## ENHANCING RELIABILITY OF CARBON CREDITS: UAV-LIDAR CARBON ESTIMATION FOR REDD+ IN BRAZILIAN SAVANNA (CERRADO)

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## Context and problem Study area **Brazil Legal** - Brazilian Savanna: a unique threatened domain and forest loss. - Importance of REDD+ projects to mitigate climate change and conservation. - The use of UAV-LiDAR technology to improve accuracy and transparency on carbon stocks estimation for REDD+ context. Question and hypothesis 2,234.12 ha soil moisture **Can elements** Kg/m<sup>2</sup> Presence of landscape enhance density, Savanna ..... accuracy in - Grassland ...... field-based Tree canopy cover and LiDAR Carbon Absence **UAV-LiDAR** flight data **Palm trees** relationship on modeling? 1,250 mm Top canopy height, m Carbon stock Model structure Methods 🌞 Detected Palm Trees **Supervised detection AGBt\*** modeling **CO2t mapping UAV-LiDAR** and field data **GLM** - Binomial DJI **UAV-lidar** Field AGBt data (laz) measurements Matrice Merging field AGBt **AGBt Mapping** and Top-canopy (30m of spatial Tiles of 300-L1 resolution) 500mx500m DTM (1m) **Excluding highly** Ground filtering Probability

120m

Overlap

70% - 70%

Goodness-of-fit for both model structures. n = 45.

Model	R <sup>2</sup>	RMSE (%)	AICc
M1	0.86	29.6	115.23
M2	0.93	21.8	86.10

correlated UAV-lidar

metrics  $(r \ge |0.9|)$ 

AGBt=f(UAV-lidar

Clipping laz files

**UAV-lidar metrics** 

computation

within field plots

Height

normalization

\* We applied Chave et al. (2014) pantropical equation with just dbh for single tree biomass

AGBt Modeling

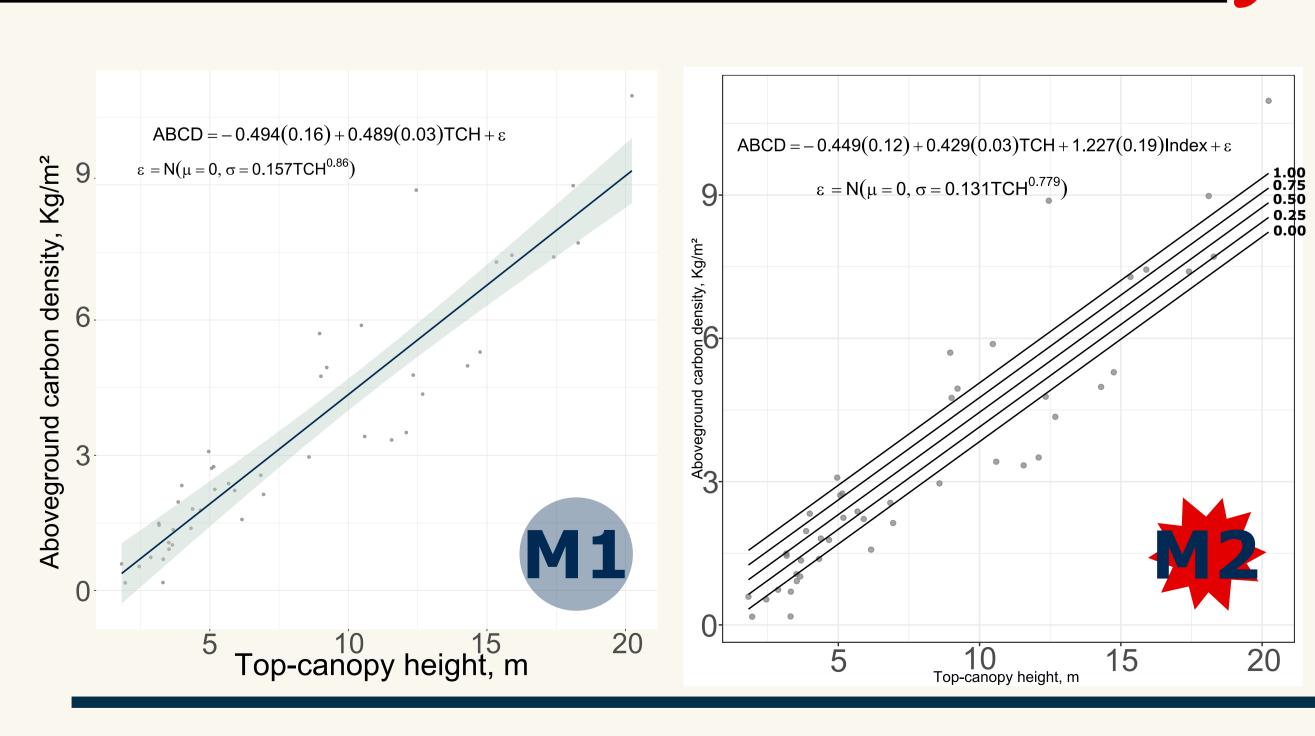
Prediction

assessment (R2, RMSE and bias)

Number of field-based

sample plots: 45

(30mx30m)



Difference accuracy

on RMSE (%)

Main findings

Statistics of model prediction and accuracy considering the whole mapped area by forest type (CO2e Mg/ha).

 $f(x) = \beta_0 + \beta_1 TCH + \epsilon$ 

 $f(x) = \beta_0 + \beta_1 TCH + \beta_2 Index + \epsilon$ 

Logit

Probability map

We used the standard

deviation of TCH as lidar

variable to detect palm

trees in a generalized

approach (logit).

mapped area b						
Savanna Type	Field-based stock	N pixels	Model id	LiDAR stock	Uncertainty (%)	Relative Difference (%)
Forest	207.45	1482	M1	188.11	2.43	-9.32
	207.43		<b>M2</b>	190.73	2.21	-8.06
Savanna	120.22	3228	M1	108.22	2.05	-9.98
	120.22		<b>M2</b>	110.47	1.99	-8.10
Grassland	61.52	1427	M1	70.92	2.52	15.26
	61.53		<b>M2</b>	70.77	2.40	15.01
Global results	125 56	6137 -	M1	122.42	1.58	-1.35
	125.56			124.00	1.51	-1.16

Consider presence/absence of palm trees as biological switch on model, improves in 27% the overall accuracy for carbon stock estimation in UAV-LiDAR data surveys. The methodology is an alternative when the tree heights in field-based data are unavailable for pan-tropical biomass equations, such as Chave et al. (2014), the main reason for heteroskedasticity in top canopy height relationship.





Map

Uncertainty

Assessment

Characterization of AGBt

stock and uncertainty

across formations

Adapted from Costa et al. (2021)



