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Financial Feasibility of Ghg Reduction. The Case of Baturité Mountain – Brazil – 2013

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Abstract

Forest carbon sequestration is a mechanism to remove greenhouse gases. Trees, through the process of photosynthesis, absorb carbon dioxide – CO_2 from the atmosphere and store it as biomass. The objective of this study was to quantify and assess the financial viability of the generation of carbon credits in the Baturité Mountain, an area of 7,000 ha of tropical montane sub humid forest in Ceará state of Brazil. GHG reduction was estimated by non-destructive methods (based on forest inventory estimates). Economic criteria used to evaluate the project were the Net Present Value (NPV) and Internal Rate of Return (IRR). The results showed that, as a result of project activitiesin the Baturité MountainGHG emissions were reduced annually by 903,120 Tones of CO_2. Based on prices and costs in 2013, forestry projects for carbon sequestrationarenon-viable if traded under the Clean Development Mechanism. The project is financially viable with returns under the New Zealand Emission Trading Scheme (IRR=28%) and in the Voluntary Carbon Standard (VCS, IRR=27%). This study provides methodological guidelines for economic evaluation of carbon capture projects. In the right environments and with the right financial incentives, keeping standing forests intact can provide benefits for the environment and higher economic benefits compared with other extractive uses.

Keywords: Carbon credit; Tropical montane subhumid; Transaction cost; Cash flow

Introduction

The Agriculture, Forestry and Other Land Use (AFOLU) sector is responsible for up to one third of global Greenhouses Gases (GHG) emissions [1]. Moreover, this sector is increasingly vulnerable to climate changes and hence requires adaptation measures to maintain food and fibre production and enhance future potential for carbon storage and sequestration. However, it is not immediately apparent which options deliver the most economically efficient reductions in GHG. In that regard, it is necessary identify low-cost options that generate significant co-benefits in the form of improved agricultural production systems, resilience, biodiversity conservation or other ecosystem services [2].

Under the Kyoto Protocol seven types of projects are considerate as a AFOLU: Afforestation, Reforestation and Revegetation (ARR), Agricultural Land Management (ALM), Improved Forest Management (IFM), Reduced Emissions from Deforestation and Degradation (REDD), Avoided Conversion of Grasslands and Shrublands (ACoGS), Wetlands Restoration and Conservation (WRC) [3].

The Baturité Mountain located in north-central Ceará State in Brazil, has diversified soils and it is covered by subtropical montane forests, semideciduous forest and lower altitude deciduous forest (BRASIL, 2004) [4]. Within this area an ARR project was implemented that was consistent with the requirements for CDM A/R (2011) project [5], with reforestation referring to activities that create a forest on land that was non forest for at least 10 years.

The VCS (2014) defines eligible ARR projects as "those that increase carbon sequestration and/or reduce GHG emissions by establishing, increasing or restoring vegetative cover (forest or non-forest) through the planting, sowing or human-assisted natural regeneration of woody vegetation.

These projects aim to create a financial value for the carbon stored in forests, offering incentives for developing countries to reduce net emissions from forested lands and invest in low-carbon paths to sustainable development. However, while there is a wide range of technical solutions, project developers must consider the overall financial feasibility of the project opportunity at each specific site. Financial viability is a critical element of project success and net discounted carbon credit revenues (taking into account transaction costs) must be sufficient to cover implementation and/or opportunity costs.

Measuring and estimating forest carbon stocks and changes in carbon stocks is an important first step in implementing a carbon sequestration project. This requires transparent and verifiable methods, and appropriate monitoring systems for carbon stocks. The second step is to evaluate the financial feasibility of the project, the study use two decision criteria from Cost – Benefits Analysis: Net Present Value (NPV) and Internal Rate of Return (IRR). These are not a requirement of the Standards for implementing CDM or other voluntary GHG emission reduction programs, but it is relevant to provide measures that help project developers assess the financial viability of a project. The objective of this study was to quantify the potential increased stock of CO_2 that might be achieved through ARR project and to evaluate the economic performance of the project under three scenarios for the sale of carbon credits.

Methods

Area

The study area encompassed the rural land of the APA of Baturité,

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a Brazilian region consisting of eight municipalities in the Ceará State (Figure 1). The predominant soils classes in the APA of Baturité are Oxisol and Utisol. According to Lima [6], the Oxisol soils in the APA of Baturité are usually deep or very deep soils (averaging over 1.50 m), varying with relief.

The Baturité Mountain represents an area of great biological importance and is priority for biodiversity conservation in Brazil [4]. In the region, the Baturité Mountain constitutes a geographic exception in comparison with surroundings emiarid neighbouring municipalities. It has high precipitation (annual average 1500 mm) and constitutes one of the most important sources of water for the metropolitan region of Fortaleza [7].

Such climatic and geomorphological characteristics has enabled the evolution of a complex vegetation cover, with the general attributes of tropical rainforest that can be divided into two large units of land cover: Tropical montane subhumid, which occupies the highest altitudes, and Tropical montane dry, which predominates in areas between 400 and 600 m altitude [8].

Forest inventory

Forest inventory is the systematic collection of data and forest information for assessment or analysis. The aim of the statistical forest inventory is to provide comprehensive information about the state and dynamics of forests for strategic and management planning. Accurate estimates of carbon in forests are crucial for forest carbon management, carbon credit trading, [9].

Traditional forest inventories provide information on stand volumes, but not on biomass or carbon stock [10]. Thus, the available volume estimates had to be converted in to biomass and carbon budget estimates. Data from these inventories can be converted to biomassand therefore to the carbon in one of two ways, depending upon the level of detail reported [11].

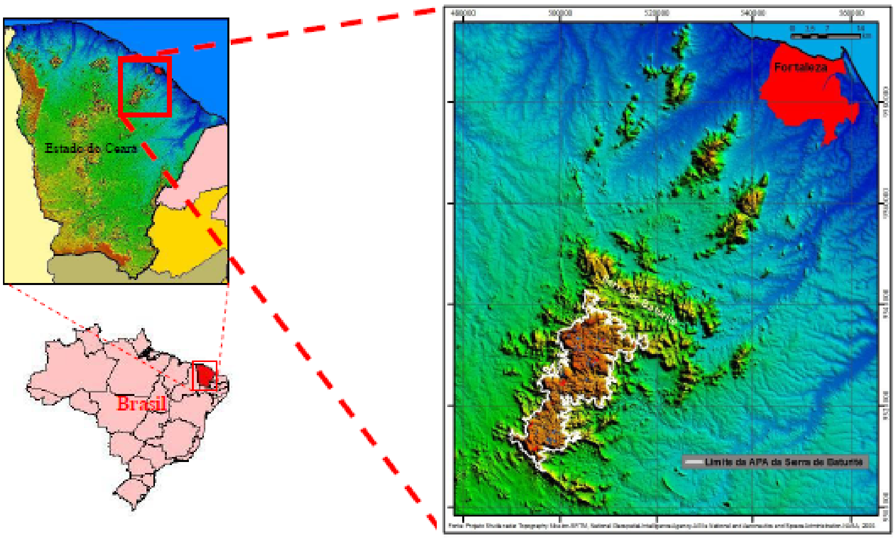
The forest inventory of the area was divided into four strata, with differing forest characteristics [7], (Table 1). The assessed sites ranged in altitude from 600 to 940 masl. The forests were similar in average height and ranged in density from 735 to 1741 stems/ha, in basal area from 14.1 to 31.2 m^2/ha and from 10.5 to 13.4 cm in average DBH.

Biomass quantification

Forest biomass can be estimated using direct and indirect methods [12]. Direct methods involve cutting a sample of trees and their components and drying and weighing each component. Indirect methods can use published allometric relationships to convert individual tree measurements from forest inventory data, to aboveground biomass or satellite images and stand level estimates of biomass, usually integrated in a geographic information system (GIS).

The net GHG reductions associated with a reforestation project can be estimated using either, or a combination of these methods. To assess project viability, proponents need to provide estimates of the values of future sequestration that are not available before the start of the Crediting Period and commencement of monitoring activities. Project proponents are generally required to adopt a conservative approach in making these future estimates.

Direct estimations of biomass based on measurements of forest



Source: Rodrigues (2011)

Figure 1: Study Area. Baturite Mountain.

Forest sites	Elevation (MASL)	Sample plot area (ha)	Density (stems/ha)	Basal Area m³/ha	Average DBH (cm)	Average Height (m)
Arvoredo	935	0.66	1215	14,1	10,5	9
Lagoa	940	0.46	1741	31,2	12.9	8.3
Sinimbu	695	0.5	1597	25,5	11.8	9
Taveiras	600	1.08	735	15,5	13.4	8

Source: Oliveira (2005)

Table 1: Structural Parameters of Forest at Serra de Baturité.

inventory by destructive harvesting are verifiable and more efficient than indirect estimates [13]. On the other hand, develop allometric relationships are time and cost consuming because they requires the destructive harvesting of a large number of trees. Stratifying forest types or ecological zones and using generalized allometric relationships is more feasible in the tropics because the diameter breast height explains over 95% of the variation in carbon stock above ground of the rainforest even in very different regions (Brown 2002).

Remote sensing techniques have been widely used in forestry studies, since it is possible to estimate biophysical parameters such as biomass, carbon and timber volume, based on the spectral properties of the components of the vegetation [14]. Imagery from satellites such as Lands at has been used to estimate forest carbon stocks, by developing statistical relationships between ground measurements and vegetation indices observed by satellite [15]. However, the method was not used for this study because the tropical montane sub humid forest is highly diverse in physiognomy and composition, complicating the determination of biomass.

Thus, for this study biomass estimates were based on forest inventories. Immediately after determining the parameters, the equation of Brown et al. [16] was used as the most robust (R2=0.97). This equation was also used by Watzlawick [17] and Fernandes et al. [18] for estimating biomass in the Atlantic Forest:

$$Y = exp\left[-3{,}1141 + 0{,}9719 * \ln(dbh^2 * h)\right] \quad (1)$$

Where

Y: Biomass

dbh=Diameter Breast Height

h=Height

Carbon stocks were estimated assuming that carbon makes up 50% of the dry biomass [18]. To convert carbon in to CO_2, the mass of carbon was multiplied by the ratio of the molecular weight of carbon dioxide to the atomic weight of carbon (44/12 or 3.67). GHG emissions and removals in the project will result from re growth of the residual forest and the effects of silvi cultural interventions such fencing, tree clearing, site preparation (mowing, slash burning, soil cultivation or drainage), tree planting (tillage, planting, fertilizer application) and tending (for example, pest and weed control). These were incorporated into baseline estimates.

Baseline

In broad terms, the baseline for a CDM or other carbon sequestration project activity is the scenario that reasonably represents the anthropogenic changes in carbon stocks in pools and emissions of GHGs by sources that would occur in the absence of the proposed project activity. A baseline shall cover both significant carbon stock changes in all relevant pools and significant emissions by sources of all GHGs that would occur within the project boundary [19].

In order to estimate the carbon stock component, the VCS AFOLU documents mandate the use of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories and this was recommended for the project design document [20]. However there is no one accepted approach for determining the baseline scenario. Different GHG programs and different GHG accounting standards specify various means for determining the baseline scenario in a standardized and impartial manner. In general, though, there are two basic kinds of baseline determination approaches, the project-specific approach and the performance standard. The performance standard is usually developed by a GHG sequestration or reduction program to simplify the accounting requirements for project proponents and to reduce the potential for subjective selection of a baseline scenario. A performance standard typically establishes a set rate of baseline emissions by analyzing the emission rates from all the potential baseline candidates [3].

A number of GHG programs have adopted a form of performance standard for reforestation projects. Under these programs, once the eligibility requirements have been met, a zero baseline is adopted. A zero baseline is adopted because in most cases the carbon stocks on non-forest land areas are assumed to not change, meaning that there are zero GHG emissions or removals from these lands.

The project specific approach for determination of the baseline scenario is more commonly applied by a GHG emissions reduction programs. These can range from simply assuming continuation of the existing land use to undertaking detailed evaluation of a range of land use alternatives. The project – specific approach assesses what would have occurred in the absence of the project, based on the specific economic and other circumstances of the individual project.

Quantifying emission and removals in tropical sub humid forests in the baturité mountain

The estimation of net GHG removals through reforestation involved stratification of the project area (Table 1) and calculation of mean annual increase in aboveground biomass carbon stock, converted to carbon dioxide equivalent.

Cost benefit analysis

Costs: Total production costs of the project include transaction costs, project implementation costs (for year 1), project maintenance costs (after the 2 year), verification and certification costs and opportunity costs [21]. Verification and certification of sequestered carbon are required to prove to investors that the estimated levels of carbon have been sequestered and can be traded. Costs were determined from project literature: Baalman and White [3], Conservation International Peru [22] and were consistent with the recommendations of Ciflorestas Brasil [2].

Transaction costs: Dudek and Wiener [23] divided transaction costs of emissions projects into six categories: (1) search (2) negotiation, (3) approval, (4) monitoring, (5) enforcement, and (6) insurance. For this study, the transaction costs of carbon projects were grouped into 2 categories based on the general AIJ guidelines/CDM project cycle model. This incorporates the categories defined by Dudek and Wiener, along with an additional two cost groupings; design and validation and registration and certification of the Emission Reductions (tCERs).

Design and validation costs: These include the cost of monitoring techniques and verification protocols, baseline and project scenario measurements and feasibility studies. The Project Design Document (PDD) is the central component in the design and validation cost. The procedures including in the PDD are: the baseline methodology and assessment of additionally, the selection of crediting period, a monitoring plan, the assessing environmental impacts and the stakeholder comments [24].

According to Social Carbon [25], the cost of developing a PDD (Estimate of baseline and with-project deforestation rates and Measurement of carbon stocks) is in average US 70.000 for the Latin

American context, and the cost of validation the PDD is in average US $20.000.

Registration and certification cost: The registry provides credibility to sell tCERs. The registry allows project developers to initiate the project registration process, upload documents and request issuance. The majority of VCS projects are registry in APX, therefore it is used as a proxy of the cost. To 2014 the cost of registry in APX is US $0.05 by tCERs. The certification is the total fees charged by standards body (VCS, NZ ETS or CDM etc.). The cost of certification used in the study is US $ 0.03 by tCERs.

Implementation costs: These are incurred in the first year. CI Florestas [26] recommended consideration of the cost of land acquisition and the cost of activities to reduce deforestation: Site assessment and planning, fencing, tree clearing: mowing, slash burning, Soil flooding or drainage, Tree planting: tillage, planting, Fertilizer application, fighting cutting ants. Operation cost: Personnel, Buildings, vehicles and equipment.

Maintenance cost: After the second year, the standing forest requires the Maintenance activities to reduce deforestation, the operating cost and the monitoring (Figure 2).

Revenues

A number of international standard and guidance documents exist that have built on the guiding rules of the Kyoto Protocol but that are designed to be scheme neutral and can be applied to any GHG reduction program. Numerous programs that include land base project activities have been developed especially in Australia, the United States, Canada and the New Zealand. There are many similarities between these different GHG programs, but they vary in the price of tCERs sold in the program.

Three different prices were used for analysis based on the payment for forest management CERs at the end of 2013: the Clean Development Mechanism (CDM, at a price of $ 1.1); the New Zealand Emission Trading Scheme (NZ ETS, with a value of $ 7.90),and the Voluntary Carbon Standard (previously called the Verified Carbon Standard, US $ 7.6).

The VCS market is the largest market in transaction volume of carbon credits [27]. After the category of renewable energy, forest management was the category with the highest number of projects transacted in the year 2013, with 29 million tCO_2. The New Zealand market was chosen because the forestry sector was the first category to be created (since 2008), due to the great importance of the forestry

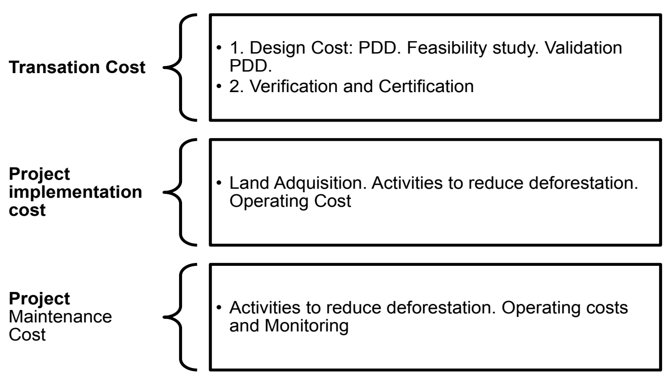


Figure 2: Disaggregation of total cost.

sector has the obligations to reduce emissions of greenhouse gases [28]. The CDM was the first institution to be created after the Kyoto Protocol, and to be regulated internationally.

The carbon market does not have a specific form of payment and various contract structures are allowed Peters [27]. The most recognized form of payment is the Spot Transaction. This type of trading is performed after verification of the claims. Therefore, the temporary Certified Emission Reductions (tCERs) may expire at the end of the commitment period and must be verified every five years. After verification, a tCER can either be re-issued (if the sequestered carbon remains intact). This means that the designer of carbon project should ensure that the benefits realized by the project are sustainable with allowances for risks in the event of fire, drought and change in government policy to ensure the sustainability of the project [27].

For the case study, it was considered the sale of ex ante credits which means that after PDD auditing, the contract is signed and the project is allowed to start. Each 5 years the Emission Reduction are verified and the investor get the revenues. The project expires at the end of the registered credit period (30 years for sustainable forest management) [29].

Cost Benefit Analysis is used to support decisions about whether to proceed with a particular project or investment or not [30] using the presentation of benefits and costs in a common framework. In this study, net present value (NPV) and relative profitability (Internal Rate of Return, IRR) were used to assess different projects.

Cash flow is the combined estimates of costs and revenues resources over time. The difference between costs and revenues is the net cash flow [31]. This can also be used to compare different projects. In this study we prepared a cash flow containing the key costs and revenue. The planning horizon of the project was 30 years, the minimum time for the proposed Forest Management activity to maintain sequestration for under the recommendations of the IPCC [13].

Forestry projects involve long term costs and benefits, often incurred and realized over decades. To bring these into a standardized accounting framework, a discount rate is used to discount future costs and revenues. The discount rate traditionally used in forestry projects typically varies between 6-12% per year [6]. In this study a real discount rate of 10% per year was used, as recommended by the Center for Integrated Studies on Environment and Climate Change of the Ministry of Environment in the document published in MMA [32], which deals with the Proposal Revised Eligibility Criteria and Indicators for the Evaluation of Projects in the CDM market in Brazil.

An alternative way to present the information is in terms of annuities. An annuity is simply a constant annual value which, when discounted and summed, produces the net present value.

Internal rate of return

The net present value rule requires the use of some predetermined social discount rate rule to discount future benefits and costs (formula 3). An alternative rule is to calculate the discount rate which would give the project a *NPV* of zero and then to compare this "solution rate" with the pre-determined social discount rate. In other words, the benefit and cost streams are presented in the next equation form:

$$NPV = \sum_{j=0}^{n} Rj(1+i)^{-j} - \sum_{j=0}^{n} Cj(1+i)^{-j} \quad (1)$$

$$PVA = \frac{VPL*i}{\left[1-(1+i)^{-n}\right]} \quad (2)$$

$$\sum_{j=0}^{n} R_j (1+IRR)^{-j} = \sum_{j=0}^{n} C_j (1+IRR)^{-j} \quad (3)$$

Where R is the revenues, C the cost, j the planned horizon of the project and *i* is the rate of discount that solves the equation. Once i is determined, the rule for accept-reject and for ranking of options is to adopt any project which has an internal rate of return (IRR) in excess of the predetermined social discount rate. As with the NPV rule, then, it remains essential to choose some acceptable discount rate. The idea of a "rate of return" is a relatively familiar concept to decision-makers and, as a result, that the IRR is a more readily understandable summary statistic of a cost-benefit appraisal than the NPV [30].

Results and Discussion

The baseline net GHG removals by sinks were assumed to be zero. As regards the required planting area, it was estimated a project totalizing 7,000 hectares. The project area is assumed to be at any of the 7 municipalities of the Baturité Mountain, at the minimum level of 900 MASL.

The final estimate of biomass for the primary rain forest was 50.07 $t.ha^{-1}$ (Table 2), giving an average stock of carbon of 23 tons. ha^{-1}. Consequently, the average value of the CO_2 removed from the atmosphere was 92,13 $t.ha^{-1}$ for the first year.

The stock of accumulated CO_2 is not so high compared with other estimates in the Atlantic Rainforest biome. Saldarriaga et al. [33] in a study on the successional development in the Amazon region, found that bole biomass in four stands of mature forest was 286 tCO_2 ha^{-1}. According to Lacerda et al, [34], Tropical Rain Forest Ibate -. São Paulo, reaches an average carbon sequestration and 96.15 tCO_2, in spite should remember that the study area is an exception in the middle of the semiarid landscape Northeast of Brazil

The total tCERs, considered the entire area is 27.093.603 tCO_2, and the average annual emission reduction corresponds to 903,120 tCO_2. In order to compare the estimation, was checked other projects developed in Brazil. The results show that the Florestal Santa Maria Project achieved ER of 997,444 tCO_2 [35] and The Cikel Brazilian Amazon REDD APD Project avoiding Planned Deforestation in 370000 tCO_2 [36]. It puts the Baturite mountain project in a middle position compared to the above two projects.

Cash flow

The simplified cash flow of activities related to CDM scenario, NZ ETS and VCS are presented in Table 3. The three scenarios presented differ in revenue. CMD market represents revenues of US $781,198.5 on the first verification (5 years of the project), derived from the price US $ 1,1 and quantity carbon accumulated in the rain forest (**710180** tCO_2). The NZ ETS market for being the highest in terms of price, represents a revenue of US $ 5,610,426 on the first verification. The VCS market with closing price of US $ 7,6*tCO_2, has revenues of US $ 6,050,091, position edit selfat an intermediate position compared to the other two scenarios evaluated. According to calculations, the project needs in its implementation year US$ 2,391,000, and the mean cost of maintenance for the following years is U$ 25,000 (Table 3).

Evaluating projects

The criteria for evaluation of projects (NPV, IRR) used in the economic analysis of the three scenarios, under a discount rate of 10% and a period of 30 years, showed that the NZ ETS and VCS scenarios are economically viable. The CDM project proved economically unviable as both the implementation (1 year) and in maintenance, had negative cash flow and hence the NPV and IRR criteria were unviable.

The IRR of the projects in the GHG program VCS and NZ ETS were higher than the discount rate, which makes them viable projects. Comparing these results with those of other forestry projects, the NZ ETS and OTC project to rain forest is greater than other forestry projects (Table 3) Net return.

The VCS scenario is feasible and is positioned at the intermediate level of profitability compared with the other two scenarios; moreover the VCS market is safe and has historically been the largest market in relation to the volume of transactions of emissions. The VCS presented a high growth in the year 2012. The growth of voluntary market is attributed to the explosion in the share of REDD market due to formal recognition in the international arena and approval of methodologies with few requirements for the projects [37].

Year	Biomass	Carbon stock	tCO_2 h^{-1}	tCO_2. By the Project (7000 ha)
1	50,07	25,03513	92,12928	644904,9
2	51,32	25,6575	94,41962	660937,3
3	52,57	26,2873	96,73726	677160,8
4	53,85	26,9245	99,08218	693575,2
5	**55,14**	**27,56912**	**101,4544**	**710180,5**
6	56,44	28,22114	103,8538	726976,4
7	57,76	28,88055	106,2804	743962,9
8	59,09	29,54736	108,7343	761139,9
9	60,44	30,22155	111,2153	778507,1
10	**61,81**	**30,90313**	**113,7235**	**796064,5**
11	63,18	31,59208	116,2589	813812
12	64,58	32,28841	118,8214	831749,5
13	65,98	32,99211	121,411	849876,7
14	67,41	33,70317	124,0277	868193,7
15	**68,84**	**34,42159**	**126,6715**	**886700,2**
16	70,29	35,14737	129,3423	905396,2
17	71,76	35,88049	132,0402	924281,5
18	73,24	36,62097	134,7652	943356,1
19	74,74	37,36878	137,5171	962619,9
20	**76,25**	**38,12394**	**140,2961**	**982072,6**
21	77,77	38,88642	143,102	1001714
22	79,31	39,65624	145,935	1021545
23	80,87	40,43338	148,7948	1041564
24	82,44	41,21784	151,6817	1061772
25	**84,02**	**42,00962**	**154,5954**	**1082168**
26	85,62	42,80871	157,5361	1102752
27	87,23	43,61511	160,5036	1123525
28	88,86	44,42882	163,4981	1144486
29	90,50	45,24983	166,5194	1165636
30	92,16	46,07813	169,5675	1186973
Total estimated ERs			27.093.603 tCO_2	
Total number of crediting years			**30**	
Average annual ERs			903,120 tCO_2	

Source: Autor.

Table 2: Biomass, Capture Carbon and Capture Dioxide Carbon average value.

Cost Year	0	1	2	3	4	5
Transaction Cost						
PDD	70000					
Registration						35509
Certification						21305
Validation	20000					
Land Acquisition	2,200,000					
Implementation Cost						
Activities to reduce deforestation and Operating cost.	100000					
Maintenance cost						
Activities to reduce reforestation and Operating Cost		20,000	20,000	20,000	20,000	**20,000**
Monitoring						10,000
Total	2,390,000	20,000	20,000	20,000	20,000	30,000
Revenues						
CDM						781,198
NZ ETZ						5,610,426
VCS						6,050,091
Profit						
CDM	-2,390,000	-20,000	-20,000	-20,000	-20,000	704384
NZ ETZ	-2,390,000	-20,000	-20,000	-20,000	-20,000	5533611
OTC	-2,390,000	-20,000	-20,000	-20,000	-20,000	5973276
Financial Results						
Discount Rate	0,1		0,1		0,1	
Total period crediting	30		30		30	
Net present Value	-$1,184,195		$6,588,178		$10,532,595	
Internal Rate of Return	4%		27%		28%	

Source: Adapted from Conservation International, CI Floresta (2011) and Baalman and White (2012)

Table 3: Cash Flow in US$ CDM, NZ ETS and VCS GHG program Cash flow in the three scenarios evaluated.

The market for CDM presented infeasibility attributed to the low market price (US$ 1.1). The sharp drop in market prices in Europe, in recent years, influenced the demand for carbon credits, causing a reduction in volumes sold and stagnation in the flow of transactions. While some politicians and nations are afraid to reverse carbon credits, several companies are voluntarily internalizing the cost of reducing emissions of their economic activities. As in the regulated market is affected by the low prices, the voluntary market continues to grow.

Conclusions

Latin America traditional offset supply countries a run for their volume, seeing 19 $MtCO_2e$ transacted from the region's projects. Through its 8 MtCO2e transaction with KfW, Brazil's Acre state – along with sizable transactions from a few REDD+ projects in other locales – pushed Brazil over the top as the market's most popular project location in 2013 [27].

The APA Sierra Baturité represents a great potential as a carbon sink, sequestering in average 903,120 tCO_2 ha^{-1}. As possibilities to contribute to the mitigation of climate change through forestry projects are profitable. According to market prices and costs for 2013, it is concluded that the forestry project for carbon sequestration is unfeasible in Clean Development Mechanism and feasible in voluntary markets (NZ ETS and VCS).

The study presented only considers the GHG reduction of above ground biomass. However GHG standards are demanding project developers that include below ground biomass, deadwood and soil organic carbon.

Transaction costs vary according to the organization that does the validation and verification of carbon credits and tend to decrease according to the size and scope of the project. This fact prevents the individual participation of small farmers in projects for the generation of carbon credits similar to the scenarios presented in this study features.

The study presented can serve as a starting point to evaluate other projects that reduce emissions of greenhouse gases. However, Trigeorges [38] notes that under uncertainty, the future value of a variable is characterized by a distribution of variability. The recommendation for future work is to model a sensitivity analysis that considers the possibilities of risks and uncertainties.

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