Developing a framework to quantify uncertainty and harmonize diverse earth observation estimates of forest carbon

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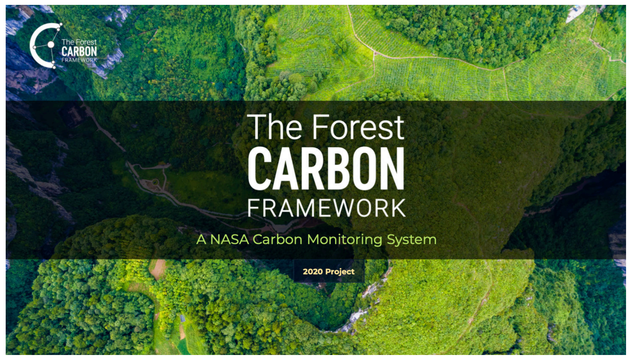
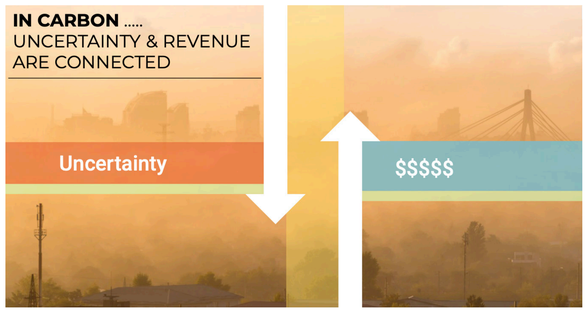


Motivation

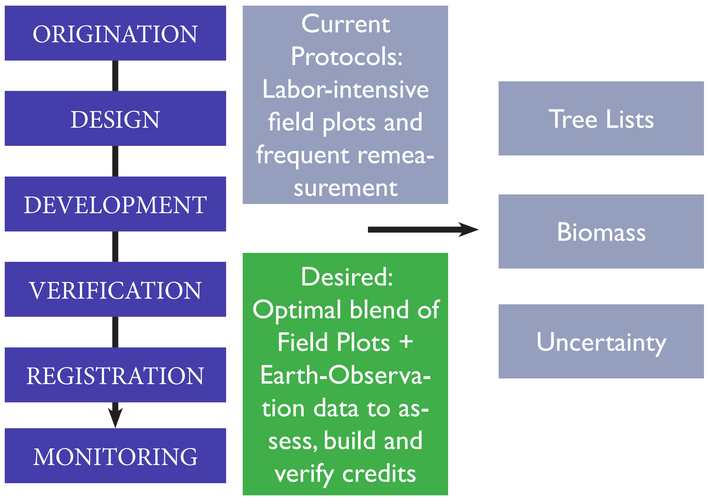
Forest carbon markets could play a key role in efforts to achieve carbon neutrality, both for private companies responding to consumer demand, and for governments responding to international agreements. Such markets work with carbon offsets: gains in carbon over and above what would happen under standard management practices. For the market to function, purchasers of carbon offsets must have **trust in the veracity of carbon credits.**



Rigorous, design-based statistical protocols are used in carbon credit markets to estimate forest carbon and its error. However, these are labor intensive and expensive, limiting entry into markets to large land owners. Earth Observation (EO) data have the potential to make the credit process more efficent and to lower the cost to entry into the market. However, frameworks must be built to provide **transparent and defensible estimates of uncertainty** that are consistent with design-based estimates of error.

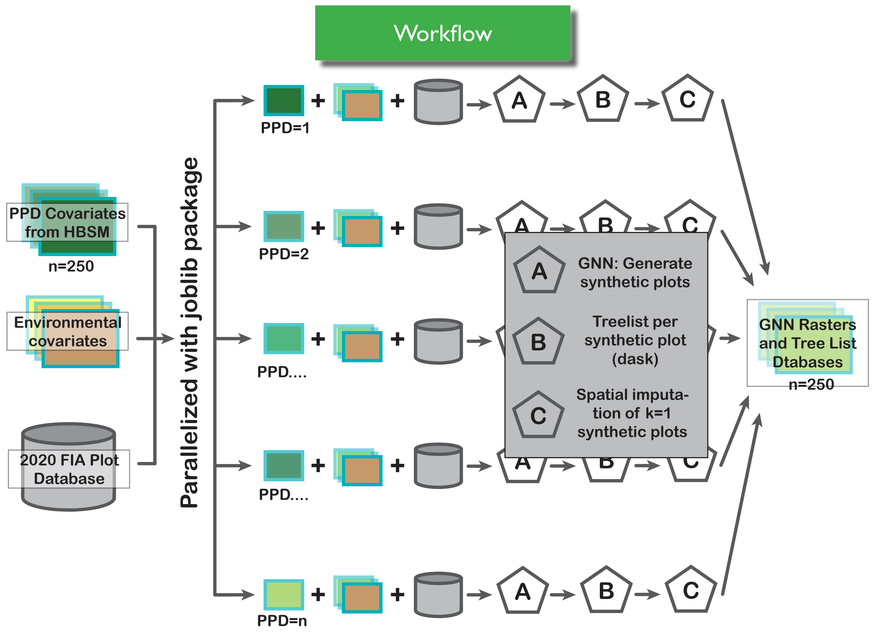
Existing Carbon Protocols

Developing and maintaining projects for carbon credits require many labor intensive and expensive steps.



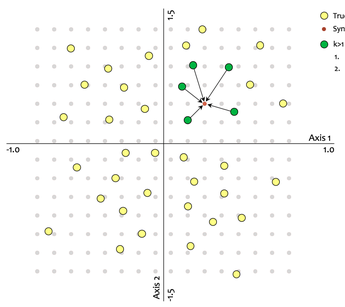
Tree List Imputation

Tree lists are critical to develop "business-as-usual" harvest and carbon estimates, against which diminished harvest can be credited. However, developing per-pixel tree list uncertainty is challenging.



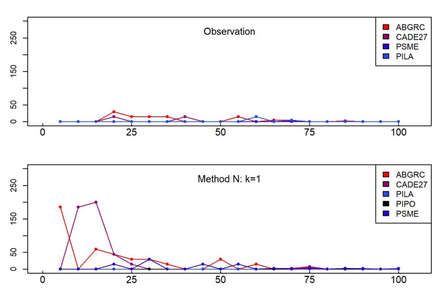
Synthetic Plots

Gradient Nearest-Neighbor (GNN) can be used to distribute synthetic plots in gradient space.

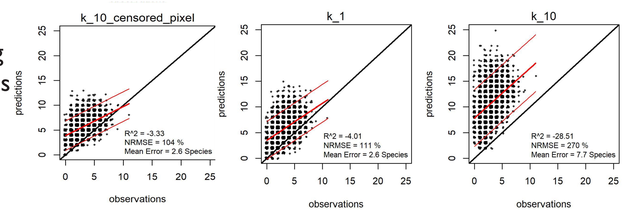


Tree Lists

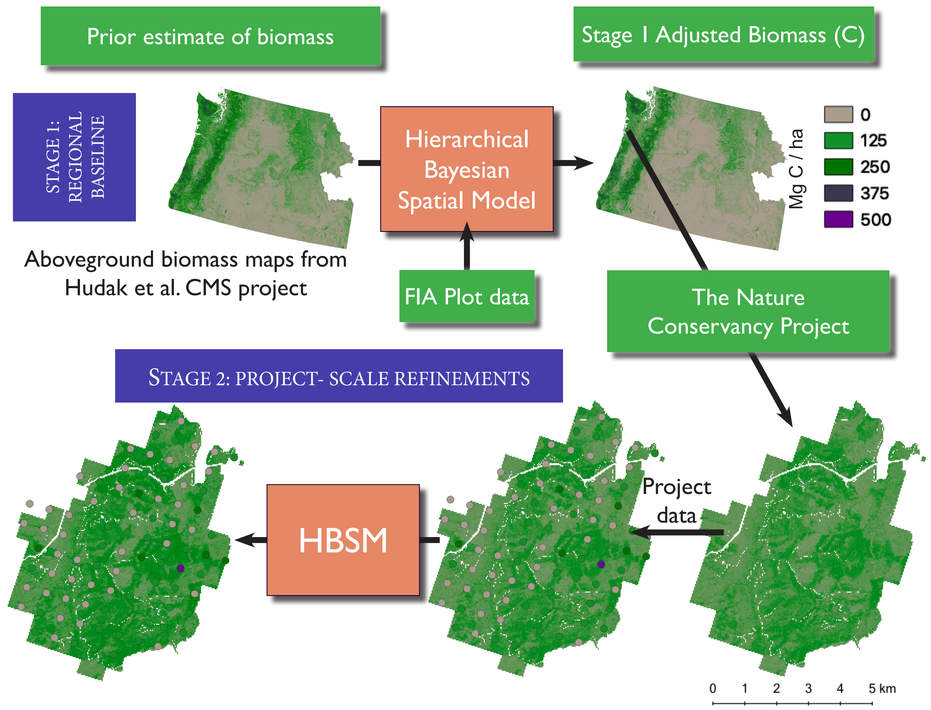
For any given realization, imputed tree lists at k=1 neighbors may not match actual distribution of species.

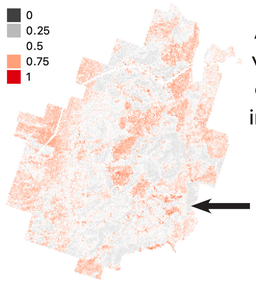


Censoring and increasing k-neighbor value improves per-realization species richness predictions.



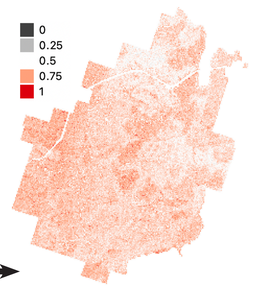
Biomass with spatial dependence





After project-scale values are included, overall uncertainty improves while spatial patterns of uncertainty are improved.

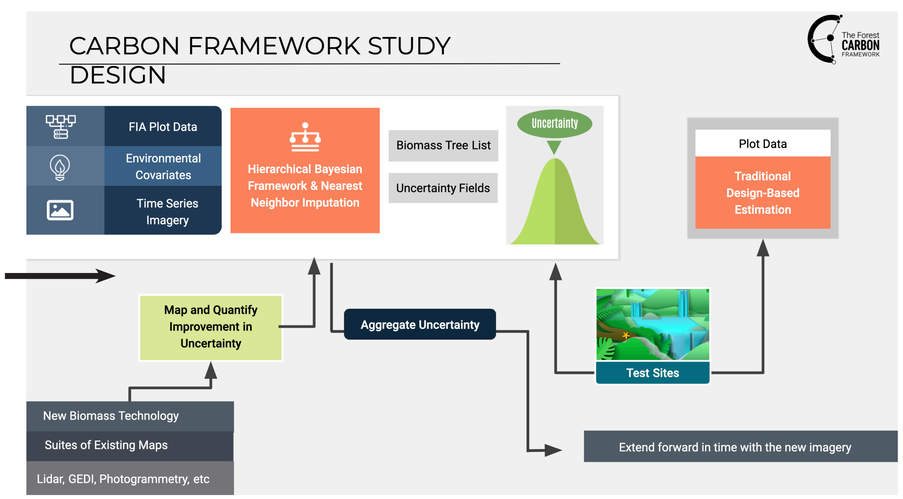
Estimated biomass surfaces blend spatial patterns of both plots and imagery. Surfaces include spatial estimate of uncertainty, scaled here as coefficient of variation relative to mean.



Stakeholders

We have engaged stakeholders from private industry, non-profits, and carbon registries to ensure that our framework meets needs of diverse users.

American Carbon Registry at Winrock International · The Nature Conservancy · Climate Action Reserve · SALO Sciences · New Forests



Future directions

We have begun translating the methods from this CMS project to help with carbon reporting in countries served by SERVIR-Southeast Asia. Additionally, we have begun working with the Research and Development theme of the Global Forest Observations Initiative (GFOI) to incorporate spatial dependence into forest carbon mapping.

SERVIR · GFOI Global Forest Observations Initiative