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Global Climate Change: Carbon Reporting Initiative

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Progress Report 4 for Year 6

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WINROCK INTERNATIONAL

Putting Ideas to Work

1. Background

The main objective of the proposed work is to expand the ability of USAID to report global climate change impacts for forest-based activities by developing and implementing a set of innovative tools with high scientific integrity. Under Year 6 of the cooperative agreement, we have continued to improve the AFOLU carbon calculator (ACC) by updating the data sets, improving the user interface, allowing for different levels of control by administrators, improving the reporting capability across all projects entered into calculator, developing a stand-alone decision tool that can estimate emission reductions or enhancement of removals of carbon over multiple years, and prepare materials for implementing training missions. The tool will continue to be simple and easy to use, and will allow the GCC Team and local missions and other stakeholders around the world to increase confidence in the integrity of results.

2. Activities for Year 6

Task 1: Develop a detailed workplan for year 6

Workplan for Year 6 was completed in November 2011. During the month of October workplan for Year 7 was drafted and submitted for USAID appreciation.

Sub-Task 1a. Data collection for emission factors

Literature reviews have been conducted to identify new spatial and non-spatial datasets that can be used to improve the USAID tool. Several spatial and literature resources were identified that are appropriate for use with the ACC and are described in more detail below.

Carbon Stocks

Mangroves

A literature review has been conducted to identify additional sources of information, both spatial and non-spatial pertaining specifically to improving carbon stock and deforestation/reforestation estimates in mangrove forests. Recently several spatial products became available better detailing the spatial extent and biophysical characteristics of mangroves. Winrock staff Mr. Michael Netzer traveled to Sioux Falls, South Dakota to visit the USGS's Earth Recourse and Observation Science (EROS) Center to gather global Mangrove data developed from Landsat Satellite imagery. This global mangrove data was developed for 2010, but also subsequent years (i.e. 2000, 2005) were developed for different countries and/or regions under separate projects and funding. Therefore that data is not organized or complete for these earlier years. The visit to the EROS data center enabled gathering this data, organizing it and getting it ready for analysis of area of change to be incorporated into the USAID ACC

Additionally, scientific literature values of mangrove biophysical characteristics (above-and below-ground biomass, total carbon) are being added to the current database based on a set of peer reviewed papers with meta-analyses of global mangrove data. We expect to have mangrove biomass estimates for all admin units that have areas of mangroves along their coasts

Agroforestry Systems

Significant new information has been published on agroforestry systems (AFS) over the past few years. Two renowned agroforestry experts had been contracted to help Winrock expand the data base and review and improve the methods used to estimate carbon benefits from AFS implementation. The consultants have concluded their tasks successfully and compiling all types of AFS in various countries present in ACC database, and identifying improvements in methods used in Agroforestry Tool. Winrock is currently organizing the carbon accumulation data compiled by on the various AFS, and grouping the different AFS into the following 5 categories:

- Silvopastoral: Tress planted on pastures
- Shaded annuals: Annual crops planted along with trees
- Shaded perennials: Perennial crops (eg coffee) planted along with trees
- Multistrata: Successional agroforestries with multiple species and heterogeneous age of stand
- Complementary: All other agroforestry systems

Next step include developing methods for grouping the carbon sequestration potential of each of the AFS types (above) into distinct ecological regions dictated mostly by climatic regimes, and geographical regions (per continent). Improved models for carbon sequestration of each AFS will be developed, refining the carbon sequestration estimates provided by the ACC.

Selective Logging Timber Extraction Rates

Winrock hired the Tropical Forest Foundation (TFF) for collecting data on extraction rates for Convention and Reduced Impact Logging (RIL) for the country of Indonesia. TFF completed the task and submitted refined extraction rates estimates that were updated in Indonesia's database.

Additionally Winrock is still pursuing marginal routes for improving extraction rate database such as literature review, direct contacts in SE Asia through the Winrock USAID- LEAF project (Malaysia, PNG, Laos, Vietnam), country's forest code review, and personal communications.

From literature review, Winrock was able to refine extraction rates for parts of Malaysia, Brazil, French Guiana, Gabon and Indonesia based on Medjibe et al., (2011)[1].

Through direct contacts with LEAF partners, Papua New Guinea indicated extraction rates varying between 12-30 m^3/ha per yr. However, a national figure does not exist as maximal extraction rates vary from logging concession to logging concession. LEAF Partners also indicated logging bans on Laos, Thailand and Cambodia, and therefore no extraction rates were associated to these countries.

Through personal communications, extraction rates for admin units in Brazilian Amazon not covered by Medjibe et al., (2011) were also improved (30 m^3/ha per yr) based on the Brazilian Forest Code.

Our research in African countries had not yielded reliable information regarding maximal allowable cut from the forest codes we have studied. The trend we have identified is that extraction rates or maximum extraction rates are identified on a concession by concession basis.

Republic of Congo: Through communications with representatives from the logging concession CIB in Pokola we were able to identify an extraction rate range for their concession (2.5 – 27.8 m3/ha) in particular and a maximum allowable rate of 45 m^3/ha. It is worth noting that these rates are specific to CIB which is an FSC certified concession and may not be representative of the country as a whole. However, efforts to identify more general extraction rates or maximum extraction allowable were not successful. Therefore the maximum allowable extraction rate of 45 m^3/ha per yr was used as the conventional logging default extraction rate.

Democratic Republic of Congo (DRC): Based on communications with colleagues from the Observatoire Satellital des Forêts d'Afrique Centrale (OSFAC) and a study conducted for the Mai-Ndombe Project in western DRC we were able to identify an estimate for average extraction rates for DRC of 4.3 m^3/ha/year. However, our colleagues in DRC noted that all though this number is based on reported data, they do not believe that it is representative of actual practices. Based on expert knowledge, such values represent a very unique set of occurrence, and considering conventional logging likely mimics practices in neighboring RoC, the 45 m^3/ha per yr rate was also used.

Secondary Forests

[1] Medjibe V. P., F. E. Putz, M. P. Starkey, A. A. Ndouna, and H. R. Memiaghe. 2011. Impacts of selective logging on above-ground forest biomass in the Monts de Cristal in Gabon. Forest Ecology and Management, 262: 1799-1806 pp.

In this quarter Winrock had identified many studies on biomass accumulation in secondary forests throughout the world in addition to the studies identified in the previous quarter. The majority of the studies were carried-out in secondary forests where the previous use had been shifting agriculture, pasture or cropland. Winrock extracted information from the studies, developed a database of aboveground biomass in secondary forests, and established an improved model for estimating carbon sequestration by secondary forest growth based on main climatic zones (wet, moist, dry), age of regrowth as well as maximum carrying capacity. The results of the analysis were integrated into the Forest Restoration/Planation Tool within the ACC to enhance the capability to estimate GHG emission reductions generated by secondary forest growth.

Additional datasets
No further progress since progress report 2, submitted in April, 2012

Sub-Task 1b. Updating national data sets.

A consultancy has been established with Dr. Sassan Saatchi and work is under way to update the forest carbon stock map. Dr. Saatchi has already updated the remotely sensed database as well as the ground data and is currently refining the map accuracy. See Annex 1 for further details on progress done on this work.

Sub-Task 1c. Refining estimates of deforestation rates.

Work is progressing on acquiring the new data on deforestation for the period 2005-2010. The release of this product has been delayed by the authors and it is now uncertain when this data product will be available. However it has been confirmed development refined deforestation map from 2005-2010. Once Winrock acquires the product, we will need to process it to obtain deforestation rates by our administration units.

Task 2: Build and test tools

Subtask 2a. Modification of the forest management tool

No further progress since progress report 1 submitted in January, 2012. We are still collecting data as described above under sub Task 1a.

Subtask 2b. Adding capability to add geographic specific details

No further progress since progress report 2 submitted in April, 2012.

Subtask 2c. Add an effectiveness rating calculation component

Winrock has developed a decision tool providing guidance to ACC users to determine an "effectiveness rating" for forest protection and afforestation/reforestation and agroforestry activities. The improved method for estimating effectiveness was submitted to several USAID partners in the AFOLU sector throughout the world for peer review. The methods and background document were revised in response to reviewer comments, and the revised document was be submitted as a separate deliverable.

The new method for rating forest protection, forest restoration and agroforestry implementation projects was be transferred to programmers and is being built into ACC.

Subtask 2d. Policy and capacity building impacts

No further progress since progress report 3 of Year 6 submitted in July, 2012

Subtask 2e. Develop a new bioenergy and land use tool.

No further progress since progress report 1 submitted in January, 2012.

Task 3. Train USAID GCC Team and mission staff (extension of Task 9 of Year 5)

No further progress since Progress Report 2 submitted in April, 2012.

Task 4. Complete outstanding Tasks from Year 5.

No further progress since progress report 1 submitted in January, 2012.

Task 5: Management and implementation

Subtask 5b. Host website.

The current version of the ACC was by DRG until the end of Year 6 (2012 fiscal year). A new web developer (Applied Geosolutions) has already been contracted to improve the features and navigability within the ACC as well as host the Calculator for Years 7-8.

Subtask 5c. Production of progress reports.

This document represents the fourth progress report to be delivered to USAID during Year 6.

ANNEX 1

Improvement of Global Tropical Forest Carbon Stock

Sassan Saatchi

Winrock International Subcontract

Objectives of the Project:

To develop a new map of forest carbon stock in pan-tropical regions at finer resolution, higher accuracy, using the most recent remote sensing and forest inventory data

TASK 1

Completion of Task 1: Update the remote sensing and ground data.

1.1 We have acquired mosaic of ALOS PALSAR data over the entire Africa and Southeast Asia for the period of 2008-2009 from Japanese Space Agency (JAXA). Data from South America will be provided to us from our project collaborator Dr. William Salas. The data has been processed to improve by applying a new terrain correction to improve the remaining effect of topography on the data. Images have been resampled to 250 m from 50 m resolution data to improve the effect of the speckle noise. We have also acquired the ALOS mosaic of African continent compiled by the Joint Research Center (JRC, ISPRA, Italy) and have included it in our wall-to-wall mapping of the African tropical rainforest and woody savanna. The following provide some examples of the compiled at and processed at 250 m resolution in tropics. Sub-task 1.1 was completed by June 30, 2012.

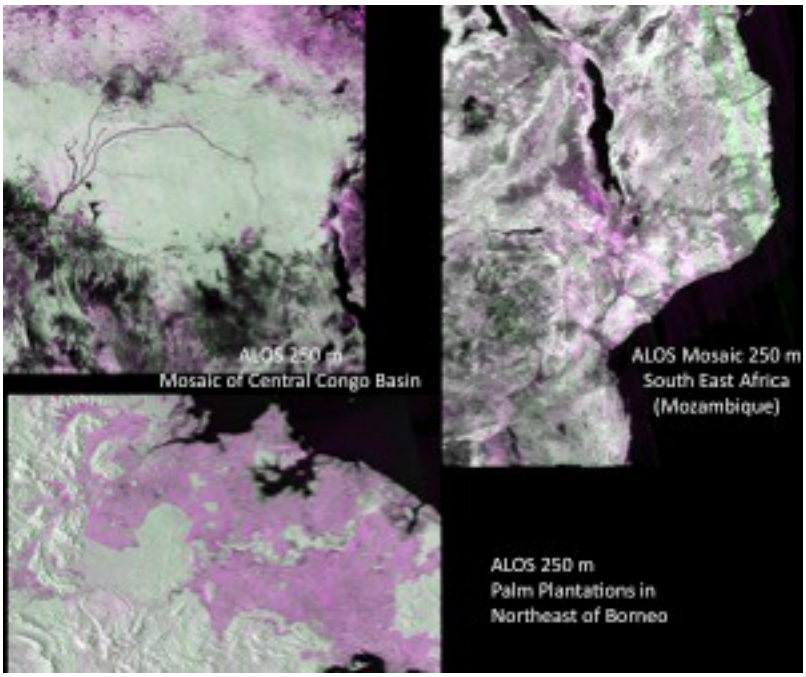


Fig.1. Samples of ALOS PALSAR 250 m mosaic over African and Southeast Asian Forests

ALOS South America data

In July 2012, we contacted Japanese Space Agency (JAXA) and negotiated the cost of purchasing the ALOS imagery over South America. This decision was based on the fact that the ALOS data significantly improved our results over Africa and Southeast Asia. We were expecting to receive the data over some of the South American countries from our collaborator William Salas. However, we decided by purchasing the entire region of our study, we will be able to complete the Pan-tropical biomass estimation without any gaps in the data. We processed the ALOS data and mosaicked the images to create a wall-to-wall mosaic at 250 m spatial resolution from the native resolution of 50 m. The processing included multi-looking of the PALSAR imagery and improving the topographic correction using the 90 m SRTM dataset.

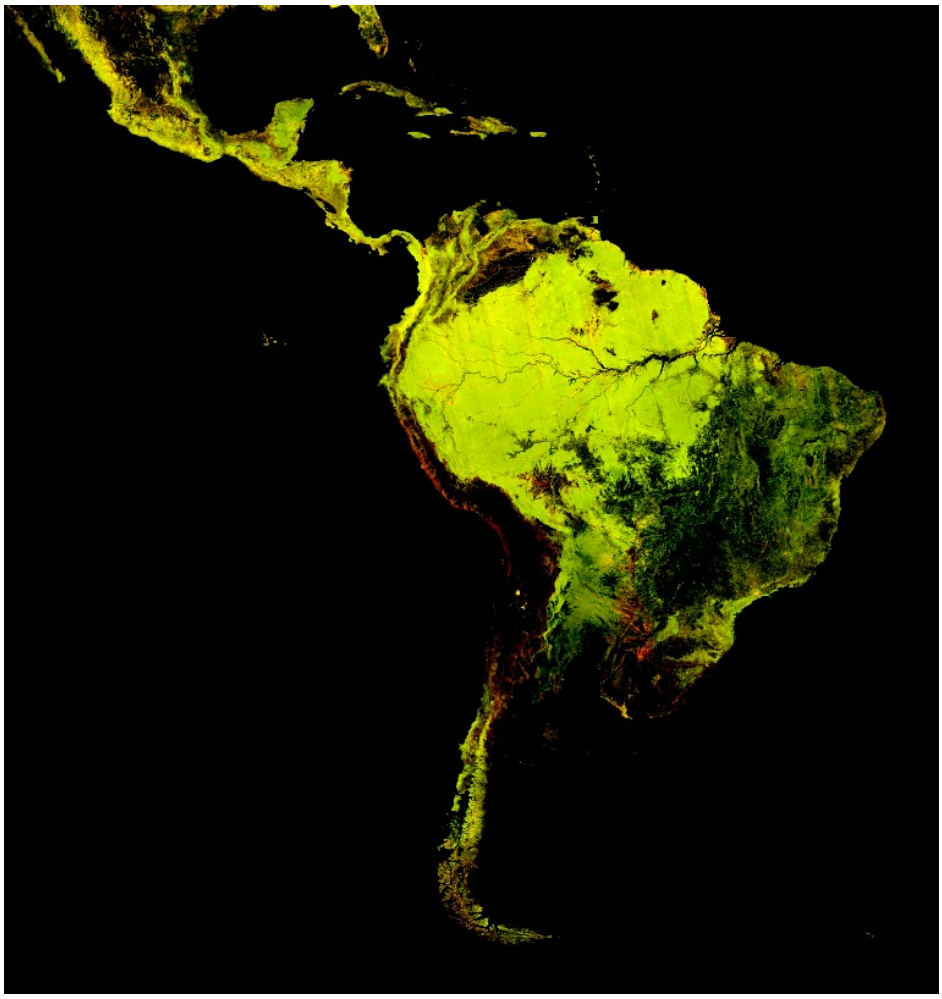


Fig.2. ALOS Mosaic of South America at 250 m spatial resolution.

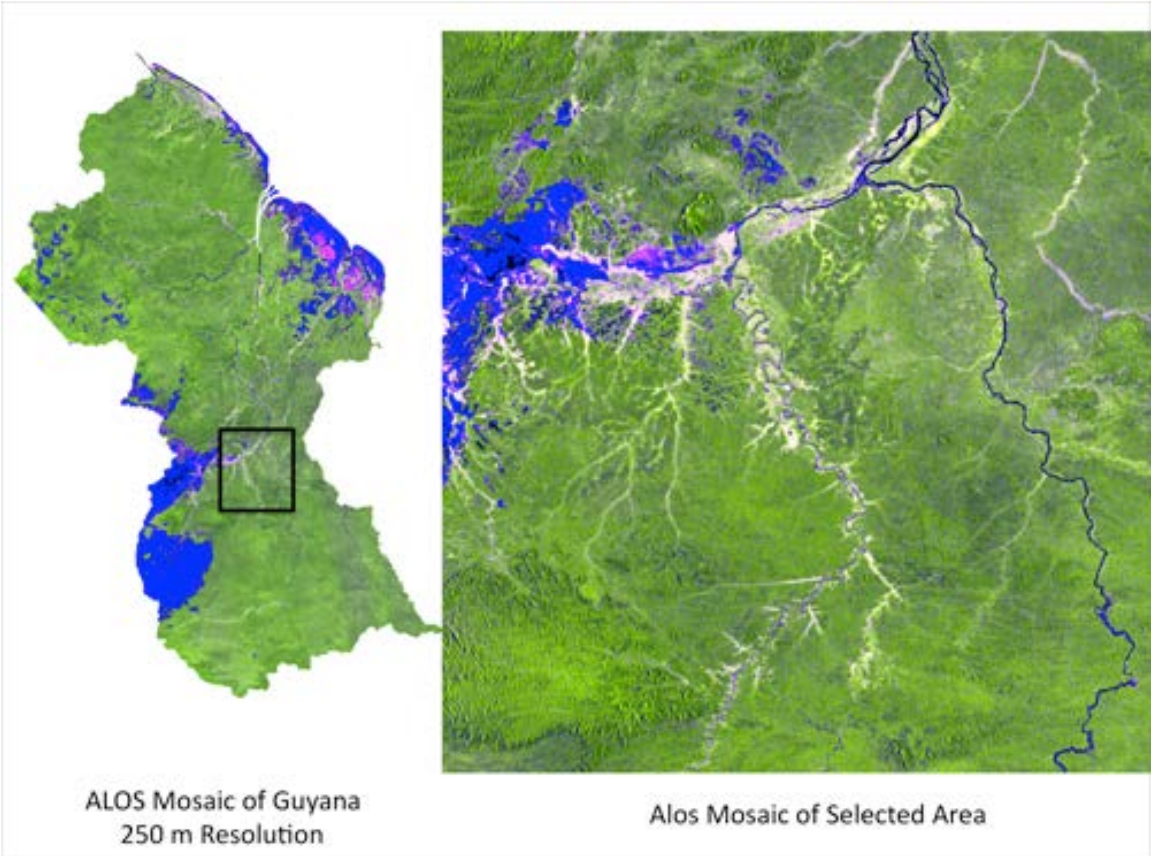


Fig. 3. Example of ALOS mosaic of Guyana (left panel) and a zoom over the selected area.

1.2 We have completed the processing of MODIS 250 m data for the period of 2000, 2005, and 2010. The data have been processed using the cloud mask and includes NDVI, band 1,2, and derived LAI product from NASA algorithm. We have included data from several years to fill the gaps produced by clouds (approximately 3 years around the period year). This will allow us to have a wall-to-wall mosaic of MODIS data to extrapolate the biomass data and have a record of any changes of forest cover that may have occurred with the composite period. Sub-task 1.2 was completed by June 30, 2012.

In addition, we reprocessed the SRTM data to create two layers of surface elevation and ruggedness (standard deviation of elevation) at 250 m spatial resolution. Sub-task 1.3 was completed by June 30, 2012.

1.3 The GLAS data has been reprocessed globally to improve the geolocation and creating several attributes to help us to understand the quality of the lidar locations with respect to land cover type and topography. This will allow us filter the data efficiently before including the lidar height metrics in the biomass estimation. In its current version, the data will include both forest maximum

height, mean canopy height, and Lorey's height and surface attributes such as slope, elevation, land cover, location, date of acquisition, signal to noise ratio. The figure below shows the comparison of new and old GLAS data over the Amazon basin including areas of savannah. Sub-task 1.2 was completed by June 30, 2012. The overall distribution is the same over forested areas. However, new data have been included in areas of secondary forests, and woody savannas.

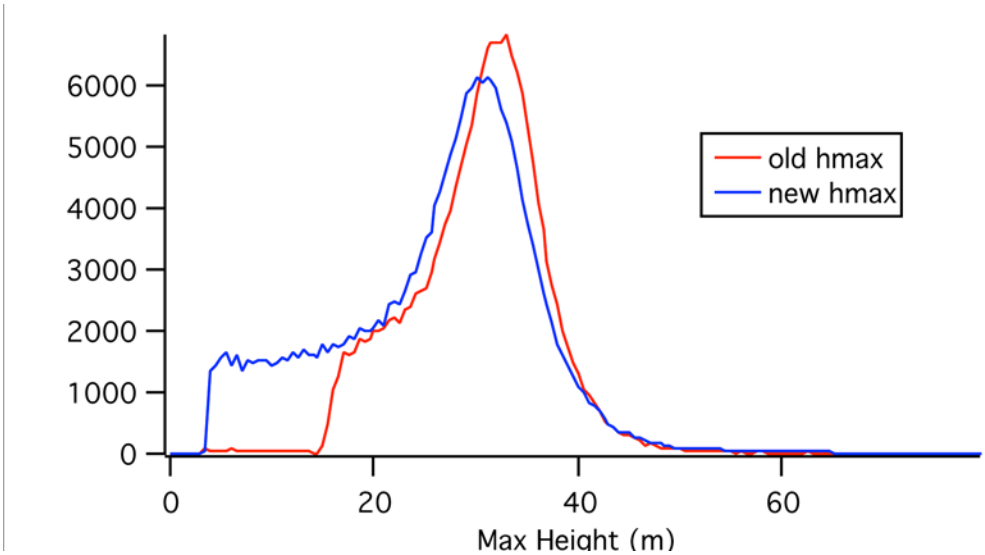


Fig. 4. Correction of GLAS Lidar data improving the height estimation over woodland savanna.

1.4 We improved our field inventory data for the Pan-tropical regions. We have contacted and received agreements from individuals or national institutions from the following countries to include their recent inventory data in the pool: Gabon, Ghana, Cameroon, Mozambique, Uganda, Colombia, Peru, and Brazil. We have contacted and waiting for final response from the SilvaCarbon group in Indonesia and Mekong region to receive inventory data. We expect Winrock and other collaborating agencies provide us with any new inventory data to be included in the next run of the model. Sub-task 1.2 was completed by June 30, 2012. Currently, we have completed a new set of data from Gabon, Mozambique, Peru, Colombia, Ecuador, and Indonesia.

TASK 2

Completion of Task 2: Develop new spatial models over pan-tropical forests by integrating the new remote sensing and ground data with earlier forest biomass map.

2.1 We completed the implementation of the non-parametric spatial distribution model based on the maximum entropy approach developed in our earlier work. This model included the recently processed GLAS data and remote sensing layers at 250 m. The pan-tropical aboveground biomass product also includes prediction errors at 250 m resolution. The first impression from the product as shown in the case of Guyana (Fig. 5) is the spatial improvement by clearly capturing areas of deforestation and degradation, swamp and non-forest landscapes. In addition, the 250 m resolution product has been able to capture areas of higher and lower biomass values that were suppressed due to averaging in 1-km pixels of earlier maps. An example of changes of landscape scale biomass distribution in the selected region in Guyana is provided in Fig. 6. The results suggests that at 250 m resolution, we improve on the underestimation of the higher biomass values and also clearly capture the low biomass regions that did not exist in the 1 km product.

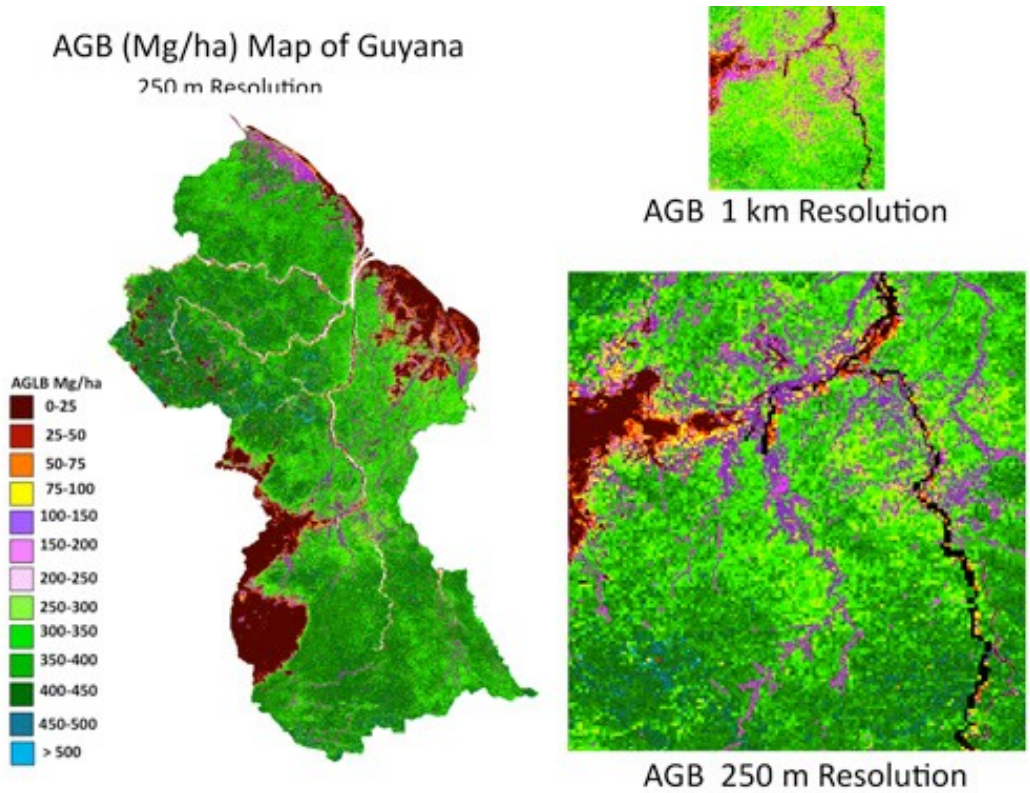


Fig. 5. Distribution of the aboveground biomass (Mg/ha) at 250 m resolution over Guyana. The map has been extracted from the South America map to demonstrate the improvements of the new map in comparison with the 1km biomass map.

2.2 We developed a parametric model for forest biomass less than 100 Mg/ha using a combination of ALOS and MODIS LAI data to improve the tropical biomass estimation over degraded and woody savanna vegetation types. This task has been

completed. We used field data collected in the secondary forests in the Amazon basin and Woodland Savanna in Africa to develop the relationship. The parametric model will be based on LAI, ALOS, and slope to make sure that we correct the biomass estimation in areas of complex topography. Figure 7 provides an example of data from a series of ground and GLAS Lidar biomass values. The region of validity of the model is below 100 Mg/ha. The sensitivity of all RS layers for parametric estimation is limited to biomass values less than 100-200 Mg/ha. We use 100 Mg/ha as the limit to implement the biomass estimations.

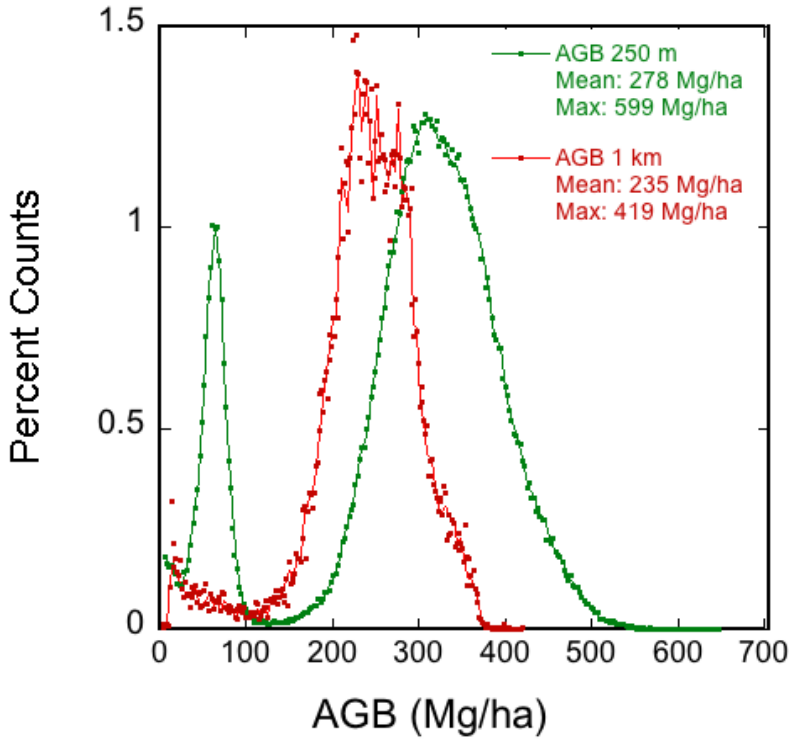
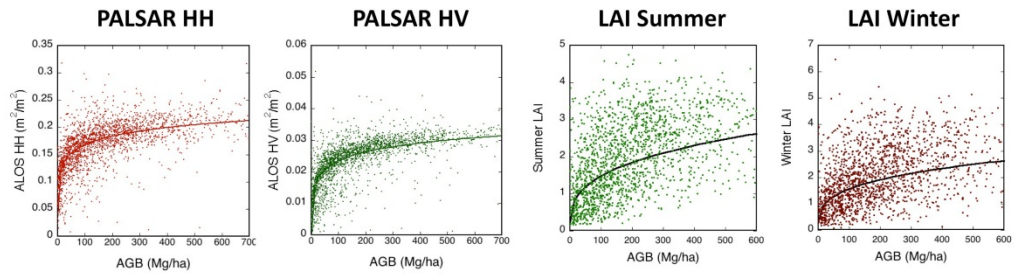


Fig. 6. Histogram of AGB estimation over the selected area (provided in Fig. 5). The distributions show clear distinction between the two maps as a result of improving the distribution. The mean over the study area has changed slightly towards higher values and the distribution has two peaks representing the low biomass regions around rivers and non-forested areas and the high biomass values in old-growth areas.



$$AGB^{\lambda} = a_0 + S\sum_{i=1}^{N} a_i X_i^{\beta_i} \qquad X = \{HH, HV, LAI, Slope\}$$

Fig. 7 Examples of parametric models developed from ALOS PALSAR and LAI developed at 250 m resolution using a combination of ground and GLAS estimated biomass. The region of validity of the model is below 100 Mg/ha.

2.3 We combined the two models to provide a seamless forest aboveground biomass map of the pan-tropical region. The parametric model has been used for areas identified over the vegetation classification map as woodland forests and also has been estimated to be less than 100 Mg/ha of biomass from Maximum Entropy approach. We have developed several tests to make sure that the regions of validity of both estimates are seamless. We used the Globcover vegetation map resamples from 300 m to 250 m (Fig. 8) to run the estimation algorithms.

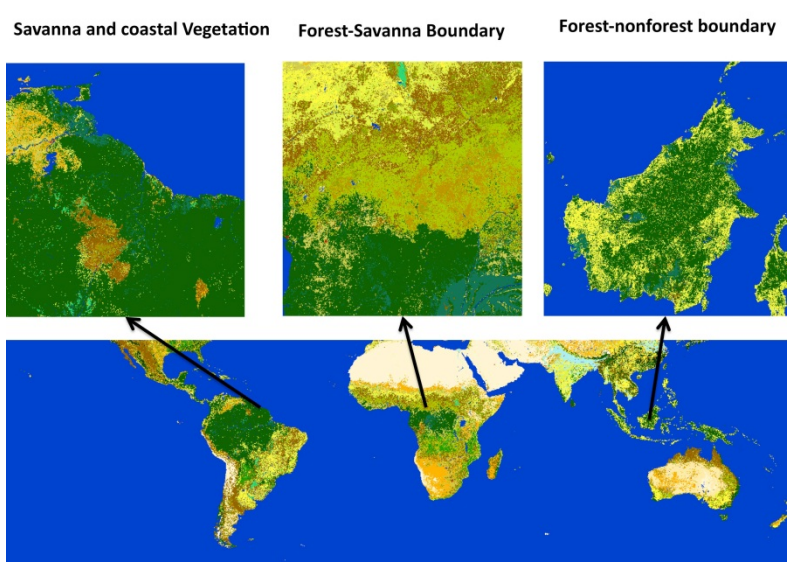


Fig. 8. Pan tropical land cover map derived from Globcover data and examples of the use of the map to separate the vegetation types for the implementation of parametric model.

We have completed Task 2 of the proposed project and have created the following products:

1. Orthorectified image mosaic of the ALOS PALSAR data at 250 m spatial resolution.
2. Image mosaic of SRTM elevation and the surface ruggedness (variance of elevation) at 250 m spatial resolution.
3. Seasonal image mosaic of MODIS bands, NDVI, EVI, at 250 m spatial resolution
4. Seasonal estimate of leaf area index (LAI) derived from MODIS bands and land cover map.
5. Resampling of global vegetation map from Globcover data.
6. Reprocessing of GLAS data to improve the data quality and add other height metrics such as Maximum and Lorey's Height.
7. First wall-to-wall AGB map at 250 m resolution over the entire tropics from a combination of parametric and non-parametric models.

TASK 3

Assess the uncertainty of forest biomass map at 250 m spatial resolution and provide above, below, and total carbon along with uncertainties as the final product.

1.1 We developed an error propagation for mean and variance of biomass distribution at pixel and regional scales by improving the uncertainty model used in the earlier work of Saatchi et al. 2011. The new model also includes several new factors that was not present in the old model. For error assessments, we focused on three approaches:

1.0 We estimated the bias between estimation and an independent test data. In our earlier work, we found a bias in our products of about 5-10 Mg/ha of underestimation. In our new approach we quantified the bias by binning the biomass in different ranges, evaluating the bias, and correcting for the bias by employing a spatial PDF matching technique.

2.0 Spatial correlation of errors was determined in our final analysis to help improve the regional and national level uncertainty. This approach allowed us to have a realistic estimate of national and regional biomass uncertainty. In general, the uncertainty can have a range of correlation extending from 250 m to several km (maximum of 5 km).

3.0 We performed a comparison with published data either in terms of maps or field and lidar estimates globally. These large scale (> 100 ha) validation of the 250 m helped to quantify the regional validity of our data. In general satellite estimation of biomass is often smaller than what the field data shows on the average. We believe, a major part of the difference is related to

the spatial variability in forest structure and biomass not adequately represented in the field data. By using data from Lidar estimates of biomass over large areas, we are able to provide an estimate of the heterogeneity of biomass and quantify any potential discrepancy existing in our pan-tropical biomass map.

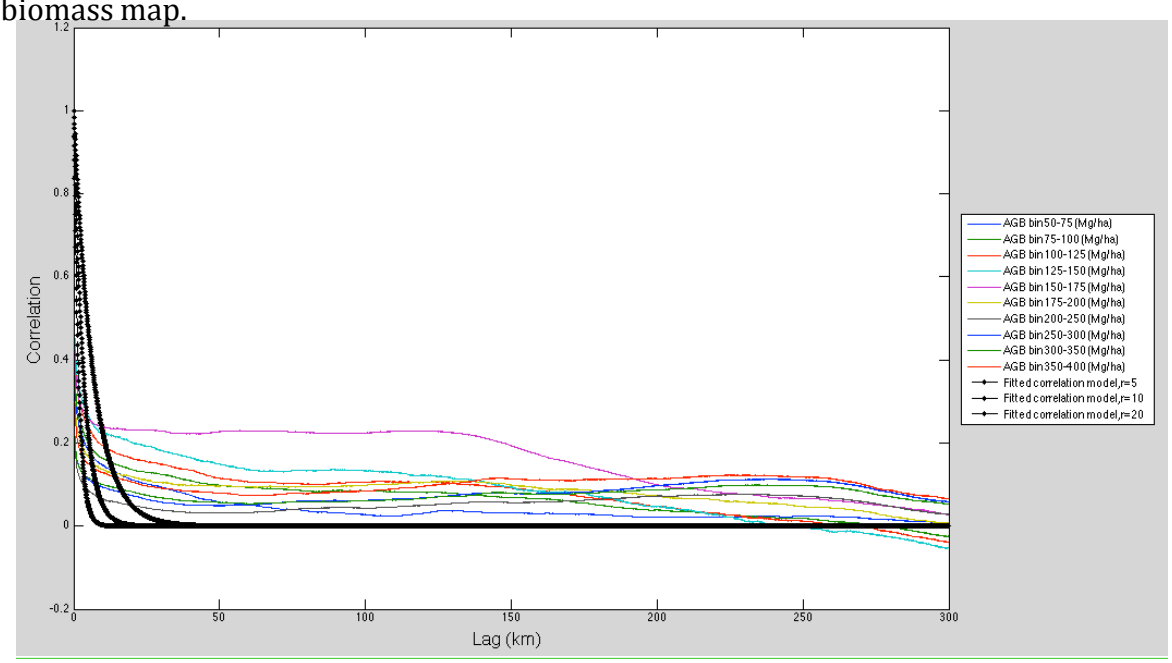


Fig. 9. Plots of estimated correlation coefficients as a function of lag, i.e., distance between pixels for predicted errors in South America Colored curves are based on our analysis of AGB estimates binned in different ranges.

1.2 We are developing maps of belowground biomass based on improved allometry of above and below ground forest biomass. For aboveground biomass, we have compiled a wood density data from ground plots distributed over the old growth forests and used the wood density to calibrate our biomass-height allometry. The preliminary results show that the allometry is improved regionally. We will complete our evaluation before the final report and delivery of products. For belowground biomass, we are using different techniques to develop variations in estimates of belowground from published allometry or biomass factors.

1.3 We have completed the maps of above, below, total carbon stock, and uncertainty at 250 m spatial resolution over the pan-tropical regions. We will deliver this product after the evaluation of errors and validation with lidar data has been completed. The preliminary products will be released to Winrock Inc. to evaluate our approach and provide us with potential feedback.

1.4 We will provide the maps and the preliminary evaluation as soon as possible and deliver the final product by the end of the extended period. We are requesting an extension of our project to complete the additional tasks for the evaluation of the products.

For more information or comments:

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