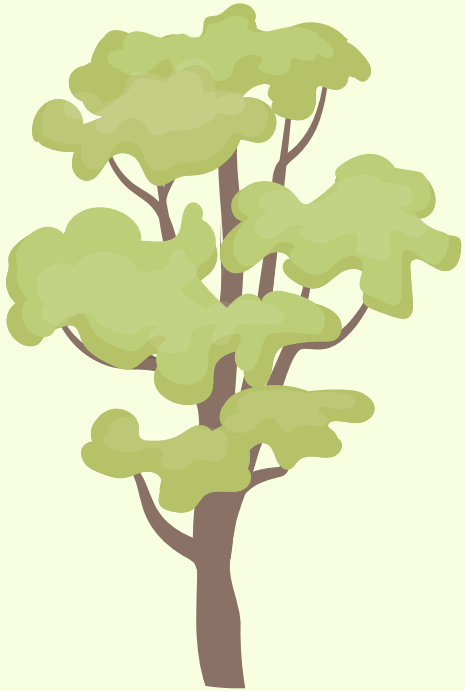
Distinguishing *Gilbertiodendron Dewevrei* and Mixed Forest in the Okapi Wildlife Reserve, Democratic Republic of Congo, using multi-source satellite data

Vanchy Li, Regs Regenye, Yu-Yun Ruan, and Caleigh Mclaren

Overview



01 Research Goals and Objectives

02 Data and Methods

03 Analysis

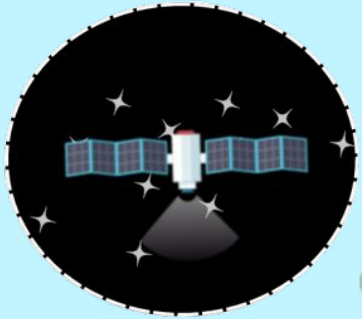
04 Conclusion and Main Takeaways

01

Research Goals and Objectives

OKAPI WILDLIFE RESERVE
N
W
E
S
Nepoko
Mande
Mubilingo
Agamba
Ngayu
Isoro
WCS Study Site
Nduye
Epulu
Eboyo
Ituri
Ibina
CENTRAL AFRIGAN REPUBLIC
CAMEROON
SOUTH SUDAN
Bomu
Bili
Ubangi
Uele
Lua
Kongala
Fleuve Congo
Lopori
Lulonga
Aruwimi
Lindi
Maringa
Kisangani
Tshopo
UGANDA
Ruki
Busira
Tshuapa
Salonga
GABON
CONGO
KENYA
Lowa
DEMOCRATIC REPUBLIC OF CONGO
RWANDA
Elila
Ulindi
Fimi
Kwa
Kasai
Kwilu
BURUNDI
Kinshasa
Sankuru
UNITED REPUBLIC OF TANZANIA
Tanganyika
Kananga
Lulua
Mbuji-Mayi
Loange
Lukuga
ANGOLA
Luvua
Moero
Nzilo
ZAMBIA
Lubumbashi
MOZAMBIQUE
AFRICA
DRC
Cities
Sampling Points
Africa
Protected Areas
Democratic Republic of Congo (DRC)
Rivers
Water Bodies
Where We Work
0 100 200 400 Km

Conceptual Model



Dry Season:
November-March

30-40 Meter
Height with
Dense Canopy

Wet Season:
March-May and
August-November

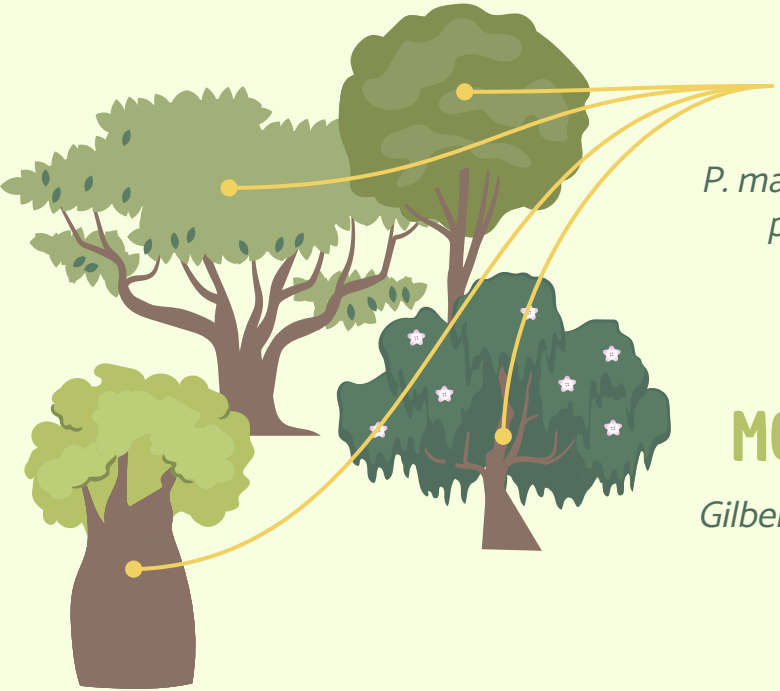
30-40 Meter Height with
Open Understory and
dense subcanopy

WCS

Gilbertiodendron

Mixed
Forest

Forest Composition in the Okapi Wildlife Reserve



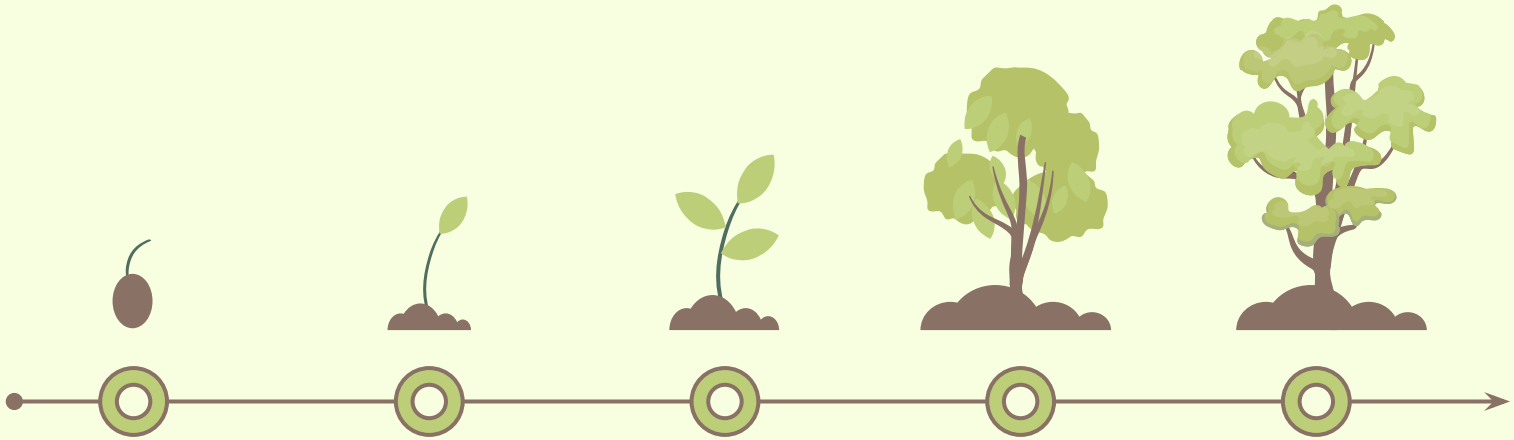
MIXED

P. macrocarpus, P. macrophylla, C. procera, D. glaucecens, & E. suaveolens

MONODOMINANT

Gilbertiodendron Dewevrei (GD)

The Mechanisms for Monodominance in the Trans-Congo Region



GD's seeds have large mass and low dispersibility

GD is an ectomycorrhizal monodominant species

GD's shade tolerant saplings give an advantage over non-shade tolerant pioneer species

GD's leaves have slow decomposition which creates beneficial conditions for large seeds

GD's seedlings share many fungal symbionts with their parents

From Steege et al., 2019

Research Goals and Objectives

1. Evaluate different satellite datasets in their ability to discern between monodominant and mixed forest

2. Create a final map that distinguishes forest types

3. Produce an explanation of the methodology for replication by WCS

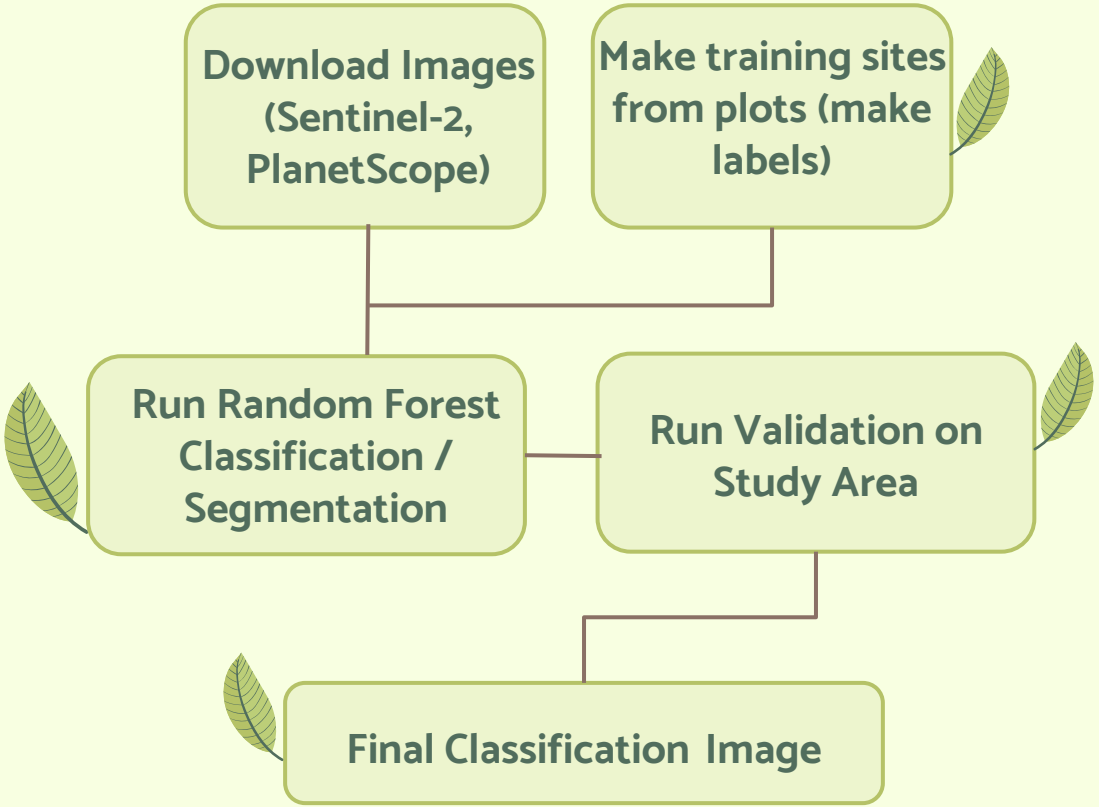
02

Data and Methods

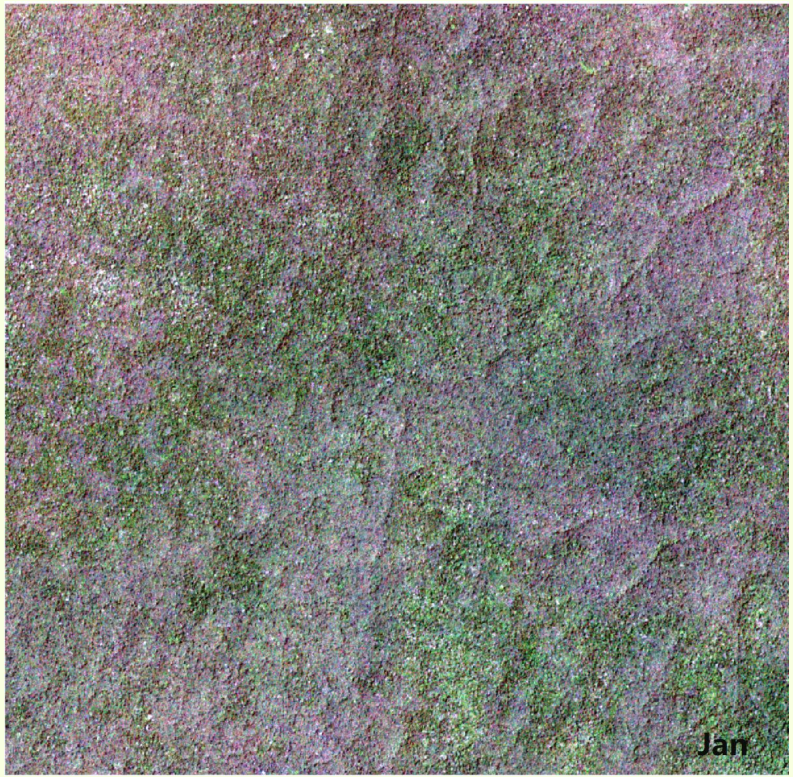
Data Table

	Description	Type	Spatial Resolution	Temporal Resolution	Spectral Resolution	Source
WCS ground data	Ground sample data	Shapefile (points)	NA	NA	NA	WCS
Sentinel-2	Optional data	raster	10m - 20m	5 days	14 bands	GEE: https://developers.google.com/earth-engine/datasets/catalog/COPERNICUS_S2_SR
PlanetScope	Optional data	raster	3 - 5m	daily	4 bands	PlanetScope: https://developers.google.com/earth-engine/datasets/catalog/projects_planet-nicfi_assets_basemaps_africa

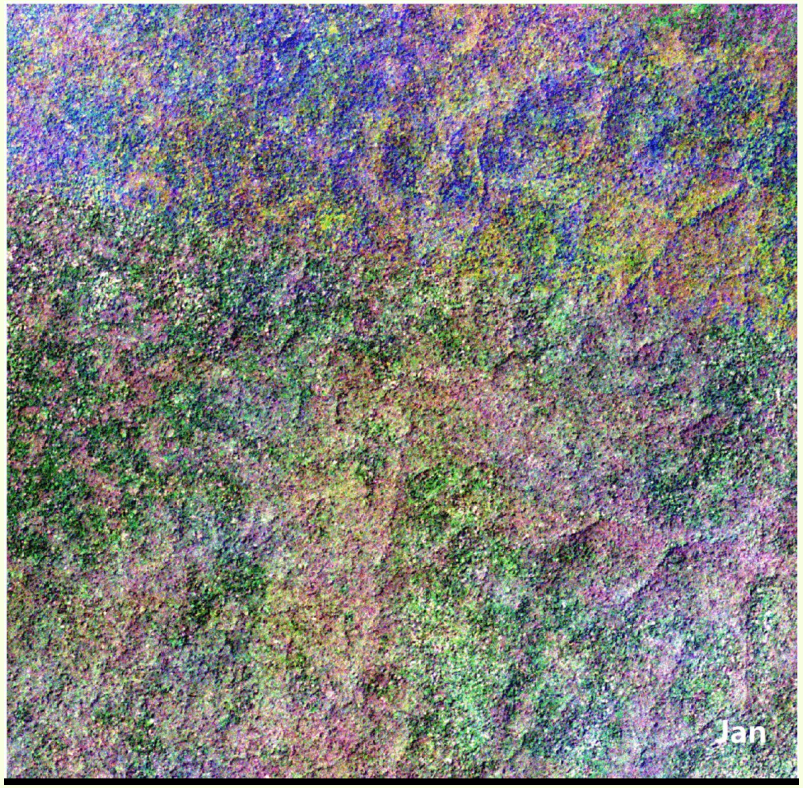
Methodology



Month Selection

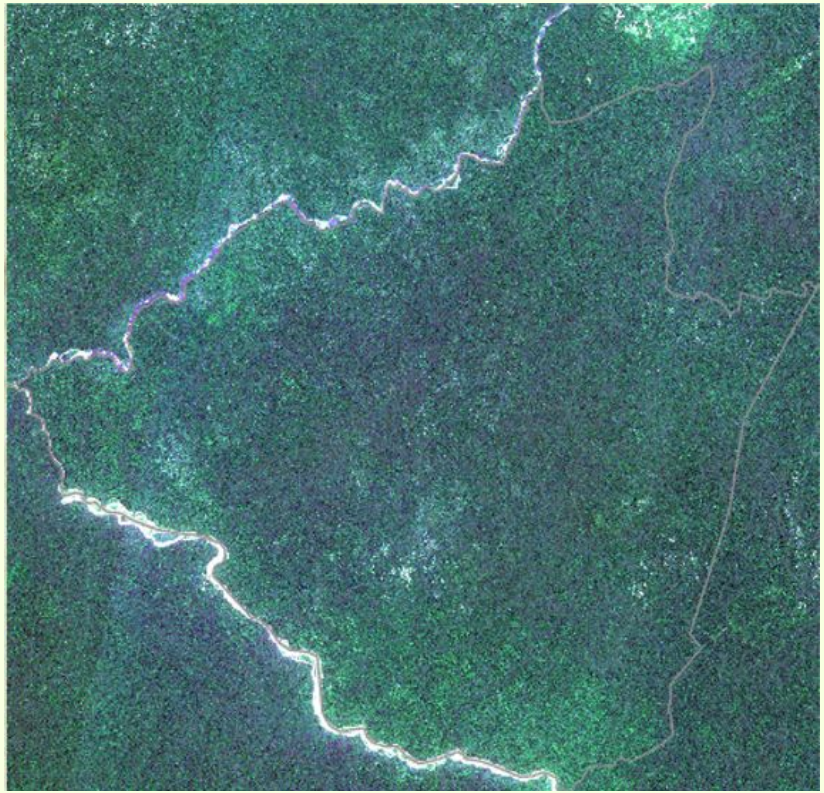


Sentinel-2 in study area from Jan to Dec, 2022

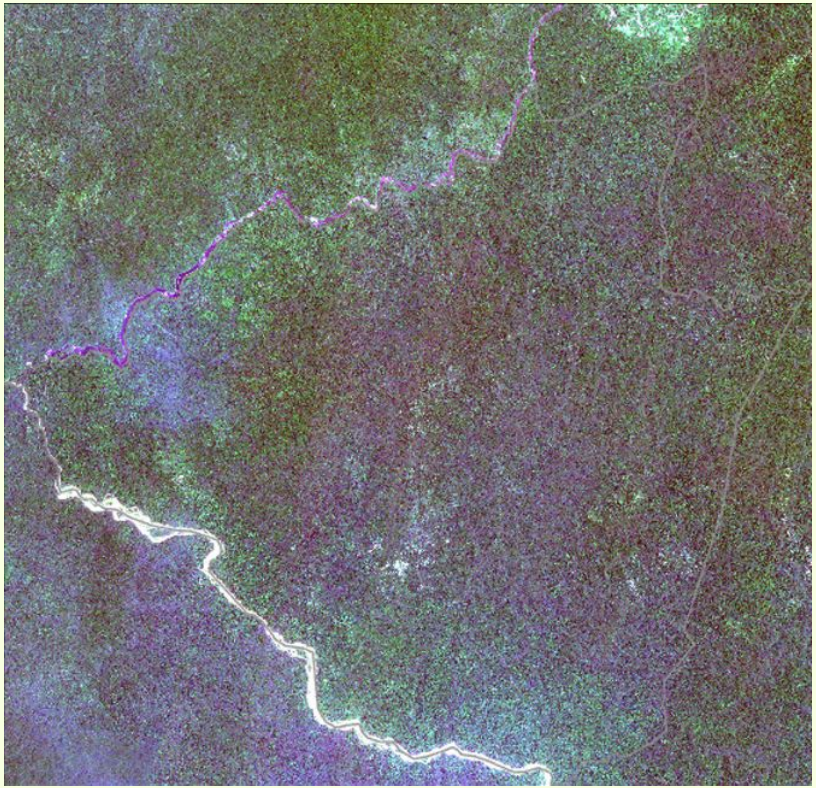


PlanetScope in study area from Jan to Dec, 2022

March 2022 Images



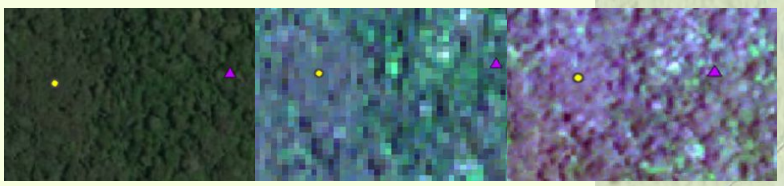
Sentinel-2

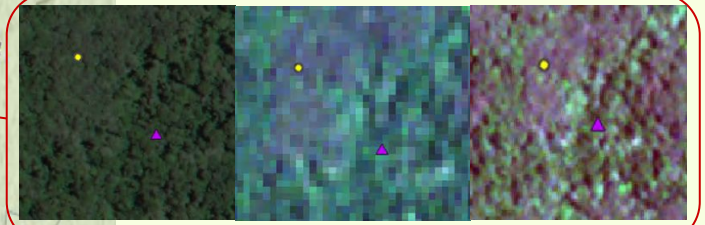


PlanetScope

How training sites were selected?

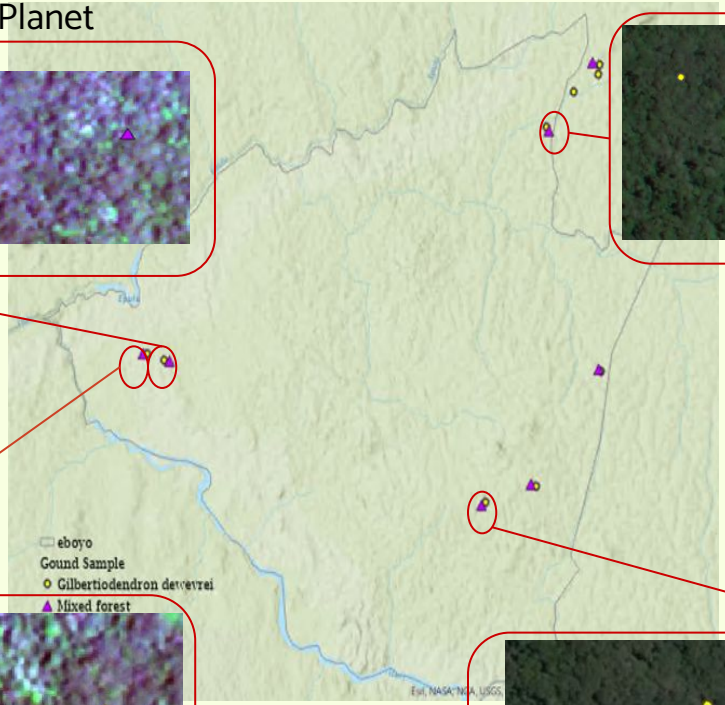
Basemap Sentinel-2 Planet

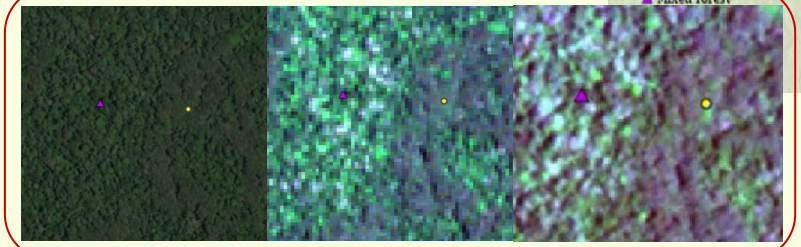


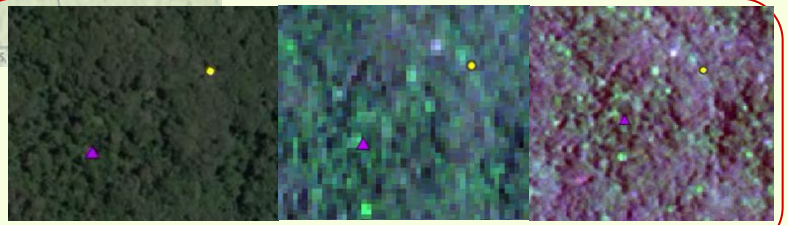


Gibert Monodominant: Darker patches created by a tense, continuous canopy

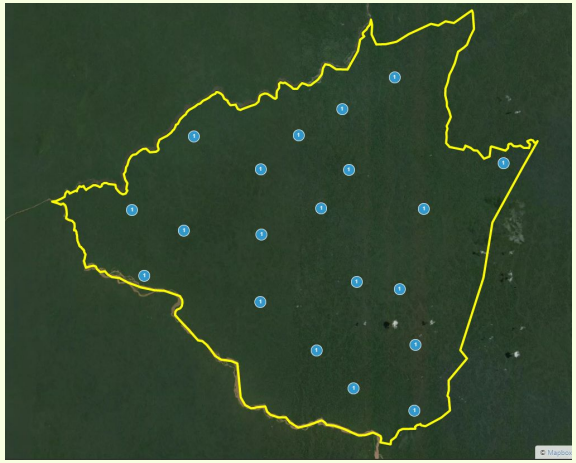
Mixed Forest: Gaps, lighter or a combination of colors



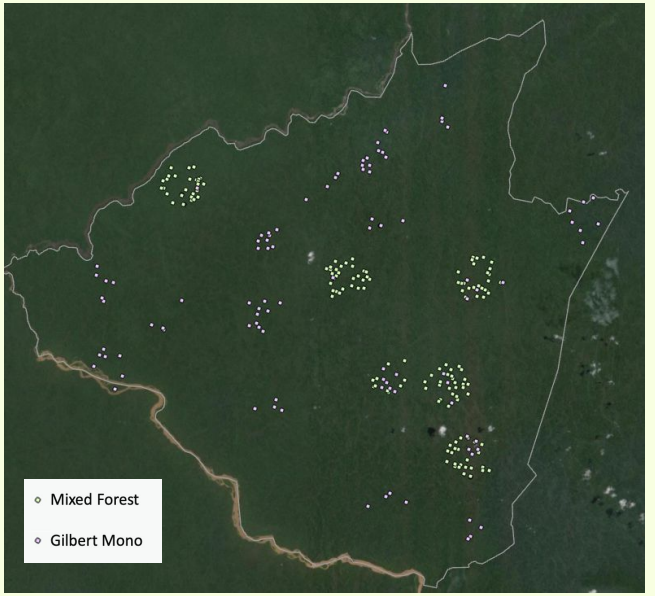


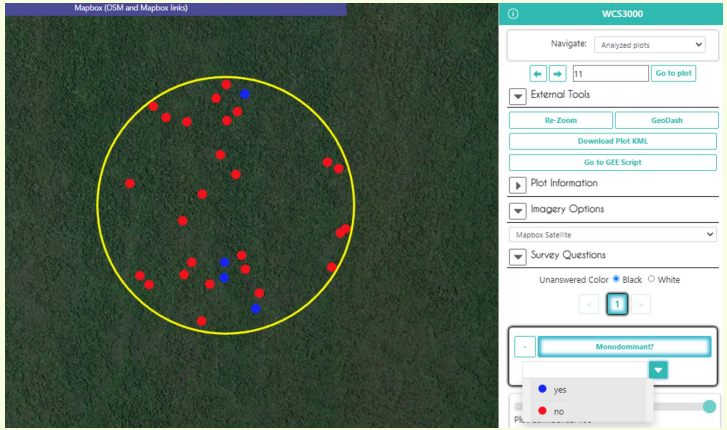


Training Sites Selection: Collect Earth Online

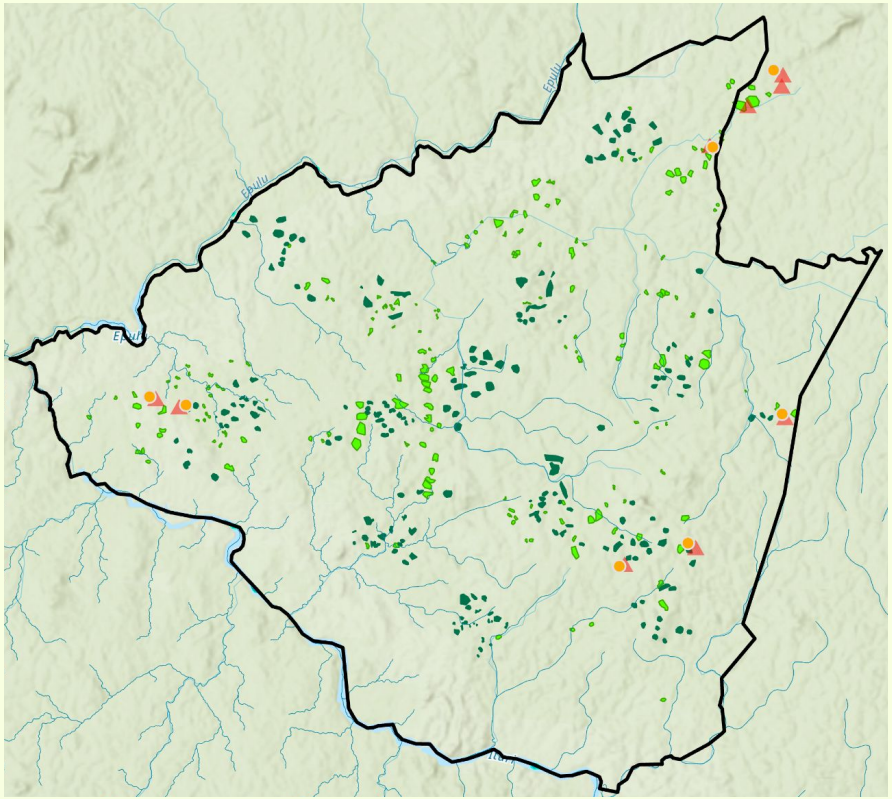


COLLECT EARTH ONLINE





Monodominant and Mixed Training Sites in Eboyo



WCS Ground Samples

- Monodominant
- Mixed

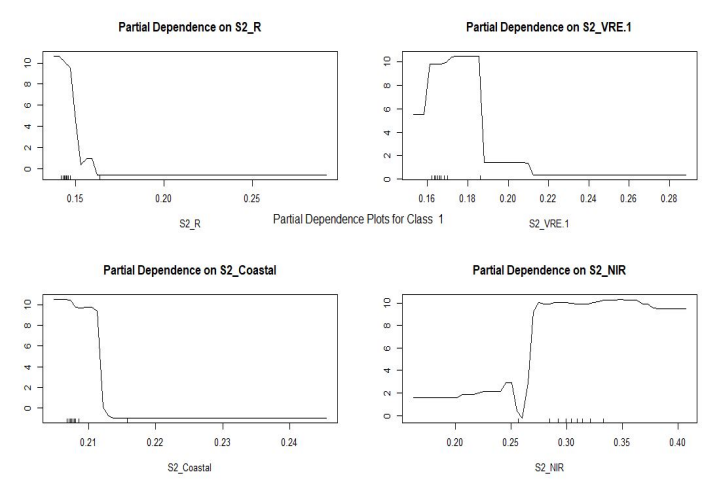
Training Sites

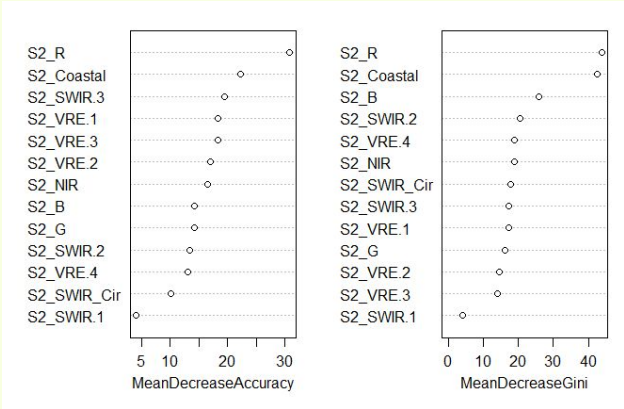
- Monodominant
- Mixed
- Water

03

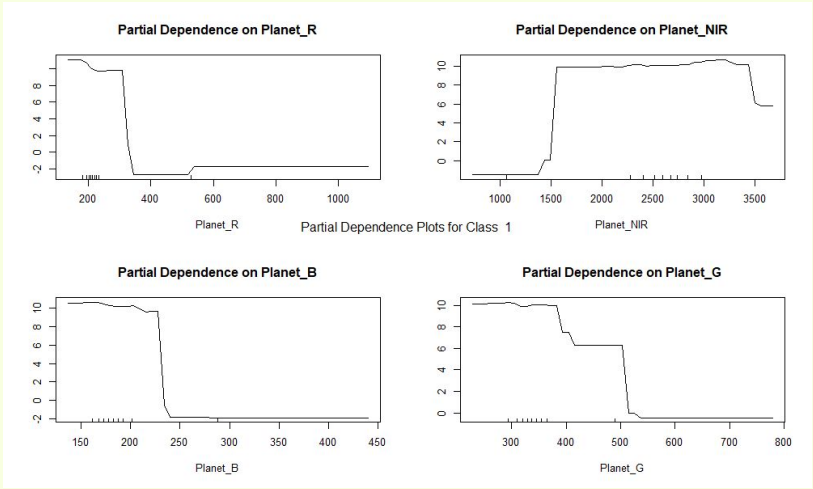
Analysis

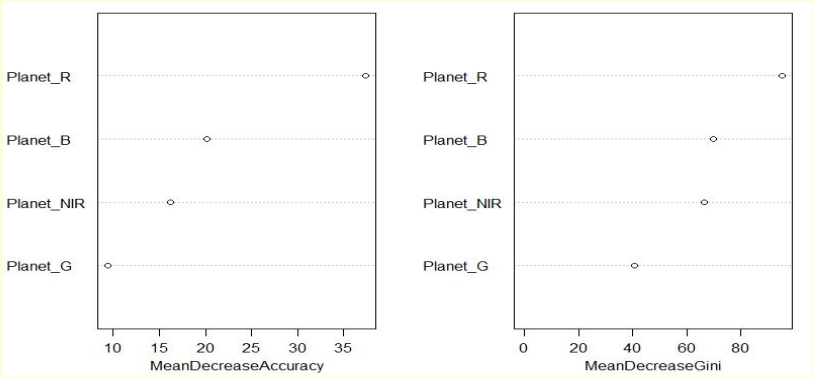
Random Forest: Partial Plots and Feature Importance Plot





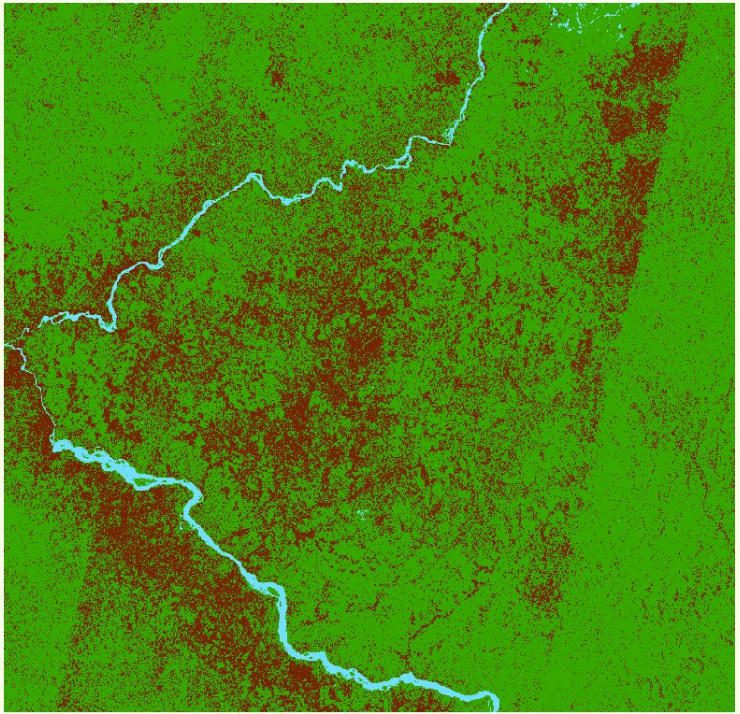
Sentinel-2





PlanetScope

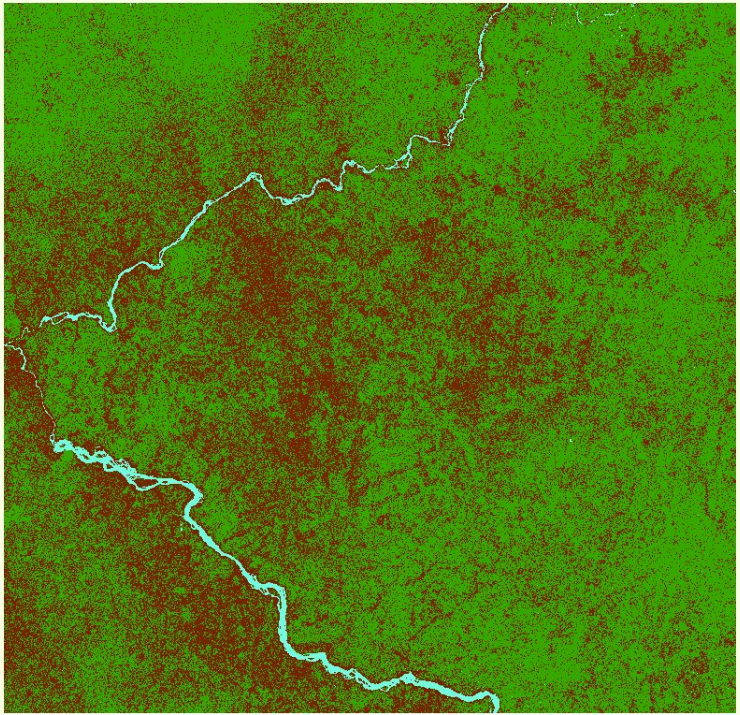
Random Forest Classification



Sentinel-2

Classification

- Monodominant
- Mixed
- Water



PlanetScope

Random Forest Validation: Confusion matrix

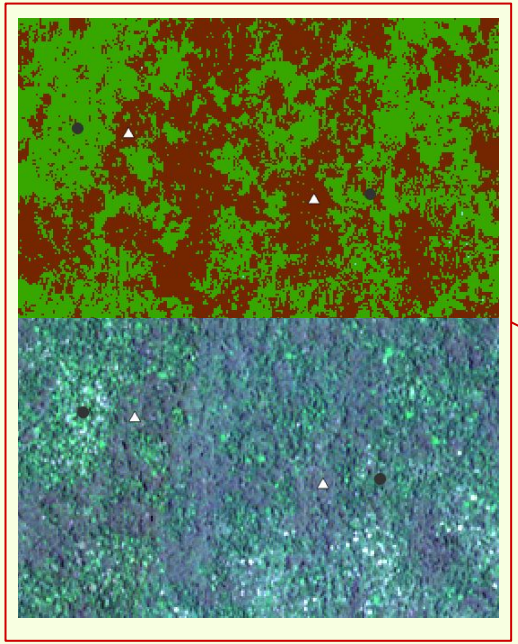
Sentinel-2				
OOB (Out of Bag) Error: 0.2183				
Confusion Matrix:				
	0 Gilbert	1 Mixed	2 Water	Class Error
0 Gilbert	154	50	0	0.245
1 Mixed	50	151	0	0.248
2 Water	0	0	53	0

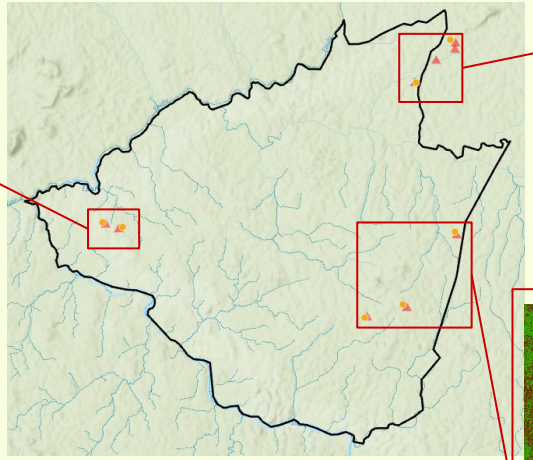
PlanetScope				
OOB (Out of Bag) Error: 0.286				
Confusion Matrix:				
	0 Gilbert	1 Mixed	2 Water	Class Error
0 Gilbert	144	60	0	0.294
1 Mixed	71	130	0	0.353
2 Water	0	0	53	0

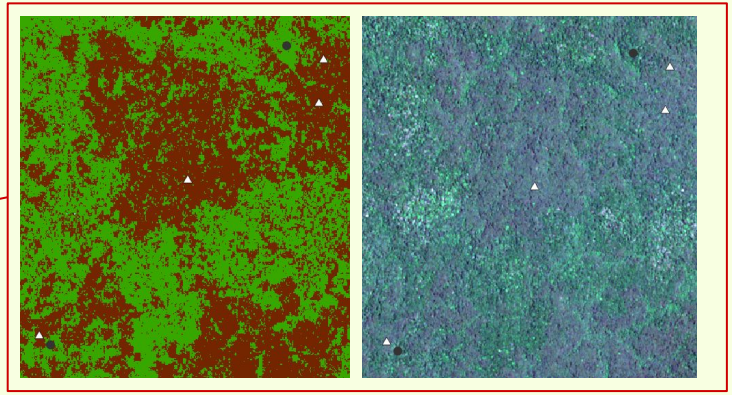
Sentinel-2

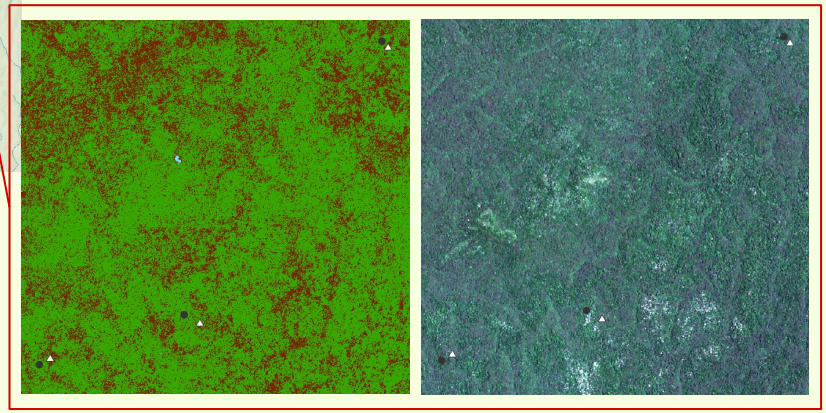
PlanetScope

Sentinel-2 Visual Validation





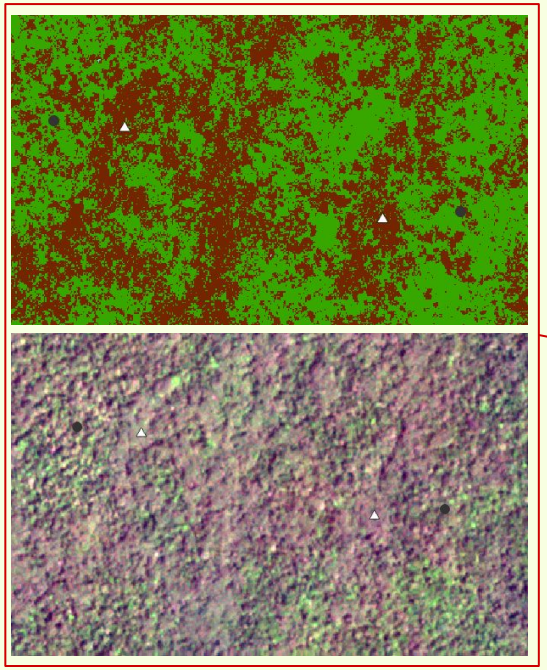


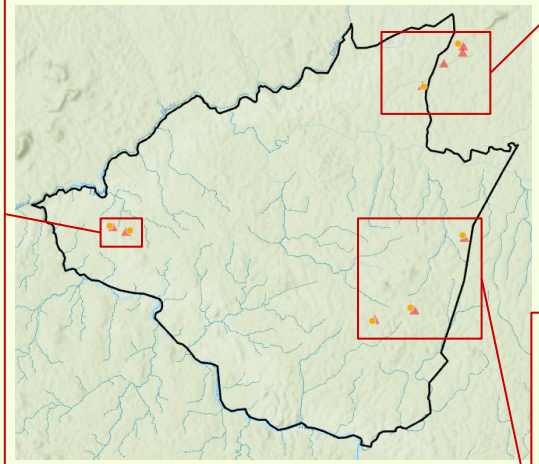


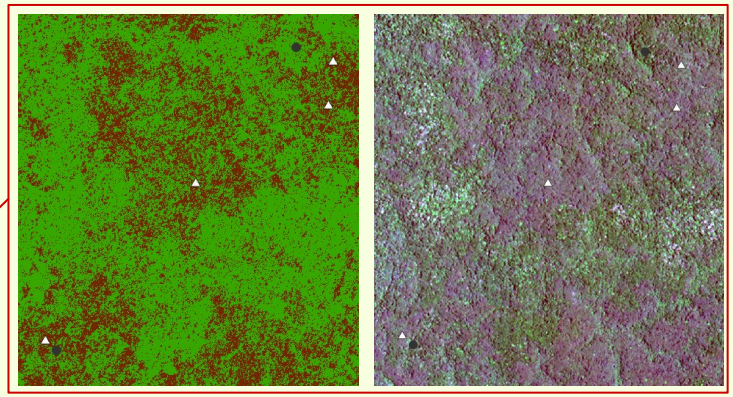
Monodominant

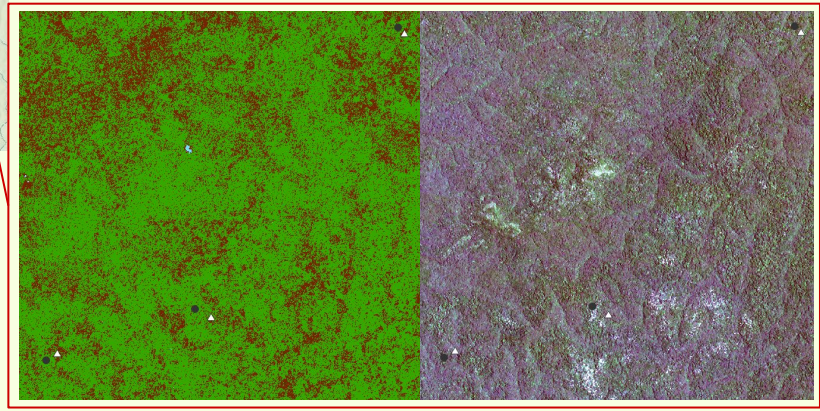
Mixed

PlanetScope Visual Validation



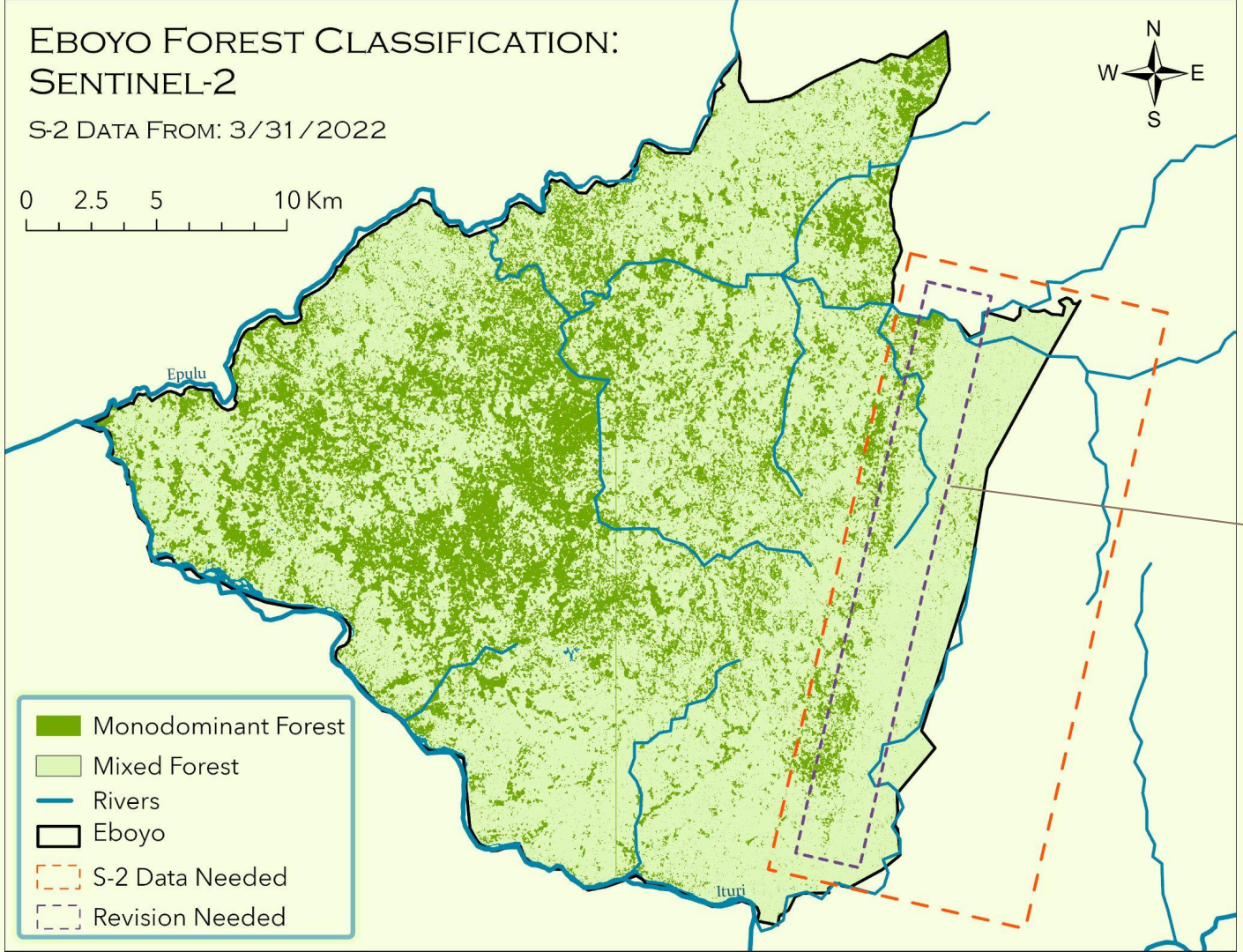




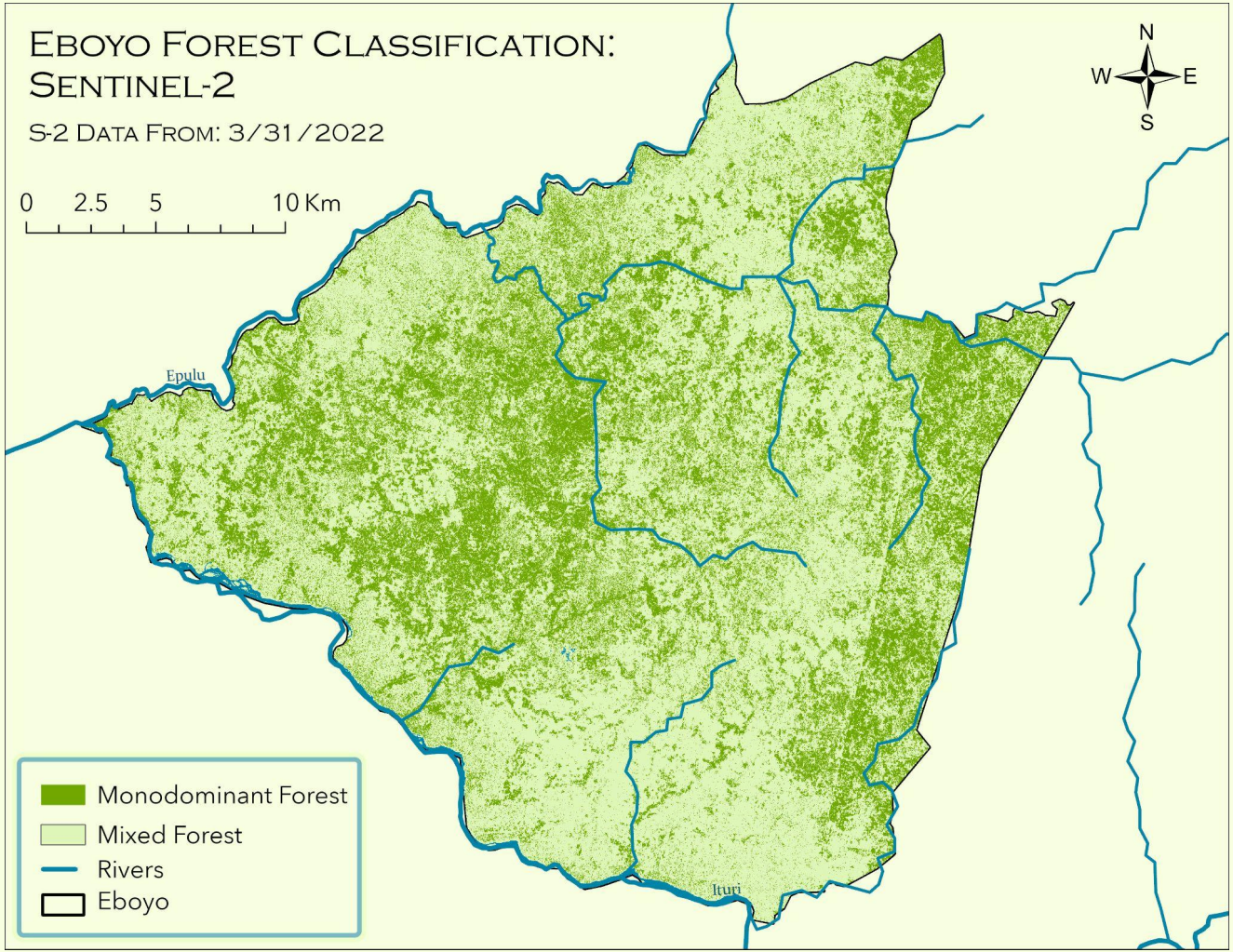


Monodominant

Mixed



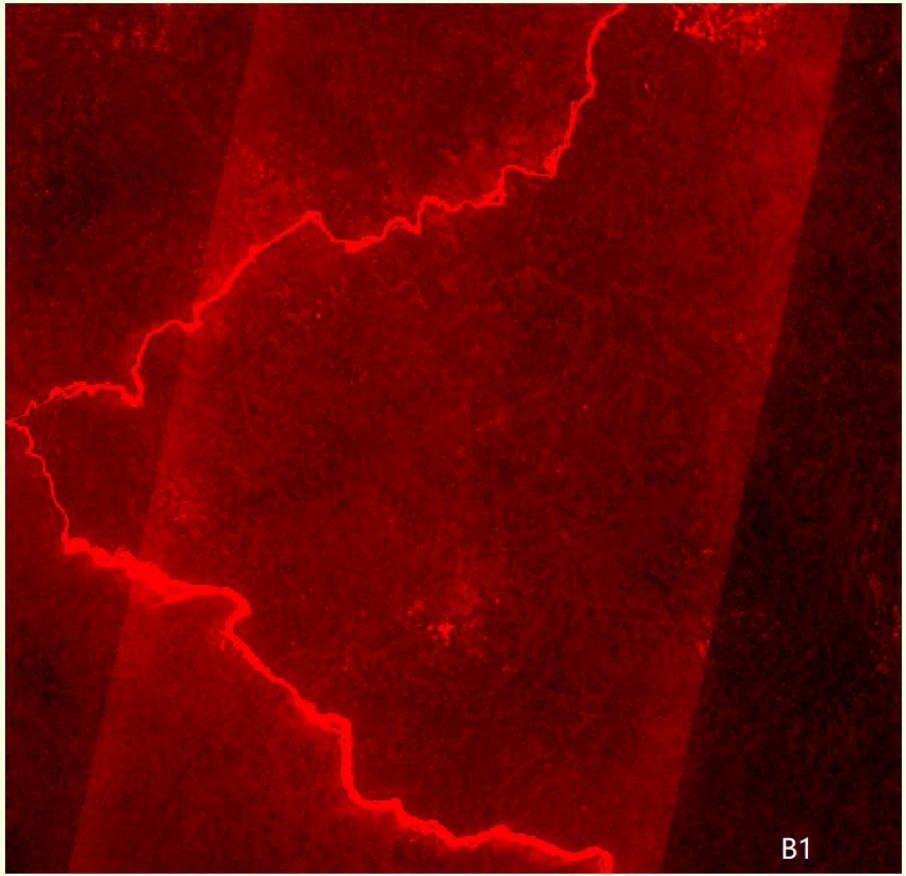
Needs further processing


Eboyo Forest Classification:
Sentinel-2
S-2 Data From: 3/31/2022
0 2.5 5 10 Km
N
W
E
S
Epulu
Ituri
Monodominant Forest
Mixed Forest
Rivers
Eboyo

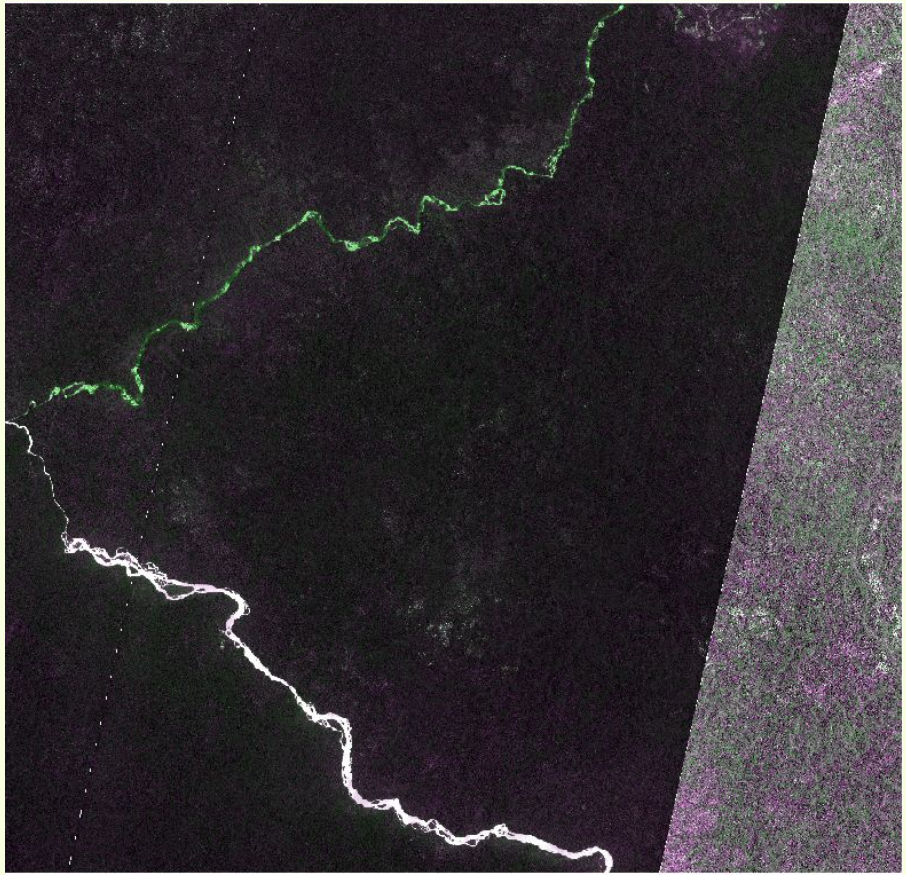
04

Conclusion and Main Takeaways

Limitations

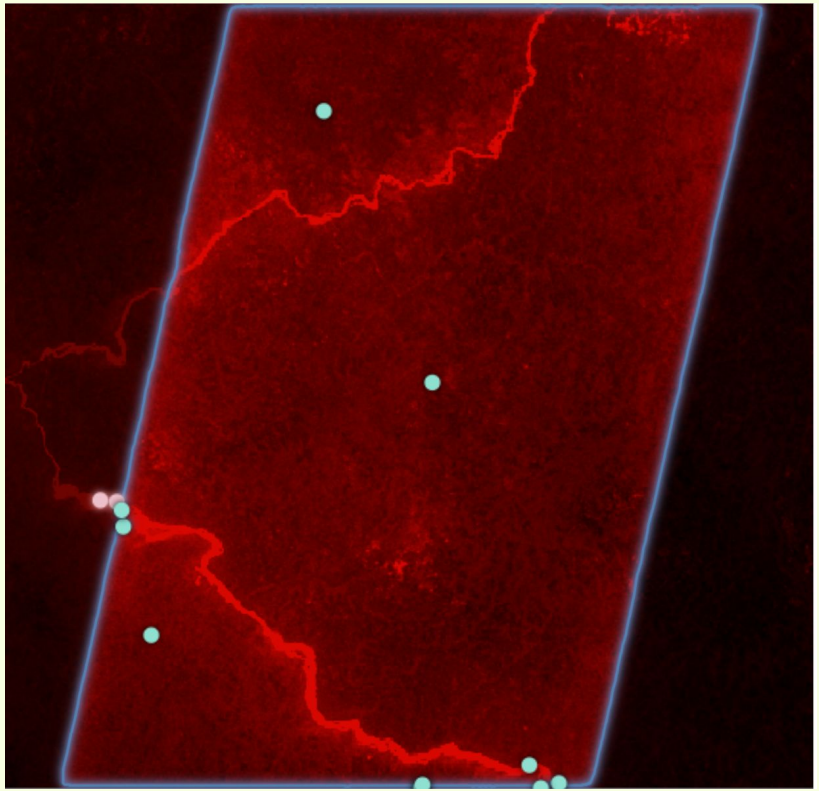


Striping issue in B1, B2, B3, and B5

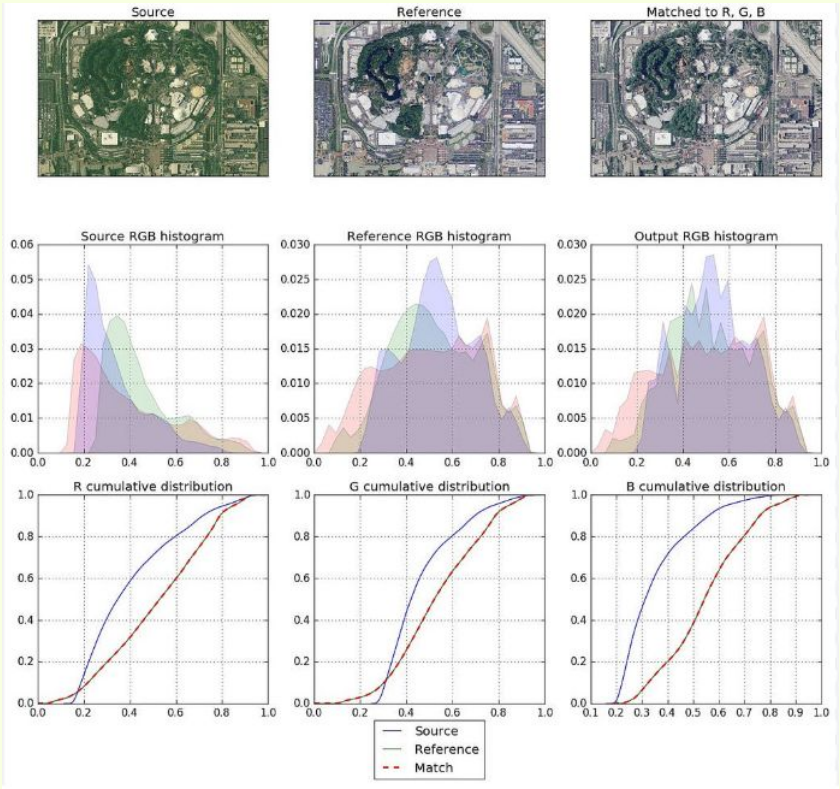


Split Raster issue

Potential Solutions



Segment Anything



Histogram Matching (Demo)

Conclusion

Forest Composition

Sentinel-2:
Monodominant: 32%
Mixed and others: 68%

PlanetScope:
Monodominant: 62%
Mixed and others: 38%

Water and Monodominance

Monodominant forests mostly occur in proximity to rivers and streams.

We found that monodominant forests tend to occur on the opposite of rivers (other environmental factors, the issue of river data)

WCS

Ground sample data.

There are strengths and limitations to analysis, but overall it is possible for WCS to recreate this analysis

Strengths and Limitations of Sentinel-2 and PlanetScope

Sentinel-2

Strengths:

- Free to download, more bands
- Have better classification accuracy

Limitations:

- Image striping issue reduces accuracy of classification
- Difficult to obtain cloud-free images of the entire Okapi area simultaneously

Planetscope

Strengths:

- Finer resolution, more no-cloud images
- No striping problem

Limitations:

- High data cost
- Tend to overfit and lower the accuracy rate

Future work: Tutorial

Explain How to Reprocess in Other Study Area

Provide Data

- Boundaries
- Ground sample data
- Training Sites Example
- Google Earth Script
- Random Forest Script

Software

- Google Earth Engine
- Collect Earth Online
- ArcGIS Pro
- Terrset
- R

GEE Data

Download Sentinel-2 data March 2022. Import to ArcGIS pro, Change Stretch Type to Standard Deviation

Training Sites

Create Random Plot on CEO, Cross Check Basemap and the Sentinel-2 image, and use Create Polygons function in ArcGIS pro

Segment Anything / Histogram Matching

Random Forest

Run Random Forest in R

Validation

Check OOB error rate and estimate Confusion Matrix in R

Segmentation

Spilt the RF output to smaller images. Use SEGMENTATION in Terrset, parameters we use:
Window width: 3
Weight mean factor:6
Similarity Tolerance:5
Weight Variance Factor:0.5

Final Classification map

References

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Kashongwe, H. B., Roy, D. P., & Bwangoy, J. R. B. (2020). Democratic Republic of the Congo Tropical Forest Canopy Height and Aboveground Biomass Estimation with Landsat-8 Operational Land Imager (OLI) and Airborne LiDAR Data: The Effect of Seasonal Landsat Image Selection. *Remote Sensing*, *12*(9), Article 9. https://doi.org/10.3390/rs12091360

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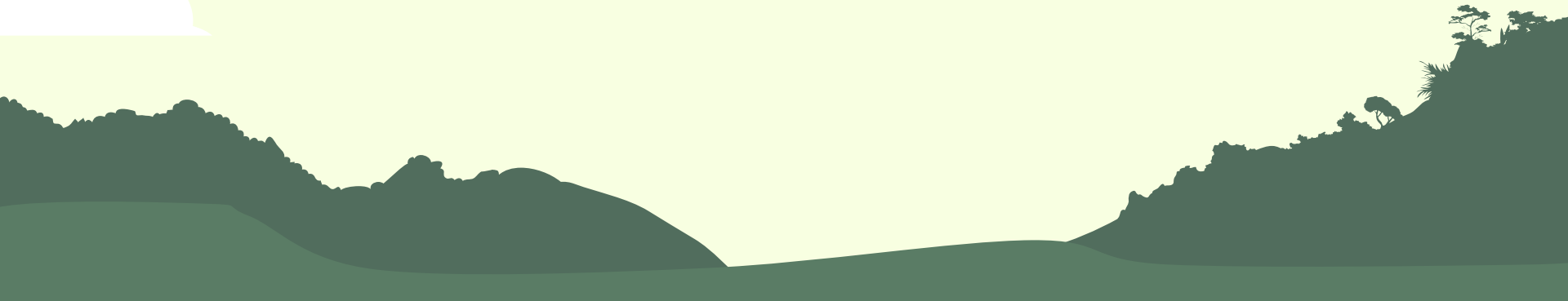
Thank you!

Questions?