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Using tropical forests to combat global climate change without compromising local livelihoods

A Research Project presented to



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University Of Cape Town

1.0 ABSTRACT

Tropical forests provide benefits to local and national economies through the provision of environmental goods and services. In the fight against climate change, the Guyanese President has proposed placing almost the entire state-owned forest under an avoided deforestation programme if the right economic incentives are created to compensate for the economic benefits that the country would have to forego. The opportunity cost which includes standing timber value, post-harvest land use value, avoided protection cost, and loss of local ecosystem services was estimated at US\$580M annually. With avoided emissions estimated at 343 tons of carbon per hectare and the abatement cost of carbon at US\$2-11 per ton, this proposal seems financially viable and important for this developing nation. However, such a programme would affect the local communities that depend on the use and conversion of forest resources for their livelihoods. This study showed that a third of the state forest can be allocated to meet the needs of local communities without compromising the potential income from the avoided deforestation programme. The continued use of a third of the state forest would not only benefit the local communities and maintain their traditional way of life but would also benefit the government who would otherwise have to spend at least US\$396M annually to supplement those resources that the forests provide free of cost.

Keywords: avoided deforestation, climate change, ecosystem services, tropical forest, local communities

2.0 INTRODUCTION

Climate change is the new threat to biodiversity according to the United Nations Convention on Biodiversity (UNCBD), and is likely to become the dominant direct driver of biodiversity loss by the end of the century (Millennium Ecosystem Assessment 2005). The United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods. The Working Group I (WGI) of the Intergovernmental Panel on Climate Change (IPCC) projected an increase in global temperatures of 1.4°C to 5.8°C by 2100 in their Fourth Assessment Report. The increased temperatures will affect natural cycles such as precipitation patterns and increase the frequency of extreme weather events, according to the UNCBD. This impacts biodiversity by forcing them to adapt or face extinction. In fact, the population size and range of majority of species across a range of taxonomic groups is declining and the current rates and magnitude of extinction have increased by as much as 1,000 times historical background rates (Millennium Ecosystem Assessment 2005).

The loss of biodiversity has tremendous implications for the well-being of the world's human population. Biodiversity provides goods (provisioning services), ecosystem services (regulating services) and cultural services (Millennium Ecosystem Assessment 2005). Loss of biodiversity reduces the availability of these services which in turn affects human welfare.

The major sources of the increased level of global greenhouse gases (GHG) that are contributing to climate change are the burning of fossil fuels, farming activities and land-use changes

(deforestation), according to the UNCBD. In fact, up to 20% of GHG comes from tropical deforestation (Houghton 2005) with net emissions of 1.5 billion tonnes of Carbon every year (1.5 Pg C year⁻¹) as a result of a loss of 13 million hectares of forest annually (FAO 2006; Canadell & Raupach 2008). As such, combating climate change through the reduction of emissions from deforestation and degradation (REDD) of tropical forests is an important step. The equivalent of 50 Pg C of emissions would be avoided if deforestation rates are halved by 2050, and deforestation is stopped when countries reach half of their current forested area (Gullison et al. 2007).

In an effort to reduce CO₂ emissions through avoided deforestation, the Guyanese President has proposed placing almost the entire country's forest under internationally verifiable protection if payment for carbon credits is adequate compensation for the opportunity cost that would be forgone. With the opportunity cost estimated at US\$580M in annual annuities and current market price of carbon at US\$2 to US\$11/tonCO₂, the proposal could be economically viable (Office of the President 2008).

Although the proposal seems feasible at the macro scale, the implications for avoided deforestation on local livelihoods, particularly those dependent on the forests, need to be considered.

Firstly, an avoided deforestation regime can impose restrictions on the extraction of Non-Timber Forest Products (NTFPs) which support many households. Rural and poor households depend on NTFPs for livelihood activities and to supplement their living needs (Shackleton & Shackleton 2004). In Guyana, the income of some rural households is entirely dependent on the gathering, making and selling of NTFPs such as crabwood oil, tibusiri craft and wooden furniture, and wild

honey. For other households, the gathering of medicinal plants, fruits and seeds, hunting of bushmeat, and the harvesting of leaves, fuelwood and poles are their only source of medicine, food, utensils and shelter as other sources are inaccessible or unaffordable. NTFPs also benefit the state as they would otherwise have to provide these basic goods and services to the rural and poor. While placing the forest under protection should not affect continued access to NTFPs, there might be restrictions in terms of spatial, temporal and quantity of harvest.

Secondly, the avoided deforestation regime can create unemployment. In 2008, the forestry sector employed 21,957 persons directly in the timber harvesting, processing and trading activities with an additional 4,500 persons indirectly employed through the making of furniture and building components, craft trade, conservation and fuelwood production (Guyana Forestry Commission 2008). This number represents ca. 10% of the labour force (Bureau of Statistics 2007). While the production of timber may continue under the avoided deforestation programme, the introduction and enforcement of possible new and strict harvesting codes will force local operators that find it difficult to comply out of business. These codes are likely to form part of compensation contracts for avoided deforestation. There may also be limitations to the spatial expansion of the forestry sector. This will create unemployment and negatively affect the household income of thousands of Guyanese.

Thirdly, the avoided deforestation regime can have a negative impact on the local timber market. Wood remains one of the most important building materials in Guyana and a decrease in supply can have negative impacts on the local economy and on deforestation rates. 61% of houses have their outer walls constructed of wood and a further 19% have outer walls made from wood and concrete (Bureau of Statistics 2007). Wood is also widely used to make furniture, as telephone poles, fence posts and for supporting building foundation. A decrease in supply will therefore

affect the construction industry and cause an increase in price for wood. This increased price can incentivize illegal harvest and thus increase deforestation. Housing prices will also increase to the disadvantage of the low-income households.

Fourthly, the avoided deforestation regime can hinder the spatial expansion and development of the hinterland. Placing the forest under protection in an effort to avoid deforestation may prohibit the development of highways and urban settlements. Since the forest occupies the central region of the country, urban development will be restricted to the coastal plain in the northeast region of Guyana and the savanna region in the southwest. The anticipated Georgetown/Lethem highway to link the two towns, and Guyana with Brazil and the rest of South America is expected to provide social and economic opportunities. However, if the forest comes under protection, the construction of the highway will conflict with the objectives of the avoided deforestation programme as deforestation will take place. Studies from neighbouring Brazil show that when highways are created through forest, deforestation occurs within a 50km reach of the highway as the area becomes readily accessible (Nepstad et al. 2001; Alves 2002).

Lastly, the avoided deforestation regime could hinder the diversification of economic activities. The predicted climate change and the dynamics of global financial market make it necessary for governments to diversify their sources of revenue and to meet new market demands. Under the avoided deforestation programme, the country's forest will be committed to long-term arrangements that would prevent the forest from being converted to other uses. In the event that biofuels or the maintenance of the forest for fresh water supply become more lucrative than carbon trading, the country may not be able to convert its forest or enter into another agreement to capitalize on those opportunities because of the ramifications of terminating a binding avoided deforestation contract.

The avoided deforestation regime however does bring national benefits including revenue from carbon trading. The concept of the Reduced Emissions from Deforestation and Degradation (REDD) programme is that countries with standing forest can be compensated for the opportunity cost that would be forgone if the forest was logged or other economic ventures were pursued. 75% or 18.6M ha of Guyana is covered with tropical rainforest (Guyana Forestry Commission 2009). Of this, 13.6M ha is state forest and the president has proposed placing almost all of this under internationally verifiable protection if the right economic incentive is created. The opportunity cost which includes standing timber value, post-harvest land use value, avoided protection cost, and loss of local ecosystem services was estimated at US\$580M annually (Office of the President 2008). With avoided emissions estimated at 343 tons of carbon per hectare and the abatement cost of carbon at US\$2-11 per ton, this proposal does seem financially viable and important for this developing nation (Office of the President 2008). The arrangement is also long-term and can therefore be a reliable source of revenue for the government.

Another potential benefit of the avoided deforestation regime is the automatic maintenance of other ecosystem services. Apart from sequestering carbon, the forest provides many other ecosystem services that benefit both the local and international communities. Avoiding deforestation will maintain these important services. Other productive sectors such as agriculture stand to receive continued benefits which includes fresh water supply, erosion control and flood management. The maintenance of these services also allows for the possibility of Guyana receiving further compensation for providing ecosystem services in addition to reducing carbon emissions.

The avoided deforestation approach and the continued extraction of timber conflict with each other but both are important for social and economical reasons. It is therefore important to develop an arrangement that will bring benefits to all users. This study attempts to propose such an arrangement and hypothesized that current forest extraction can continue in order to support local livelihoods dependent on forest resources without compromising the economic viability of the avoided deforestation proposal for Guyana.

In testing the hypothesis, the following questions were asked:

1. What would be the amount of state forest required to maintain current extraction of forest resources for the benefit of the local economy and national development?
2. What would be the economic implication when part of the state forest is allocated to maintain current extraction of forest resources for the benefit of the local economy and national development, and the remainder is allocated to the proposed avoided deforestation programme?
3. How would the allocation of state forest to maintain current extraction of forest resources for the benefit of the local economy and national development affect forest cover?

3.0 METHODOLOGY

Study area

The study focuses on the forested state land of Guyana. Guyana is located in the northern coast of South America (see Figure 1) and has a land territory of 21.5M ha. The climate is tropical and the country is divided into four natural regions (see Figure 2): low coastal plain, hilly sand and clay region, interior savanna and forested highland region, of which the latter covers ca. 75% of Guyana's territory. The state forest, approximately 13.8M ha in size is managed by the Guyana Forestry Commission (GFC). The country is also divided into ten administrative regions (see Figure 3) and the population is approximately 750,000 according to the last census in 2002 (Bureau of Statistics 2007).

The major economic activities of the country are agriculture with rice and sugar as the main exports, fishing, logging, quarrying and mining. In 2008, rice and sugar contributed ca. 10% to Guyana's Gross Domestic Product (GDP), fisheries contributed ca. 7%, and mining and quarrying ca. 11% (Bureau of Statistics 2009a). The forestry sector generated US\$57M in export revenue in 2008 and this contributed ca. 3.5% to national GDP (Guyana Forestry Commission 2009). GDP per capita is US\$2,308 (Bureau of Statistics 2009b).

Data Analysis

For this study, the current trend of resource extraction from forest was estimated and used as baseline from which extrapolations were made to determine how much of state forests should be allocated to meet the future demand for the local timber market, agricultural land in the hinterland, construction of the Georgetown/Lethem highway and creation of protected areas.

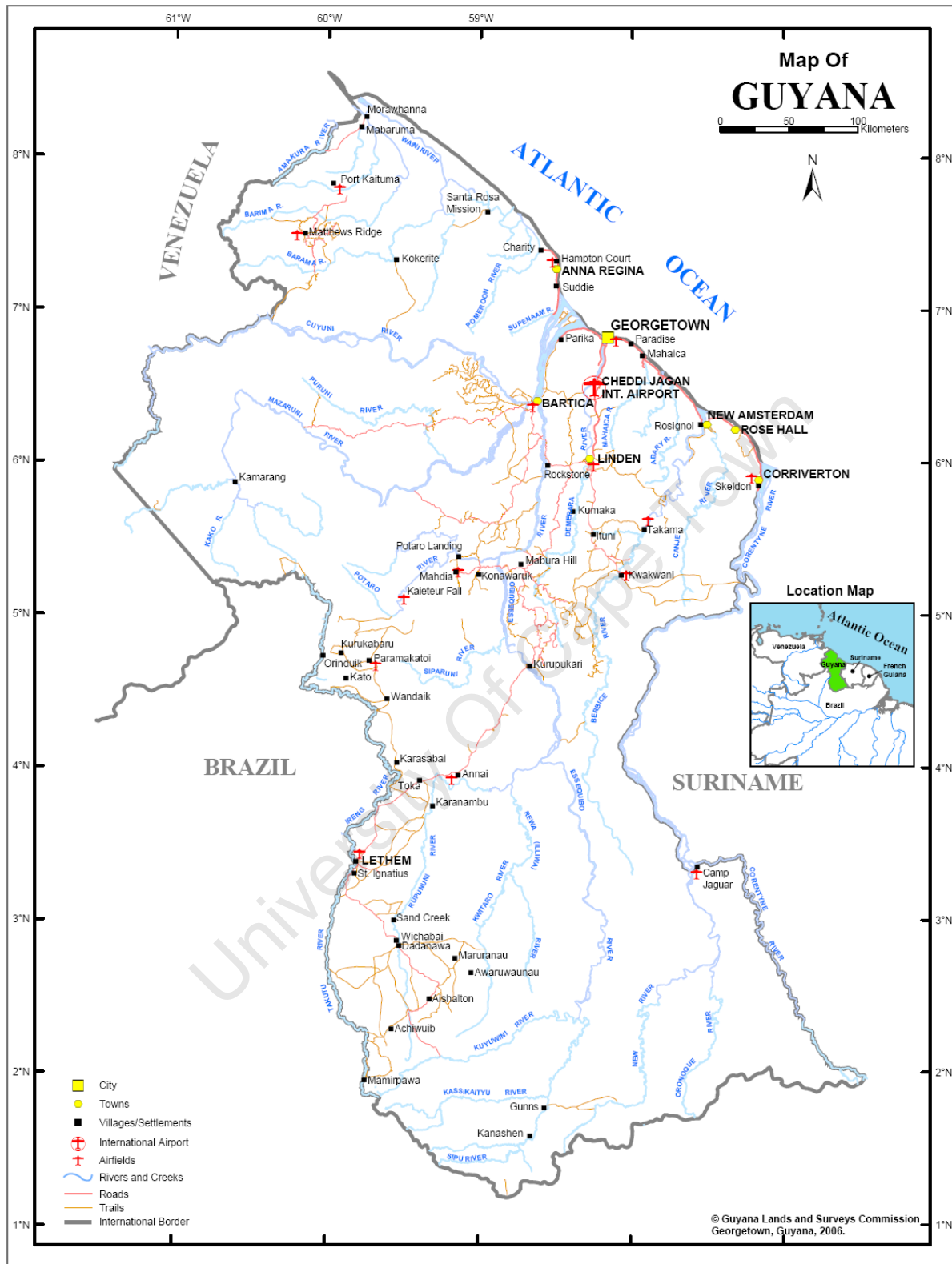


Figure 1. Map showing the geographic location of the study area, Guyana.

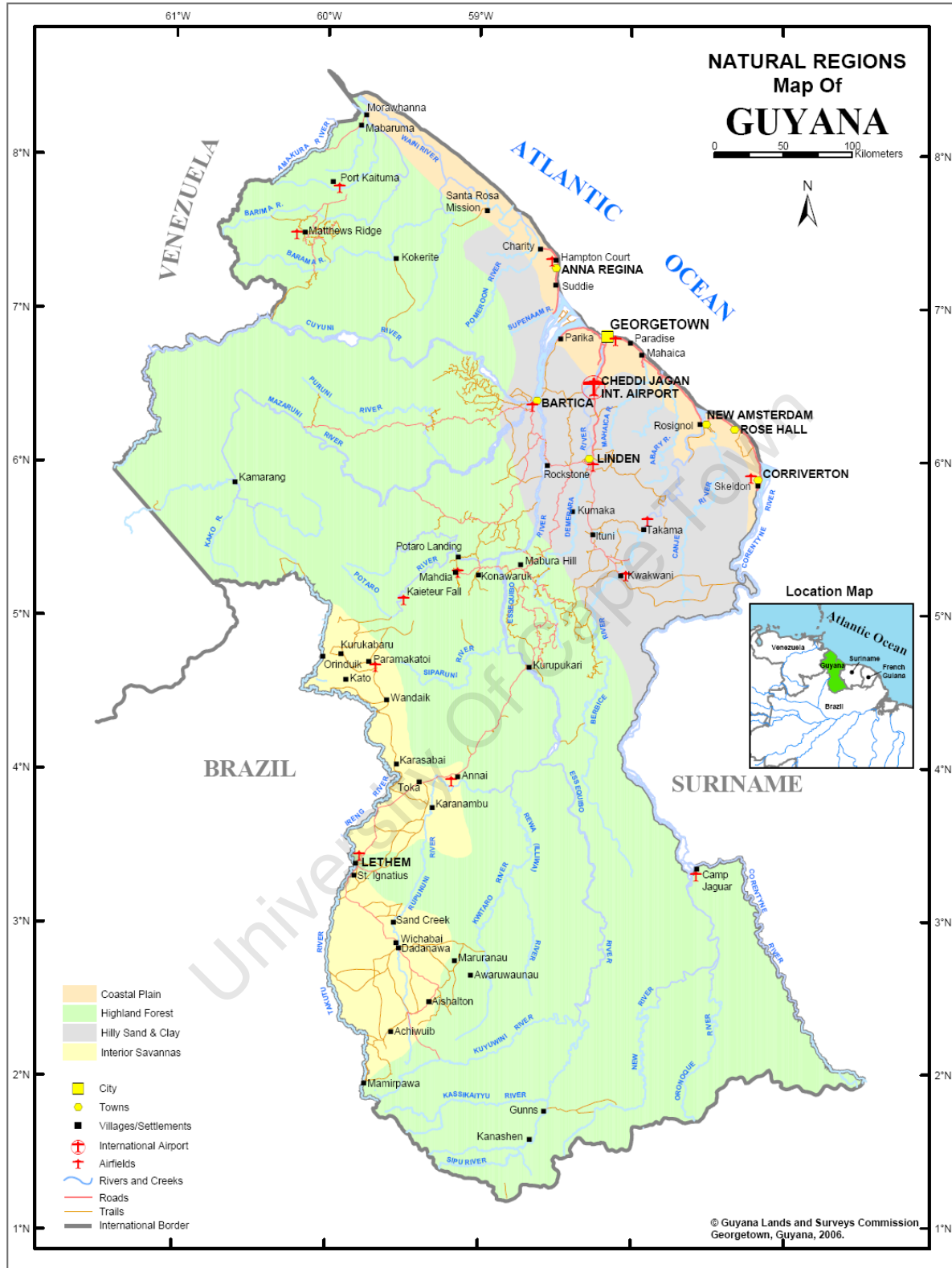


Figure 2. Map of Guyana showing the four natural regions.

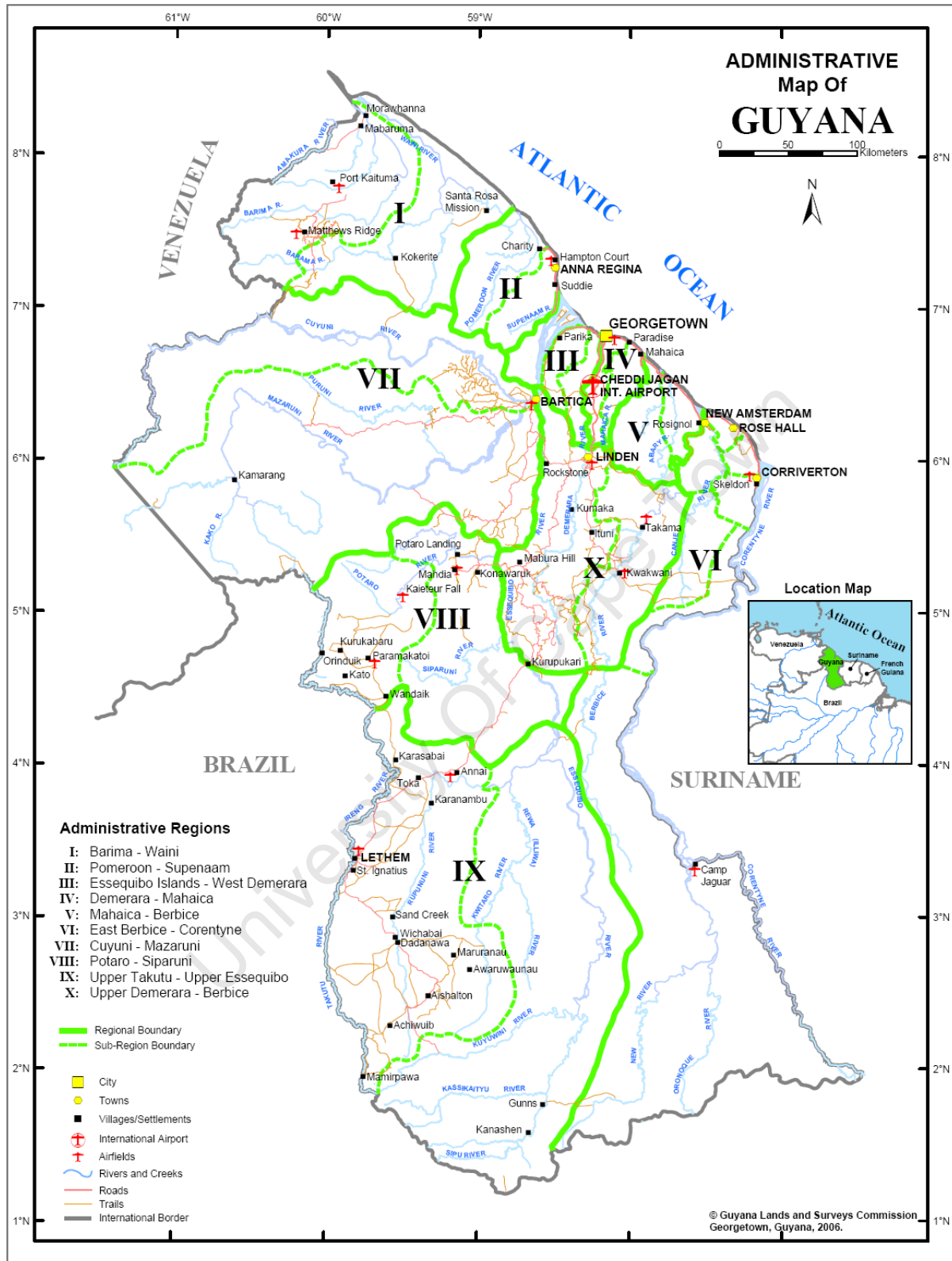


Figure 3. Map of Guyana showing the ten administrative regions.

The contribution to the economy for each of the above mentioned allocations was then calculated using available data on gross revenue earned/saved by the respective sectors and projections were made on potential income in the future. Finally, the future forest cover as a result of the above-mentioned allocations was projected under a range of possible deforestation rates.

Gross values were used in the calculations as the intention of this initial study was to draw attention and generate policy discussion to the potential impacts of the avoided deforestation proposal on local communities. The values therefore do not adjust for actual intermediate input costs and inflation, and this was mainly due to the time constraint of the research period and unavailability of relevant data. Follow-up studies should be conducted at a more detailed scale over a longer research period and incorporate adjustments, such as inflation, to derive accurate values of measure.

Forested area required for continued timber extraction for local market

In 2008, 382,362m³ of logs and wood were produced of which 169,501m³ was exported (Guyana Forestry Commission 2008; Bureau of Statistics 2009b). Therefore the difference of 212,861m³ was assumed to have been consumed by the local market (refer to Table 1). The 2008 production was harvested from 1,717,699ha of state forest allocated for timber harvest and this equals to a production of 0.22m³ per hectare. Timber extraction is done under a 60year cycle and the average allowable cut per hectare per year under the GFC guidelines is 0.33m³ (Office of the President 2008). The 2008 production was within the guideline set out by GFC for sustainable harvest and with each hectare of forest producing 0.22m³ of timber, it would have taken approximately 967,550ha of forest to produce the volume of timber consumed locally in 2008.

The economic value of each hectare of forest from logging was calculated by dividing the estimated revenue of timber for 2008 by the volume of timber produced in 2008 (see Table 1).

The revenue data was obtained from the Bureau of Statistics and the selling price for timber on the local market was obtained from the GFC's Quick Assessment Paper. An exchange rate of G\$200 = US\$1 was used.

To estimate the size of forest required to meet the demand for timber by the local market in the future, it was assumed that demand would grow at the same rate as population growth. Using the 2008 population size and demand as the baseline, four scenarios of population growth over the next twenty-five years were considered: -10%, 0%, 10% and 50%. The medium variant projections for 2005 to 2025 by the Bureau of Statistics show a gradual increase of approximately 7%. In this study, growth rates of -10%, 0% and 50% were assumed for sensitivity analyses.

Table 1: Estimation of the economic value per hectare of forest logged in 2008.

State Forest Allocation		Area harvested in 2008 (ha)	
State Forest Permit (SFP)		1,148,046	
SFP Conversion areas		497,846	
Wood Cutting Lease & Timber Sales Agreement		71,807	
Total		1,717,699	

Product	Amount produced (m³)	Amount exported (m³)	Export value (US\$)	Local use (m³)	Local rate/m³ (US\$)	Local value (US\$)	Total Value (US\$)	Value/ha (US\$)
Logs	275,320	92,404	15,575,230.00	182,916	140.65	25,727,135.40	41,302,365.40	
Roundwood	18,722	10,323	2,504,290.00	8,399	198.74	1,669,217.26	4,173,507.26	
Primary lumber	66,958	47,603	26,045,982.00	19,355	320.07	6,194,954.85	32,240,936.85	
Splitwood	731	3,415	2,613,663.00	-	192.44	-	2,613,663.00	
Plywood	20,631	15,756	6,582,135.00	4,875	583.4	2,844,075.00	9,426,210.00	
Total	382,362	169,501	53,321,300.00	215,545		36,435,382.51	89,756,682.51	52.25

Local use = Amount produced less amount exported
 Total value = Export value + Local value
 Value/ha = Total value divided by number of hectares harvested
 NB: Amount of splitwood exported exceeds amount produced for 2008
 Firewood and charcoal treated separately under NTFPs

Forested land required for agriculture

One of the policies of the government is food security for the nation. As such, areas should be allocated for agricultural development before committing the forest to an avoided deforestation arrangement. While much of the agricultural sector is concentrated on the coastal strip, communities living in and around forests farm in forested areas by clearing patches of forest. During 2007-2008, an estimated 21,903ha of forest was cleared for subsistence agriculture (Guyana Forestry Commission 2009). One of the reasons could be that fresh produce from the coast is not readily available to these remote communities and even if they are available, the cost is prohibitive. As such, it is important to set aside areas for agricultural activities in the forested area.

An estimated 168,900ha of land was under rice and sugar cultivation in 2008 (Bureau of Statistics 2009b) and cultivation generally occurred in Regions 2,3,4,5 and 6 with a total population of 638,757 (Bureau of Statistics 2007). Assuming that area under cultivation is related to population size, then one person requires 0.26ha of land for cultivation. Considering that the populations of Regions 1,7,8,9 and 10 amounted to 112,466 persons (Bureau of Statistics 2007) and those regions are predominantly covered by forest, an area of 29,738ha of forest would be required for agricultural development.

Rice and sugar were used to estimate the value of agricultural crops as they are the main crops produced and accounted for 38% of agricultural GDP in 2008 (Bureau of Statistics 2009a). The revenue and production data was obtained from the Bureau of Statistics.

To estimate the size of forest required for agricultural development in the future to meet the demand of populations living in forested and remote communities (Regions 1,7,8,9 and 10), it

was assumed that demand would be influenced by population size. Using the 2008 hinterland population size and demand as the baseline, four scenarios of population growth were considered: -10%, 0%, 10% and 50%. The latter assumption was considered potentially realistic if the Georgetown-Lethem highway becomes a reality and accessibility to the hinterland regions is improved. This may create opportunities for the establishment of new settlements and expansion of existing communities thus a dramatic increase in hinterland population is likely.

Forested land required for the potential Georgetown /Lethem Highway

A potential highway connecting Georgetown and Lethem, and the rest of South America is important for social and economic development. The current dirt road between the two towns is 450km (MacDonald 2008) and an estimated 75% or 340km (distance from the end of the paved road in Linden to Annai) passes through forested area. With studies showing 50km of forest along highway corridor is deforested as a result of the highway opening accessibility to the forests (Nepstad et al. 2001; Alves 2002), then 1.7M ha of forest will be effectively lost to this venture in a worst case scenario.

The potential contribution to the economy from development of the highway was not assessed in this study due to limited availability of the necessary data.

Forested land required for Protected Areas

Under the United Nations Convention for Biological Diversity (UNCBD) of which Guyana is a party, Guyana is obligated to place under protection at least 10% of its territory. The GFC has 1,485,343ha (10.9%) of state forest listed as reserves; this represents 8% of total forest cover and

6.9% of total land area. Though the reserves are not formally declared protected areas, this size of forest was assumed to be sufficient to meet the UNCBD obligation, as other areas of biomes will have to be considered as well. In addition, the two formally created protected areas, Iwokrama and Kaieteur National Park, cover an area of 433,700ha, most of which is forested. As such, there was no need to allocate additional state forest for protected areas in this study.

Further, Amerindian communities can also declare part or all of their lands as protected areas and have such areas included in the national system, according to the New Amerindian Act. The Amerindian community of Konashen declared most of their 400,000ha land as community owned conservation area (Rapid Assessment Program 2008).

While protected areas may not receive compensation for maintaining ecosystem services, they have the potential to generate income from tourism activities. The estimated economic value of each hectare of forest from tourism was calculated by dividing Iwokrama's tourism revenue for 2008 by 371,000ha, the size of the Iwokrama Forest. The revenue data was obtained from the Annual Review 2008 published by Iwokrama. With Iwokrama's tourism revenue showing a trend of gradual increase of 26% in 2008 over 2007 level (Iwokrama 2008), increases in the value per hectare of 25%, 50% and 75% were considered.

Forest required for the continued extraction of NTFPs

This activity should be allowed under any management arrangement for avoided deforestation as NTFP extraction is not likely to result in deforestation since it involves collection of plant parts and not entire plants/trees. This is also in keeping with legislation that permits the traditional

extraction of forest resources such as bushmeat, seeds, and barks. As such, setting aside forest to facilitate the continued extraction of NTFPs was not necessary in this study.

The estimated economic value of three major NTFPs, fuelwood, roofing leaves and bushmeat was calculated based on available data for consumption per household/capita and local market price.

Forest required for carbon stock management

The remainder of the state forest after subtracting the above mentioned areas of forest required can then be allocated for carbon stock management under the proposed avoided deforestation programme.

With the current global abatement cost at US\$2 to US\$11/tonCO₂ (Office of the President 2008) the potential income from avoided deforestation using the remaining forest following allocations for continued timber harvest, agricultural development, protected areas and the Georgetown-Lethem highway was calculated. In addition, the forest being managed for carbon sequestration also contributes to the maintenance of other ecosystem services. The economic potential of these services was calculated using the values estimated by Costanza et al. (1997) for those services that are relevant to Guyana's forest.

Deforestation

Using satellite data and ground truthing, the GFC calculated deforestation rates of 0.25% in the State Forest Estate and an overall deforestation rate of 0.29% (Guyana Forestry Commission

2009). The deforestation rate is low compared to the states of neighbouring Brazil where the annual deforestation rates for the period 2000-2005 were 0.82% in Roraima, 2.16% in Rodonia, 4.50% in Para, and 10.66% in Mato Grosso (Guyana Forestry Commission 2009). The low deforestation rate can be attributed to GFC's Sustainable Forestry Management principles (Guyana Forestry Commission 2009) which include reduced impact logging, selective logging, harvesting cycles and creating biodiversity reserves in each concession. Low population density within the forested areas due to inaccessibility could be another contributing factor to the low deforestation rate.

For this study, it was assumed that the rate of deforestation for the timber harvesting area would remain at 0.25% per annum; 25% for land conversion to agriculture and to facilitate the development of the Georgetown-Lethem highway; and 0% for Protected Areas and areas allocated to maintain carbon stock as it is assumed that these would be closely managed to prevent deforestation. This scenario was compared to the forest cover projections by FAO's 2005 Global Forestry Assessment. Just to note that the FAO's assessment included all of Guyana's forest while this study considered only state forest since this area is managed by the government.

4.0 RESULTS

Size of state forest required for the continued extraction of forest resources and conversion to meet local needs

The size of state forest required to continue timber extraction to meet local demand in the future ranged from 0.9M ha to 1.5M ha (see Table 2); to facilitate agricultural development in the hinterland regions, the size ranged from 0.03M ha to 0.04M ha (Table 3); to facilitate the development of the Georgetown-Lethem highway, an estimated 1.7M ha of forest would be effectively lost; and to create protected areas, an area of 1.5M ha has been listed as reserves by GFC.

Table 2. Estimation of the potential economic contribution of continued timber production to the local economy

Scenarios	Forest size required (ha)	At US\$52.25/ha [estimated value in 2008] (US\$)	At 10% increase of the 2008 est. value/ha (US\$)	At 10% decrease of the 2008 est. value/ha (US\$)	At 50% increase of the 2008 est. value/ha (US\$)
Population size and demand remain at the 2008 level	967,550	50,554,488	55,614,774	45,503,877	75,836,569
Population size and demand increase by 10%	1,064,305	55,609,936	61,176,251	50,054,264	83,420,226
Population size and demand decrease by 10%	870,795	45,499,039	50,053,297	40,953,489	68,252,912
Population size and demand increase by 50%	1,451,325	75,831,731	83,422,161	68,255,815	113,754,854

Table 3. Estimation of the potential economic contribution of agriculture in the hinterland regions.

Scenarios	Forest size required (ha)	At US\$1,882.03/ha [estimated value in 2008] (US\$)	At 10% increase of the 2008 est. value/ha (US\$)	At 10% decrease of the 2008 est. value/ha (US\$)	At 50% increase of the 2008 est. value/ha (US\$)
Population size and demand remain at the 2008 level	29,738	55,967,808	61,564,500	50,371,117	83,951,861
Population size and demand increase by 10%	32,712	61,564,589	67,720,950	55,408,228	92,347,047
Population size and demand decrease by 10%	26,764	50,371,027	55,408,050	45,334,005	75,556,675
Population size and demand increase by 50%	44,607	83,951,712	92,346,750	75,556,675	125,927,791

Taking the upper-end of these ranges, approximately 4.7M ha of state forest should be allocated to meet local and national developmental needs. This makes available approximately 9.1M ha or two-thirds (see Figure 4) of state forest available for carbon stock management and possible compensation under the proposed avoided deforestation programme.

Current value per hectare from timber production was estimated at US\$52.25 (see Table 1); the current value per hectare of agricultural land was estimated at US\$1,882.03 (see Table 4); the current tourism value per hectare of protected area was estimated at US\$0.83; and the value of NTFPs was estimated at US\$15M (see Tables 5, 6 and 7).

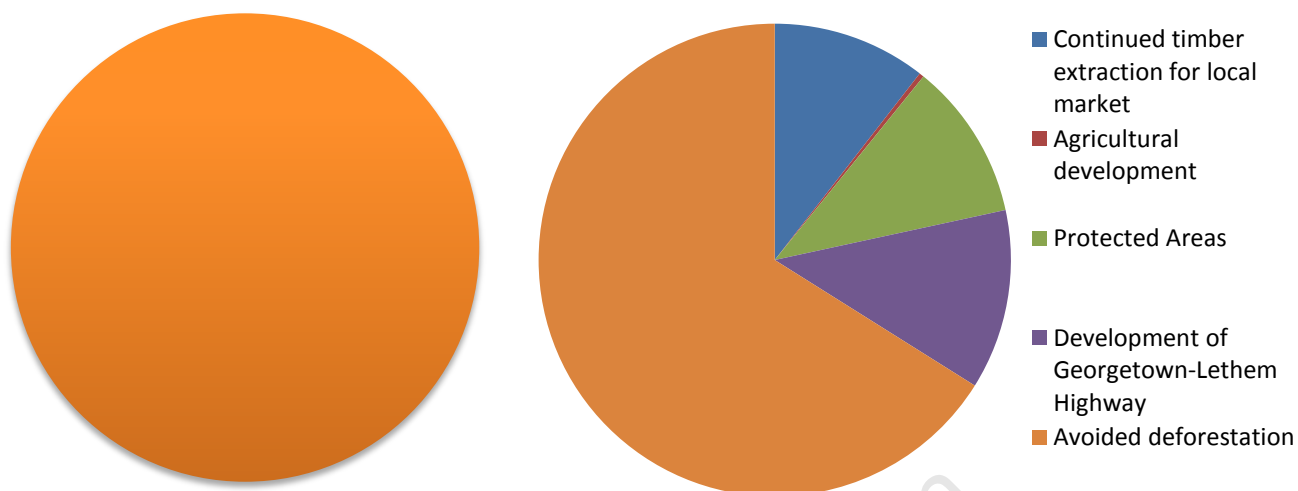


Figure 4. Charts showing the possible allocation of state forest under the President’s avoided deforestation proposal vs the recommended allocation according to the findings of this study.

Continued timber extraction to meet local demand in the future can contribute US\$41M – US\$113M annually to the economy (see Table 2); agricultural development in the hinterland regions can contribute US\$45M – US\$126M annually (see Table 3); tourism in protected areas can contribute US\$0.4M – US\$4M annually (see Table 8); and NTFPs can contribute approximately US\$16.5M annually (see Tables 5, 6 and 7). The mean annual revenue from maintaining the carbon stock of the 9.1M ha of state forest ranged from US\$202M to US\$1.1B (see Table 9). Assuming that the economic value of the above activities gradually increase in the future and carbon stocks are compensated at US\$2/ton, the recommended allocation of state forest according to this study can contribute approximately US\$396M annually (see Table 10) to the economy.

Table 4. Estimation of the economic value per hectare of land under cultivation.

Crop	Estimated area cultivated (ha)	2008 Production (tons)	2008 Export value (US\$)	Estimated local sales (US\$)	Total Value (US\$)	Value/ha (US\$)
Rice	119,800	329,574	119,149,000.00	51,063,857.14	170,212,857.14	
Sugar	49,100	226,267	138,688,000.00	8,974,500.00	147,662,500.00	
	168,900	555,841	257,837,000.00	60,038,357.14	317,875,357.14	1,882.03

Value/ha = Total value divided by number of hectares cultivated

Table 5. Estimation of the economic value of fuelwood (NTFP).

Region	# of Villages	#HH use Firewood	#HH use coal	# HH use Fuelwood	Total HH/region	%HH use Fuelwood	HH use @ 24.024 cu.mt (cu. mt)	Est. value @ US\$21.69/cu.mt (US\$)	Est. value @ 10% increase in price (US\$)
1	82	2,371	77	2,448	3,974	62	58,811	1,275,605	1,403,166
2	159	7,087	422	7,509	11,219	67	180,396	3,912,794	4,304,073
3	272	2,097	44	2,141	25,954	8	51,435	1,115,633	1,227,197
4	228	1,820	301	2,121	77,937	3	50,955	1,105,212	1,215,733
5	237	1,114	22	1,136	12,945	9	27,291	591,948	651,142
6	230	4,013	44	4,057	31,649	13	97,465	2,114,024	2,325,426
7	59	1,160	66	1,226	3,641	34	29,453	638,845	702,729
8	35	1,297	50	1,347	1,837	73	32,360	701,896	772,085
9	61	2,635	3	2,638	3,543	74	63,375	1,374,611	1,512,072
10	101	246	113	359	8,817	4	8,625	187,068	205,775
Total	1,464	23,840	1,142	24,982	181,516	14	600,168	13,017,635	14,319,398

Survey of 9 Amerindian communities in 2005: Average household (HH) consumption of firewood/week = 7 warashi
 Considering volume of warishi (700mmx420mmx225mm) = 0.066 cu.mt
 Therefore, average household (HH) consumption of fuelwood/year (7 warashi x 52 weeks x 0.066 cu.mt) = 24.024 cu.mt

Table 6. Estimation of the economic value of roofing leaves (NTFP).

Region	# of Villages	#HH Thatched roof	Total HH/region	%HH Thatched	HH use @ 80Kg/HH (Kg)	Value @ US\$0.625/Kg (US\$)	Value @ 10% increase in price (US\$)
1	82	1,945	3,974	49	155,600	97,250	106,975
2	159	205	11,219	2	16,400	10,250	11,275
3	272	172	25,954	1	13,760	8,600	9,460
4	228	266	77,937	0	21,280	13,300	14,630
5	237	150	12,948	1	12,000	7,500	8,250
6	230	212	31,649	1	16,960	10,600	11,660
7	59	468	3,641	13	37,440	23,400	25,740
8	35	58	1,837	3	4,640	2,900	3,190
9	61	2,759	3,543	78	220,720	137,950	151,745
10	101	103	8,817	1	8,240	5,150	5,665
Total	1,464	6,338	181,519	3	507,040	316,900	348,590

Cost of roof measuring 4.5m x 3m is US\$50-60 and uses 80Kg of leaves [US\$0.625/Kg] (van Andel 1998)

Table 7. Estimating the economic value of bushmeat (NTFP).

Region	# of Villages	# of HH	Assume 75% of HH use bushmeat	# of persons/HH	HH use @ 31Kg/capita/yr (Kg)	Value @ \$1.10/Kg (US\$)	Value @ 10% increase in price (US\$)
1	82	3,974	2,981	14,903	461,978	508,175	558,993
2	159	11,219	8,414	42,071		-	-
3	272	25,954	19,466	97,328		-	-
4	228	77,937	58,453	292,264		-	-
5	237	12,945	9,709	48,544		-	-
6	230	31,649	23,737	118,684		-	-
7	59	3,641	2,731	13,654	423,266	465,593	512,152
8	35	1,837	1,378	6,889	213,551	234,906	258,397
9	61	3,543	2,657	13,286	411,874	453,061	498,367
10	101	8,817	6,613	33,064		-	-
Total	1,464	181,516	136,137	680,685	1,510,669	1,661,736	1,827,909

Only Regions 1, 7, 8 and 9 were considered due to remoteness and limited accessibility to domesticated meat markets

MICS 2006: HH of Regions 1, 7, 8 and 9 are bottom poorest 20 percent of HH [therefore may not afford to purchase meat produced outside of region]

Census 2002: Average HH size for Regions 1, 7, 8 and 9 is 5

FAO 2004: Meat consumption for Guyana is 31Kg/yr/capita

Sullivan 1999: Assakata Village with a population of 176 catches 27,735Kg bushmeat per year; up to 61% of catch sold (39% consumed); Therefore consumption/person is 61.5Kg/yr/person

Rushton 2005: Bushmeat consumption/indigenous person in Trio, Suriname is 47.5Kg/yr, Yanomano, Venezuela is 52.2Kg/yr; Yekwana, Venezuela is 58Kg/yr, and Kainsang, Brazil is 34.7Kg/yr

MoAA UNDP/GoG 2006: Price for bush meat ranges from US\$0.40 (fresh meat) to US\$0.70 (salted meat) per pound. Assume US\$0.50/lb = US\$1.10/Kg

Table 8. Estimation of the potential economic contribution of tourism from protected areas.

Scenarios	Forest size (ha)	At US\$0.83/ha [estimated value in 2008] (US\$)	At 25% increase of the 2008 est. value/ha (US\$)	At 50% increase of the 2008 est. value/ha (US\$)	At 75% increase of the 2008 est. value/ha (US\$)
Area under legal protection (Iwokrama and Kaieteur Park)	433,700	359,971	451,048	680,909	1,188,338
Area identified as reserves by GFC	1,485,343	1,232,835	1,544,757	2,331,989	4,069,840
Total	1,919,043	1,592,806	1,995,805	3,012,898	5,258,178

Table 9. Estimation of the potential revenue from maintaining carbon stock in 9Mha of forest over a 30year period.

Remainder of state forest after allocation for local needs (ha)	9,118,725		
CO ₂ /ha (tons)	343*		
Total CO ₂ stock (tons)	3,127,722,675		
		US\$2/ton CO₂	US\$5/ton CO₂
Total revenue constant (US\$)	6,255,445,350	15,638,613,375	34,404,949,425
Mean annual revenue (US\$)	201,788,560	504,471,399	1,109,837,078

*Estimate of t C/ha for above ground biomass only (FAO 2005)

Table 10. Comparative economic contribution of the recommended allocation of state forest versus total allocation of state forest to the proposed avoided deforestation programme.

Activity	Forest required (ha)	Potential annual contribution to economy (US\$)	Potential annual income from avoided deforestation @ \$2/ton CO2 (US\$)	Potential annual income from avoided deforestation @ \$5/ton CO2 (US\$)	Potential annual income from avoided deforestation @ \$11/ton CO2 (US\$)
Continued timber extraction for local market	1,451,325	83,422,161	32,116,418	80,291,044	176,640,298
Agricultural development	44,607	92,346,750	987,110	2,467,774	5,429,104
Protected Areas	1,485,343	1,544,757	32,869,203	82,173,008	180,780,617
Development of Georgetown-Lethem Highway	1,700,000	Not Assessed	37,619,355	94,048,387	206,906,452
Extraction of NTFPs*	Not required	16,495,897	-	-	-
Carbon stock management	9,118,725	201,788,560	201,788,560	504,471,399	1,109,837,078
Total	13,800,000	395,598,124	305,380,645	763,451,613	1,679,593,548

* fuelwood, bushmeat and roofing leaves (see Tables 5, 6 and 7)

The allocation of 1.5M ha of state forest to continued timber extraction for local needs as against allocation for maintaining carbon stock is economically viable. However, if price for carbon stock exceeds US\$5/ton and the local demand for timber does not increase significantly, the situation becomes competitive.

The allocation of 0.04M ha of state forest for agricultural development in the hinterland as against allocation for maintaining carbon stock is most economically viable. On the other hand, the allocation of 1.5M ha of state forest for protected areas as against allocation for maintaining carbon stock is least economically viable based on the estimated tourism revenue.

Forest Cover

Approximately 4.7M ha of forest could be lost under the recommended allocation of state forest according to this study. During the first ten years, deforestation can be high if the development of agriculture and the highway commenced immediately and simultaneously. The rate of deforestation stabilizes afterwards as the forested area allocated for land conversion would have been deforested and the remaining forested areas are under protection from deforestation. However, the deforestation rate and forest cover loss is significantly less than the projections reported in FAO's 2005 Global Foresty Assessment (see Figure 5). The FAO projection shows complete deforestation of Guyana's forest in twenty-five years which could be due to growing economic pressures to increase value from forest resources (Office of the President 2008).

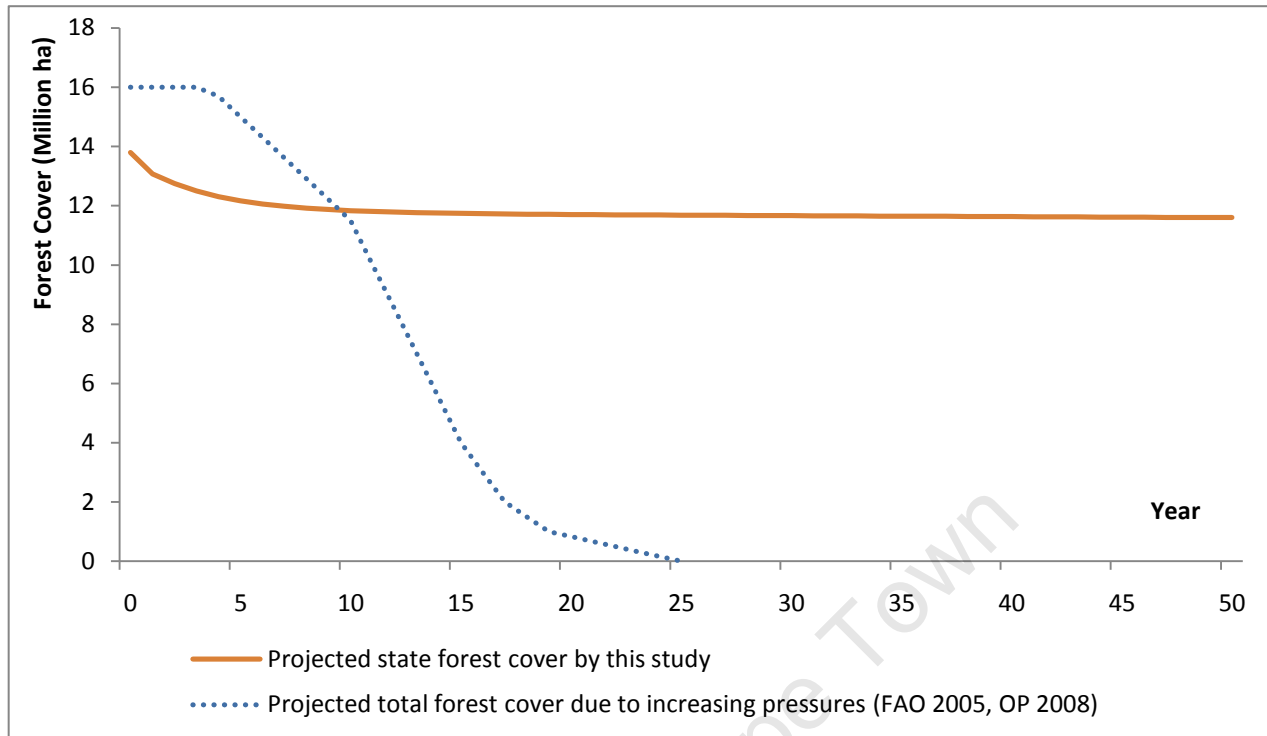


Figure 5. Graph showing the comparative forest cover under the recommended allocation of state forest according to this study and FAO’s projection. Note: FAO’s projection considers the total forest cover while this study considers cover for state owned and managed forests.

5.0 DISCUSSION

Economic Viability

The Economic Value to Nation for Guyana's state forest was estimated at US\$580M annually (Office of the President 2008). The findings of this study shows that there is sufficient state forest to meet the needs of the local economy and contribute to the fight against global climate change, and still have the potential to earn more than US\$580 annually. Apart from the above allocation, taking 65% of the state forest alone can earn the country more than US\$580M annually at US\$6/tC.

In addition to the 65% of the state forest earning revenue from storing carbon, that forest is also maintaining other ecosystem services. Using Costanza et al (1997) values for regulating and supporting services provided by tropical forests, Guyana can potentially earn a further US\$6B (see Table 11).

Table 11. Potential income for maintaining other ecosystem services in addition to carbon storage.

Other regulating and supporting Services provided by tropical forests	Est. value ha/yr* (US\$)	Est. annual value from ca. 9M ha of state forest (US\$)
disturbance regulation	5	45,593,625
water regulation	6	54,712,350
water supply	8	72,949,800
erosion control	245	2,234,087,625
soil formation	10	91,187,250
waste treatment	87	793,329,075
genetic resources	41	373,867,725
habitat/refugia	169	1,541,064,525
recreation	112	1,021,297,200
cultural	2	18,237,450
Total		6,246,326,625

*based on values by Costanza et al (1997)

Allocating forest areas to meet local and national development needs.

At the local level, continued extraction of forest resources is important for the maintenance of livelihoods. With the national minimum wage of US\$125/month and the average household income of some Amerindian communities ranging from US\$20 to US\$30, many households cannot afford to purchase food, medicine and building materials. Without continued use of the forest, the government would have to supplement those needs which can cost the national treasury at least US\$396M annually. Therefore the continued use of the forest resources and land for agriculture is not only vital for the survival of the local communities and the practice of their traditional way of life, but is also beneficial to the government.

The pathway for a Georgetown/Lethem highway has more or less been defined by the existing dirt road. However, considerations should be given for alternate routes if the current route passes through areas that are sensitive to human impact. Allocations for agricultural land should be close to the highway so as to facilitate the transport of produce and reduce the need for additional roads to connect farms and highway. The land should be of Class 1 or Class 2 soil type as these are considered good to moderate agricultural land (Guyana Lands and Surveys Commission 2004). The allocation for agricultural land should also be concentrated where large settlements exist.

Allocation for protected areas should take into account areas of high biodiversity value in terms of uniqueness, areas of refugia, replaceability and resilience to disturbances, among others. The allocation should also take into account the priority areas proposed for protection by the government. These areas include the Kanuku Mountains and Mount Roraima.

Addressing deforestation in the future

The continued extraction of timber to meet the local market is not expected to increase the current rate of deforestation if the GFC's Code of Practice for sustainable harvesting is adhered to. These include Reduced Impact Logging (RIL) and Selective Logging.

The rate of deforestation in the future would also be influenced by the demand for wood and wood products. Limited options for alternatives to wood and high prices for such alternatives would increase demand. Policies pertaining to the reduced dependency on wood should be introduced. These can include providing alternative fuels for cooking and materials for building

houses that are environmentally friendly and cost effective. These policies should also complement the government's low-carbon development initiative.

Forested areas identified for carbon storage under the proposed avoided deforestation programme would need to be carefully monitored to prevent deforestation that would compromise the programme. Protocols for harvesting NTFPs must be developed and implemented in close collaboration with the users to prevent the loss of livelihood activities.

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6.0 CONCLUSION

The amount of Guyana's state forest that would be required to meet the future demand of local communities for forestry goods was estimated at 4.8M ha. This estimated area of forest has the potential to generate approximately US\$396M annually from those goods. This leaves an area of 9.1M ha of the state forest available for the proposed avoided deforestation programme where the country can be compensated for reducing carbon emissions as a result foregoing economic opportunities from forest conversion. At US\$2/ton carbon emitted, the 9.1M ha of forest can generate an estimated US\$200M annually, in addition to US\$396M from the 4.7M ha. With the Economic Value to the Nation (EVN) of Guyana's forest estimated at US\$580M annually (Office of the President, 2008), the allocation of the state forest into an avoided deforestation portion and a continued extraction/conversion for local livelihood portion could be an economically viable alternate option.

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8.0 REFERENCES

Alves, D. S. 2002. Space-time dynamics of deforestation in Brazilian Amazonia. *International Journal of Remote Sensing* 23: 2903 – 2908.

Amsterdam, D. 1997. Tropical forest degradation: Global and Guyanese perspectives. Pages 41-52 in P.E. Williams, J.T. Parry and M.J. Eden, editors. *Land use, land degradation and land management in Guyana*. Commonwealth Geographical Bureau, London.

Bureau of Statistics. 2006. MICS Technical Report

Bureau of Statistics. 2007. Population and housing census 2002: National Census Report.

Bureau of Statistics. 2009a. National accounts data. Retrieved February 14, 2010 from <http://www.statisticsguyana.gov.gy/nataccts.html#natdiv>

Bureau of Statistics. 2009b. Statistical bulletin.

Canadell, J. G., and M. R. Raupach. 2008. Managing Forests for Climate Change Mitigation. *Science* 320: 1456-1457.

Conservation International. 2009. Reducing deforestation and forest degradation while promoting sustainable development.

Costanza, R., R. d'Arge, R. de Groot, S. Farberk, M. Grasso, B. Hannon, K. Limburg, S. Naeem, R. V. O'Neill, J. Paruelo, R. G. Raskin, P. Sutton, and M. van den Belt. 1997. The value of the world's ecosystem services and natural capital. *Nature* 387: 253-260.

Food and Agriculture Organization of the United Nations (FAO). 2004. FAOSTAT on-line statistical service.

Food and Agriculture Organization of the United Nations (FAO). 2006. Global Forest Resource Assessment 2005. Food and Agriculture Organization of the United Nations, Rome.

Gullison, R. E., P. C. Frumhoff, J. G. Canadell, C. B. Field, D. C. Nepstad, K. Hayhoe, R. Avissar, L. M. Curran, P. Friedlingstein, C. D. Jones, and C. Nobre. 2007. Tropical Forests and Climate Policy. *Science* 316: 985 – 986.

Guyana Forestry Commission. 2008. Forestry Sector Information Report: Annual Review 2008.

Guyana Forestry Commission. 2009. Quick Assessment Paper: Deforestation and forest degradation in Guyana.

Guyana Lands and Surveys Commission. 2004. Region VI sub-regional Land Use Plan.

Houghton, R. A. 2005. Tropical deforestation as a source of greenhouse gas emissions. Pages 13-22 in P. Moutinho, and S. Schwartzman, editors. Tropical deforestation and climate change Amazon Institute for Environmental Research, Brazil, and Environmental Defense, Washington.

Iwokrama International Centre for Rainforest Conservation and Sustainable Development. 2008. Annual Review 2008.

MacDonald, M. 2008. Georgetown - Lethem Road Pre-Feasibility Study: Final Report.

Millennium Ecosystem Assessment. 2005. Ecosystems and Human Well-being: Biodiversity Synthesis. World Resources Institute, Washington, DC.

Ministry of Amerindian Affairs (MoAA) UNDP/GOG. 2006. Capacity Building for the Management of Natural Resources and the Environment Project; sub-project Promoting Community Participation in the Management of Natural Resource and the Environment.

Nepstad, D., G. Carvalho, A. C. Barros, A. Alencar, J. P. Capobianco, J. Bishop, P. Moutinho, P. Lefebvre, U. L. Silva, and E. Prins. 2001. Road paving, fire regime feedbacks, and the future of Amazon forests. *Forest Ecology and Management* 154: 395-407.

Office of the President. 2008. Creating incentives to avoid deforestation.

Office of the President. 2009. Transforming Guyana's economy while combating climate change.

Pimentel, M. 2000. Study on the Feasibility of the Production of Clay Tiles for Floors and Roofs in the Rupununi. United States Agency for International Development, Guyana.

Rapid Assessment Program. 2008. Biodiversity in the Konashen Community-Owned Conservation Area, Guyana. Conservation International, Arlington, VA, USA.

Rushton, J., R. Viscarra, C. Viscarra, F. Basset, R. Baptista, and D. Brown. 2005: How Important is Bushmeat Consumption in South America: Now and in the Future? ODI Wildlife Policy 11: 1-4.

Shackleton, C., and S. Shackleton. 2004. The importance of non-timber forest products in rural livelihood security and as safety nets: a review of evidence from South Africa. South African Journal of Science 100: 658-664.

Sullivan, C. 1999. Valuation of NTFP: A case study for three Amerindian villages in Guyana. PhD Thesis. Keele University, Keele.

van Andel, T.R. 1998. Commercial exploitation of Non-Timber Forest Products in the North-West District of Guyana. Caribbean Journal of Agriculture and Natural Resources 2 (1): 15-28.

United Nations Convention on Biological Diversity. Climate change and biological diversity.

Retrieved January 28, 2010 from <http://www.cbd.int/climate/>

United Nations Framework Convention on Climate Change. Retrieved January 25, 2010 from

http://unfccc.int/essential_background/feeling_the_heat/items/2917.php

United Nations-REDD Programme. 2009. Retrieved January 25, 2010 from [http://www.un-](http://www.un-redd.org/AboutREDD/tabid/582/language/en-US/Default.aspx)

[redd.org/AboutREDD/tabid/582/language/en-US/Default.aspx](http://www.un-redd.org/AboutREDD/tabid/582/language/en-US/Default.aspx)

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