Carbon Sinks Assessment of the Native Forests in Papua New Guinea through Direct Quantification and Remote Sensing

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Abstract

Global warming phenomena affect virtually all components of the ecosystem, and bring out a diversity of ideas and actions for its control. The time is set for Papua New Guinea to actively be involved in these efforts by trading carbon stored in its native forests within the framework given by "Reduced emissions from deforestation and degradation" (REDD) initiative of the United Nations Framework Convention on Climate Change. As "good will" is not enough impetus for doing so, the possibilities for carbon sequestration assessment and monitoring in demonstrative areas of common property are discussed. Best options regarding minimum area to be evaluated, location, sampling, additionality, and leakage remain open for discussion.

Keyword

Carbon sequestration, global warming, native forests, REDD policy.

Global Warming and Deforestation

The worldwide release of carbon to the atmosphere due to land use change (20–25% of total emissions) is of 1.7 billion tons/year, more than the total emissions coming from the transport sector (IPCC, 2006). Papua New Guinea (PNG) is the largest continuous forested area in the Asia-Pacific region and the third largest tropical rainforest on the planet (Brooks *et al.*, 2006).

It was found that its annual release of 64−73 million tonnes of carbon to the atmosphere has greater monetary value than its log exports (UPNG, 2008), being an underutilized resource if is not stored and accurately measured. Reducing deforestation is a highly cost-effective way to quickly curtail green house gas (GHG) emissions in lands with low opportunity costs. Presently, PNG is developing the legal framework to guide the necessary actions of climate change control in the country, this article intends to provide practical ideas and methodologies that have proved successful in other places and could be adapted here.

Implications of the new REDD policy

The Kyoto protocol (KP) is a legally binding international agreement that commits industrialized countries to reduce their emissions of six GHGs. It only recognizes afforestation and reforestation, excluding activities geared towards the management of existing natural forests or towards the reduction of emissions by avoiding deforestation. One reason for this is the uncertainty in quantifying and controlling leakage (off-site impacts caused by a project), which has been reported as significant (Dushku and Brown, 2003).

The approval of the REDD policy will mean that meso- and macro-level data would become a necessity for carbon forestry implementation in non-Annex countries (Minang *et al.,* 2007). Continuous forest inventories would be needed so that the country could weigh forest gains in some areas against losses in others, since only the absolute gains in forest would be rewarded. The basic questions in this inquiry will be: (a) What does a project need to demonstrate in order to meet a high standard of credibility for emission reductions or carbon sequestration; and (b) How can the facts about projects be captured in a registry as a means of documenting the credibility of registered projects?.

Accreditation of the Clean Development Mechanism

Land Use, Land Use Change and Forestry—(LULUCF) projects must meet certain conditions in order to acquire Certified Emission Reductions (CERs). CERs represent the emission reduction outputs of projects and constitute the basis on which payments are made. Projects must fulfil specific criteria in order to be issued CERs, including eligibility, additionality, and acceptability in terms of environmental and social impacts, sustainable development, and leakage. Fulfilment of these requirements implies the provision of reliable, documented and archived evidence demonstrating adherence to these criteria. Project calculations need to be transparent to reviewers, which can be complicated since land rights in PNG are fuzzy and open-ended (Sullivan, 2002). The project concreteness and measurability are usually assessed independently by a third-party accredited by the CDM. Project registration is enabled with the emission of a Certified Emissions Reduction (1 × carbon credit = 1 tonne of CO_2 emitted from burning fossil fuels) after validation (measures the agreement between the model prediction and independent data) and verification. To achieve the maximum carbon credit for the project it is necessary to produce a minimum reference case and a maximum project case. The growth of a forest between two time periods is partly the result of natural change and partly the result of the manager's actions. Without credible ways to separate these two effects, there is the risk that project developers may attempt to achieve credit for carbon that is either not present, or that would have been present with or without the project.

Baselines

A baseline for a REDD project is the scenario that reasonably represents the anthropogenic emissions by sources of GHG that would occur in the absence of the proposed project activity.

This notion is essential to bring credibility to the project. Baselines at National level should detect and account gains and losses (Dushku and Brown, 2003).

Regional baseline setting methods must address two questions: (1) How much land use change is likely to occur in the future without intervention? (2) Where will this most likely take place? For example, in a land-based project, a piece of land might have remained in cultivation without the project. That could result in a flat baseline (i.e. one indicating no change in carbon on the site), a declining baseline (i.e. from continued soil erosion), or an increasing baseline (i.e. improved cultivation techniques); which of these are chosen for the analysis depends on the arguments and assumptions the analyst brings to the construction of the reference case (Sampson, 2004). Computer models such as GEOMOD have been used to produce projections of future deforestation based on a geographic analysis of deforestation trends in the recent past, as reflected by remote imagery. It assigns statistical weights to diverse physical, cultural, and economic factors that are associated with past deforestation, and build future projections based on how they will drive deforestation pressure within the project area (Pontius *et al.*, 2001).

When regional baselines are adopted, the growth data produced by the forest inventory is used as baseline for the different types of forest in each region. Those data reflect the measured growth rates by forest type achieved by all owners, across all soils and sites in the region. A project that can demonstrate that its growth rates are above the regional baseline through periodic measurements can claim that difference as a carbon credit produced by project action.

First Steps on Carbon Mensuration

Lowland rainforests are potential areas to focus efforts on awareness, training and monitoring of permanent plots (Table 1). They are primarily located in Western, Gulf, Morobe, Madang, East Sepik, West Sepik and Southern Highlands provinces (Fig. 1). A preliminary survey on management regimes will determine if these forests act as carbon sources or sinks. The variables that explain land use change depend on the survey scale (Veldkamp and Lambin, 2001): social and accessibility factors at the farm level, topography and agroclimatic potential at the landscape level, and climatic, macro-economic and demographic factors at the regional level. If land use change information is not available, oral narratives on land tenure should be recorded.

Table 1: Forest types in Papua New Guinea (UPNG 2002).

Type	%
Rainforest, lowland	40
Rainforest, lower montane	19
Rainforest, upper montane	2
Dry evergreen forest	2
Swamp forest	7
Mangrove	1
Non forest	30

Carbon measurements require multi strata data on tree heights and diameters, and dry weights in subplots for all species. Carbon can be sequestered into several “pools” including above- and below-ground biomass, soil carbon, forest floor, and understory growth. The method of establishing current carbon stocks in each pool should be stated.

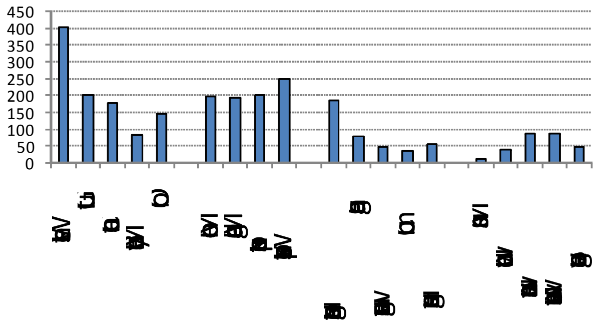

Fig. 1: Area (×10,000 ha) of non-degraded rainforest per province. Source: UPNG (2002). The provinces are grouped into the four regions.

By classifying customary land according to its real potential, conservation zones for carbon trade can be excluded from areas of intensive/semi-intensive use. Randomly selected plots of 100 × 100 m^2 are established, in which tree biomass allometries are calculated by relating the dry biomass (W) with the cylindrical bole diameter (D) of sampled trees; they follow Eqn. 1 (Satoo, 1982).

$W = a \times Db$ *Eqn. 1a*

$W = a + bD^2$ *Eqn. 1b*

A model for tropical hardwoods is shown in Eqn. 2 (Husch *et al.*, 1982).

$\log_e W = bo + b1 \times \log_e(D^2 h)$ *Eqn. 2*

where W = Tree Mass, a, bo and b1 = regression coefficients, D = diameter at breast height and h = total height (m).

To simplify the calculation of tree weights, wood densities of tropical tree species in three continents and biomass data for regression equations have been developed by FAO (1997).

The best predictors of above ground biomass of a tree, in decreasing order of importance, are the trunk diameter a chest height, wood specific gravity, h and forest type (dry, moist, or wet) (Chavez *et al.,* 2005).

As reported in Africa (Minang *et al.*, 2007), there is the risk that not all activities in the management plan may be implemented because of lack of funds, the remoteness of the community and leadership inadequacies. Moreover, Laki (2008) in a survey at Busamang (Morobe Province) found that most villagers were willing to participate and set aside forested areas for carbon trade, however less than half of them had the basic knowledge regarding the reasons and the procedures to develop it. Therefore a preliminary social mapping will be useful since men can claim rights to land through a wide range of connections with a place (Sillitoe, 1996), and genealogical claims may take precedence over tenancy (Sullivan, 2002).

Carbon Trade

Carbon trade brings environmental (large areas of tropical forest are better protected) and social (new source of income) to the local communities. Carbon sequestration rates in India goes up to 2.79 t C/ha/yr (10.23 t CO_2 ha/yr) under normal management conditions and after non-timber forest products are extracted; which is worth US$162.84 ha/yr (@ US$12/t CO_2). In Nepal there has been an increase of total carbon stock of more than 1 ton/ha (Tewari and Singh, 2007), which represents around 2% growth annually of the carbon stock, equivalent to 4 t CO_2 ha/yr. In Tanzania, with 34 million ha forestlands, a global benefit of $630 million/year is expected ($119/rural household) from CFM projects under the REDD policy (Zahabu *et al.*, 2007).

The Noel Kempf Climate Action Project over 642,458 ha in Bolivia, after indemnifying existing timber concessions and expanding the parks area, developed a forest protection, community development, carbon monitoring and conservation finance programs. Although this large scale avoided deforestation project could produce measurable offsets and rigorous certification criteria (Seifert-Granzin, 2006), some questions that remain are: • How can the changes on carbon stocks be measured and monitored in a cost effective manner? • Is there leakage to other areas? How much? • Should a possible mechanism of Carbon trade in PNG be based on avoided deforestation, or deforestation and degradation? • How closely should carbon stocks be tracked? • What are the rates of degradation in unmanaged forests? • How can the carbon stock changes be measured and monitored in a cost effective manner? • What would be the possibility of bundling several environmental services to reduce transaction costs? • What are the rules/procedures for internal payment? • Will such payments benefit the “unrepresented”?

PNG can still take advantage of an emerging ‘non-compliance’ or ’voluntary’ market from private sector organizations that are interested in purchasing carbon offsets even if these are not officially certified by the UNFCCC. Most non-compliance projects nowadays involve tree planting, rather than management of natural forest (Zahabu, 2005). An example is the Dutch FACE Foundation (Forests Absorbing Carbon dioxide Emissions) established by NV SEP (The Dutch Electricity Generating Board).

Summary

1. *PNG has decided to involve the nation's natural forests into the global trade of carbon credits at an average price of $10/ton. The willingness to participate is high in the rural areas However, fundamental aspects regarding organization and implementation of a monitoring system that works are still to be sorted out. This system, regardless of carbon trading, is needed to create an effective system for forest monitoring and compliance.*
2. *It is widely accepted that remote sensing analysis provides effective tools and methods to estimate Carbon intake by forests. However, the local capacity (know how) regarding the quantification of total biomass on the ground, and monitoring, reporting and verification of emissions and removals over the time, is limited and dispersed. This limitation can be overcome if the government, NGOs and universities share capacities and responsibilities.*

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