Republic of Congo Forest Cover Loss Area by Forest and Disturbance Type: 2001 - 2014

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INTRODUCTION

- In 2001 the Congo basin rainforest occupied about 22.5 million hectares of land in the Republic of Congo, which accounts for about 66% of all land in the entire country (World Bank Open Data, 2016).
- The Congo basin rainforest serves as a net carbon sink in the carbon cycle with storage of large amounts of carbon in old growth trees (especially in larger trees), also known as primary forests(Fisher et al, 2013).
- The rainforest through the logging industry alone supports between 2% and 6% of the GDP for the Republic of Congo (de Wasseige et al, 2015).
- Monitoring the Congo basin rainforest has vast implications, especially with regard to sustainable forest development. This is important considering that the Republic of Congo is one of the few countries with high forest cover but low deforestation(HFLD)(Brown 2009).
- Policies such as reducing emissions from deforestation and degradation (REDD+) derived from the United Nations Framework Convention on Climate Change (UNFCCC) require the accurate mapping of forest cover change, particularly as it pertains to loss (Potapov et al, 2015.
- The goal of this study was to utilize the University of Maryland Global Forest Watch Data in an effort to produce unbiased estimates of forest cover loss area between 2001 and 2014 by forest type and disturbance type.
- To accomplish this study's goal, a stratified random sample of 700 30x30m pixels was visually interpreted using Landsat data and high resolution imagery from Google Earth.
- The results of this study are suitable for national carbon monitoring purposes and sustainable forest policy development in the Republic of Congo.

METHODS

Sampling Design

- Stratified random sampling was utilized to accurately measure forest cover loss area. One sampling stratum (or class) was designated as "loss" to identify forest loss between 2001 and 2014 as revealed by the UMD global map(Hansen et al., 2013). Another stratum was designated as "probable loss", consisting of a 60m buffer around areas identified as forest loss. Lastly, a stratum deemed as "no loss", was defined to include all areas outside of the loss and probable loss strata.
- The sampling unit used was a 30m x 30m pixel, and 10,000 sample pixels were randomly generated across the Congo Basin Forest Partnership countries with 20% of samples distributed to the loss stratum, 30% to the probable loss stratum, and 50% to the no loss stratum. This sampling strategy resulted in 700 samples being allocated within the Republic of Congo: 73 within the loss stratum, 166 within the probable loss stratum, and 461 within the no loss stratum.

Sample Interpretation

The occurrence of forest loss in sample pixels was determined based in part on observations of the following properties of the annual Landsat image composites:

- Color: Did a change in the pixel color occur? Spectral band combination used in the analysis was SWIR-NIR-RED displayed as RGB. In this band combination forest appears dark green, and bare ground is pink.
- Shape or spatial pattern. Some disturbance types have a distinct spatial pattern, e.g. regular network of logging roads indicates the presence of selective logging

Forest loss was also identified using:

- High Resolution satellite imagery: Google Earth
- 16 Day Landsat Composites: all available Landsat observations from 1999 to 2014 composited at 16day intervals
- Temporal graphs of Landsat-derived NDVI (vegetation health), NWI (vegetation water content) and SWIR band valued

For each pixel with detected loss, the date of loss was recorded, as well as the type of forest cover prior to the disturbance (primary humid tropical forest, secondary humid tropical forest…) and forest disturbance that caused loss (plantations, logging, small holder clearing…).

Statistical Analysis

Forest Cover Loss Area by Forest Type

To estimate the area of forest cover loss by forest type the number of pixels in each stratum was divided by the number total number of pixels in the Republic of Congo to yield a ratio. The ratio of a stratum was then multiplied by the respective number of loss samples for a respective forest type and then divided by the respective total pixels, the resulting value was calculated for each stratum and summed up. The resulting sum was then multiplied by the map area in hectares to yield the area of forest loss for a particular forest type (Olofsson et al, 2013, 125).

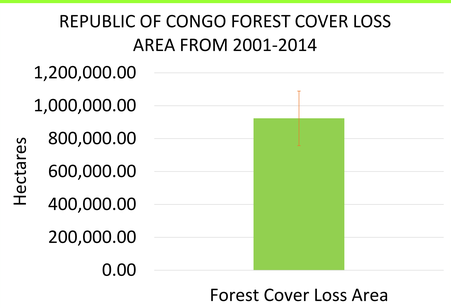
Forest Cover Loss Area by Forest Type

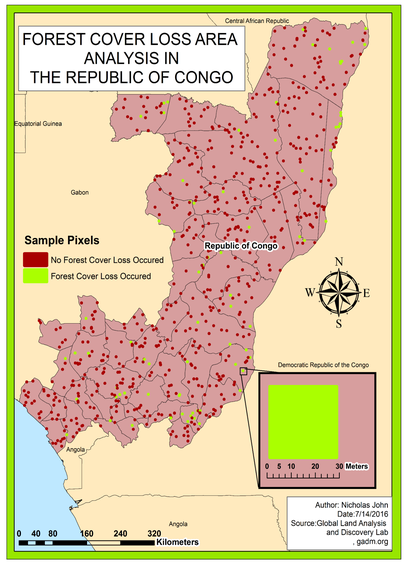
The estimation of forest cover loss area by disturbance type involved the same method to that of forest type, the only difference being that forest disturbance types were utilized instead of forest types.

RESULTS

FOREST COVER LOSS ANALYSIS

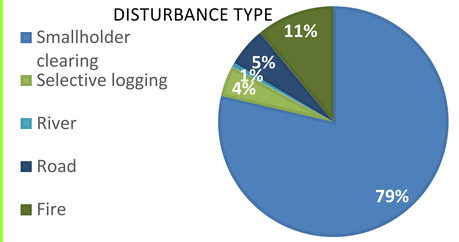
Landsat Satellite Imagery Loss Interpretation



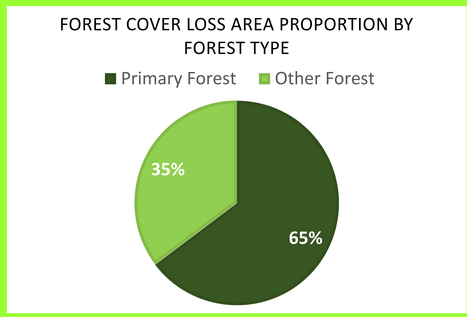


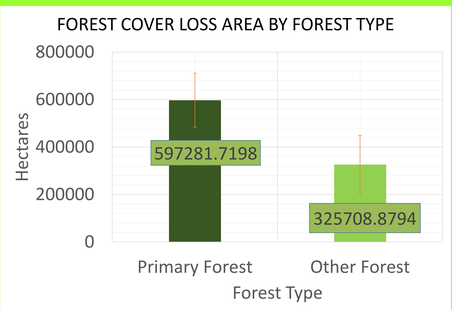
FOREST COVER LOSS AREA BY YEAR

FOREST COVER LOSS BY DISTURBANCE TYPE



FOREST COVER LOSS BY TYPE





DISCUSSION

- The results indicate that close to 3% of the Republic of Congo's Forest cover was lost from 2001 to 2014.
- This is a relatively low amount of forest loss, and it in part gives the Republic of Congo the distinction of a high forest cover but yet low deforestation (HFLD) country (Brown 2009). This distinction makes initiatives such as REDD+ more problematic due to the already low levels of forest degradation and forest cover loss occurring.
- Moreover, most of the forest cover loss was from primary forests (65%) . The subtly increasing annual primary forest destruction has implications for carbon accountability as well as biodiversity, as old growth forests hold large amounts of carbon and simultaneously provide habitats for many animals and plant species(Lewis et al, 2009) (Mayaux et al, 2013).
- Furthermore, the vast majority of forest cover loss occurred due to small holder clearing, followed by fire, road construction, selective logging, and lastly by river meandering.
- It is notable that the amount of forest cover lost to selective logging is rather small but provides a substantial economic benefit to the Republic of Congo in terms of the 2 to 6% impact that it has on GDP (de Wasseige et al, 2015).

FUTURE RESEARCH

Due to the large occurrence of small holder clearing as a cause of forest cover loss the drivers behind this form of forest disturbance will need to be understood and monitored in the future. Additionally, the feasibility of REDD+ will need to be studied amongst the relatively low deforestation environment in the Republic of Congo.

REFERENCE

de Wasseige, C., M. Tadoum, R. Eba'a Atyi, and C. Doumenge. 2015. *The Forests of the Congo Basin - Forests and Climate Change*. http://www.observatoire-comifac.net/.

Fisher, Joshua B, Munish Sikka, Stephen Sitch, Philippe Ciais, Benjamin Poulter, David Galbraith, Jung-Eun Lee, et al. 2013. "African Tropical Rainforest Net Carbon Dioxide Fluxes in the Twentieth Century." *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences* 368 (1625): 20120376. doi:10.1098/rstb.2012.0376.

Hansen, M C. 2013. "High-Resolution Global Maps of" 850 (November): 850–54. doi:10.1126/science.1244693.

Lewis, Simon L, Gabriela Lopez-Gonzalez, Bonaventure Sonké, Kofi Affum-Baffoe, Timothy R Baker, Lucas O Ojo, Oliver L Phillips, et al. 2009. "Increasing Carbon Storage in Intact African Tropical Forests." *Nature* 457 (February): 1003–6. doi:10.1038/nature07771.

Mayaux, Philippe, Jean-François Pekel, Baudouin Desclée, François Donnay, Andrea Lupi, Frédéric Achard, Marco Clerici, et al. 2013. "State and Evolution of the African Rainforests between 1990 and 2010." *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences* 368 (1625): 20120300. doi:10.1098/rstb.2012.0300.

Olofsson, Pontus, Giles M. Foody, Stephen V. Stehman, and Curtis E. Woodcock. 2013. "Making Better Use of Accuracy Data in Land Change Studies: Estimating Accuracy and Area and Quantifying Uncertainty Using Stratified Estimation." *Remote Sensing of Environment* 129. Elsevier Inc.: 122–31. doi:10.1016/j.rse.2012.10.031.

Potapov, P V, J Dempewolf, Y Talero, M C Hansen, S V Stehman, C Vargas, E J Rojas, et al. 2014. "National Satellite-Based Humid Tropical Forest Change Assessment in Peru in Support of REDD+ Implementation." *Environmental Research Letters* 9 (12). IOP Publishing: 124012. doi:10.1088/1748-9326/9/12/124012.

"World Bank Open Data." 2016. Accessed July 14. http://data.worldbank.org/.

Brown, Sandra. 2009. *Reducing Emissions from Deforestation and Forest Degradation (REDD): An Options Assessment Report*. *Ecological Modelling*. Vol. 6. doi:10.1088/1755-1307/6/25/252020.