Exploring the Forestry Carbon Finance Potential for an Indigenous Cultural Community in the Philippines

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WorldFish

Published by WorldFish (ICLARM) - Economy and Environment Program for Southeast Asia (EEPSEA)
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Laguna 4031 Philippines; Tel: +63 49 536 2290 loc. 196; Fax: +63 49 501 7493; Email: admin@eepsea.net

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ISBN: 978-971-9994-25-1

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January, 2013

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EEPSEA is supported by the International Development Research Centre (IDRC) and the Swedish International Development Cooperation Agency (Sida). WorldFish of the CGIAR consortium has been administering EEPSEA since November 2012.

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ACKNOWLEDGEMENTS

We would like to thank the Economy and Environment Program for Southeast Asia (EEPSEA) and the International Development Research Center (IDRC) for providing funding support to this project. We especially thank Dr. Herminia A. Francisco, EEPSEA Director for her guidance and valuable comments and suggestions. We also appreciate Ms. Cathy Ndiyea's assistance to ensure the smooth implementation of the project.

We recognize the support of the University of the Philippines Los Baños through our Chancellor, Dr. Luis Rey I. Velasco, and Dr. Rex Victor O. Cruz , Dean of the College of Forestry and Natural Resources, and Dr. Enrique L. Tolentino, Jr., Director of the Institute of Renewable Natural Resources. We also thank Ms. Myranel G. Salvador for providing administrative support to the project.

We are grateful to the Magbukún Aytas of Kanawan for their trust and openness to the project team and to the Center for BioMolecular Science Foundation (CBMSF) for the assistance of its staff and the use of its facilities in Morong, Bataan.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXPLORING THE FORESTRY CARBON FINANCE POTENTIAL FOR AN INDIGENOUS CULTURAL COMMUNITY IN THE PHILIPPINES

Margaret M. Calderon, Nathaniel C. Bantayan,
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EXECUTIVE SUMMARY

The project explored the potentials of a forestry carbon project for an indigenous cultural community in the Philippines. Specifically, it assessed the global potential of forestry carbon finance; reviewed the legal and policy environments of forestry carbon projects in the Philippines; and evaluated the feasibility of a forestry carbon project in an Ayta community.

The literature indicates the great potential of forestry carbon projects in both the global and local markets. In the Philippines, two such projects have passed the voluntary carbon market standard, and there are efforts to develop projects under the National REDD+ Strategy. The Philippines is committed to addressing climate change, as evidenced by its signing the ratification of the United Nations Framework Convention on Climate Change and the Kyoto Protocol, and the enactment of Republic Act 9729, otherwise known as the Climate Change Act of 2009.

The results of the feasibility analysis reveal that developing a forestry carbon project for the Magbukún Ayta of Kanawan, Morong, Bataan is technically and financially feasible. The projected carbon loss in the ancestral domain due to possible deforestation in the old growth forest is a lot higher than expanding second growth forests and brushlands, thus creating an excellent opportunity for the community to be engaged in a forestry carbon project. The net present value (NPV) and internal rate of return (IRR) at the most conservative conditions (i.e., high scenario, price of USD 5/ton CO_2, and 20% discount rate) are PhP 170.271 million and 40 %, respectively, which show that the forestry carbon project is financially viable. The Magbukún Ayta have also expressed in a resolution that they are amenable to the possibility of being involved in a payment for ecosystem services (PES) project, specifically on the carbon sequestration potential of their forests, making the forestry carbon project socially acceptable.

It is therefore recommended that the potential of developing a forestry carbon project for the Magbukún Ayta be pursued.

1.0 INTRODUCTION

The Millennium Ecosystem Assessment (MEA 2005) recognizes the various goods such as food, fresh water, fuel and fiber; regulating services such as climate, flood and disease regulation, and water purification; supporting services such as nutrient cycling and soil formation; and services that forests, oceans, and cultivated/agricultural lands provide. These services include environmental cultural services such as aesthetic, spiritual, educational, and recreational services. Many of these services have traditionally been undervalued and taken for granted, resulting in their overutilization or degradation. The MEA reports that more than 60 % of the environmental services studied are being degraded faster than the recovery rate. To address this problem, new approaches to conservation and provision of incentives for restoration have evolved, one of which is payment for ecosystem services (PES). PES is based on the principle that resource users and communities that provide ecosystem services should be compensated for the costs of providing these by those who benefit from such services (Mayrand and Paquin 2004).

Philippine forestlands produce many ecosystem services such as carbon benefits, watershed services and landscape beauty. While some forestlands are being managed for timber production, some

[1] Philippine National Scientist

have been placed under other forms of management, such as community-based forest management. The rights of indigenous peoples (IPs) over their ancestral lands are also recognized under the Indigenous Peoples' Rights Act (IPRA), and many IP groups have formalized their claims through a Certificate of Ancestral Domain Claim (CALC), and for these to be eventually titled through a Certificate of Ancestral Domain Title (CADT).

The Magbukún Aytas are an indigenous tribe living in the Bataan Natural Park (BNP). The Park is one of the 10 priority reserves of the Conservation of Priority Protected Areas Project (CPPAP) that was implemented with funds from the Global Environment Facility (GEF) through the World Bank (Forest Peoples Program 2008). The BNP covers 23,688 ha of land that fall under the jurisdiction of the municipalities of Hermosa, Samal, Orani, Abucay, Bagac, Balanga, and Morong, all in the province of Bataan.

In 2004, the Magbukún Aytas of Kanawan, Morong applied for a CADT for a 10,000-ha area that straddles the Morong and Subic Freeport Zone parts of BNP. The Aytas were also able to get funds from the Philippine Tropical Forest Conservation Foundation (PTFCF) to do ecorestoration work in about 1,500 ha of forest in the BNP. Under the project, the Aytas conduct monitoring activities in their ancestral land, raise tree seedlings in community nurseries and backyards, use indigenous forest trees for ecorestoration of forest gaps/denuded areas, and plant fruit trees and vegetables for alternative livelihood activities based on non-timber forest products (NTFPs). Most of the seedlings are used in reforesting the project area, but the Aytas are exploring the possibility of selling these for additional income. Under the PTFCF project, the Aytas are also expected to impart what they learned about ecorestoration, biodiversity conservation, and NTFP-based sustainable livelihood to the five other Magbukún Ayta communities in BNP and eventually the 11 other Magbukún communities in Mariveles Mountain and other areas of Bataan (Lourdes Cruz, personal communication, December 2010).

The funds that the Aytas receive for projects, such as the PTFCF project, are for a specific period of time and are therefore not sustainable. On the other hand, they need funds to allow them to conserve and manage their ancestral land, which is under constant threat. In addition, the Aytas need support to build their capacity to manage their ancestral land, particularly technical know-how and an understanding of the administrative and legal aspects. All these require substantial funds, which the Ayta community may not have at present.

Thus, there is a need to explore possible mechanisms to raise funds for the Ayta community that would not only provide the Aytas with incentives to conserve and manage their ancestral land, but also build up their capacity to manage their natural and social assets. Aside from the seedlings and NTFPs that they have started to sell, the potential of selling some ecosystem services, particularly carbon, should be explored.

The atmosphere for involving indigenous and other local communities in carbon projects has become more conducive with REDD+(reducing emissions from deforestation and forest degradation). The REDD+ strategy aims to create a financial value for the carbon stored in forests, and offers incentives for developing countries to reduce their emissions from forested lands and invest in low-carbon paths to sustainable development (UN-REDD.org). The United Nations Climate Change Conference held in Copenhagen in December 2009, recognized the importance of not only reducing emissions from deforestation and forest degradation, but also enhancing the forests' capacity to remove greenhouse gases. This led to the REDD+ strategy, which addresses concerns about deforestation and forest degradation, as well as the role of conservation, sustainable management of forests, and enhancement of forest carbon stocks (Harvey et al. 2010).

It is in this context that the potentials of a forestry carbon project was explored in the context of an indigenous cultural community in the Philippines. Specifically, the project sought to: (1) assess the global potential of forestry carbon finance; (2) review the legal and policy environments of forestry carbon projects in the Philippines; and (3) evaluate the feasibility of a forestry carbon project in an Ayta community.

2.0 RESULTS

2.1 Assessment of the Global Potential of Forestry Carbon Finance

In recognition of the potential adverse impacts of climate change, the United Nations Framework Convention on Climate Change (UNFCCC) was opened for signature in 1992. The main goal of the Convention is to "stabilize greenhouse gas (GHG) concentrations in the atmosphere at a level that would prevent dangerous anthropogenic (human-induced) interference with the climate system." At present, around 195 countries (194 states and 1 regional economic integration organization) are signatories to the UNFCCC (UNFCCC 2010).

The Convention divided the countries into two groups: Annex 1 and Non-Annex 1. Annex 1 is composed of the industrialized countries that were members of the Organization for Economic Co-operation and Development (OECD) in 1992 and the countries with economies in transition (the EITs), including the Russian Federation, the Baltic states, and several central and eastern European states. Non-Annex 1, on the other hand, is composed of developing nations (UNFCCC 2002).

Five years after the signing of the UNFCCC, a more concrete action was undertaken by the countries party to the convention. The third Conference of Parties (COP-3) in 1997 saw the adoption of the Kyoto Protocol (KP). Unlike the UNFCCC which merely urged Annex 1 countries to stabilize GHG concentrations in the atmosphere, the KP pushed them to make commitments. KP sets legally binding targets for Annex 1 countries: to reduce GHG emissions by 5% of their 1990 levels from 2008 to 2012. Table 1 shows the emissions targets of the countries.

Table 1. Emissions targets of countries

Country	% Target (1990[2]-2008/2012)
EU-15[1], Bulgaria, Czech Republic, Estonia, Latvia, Liechtenstein, Lithuania, Monaco, Romania, Slovakia, Slovenia, Switzerland	-8
US[3]	-7
Canada, Hungary, Japan, Poland	-6
Croatia	-5
New Zealand, Russian Federation, Ukraine	0
Norway	+1
Australia	+8
Iceland	+10

[1] The 15 states who were EU members in 1997 when the Kyoto Protocol was adopted took on the 8 % target that will be redistributed among themselves, taking advantage of a scheme under the Protocol known as a "bubble", whereby countries have different individual targets, but which are combined to make an overall target for that group of countries. The EU has already reached an agreement on how its targets will be redistributed.

[2] Some Economies in Transition (EITs) have a baseline other than 1990.

[3] The US has indicated its intention not to ratify the Kyoto Protocol.

Note: Although they are listed in the Convention's Annex 1, *Belarus* and *Turkey* are not included in the Protocol's Annex B as they were not parties to the Convention when the Protocol was adopted.

2.1.1 Compliance Carbon Market

Under the Kyoto Protocol, countries must meet their emissions reduction targets mostly through domestic actions. This means that Annex 1 countries must implement programs and/or policies that will lead to reduction of GHG emissions. In addition to domestic actions, KP proposes additional ways by which Annex 1 countries can meet their emission reduction targets. These include: Emissions Trading (ET), Joint Implementation (JI), and Clean Development Mechanism (CDM).

In Emissions Trading, a European country with unused emissions allowance can sell carbon credits to another European country that exceeds its emission allowance. The European Union (EU) trading scheme began in 2005. As of 2009, a total of 3Gt CO_2e had already been traded with a value of USD 91 billion.

On the other hand, JI, covers a wider area for carbon trading compared with ET where trading happens between EU countries only. In JI, carbon is traded between Annex 1 countries. As of 2009, around 20 Mt CO_2e were traded with a value of USD 294 million.

CDM was established to attain the dual goals of assisting the non-Annex 1 countries to achieve sustainable development and to assist countries included in Annex 1 to achieve compliance with their quantified emission limitation and reduction commitments through supporting projects in developing countries. It is to be noted, however, that Land Use, Land Use Change, and Forestry Projects (LULUCF) were included in CDM during the 6th Conference of Parties (COP-6) only because of the many issues associated with such projects (e.g., permanence, additionality, leakage). Eligible LULUCF projects are limited to afforestation and reforestation (A/R) (Lasco et al. 2004).

Figure 1 shows the project cycle under the CDM. It begins with the preparation of a project design document (PDD), which describes the project using the template provided in the UNFCCC website. The PDD has to be endorsed by the Designated National Authority (DNA) to the Designated Operational Entity (DOE). In the Philippines, the Secretary of the Department of Environment and Natural Resources (DENR) is the DNA. The DOE checks the validity of the proposed project. Projects found valid are forwarded to the Executive Board (EB) for registration.

As of 6 April 2011 there were a total of 2,950 registered CDM projects. Of these, only 21 projects are on afforestation and reforestation, representing 0.60 %. The bulk (2,285) of the registered CDM projects are from the energy sector. Figure 2 shows the distribution of projects by scope (htpp://cdm.unfccc.int, accessed 6 April 2011).

In the Philippines, a number of groups have attempted to develop A/R CDM projects but unfortunately none of them has been successfully registered with the EB. Lasco et al. (2010) cited several reasons for this. Foremost is the small income that can be derived from carbon credits, which is not enough to recover the cost of planting and maintenance. Second, the transaction cost of CDM projects is very high. Neef and Henders (2007) cited that transaction cost is around USD 200,000. Third, the Philippines has not yet submitted its definition of "forest", which is required prior to approval of projects. The definition currently adopted in the Philippines is that a "forest" is a minimum area of land of 0.5 hectare with a tree crown cover (or equivalent stocking level) of 10 % and the potential to reach a minimum height of 5 meters at maturity in situ. This definition is quite limiting because areas with very little cover will still be classified as "forest" but will be disqualified by the EB. This has been the experience of the Laguna Lake Development Authority (LLDA), which was among the first organizations that attempted to develop an A/R CDM project. LLDA's proposal was rejected by the third party auditor because the proposed project area had only very few small trees.

In December 2007 during COP 13, another mechanism to access carbon finance was launched - Reducing Emissions from Deforestation and Degradation (REDD). Under REDD, policy approaches and positive incentives on issues relating to reducing emissions from deforestation and forest degradation in developing countries will be implemented (UNFCCC 2007). Aside from REDD, there are other options explored under this scheme: REDD and enhancement of carbon stocks (REDD+) and REDD+ and all other land uses (REDD++) or reducing emissions from all land uses (REALU) or agriculture, forests and other land uses (AFOLU) (Lasco et al. 2010).

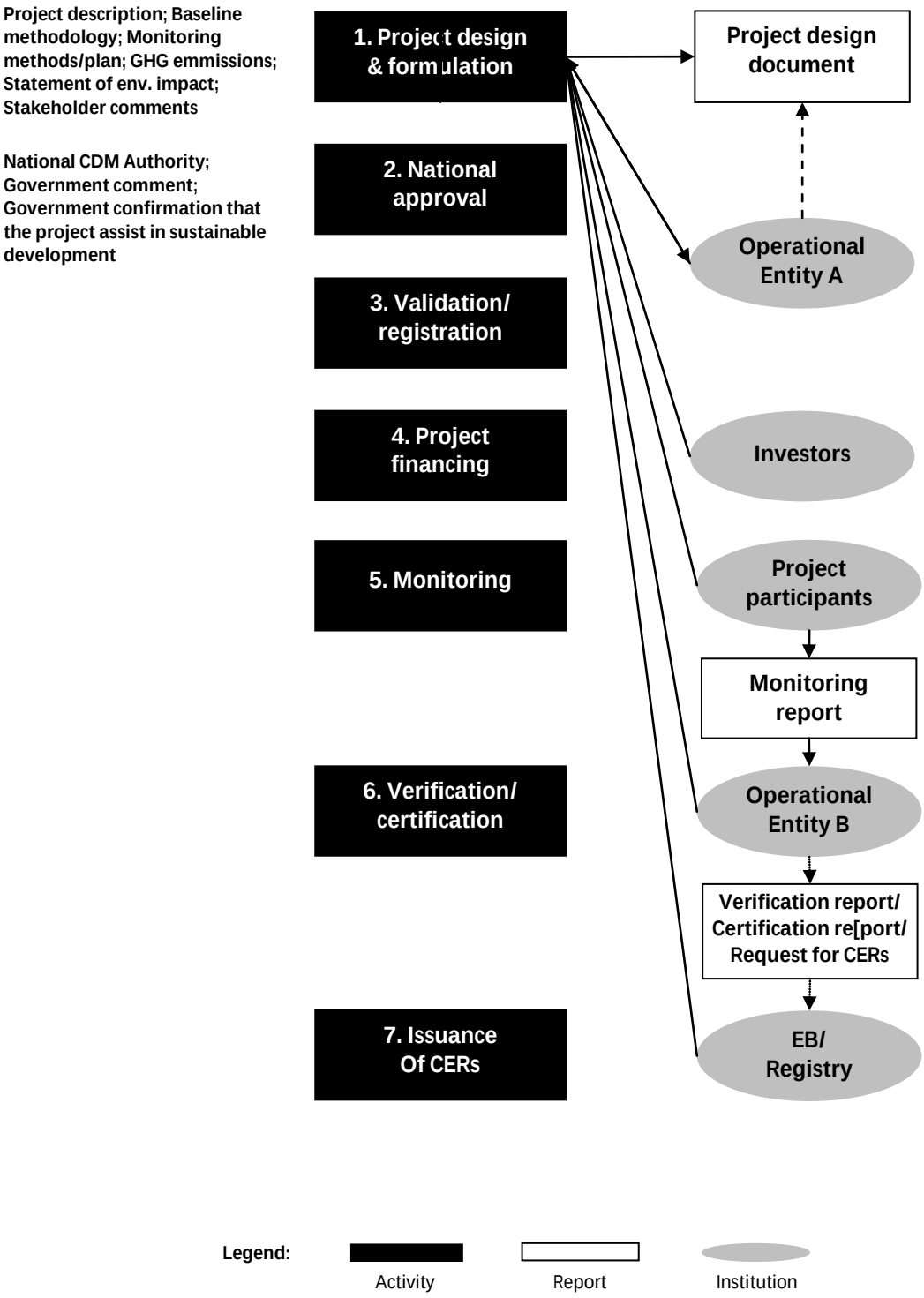

Figure 1. The Clean Development Mechanism (CDM) project cycle

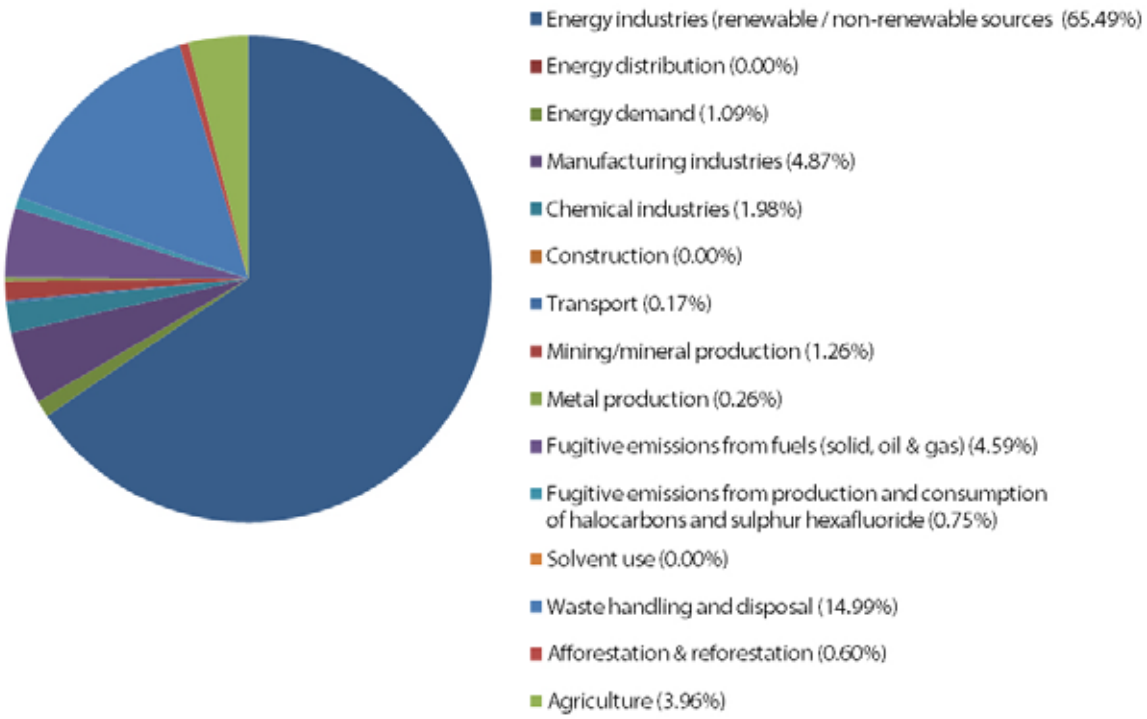

Figure 2. Distribution of registered CDM projects, by scope
(http://cdm.unfccc.int, accessed 6 April 2011)

2.1.2 Voluntary carbon market

Aside from the compliance carbon market, carbon sequestered by a forestry project can be sold in a voluntary carbon market (VCM). One of the benefits of this type of market is that it does not comply with any legal binding caps. Thus, any institution, business, or individual can offset its emissions through financing forestry projects (Lopes 2009). A number of VCM standards are available currently. These include: Voluntary Carbon Standard (VCS), Gold Standard (GS), California Action Reserve (CAR), American Carbon Registry (ACR), Chicago Climate Exchange (CCX), Greenhouse Friendly, Climate Community and Biodiversity Alliance (CCBA), Carbon Fix, Social Carbon, ISO 14064, and Verified Emissions Reduction (VER+).

In the Philippines, two forestry carbon projects have passed the VCM standard. Both projects were developed by Conservation International and are located in the provinces of Quirino and Cagayan. They are the Quirino Forest Carbon Project (QFCP) and the Peñablanca Sustainable Reforestation Project (PPSRP).

The Quirino project, which covers 13,457 ha of Community-Based Forest Management Agreement (CBFMA) farms,is located in the municipalities of Nagtipunan, Maddela, and Aglipay. Funded by More Trees, the project aims to generate 18,000t CO_2e (Pasion 2009).

The Peñablanca project, which has a total area of 2,500 ha, covers five *barangays* (villages) in the Peñablanca Protected Landscape and Seascape (PPLS). Funded by Toyota Motors Corporation in Japan, the project is expected to generate 362,000t CO_2e (Duya 2009).

2.2 Legal and Policy Environments in the Philippines

The Philippines' commitment to address climate change is evidenced by its creation of the Inter-Agency Committee on Climate Change (IACCC) on 8 May 1991 through Presidential Order No. 220. The IACCC is chaired by the Secretary of the Department of Environment and Natural Resources (DENR) and co-chaired by the Secretary of the Department of Science and Technology (DOST). Its members include representatives from the Philippine Atmospheric, Geo-Physical, and Astronomical Services Administration (PAG-ASA), Department of Foreign Affairs (DFA), Environment Committees of the two houses of the

Philippine Congress, Department of Energy (DOE), Department of Transportation and Communication (DOTC), Department of Agriculture (DA), National Economic and Development Authority (NEDA), Department of Public Works and Highways (DPWH), Forest Management Bureau (FMB), National Mapping and Resource Information Agency (NAMRIA), and Philippine Network on Climate Change (representing the non-government organizations). The Environmental Management Bureau serves as the IACCC Secretariat (IACCC 1999).

The IACCC primarily coordinates, develops, and monitors all climate change activities carried out by government agencies and civil society. In addition, it formulates climate change policies, and prepares the Philippine positions at international negotiations (Merillo 2009).

On 12 June 1992, the Philippine government signed the UNFCCC and ratified it on 2 August 1994. As a signatory, the Philippines submitted to the UNFCCC its Initial National Communication (INC) in 2000. The INC contains the results of the 1994 GHG inventory of the five sectors: waste, energy, agriculture, LULUCF, and industries. Likewise, it outlines the planned actions to be undertaken and actual actions being undertaken to fulfill the country's commitments to the Convention. These include activities to attain sustainable development, research and systematic observation, awareness raising, education and training, adaptation measures, and capacity building (The Philippines' Initial National Communication 1999.)

On 15 April 1998, the Philippines signed the Kyoto Protocol and ratified it on 22 November 2001. Being a signatory to both the UNFCCC and KP, the Philippines has committed to be active in engaging in activities that will help in climate change mitigation and adaptation (http://www.emb.gov.ph, accessed on 7 April 2011).

In 2007, the government created the Presidential Task Force on Climate Change (PTFCC) through Administrative Order 171. The PTFCC is mandated to address and mitigate the impact of climate change in the Philippines, paying special attention to adaptation, mitigation, and technological solutions. Its functions include: (1) conducting rapid assessments on the impact of climate change, particularly on vulnerable sectors such as water resources, agriculture, coastal areas, and terrestrial and marine ecosystems; (2) ensuring compliance to air emission standards, and combating deforestation and environmental degradation; (3) initiating and undertaking strategic approaches and measures to prevent or reduce GHG emissions; (4) conducting massive and comprehensive nationwide public information and awareness campaigns; (5) designing concrete risk reduction and mitigation measures and adaptation responses, focusing on short-term vulnerabilities in sectors and areas most affected by climate change; (6) collaborating with international partners to stabilize GHG emissions; and (7) integrating and mainstreaming climate risk management into development policies, plans, and programs of the government.

Unlike in IACCC where the DENR Secretary serves as Chair, the PTFCC is headed by the DOE Secretary. The DENR Secretary is Vice Chair; the IACCC serves as the technical arm of the PTFCC.

One major accomplishment of the PTFCC is the drafting of the Philippine Climate Change Strategic Framework and Action Plan in October 2007. The plan provides the strategic directions the country will take to address climate change.

On 27 July 2009, the President of the Philippines signed into law Republic Act 9729 known as the Climate Change Act of 2009. The law establishes a Climate Change Commission (CCC), an autonomous body. CCC has the same status as that of a national government agency and is directly attached to the Office of the President. It serves as the only policy-making body of the government tasked to coordinate, monitor, and evaluate the programs and action plans of the government relating to climate change pursuant to the provisions of RA 9729 (Republic of the Philippines 2009).

The Commission is headed by the President of the Republic of the Philippines. Under the President are three Commissioners appointed by the President; one of them serves as Vice Chair of the Commission (Republic of the Philippines 2009). Serving as Advisory Board are the Heads of the following agencies: DA, DOE, DENR, Department of Education (DepEd), DFA, Department of Health (DOH), Department of Interior and Local Government (DILG), Department of National Defense (DND), DPWH, DOST, Department of Social Welfare and Development (DSWD), Department of Trade and Industry (DTI), Department of Transportation and Communications (DOTC), NEDA, National Security Council, National Commission on the Role of Filipino

Women, League of Provinces, League of Cities, League of Municipalities, *Liga ng mga Barangay*[2] (League of Barangays), representatives from the academe, business sector, NGOs, and disaster risk reduction community (Republic of the Philippines 2009).

In April 2009, Executive Order 881 was issued, directing the CCC to coordinate existing climate change initiatives, REDD+, and other similar mechanisms, and designating the DENR as the operational implementer of REDD+ (Natividad and Corpuz 2010).

Sometime in 2009, several sectors saw the Philippines forests' potential to benefit from the REDD+ mechanism. A group of NGOs called CoDe REDD spearheaded the formulation of the Philippine National REDD+ Strategy (PNRPS) in 2010. PNRPS presents a broad range of strategies and corresponding activities over a 10-year horizon (2010-2020), and seeks to prepare forestlands managers throughout the country to assume responsibility in implementing REDD+ programs, research, projects, and activities with the support of international, national and local agencies, NGOs, and other support groups. PNRPS has seven components: enabling policy; governance; resource use, allocation and management; research and development; measuring, reporting and verification (MRV) of emissions reductions and review procedures for non-carbon social and environmental impacts and benefits; and sustainable financing and capacity-building and communication (Philippine REDD Plus Strategy Team 2010).

Currently, a number of organizations are piloting REDD projects in the Philippines. For example, Fauna and Flora International (FFI) is coordinating a project in southern Sierra Madre, Quezon Province. FFI, together with Non-Timber Forest Products-Exchange Programme (NTFP-EP), is working on a 50,000-ha pilot project in the Victoria-Anepahan mountain range in Palawan. Forest Policy and REDD project, in collaboration with DENR and funded by Germany's Federal Ministry for Environment, Nature Conservation and Nuclear Safety (BMU) GTZ, has demonstration sites on the islands of Panay and Leyte (Philippine REDD Plus Strategy Team 2010).

On 28 April 2010, then President Gloria Macapagal-Arroyo signed the National Framework Strategy on Climate Change (NFSCC). The NFSCC provides a basis for the national program on climate change. It identifies key result areas (KRAs) to be pursued in addressing the adverse effects of climate change in key climate sensitive sectors (Republic of the Philippines 2010). The KRAs relevant to forestry carbon projects are the National REDD+ Strategy and integrated ecosystem-based management.

A National REDD+ Strategy not only puts the country at an advantage in terms of its participation in the international REDD+ mechanism. It also promotes conservation and enhancement of carbon stocks in the forest ecosystem and helps the forestry sector and upland communities become more resilient to the impacts of climate change (Republic of the Philippines 2010).

Integrated ecosystem-based management, which will hopefully be achieved using the river basin management approach, has the following strategic priorities: (1) rehabilitation and development of watershed resources through the improvement of resource use and governance; (2) enhancement of vulnerability and adaptation assessments; (3) enhancement of ecosystem services to control droughts, floods and landslides; (4) establishment of appropriate and participatory institutional arrangements with local government units, private sector, and civil society organizations; and (5) reduction of risks and vulnerability of watershed and biodiversity through ecosystem-based management approaches, conservation efforts, and sustainable environment and natural resource-based economic endeavors such as ecotourism (Republic of the Philippines 2010).

2.3 Evaluation of the Feasibility of a Forestry Carbon Project for the Ayta Community

The feasibility of a forestry carbon project for the Ayta community was evaluated from three aspects: technical feasibility, social acceptability, and financial feasibility. The activities that were undertaken for this objective include consultation meetings, community mapping, carbon benefit estimation, and financial analysis.

[2] A *barangay* is the smallest political unit in the Philippines

The first consultation meeting with the Magbukún Aytas was conducted on 26 February 2011 at the Center for BioMolecular Science Foundation office in Morong, Bataan. Thirteen community members attended the meeting. A second consultation meeting was held on 9 April 2011 in Barangay Kanawan, where the research team presented the project to the general assembly to obtain its decision on whether or not to support the project. Thirty-eight community members were present.

2.3.1 Technical feasibility

The following activities were undertaken to evaluate the technical feasibility of the forestry carbon project: identification of the causes of land use change, degradation and deforestation through time; estimation of carbon and potential carbon benefits (determine land use change in the past 15 years; estimation of carbon losses; estimation of carbon benefits with and without the project using carbon density values from previous studies; and projection of carbon benefits through time.

During the consultation meeting, the community was asked to identify the area covered by their ancestral domain on the map. Using the template prepared by the team and the map, the condition of various areas was assessed, specifically with respect to original and current land uses, drivers of land use change, areal extent, and impacts on the environment, among others.

During the mapping process, the participants were first oriented on the map and its features (Figure 3.) First they were asked: What can you find in the area (*Anu-ano ang makikita sa iyong lugar*)? Then they were asked to choose symbols to represent every feature (*Mamili ng simbolo para sa bawa't isang bagay).* After this, they were asked to place symbols on the map where they features could be found (*Ilagay sa mapa kung saan ito makikita*). This allowed participants to indicate the relative locations within the study area. A preliminary set of features were collected from the Ancestral Domain Sustainable Development and Protection Plan (ADSDPP) as shown in Table 2. With help from the research team, the participants assigned appropriate symbols to represent land use, landmarks, and other points of interest, then placed these symbols on the map. The result was an updated map showing the current features.

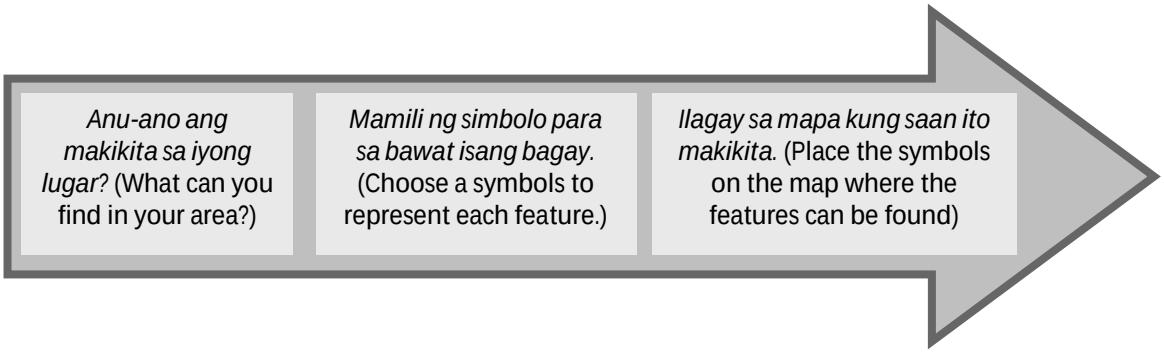

Figure 3. The community mapping process

Figures 4 and 5 show the land use before and after the community mapping activity, which reflect the entries in the accomplished template shown in Table 2. The boundary of the ancestral domain extends toward the west inside of the Subic Bay Management Authority (SBMA). This follows the Boton River and the administrative boundaries between Morong and the adjacent towns of Orani, Samal, Abucay, and Bagac.

Table 2. Land use, land marks, points of interest, and important trees

Land cover/use	Landmark	Important tree
Forest	Hanging foot bridge	Almaciga
Agricultural farm	Bisay falls	Banaba
Cogon grass	Snake trail	Binukao
Charcoal kiln	Mt. Silanganan peak	Lanas bundok
Coffee plantation	Mt. Sta. Rosa peak	Tangisang bayawak
Hunting area	Mt. Natib peak	Tibig
Gathering area	*Bulbophyllum dearei* Reich	Uai
Gasak (rainfed farms)		
Irrigated rice		

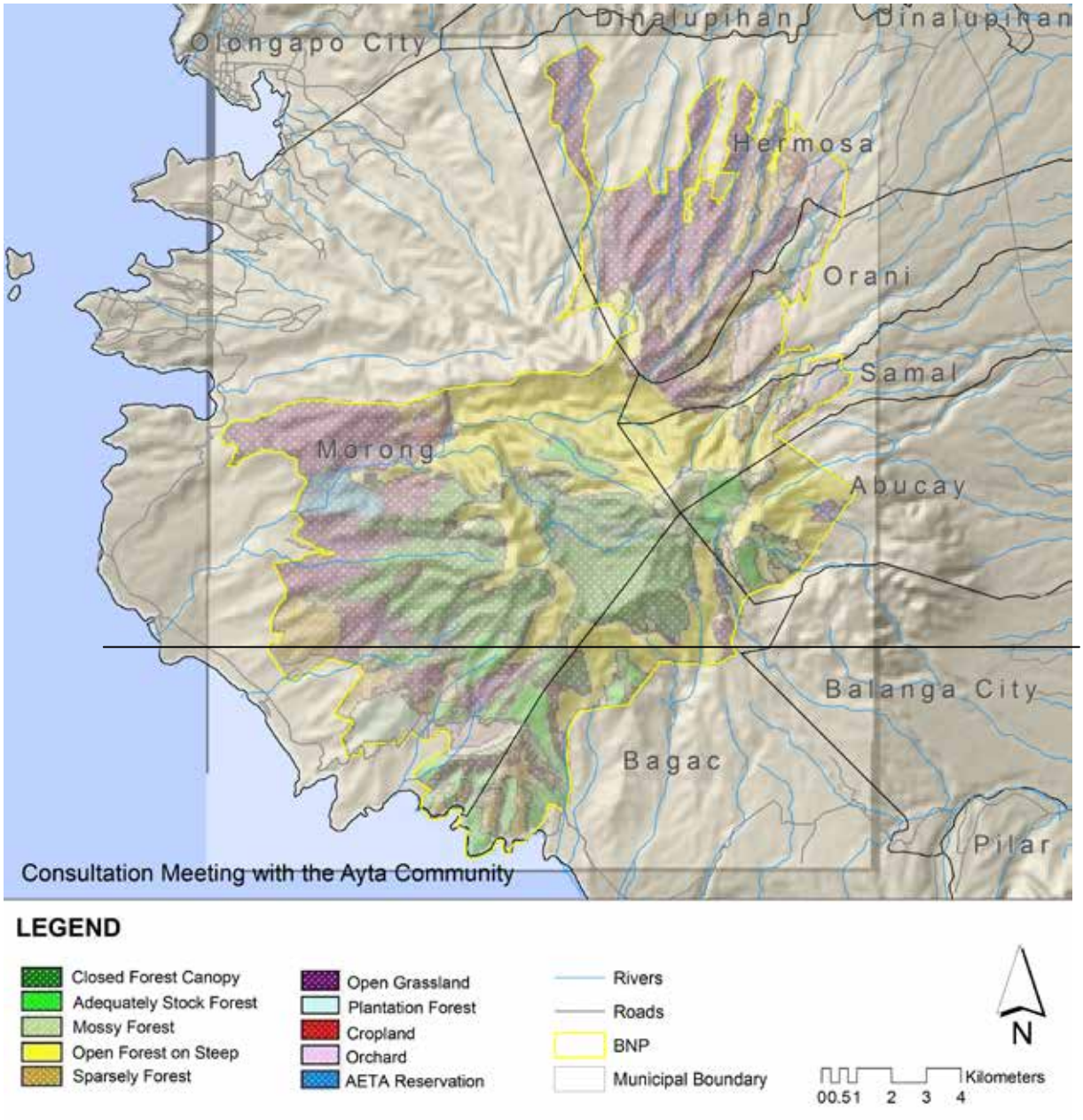

Figure 4. Map before the community mapping exercise

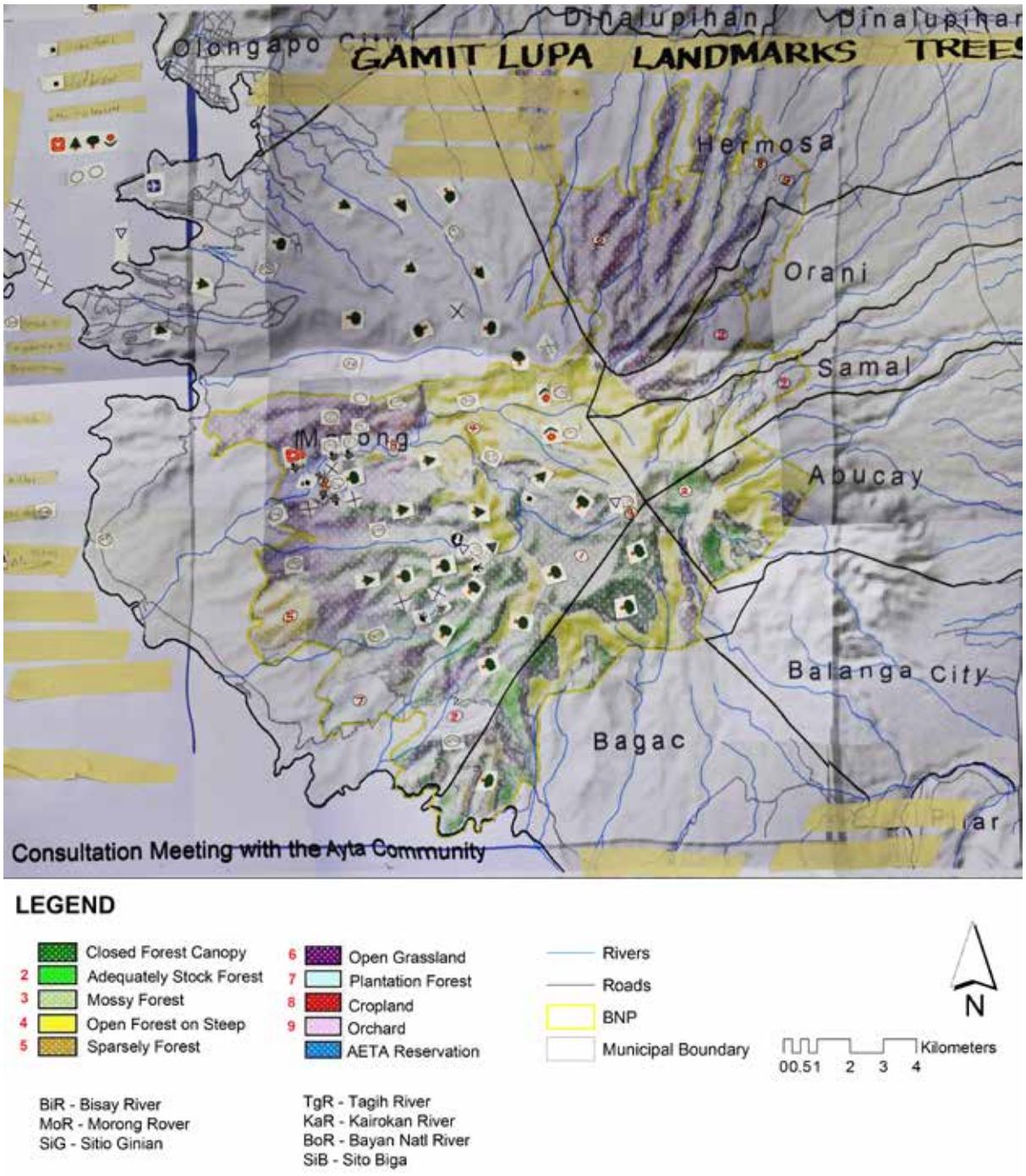

Figure 5. Map after the community mapping exercise

Estimating land use change

Land use and land cover changes can be determined from satellite images. The image processing techniques available vary depending on the purpose of the study. For land use and land cover change, Normalized Difference Vegetation Index (NDVI) provides a quick estimate. NDVI is a ratio-based comparison of Red and Near-Infrared bands to represent vegetation density. Studies show that the Red and Near-IR bands are most sensitive to vegetation and thus ideal for estimating the amount of vegetation (Baret and Guyota 1991). This study estimated changes in land use and land cover using Landsat ETM+[1] images from two time periods, 1976 and 2001, and expressed in terms of change in vegetation density.

The choice of the year stamp of the satellite image depended on the cloud cover. In this case, the data from 1976 and 2001 had the least cloud cover and thus allowed comparison. Moreover, the difference

in time period was far enough, enabling carbon stock comparison. Due to lack of time and resources, it was not possible to undertake a comprehensive ground validation of the image processing. Alternatively, the results of the community mapping exercise (see Figure 5) were used to validate the change analysis. The results of image processing generally agreed with the community's inputs.

Results showed a decrease in vegetation density between the two periods (see Table 3 and Figure 6). An increase in hectarage for vegetation density of less than 70 % was observed. On the other hand, vegetation density of above 70 % registered a decline from 6,973 ha to 5,540 ha or a decrease of about 20.6 %.

Table 3. Vegetation density (%) between 1976 and 2001 (in ha)

Year	Bare	< 20%	>20 - <40%	>40 - <70%	>70%	Total
1976	5	492	552	1,753	6973	9,775
2001	115	538	990	2,592	5540	9,775

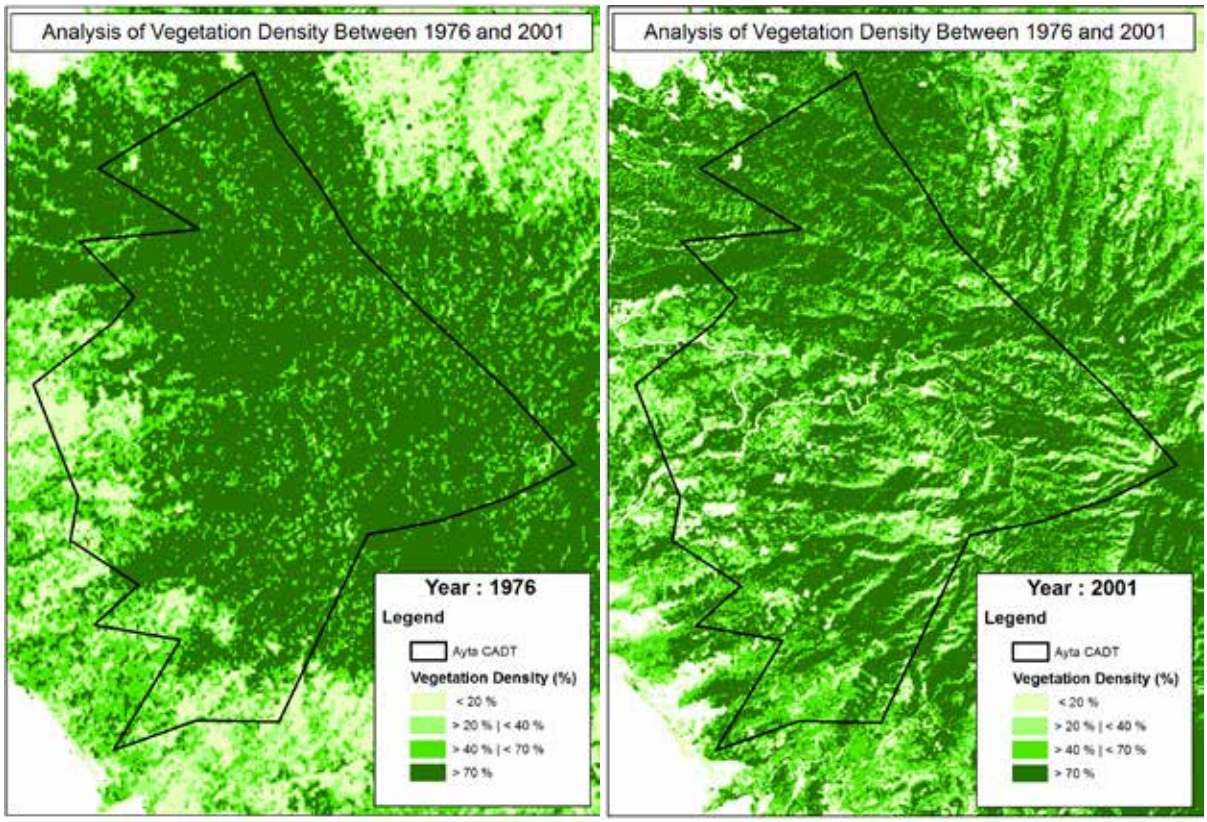

Figure 6. Analysis of vegetation density between 1976 (left) and 2001 (right)

Carbon of ancestral domain under current land use

To determine the amount of carbon gain or loss of the ancestral domain over time, the rates of change of the different land cover types were determined using the land cover data for 1976 and 2001. Results show that land with more than 70 % cover annually decreased by 0.82 % while lands with more than 40 - 70 % cover and less than 40 % cover increased yearly by 1.91 % and 2.26 %, respectively. Using these rates of change, areas covered by each land use were estimated over a 30-year period (2011-2040), the proposed project lifetime.

Land with more than 70 % canopy cover, which covered 5,100 ha in 2011, is expected to decline to 4,014 ha by year 2040. It is assumed that the area (more than 1,000 ha) that would be lost would be converted to land with cover from 40 - 70 % and less than 40 %. Thus, land with 40-70 % cover (2,848 ha in 2011), would increase to 3,484 ha by 2040; while land with less than 40 % cover (1,825 ha in 2011), is expected to expand to 2,276 ha by year 2040 (Table 4).

Table 4. Projected land use of the ancestral domain, Morong, Bataan (2011-2040) under baseline scenario

Year	Land use		
	<40%	40-70%	>70%
2011	1,825.22	2,848.94	5,100.84
2012	1,842.62	2,873.49	5,058.89
2013	1,859.89	2,897.83	5,017.28
2014	1,877.01	2,921.97	4,976.02
2015	1,893.99	2,945.92	4,935.09
2016	1,910.83	2,969.67	4,894.50
2017	1,927.54	2,993.22	4,854.24
2018	1,944.10	3,016.58	4,814.32
2019	1,960.53	3,039.75	4,774.72
2020	1,976.83	3,062.72	4,735.45
2021	1,992.99	3,085.51	4,696.50
2022	2,009.02	3,108.11	4,657.87
2023	2,024.91	3,130.53	4,619.56
2024	2,040.67	3,152.76	4,581.57
2025	2,056.31	3,174.81	4,543.88
2026	2,071.82	3,196.67	4,506.51
2027	2,087.19	3,218.36	4,469.45
2028	2,102.45	3,239.86	4,432.69
2029	2,117.58	3,261.19	4,396.23
2030	2,132.58	3,282.35	4,360.07
2031	2,147. 46	3,303.33	4,324.21
2032	2,162.22	3,324.14	4,288.64
2033	2,176.85	3,344.78	4,253.37
2034	2,191.36	3,365.25	4,218.39
2035	2,205.76	3,385.55	4,183.69
2036	2,220.04	3,405.68	4,149.28
2037	2,234.20	3,425.65	4,115.15
2038	2,248.25	3,445.45	4,081.31
2039	2,262.17	3,465.09	4,047.74
2040	2,275.99	3,484.57	4,014.45

Using these values, biomass loss through time was estimated by multiplying the area of a land cover type with its biomass density value. For land with more than 70 % cover, the biomass density used was that of the old growth forests (445 t/ha).For the lands with 40-70 % cover, the carbon density value of second growth forest (207.9t/ha) was used. Lands with less than 40 % cover were assumed to be areas with shrubs, hence the biomass density of brushlands (30.8 t/ha) was used. Corresponding carbon present in the different land cover types was calculated by multiplying the biomass with 45 %, which is the average carbon content value for Philippine forests based on studies conducted.

Results show that over time, carbon loss in old growth forests is primarily due to deforestation (Figure 7). Old growth forests (land with 70% cover) are being converted into second growth forests (40-70% cover) and brushlands (<40% cover). From a total of 1.02 million tons in 2011, the carbon contained in old growth forests is expected to be reduced to 0.804 million tons by year 2040. Carbon lost by old growth forests is carbon gained by brushlands and second growth forests. From 0.025 million tons in 2011, carbon present in brushland is expected to increase to 0.031 million tons in year 2040. In second growth forests,

carbon is also expected to increase from 0.27 million tons in 2011 to 0.325 million tons in 2040. Overall, however, there would be carbon loss in the ancestral domain because the biomass density value of the land cover type (old growth forest) that is being lost over time is a lot higher than the expansion of second growth forests and brushlands. From 1.31 million tons in 2011, carbon contained in the ancestral domain is estimated to drop to around 1.16 million tons by 2040.

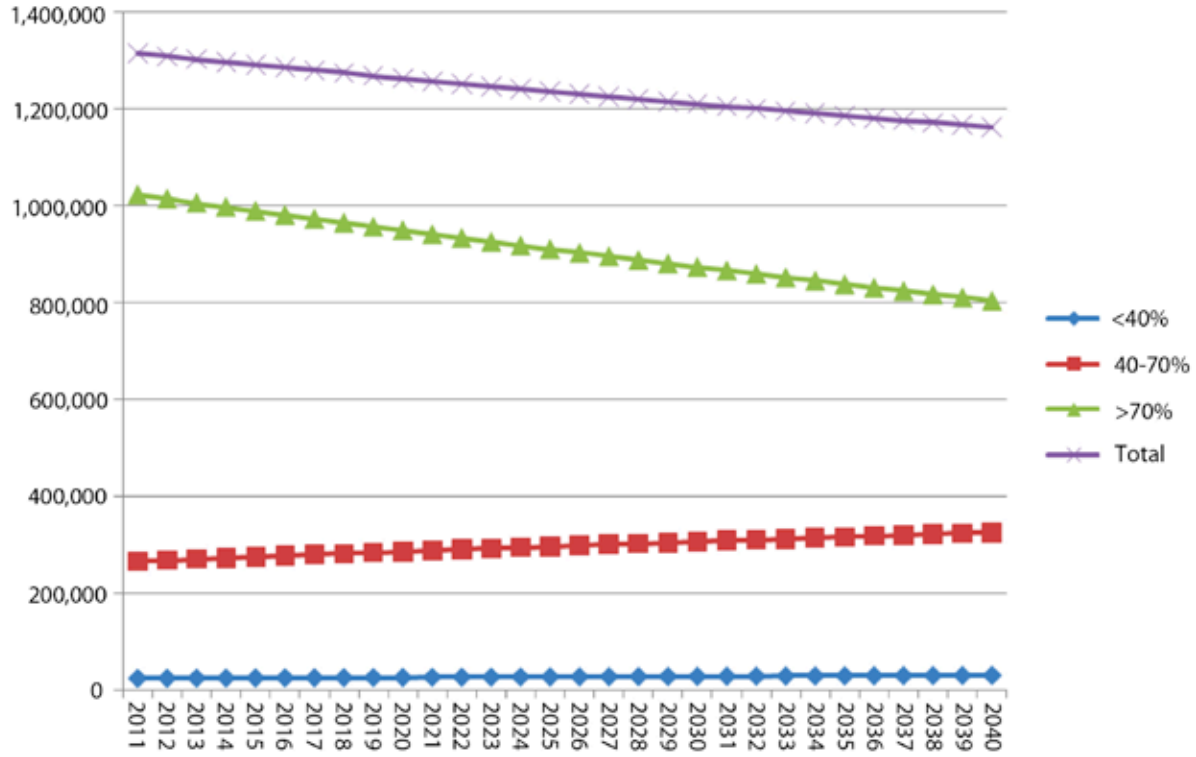

Figure 7. Carbon contained in the different land cover types over time (2011-2030)

Carbon benefits

To reverse the current deforestation trend in the ancestral domain, it is proposed that a forestry carbon project be introduced in the area. The proposed project will have three components: reforestation, enrichment planting, and forest protection. Reforestation will be undertaken in the brushlands while enrichment planting and forest protection will be implemented in second growth and old growth forests, respectively. Four scenarios (high, medium high, medium low and low) were used in the analysis. The assumptions used for each scenario are summarized in Table 5.

Table 5. Assumptions used for four project scenarios

Scenario	% Old Growth Forest Protected (Area: 5,101 ha)	% Second Growth Forest Enriched (Area: 2,849 ha)	% Brushland Reforested (Area: 1,825)
Low	100	50	20
Medium low	100	60	30
Medium high	100	70	40
High	100	80	50

Results show that without the project, the brushland would continue to exist in a degraded state, and would sequester only a minimal amount of carbon under the four scenarios: 0.15MtC (low scenario); 0.23MtC (medium low scenario); 0.3MtC (medium high scenario); and 0.37 MtC (high scenario). With the

project, however, the brushlands are expected to sequester the following amounts of carbon: 0.41MtC (low scenario); 0.61MtC (medium low scenario); 0.81MtC (medium high scenario); and 1.01MtC (high scenario). These values are around 2.7 times more than the amount of carbon sequestered by the brushlands without the project.

Similar to brushlands, second growth forests would remain in a degraded state without the project (Appendices 3, 6, 9 and 12). Second growth forests are estimated to contain a total of 3.99 million tons of carbon and 6.4 million tons under high and low scenarios, respectively. Under medium low and medium high scenarios, this land cover type would contain 4.79 million tons and 5.59 million tons of carbon, respectively. With the project, on the other hand, the values increase by around 1.4 %, resulting in a total sequestration of 5.57 million tons under the low scenario, 6.68 million tons under the medium low scenario, 7.79 million tons under the medium high scenario, and 8.89 million tons under the high scenario.

As for old growth forests, without the project these would continue to be unprotected from illegal logging and encroachment, resulting in a decline of the area coverage through time and, thus, carbon loss (Appendices 4, 7, 10 and 13). Under the different scenarios, there would be carbon loss of around 11 % due to the decline of areas covered by old growth forests. However, once forest protection is put in place in old growth forests, carbon loss will be prevented and the forests' capacity as a carbon sink will be enhanced. At the end of the 30-year period, a total of 37 million tons of carbon are estimated to be sequestered by old growth forests under the four scenarios.

The total net carbon benefits from the three project components under the four scenarios are summarized in Table 6. Under the low scenario, total carbon benefits attributed to project activities amount to 5.53 MtC or 20.26 MtCO2e. Carbon benefits are expected to increase when reforestation and enrichment planting efforts are intensified. For instance, under the medium low scenario, total carbon benefits amount to 5.96 MtC or 21.86 MtCO2e. Carbon benefits further increase under the high and medium high scenarios. Results of the analysis show that under the high scenario total carbon benefits are 6.84 MtC or 25.07MtCO2e while under the medium high scenario total carbon benefits of the project amount to 6.40Mt or 23.47MtCO2e.

Table 6. Total net carbon benefits from project components under four scenarios, 30 years

Scenario	Project Component						Total	
	Reforestation		Enrichment Planting		Forest Protection			
	C	CO_2	C	CO_2	C	CO_2	C	CO_2
Low	256,124	939,120	1,570,157	5,757,244	3,700,277	13,567,682	5,526,558	20,264,045
Medium low	381,559	1,399,051	1,880,991	6,896,966	3,700,277	13,567,682	5,962,827	21,863,699
Medium high	509,603	1,868,544	2,191,396	8,035,117	3,700,277	13,567,682	6,401,275	23,471,343
High	634,750	2,327,417	2,501,441	9,171,948	3,700,277	13,567,682	6,836,468	25,067,048

2.3.2 Social acceptability

This aspect looked into how the community implements projects, its benefit sharing and conflict resolution mechanisms, the members' familiarity with PES, the acceptability of a forestry carbon project, their experience with contracts, and whether contracts are compatible with their cultural values and practices. This was achieved by assessing the indigenous system of governance through consultation meetings, key informant interviews, focus group discussions, review of the community ADSDPP, and literature review.

During the first consultation meeting with the Ayta community, the team explored the acceptability of projects with contracts to the community by asking them about the projects they had been involved with,

including information on funds and fund sources, indicators of success, and benefit-sharing scheme. The community members also raised questions regarding forestry carbon projects. They informed the team that they would first echo the matters taken up during the consultation meeting with other community members. After the information was echoed to the community members, the team was invited to make a presentation to the General Assembly of the Magbukún Ayta on 9 April 2011. The second consultation meeting was attended by 39 community members, including the Tribal Chieftain of the Magbukún Ayta.

Management structure

The Magbukún Ayta have already developed their ADSDPP with funding support from the World Bank and the Japan Social Development Fund , and assistance from the Department of Agrarian Reform, NEDA, National Commission on Indigenous Peoples (NCIP), and Philippine Rural Reconstruction Movement, among others.

The Magbukún Ayta's ADSDPP reveals that they already have a management structure, policies, and mechanisms for the implementation of the community's programs and projects (DAR and NCIP n.d.). The political structure of the Magbukún Ayta (Figure 8) shows that the community is divided into three levels: *Pangkatutubong Kapulungan* (Indigenous General Assembly), *Konseho ng Matatanda* (Council of Elders), and *Pamunuan ng Tribo* (Tribal Council). The *Pangkatutubong Kapulungan* is the highest decision-making body and is composed of all members of the community .

The responsibility to administer, implement, and supervise the community's programs and projects lies with the *Pamunuan ng Tribo* in coordination with NCIP.

The *Pagkatutubong Kapulungan* is consulted by the Tribal Council and Council of Elders for any development, decision, or policy that will be conducted, made, or implemented in the community. The general assembly meets quarterly, every last Saturday of the third month.

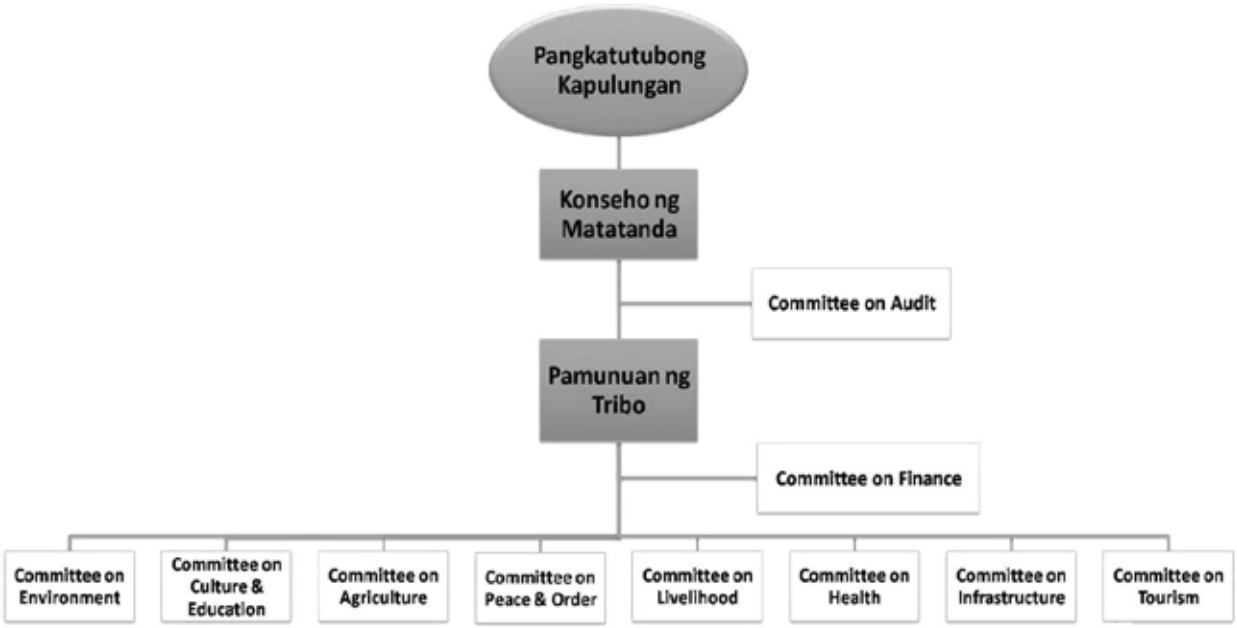

Figure 8. Organizational structure of the Magbukún Ayta

The General Assembly proceeds with its meetings if 60 % of the members are present. A community agreement is reached if at least 90 % of the community members support the decision. Members who are absent when a decision is made are expected to abide and respect the agreement, provided they are informed of it. To ensure continuity, newly-elected officers are expected to abide by and respect the agreements made by the community before their term.

The Magbukún Ayta allow only legitimate members of the community to participate in the decision-making process, with any of the following qualifications:

- Ayta from Kanawan
- Ayta from outside Kanawan but who is married to a legitimate Kanawan Ayta resident, including the widow/widower of a legitimate Kanawan Ayta who has not remarried a non-legitimate Kanawan Ayta
- Ayta from other communities but who have resided in Kanawan for more than 15 years and have actively participated and cooperated in community activities, and abide by the community's rules and regulations

The Council of Elders is composed of respected elder members of the community. The members are chosen by the community based on their credibility and wisdom, and not through election. There is no definite number of members in the Council. Among the duties of the Council of Elders is to serve as arbitrator in settling critical problems in the community.

The Tribal Council administers, regulates, and implements the community affairs. It also formulates policies, rules and regulations, as well as screens, assesses, facilitates, and recommends programs and projects to the Council of Elders and General Assembly. The Tribal Council likewise represents the community in external affairs.

A member of the Tribal Council should have the following qualifications:

- Pure Ayta or mestizo/mestiza and legitimate Ayta resident of Kanawan
- Highly respected by the family and community
- Has personal discipline
- Broad-minded
- Open to criticisms and suggestions
- Intelligent
- At least 25 years old (Tribal Chieftain) or 18 years old for other Tribal Council members

The ADSDPP describes in detail the qualifications, role, duties, and responsibilities, including resignation and/or impeachment and replacement processes of different positions and committees in the Magbukún Ayta's organizational structure.

The research team experienced how the organization structure works when it presented the project to the community during two meetings: the first to a small group of Aytas and the second to the General Assembly.

Benefit sharing mechanism

A review of the community's ADSDPP revealed that the community already has a benefit sharing mechanism. In general, the community's guiding principles in benefit sharing are equity and greatest number of beneficiaries possible. During the first consultation meeting, it was learned that the community has been involved already in at least nine projects, one of them with foreign funding (US National Institutes of Health through the Michigan State University).

The completed MSU project involved biodiversity exploration as well as medical missions to the community. However, it was not able to achieve its intention of sourcing more funds for a major project mainly because of the delay in the issuance of the free and prior informed consent (FPIC) of the community, and later because of NCIP procedures. The benefit sharing agreement under this project was 60 % for the community and 40 % for University of the Philippines-MSU, depending on the inputs of parties. If there was no technological input from UP-MSU, almost 100 % of the benefits went to the community.

In 2001-2002, the community had a project with the Center for BioMolecular Science Foundation (CBMSF) and the Bataan Center for Innovative Science and Technology (BCISTI) on commercial beekeeping. The proceeds from the sale of honey were divided among community members based on their inputs. Food-

for-work was also practiced in the community, particularly in connection with the PTFCF project on reforestation using indigenous tree species.

Conflict resolution mechanism

The ADSDPP also contains the community's conflict resolution mechanism in the context of the Magbukún Ayta's customary laws. Conflicts among community members are usually resolved by the Tribal Council and community elders, usually through amicable settlement where both parties are appeased and an agreement is arrived at.

Community's familiarity with Payment for Ecosystem Services (PES)

When the team directly asked the community members if they were aware about payments for ecosystem services (PES), one member, Mr. Joe Salonga, answered in the affirmative. Mr. Salonga said that he saw the potential of PES, as *"manggagaling din sa gubat ang gagamitin natin para mapangalagaan ang gubat"* (what we need to conserve the forest will come from the forest itself).

Among the issues raised by the community members and the answers of the team *(*in italics*)* are:

- What will happen to their traditional activities such as hunting and honey gathering? In the case of the latter, they have to cut branches and burn leaves and twigs to smoke the bees out of their hives.

- The Aytas traditionally hold bonfires, where they discuss matters concerning the community. They also use fire to warm their bodies in the morning and at night, which means they have to burn wood.

  Hunting is not incompatible with PES for carbon storage, but cutting trees may not be allowed for a certain period. In the case of burning for honey gathering or other activities, this can be considered in carbon accounting.

- The Aytas have already been doing reforestation as part of their culture. They need to plant 15 to 20 seedlings for every tree they cut to use as house post.

- If the community will agree to be involved in PES, they will need to identify the areas that they can commit and the activities that they can do.

Community's experience with contracts

Of the nine projects the community has been involved in since the 1990s, only one (1) project involved a contract. This project, funded by the Philippine Tropical Forest Conservation Foundation (PTFCF), had been implemented in three phases over a five-year period. The total funds amounted to PhP 6,000,000. Mostly, the members benefited from the project's food-for work scheme; only the coordinators received honoraria of PhP 4,000/month (1 person) and PhP 3,000/month (3 persons).

The community actively participated in the following activities of the PTFCF project: biodiversity inventory, development of a pictorial guide to the plants of Bataan National Park, collection of seeds and phenology data, establishment and maintenance of nurseries, enrichment planting in forest enrichment areas, planting of fruit trees in agroforestry areas, maintenance of forest restoration areas, conservation efforts, ecotourism and bird watching, monitoring and protection of the ancestral domain, zoning of the Kanawan Negritos Reservation Area, establishment of a duck farm, production of non-wood forest products, information and education communication (IEC), capability-building, and protection of IP rights.

Acceptability of a forestry carbon project

After deliberation, the Magbukún Ayta issued a resolution dated 1 July 2011 stating that they are amenable to the possibility of being involved in a PES project, specifically on the carbon sequestration potential of their forests. The resolution was signed not only by officers of the Tribal Council and Council of Elders, but also by 74 members of the General Assembly.

Responsibilities of the Magbukún Ayta in a forestry carbon project

The rate of deforestation can be reversed by providing Aytas with support and incentives to continue their efforts in ecorestoration and forest protection beyond the PTFCF–supported project that recently ended. For Magbukún Aytas, conservation of the forest in their ancestral domain is integral to the preservation of their identity and cultural heritage. Thus, the PTFCF project envisioned that the Aytas would continue with their role as stewards of the forest for as long as they can sustainably maintain livelihood activities based on non-timber forest products and the sale of fruits and other crops from small farms within the 227-hectare Kanawan Negritos Reservation Area (KNRA).

From 2005 to 2011, the income of Kanawan Aytas had increased from USD 0.47 per day per person (Motin et al., 2006) to the upper border of extreme poverty level or getting by at USD 1.25 per day per person (Cruz et al., manuscript in preparation). The improvement in economic status has come from the employment of more Aytas at the Subic Bay Freeport Zone (SBFZ) after the Aytas asserted their IP rights over their ancestral domain that extends into a big portion of SBFZ. The Aytas of KNRA who are not employed go on with their traditional way of life as hunter-gatherers in the forest in addition to tending small farms in KNRA. Although the unemployed Aytas continue to monitor and to take care of the forest by spreading seeds and transplanting seedlings into forest enrichment sites as they hunt and gather NTFPs, persevering with the conservation effort remains a tall order for a community that remains at the border of extreme poverty. A big threat is the increasing encroachment into the Aytas' ancestral domain by informal settlers who compete with Aytas for honey and cut trees for charcoal making.

The proposed forestry carbon project can provide Aytas the means to increase their effort in performing their responsibilities and implementing strategies for forest protection, enrichment planting, and reforestation. The Ayta community will be expected to perform the following responsibilities:

1. Ensure protection of areas with >70 % forest cover
    a. Strengthen the capability of *Bantay Gikut* members (BGMs) or forest guards through regular training by DENR personnel.
    b. Equip BGMs with cell phones with cameras to document activities in the forest.
    c. Establish systems to facilitate reporting of destructive activities to the local government unit (LGU) and DENR offices.
    d. Collect fines and impose punishment on community members involved in activities destructive to the forest.
    e. Coordinate with LGU and DENR regarding imposition of fines and punishment of non-community members involved in activities destructive to the forest.
2. Actively engage in ecorestoration of forest gaps
    a. Enrich secondary forests by direct transplantation of wildings of dipterocarps and other hardwood trees during the rainy season.
    b. Continue with their practice of dispersing seeds of rattan, etc. around the forest.
    c. Maintain saplings by removing vines that can suffocate their growth.
    d. Water saplings when necessary.

3. Engage in reforestation/ecorestoration of grasslands

    a. Initially plant assorted indigenous pioneer trees in grasslands by direct seeding or planting of seedlings from nurseries maintained in the nearest place where water is abundant.

    b. Plant dipterocarps and other hardwood trees once the pioneer trees can provide shade.

    c. Protect reforestation/ecorestoration areas adjacent to grasslands by setting up five-meter firebreaks planted with sweet potato as ground cover. Sweet potatoes can grow in cogonal areas in the direction of the wind and eventually compete out the grass.

    d. Plant leguminous ground covers in reforestation/ ecorestoration areas.

The Aytas can undertake also other protective strategies to ensure the symbiosis of community and the Bataan National Park. These activities are as follows:

1. Ensure that cutting of trees will be done only in the agroforestry areas within KNRA. For every tree cut, 6 seedlings or saplings should be planted.
2. Establish an agroforestry area in KNRA for trees that can provide for the structural needs of the Ayta community and KNRA residents.
3. Establish a plantation area for fuel trees, which will be jointly managed by Aytas and informal settlers. Prohibit cutting of forest trees for charcoal making.
4. Ensure that farming activities are restricted within the 227-hectare KNRA.
5. Prohibit the opening of new *kaingin* farms and establish a system of punishment for those who burn forest to open areas for swidden farming. (Under the PTFCF-supported project, the Aytas signed a resolution that they will no longer engage in *kaingin*.)
6. Set up a system for household production of organic fertilizer and vermicomposting.
7. Increase productivity of farms within KNRA by multiple cropping, crop rotation, and the use of organic fertilizer and vermicompost.
8. Encourage planting of fruit trees such as coffee and cashew.
9. Plant dipterocarps and other flowering forest trees that can act as nectar and pollen sources of wild bees to increase honey production.

2.3.3 Financial feasibility

The financial feasibility of a forestry carbon project for the Ayta community was evaluated by comparing the costs of implementing the project with the potential carbon benefits. The carbon benefits considered in the analysis are already net benefits, and were derived using the with and without project analysis discussed in Section 2.3.1 and as summarized in Appendix 1-4.

The following assumptions were made:

Period of analysis 30 years

Scenarios used in estimating carbon benefits:

Low scenario	100% protection of old growth forests 50% of second growth forests for enrichment planting 20% of brushlands for reforestation
Medium low scenario	100% protection of old growth forests 60% of second growth forests for enrichment planting 30% of brushlands for reforestation

Medium high scenario	100% protection of old growth forests 70% of second growth forests for enrichment planting 40% of brushlands for reforestation
High scenario	100% protection of old growth forests 80% of second growth forests for enrichment planting 50% of brushlands for reforestation
Establishment of project activities	Years 1-5 (2011-2015)
Activity from Year 6 onwards	Forest protection
Reforestation cost	PhP 30,000/ha
Enrichment planting cost	PhP 20,000/ha
Protection cost	PhP 1,500/ha/year
Price of tCO_2	USD 5, 10, and 20
Discount rate	10%, 15%, and 20%

Table 7 summarizes the costs that will be incurred for the different activities over the 30-year period, while the costs and benefits of the project at different prices per tCO_2 for the four scenarios are provided in Appendix 1-4. At USD 5 per tCO_2, the four scenarios' net benefits for years 1 to 3 will be negative, but will become positive from year 6 onward. At USD 10 per tCO_2, the four scenarios' net benefits will be negative at years 1 to 2, while at USD20 per tCO_2, the net benefits for the medium low, medium high, and high scenarios will be negative for years 1 to 2. However, the low scenario's net benefit for USD20 per tCO_2 will be negative only in year 1 and will become positive from year 2 onwards.

The net present values (NPVs) of the forestry carbon project at different prices per tCO_2 and for the four scenarios were computed using discount rates of 10 %, 15 %, and 20 % (Table 8). As expected, the highest NPVs (PhP 3.874 million, PhP3.137 million, PhP3.339 million, and PhP 3.537 million, respectively) will be realized for the highest price per tCO_2 of USD 20 and at 10 % discount rate for the low, medium low, medium high and high scenarios, respectively. However, the NPVs of the project under the low scenario at the three alternative tCO_2 prices and alternative discount rates are all higher than the NPVs under the high scenario. This is explained by the higher costs of the different project components under the high scenario, owing to the higher areas that will be subjected to reforestation and enrichment planting.

The internal rates of return (IRR) of the project under the low scenario at the three alternative tCO_2 prices are likewise higher than those of the other three scenarios. It is expected that the highest IRR would be attained at the highest tCO_2 price (USD 20).

Still, even at the most conservative price of USD 5 per tCO_2, the NPVs at the highest discount rate of 20 % for the four scenarios are positive, indicating that the forestry carbon project is financially feasible.

Table 7. Costs of different project activities

Component	Cost/Year (PhP)					
	1	2	3	4	5	6 onward
Low scenario						
Reforestation	2,190,300	2,190,300	2,190,300	2,190,300	2,190,300	NA
Enrichment planting	5,697,800	5,697,800	5,697,800	5,697,800	5,697,800	NA
Protection	7,651,260	8,188,114	8,505,936	8,933,271	9,360,606	10,335,510
Total	**15,539,360**	**16,076,214**	**16,394,036**	**16,821,371**	**17,248,706**	**10,335,510**
Medium low scenario						
Reforestation	3,285,396	3,285,396	3,285,396	3,285,396	3,285,396	NA
Enrichment planting	6,837,456	6,837,456	6,837,456	6,837,456	6,837,456	NA
Protection	7,651,260	8,328,339	9,005,418	9,682,497	10,359,576	11,036,655
Total	**17,774,112**	**18,451.191**	**19,128,279**	**19,805,349**	**20,482,428**	**11,036,655**
Medium high scenario						
Reforestation	4,380,528	4,380,528	4,380,528	4,380,528	4,380,528	NA
Enrichment planting	7,977,032	7,977,032	7,977,032	7,977,032	7,977,032	NA
Protection	7,651,260	8,468,564	9,285,868	10,103,171	10,920,475	11,737,779
Total	**20,008,820**	**20,826,124**	**21,643,428**	**22,460,731**	**23,278,428**	**11,737,779**
High scenario						
Reforestation	5,475,600	5,475,600	5,475,600	5,475,600	5,475,600	NA
Enrichment planting	9,116,600	9,116,600	9,116,600	9,116,600	9,116,600	NA
Protection	7,651,260	8,608,789	9,018,751	9,702,496	10,386,241	12,438,885
Total	**22,243,528**	**23,200,989**	**23,610,951**	**24,294,696**	**24,978,441**	**12,438,885**

Table 8. Net present value (NPV) and internal rate of return (IRR) of forestry carbon project at different prices per tCO_2 and at four scenarios

Scenario	Net Present Value (PhP)			IRR (%)		
	USD 5/tCO_2	USD 10/tCO_2	USD 20/tCO_2	USD 5/tCO_2	USD 10/tCO_2	USD 20/tCO_2
Low scenario				52	84	127
i=10%	878,032,854	1,876,785,641	3,874,291,214			
i=15%	366,838,291	821,669,924	1,731,333,188			
i=20%	176,405,089	422,041,628	913,314,704			
Medium low scenario				46	71	102
i=10%	679,870,022	1,498,881,711	3,136,905,088			
i=15%	318,221,034	738,466,857	1,578,958,503			
i=20%	161,197,725	402,899,229	886,302,235			
Medium high scenario				43	64	88
i=10%	724,099,517	1,595,812,003	3,339,236,973			
i=15%	334,747,196	779,010,268	1,667,536,412			
i=20%	166,240,537	419,667,996	926,522,914			
High scenario				40	59	79
i=10%	764,695,264	1,688,736,136	3,536,817,881			
i=15%	349,417,625	817,531,146	1,753,758,188			
i=20%	170,271,357	435,341,680	965,482,328			

2.3.4 Potential buyers of the Ayta community's carbon

The team identified potential buyers of the forestry carbon that the Ayta community may produce from among the firms registered with the Philippine Business for Social Progress (PBSP), as well as locators in Subic Bay Freeport and Clark Freeport Zones.

The PBSP is composed of 230 small, medium, and large corporations in the Philippines (http://www.pbsp.org.ph/). Each year, it raises a billion pesos from the contributions of its members to finance its projects nationwide. The mission of PBSP emphasizes its commitment to "poverty reduction by promoting business sector leadership in and commitment to programs that lead to self-reliance."

PBSP has a Center for Corporate Citizenship that tests, evaluates, documents, and promotes leading-edge practices on social investment, corporate-community partnership, managing workplace concerns, and environmental stewardship. It envisions itself as a business community that is fully and actively committed to making strategic contributions to the development of society, the sustainability of the environment, and the improvement of the Filipino people's quality of life.

A review of the projects of PBSP shows that most of them have been in the areas of education, health, and sanitation. However, some of PBSP's members have pursued environment-related projects, such as:

- Unilever Philippines – solid waste management, Pasig River rehabilitation, Laguna Lake conservation, conservation and reforestation of La Mesa Watershed
- Cemex Asia Pte. Ltd. – adoption of species on the Red List of IUCN
- First Philippine Holdings – rehabilitation of Pasig River
- Energy Development Corporation – development of parks using endangered and premium native species
- Saggitarius Mines – reforestation program

The approaches that may be employed in finding carbon buyers include face-to-face presentations with concerned personnel of companies and inviting them to attend forestry carbon presentations. The presentations should capitalize on the corporate social responsibility of firms. However, it is notedthat the estimates of the forestry carbon benefits appear to be quite large, hence, it may be necessary to tap groups of firms instead of individual firms.

Foreign buyers are another potential market for carbon credits. At present, the Philippines has two forestry carbon projects in the provinces of Quirino and Isabela, where the buyers are foreign companies, namely: More Trees and Toyota Motors Corporation, respectively. Both projects were developed by Conservation International.

The research team participated in an Environmental Service (ES) Market Fair held on April 12, 2012 at Traders Hotel, Manila. The Market Fair was organized by the World Agroforestry Centre (ICRAF) Philippines and the Food and Agriculture Organization of the United Nations (FAO). The Fair aimed to: (1) link environmental and community projects with the private and public sectors; and (2) provide updates on current payments for environmental services (PES) status and experiences in the country from the point of view of project implementers and businesses/institutions that have implemented PES for community development and environmental conservation.

The ES Market Fair brought together potential buyers and sellers of the environmental services such as carbon, water, biodiversity and landscape/seascape beauty. Potential forestry carbon projects were showcased through Project Idea Notes, which provided information on project profile and carbon benefits.

2.3.5 Recent initiative on PES

The Philippines' Climate Change Commission is currently crafting a policy that will institutionalize PES under the National Climate Change Adaptation Plan (NCCAP). PES is seen as one of the sustainable

financing mechanisms that will be used to implement climate change adaptation programs and projects. In turn, the payments will benefit communities and other providers of ecosystem services.

Moreover, the policy will provide the legal framework that has long been a barrier to the implementation of PES initiatives.

2.4 Project Extension

The research team recognized that there are several worthwhile activities that need to be pursued to strengthen the Magbukún Ayta's position in preparation for its participation in the forestry carbon market. Thus, the team was granted an extension of the project to enable it to undertake the following activities:

2.4.1 Creation of awareness about the Magbukún Ayta and potential to participate in the forestry carbon market

The team hired a web programmer to develop a website for the Magbukún Ayta. As conceptualized, the website will showcase what the community has been doing, the projects it has undertaken, the problems it faces, and its capacity to undertake projects that will lead to the sustainable management of its ancestral domain. It will also be a useful venue to generate awareness and support for the cause of indigenous peoples.

The plan for the website will include buying the domain name www.kanawan.org. Initially, the administration of the website will be under the care of the Center for BioMolecular Science Foundation (CBMSF), which has an on-going project with the community and with which the research team has been collaborating.

As of this writing, the project area has no internet access. CBMSF is currently exploring the possibility of installing an internet connection in the area.

2.4.2 Community-based mapping

As part of the team's efforts to elicit local knowledge on the land use, a 3D relief map was constructed with the participation of the community. This method is an effective way of putting local knowledge onto a map that people can easily identify with. This has been used successfully on many occasions to elicit local knowledge on resource distribution like land cover and use, water sources, habitats; resource use, control and access like farming and gathering from the wild, among others; and identification of places of significance like ancestral grounds and sacred areas (Rambaldi 2005).

There are at least five simple steps in constructing a 3D relief map, and these were followed in the workshop for the community. These are: preparation of basemap and materials, tracing, cutting, gluing and painting/marking.

Preparation of basemap and materials*:* The basemap can be prepared from a digitized contour map or derived from a digital elevation model (i.e. SRTM[1]). The materials for constructing the 3D relief model and for encoding the geographic features include colored twines, water-based paint, scissors, used cardboard boxes, cutters, glue, carbon paper and crepe paper[2].

Tracing: Individual contours from an elevation map are traced onto individual sheets of corrugated carton that are sized uniformly. These figures traced onto corrugated carton are then carefully cut.

Gluing: The corrugated carton figures are then pasted on top of each other following the elevation values. After the last elevation is pasted, sheets of white crepe paper are glued onto the model until a blank relief model is produced (Figure 9).

Figure 9. Blank relief model

Painting/Marking: Once the blank relief model is finished, geographic features like the river system, land cover like forest, among others are painted and/or drawn onto the model.

The final relief map (Figure 10) coded with the corresponding information is shown below (blue twine indicates rivers; dark green paint indicates forest areas, light green paint along the boundaries of the rivers are shrubs/forests, green twine indicates thick forest areas and red paint indicates open areas). The red twine surrounding the area refers to the boundary of the ancestral domain.

Figure 10. Final map

2.4.3 Presentation of the project idea to potential buyers

Dr. Lourdes J. Cruz, a member of the research team, was invited by the World Agroforestry Center (ICRAF) and the Department of Environment and Natural Resources (DENR) to participate in the Environmental Service Market Fair held on April 12, 2012. The said ES Market Fair was organized with the support of the Food and Agriculture Organization.

The Fair aimed:

1. to link environmental and community projects with the private and public sectors; and
2. to provide updates on current PES (payments for environmental services) status and experiences in the country from the point of view of project implementers and businesses/institutions who have implemented PES for community development and environmental conservation.

The team presented a poster to showcase the feasibility of a forestry carbon project for the Magbukún Ayta in the ES Market Fair organized by ICRAF on April 12, 2012. The presence of two Ayta collaborators at the fair helped attract interest on the poster presentation.

5.0 CONCLUSIONS

Based on the results of the study, the research team made the following conclusions:

1. Forestry carbon projects have great potential in both the global and local markets for carbon. In the Philippines, several groups have attempted to develop reforestation/afforestation projects, but none have prospered. On the other hand, there are now two forestry carbon projects that have passed the voluntary carbon market standard. At present, there are also efforts to develop projects under the National REDD+ Strategy.

2. The Philippines is committed to addressing climate change, as evidenced by the creation of the Inter-Agency Committee on Climate Change, the signing and ratification of the United Nations Framework Convention on Climate Change, the signing and ratification of the Kyoto Protocol, creation of the Philippine Task Force on Climate Change, and the enactment of Republic Act 9729, otherwise known as the Climate Change Act of 2009.

3. Developing a forestry carbon project for the Magbukún Ayta of Kanawan, Morong, Bataan is technically and financially feasible. Overall, there will be carbon loss in the ancestral domain because the biomass density value of old growth forest lost through time is much higher than expanding second growth forests and brushlands. Thus, there is an excellent opportunity for the community to be engaged in a forestry carbon project.

4. The NPV and IRR at the most conservative conditions (i.e., high scenario, price of USD 5/ton CO_2, and 20% discount rate) are PhP 170.271 million and 40 %, respectively. These figures show that the forestry carbon project is financially viable.

5. The Magbukún Ayta already have their Ancestral Domain Sustainable Development and Protection Plan, as well as benefit-sharing and conflict resolution mechanisms, which will be important if they decide to pursue a forestry carbon project. The Magbukún Ayta have expressed in a resolution that they are amenable to the possibility of being involved in a PES project, specifically on the carbon sequestration potential of their forests.

6.0 RECOMMENDATIONS

It is recommended that the potential of developing a forestry carbon project for the Magbukún Ayta be comprehensively studied and that a Project Idea Note (PIN) be developed. This will require the following activities:

1. ***Identification of the project boundary.*** This will entail the purchase and analysis of satellite images in two time slices (e.g., 1989 and 2010); ground-truthing to verify results of satellite image analysis; and production of thematic project maps (e.g., land use, elevation, vegetation, administrative boundary).

2. ***Carbon stock assessment of the various land uses in the ancestral domain.*** Sampling plots will be established in the different land use zones to estimate their carbon densities. Carbon in the different pools (tree, understorey, litter, roots, and soil) will be measured following the proper protocol stated in the IPCC Good Practice Guidance.

3. ***Biophysical survey.*** This will make use of both primary and secondary data (biodiversity, soils, climate, water resources, etc.).

4. ***Socioeconomic survey***. This will generate basic information on the communities inside the project boundary (individual and household populations, occupation, income, ownership of land, cultural practices, knowledge, perceptions and attitude about the forestry carbon project, willingness to participate in the project, desired species to be planted, etc.).

Using the information generated from the above-mentioned activities, the PIN will be developed. The PIN will describe in detail the proposed forestry carbon project. In addition to this, there will be a discussion on the appropriate methodology to be used and how issues on leakage and additionality will be addressed.

These activities were not part of the current project, which focused on an initial assessment of the feasibility of a forestry carbon project for the Magbukún Ayta. Based on the results of the study, the project has a high potential to promote the environmental stability of the Magbukún Ayta's ancestral domain and, at the same time, improve their well-being. However, the pursuit of the activities toward making a forestry carbon project a reality for the Magbukún Ayta will require both technical and financial assistance.

In this regard, it is recommended that funding be made available to conduct the above mentioned activities.

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APPENDICES

Appendix 1. Benefits and costs of forestry carbon project, low scenario

Year	Carbon benefits (P, 1US$:P44)			Total cost (P)	Net carbon benefits (P, 1US$:P44)		
	$5/t CO2	$10/t CO2	$20/t CO2		$5/t CO2	$10/t CO2	$20/t CO2
2011	(3,186,040)	(6,372,080)	(12,744,160)	15,539,360	(18,725,400)	(21,911,440)	(28,283,520)
2012	5,287,920	10,575,840	21,151,680	16,076,214	(10,788,294)	(5,500,374)	5,075,466
2013	14,577,200	29,154,400	58,308,800	16,394,036	(1,816,836)	12,760,364	41,914,764
2014	24,674,980	49,349,960	98,699,920	16,821,371	7,853,609	32,528,589	81,878,549
2015	35,579,720	71,159,440	142,318,880	17,248,706	18,331,014	53,910,734	125,070,174
2016	46,476,540	92,953,080	185,906,160	10,335,510	36,141,030	82,617,570	175,570,650
2017	57,369,840	114,739,680	229,479,360	10,335,510	47,034,330	104,404,170	219,143,850
2018	68,259,840	136,519,680	273,039,360	10,335,510	57,924,330	126,184,170	262,703,850
2019	79,150,720	158,301,440	316,602,880	10,335,510	68,815,210	147,965,930	306,267,370
2020	90,040,720	180,081,440	360,162,880	10,335,510	79,705,210	169,745,930	349,827,370
2021	100,931,820	201,863,640	403,727,280	10,335,510	90,596,310	191,528,130	393,391,770
2022	111,823,800	223,647,600	447,295,200	10,335,510	101,488,290	213,312,090	436,959,690
2023	122,716,220	245,432,440	490,864,880	10,335,510	112,380,710	235,096,930	480,529,370
2024	133,609,080	267,218,160	534,436,320	10,335,510	123,273,570	256,882,650	524,100,810
2025	144,422,520	288,845,040	577,690,080	10,335,510	134,087,010	278,509,530	567,354,570
2026	154,917,400	309,834,800	619,669,600	10,335,510	144,581,890	299,499,290	609,334,090
2027	165,413,380	330,826,760	661,653,520	10,335,510	155,077,870	320,491,250	651,318,010
2028	175,911,560	351,823,120	703,646,240	10,335,510	165,576,050	341,487,610	693,310,730
2029	186,411,500	372,823,000	745,646,000	10,335,510	176,075,990	362,487,490	735,310,490
2030	196,912,320	393,824,640	787,649,280	10,335,510	186,576,810	383,489,130	777,313,770
2031	207,413,800	414,827,600	829,655,200	10,335,510	197,078,290	404,492,090	819,319,690
2032	217,917,040	435,834,080	871,668,160	10,335,510	207,581,530	425,498,570	861,332,650
2033	228,419,400	456,838,800	913,677,600	10,335,510	218,083,890	446,503,290	903,342,090
2034	238,922,420	477,844,840	955,689,680	10,335,510	228,586,910	467,509,330	945,354,170
2035	249,426,980	498,853,960	997,707,920	10,335,510	239,091,470	488,518,450	987,372,410
2036	259,930,880	519,861,760	1,039,723,520	10,335,510	249,595,370	509,526,250	1,029,388,010
2037	270,435,220	540,870,440	1,081,740,880	10,335,510	260,099,710	530,534,930	1,071,405,370
2038	280,937,800	561,875,600	1,123,751,200	10,335,510	270,602,290	551,540,090	1,113,415,690
2039	291,441,480	582,882,960	1,165,765,920	10,335,510	281,105,970	572,547,450	1,155,430,410
2040	301,943,620	603,887,240	1,207,774,480	10,335,510	291,608,110	593,551,730	1,197,438,970
				NPV, 15%	366,838,291	821,669,924	1,731,333,188
				NPV, 10%	878,032,854	1,876,785,641	3,874,291,214
				NPV, 20%	176,405,089	422,041,628	913,314,704
				IRR	52%	84%	127%

Appendix 2. Benefits and costs of forestry carbon project, medium low scenario

Year	Carbon benefits (P, 1US$:P44)			Cost (P)	Net carbon benefits (P, 1US$:P44)		
	$5/t CO2	$10/t CO2	$20/t CO2	Total	$5/t CO2	$10/t CO2	$20/t CO2
2011	(4,985,640)	(9,971,280)	(19,942,560)	17,774,112	(22,759,752)	(27,745,392)	(37,716,672)
2012	3,918,200	7,836,400	15,672,800	18,591,416	(14,673,216)	(10,755,016)	(2,918,616)
2013	13,846,580	27,693,160	55,386,320	19,408,720	(5,562,140)	8,284,440	35,977,600
2014	24,790,920	49,581,840	99,163,680	20,226,023	4,564,897	29,355,817	78,937,657
2015	36,749,680	73,499,360	146,998,720	21,043,327	15,706,353	52,456,033	125,955,393
2016	48,696,780	97,393,560	194,787,120	11,737,779	36,959,001	85,655,781	183,049,341
2017	60,638,160	121,276,320	242,552,640	11,737,779	48,900,381	109,538,541	230,814,861
2018	72,574,480	145,148,960	290,297,920	11,737,779	60,836,701	133,411,181	278,560,141
2019	84,509,920	169,019,840	338,039,680	11,737,779	72,772,141	157,282,061	326,301,901
2020	96,443,160	192,886,320	385,772,640	11,737,779	84,705,381	181,148,541	374,034,861
2021	108,376,620	216,753,240	433,506,480	11,737,779	96,638,841	205,015,461	421,768,701
2022	120,309,860	240,619,720	481,239,440	11,737,779	108,572,081	228,881,941	469,501,661
2023	132,242,880	264,485,760	528,971,520	11,737,779	120,505,101	252,747,981	517,233,741
2024	144,175,240	288,350,480	576,700,960	11,737,779	132,437,461	276,612,701	564,963,181
2025	155,986,820	311,973,640	623,947,280	11,737,779	144,249,041	300,235,861	612,209,501
2026	167,416,260	334,832,520	669,665,040	11,737,779	155,678,481	323,094,741	657,927,261
2027	178,846,360	357,692,720	715,385,440	11,737,779	167,108,581	345,954,941	703,647,661
2028	190,278,220	380,556,440	761,112,880	11,737,779	178,540,441	368,818,661	749,375,101
2029	201,711,180	403,422,360	806,844,720	11,737,779	189,973,401	391,684,581	795,106,941
2030	213,144,800	426,289,600	852,579,200	11,737,779	201,407,021	414,551,821	840,841,421
2031	224,578,860	449,157,720	898,315,440	11,737,779	212,841,081	437,419,941	886,577,661
2032	236,014,020	472,028,040	944,056,080	11,737,779	224,276,241	460,290,261	932,318,301
2033	247,448,080	494,896,160	989,792,320	11,737,779	235,710,301	483,158,381	978,054,541
2034	258,882,360	517,764,720	1,035,529,440	11,737,779	247,144,581	506,026,941	1,023,791,661
2035	270,318,180	540,636,360	1,081,272,720	11,737,779	258,580,401	528,898,581	1,069,534,941
2036	281,752,900	563,505,800	1,127,011,600	11,737,779	270,015,121	551,768,021	1,115,273,821
2037	293,187,840	586,375,680	1,172,751,360	11,737,779	281,450,061	574,637,901	1,161,013,581
2038	304,620,580	609,241,160	1,218,482,320	11,737,779	292,882,801	597,503,381	1,206,744,541
2039	316,054,200	632,108,400	1,264,216,800	11,737,779	304,316,421	620,370,621	1,252,479,021
2040	327,486,280	654,972,560	1,309,945,120	11,737,779	315,748,501	643,234,781	1,298,207,341
				NPV, 15%	318,221,034	738,466,857	1,578,958,503
				NPV, 10%	679,870,022	1,498,881,711	3,136,905,088
				NPV, 20%	161,197,725	402,899,229	886,302,235
				IRR	46%	71%	102%

Appendix 3. Benefits and costs of forestry carbon project, medium high scenario

Year	Carbon benefits (P, 1US$:P44)			Cost (P)	Net carbon benefits (P, 1US$:P44)		
	$5/t CO2	$10/t CO2	$20/t CO2	Total	$5/t CO2	$10/t CO2	$20/t CO2
2011	(6,786,120)	(13,572,240)	(27,144,480)	20,008,820	(26,794,940)	(33,581,060)	(47,153,300)
2012	2,546,500	5,093,000	10,186,000	20,826,124	(18,279,624)	(15,733,124)	(10,640,124)
2013	13,112,220	26,224,440	52,448,880	21,643,428	(8,531,208)	4,581,012	30,805,452
2014	24,901,360	49,802,720	99,605,440	22,460,731	2,440,629	27,341,989	77,144,709
2015	37,911,500	75,823,000	151,646,000	23,278,035	14,633,465	52,544,965	128,367,965
2016	50,906,900	101,813,800	203,627,600	11,737,779	39,169,121	90,076,021	191,889,821
2017	63,894,160	127,788,320	255,576,640	11,737,779	52,156,381	116,050,541	243,838,861
2018	76,874,380	153,748,760	307,497,520	11,737,779	65,136,601	142,010,981	295,759,741
2019	89,852,180	179,704,360	359,408,720	11,737,779	78,114,401	167,966,581	347,670,941
2020	102,826,900	205,653,800	411,307,600	11,737,779	91,089,121	193,916,021	399,569,821
2021	115,800,520	231,601,040	463,202,080	11,737,779	104,062,741	219,863,261	451,464,301
2022	128,772,820	257,545,640	515,091,280	11,737,779	117,035,041	245,807,861	503,353,501
2023	141,744,240	283,488,480	566,976,960	11,737,779	130,006,461	271,750,701	555,239,181
2024	154,714,340	309,428,680	618,857,360	11,737,779	142,976,561	297,690,901	607,119,581
2025	167,686,420	335,372,840	670,745,680	11,737,779	155,948,641	323,635,061	659,007,901
2026	180,048,440	360,096,880	720,193,760	11,737,779	168,310,661	348,359,101	708,455,981
2027	192,410,680	384,821,360	769,642,720	11,737,779	180,672,901	373,083,581	757,904,941
2028	204,774,240	409,548,480	819,096,960	11,737,779	193,036,461	397,810,701	807,359,181
2029	217,138,680	434,277,360	868,554,720	11,737,779	205,400,901	422,539,581	856,816,941
2030	229,503,340	459,006,680	918,013,360	11,737,779	217,765,561	447,268,901	906,275,581
2031	241,867,780	483,735,560	967,471,120	11,737,779	230,130,001	471,997,781	955,733,341
2032	254,233,320	508,466,640	1,016,933,280	11,737,779	242,495,541	496,728,861	1,005,195,501
2033	266,597,540	533,195,080	1,066,390,160	11,737,779	254,859,761	521,457,301	1,054,652,381
2034	278,961,540	557,923,080	1,115,846,160	11,737,779	267,223,761	546,185,301	1,104,108,381
2035	291,326,420	582,652,840	1,165,305,680	11,737,779	279,588,641	570,915,061	1,153,567,901
2036	303,690,420	607,380,840	1,214,761,680	11,737,779	291,952,641	595,643,061	1,203,023,901
2037	316,054,200	632,108,400	1,264,216,800	11,737,779	304,316,421	620,370,621	1,252,479,021
2038	328,415,340	656,830,680	1,313,661,360	11,737,779	316,677,561	645,092,901	1,301,923,581
2039	340,777,360	681,554,720	1,363,109,440	11,737,779	329,039,581	669,816,941	1,351,371,661
2040	353,137,620	706,275,240	1,412,550,480	11,737,779	341,399,841	694,537,461	1,400,812,701
				NPV, 15%	334,747,196	779,010,268	1,667,536,412
				NPV, 10%	724,099,517	1,595,812,003	3,339,236,973
				NPV, 20%	166,240,537	419,667,996	926,522,914
				IRR	43%	64%	88%

Appendix 4. Benefits and costs of forestry carbon project, high scenario

Year	Carbon benefits (P, 1US$:P44)			Cost (P)	Net carbon benefits (P, 1US$:P44)		
	$5/t CO2	$10/t CO2	$20/t CO2	Total	$5/t CO2	$10/t CO2	$20/t CO2
2011	(8,587,040)	(17,174,080)	(34,348,160)	22,243,528	(30,830,568)	(39,417,608)	(56,591,688)
2012	1,173,480	2,346,960	4,693,920	23,201,057	(22,027,577)	(20,854,097)	(18,507,137)
2013	12,375,220	24,750,440	49,500,880	23,611,019	(11,235,799)	1,139,421	25,889,861
2014	25,007,620	50,015,240	100,030,480	24,294,764	712,856	25,720,476	75,735,716
2015	39,067,380	78,134,760	156,269,520	24,978,509	14,088,871	53,156,251	131,291,011
2016	53,109,100	106,218,200	212,436,400	12,438,885	40,670,215	93,779,315	199,997,515
2017	67,140,480	134,280,960	268,561,920	12,438,885	54,701,595	121,842,075	256,123,035
2018	81,163,060	162,326,120	324,652,240	12,438,885	68,724,175	149,887,235	312,213,355
2019	95,181,680	190,363,360	380,726,720	12,438,885	82,742,795	177,924,475	368,287,835
2020	109,196,120	218,392,240	436,784,480	12,438,885	96,757,235	205,953,355	424,345,595
2021	123,208,140	246,416,280	492,832,560	12,438,885	110,769,255	233,977,395	480,393,675
2022	137,218,400	274,436,800	548,873,600	12,438,885	124,779,515	261,997,915	536,434,715
2023	151,226,460	302,452,920	604,905,840	12,438,885	138,787,575	290,014,035	592,466,955
2024	165,232,760	330,465,520	660,931,040	12,438,885	152,793,875	318,026,635	648,492,155
2025	179,240,160	358,480,320	716,960,640	12,438,885	166,801,275	346,041,435	704,521,755
2026	192,533,660	385,067,320	770,134,640	12,438,885	180,094,775	372,628,435	757,695,755
2027	205,826,940	411,653,880	823,307,760	12,438,885	193,388,055	399,214,995	810,868,875
2028	219,120,880	438,241,760	876,483,520	12,438,885	206,681,995	425,802,875	864,044,635
2029	232,415,480	464,830,960	929,661,920	12,438,885	219,976,595	452,392,075	917,223,035
2030	245,709,860	491,419,720	982,839,440	12,438,885	233,270,975	478,980,835	970,400,555
2031	259,003,800	518,007,600	1,036,015,200	12,438,885	246,564,915	505,568,715	1,023,576,315
2032	272,298,180	544,596,360	1,089,192,720	12,438,885	259,859,295	532,157,475	1,076,753,835
2033	285,591,020	571,182,040	1,142,364,080	12,438,885	273,152,135	558,743,155	1,129,925,195
2034	298,883,420	597,766,840	1,195,533,680	12,438,885	286,444,535	585,327,955	1,183,094,795
2035	312,176,700	624,353,400	1,248,706,800	12,438,885	299,737,815	611,914,515	1,236,267,915
2036	325,468,220	650,936,440	1,301,872,880	12,438,885	313,029,335	638,497,555	1,289,433,995
2037	338,759,740	677,519,480	1,355,038,960	12,438,885	326,320,855	665,080,595	1,342,600,075
2038	352,048,400	704,096,800	1,408,193,600	12,438,885	339,609,515	691,657,915	1,395,754,715
2039	365,337,500	730,675,000	1,461,350,000	12,438,885	352,898,615	718,236,115	1,448,911,115
2040	378,624,620	757,249,240	1,514,498,480	12,438,885	366,185,735	744,810,355	1,502,059,595
				NPV, 15%	349,417,625	817,531,146	1,753,758,188
				NPV, 10%	764,695,264	1,688,736,136	3,536,817,881
				NPV, 20%	170,271,357	435,341,680	965,482,328
				IRR	40%	59%	79%

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