To Burn or Not To Burn: Making the Burning of Chocolate Hills of Bohol, Philippines Carbon Neutral

Nathaniel C. Bantayan, Margaret M. Calderon,
Florencia B. Pulhin, Canesio D. Predo and Rose Ann C. Barruga

WorldFish

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

EEPSEA Research Reports are the outputs of research projects supported by the Economy and Environment Program for Southeast Asia. All have been peer reviewed and edited. In some cases, longer versions may be obtained from the author(s). The key findings of most *EEPSEA Research Reports* are condensed into *EEPSEA Policy Briefs*, which are available for download at www.eepsea.net. EEPSEA also publishes the *EEPSEA Practitioners Series*, case books, special papers that focus on research methodology, and issue papers.

ISBN: 978-971-9994-09-1

Front cover photo credit: dailykimchi

To Burn or not to Burn: Making the Burning of Chocolate Hills of Bohol, Philippines Carbon Neutral

Nathaniel C. Bantayan
Margaret M. Calderon
Florencia B. Pulhin
Canesio D. Predo
Rose Ann C. Barruga

February, 2013

Comments should be sent to:
Dr. Nathaniel C. Bantayan, Institute of Renewable Natural Resources,
College of Forestry and Natural Resources, University of the Philippines Los Baños,
College, Laguna 4031 Philippines
Telefax: 63 49 536 2557
Email: ncbantayan@uplb.edu.ph

The Economy and Environment Program for Southeast Asia (EEPSEA) was established in May 1993 to support research and training in environmental and resource economics. Its objective is to enhance local capacity to undertake the economic analysis of environmental problems and policies. It uses a networking approach that involves attendance in courses and meetings, technical support, access to literature, and opportunities for comparative research. Member countries are Thailand, Malaysia, Indonesia, the Philippines, Vietnam, Cambodia, Lao PDR, China, Myanmar, and Papua New Guinea.

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.

EEPSEA publications are also available online at http://www.eepsea.net.

ACKNOWLEDGMENTS

We would like to thank EEPSEA for providing funding support for this project.

We are also grateful for the support of the University of the Philippines Los Baños Foundation, Inc. and the leadership of UPLB , especially Chancellor Dr. Luis Rey I. Velasco, CFNR Dean Dr. Rex Victor O. Cruz, and Institute of Renewable Natural Resources Director Dr. Enrique L. Tolentino, Jr.

We would also like to thank Dr. Theresa Mundita S. Lim, Director of Protected Areas and Wildlife Bureau (PAWB); Dr. Adeluisa G. Siapno, Director of Ecosystem Research and Development Bureau (ERDB); and Mr. Leonardo R. Sibbaluca, Regional Executive Director of DENR-Region 7 for their support.

Our gratitude also goes to Bohol Governor Erico B. Aumentado; Mr. Renato C. Villaber, Deputy Head of Bohol Environment Management Office (BEMO); Ms. Josephine Cabarrus of the Bohol Tourism Office; Tomas Reyes of Bohol Island State University; the Municipal Planning and Development Officers, Mr. Rizalino S. Canda, Mr. Fermin L. Balili and Mr. Maximo G. Lomosbog of Batuan, Carmen and Sagbayan, respectively; Ms. Feliza Juliet Torralba of Carmen Tourism Office; Ms. Jesuselda Lagare, Operations Manager of Chocolate Hills Complex Hotel and Restaurant; and the barangay captains, farmers, tourists, and other stakeholders who participated in our key informant interviews, workshops, and surveys.

Many thanks to CHNM Protected Area Superintendent (PASu) Forester Marcial Ugay; the people of Batuan and its mayor, Hon. Gregoria D. Pepito, the people of Carmen and its mayor Hon. Manuel R. Molina; and the people of Sagbayan and its mayor Hon. Jimmy R. Torrefranca.

NCBantayan
MMCalderon
FBPulhin
CDPredo
RACBarruga

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

TO BURN OR NOT TO BURN: MAKING THE BURNING OF CHOCOLATE HILLS OF BOHOL, PHILIPPINES CARBON NEUTRAL

Nathaniel C. Bantayan, Margaret M. Calderon, Florencia B. Pulhin,
Canesio D. Predo and Rose Ann Barruga

EXECUTIVE SUMMARY

This study was conducted to evaluate the current management regime of burning vis-à-vis burning with carbon offsets for the Chocolate Hills Natural Monument (CHNM) in Bohol, Philippines. The current scheme of burning to maintain the grass-covered (tree-less) and brown hills to sustain tourist arrivals is seen as environmentally unsound and inconsistent with existing environmental laws. The study estimated the carbon loss from burning and compared the carbon loss value with the tourism income of the Chocolate Hills under the status quo with the end view of evaluating a carbon offset project as an alternative management scheme. A comparison of the benefits and costs of the status quo and the proposed management regime was conducted. Based on these assessments, policy recommendations were drawn up for consideration by the CHNM management.

Historically, the hills of CHNM were burned for the grazing of animals. This made the hills' landscape visually appealing and consequently attractive to tourists. However, when it was declared as a protected area (PA), burning of the hills was discouraged. Tree species, mostly indigenous, were allowed to grow in the hills characteristic of natural regeneration. This resulted to the loss of the unique hill landscape preferred by tourists. Such situation created a divide between the tourism office and the Protected Area Management Board (PAMB). The tourism office, managed by the local government of Carmen, wanted to maintain the hills bare for tourism, while the PAMB of CHNM is mandated to ensure compliance to environmental laws such as the ban on burning.

This study evaluated the establishment of a carbon offset project to make up for the carbon loss if a certain number of hills were burned to maintain their tourism value.

The vegetation and biomass analysis and the carbon study showed that an estimated 153 ha of forest should be established to offset the carbon emission due to the clearing of such hills. This means that the carbon offset project will require the establishment of one hectare of forest for every two hills cleared. The cost of forestation could be supported by income from tourism in a form and manner that directly involve the community.

The study found that the present value of tourism income was very much higher than the cost of carbon emission due to burning. The study recommends that the PAMB consider establishing a carbon offset project to make the current management practice carbon neutral.

1.0 INTRODUCTION

1.1 Rationale

The Chocolate Hills of Bohol is one of the Philippines' top tourist destinations. The hills' unique landscape – brown in summer and green the rest of the year -may seem to be nature's scenic design. However, during a visit to the place in 2007, we witnessed what we learned later was a regular practice to keep the grass vegetation of the hills. The hills are burned to prevent trees from growing. The practice is allowed on a limited scale by the Protected Area Management Board (PAMB), which oversees the Chocolate Hills Natural Monument (CHNM).

What are the effects of wildfires on the economic value of outdoor recreation? Englin et al. (2009)[1] found that recreation demand changed following large wildfires although the direction (increase or decrease) was not definitive. The same study suggested on-site surveys to better understand visitor preference. The CHNM's management presumes that tourists prefer the hills to be covered with grasses that turn brown in summer. However, it is possible that tourists may simply be fascinated by the hill formations that are as beautiful when they are green.

Regular burning of the Hills to preserve the grassland vegetation translates to tampering with the natural course of succession. Clements (1916 as cited by Daniel et al., 1980) is recognized to have conceptualized the successional changes in plant communities through time. He theorized that for a given microclimate and site, the interactions among soil, plants, and climate will lead to a plant community that is so adapted to its environment that it will be able to withstand competition from any outside species. Such a community is called a climatic climax.

For there to be a climatic climax, mature soil, stable climate, and no disturbance are required (Daniel et al. 1980). These requirements are not likely to occur over a considerable space or time, but climatic climaxes do exist. However, a disturbance in an area can set back succession to an earlier stage. With regular disturbances, the development of the complete cycle of an area from being barren to a climax formation, known as the sere, may take longer compared to an area without disturbances.

The Hills already support higher forms of vegetation. This is evidenced by many of the other hills now being covered by shrubs and small trees, mainly pioneer tree species, instead of grass. Aside from interfering with natural succession, the practice of regularly burning the hills also produces carbon emissions and may adversely affect the biodiversity in the area. However, Englin et al. (2009) also cited beneficial effects of burning. These include reducing fuel loads, mimicking natural processes (i.e., forest regeneration and succession after a wildfire), or 'observing the effects of wildfire on natural processes in fire-adapted ecosystems.' Considering the varied claims, this study was an opportunity to understand better the ecological dynamics in the management regimes of the Hills.

1.2 Description of the Project Area

The CHNM has always been a favorite destination of tourists in the island province of Bohol. The hills are spread in the middle of the island in six municipalities, namely: Carmen, Sagbayan, Batuan, Bilar, Valencia, and Sierra Bullones. But a magnificent view can be seen from the view deck of the Chocolate Hills Complex (CHC) in the municipality of Carmen.

To this day, there is no consensus yet among geologists as to the origin of the Chocolate Hills[2], but several legends abound on how the hills have been formed. The most commonly accepted theory, however, is that the Hills used to be underwater, as evidenced by their marine limestone material. In fact, the hills, which are technically called *kegelkarst* or cone karst, represent one of the world's premier cone karst environments (Urich et al., 2001).

The 1,776 hills complex was declared as a natural monument through Proclamation No 1037 on July 1, 1997. However, as early as 1993, the local government had already realized the need for a management committee to oversee all the activities and projects in the operations of CHC. During the same year, the provincial treasurer was granted the power to charge directly to the income derived from the CHC any purchase of equipment, maintenance, and other incidental expenditures in the operation of the complex.

Likewise, the management and operation of the CHC was awarded to the municipality of Carmen on July 16, 1993 with a memorandum of agreement between the province of Bohol and the municipality of Carmen through Provincial Resolution No. 307, Series of 1993. Realizing that there were no data on the Hills, the provincial committees on tourism and on environmental protection requested the DENR's National Committee on Geological Sciences to identify the 1,268[3] hills and also their metes and bounds through

[1] http://www.srs.fs.usda.gov/pubs/ja/ja_englin003.pdf
[2] http://www.bohol.ph
[3] Estimated number before the proclamation

Provincial Resolution No. 199, Series of 1995. On July 28, 1995, the National Committee on Geological Sciences accomplished this task.

Provincial Resolution No. 292, Series of 1997 was issued on June 20, 1997 requesting the Philippine Congress to enact laws imposing stiffer penalties on the plunder of the Chocolate Hills and to declare the said tourist spot as a National Geological Monument, which is part of National Patrimony. To further strengthen this resolution, Provincial Resolution Nos. 182, 183 and 184, Series of 1997, were enacted on April 11, 1997.Resolution No. 182 requested the Provincial Governor to refrain from issuing permits for the extraction of quarry materials in 32 barangays identified by the DENR as the places where the Chocolate Hills complex is located. Resolution No. 183, on one hand, called for the creation of a special committee of the Sangguniang Panlalawigan to study possible legislative measures to protect and preserve the Hills. Resolution No. 184enjoined all concerned Sangguniang Pambarangays to enact an ordinance prohibiting the destruction of the Chocolate Hills located in their respective areas of jurisdiction.

Accordingly, Presidential Proclamation No.1037 in 1997established the areas within, around, and surrounding the CHNM as a Natural Monument. The proclamation aimed to protect and maintain the Hills' natural beauty and to provide restraining mechanisms for inappropriate exploitation. Further, the proclamation states that "regardless of the existence of prior vested rights, no activity of any kind including quarrying, which will alter, mutilate, deface, or destroy the hills shall be conducted and the proclaimed area shall be under the administrative jurisdiction, supervision, and control of the DENR, which shall coordinate with other government agencies and the local government units (LGUs) with the objective of maintaining and protecting the Chocolate Hills' natural features for tourism, scientific, educational and recreational purposes."

Substantial amendments to Presidential Proclamation No. 1037 were later made in 2003 to respond to complaints regarding the loss of livelihood and the stability of peace and order in the Hills. Thus, on February 28, 2003, Presidential Proclamation No. 333 excluded alienable and disposable flat lands in between hills as subject to actual ground delineation. Due to lack of funds, however, actual ground delineation has yet to be implemented.

2.0 THE RESEARCH PROBLEM

Proclamation No. 333, which amended Proclamation No. 1037, placed the Hills under government control but excluded lands that are alienable and disposable (A&D)[4] in flat and rolling lands below 18% slope. However, the law retained the provision that *regardless of the existence of prior private rights, no activity of any kind which will alter, mutilate, deface or destroy the Hills, including but not limited to quarrying, shall be allowed*. In effect, the Hills shall be *under the administrative jurisdiction, supervision, and control of the DENR, which shall coordinate with other national government agencies and local government units with the objective of maintaining and protecting the CHNM's natural features for tourism, scientific, educational, and recreational purposes*.

To appreciate their "chocolateness", the Hills are best seen during summer, when the grasses dry out and turn brown. One would think that this is what nature had intended for the Hills – to be always covered with grass– such that it appears green during the rainy season and brown during the summer months. However, during a visit to the place in 2007, we witnessed what we learned was a regular practice to keep the grass vegetation of the hills. The hills are burned to prevent trees from growing. And the DENR-Protected Area Management Board (PAMB) allows the practice on a limited scale.

In a study on the effects of wildfires on the economic value of outdoor recreation, Englin et al. (2009)[5] found that recreation demand changed following large wildfires. However, the direction - increase or decrease-was not definitive. The same study suggested on-site surveys to better understand visitor preference. The CHNM management, for instance, presumed that tourists prefer the hills to be covered with grasses that turn brown in summer. However, tourists may also be simply fascinated by the hill formations that are as beautiful when they are green.

[4]Private lands
[5]http://www.srs.fs.usda.gov/pubs/ja/ja_englin003.pdf

Regular burning of some of the Hills to preserve the grassland vegetation translates to tampering with the natural course of succession. The successional changes in plant communities through time were conceptualized by Clements (1916 as cited by Daniel et al., 1980). He theorized that for a given microclimate and site, the interactions among soil, plants, and climate will lead to a plant community that is so adapted to its environment and will be able to withstand competition from any outside species. Such a community is called a climatic climax. By this time, the Hills can already support higher forms of vegetation as evidenced by many of the other hills covered by shrubs and small trees, presumably pioneer tree species.

Aside from interfering with natural succession, regularly burning the hills also produces carbon emissions and may adversely affect the biodiversity in the area. Nevertheless, Englin et al. (2009) cited also the beneficial effects of burning. They said that burning reduces fuel loads and mimics natural processes (i.e., forest regeneration and succession after a wildfire).

This study enables us to 'observe the effects of wildfire on natural processes in fire-adapted ecosystems.' It also provides us an opportunity to understand better the ecological dynamics in the management regimes of the Hills.

2.1 Research Objectives

The study aimed to evaluate the current management regime of burning vis-à-vis a proposed one (burning with carbon offsets) for the CHNM in Bohol, Philippines.

Specifically, the study aimed to:

1. estimate the carbon loss from the burning practice of the Chocolate Hills;
2. compare the carbon loss value with the income from tourism of the Chocolate Hills under the status quo;
3. assess the potential of establishing carbon offset projects to make the current management regime carbon neutral;
4. compare the costs and benefits of the status quo and draw up the proposed management regimes; and
5. propose policy recommendations for the sustainable management of the CHNM.

2.2 Conceptual Framework

This study evaluated if a carbon offset project could offer a way to protect the environment while providing income to the CHNM managers from tourism revenues. The study was guided by the conceptual framework presented in Figure 1.

To provide baseline information, a resource and use assessment of the hills was first conducted. The carbon loss from the burning practice of the Chocolate Hills was compared with the loss value of the tourism income from the Chocolate Hills under the status quo. These results became the basis for evaluating an alternative carbon offset project. It is hypothesized that a carbon offset project will make the current practice of burning the hills acceptable from the social, environmental, and economic points of view. A cost benefit analysis of the two management regimes (i.e., status quo and proposed carbon offset project) was also done.

The study did not directly measure some environmental parameters such as carbon emission from the burning of grass and other vegetation. But biophysical assessment for biomass density analysis was conducted in connection with the site characterization. The hydrologic and geologic features of the study area were inferred from secondary data.

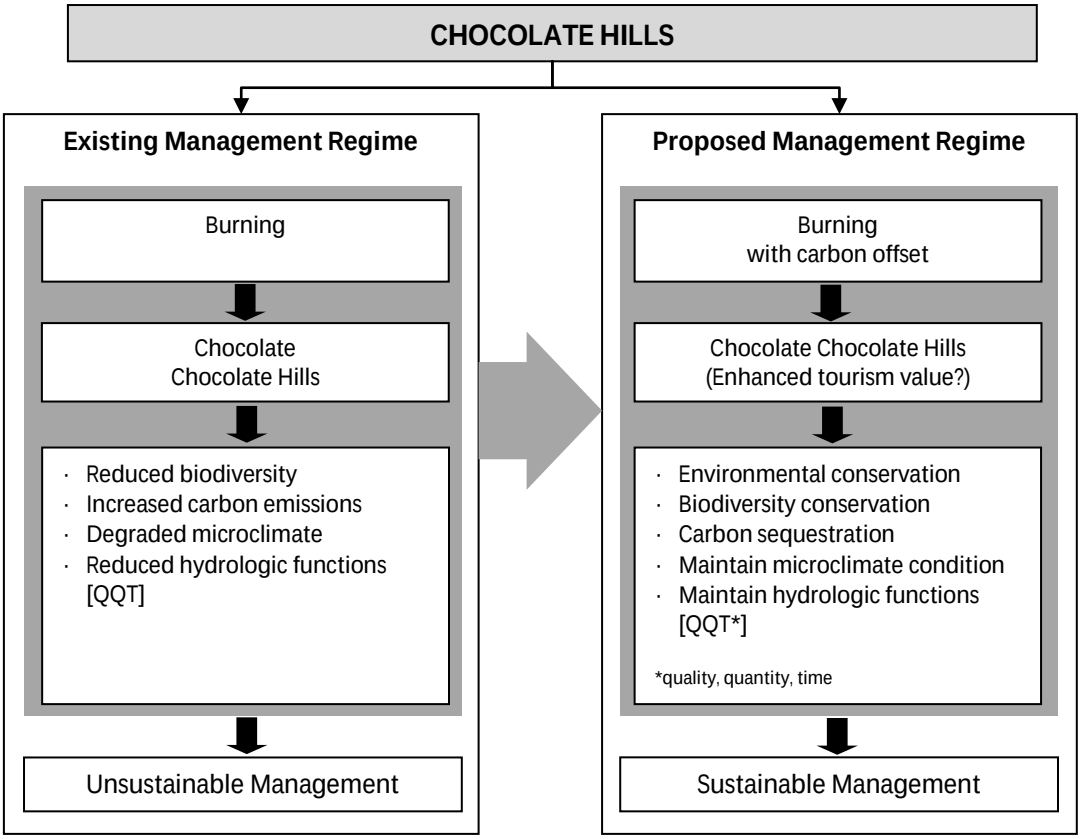

Figure 1. Conceptual framework of the study

3.0 RESEARCH METHODS

The study sought to answer the following questions:

1. What are the current management practices in the Chocolate Hills?
2. What are the property rights regime and land use practices in the area?
3. What are the benefits that local people derive from the CHNM?
4. What are the costs and benefits of the current management regime of the Hills that allow burning of some hills and the alternative method of allowing burning with carbon offsets?

In order to answer these questions, the biophysical situation, carbon stocks, and socio-economic status were assessed. Secondary data such as records on land ownership and property rights were analyzed. Baseline information including maps, reports, and other statistics about the Chocolate Hills were gathered from the Chocolate Hills Complex, local government units (LGU), Department of Tourism (DOT), Department of Environment and Natural Resources (DENR), and other relevant agencies and institutions that implement programs focusing on the Chocolate Hills.

Focus group discussions (FGD) and key informant interviews (KI) with key stakeholders were conducted to generate baseline information about land management practices, policies, and government agencies' priorities about the environment and tourism. Representatives and stakeholders from the Chocolate Hills Complex, LGU, DOT, DENR, and other agencies and institutions that implement programs on the Chocolate Hills were interviewed to gather data on the management regime and the extent of burning of the Chocolate Hills. Data gathered included information on the landowners (household survey); size of land holdings; reasons and benefits (if any) from burning of some hills; and abiding or not with the prescribed land uses by the landowners.

3.1 Biophysical Assessment

The area was assessed biophysically using existing maps and reports, databases, and GPS[6]-assisted survey methods. Representative hills with and without burning were chosen to compare their floral diversity and biomass density. Data on land cover and land use gathered from the field were augmented with available secondary data, specifically from LGUs and national government agencies. GPS-based field inventory techniques as outlined in Bantayan (2006) were used in the biophysical assessment. On each hill, two survey plots were established (Figure 2). Each plot was circular with a center that is GPS-located. From a radius of 5 m and 10 m from the plot center, all vegetation occurrences and trees with a minimum diameter of 15 cm, respectively, were plotted.

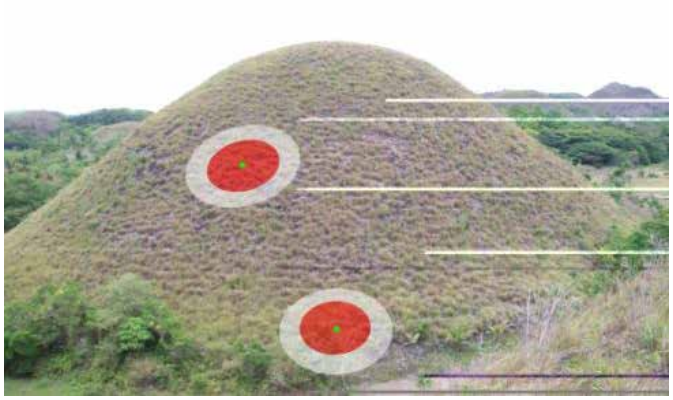

Figure 2. Survey plots in Chocolate Hills for biophysical assessment

Other data like geology, topography, soils, and other physiographical characteristics were generated from the Bureau of Soils and Water Management (DA-BSWM)[7], Mines and Geosciences Bureau (DENR-MGB)[8], National Mapping and Resources Information Authority (NAMRIA),[9] and other agencies. The dataset included data and information layers such as: land cover including vegetative condition; land use including rivers and other water bodies, road network, agriculture, and population centers; and topography and slope, geology and soils.

3.2 Carbon Stocks Assessment

From a selected number of hills, the amount of carbon stored in CHNM with three different types of cover: (1) hills with 100% trees; (2) hills with 100% grass; and (3) hills with 20% trees were assessed. Their distribution was as follows:

- 10 hills with 100% trees: Carmen (3); Batuan (4) and Sagbayan (3)
- 5 hills with 100% grass: Carmen (3); Batuan (1) and Sagbayan (1)
- 5 hills with 20% trees (all in Carmen)

On hills with 100% trees, various carbon pools were measured: trees, understorey vegetation, litter, and soil. The method used involved a combination of destructive sampling for trees measuring ≤5 cm and non-destructive sampling for trees > 5 cm.

On hills with 100% grass, carbon pools measured included grasses and soil. On hills with 20% trees, carbon pools evaluated were trees, grass, and soil. Similar to those hills with 100% trees, destructive sampling was used for trees with dbh ≤5 cm and non-destructive sampling for trees > 5 cm.

[6] GPS – global positioning system
[7] Attached agency under the Department of Agriculture (DA)
[8] Line agency under the Department of Environment and Natural Resources (DENR)
[9] Attached agency of the DENR

Tree biomass

On hills with 100% trees and 20% trees, sample plots measuring 5m x 40m were established. All trees present inside the sample plot with diameter at breast height of ≥ 5 cm were enumerated and identified. On hills where there were trees with dbh>30 cm, additional 20 m x 100 m plots were laid out, whether or not trees were included in the sample plots established.

Understorey and herbaceous vegetation

Four frames measuring 1m x 1m were laid out inside the 5m x 40m plots on hills with 100% trees. Random numbers were generated to determine the location of the subplots. All herbaceous and woody vegetation (less than 5 cm dbh) inside the frame were collected. Prior to oven drying, the fresh weight of the samples was determined.

Litter

Inside the same sampling frames used for measuring understorey and herbaceous vegetation, a 0.5 m x 0.5 m transect was established for litter collection. Total fresh weight of all the samples were taken after which about 300 grams was reserved for air and oven drying. Samples were dried inside the oven with a temperature of ± 102°C for at least 48 hours or until their weight became constant.

Grass

In each of the hills with 100% grass and 20% trees, 2m x 2m sampling frames were laid on the ground. Grasses inside the sampling frames were harvested to determine their biomass. Similar to understorey and litter, fresh samples were weighed and a sample of 300 grams was set aside for oven drying.

Soil organic carbon

Soil samples were collected within the sample plots of all the hills at 30 cm depth. Samples were air dried and taken to the Soils Laboratory of the Soil Science Department of the College of Agriculture, University of the Philippines Los Baños (UPLB) for analysis.

To determine bulk density, samples were collected using a ring metal with a height of 10 cm, and diameter of 3 cm at 20-30 cm depth.

Biomass calculation

Tree biomass was calculated using the following allometric equations (Brown, 1997):

Y (kg) =EXP(-2.134+2.53*LN(D), for trees with dbh< 60 cm (Equation 1)

Y (kg) = 42.62-12.8*(D) + 1.242*(D)2, for trees with dbh 60-148 cm (Equation 2)

Where:
Y = biomass (kg)
D = diameter of the tree at breast height

Biomass values for litter, understory, and grass were calculated using the following formula:

$$ODWt = TFW - \frac{(TFW * (SFW - SODW))}{SFW}$$

Where:
ODW = total oven dry weight
TFW = total fresh weight
SFW = sample fresh weight
SODW = sample oven-dry weight

Carbon density calculation

Carbon density was computed using the formula below:

C Density = Biomass Density x %Carbon

3.3 Socio-Economic Assessment

3.3.1 Household survey and key informant interviews

A household survey was conducted among residents of selected municipalities of Carmen, Batuan, and Sagbayan, which have areas of the Chocolate Hills. The nine barangays in the survey were selected through systematic random sampling. The survey aimed to evaluate the land use practices and benefits that residents derive from the CHNM. Using the same selection method, a total of 250 respondents were selected and interviewed from March to April, 2010 (Carmen - 78; Batuan- 74; Sagbayan- 98).

Key informant interviews were conducted with key officials of various government offices in Bohol, such as the Bohol Tourism Officer, Protected Area Superintendent, Mayor of Carmen, Municipal Planning and Development Officers (MPDO) of Batuan and Sagbayan, Operations Manager of the Chocolate Hills Complex, and the Barangay Captain of Buenos Aires, Carmen.

Likewise, key informant interviews involving 33 tourists were conducted at the Chocolate Hills Complex to determine the characteristics of the Chocolate Hills that were important to the visitors, as well as their perceptions about the place's management practices.

3.3.2 Property rights and land use practices in the area

The property rights regime and land use practices in the area were gathered from secondary data, key informant interviews, and the household survey. Literature and other records, particularly ordinances and policy issuances, were collected and analyzed.

3.4 Cost-benefit analysis

Based on the biophysical and carbon stocks assessments, a cost-benefit analysis (CBA) was undertaken to compare the proposed policy alternative against the *status quo* or the base case. The alternative policy involves allowing burning of some hills with carbon offsets, while the base case allows burning of some hills that are in the immediate vicinity of the Chocolate Hills Complex.

In the evaluation, the benefits and costs were considered at two levels: the private land owners who own some of the hills that may be affected by the policy, and the provincial/ national government.

For the base case, the benefits were in the form of entrance fee revenues (for the local government) and business revenues (for the business sector) derived from tourism in the area. On the other hand, the costs came from the environmental cost of carbon emissions due to burning. For the carbon offset project, benefits would still come from entrance fee revenues, business revenues, carbon offset benefits, and timber revenues. The costs would come from the establishment and maintenance of the carbon offset plantations as well as from the carbon emission from burning that would still be allowed.

The net present values (NPV) of the two cases were estimated under scenarios of one rotation and perpetual rotations using discount rates of 10% and 15% and prices of USD5, USD10, and USD20[10] per tC.

[10] USD1:PhP5

4.0 RESULTS AND DISCUSSION

4.1 Biophysical Assessment

Expectedly, the geology of the CHNM is mostly composed of limestone origin specifically Maribojoc limestone (Figure 3a). Some portions of the CHNM on the east is composed of Carmen formation (i.e., sandstone, conglomerate, shale, and marl) and Sierra bullones limestone on its southern tip (Urich, 2001). In terms of soils (Figure 3b), about 72% of the CHNM is composed of Batuan Faraon Complex soils, again attributable to its geologic origin. The rest of the soils are more or less evenly spread except for Batuan clay at 13% (Table 1), which can be found in the towns of Batuan and Bilar

Table1. Distribution of soils in CHNM

Municipality	Bantog Clay	Batuan Clay	Batuan-Faraon Complex	Bolinao Clay	Faraon Complex	Inabanga Clay	Sevilla Clay	Ubay Clay	Un-classified
Batuan	-	1,188	2,708	-	-	-	238	-	8
Carmen	16	-	3,162	-	187	-	-	468	252
Sagbayan	-	-	3,365	167	-	136			-
Bilar	-	651	684	-	-	-	-	-	-
Sierra Bullones	-	-	-	-	-	-	-	115	-
Valencia	-	-	206	-	242	-	-	331	-
Total and %	**16 (0.1%)**	**1839 (13%)**	**10,124 (72%)**	**167 (1%)**	**429 (3%)**	**136 (1%)**	**238 (2%)**	**914 (6%)**	**260 (2%)**

The elevation range in the CHNM is characteristic of this part of the island, which is described as a plateau-like limestone (Urich, 2001). The minimum and maximum elevations estimated are 125 m and 530 m above sea level, respectively. Majority of the elevations (61%) fall within the range of 200-300m elevation (see Figure 4a; Table 2).

In addition, the slope in the study area is ideal for agriculture where an estimated 85% belong to slopes 18% and below (Figure 4b; Table 3). The rest of the area is above 18% slope (13% between 18% and 50% slope and 2% above 50% slope).

Table 2. Elevation range in meters above sea level inside the CHNM

Municipality (in ha)	Elevation (m)				
	100-200	200-300	300-400	400-500	500-600
Batuan	253	2,594	1,102	194	-
Carmen	67	1,619	1,440	958	-
Sagbayan	83	3,508	16	0	-
Bilar	-	890	379	65	-
Sierra Bullones	-	-	21	95	-
Valencia	-	-	-	-	720
Total and %	**403 (3%)**	**7,722 (61%)**	**2,579 (21%)**	**1,247 (9%)**	**720 (5%)**

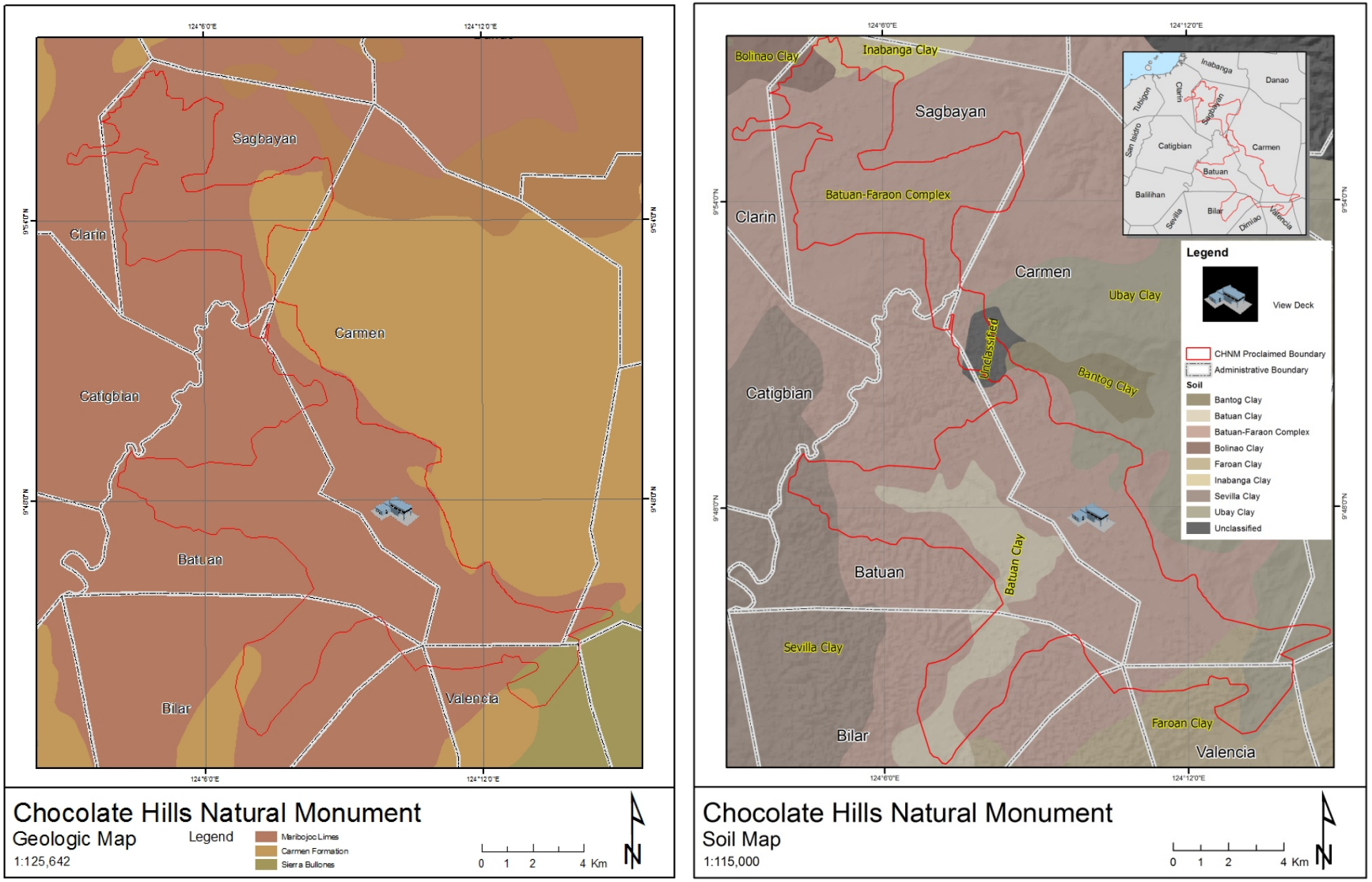

Figure 3. Geologic (left) and soil (right) maps of CHNM

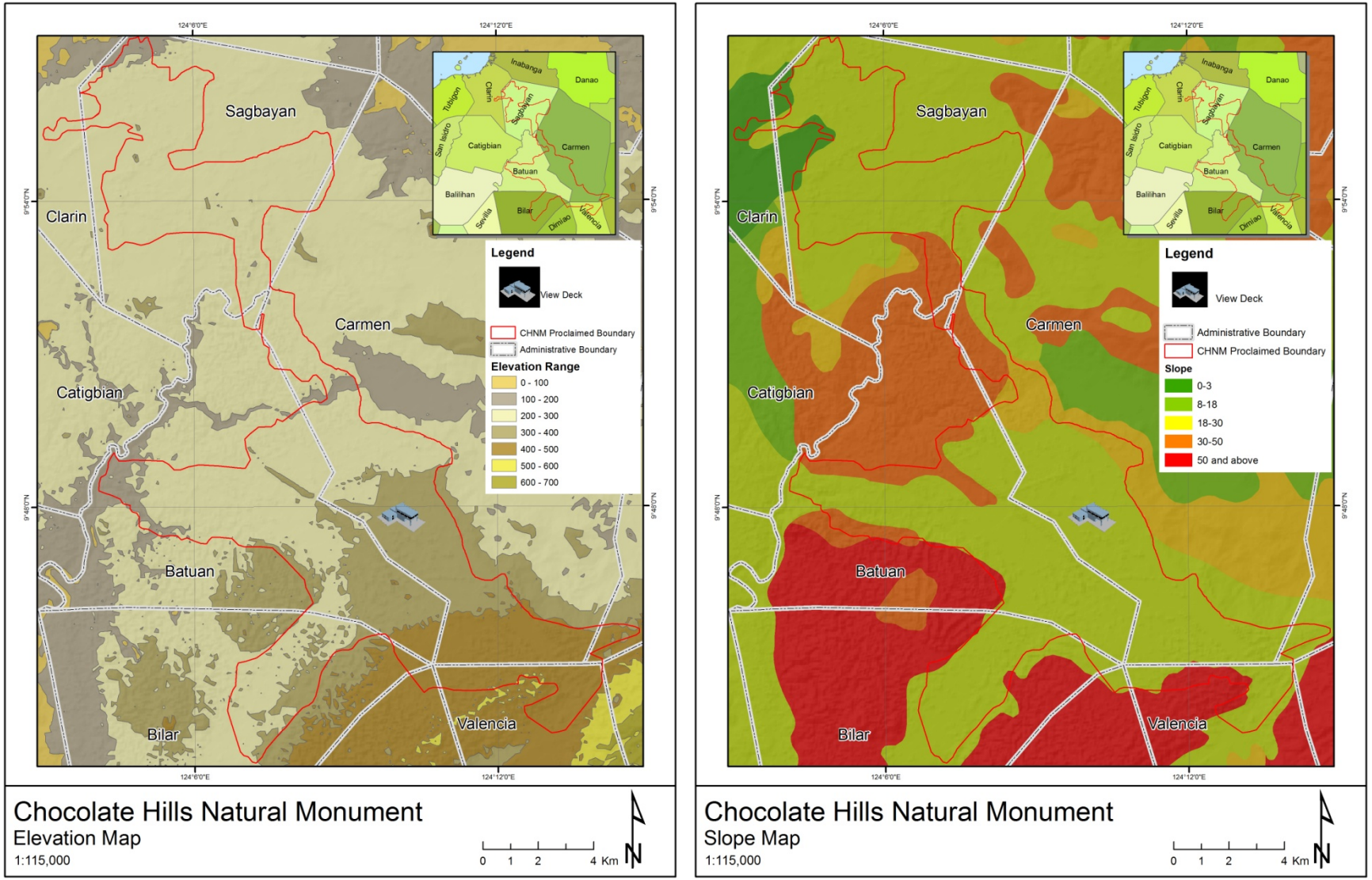

Figure 4. Elevation (left) and slope (right) maps of the CHNM

Table 3. Distribution of slopes inside the CHNM [Values are in ha]

Municipality (in ha)	Slope		
	0 - 18%	18-50%	above 50%
Batuan	3,359	727	57
Bilar	1,296	-	38
Carmen	3,277	803	5
Sagbayan	3,404	264	-
Sierra Bullones	115	-	-
Valencia	566	-	213
Total and %	**12,017 (85%)**	**1,794 (13%)**	**313 (2%)**

Figure 5a (see also Table 4) shows the land cover of the CHNM. Based on available secondary data, 95% is devoted to agriculture, while only about 2% and 3% are devoted to forest (on the western and southern portions) and to other uses (e.g., roads, infrastructure, settlements), respectively. At the same time, before Proclamation 1037 was promulgated, 77% of CHNM was privately-owned, while only 23% were categorized as forest land or belonging to the state. With such a declaration, all lands inside the CHNM reverted to the government, hence igniting social unrest. This prompted the government to rescind and issue an amendment (i.e.,Proclamation 333), thus excluding alienable and disposable flat lands in between hills subject to actual ground delineation. To date, actual ground delineation has yet to be implemented.

Table 4. Land cover and legal land classification in the CHNM

Municipality (in ha)	Land cover and land use			Legal land classification	
	Forest	Agriculture	Other uses	A&D	Forestland
Batuan	-	3,990.8	152	3,494	649
Bilar	105	1,108.6	121	472	863
Carmen	40	3,920	124	3,041	1,044
Sagbayan	-	3,667	-	3,543	124
Sierra Bullones	22	93	-	4	111
Valencia	117	662	-	323	456
Total and %	**284 (2%)**	**13,442 (95%)**	**397 (3%)**	**10,876 (77%)**	**3,247 (23%)**

Note: A&D means alienable and disposable

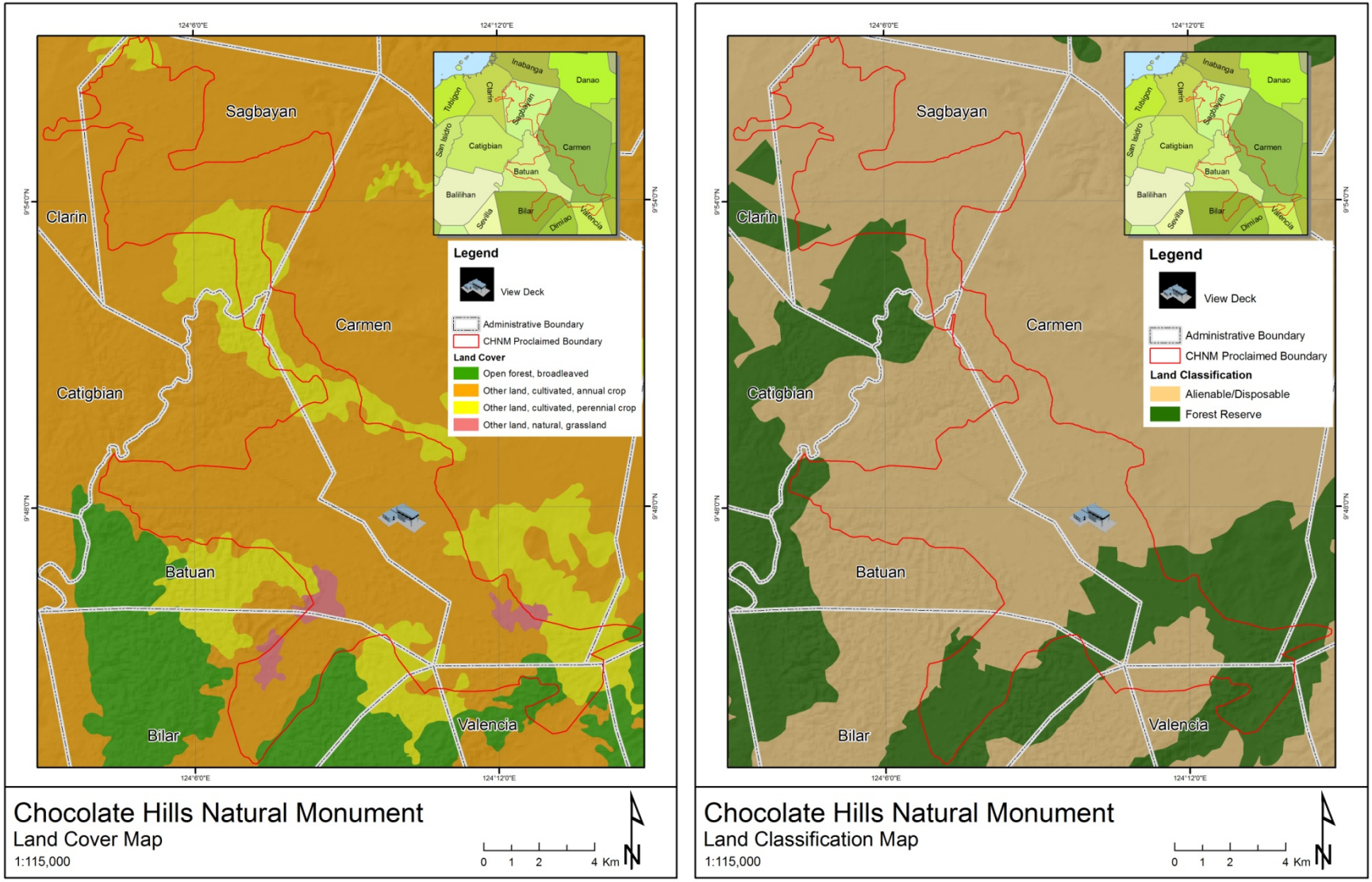

Figure 5. Land cover (left) and legal land classification (right) maps of the CHNM

Vegetation Analysis

A total of 123 randomly selected hills in the towns of Carmen, Batuan, and Sagbayan were analyzed. Of this number, 20 hills were evaluated specifically for carbon stock assessment following the evaluation methods described in Section 3.2.Of the remaining 103 hills, two plots on each hill (uphill and downhill) were established where vegetation was surveyed and analyzed in terms of height (in m), DBH (diameter at breast height in cm), and species. There were 200 plots established (since 12 hills shared uphill plots) following evaluation methods described in section IIIC. All in all, a total of 220 plots were established.

The study identified a total of 2,565 species belonging to 69 species of plants. Of these species, 49 species were found to be indigenous to Bohol, while 20 species were exotic. In all the towns surveyed, indigenous plants dominated (Figure 6 and Table 5). The top 20 species in terms of occurrence are shown in Table 6.

The study also found that of the 103 hills surveyed, more hills were forested (81) than covered with grass (22). This is true in all the towns visited (Table 7). Moreover, the results show that younger plants dominate the area (i.e., higher number of plants in lower diameter classes and lower height classes) (Tables 8 and 9). This is indicative of the early stages of succession where pioneer species are starting to populate the area.

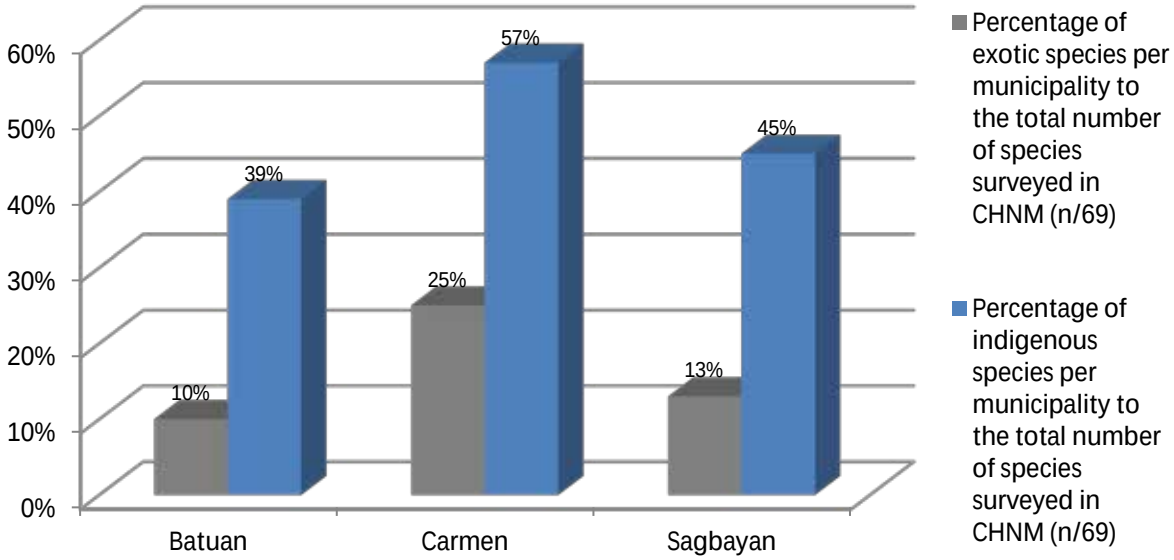

Figure 6. Percentage of exotic and indigenous species

Table 5. Vegetation in the CHNM

Vegetation	Municipality			
	Batuan	Carmen	Sagbayan	Total
Exotic	202	727	281	1210
Indigenous	228	771	356	1355
Total	**430**	**1498**	**637**	**2565**

Table 6. Top 20 species in the CHNM

Scientific Name	Common Name	Total
Swietenia macrophylla King	Mahogany	770
Cocosnucifera L.	Niog	293
Gmelina arborea Roxb.	Gmelina	243
Musa acuminate Colla	Saging	172
Heterospathe elata Scheff.	Saguisi	154
Leucaenal eucocephala (Lam.) de Wit	Ipil-ipil	108
Imperata cylindrica(L.) Beauv.	Cogon	101
Vitex parvifloraJuss.	Molave	74
Bambusa vulgaris Schrad.	Kawayan	70
Nauclea orientalis (L.) L.	Bangkal	62
Koordersiodendron pinnatum (Blanco) Skeels	Amugis	52
Endospermum peltatum Merr.	Gubas	42
Artocarpus blancoi (Elmer) Merr.	Antipolo	39
Hopea foxwothyi Elmer	Daling-dingan	39
Diplazium esculentum (Retz.) Sw.	Pako	32
Caryota rumphiana Mart. var. philippinensis Becc.	Takipan	30
Ficusseptica Burm. f.	Hauili	24
Kingiodendron alternifolium(Elmer) Merr. & Rolfe	Balite	21
Gliricidia sepium(Jacq.) Kunth ex Walp.	Kakauate	21
Bischofia javanica Blume	Tuai	19

Table 7. Comparison of plots in the CHNM

Plot Condition		Forested	Grass
Carmen	Uphill[11]	40	9
Batuan		17	7
Sagbayan		24	6
Sub Total		**81**	**22**
Carmen	Downhill[12]	41	4
Batuan		22	1
Sagbayan		29	0
Sub Total		**92**	**5**
Total		**173**	**27**

[11]Also termed Higher
[12]Also termed Lower

Table 8. Diameter classes of plants in the CHNM

DBH class (cm)	Municipality			
	Batuan	Carmen	Sagbayan	Total
Below 15	275	834	344	1453
16-25	134	471	210	815
26-35	21	189	83	293
36-45	0	4	0	4
Total	**430**	**1498**	**637**	**2565**

Table 9. Height classes of plants in the CHNM

Height class (m)	Municipality			
	Batuan	Carmen	Sagbayan	Total
0-4	236	732	299	1267
5-8	26	295	61	382
9-12	137	346	218	701
13 above	31	125	59	215
Total	**430**	**1498**	**637**	**2565**

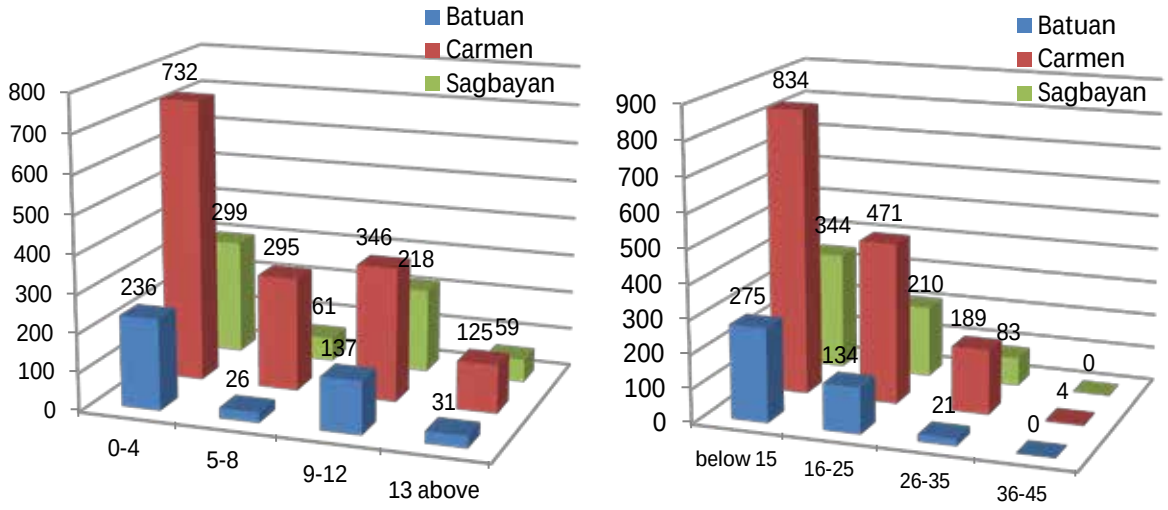

Figure 7. Vegetation height (left) and DBH (right) distribution of plants in the CHNM

4.2 Carbon Stocks Assessment

Hills with 100% trees

Carbon densities of hills with 100% trees range from 50.85 t/ha to 117.01 t/ha or an average of 74.34 t/ha (Figure 8). The highest carbon density was observed at the sampled hill in Poblacion, Sagbayan, while the lowest carbon density was noted at the sampled hill in Rosariohan, Batuan. This can be attributed to the presence of quite a number of relatively big trees in the sampled hill in Poblacion, Sagbayan. A total of 12

trees measured in the said hill had a diameter range (dbh) of 30.5 cm to 64.2 cm. Two trees sampled hill in Rosariohan had a diameter range of only 30.5 cm and 41.5 cm.

Large percentage of the total carbon stored in the hills was found in the trees and soil (Figure 9). The trees contributed around 44-68%, while the soil contained 30-54% of the total carbon stored. This result was consistent with that of previous studies regardless of the types of forests examined.

Aside from absorbing large amounts of carbon, soil had the longest residence time among the organic carbon pools in the forest (Lugo and Brown, 1993). Compared with vegetation, soil held carbon at longer periods of time. Thus, Bouwman (1989cited by Lugo and Brown, 1993) stressed that soil has big potential to become significant sinks and sources of carbon.

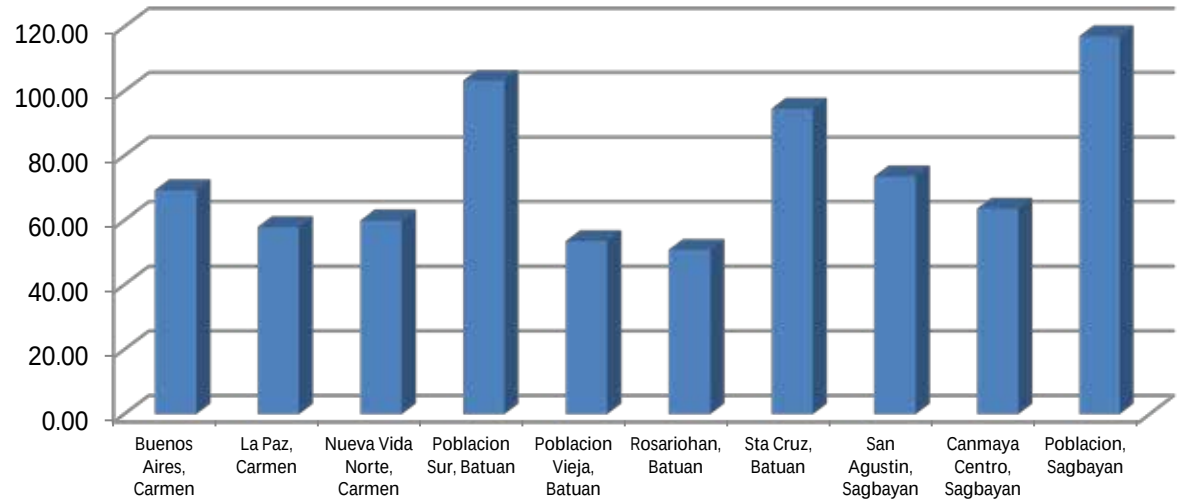

Figure 8. Carbon density of hills with 100% trees

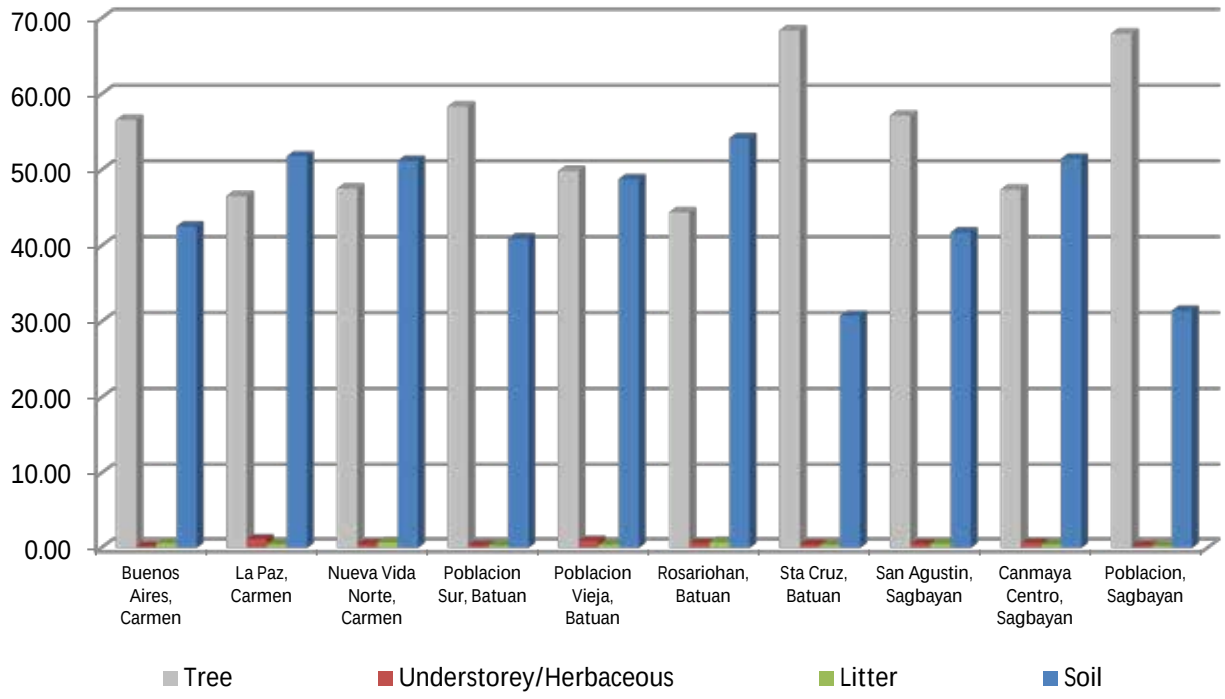

Figure 9. Percent contribution of the different carbon pools in the hills with 100% trees

Lugo and Brown (1993) said that the capacity of the soil to store soil organic carbon is influenced by a number of factors, namely: (1) mean annual precipitation; (2) degree of forest disturbance; and (3) extent of land use change. Birdsey (1992) reported that conversion of forests to agriculture production reduced carbon content by 40%.

Litter and understorey both shared a small portion of the total amount of carbon stored in the hills examined. Litter and understorey/herbaceous contributed around 0.29-0.78 t/ha and 0.21-1.15 t/ha, respectively.

Hills with 100% grass

Hills with 100% grass had carbon densities ranging from 0.91 t/ha to 4.03 t/ha or an average of 2.40 t/ha (Figure 10). The highest carbon density value was observed at Nueva Vida, Carmen, while the lowest value was noted in Buenos Aires, Carmen. This value was about three to nine times lower than the carbon density obtained in the grassland area of the PNOC Leyte Geothermal Reservation depending on the dominant species studied (Lasco et. al., 1999). Grasslands in Leyte had carbon density of 5.17 to 12.52 t/ha for old swards of cogon (*Imperatacynlindrica*) and 8.82 to 26.46 t/ha for old swards of talahib (*Saccharumspontaneum*). Also, the obtained biomass density from this study was lower than the value reported by Fearnside (1996) for pastures and agricultural areas. According to Fearnside, these areas had an average total biomass of 19.57 Mg/ha.

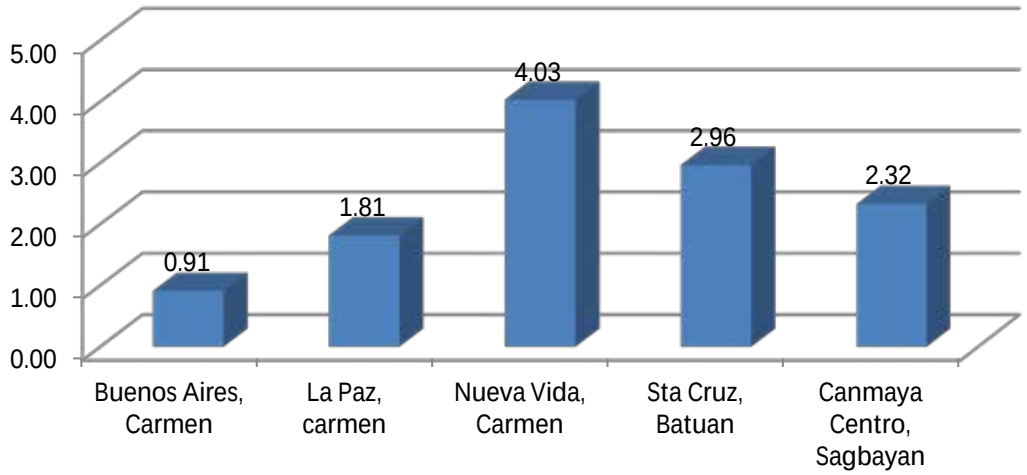

Figure 10. Carbon densities of hills with 100% grass

Using the values obtained, average carbon dioxide emission per hill per year amounted to 9.38 tons. Assuming that 300 hills will be maintained under grass vegetation for tourism, a total of 2813 tons of CO_2 will be emitted per year. This can be offset by establishing a carbon project in Bohol. At a sequestration rate of 5t/ha a year, a total of 153 ha must be established as a carbon offset project.

Hills with 20% trees

Carbon densities of hills with 20% trees ranged from 18.46 t/ha to 131.78 t/ha. On the average, carbon density of hills with 20% trees was about 68.42 t/ha (Figure 11). The large carbon density observed in one of the hills in Buenos Aires could be attributed to the presence of many trees. This hill is densely planted with *Swietenia macrophylla* with a dbh range of 5 to 26 cm. In one small plot alone, 44 trees were included in the carbon assessment. Considering that only 20 m from the base had been planted, trees were planted at quite close spacing.

The relative capacities of the different carbon pools in the hills with 20% trees were as follows (in order): tree> SOC > grass. Around 85% of the total carbon stored was found in the trees, while about 11% and 4% were found in the soil and grass, respectively.

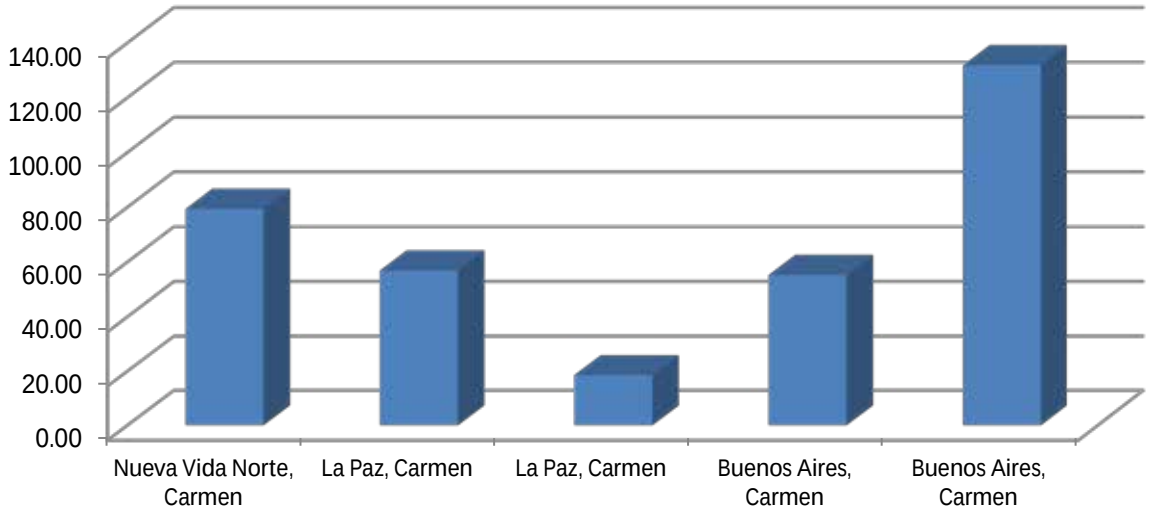

Figure 11. Carbon densities of hills with 20% trees

Comparing the hills with different covers, results showed that carbon density of hills with 100% trees did not differ much with the carbon density value of hills with 20% trees. Carbon density of hills with 100% trees was 74.34 t/ha, while that of the hills with 20% trees was valued at 68.32 t/ha (Figure 12).

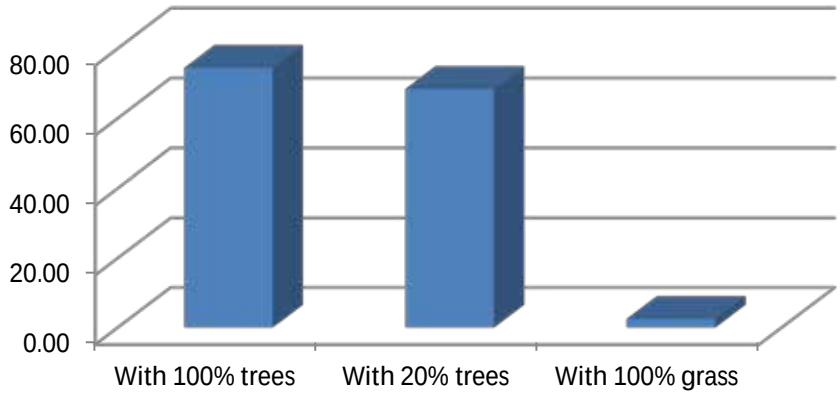

Figure 12. Carbon density of hills with different covers

4.3 Socio-economic Assessment

4.3.1 Household survey

A total of 250 respondents from the municipalities of Carmen (Barangays Buenos Aires, La Paz, Nueva Vida Este), Batuan (Barangays Poblacion Vieja, Garcia, Santa Cruz), and Sagbayan (Barangays San Agustin, Canmaya Diot, Canmaya Centro)were interviewed.

There were 100 male and 150 female respondents, 84% of whom were married. In terms of educational attainment, 35% were elementary graduates, 22% were high school graduates, and 13% college

graduates. About an equal proportion of the respondents were unemployed (41%) and self-employed (40%), while the others were government and private sector employees and retirees. Almost all of the respondents (91%) owned houses, only 7% lived with relatives, and very few rented their houses.

4.3.2 Awareness about key policy issuances

The household respondents were asked about their awareness of Presidential Proclamation 1037 (Declaring the Chocolate Hills Natural Monument and putting the hills under government control and supervision) and Presidential Proclamation 333 (Amending Proclamation1037 excluding lands that are alienable and disposable in flat and rolling lands below 18% slope) (Table 10).

It appeared that more respondents were more aware of Proclamation 333 (56%) than of Proclamation 1037 (25%). This may be because the latter was more recent, and it is the proclamation being referred to by the barangay council during meetings. It must be noted that a major reason for non-awareness was poor information dissemination of both policy issuances. However, some respondents said that they were not able to attend meetings where these might have been discussed. Most of the farmers (70%) were engaged in farming than in other forms of livelihood (Table 11).

Table 10. Awareness of major policy issuances regarding the CHNM

Barangay/ Municipality	Presidential Proclamation 1037			Presidential Proclamation 333		
	Aware (%)	Not Aware		Aware (%)	Not Aware	
		Poor info dissemination (%)	Non-attendance in meetings (%)		Poor info dissemination (%)	Non-attendance in meetings (%)
Carmen	13	18	0.4	20	11	0.8
Batuan	3	26	0.4	12	18	0.4
Sagbayan	9	30	0.4	24	15	0.4
Total	25	74	1.0	56	44	2.0

Table 11. Engagement of households in farming, 2009

Municipality/Barangay	Engaged in farming	Not engaged in farming
Carmen	***50***	***28***
Buenos Aires	16	12
La Paz	19	11
Nueva Vida Este	15	5
Batuan	***56***	***18***
Poblacion Vieja	18	10
Garcia	11	2
Santa Cruz	27	6
Sagbayan	***69***	***29***
San Agustin	17	8
Canmaya Diot	30	8
Canmaya Centro	22	13
Total	**175**	**75**

There were 25 respondents who said that they owned hills. They were asked whether or not they received advice from the government regarding the land use practices that were allowed after the

Chocolate Hills was declared a protected area. Many of the respondents said that they received advice that burning (80%) and tree cutting (92%) were no longer allowed in the Chocolate Hills Complex (Table 12).

Table 12. Advice received by respondents about allowed land use practices

Municipality	Advice (%, n=25)			
	Crops	Elevation	Burning	Tree cutting
Carmen	12	8	20	20
Batuan	16	8	32	40
Sagbayan	12	0	28	32
Total	**40**	**16**	**80**	**92**

Note: Only the 25 respondents who owned hills were asked these questions.

More than 70% of the respondents owned land, and the main basis of ownership was the land title (Table 13). The areas owned by the respondents ranged from 0.006 ha to 5 ha, or an average of 0.541 ha. However, 59% of the respondents used their land for residential purposes, and only 33% of the respondents used their land for farming as their farm lands were usually tenanted (Table 14). Some residents derived negative net incomes from farming, mainly because of low productivity due to floods and droughts. The average incomes from farming in 2009 for Carmen, Batuan, and Sagbayan were quite low at PhP18,546, PhP12,507, and PhP8,754 for the year, respectively.

More than half or 15 of the respondents said that trees such as mahogany (*Swieteniamacrophylla)*, yemane (*Gmelinaarborea*), molave (*Vitexparviflora*), and coconut (*Cocusnucifera*) grew better on the hills compared to agricultural crops such as corn and cassava.

Table 13. Respondents' status of land ownership in the CHNM

Municipality	Land ownership (%)		Basis of ownership (%)		Area (ha)	
	Yes	No	Title	Tax Dec	Range	Average
Carmen	25.2	6	31.8	5.5	0.006 – 4.000	0.593
Batuan	21.6	8	23.9	2.7	0.001 – 2.000	0.416
Sagbayan	24.8	14.4	31.4	4.7	0.004 – 5.000	0.582
Total	**71.6**	**28.4**	**87.1**	**12.9**	**0.001 – 5.000**	**0.541**

Note: Some landowners have more than one title.

Table 14. Respondents' current land uses and farm income

Municipality	Current Land Uses (%, n=250)				Average 2009 farm income (PhP per year)
	Residential	Farming	Residential and farming	Idle	
Carmen	20	14	4	0.4	18,546.22
Batuan	17	7	7	0	12,506.54
Sagbayan	22	12	2	0	8,753.60
Total	**59**	**33**	**13**	**0.4**	

The 25 respondents who said that they owned hills were asked what they wanted to do with their hills. There were 11 respondents who said that they would like to plant the hills with trees only, while eight (8) said that they would just leave the hills as they were as the land is not productive. Only a few respondents said that they wanted to plant agricultural crops on the hills. The apparent decision not to use the hills for farming could be a result of the low income generated by the farmers from farming the hills.

Tourist Arrivals for 2008 and 2009

Only tourist arrival data for the years 2008 and 2009 were available, as shown in Table 15. There was a 17%increase in the 2009 arrivals over the previous year, with Filipinos dominating the tourist arrivals for 2008 (81%) and for 2009 (86%). Other visitors came from Asian and European countries.

Table15. Tourist arrivals by origin, 2008 and 2009

Origin	2008		2009	
	Number	%	Number	%
Philippines	*287,454*	80.87	*358,513*	86.22
Other Asian countries	*50,412*	14.18	*33,283*	8.00
Total, Asian countries	**337,866**	**95.05**	**391,796**	**94.22**
Australia	1,261	0.35	1,625	0.39
Africa	31	0.01	428	0.10
Europe	11,117	3.13	17,472	4.20
North America	5,101	1.44	4,170	1.00
South America	69	0.02	342	0.08
Total	**355,445**	**100**	**415,833**	**100**
Revenues from entrance fees (PhP)	**8,925,975**		**20,791,650**	

The highest monthly tourist arrivals for both years were recorded in May and April 2008, which are summer vacation months for students in the Philippines. On the other hand, the lowest monthly arrival for the two-year period was in June 2008 at 20,088 visitors, which was still quite high (Figure 13). Other than the peak months of April and May, the difference of the monthly number of visitors to the Chocolate Hills Complex between the months with lowest and highest arrivals for 2008 was 14,598 visitors, and this was reduced to only 7,702 visitors in 2009.

According to the Mayor of Carmen, the Sangguniang Bayan (municipal council) approved an ordinance in 2005 increasing the entrance fee from PhP10 per person to PhP25 per person (personal communication, September 24, 2009). However, this was not implemented until January 1, 2008. On January 1, 2009, the entrance fee was further increased to PhP50 per person. Table 15 suggests that the tourist arrival to the Chocolate Hills Complex was not adversely affected by the 100% increase in the entrance fee. Furthermore, the revenues generated from entrance fees increased by more than 100% from PhP8.926 million to PhP20.791.

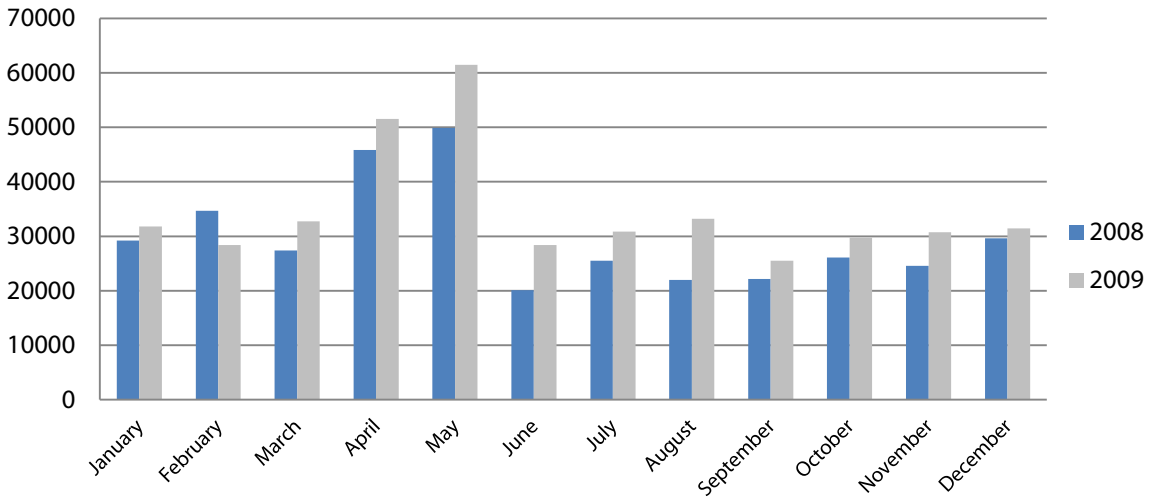

Figure 13. Monthly tourist arrivals in the Chocolate Hills

4.3.3 Key informant interviews with tourists

A total of 33 tourists were interviewed as key informants, all of them coming from the Philippines (Table 16). The research team generally found it difficult to recruit key informants because most of the tourists came on package tours, and the time they spent at the Chocolate Hills Complex was limited. The research team also tried to approach foreign tourists, but the members were not able to interview any because of the above reason and also because of the language problem.

Table 16. Characteristics of key informants: tourists

Origin	Male	Female	Total
Luzon	2	11	13
Visayas	4	7	11
Mindanao	1	6	7
No information	0	2	2
Total	**7**	**26**	**33**

Most of the respondents (64%) were first-time visitors to Bohol and the Chocolate Hills. Majority (82%) expressed satisfaction with the appearance of the Chocolate Hills. Almost half of the respondents (49%) were most interested to see the place, while 12% had the Loboc River Cruise as their top priority. As for the characteristics of the Chocolate Hills, 58% liked the natural hill formation best, while 24% liked the brown color of the hills.

The key informants were asked to agree or disagree with several statements about the Chocolate Hills. Many of them agreed that the shape of the hills is natural (97%), and that the hills look better when covered with grass than with trees (94%) (Table 17). Furthermore, 88% agreed that the grass vegetation of the hills is natural, and several informants said that they got this information from their tour guides. They also said that their guides told them that the grasses on the hills burn naturally during the summer months because of the intense heat. Only a few informants said that trees could not grow on the hills, as many of them observed the presence of trees on many of the hills.

Table 17. Key informants' perceptions about the CHNM in percent (n=32)

Statement	Attitude (%)		
	Agree N=32	Disagree N=32	No answer N=32
The shape of the Chocolate Hills is natural.	97	3	0
The Chocolate Hills look better when covered with grass than with trees.	94	6	0
The grass vegetation on some of the hills is their natural vegetation.	88	9	3
Trees cannot grow on the hills.	31	53	16

Note: Only 32 out of 33 respondents were able to complete the interview.

Interestingly, 97% of respondents said they would be disturbed if the hills had to be burned to maintain the grass cover, citing negative environmental impacts and carbon emissions/global warming as their reasons. Furthermore, 57% of respondents said they would no longer come if the hills were covered with trees, saying that the hills would no longer be unique and that they would look like forests.

4.4 Property Rights Regime and Land Use Practices in the Area

Prior to the proclamation of the Chocolate Hills as a protected area, most of the hills were alienable, disposable, and titled. However, many households living near the hills are only tenants of the owners. Some hills owners continue paying taxes even if they have been banned from using the hills for some activities.

There was a move to cancel the titles of the hills included in the protected area, but this did not push through for lack of funds.

Traditionally, the hills were regularly burned by the farmers to stimulate grass growth to feed their livestock, mainly carabaos. With the proclamation that burning is no longer allowed, farmers have been deprived of fodder source for their livestock. Consequently, the livestock population, especially carabaos, has dwindled. This had adversely affected many local residents whose source of livelihood is livestock raising as well as farmers who use carabaos as work animals in their farms.

Before the proclamation of the hills as a protected area, some hills were allowed to be quarried for the gravel needs of the municipalities concerned and the Department of Public Works and Highways (DPWH). This is no longer allowed.

The following ordinances/resolutions were promulgated in connection with the ban on quarrying:

Provincial Resolution No. 182, Series of 1997 - A resolution requesting the Office of the Provincial Governor to refrain from issuing permits for the extraction of quarry materials in 32 barangays identified by the DENR as the places where the Chocolate Hills are located

Provincial Resolution No. 183, Series of 1997 - A resolution creating a special committee of the Sangguniang Panlalawigan to study on the possible legislative measures that need to be crafted to protect and preserve the "Chocolate Hills" of the Province of Bohol

Provincial Resolution No. 184, Series of 1997- A resolution enjoining all Sangguniang Pambarangays concerned to enact an ordinance prohibiting destruction of the "Chocolate Hills" located in their respective areas of jurisdiction

The proclamation and the resolutions have caused a problem to the local governments because they no longer had sources for backfilling materials. Also, owners of hills could no longer use their land titles for loan collaterals as banks now verify the location of properties offered for collateral, and do not accept titles for the hills.

Urich (2001) reported that 93% of the hills are privately owned, but this figure is difficult to verify with the concerned municipalities. In fact, GIS analysis from available map data on the CHNM show that 77% are privately owned (Figure 5b). For one thing, records about the hills do not indicate whether these are within the boundary of the protected area or not. For another, according to DENR, not all the hills are titled and some are covered with tax declaration.

Current records are incomplete and do not identify owners of specific hills. It was learned from the Protected Area Superintendent (PASu) Forester Marcial Ugay and the planning officers of the three municipalities of Sagbayan, Batuan, and Carmen that the titles of the privately owned hills are not segregated in the registry of hills. Moreover, the hills included in the proclamation have been identified merely from the topographic map without ground validation. Even the PASu did not know which hills were included in the proclamation.

In 1997, before the inception of the area into the protected area system of the government, the land owners exercised traditional practice on the land. Traditional practice can be described by seasonal burning of the hills to encourage growth of grass shoots to feed farm animals like cattle and water buffalo. The hills are especially important as pasture land during the wet season when most of the lowlands are under cultivation. During the wet season, the animals are grazed on the hills to avoid hoof rot – a condition that results from standing for extended periods in the flooded lowlands (Urich, 1989 as cited by Urich et al., 2001).

In the 1990s, the DENR aggressively promoted the green movement, which led many farmers to purchase unused and underused hills for the establishment of tree plantations. Fast-growing and exotic species were planted on the hills resulting to an observed increase in land value as the reforestation program intensified.

The ownership of the area has since been abrogated to the government, and current management practice now rests with the PAMB as a result of Presidential Proclamation No. 1037 in 1997. The Proclamation designated the more or less1,776 hills and areas around and surrounding the hills located in the municipalities of Bohol, namely: Carmen, Batuan, Sagbayan, Bilar, Velencia, and Sierra Bullonesas a Natural Monument. The proclamation also states that:

> *". . . regardless of the existence of prior vested rights, no activity of any kind including quarrying, which will alter, mutilate, deface, or destroy the hills shall be conducted and the proclaimed area shall be under the administrative jurisdiction, supervision and control of the DENR, which shall coordinate with other government agencies and the local government units with the objective of maintaining and protecting the chocolate hills natural features for tourism, scientific, educational and recreational purposes.. ."*

4.5 The Carbon Offset Project

A carbon offset project is an investment that a group or company may undertake to compensate for the greenhouse gas emissions resulting from their activities. This can be a forestation project where an open area is developed by planting trees. Forests have been regarded as a significant sink of carbon because of their ability to absorb large amounts of carbon dioxide from the atmosphere through the process of photosynthesis. Trees use carbon dioxide for their growth by fixing it in their biomass. In the Philippines, several studies assessing carbon stored in tree plantations have been conducted. Results of such studies showed that, on the average, tree plantations have a carbon density of 59 t/ha.

As for the Chocolate Hills of Bohol, the research team discussed with the PAMB the possibility of setting up a carbon offset project to compensate for the carbon emissions due to the burning of the hills within the Chocolate Hills Complex. This scheme is similar to the concept of the Clean Development Mechanism (CDM) where a developed country can invest in a project in a developing country to get carbon credits. The amount of carbon generated by the project in the developing country shall form part of the emissions reductions of the developed country.

Locating the carbon offset project inside CHNM presents several advantages:

a. PAMB exercises jurisdiction over these areas, thus facilitating implementation, monitoring, and evaluation;

b. It will be accessible to the tourists who will finance the venture;

c. PAMB can promote the area as carbon neutral, thus increasing the marketability of the hills; and

d. The project can be a boon to tourism since the study showed that tourists feel strongly against burning. The carbon offset project provides a compromise to current practice.

Based on the vegetation analysis and biomass calculations, the research team estimated that the carbon offset project will cover a total of 166 ha to offset the carbon emissions from the burning of the proposed 300 hills. This will be developed within the three- year period following this schedule: Year 1- 50 ha; Year 2 – 50ha; and Year 3 – 66 ha. To ensure high survival rate of the planted seedlings, indigenous species will be selected. Furthermore, it is recommended that the carbon offset project be community-based. This approach has several advantages:

a. It will increase awareness of the community on the environmental impacts of burning and other natural resource exploitation activities;

b. It will increase awareness of the community on the policies of government to combat global warming and engender support to climate change mitigation and adaptation; and

c. It will provide additional income to the local communities.

The team then made an assessment if the carbon offset project could be developed using the income from tourism generated by the LGU in managing the complex and if it shall be managed by the PAMB.

As shown by the cost-benefit analysis (see Section 4.6), the cost of the status quo (burning of the hills) will be higher. This is because of the reduced biodiversity, increased carbon emission, degraded microclimate, and reduced hydrologic functions. With a carbon offset project, on the other hand, these aspects will be positively improved.

4.6 Cost-Benefit Analysis

The streams of benefits and costs for the base case (with burning) and the proposed management regime (burning with carbon offsets) are presented in Tables 1 to 5. The base case has two sources of benefits, i.e., entrance fee and business revenues. The proposed management regime also has these two sources of benefits, but with additional benefits arising from carbon offsets and timber revenue.

For both cases, the same tourist arrival projections were used as the proposed regime does not involve an increase in entrance fees yet. The costs of the carbon emissions that will result from burning (allowed in both cases) are also the same. The costs were based on the estimates generated from the carbon study that is described in another part of the report.

Under the proposed management regime as described in Section 4.5, plantations using indigenous tree species will be established as carbon offsets over a three-year period. The alternative management regime will have two additional sources of benefits, namely: annual benefits from the carbon offsets and the revenues from timber that will be realized in years 30 to 32 after the carbon commitment period has been met. Furthermore, the alternative management regime will have two additional cost sources: the plantation establishment costs in years 0 to 2 and the plantation maintenance costs from year 1 until year 30. However, the costs of setting up the project, particularly transaction costs, were not included in the analysis.

The net present values (NPVs) for the initial and perpetual rotations at 10% and 15% discount rates and various carbon prices are summarized in Table 18. At 10% discount rate, the NPVs for the initial rotation and for perpetual rotations are higher with the carbon offsets than without for all levels of carbon prices of USD5, USD10, and USD20. For example, the NPV for the initial rotation under the business as usual case at the lowest carbon price of USD5/tC and 10% discount rate is PhP208, 061, 040, which is lower than the NPV with carbon offset of PhP215, 625, 619. The same trend can be observed for the NPVs for perpetual rotations, and across different carbon prices and discount rates. However, the advantage of the case with carbon offset is reduced at 15% discount rate.

Table 18. Summary of net present values for initial and perpetual rotations at carbon prices of USD5, USD10 and USD20/tC and discount rates of 10% and 15%

Option	Net Present Value (NPV, PhP)					
	USD5/tC		USD10/tC		USD20/tC	
Initial rotation	**10%**	**15%**	**10%**	**15%**	**10%**	**15%**
Business as usual	208,061,040	144,309,484	208,024,880	144,284,297	207,952,558	144,233,924
With carbon offset	215,625,619	144,437,895	223,662,468	148,714,965	239,736,167	157,269,104
Perpetual rotations						
Business as usual	219,984,717	146,488,997	219,946,483	146,463,430	219,870,017	146,412,296
With carbon offset	227,982,811	146,619,348	236,480,240	150,961,014	253,475,098	159,644,346

A comparison of the present value from tourism income and the cost of carbon dioxide emissions from controlled burning is shown in Table 19. At different price levels of carbon emissions, the present value of tourism income was found to be very much higher than the environmental cost that will result from carbon emission due to burning.

An entrance fee of PhP50 per visitor was used to calculate the annual tourism income by projecting the annual visitors over the period of 30 years. The annual tourist arrival was projected using one-period

moving average forecast. This result suggests that a carbon offset plantation project to make the CHNM operation carbon neutral could be financed from its tourism revenue.

Table 19. Present value from tourism income and the cost of carbon dioxide emission from burning calculated at 10% discount rate

Item	Present Value (PhP)
Cost of Carbon emission	
-USD 5/tC	1,627,232
-USD 10/tC	3,254,463
-USD 20/tC	6,508,926
Tourism revenue	622,353,450

The status quo and the proposed alternative management regime were compared using social, economic, environmental, political, and administrative criteria. As shown in Table 20, a carbon offset project may prove to be more beneficial to the local community as well as to the larger community. From the social point of view, the project will not only benefit the host local governments (Carmen municipality and the barangay of Buenos Aires) but also the community that will be directly involved in the project, including those from other municipalities and barangays. The global community will also benefit from the reduction in carbon emission.

Table 20. Comparison of the status quo and proposed alternative

Criterion	Status Quo	Proposed Alternative
Social		
Beneficiary	LGU (Carmen host municipality and barangay Buenos Aires)	LGU (Carmen host municipality and barangay Buenos Aires); Local community/ies that will be involved; Global community
Acceptability		
LGU	High	High
Tourists	Low	High
PAMB	Low	High
Economic		
Benefits	Income from tourism (entrance fees and business)	Income from tourism (entrance fees and business) Carbon sequestered
Costs	Reduced biodiversity; Increased carbon emissions; Degraded microclimate; Reduced hydrologic functions	Carbon offset establishment
Environmental	Degraded microclimate; Reduced hydrologic functions	Carbon sequestration; Environmental conservation; Biodiversity conservation; Microclimate maintenance; Hydrologic functions maintenance
Political Acceptability	High	Medium
Administrative	Less transparency about management activities	Greater transparency about management activities

Moreover, the alternative regime has a high acceptability rating for the tourists, the PAMB, and the LGU. For the tourists, the project will allow burning during the dry months, which will give the Chocolate Hills their "chocolate" appearance. For the PAMB, the project will entail the development of carbon offsets, which will neutralize the carbon emissions that will result from the controlled burning of some hills. From the economic aspect, the carbon offset project will likewise generate more benefits and reduce costs, especially environmental costs.

However, the political acceptability of the status quo is perceived to be higher than that of the proposed alternative. This is mainly because burning of the hills will result in the sharing of benefits among the three municipalities that have jurisdiction over the Chocolate Hills. In the present setup, only the municipality of Carmen benefits from tourism revenues. Consequently, the adoption of the proposed alternative can enhance transparency in management activities.

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The study developed a carbon offset project based on scientific information and subjected the project to an economic analysis. The carbon offset project could be an alternative to the occasional burning of the Chocolate Hills for consideration by the PAMB of the Chocolate Hills Natural Monument (CHNM) in Bohol, Philippines.

The CHNM is dominated by agriculture. Historically, 77% of the area was privately-owned even though Presidential Proclamation (1037) recognized the land titles and prior claims of the residents especially in the lowlands devoted to agriculture. Only the hills were reverted to government ownership. However, actual areas have yet to be determined and delineation and demarcation on the ground have yet to start. In fact, records about the hills do not indicate whether these are within the boundary of the protected area or not. For another, not all the hills are titled, and some are covered with tax declaration.

As a protected area, burning and quarrying are no longer allowed; this may explain the signs of natural regeneration in the area. Vegetation analysis of 123 randomly selected hills in the towns of Carmen, Batuan, and Sagbayan showed that more hills are forested than covered with grass. The plants mostly belong to the low diameter (i.e., DBH) and height classes. Moreover, the plants are dominated by indigenous species.

Based on the household survey results, more than 70% of the respondents owned land, and the main basis of ownership was the land title. However, only 33% used their land for farming as their farm lands are usually tenanted. The average income from farming in 2009 for all municipalities was quite low at PhP8, 934 for the year.

Comparing the hills with different cover, results showed that carbon density of hills with 100% trees did not differ much from that of hills with 20% trees. Carbon density of hills with 100% trees was 74.34 t/ha and 68.32 t/ha for hills with 20% trees.

At alternative discount rates of 10% and 15%, the NPVs for the initial rotation and for perpetual rotations were higher with the carbon offsets than without carbon offsets for all levels of carbon prices (USD5, USD10 and USD20). The NPV for the initial rotation under the status quota the lowest carbon price of USD5/tC and 10% discount rate was PhP208, 061, 040, and this was lower than the NPV with carbon offset of PhP215,625,619. Comparison of the present values of the income from tourism and the cost of carbon dioxide emissions from burning shows that at different price levels of carbon emissions, the present value of tourism income was found to be very much higher than the cost of carbon emission due to burning. This result suggests that a carbon offset plantation project to make the CHNM operation carbon neutral could be financed from its tourism revenue.

5.2 Recommendations

The study recommends that the PAMB consider initiating the establishment of a carbon offset project to make the current management practice carbon neutral. This was already articulated by the research team during the exit conference with the PAMB held on June 3, 2010 in Batuan, Bohol. After the meeting, a PAMB resolution (Appendix1) dated June 4, 2010 indicated that they would use the data and information provided by this study 'in the formulation of policy and management plan of the Chocolate Hills Natural Monument'.

The CHNM PAMB wanted to help the tourism industry by agreeing to the clearing of 300 hills around the CHNM complex by the LGU of Carmen. However, they had no scientific basis for the clearing. They proposed an arbitrary scheme where some 300 hills would be cleared of vegetation up to 80% from the top and leaving the bottom 20% vegetated (80-20 scheme).The results of the carbon study showed that PAMB's arbitrary scheme can be justified by establishing one hectare of forest for every two hills cleared. As such, if the PAMB plans to clear 300 hills for tourism purposes, then a corresponding minimum of150 ha of forest need to be established. Included in this report is a draft resolution for the PAMB to initiate a carbon offset project for the CHNM (Appendix2).

REFERENCES

Bantayan, N.C. 2006. *GIS in the Philippines – Principles and Applications in Forestry and Natural Resources.* Los Banos: PARRFI and AKECU-AKECOP.173 p.

Boardman, A. E., D. H. Greenberg, A. R. Vining and D. L. Weimer. 2001. *Cost-Benefit Analysis: Concepts and Practice*, 2nded. USA: Prentice Hall, Inc. 526 p.

Brown, S. 1997. Estimating biomass and biomass change of tropical forests: *A Primer. FAO Forestry Paper 134*. Rome: FAO. 55p.

Englin, J., T.P. Holmes and J. Lutz, 2009. Wildlife and the economic value of wilderness recreation. Retrieved [May 2009] from http://www.srs.fs.usda.gov/pubs/ja/ja_ englin003.pdf

Fearnside, P. M., P.M.L. de Alencastro Graca and F.J.A. Rodrigues, 2001. Burning of Amazonian rainforests: Burning efficiency and charcoal formation in forest cleared for cattle pasture near Manaus, Brazil. *Forest Ecology and Management*. 146 (1),115-128.

Hellingman, J. 2011. Bohol, Philippines: God's Little Paradise. Retrieved [November 2011] from http://www.bohol.ph

Lasco, R. D., J. S. Lales, M. T. Arnuevo and I. Q. Guillermo. 1999. *Carbon Dioxide Absorption and Sequestration in the PNOC-Leyte Geothermal Reservation. Final Report.* Environmental Forestry Programme. College of Forestry and Natural Resources, University of the Philippines Los Baños, College, Laguna.

Palma, L. n.d. Chocolate Hills in Bohol. Retrieved [May 2009] from http://www.luzpalma.com

Urich, P.B., M.J. Day and F.Lynagh. 2001. Policy and practice in karst landscape protection: Bohol, the Philippines. *The Geographical Journal* (167:4): 305-323.

APPENDICES

Appendix 1. CHNM PAMB Resolution No. 3 Series 2010

EXCERPTS FROM THE MINUTES OF MEETING OF THE CHOCOLATE HILLS NATURAL MONUMENT (CHNM) PAMB HELD ON JUNE 3, 2010 AT THE BALAY SA HUMAY, POBLACION SUR BATUAN, BOHOL.

MEMBERS PRESENT:

1. Dorteo Aparicio
2. Rufo Calamba
3. Serapion Organiza
4. Crispina Maluyo
5. Alexander Chatto
6. Venecio Idusma
7. Julito Ancog
8. Eleno Dapar
9. Lilio A. Palac
10. Benito Tandog
11. Pedro Macbudbod
12. Reynaldo Polinar
13. Teofanis Sandimas
14. Jessie Medina
15. Francisco Bungato
16. Rizalino Canda
17. Felipe Ramo Sr.
18. Edwin Logroño
19. Loreto Anino
20. Casimero Aceron
22. Richard Cabusao
23. Isidro Clavite
24. Remegio Man-on
25. Romeo Decierdo
26. Neria Langamen
27. Patricio Sagolili
28. Fabian Plaza
29. Rufe Sumampong
30. Modesto Pan
31. Ricardo Tinahoro
32. Cepriano Vargas

DENR Personnel:

1. Marcial B. Ugay
2. Sabiniano A. Cafe
3. Victoria A. Elle

Guest:
UPLB
1. Nathaniel Bantayan
2. Florencia Pulhin
3. Margaret Calderon
4. Rose Ann Baruga

RESOLUTION NO. 03
Series of 2010

A RESOLUTION RECOGNIZING THE EFFORTS OF THE UNIVERSITY OF THE PHILIPPINES LOS BAÑOS (UPLB) LAGUNA IN CONDUCTING RESEARCH ON THE ANALYSIS OF ALTERNATIVE MANAGEMENT REGIMES FOR THE CHOCOLATE HILLS.

WHEREAS, the research team of the UPLB has conducted bio-physical assessment of the Chocolate Hills Natural Monument with a total of 123 hills located in the municipalities of Carmen, Batuan and Sagbayan;

WHEREAS, the preliminary result of the analysis of alternative management regimes for the chocolate hills presented by the research team will justify the affirmed resolution of the PAMB for the clearing of trees vegetation 80% from the top of the hill in order to maintain the unique features of the chocolate hills;

WHEREAS, the research of the UPLB has substantial and informative data as follows:

- tourist visitors had expressed their satisfaction of the unique features of the chocolate hills.
- hills with grass cover have unique attraction.

- burning of hills will disturb the bio-diversity and cause carbon emission and global warming.
- tourists will not come to see the chocolate hills if the hills will be covered with trees/forest vegetation.
- clearing of trees 80% from the top of the hill with a total of 300 hills for eco tourism can be offset by planting of trees in other areas of Bohol.

WHEREAS, the research of the UPLB provides data and information that can be used as a tool in the formulation of policy and management plan of the Chocolate Hills Natural Monument;

WHEREAS, the UPLB will provide a copy of the research/study to the PAMB and DENR for reference;

WHEREFORE, on mass motion, be it;

RESOLVED, as it is hereby resolved to recognize the efforts of the University of the Philippines Los Baños (UPLB) in conducting research on the analysis of alternative management regimes for the chocolate hills.

RESOLVED FURTHER that copies of this instrument shall be furnished to the concerned agencies for their information and subsequent action.

So adopted this 4th day of June 2010.

Certified true and correct:

MARCIAL B. UGAY
PASu

Attested and concurred by:

FELIPE L. RAMO SR.
Presiding Officer

Approved/Affirmed:

LEONARDO R. SIBBALUCA
Regional Executive Director

Appendix 2. Draft resolution for the establishment of a carbon offset project inside CHNM

RESOLUTION No. __
Series of 2010

A RESOLUTION FOR THE ESTABLISHMENT OF A CARBON OFFSET PROJECT INSIDE THE BOUNDARIES OF CHNM AS A MEANS TO OFFSET THE CARBON EMISSIONS FROM THE CLEARING OF 300 HILLS AROUND THE IMMEDIATE VICINITY OF THE CHOCOLATE HILLS COMPLEX

WHEREAS, the research team of the University of the Philippines Los Baños (UPLB) Laguna conducted a study on the analysis of alternative management regimes for the Chocolate Hills Natural Monument (CHNM). Further, the UPLB research team was recognized for their efforts in conducting research on CHNM management through a PAMB Resolution No. 03 Series of 2010 dated 4 June 2010

WHEREAS, the UPLB research team found that the current scheme of burning releases carbon dioxide that contributes to global warming and is inconsistent with existing laws. Further, the UPLB research team found that the carbon density of hills with 100% trees is comparable to the carbon density of hills with 20% trees.

WHEREAS, the UPLB research team found that if 300 hills will be cleared around the immediate vicinity of the Chocolate Hills Complex, as proposed by the Carmen local government, an equivalent of 166 hectares need to be established to offset the carbon emission.

WHEREAS, a certain number of hills can be allowed to be cleared so long as the carbon emission be offset by reforestation, a scheme known as carbon offset project. A carbon offset project is an activity that can be undertaken to compensate for the greenhouse gas emissions resulting from their activities. Such carbon offset project can be are forestation project where an open area is developed by planting trees. Further, forests are regarded as a significant sink of carbon because of their ability to absorb substantial amounts of carbon dioxide from the atmosphere through the process of photosynthesis. Trees use carbon dioxide for their growth by fixing it in their biomass. In the Philippines, several studies assessing carbon stored in tree plantations have been conducted showing that on the average, tree plantations have a carbon density of 59 t/ha.

WHEREAS, the UPLB research team recommends to the PAMB that a carbon
offset project be established to compensate for the carbon emissions due to the burning of the hills within the Chocolate Hills Complex.

WHEREAS, the carbon offset project shall cover a minimum of 166 ha to offset the carbon emissions from the burning of the proposed maximum of 300 hills. This will be developed within the 3 year period following this schedule: Year 1- 50 ha; Year 2 - 50ha; and Year 3 – 66 ha.

WHEREAS, to ensure high survival rate of the planted seedlings, indigenous species will be selected.

WHEREAS, the carbon offset project be community-based to ensure increased participation among the local communities and become an additional source of income for them.

WHEREAS, the carbon offset project be developed using the income from tourism generated by the local government unit.

WHEREAS, the carbon offset project be managed by the PAMB.

WHEREFORE, on mass motion, be it;

RESOLVED, as it is hereby resolved to establish a carbon offset project inside the boundaries of CHNM as a means to offset the carbon emissions from the clearing of hills around the immediate vicinity of the Chocolate Hills Complex.

So adopted this __ day of September 2010.

Certified true and correct:

MARCIAL B. UGAY
PASu

Attested and concurred by:

FELIPE L. RAMO SR.
President Officer

Approved/affirmed:

LEONARDO R. SIBBALUCA
Regional Executive Director

Strengthening local capacity in the economic analysis of environmental issues

Recent EEPSEA Research Reports

Exploring the Forestry Carbon Finance Potential for an Indigenous Cultural Community in the Philippines
Margaret M. Calderon, Nathaniel C. Bantayan, Florencia B. Pulhin, and Lourdes J. Cruz
2013-RR1

Response of Fishermen to Fishing Control Policies in Southern Songkhla Lake, Thailand: A Field Experiment
Kunlayanee Pornpinatepong, Pathomwat Chantarasap, Jumtip Seneerattanaprayul, Wittawat Hemtanon and Papitchaya Saelim
2013-RR2

Economic Analysis of Multi-pollutant Control in Coal-fired Electricity Plants in China
Wu Dan and Xie Xuxuan
2013-RR3

Impact of Piped Water on Household Welfare in Vietnam
Nguyen Viet Cuong, Vu Thieu, Pham Minh Thu, and Nguyen Xuan Truong
2013-RR4

Evaluating the Pilot Implementation of Payment for Forest Environmental Services in Lam Dong, Vietnam
Nguyen Thi Y Ly
2013-RR5

To Burn or not to Burn: Making the Burning of Chocolate Hills of Bohol, Philippines Carbon Neutral
Nathaniel C. Bantayan, Margaret M. Calderon, Florencia B. Pulhin, Canesio D. Predo, and Rose Ann C. Barruga
2013-RR6

An Economic Analysis of the Use of Water Hyacinth for Phytoremediation and Biogas Production in Dianchi Lake, China
Zanxin Wang and Jin Wan
2013-RR7

Economic Analysis of Rice Straw Management Alternatives and Understanding Farmers' Choices
Cheryll C. Launio, Constancio A. Asis, Jr., Rowena G. Manalili, and Evelyn F. Javier
2013-RR8

Impact of Eco-Labelling on Indonesia's Smallholder Coffee Farmers
Nuva, Yusif, Nia Kurniawati H., and Hanna
2013-RR9

Linking Climate Change, Rice Yield and Migration: The Philippine Experience
Flordeliza H. Bordey, Cheryll C. Launio, Eduardo Jimmy P. Quilang, Charis Mae A. Tolentiono and Nimfa B. Ogena
2013-RR10

Determinants of Flashflood Evacuation Choices and the Assessment of Preferences for Flashflood Warning Channels: The Case of Thailand
Kannika Thampanishvong
2013-RR11

Insurance Approach for Financing Extreme Climate Event Losses in China: A Status Analysis
Haitao Yin
2013-RR12

The Way to CO_2 Emission Reduction and the Co-benefits of Local Air Pollution Control in China's Transportation Sector: A Policy and Economic Analysis
Mao Xianqiang, Yang Shuqian, and Liu Qin
2013-RR13

Sida IDRC CRDI