Mangrove Forest Biomass Estimates, Community Structure and Classification in the Nigerian Niger Delta.

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1. INTRODUCTION:

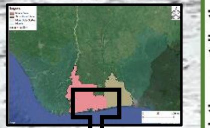
Nigerian mangroves are hotspots of oil pollution, urban development and invasive species, especially in the Niger Delta. There is sparse information on the carbon potential of the Niger Delta. This is compounded by research challenges including security, and navigation. Oil pollution, although the largest cause of mangrove loss in the region. The impact of local disturbance of mangrove stands from harvesting is also sparsely reported which could be as a result of change from fishery to logging as a source of income. The local impact of nipa invasion and disturbance has also been sparsely reported in the Niger Delta. The use of field surveys and remote sensing can address the impact of disturbance on the mangrove landscape while modelling options can inform temporal and spatial changes in carbon stock in the region.

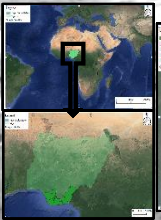
- Little information on mangrove biomass and stand structure.
- No information on current mangrove and nipa coverage.

2. OBJECTIVE:

To provide information on mangrove forests AGB, stand structure across various disturbance regimes in the Niger Delta, with classification and biomass map of the region.

Study Region in the Niger Delta



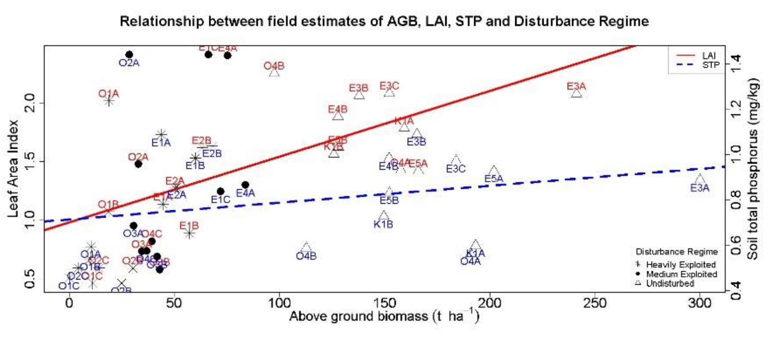


3. AGB and Stand Structure in the Niger Delta

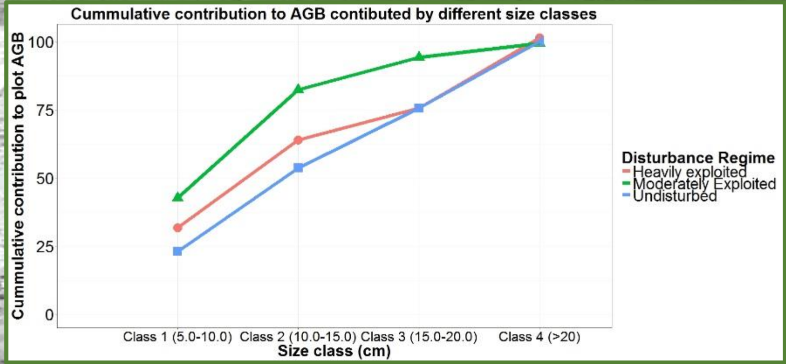
a) Methodology:

25 50m square plots established in 10 transects across 3 locations. Diameter at Breast Height (dbh), leaf and soil samples, and Aboveground Biomass (AGB) estimated using mangrove general allometric equation and Leaf Area Index (LAI) using hemispherical photos.

b) Results



A total of 5 729 stems were recorded over a total area of 6.3 ha. Stem density, average dbh, basal area, LAI and total AGB during the study were 903 stems ha^{-1}, 9.9 cm, 8 m^2 ha^{-1} , 1.45 and 77 t ha^{-1} (mean 83.73 t ha^{-1} across plots) respectively.
A significant and strong positive correlation between LAI and AGB (p value = <0.001, S.rho= 0.62) and between AGB and soil phosphorus (p-value = <0.05, S.rho= 0.44)



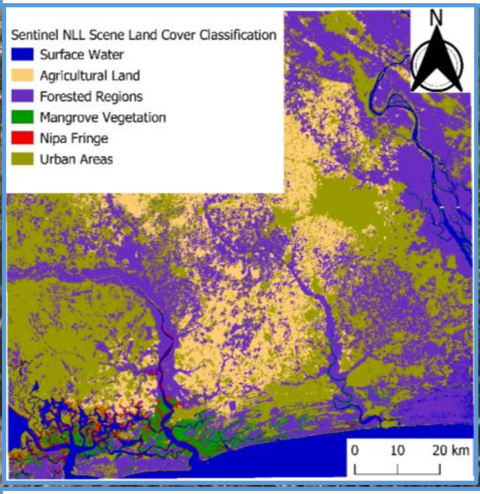
Although, the dbh stands lower class 1 make up 65% of the stand population, the highest size class 4 make up 22% of the total AGB of the region.
The contributory proportion of each dbh size class to the AGB in the undisturbed regime are more even (20-30%) while the 2 lowest size classes in the heavily and moderately disturbed plots contributed about 70% of the AGB.

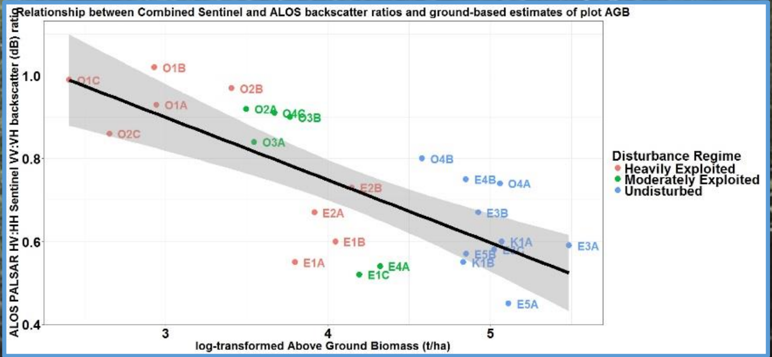
4. Classification and Biomass Map of the Niger Delta

a) Methodology :

Ground truthing during the field survey. Sentinel radar and optical data, Advanced Land Observing Satellite Phased Array type L-band Synthetic Aperture Radar (ALOS PALSAR) 2015 and Digital Elevation Model – Shuttle Radar Topography Mission (DEM- SRTM) 2000 were used in classification and relationship with field estimates of AGB.

b) Results: Maximum Likelihood Classification of the Niger Delta





Fitted parameters for AGB and Combined Sentinel radar and ALOS PALSAR backscatter model [log(AGB)= a + b σ^0]

Explanatory Variable	a (intercept)	b	R²	*P* value	*RE*	*rmse*
ALOS PALSAR HV	0.10	-0.31	0.35	<0.05	1.99	0.56
ALOS PALSAR HV:HH	6.01	-6.41	0.40	<0.05	1.94	0.53
Sentinel VV:VH	6.60	-5.78	0.46	<0.001	1.87	0.50
Sentinel VV	6.37	0.39	0.47	<0.001	1.86	0.50
ALOS PALSAR HV/HH: Sentinel VV/VH	2.38	11.66 6.97 -35.38	0.57	<0.001	1.75	0.45

Confusion Matrix: Overall accuracy= 99.6%, Kappa Coefficient= 0.99

Class	Commission (%)	Omission (%)	Producers Accuracy (%)	User Accuracy (%)
Surface water	0	0.78	99	100
Farmland	0	0.19	99.8	100
Forest regions	0.37	0.34	99.6	99.6
Mangrove	0.78	1.93	98	99.2
Nipa	17.11	0	100	83
Urban regions	0.08	0	100	99.6

Results

Low commission for all classes except Nipa fringes with 17% commission while the relationship between AGB and Sentinel: ALOS PALSAR ratio had the highest correlation.

5. DISCUSSION:

The relationship between AGB and Soil P and LAI shows P limitation to productivity and that productivity can be estimated using NDVI as a proxy for landscape LAI. Local disturbance increases the risk of light gaps and nipa palm colonisation due to focused logging of target dbh sizes. The use of optical and radical sensors can improve classification accuracy. However, nipa fringes are difficult to classify, evident from the low Nipa commission. Random forest classification could improve this. The regression analysis shows that landscape AGB can be mapped using radar backscatter. This can be improved by more plot data.

6. NEXT STEPS:

- Upscaling of site biomass to regional landscape of the Niger Delta.
- Options for long term monitoring of mangrove degradation
- Combination of an ecosystem carbon model with satellite observations of leaf area and biomass and soil carbon data of the Niger delta in order to retrieve carbon cycle state and process variables.