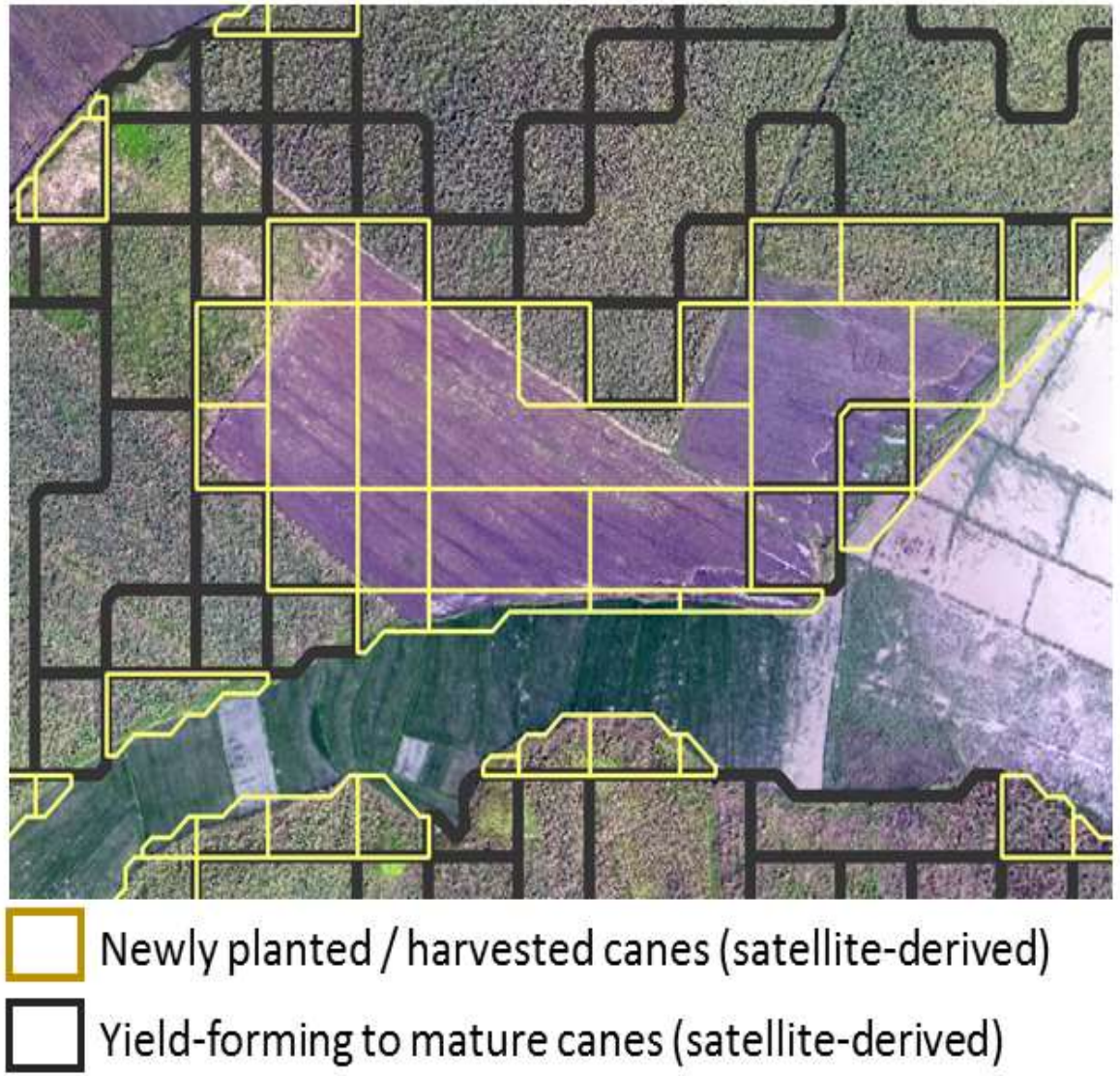

PIX4D
MAPPER

UAS 3D

UAS 3D

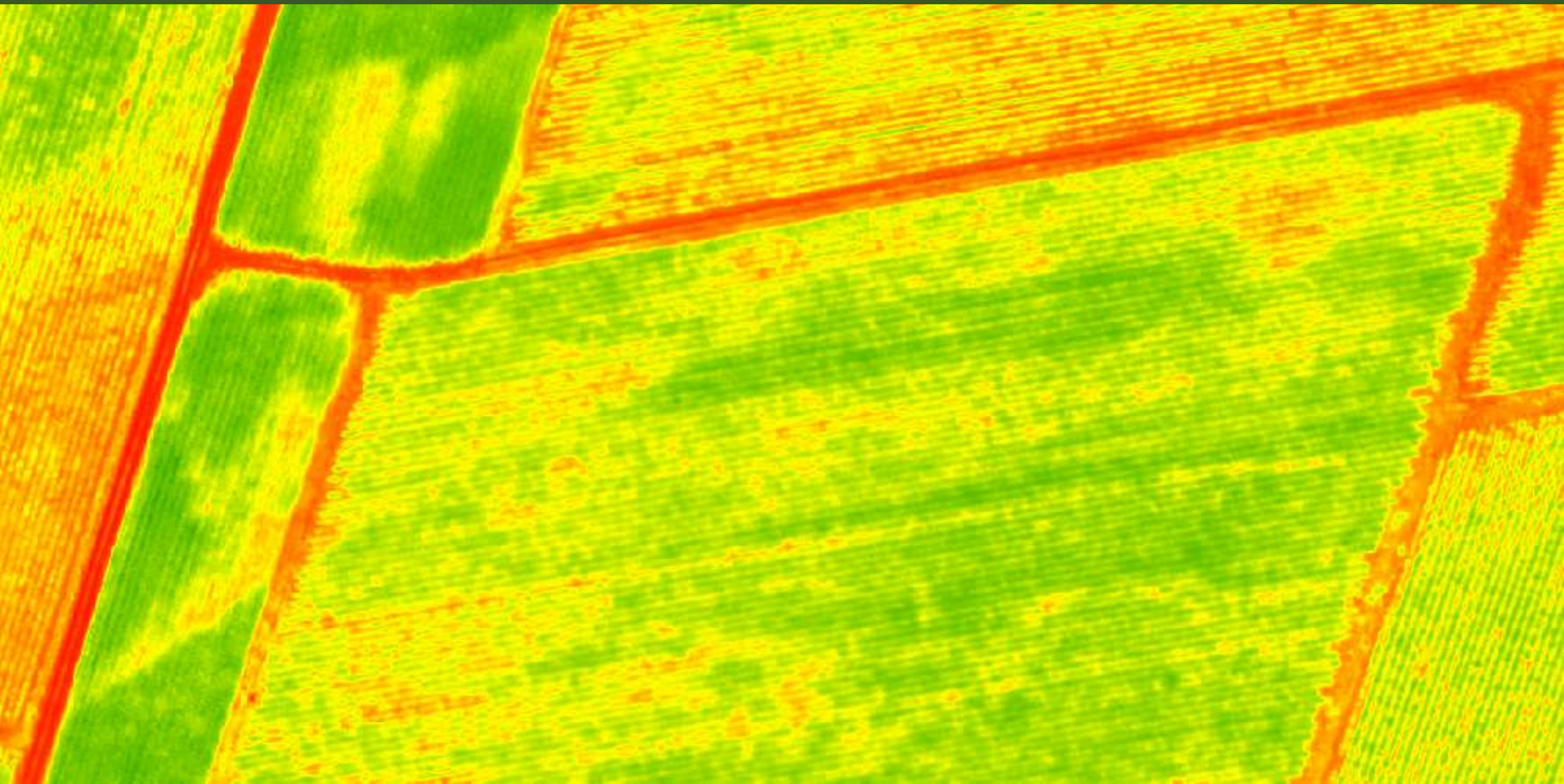
UAS Data: For Validation



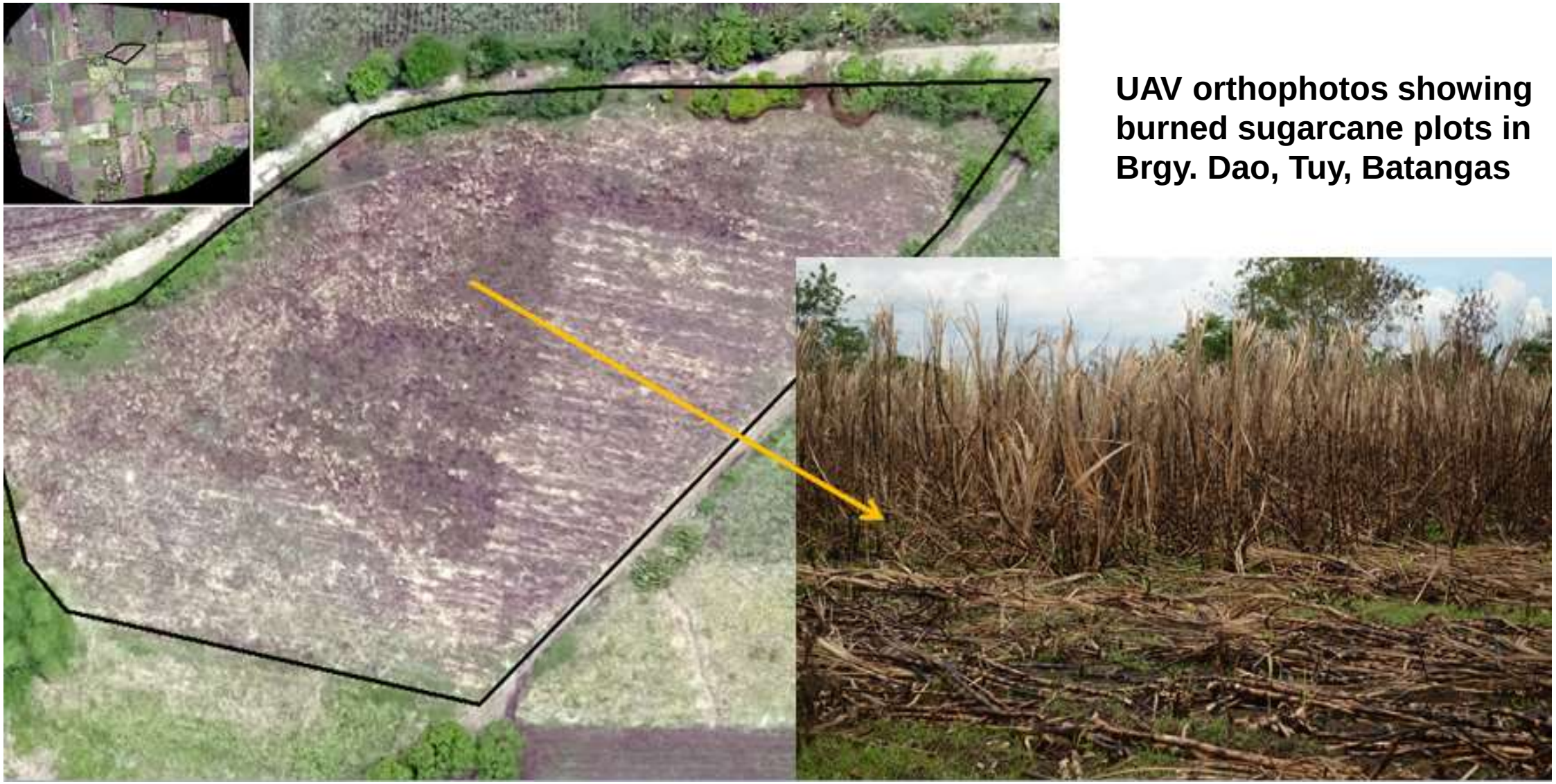


UAS Data: High Resolution NDVI

Brgy. Asturias, Tarlac

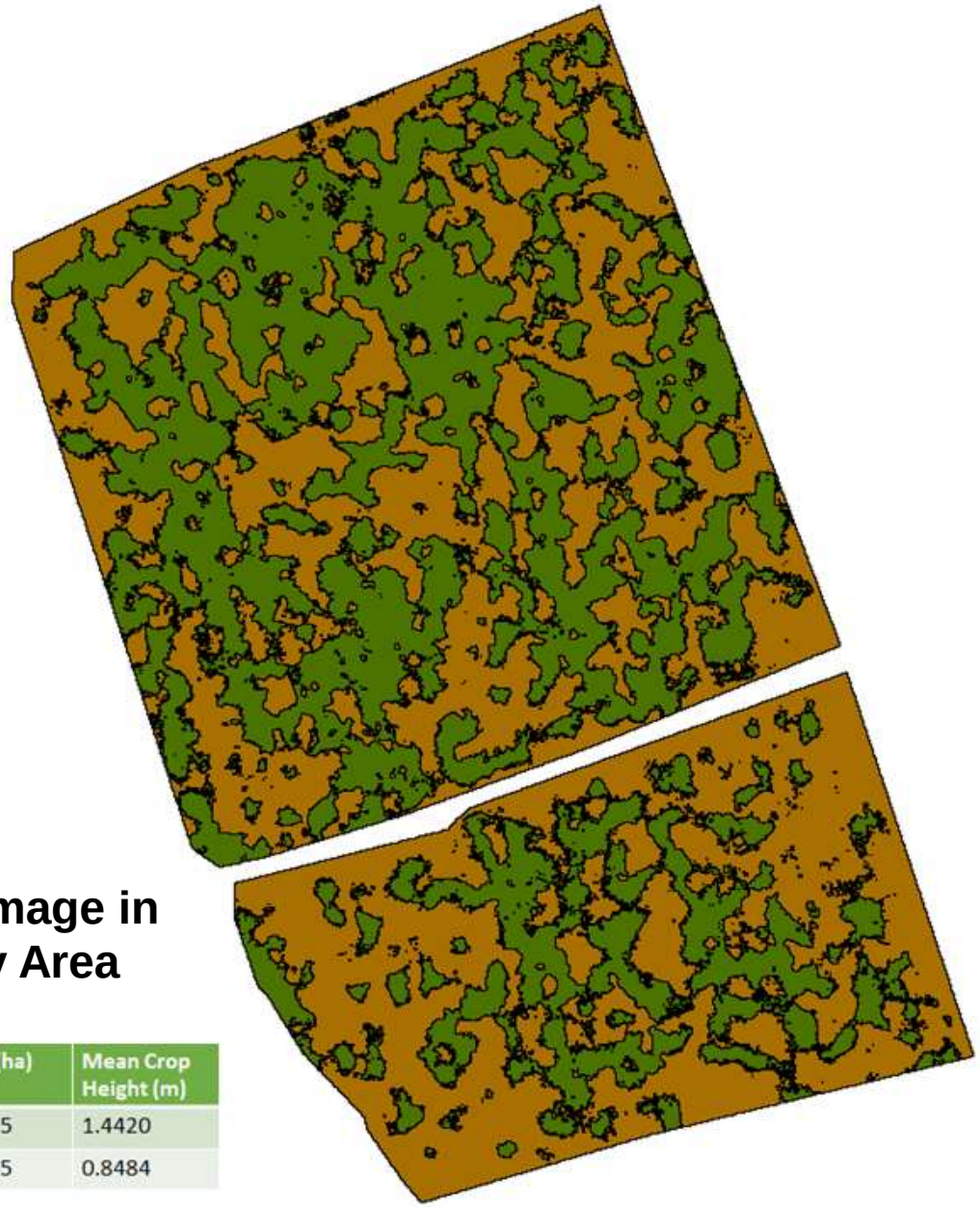


UAS Burned Area



UAV orthophotos showing burned sugarcane plots in Brgy. Dao, Tuy, Batangas

Crop Damage Assessment



Classified UAV image in Cagayan Study Area

		Area (ha)	Mean Crop Height (m)
	Healthy/standing canes	1.1235	1.4420
	Damaged/lodged canes	1.3745	0.8484

Green (G)

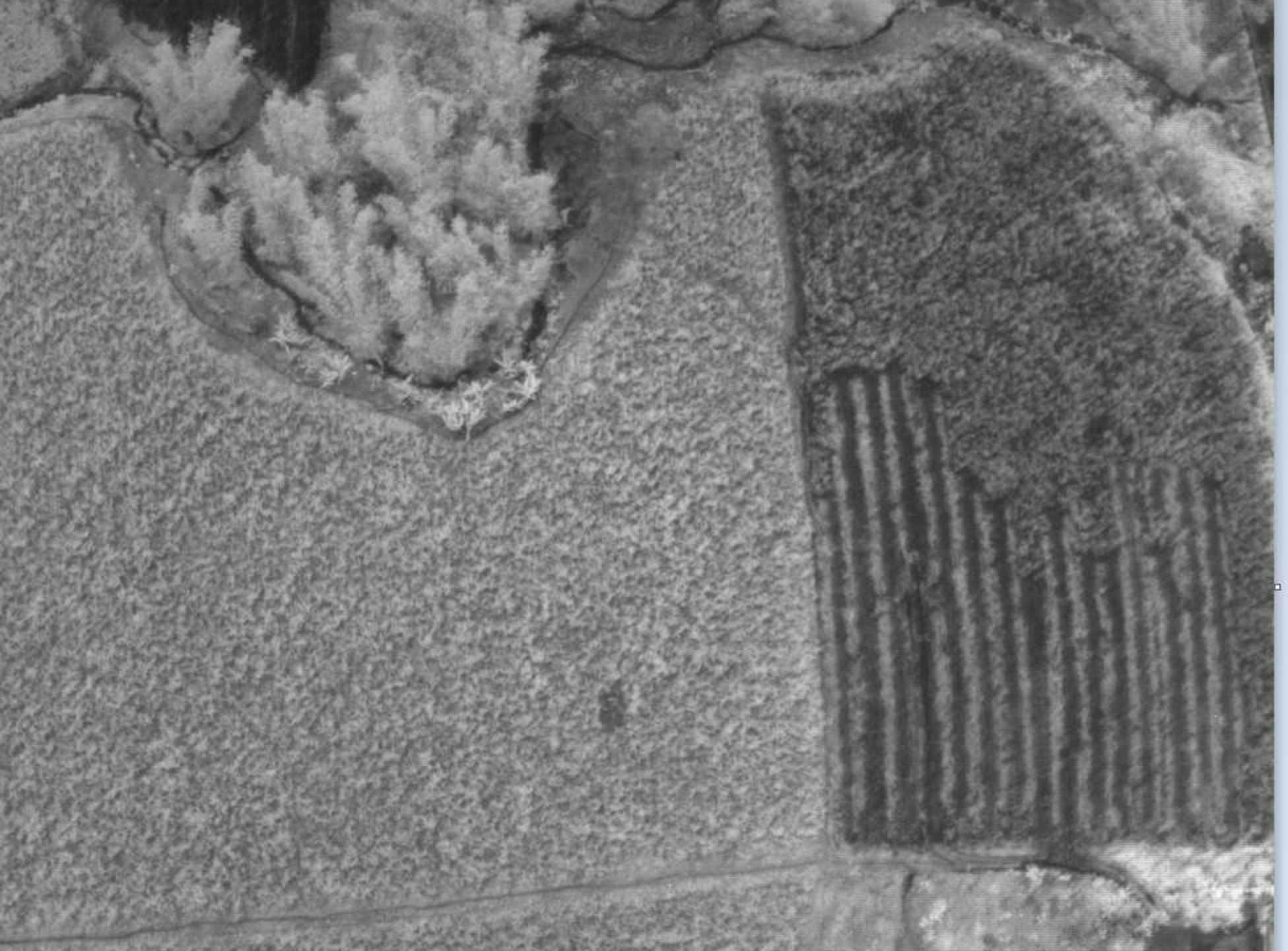
Sample Image

Red
(R)

Sample Image

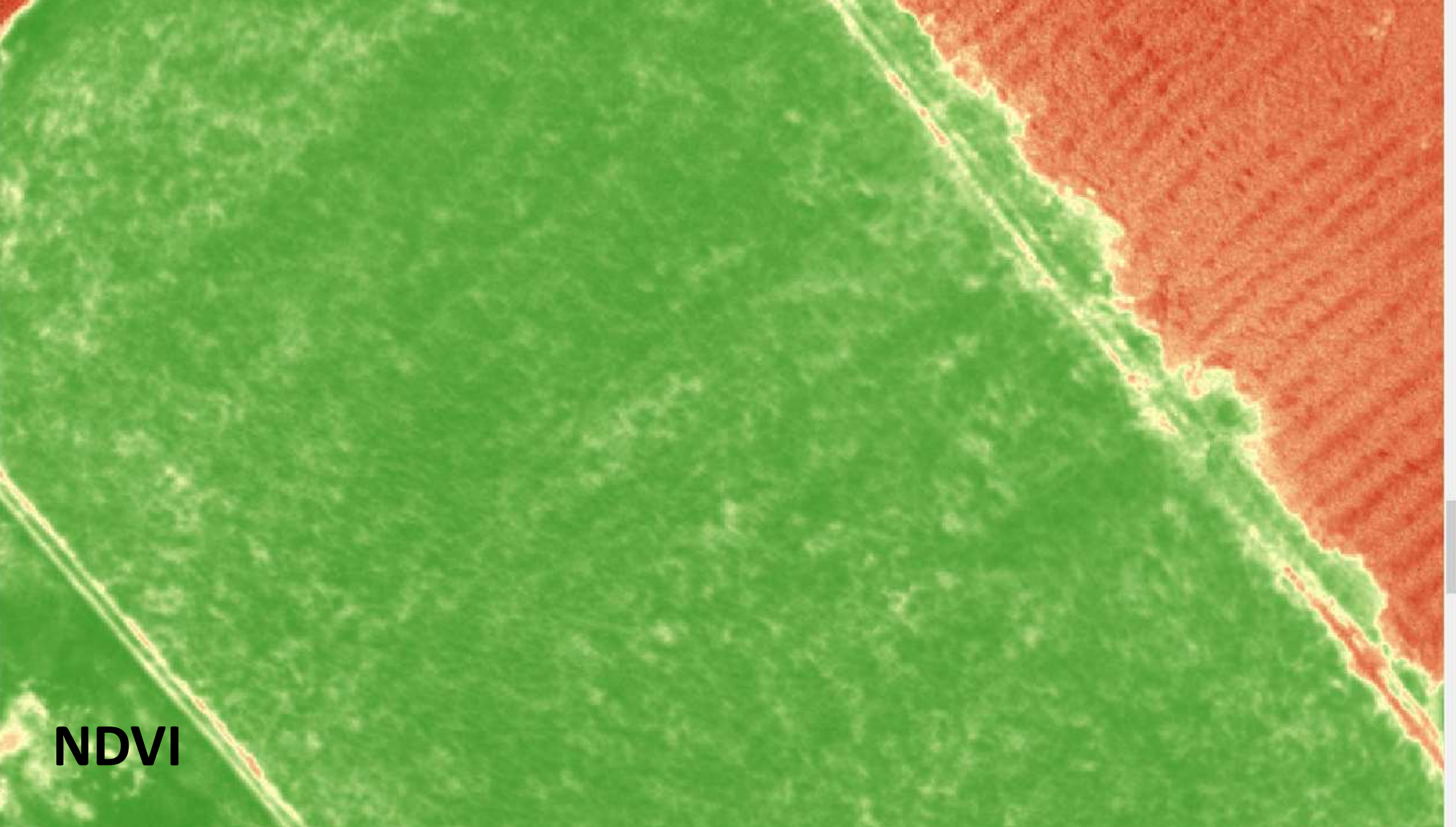
Red Edge (RE)

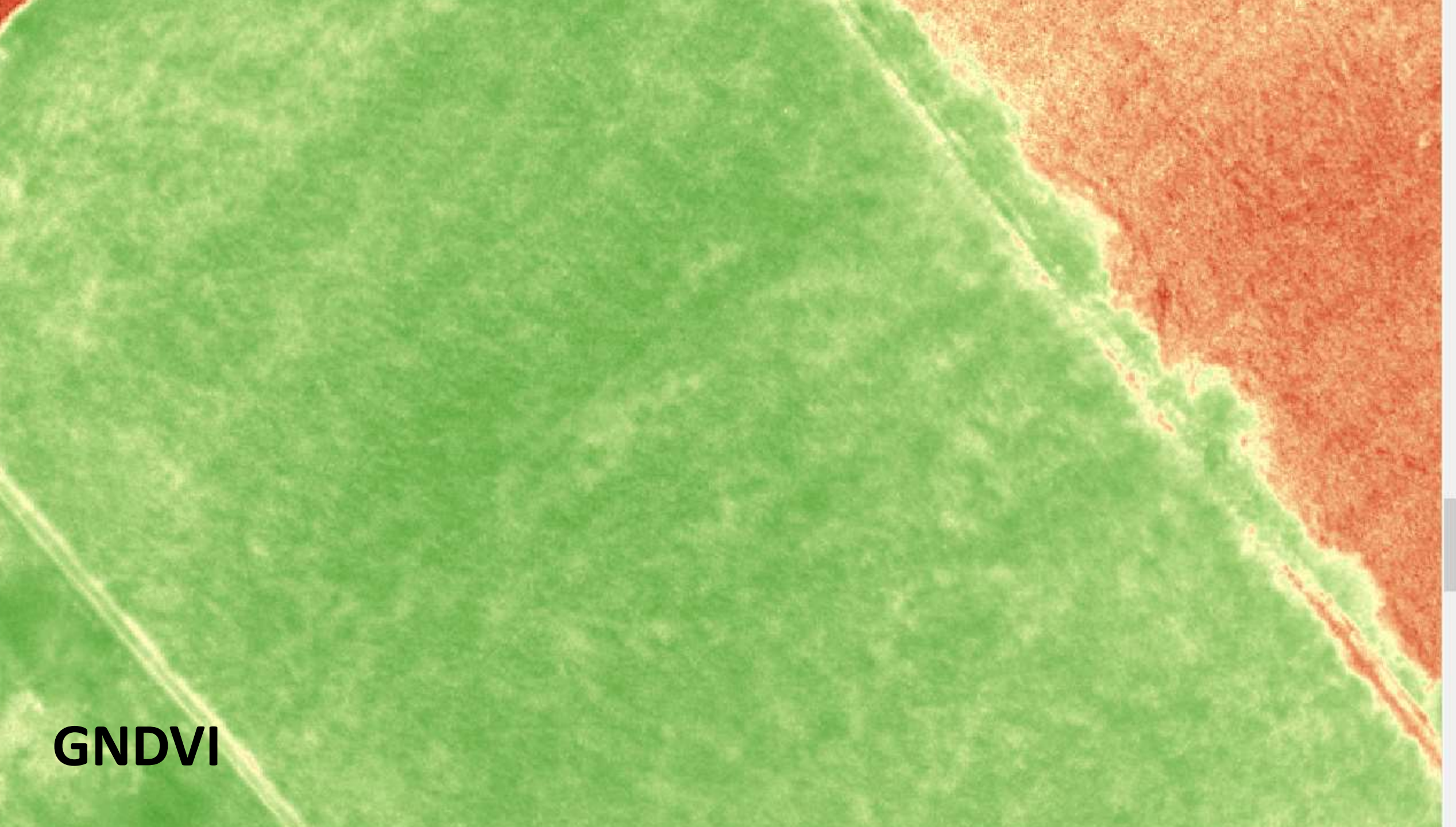
Sample Image

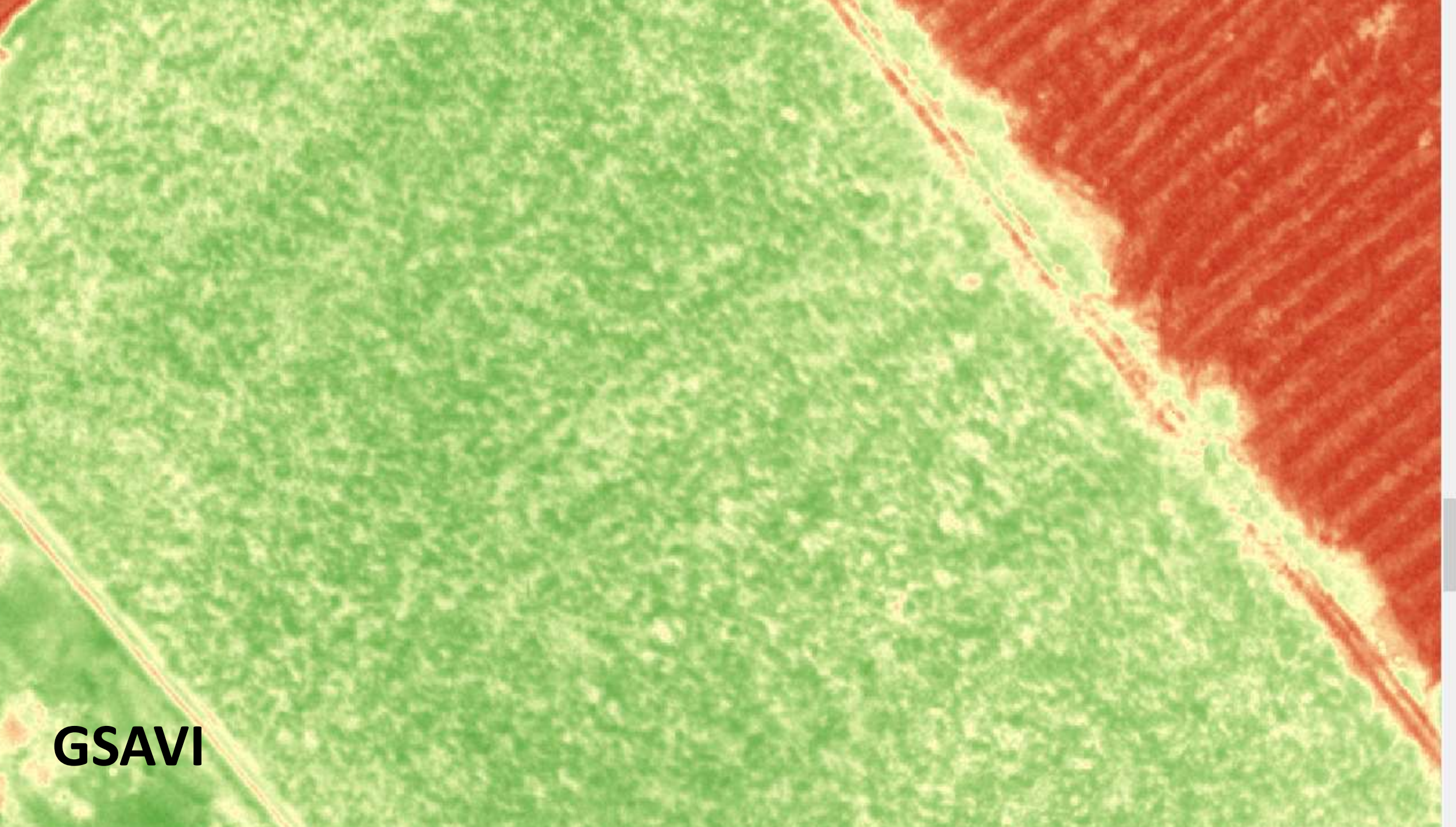


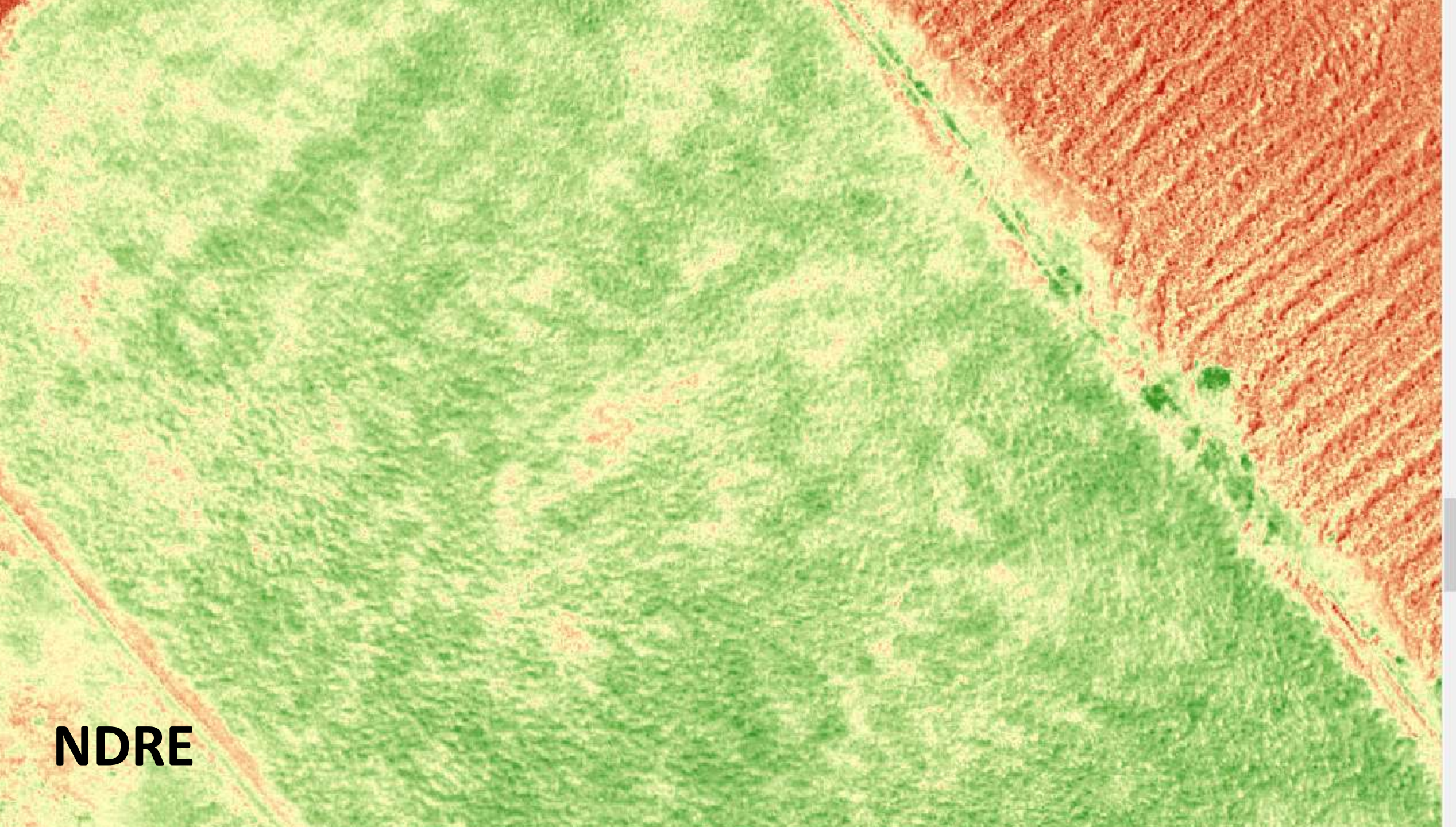
Near Infrared (NIR)

Sample Image

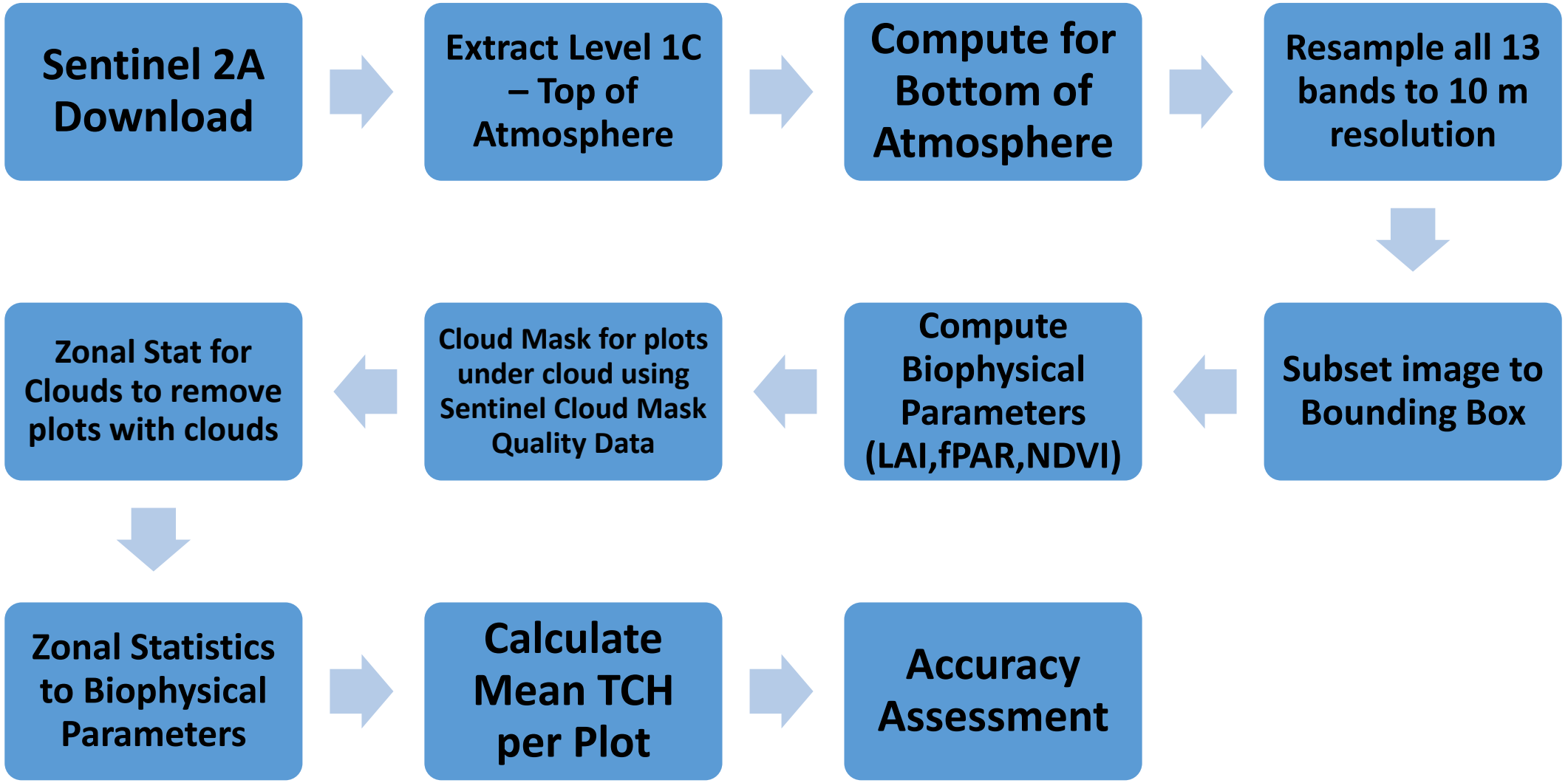

NDVI


GNDVI

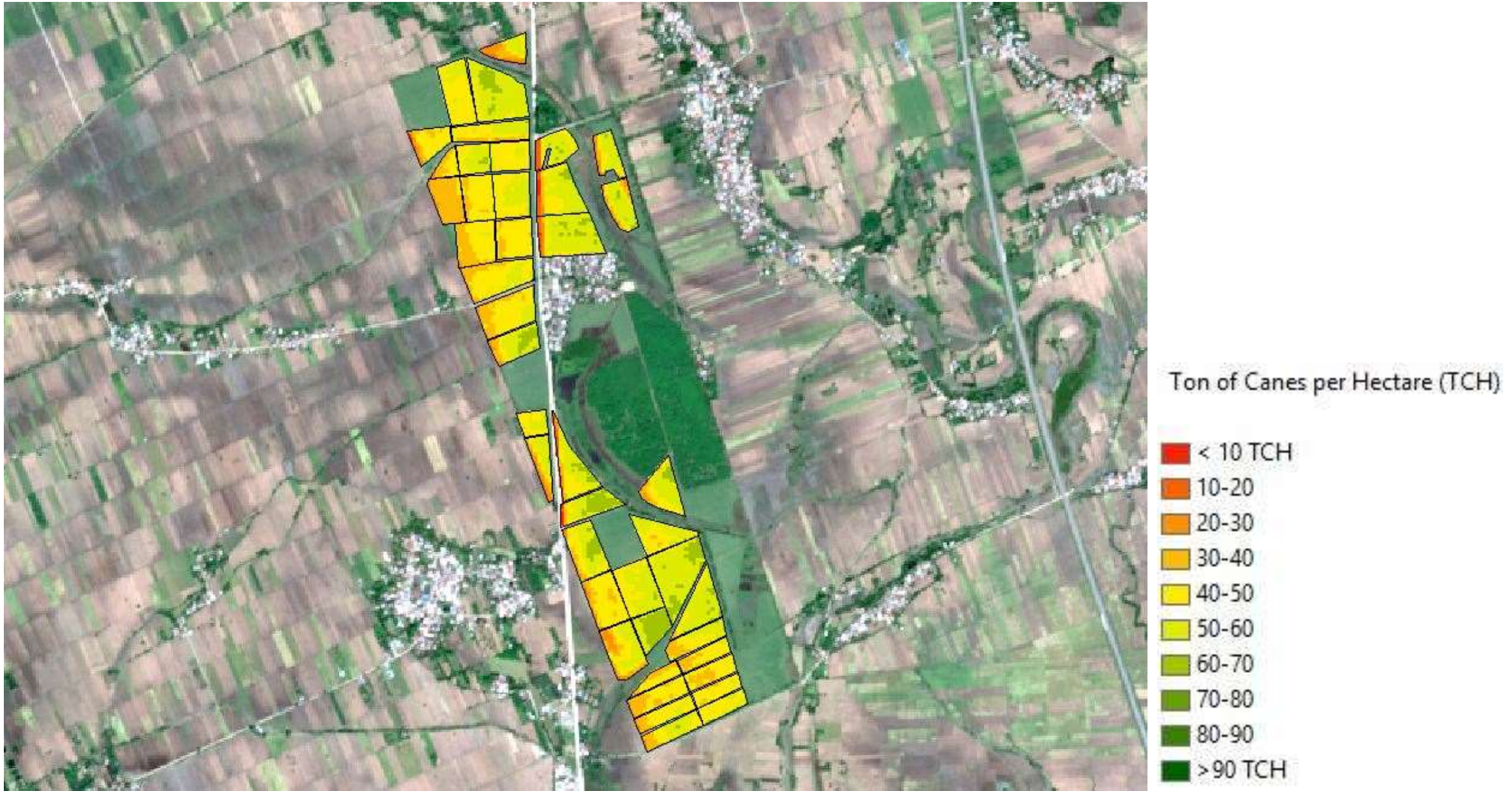

GSAVI


NDRE

Estimating Mean TCH per Plot Using Sentinel 2



TCH Estimation



TCH Estimation

TCH Estimation

LKG per TC Estimation (Municipality level)

Table XII. Summary of Regression Outputs for Average LKG per TC

VARIABLE	CAPAS	CONCEPCION	GERONA	PANIQUI	PURA	TARLAC CITY	VICTORIA
Intercept	1.05	1.03	0.48	0.41	1.47	-0.16	2.54
FPAR_YF	0.58	0.34	0.97	0.30	1.70	-0.61	2.29
FPAR_MS	-0.78	0.95	1.30	2.02	1.36	3.16*	-5.15*
LAI_YF	-0.27	-0.16	0.06	0.18	-0.13	-0.16*	-0.50
LAI_TM	0.17	0.10	0.06	-0.18	0.10	0.27*	0.05
LAI_MS	0.26	-0.40	-0.49	-0.84	-0.65	-0.78	2.23*
NDVI_YF	0.89	0.45*	0.04	-0.16	0.59	0.72*	-0.03
NDVI_MS	0.56	-0.14	-0.33	0.77	-1.58	0.32	-1.60
RAIN_YF	0.00	0.00*	0.01*	0.01*	0.00	0.01*	0.00
RAIN_MS	0.00	0.00	0.00	0.00	0.00	0.00	0.00
R-square	0.82	0.55	0.46	0.59	0.89	0.85	0.94
Adj R-square	0.49	0.39	0.30	0.41	0.69	0.76	0.82
St. Error	0.069	0.069	0.09	0.093	0.047	0.055	0.047

LKG per TC Estimation (Barangay or Village level)

Equation 5. Model Derived for Pura

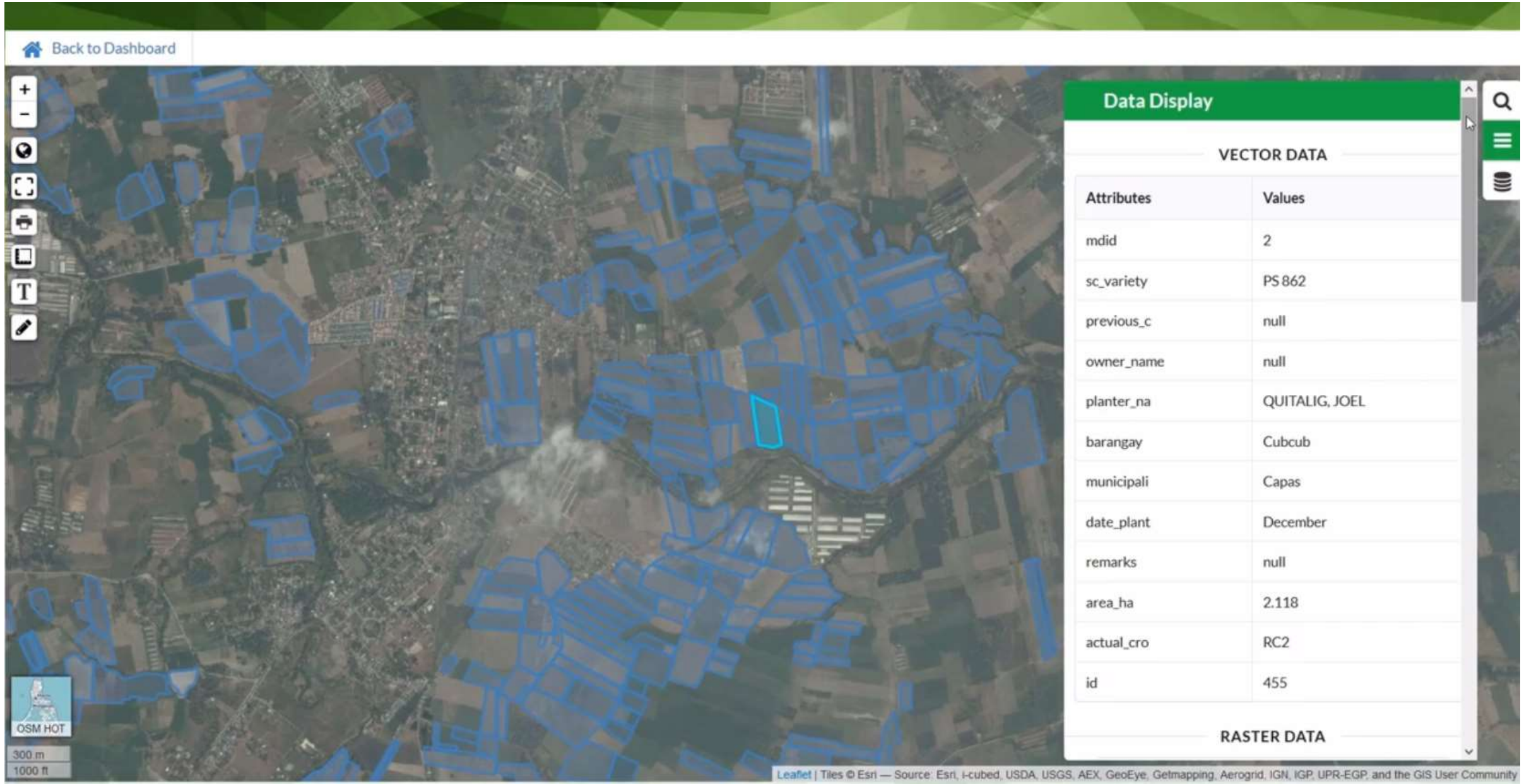
$$LKGTC\_EST_{Pura} = 1.51 + 1.84*FPAR\_YF - 0.16*LAI\_YF - 0.38*LAI\_MS + 0.63*NDVI\_YF - 0.75*NDVI\_MS$$

Table XVII. CY1617 Average LKG per TC Estimates for Pura

Barangay	LKGTC_EST	FPAR_YF	LAI_YF	LAI_MS	NDVI_YF	NDVI_MS
Cadanglaan	1.68	0.56	1.47	1.73	0.79	0.62
Linao	1.85	0.59	1.82	1.35	0.78	0.59
Maungib	1.67	0.54	1.39	1.62	0.73	0.62
Pura	**1.73**					

This has a relatively high R-square of **0.89** and standard error of **0.04**.

SRA WebGIS


Back to Dashboard
Data Display
VECTOR DATA
Attributes
Values
mdid
2
sc_variety
PS 862
previous_c
null
owner_name
null
planter_na
QUITALIG, JOEL
barangay
Cubcub
municipali
Capas
date_plant
December
remarks
null
area_ha
2.118
actual_cro
RC2
id
455
RASTER DATA
OSM HOT
300 m
1000 ft
Leaflet | Tiles © Esri — Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, UPR-EGP, and the GIS User Community

Looking Forward…

Utilizing more imagery, including from the Philippines' microsatellite and UAS…

Incorporating damage due to infestations…

Projecting damages due to typhoons and drought…

Improving the yield estimation models…

Providing other useful geospatial information…

Thank you!

SRA-YESS
UP-SRA YIELD ESTIMATION SYSTEM FOR SUGARCANE