How to Make Burning of Chocolate Hills of Bohol, Philippines Carbon Neutral?

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EXECUTIVE SUMMARY

This study was conducted to evaluate the current management regime of burning vis a 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 and sustain tourist arrivals is seen as environmentally unsound and is 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 in 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. On the basis of the results of these assessments, policy recommendations were drawn up for consideration of the CHNM management.

Historically, the hills of CHNM were burned for grazing of animals. This made the hill landscape visually appealing and consequently attracted tourists to the area. However, when it was declared as a protected area, burning of the hills was discouraged. This led to the growth of tree species (mostly indigenous) on the hills characteristic of natural regeneration. This resultedin the loss of the unique hill landscape preferred by the tourists. The tourism office, managed by the local government of Carmen, expectedly wanted to maintain the hills bare for tourism. On the other hand, the protected area management board (PAMB) of CHNM is mandated to ensure that environmental laws, one of which bans burning, are adhered to. Thus, the study sets out to evaluate the establishment of a carbon offset project to make up for the carbon loss if a certain number of hills are burned to maintain the tourism value.

The vegetationand biomass analysis and the carbon study reveal an estimated 153 ha of forest should be established to offset the carbon emission due to clearing of such hills. This means thatthecarbon offset projectwill require the establishment of one hectare of forest for every two hills cleared. The cost of forestationcould be supported byincome from tourism in a form and manner that directly involves the community.Thestudy 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 considerthe establishment of a carbon offset project to make the current management practice carbon neutral.

1.0 INTRODUCTION

1.1 Rationale

The Chocolate Hills of Bohol are one of the Philippines' top tourist destinations due to its unique hill landscape that are brown in summer and green the rest of the year. One would think that this is what nature had intended for the Hills – to be always covered with grasses, green during the rainy season, and brown during the summer months. However, during a visit to the place in 2007, we were witnesses to what we learned was a regular practice to keep the grass vegetation of the hills. That is, the hills are burned to prevent trees from growing. The Protected Area Management Board (PAMB) which oversees the Chocolate Hills Natural Monument (CHNM) allows the practice on a limited scale. In a study on the effects of wildfires on the economic value of outdoor recreation (Englin, J. et al, 2009)[1], recreation demand changed following large wildfires although the direction (increase or decrease) is not definitive. The same study suggested on-site surveys to better understand visitor preference. The presumption of CHNM management is 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 and 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, a 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 as it develops from being barren to a climax formation, otherwise known as the sere, may take longer compared to an area without disturbances.

[1] http://www.srs.fs.usda.gov/pubs/ja/ja_englin003.pdf

The Hills already support higher forms of vegetation. This is evidenced by many of the other hills that are no longer covered by grass but by shrubs and small trees, mainly pioneer tree species. Aside from interfering with natural succession, the practice of regularly burning the hills

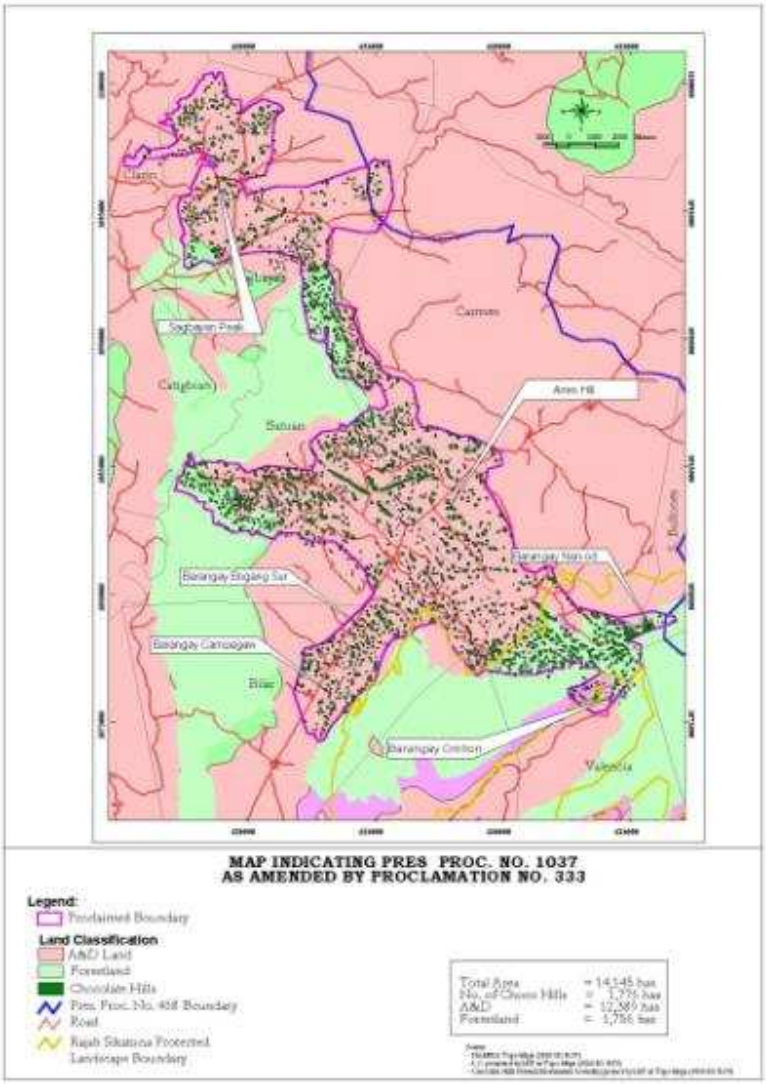


Figure 1. Map of Chocolate Hills of Bohol, Philippines [Source: DENR]

also produces carbon emissions and may adversely affect the biodiversity in the area. Englin, J. et al. (2009) cite the beneficial effects of burning to reduce fuel loads, mimic natural processes (i.e. forest regeneration and succession after a wildfire), or 'observe the effects of wildfire on natural processes in fire-adapted ecosystems.' This study was an opportunity to understand better the ecological dynamics relative to the management regimes in the Hills.

1.2 Description Of The Project Area

CHNM is located in the island-province of Bohol where the 1,776 hills complex was established as a natural monumentthroughProclamation No 1037 on July 1, 1997. The hills are spread in the middle of the island insixmunicipalities, namely: Carmen, Sagbayan, Batuan, Bilar, Valencia and Sierra Bullones (see Figure 1).

The CHNM has always been a favorite destination for tourists which can be seen from the viewdeck of the Chocolate Hills Complex (CHC) in the municipality of Carmen. As early as 1993, the need for a management committee to oversee all the activities and projects relative to the operations of CHC has been recognized. During the same year, the provincial treasurer was granted power to charge directly to the income derived from the CHC for the purchase of equipment and the 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 the memorandum of agreement between the province of Bohol and the municipality of Carmen through Provincial Resolution No. 307, Series of 1993. Since the Committees on Tourism and on Environmental Protection found that there had been no data regarding the chocolate hills, Provincial Resolution No. 199, Series of 1995, requesting the National Committee on Geological Sciences of the DENR to identify the 1,268[2] hills and also their metes and bounds was resolved on July 28, 1995.

Provincial Resolution No. 292, Series of 1997 was resolved on June 20, 1997 requesting the Philippines Congress to enact laws imposing stiffer penalties on 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, on April 11, 1997, Provincial Resolution Nos. 182, 183 and 184, Series of 1997 were enacted. Resolution No. 182 requested the Provincial Governor to refrain from issuing permits for the extraction of quarry materials in 32 barangays identifies by the DENR as the places where the chocolate hills are located. Resolution No. 183, on one hand was about creating a special committee of the SangguniangPanlalawigan to study on the possible legislative measures that need to be crafted to protect and preserve the chocolate hills of the province. Resolution No. 184, on the other hand was about enjoining all SangguniangPambarangays concerned to enact an ordinance prohibiting 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 CHNM as a Natural Monument to protect and maintain its natural beauty and to provide restraining mechanisms for inappropriate exploitation. 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. Since complaints have been received regarding the loss of livelihood and the stability of peace and order situation as a result of Presidential Proclamation Nos. 1037, substantial amendments to the proclamation were brought forward.

[2] Estimated number before the proclamation

Thus, on February 28, 2003, Presidential Proclamation No. 1037 was amended through Presidential Proclamation No. 333 by excluding alienable and disposable flat lands in between hills subject to actual ground delineation. To date, actual ground delineation has yet to be implemented due to lack of funds.

There are several legends about how this natural formation came about. To this day, there is no consensus yet among geologists as to the origin of the Chocolate Hills[3]. 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).

2.0 THE RESEARCHPROBLEM

Proclamation No. 333 which amended Proclamation No. 1037 placedthe 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 Department of Environment and Natural Resources (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 grasses, green during the rainy season, and brown during the summer months. However, during a visit to the place in 2007, we were witnesses to what we learned was a regular practice to keep the grass vegetation of the hills. That is, the hills are burned to prevent trees from growing. The 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, J. et al, 2009)5, recreation demand changed following large wildfires although the direction (increase or decrease) is not definitive. The same study suggested on-site surveys to better understand visitor preference. The presumption of CHNM management is 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 some 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

[3] http://www.bohol.ph

[4] Private lands

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

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.

It would be safe to say that by this time, the Hills can already support higher forms of vegetation. This is evidenced by many of the other hills that are no longer covered by grass but by shrubs and small trees, presumably pioneer tree species. 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. Englin, J. et al. (2009) cite the beneficial effects of burning to reduce fuel loads, mimic natural processes (i.e. forest regeneration and succession after a wildfire), or 'observe the effects of wildfire on natural processes in fire-adapted ecosystems.' This study is an opportunity to understand better the ecological dynamics relative to the management regimes in the Hills.

2.1 Research Objectives

The study aimed to evaluate the current management regime of burning vis a vis a proposed one (burning with carbon offsets) for the Chocolate Hills Natural Monument (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 tourism income 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 benefits and costs of the status quo and the proposed management regimes; and
5. draw up policy recommendations for the sustainable management of the CHNM.

2.2 Conceptual Framework

The focus of this study was to evaluate 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 2. The study first conducted a resource and use assessment of the hills, which provided baseline information. The study also looked into the carbon loss from the burning practice of the chocolate hills and compared the loss value with the tourism income of the chocolate hills under the status quo. This became the basis for evaluating what the carbon offset projectmust be to offer as an alternative to current practice of burning of hills. It is hypothesized that a carbon offset project will make the current practice acceptable from the social, environmental and economic points of view. A cost benefit analysis of the two management regimes (i.e. status quo and proposedcarbon offset project) was conducted.

The study did not directly measure some environmental parameterssuch as carbon emission from burning of the grass and other vegetation, although 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.

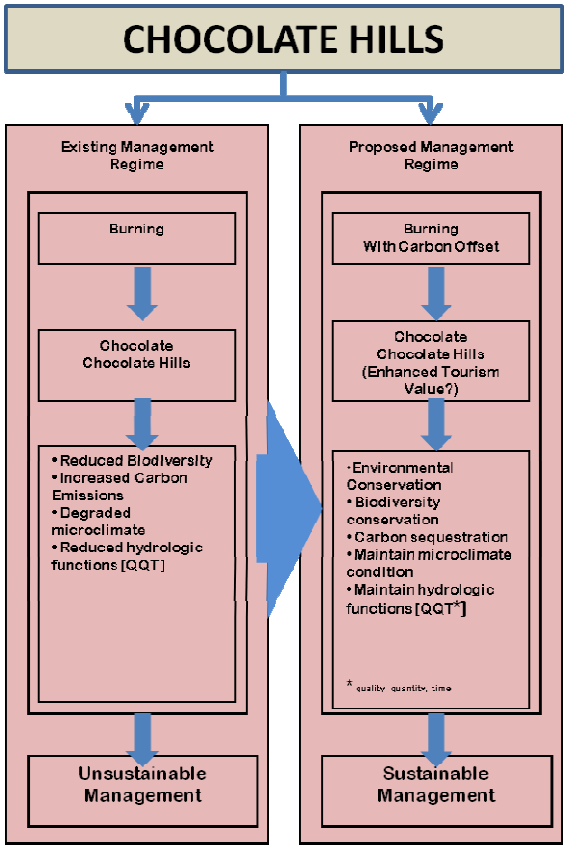


Figure 2. Conceptual framework

3.0 RESEARCHMETHODS

The study sought to answer the following questions:

1. What are the current management practices in the Chocolate Hills?
2. Whatare 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 allows burning of some hills and the alternatives of allowing burning with carbon offsets?

In order to answer these questions, assessment methods with regard to the biophysical situation, carbon stocks and socio-economic status were employed. Secondary data analysis focusing on the records regarding land ownership and property rights were conducted. Focus group discussions (FGD) and key informant interviews (KI) with key stakeholders were also conducted to generate baseline information about land management practices, policies, and government agencies' priorities with respect to the environment and tourism.Baseline information including maps, reports and other statistics about the Chocolate Hills were gathered from the Chocolate Hills Complex, local government units, Department of Tourism, Department of Environment and Natural Resources, and other relevant agencies and institutions that implement programs focusing on the Chocolate Hills. Representatives of these agencies and other stakeholders were interviewed to gather data on the management regime and likewise, assess the extent of burning of the Chocolate Hills.The data gathered included information on the landowners; size of land holdings; whether landowners benefit in any way from the burning of some of the hills; HH survey; reasons why landowners allow their hills to be burned; and whether there are landownerswhodo not follow the prescribed land uses.

3.1 BiophysicalAssessment

A biophysical assessment of the area was undertaken using existing maps and reports, databases and GPS[6]-assisted survey methods. Representative hills with and without burning were chosen to determine the difference in their floral diversity and biomass density. Data on land cover and land use that were gathered in the field were augmented with available secondary data, specifically from the local government units 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 (see Figure 3). Each plot is circular whose center 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.

[6] GPS – global positioning system.

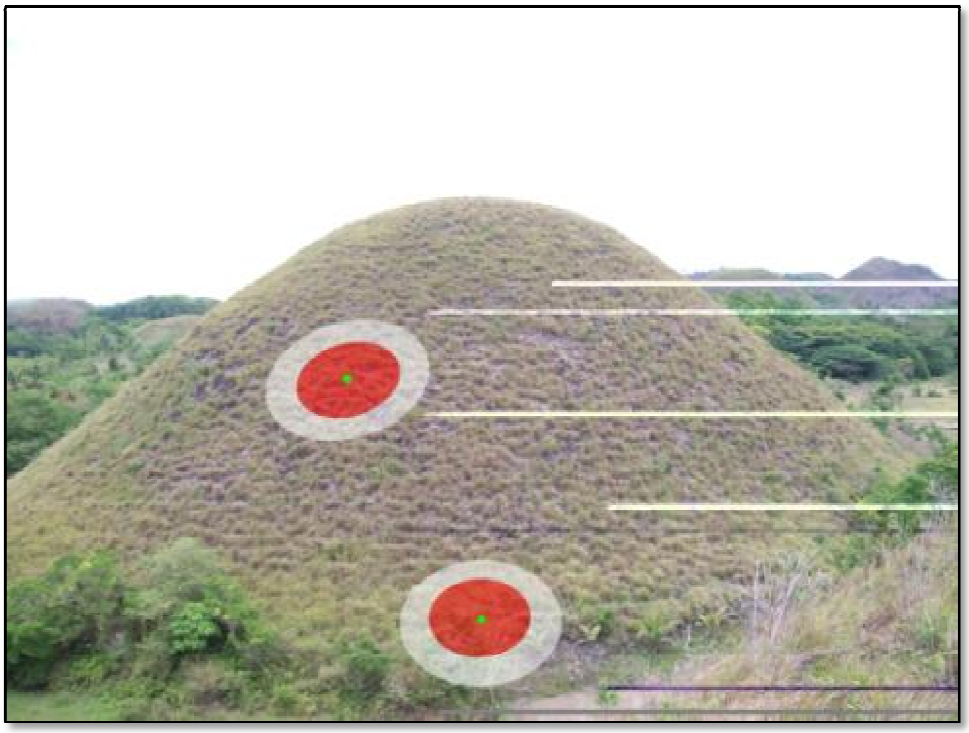


Figure 3. Survey plots for biophysical assessment

Other data like geology, topography, soils and other physiographic 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, population centers; 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 were 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. Method used involved a combination of destructive sampling for trees measuring ≤5 cm and non-destructive sampling for trees > 5 cm.

[7] Attached agency under the Department of Agriculture
[8] Line agency under the Department of Environment and Natural Resources
[9] Attached agency of the Department of Environment and Natural Resources

On hills with 100% grass, carbon pools measured include grasses and soil while 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.

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 exist trees with dbh>30 cm whether or not they are included in the sample plots established, additional 20 m x 100 m plots were laid out.

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 weights of the samples become 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 for biomass determination. 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 for analysis.

For bulk density determination, samples were collected using a ring metal with 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, understorey 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 chocolate hills. The nine barangays that were included in the survey were selectedvia 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). The interview schedule used for the survey is given in Annex 7.1.

Key informant interviews were conducted with key officials various government offices in Bohol, such as the Bohol Tourism Officer, Protected Area Superintendent, Mayor of Carmen, Municipal Planning and Development Officers of Batuan and Sagbayan, Operations Manager of the Chocolate Hills Complex, and 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 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, in particular 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 base case, which allows burning of some hills that are in the immediate vicinity of the Chocolate Hills Complex, was evaluated against the policy alternative of allowing burning of some hills with carbon offsets. The benefits and costs that were considered in the evaluation came with two (2) 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 (local government) and business revenues (business sector) derived from tourism in the area, while the costs came from the environmental cost of carbon emissions from burning. For the carbon offset project, there will still be benefits from entrance fee revenues, business revenues, carbon offset benefits, and timber revenues, while the costs came from the establishment and maintenance costs of the carbon offset plantations, and the carbon emission from burning that would still be allowed. The assumptions used in arriving at the benefits and costs are given in Annex 7.2.

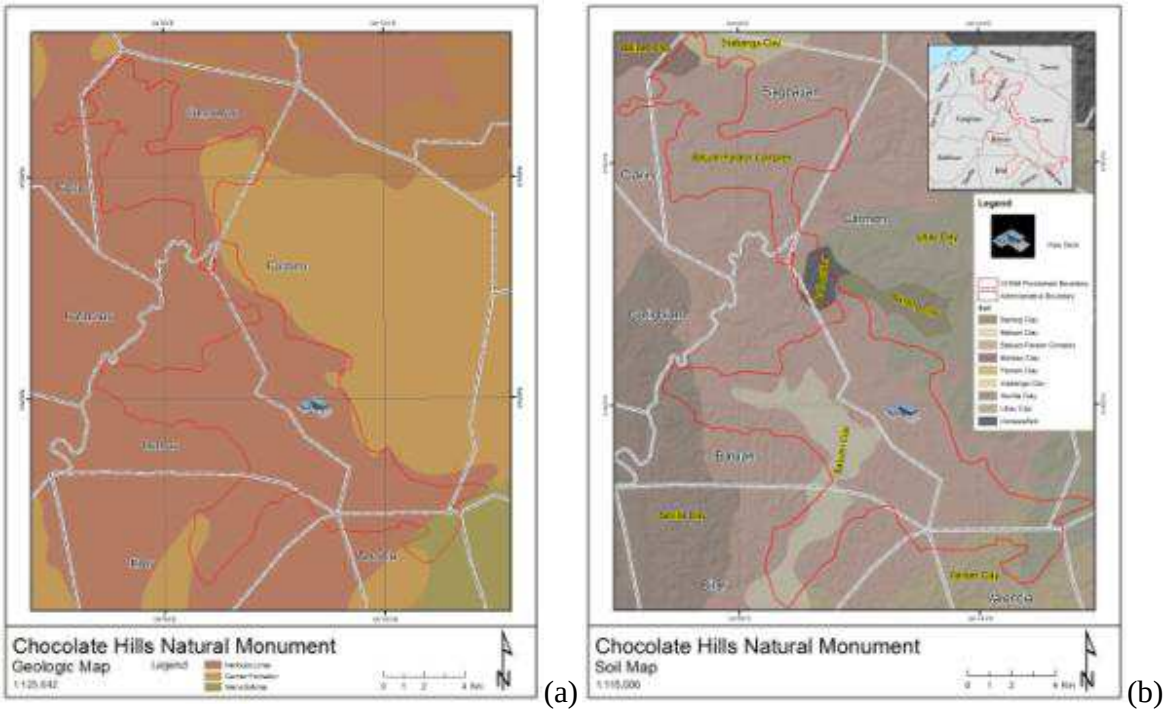
The net present values (NPV) of the two cases were estimated under scenarios of one rotation and perpetual rotations using discount rates of 10% and 15% and prices of $5, 10 and 20[10] per tC.

[10] $1:PhP5

4.0 RESULTS AND DISCUSSION

4.1 Biophysical Assessment

Expectedly, the geology of CHNM is mostly composed of limestone origin specifically Maribojoc limestone (Figure 4a). Some portions of CHNM on the east is composed of Carmen formation (i.e. sandstone, conglomerate, shale and marl) and on its southern tip, Sierra bullones limestone (Urich, 2001). In terms of soils (Figure 3b), about 72% of 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.



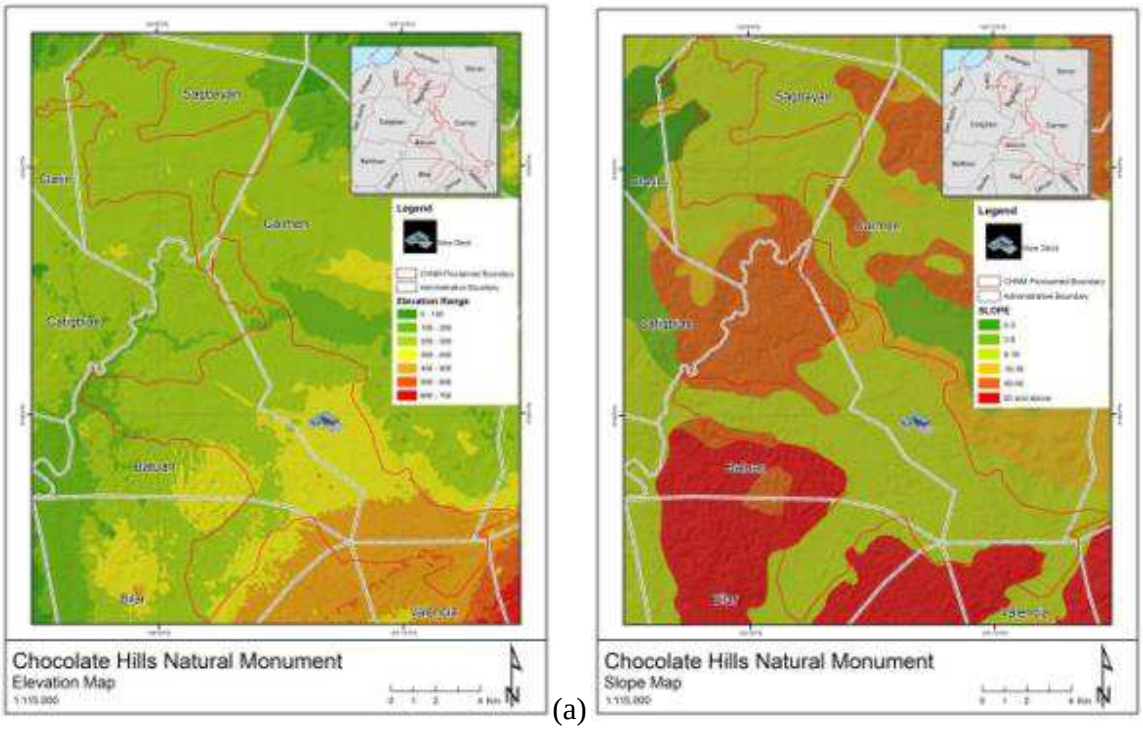
(a) (b)

Figure 4. Geologic (a) and soil (b) maps of CHNM

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 CHNM is characteristic of this part of the island which is described as a plateau-like limestone (Urich , 2001) with minimum and maximum elevations estimated at 125 m and 530 m above sea level. Majority (61%) falls within the range of 200-300m elevation (see Figure 5a; Table 2).



(a) (b)

Figure 5. Elevation (a) and slope (b) maps of CHNM

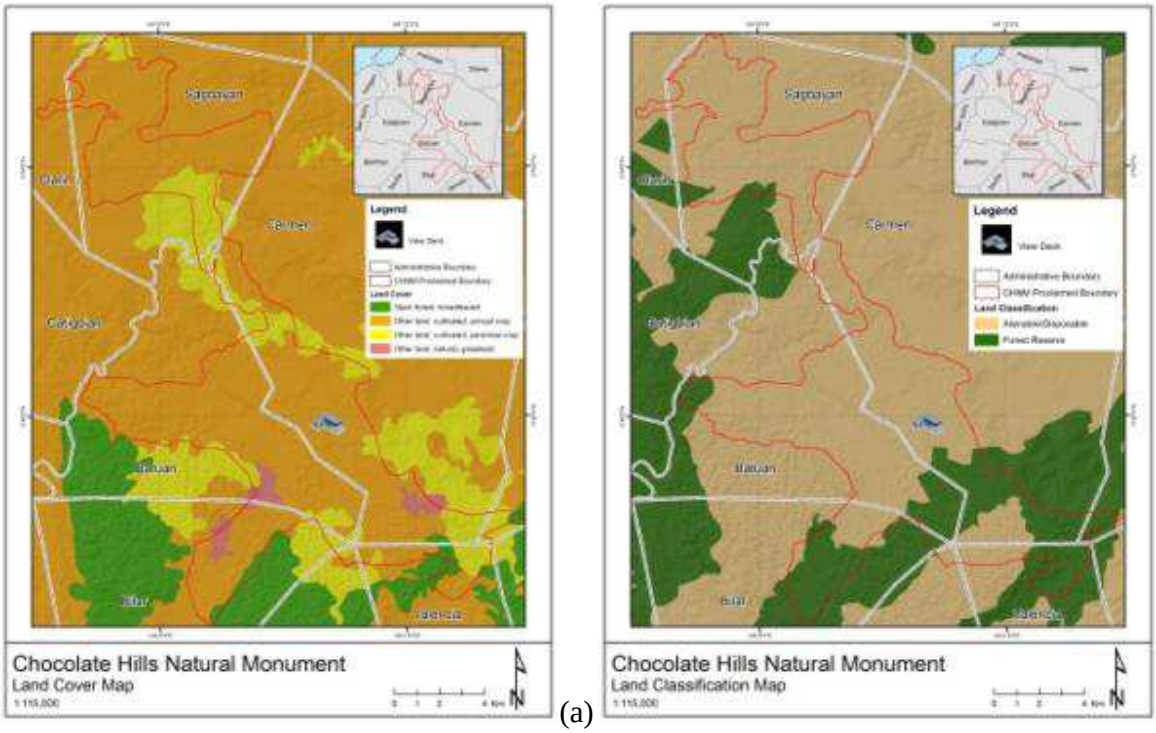
In addition, the slope in the study area is ideal for agriculture where an estimated 85% belongs to slopes 18% and below (Figure 5b; Table 3). The rest of the area is above 18% slope (13% between 18% and 50% slope and 2% above 50% slope).

Table 2. Elevation range in meters above sea level inside CHNM. [Values are in hectares]

Municipality	**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%)

Table 3. Distribution of slope inside CHNM. [Values are in hectares]

Municipality	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%)



(a) (b)

Figure 6 . Land cover (a) and legal land classification (b) maps of CHNM

Figure 6a (see also Table 4) shows the land cover of 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 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% was categorized as forest land or belonging to the state. With such a declaration, all lands inside CHNM reverted to the government 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 CHNM. [Values are in hectares]

Municipality	Land cover and land use			Legal land classification	
	Forest	Agriculture	Other land 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%)

Vegetation Analysis

A total of 123 randomly selected hills in the towns of Carmen, Batuan and Sagbayanwereanalysed. Of this number, 20 hills were evaluated specifically for carbon stock assessment following 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 analysed in terms of height (in meters), DBH (diameter at breast height in cm) and species. There were a total of 200 plots established (since 12 hills shared uphill plots) following evaluation methods described in section IIIC and a sample map of the plot design is shown in Annex 7.5. All in all, a total of 220 plots were established.

The study identified a total number of 2565 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 towns surveyed, the indigenous plants dominated (Figure 7 ; Table 5). The top 20 species in terms of occurrence are shown in Table 6.

Table 5. Vegetation in CHNM.

Vegetation	**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 CHNM. [see Annex 7.7 for a complete listing]

Scientific Name	Common Name	Total
SwieteniamacrophyllaKing	Mahogany	770
CocosnuciferaL.	Niog	293
GmelinaarboreaRoxb.	Gmelina	243
Musa acuminataColla	Saging	172
HeterospatheelataScheff.	Saguisi	154
Leucaenaleucocephala(Lam.) de Wit	Ipil-ipil	108
Imperatacylindrica(L.) Beauv.	Cogon	101
VitexparvifloraJuss.	Molave	74
Bambusa vulgaris Schrad.	Kawayan	70
Naucleaorientalis(L.) L.	Bangkal	62
Koordersiodendronpinnatum(Blanco) Skeels	Amugis	52
EndospermumpeltatumMerr.	Gubas	42
Artocarpusblancoi(Elmer) Merr.	Antipolo	39
HopeafoxwothyiElmer	Daling-dingan	39
Diplaziumesculentum(Retz.) Sw.	Pako	32
CaryotarumphianaMart. var. philippinensisBecc.	Takipan	30
FicussepticaBurm. f.	Hauili	24
Kingiodendronalternifolium(Elmer) Merr. & Rolfe	Balite	21
Gliricidiasepium(Jacq.) Kunth ex Walp.	Kakauate	21
BischofiajavanicaBlume	Tuai	19

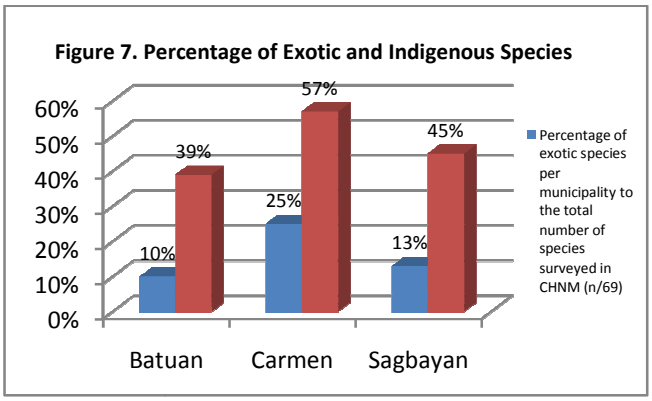


Figure 7. Percentage of Exotic and Indigenous Species

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 diameterclassesand 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.

Table 7. Comparison of plots in 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

Table 8. Diameter classes of plants in CHNM

DBH class (cm)	**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 CHNM

Height class (m)	**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

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

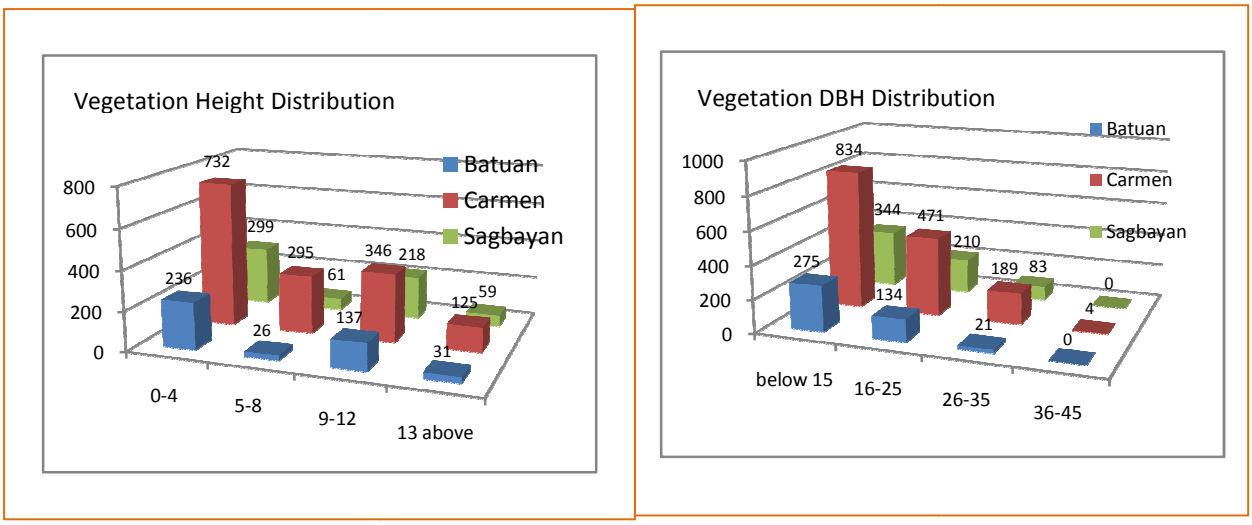


Figure 8.Vegetation height (a) and DBH (b) distribution of plants in CHNM.

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 9). Highest carbon density is observed at the sampled hill in Poblacion, Sagbayan while lowest carbon density is 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. There are a total of 12 trees measured in the said hill with diameter range of 30.5 cm to 64.2 cm. Sampled hill in Rosariohan contains two trees only with dbh of 30.5 cm and 41.5 cm.

Large percentage of the total carbon stored in the hills is found in the trees and soil (Figure 10). Contribution of the trees is around 44-68% while soil contains 30-54% of the total carbon stored. This result is consistent with the results of the studies previously conducted regardless of the type of forests examined.

Aside from absorbing large amount 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 (1989), as cited by Lugo and Brown (1993), stressed that soil has big potential to become significant sinks and sources of carbon.

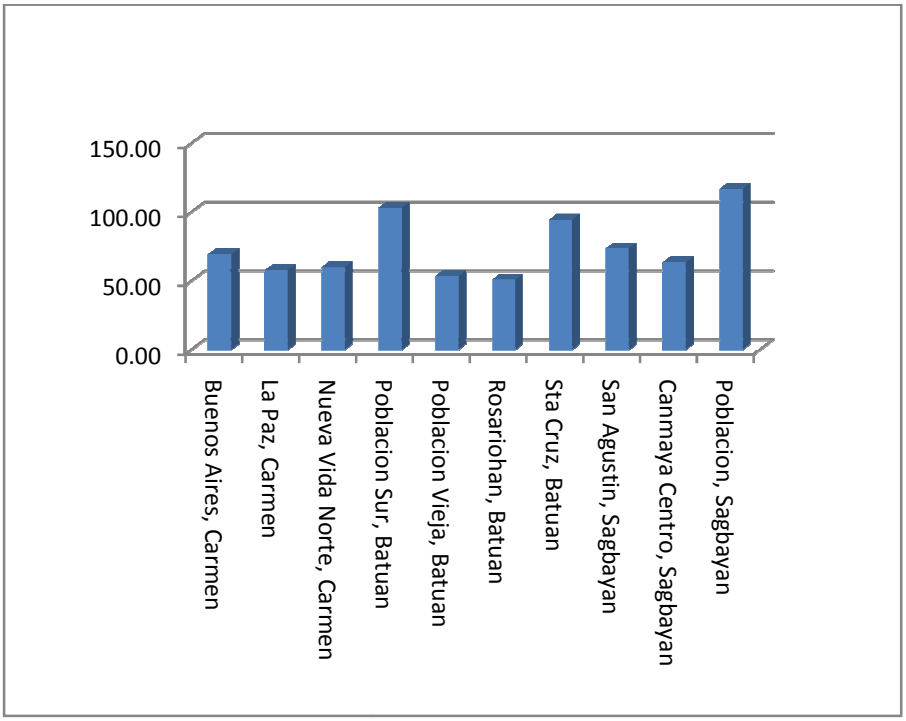


Figure 9. Carbon density of hills with 100% trees.

Lugo and Brown (1993) mentioned that the capacity of the soil to store soil organic carbon was influenced by a number of factors: (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 percent.

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

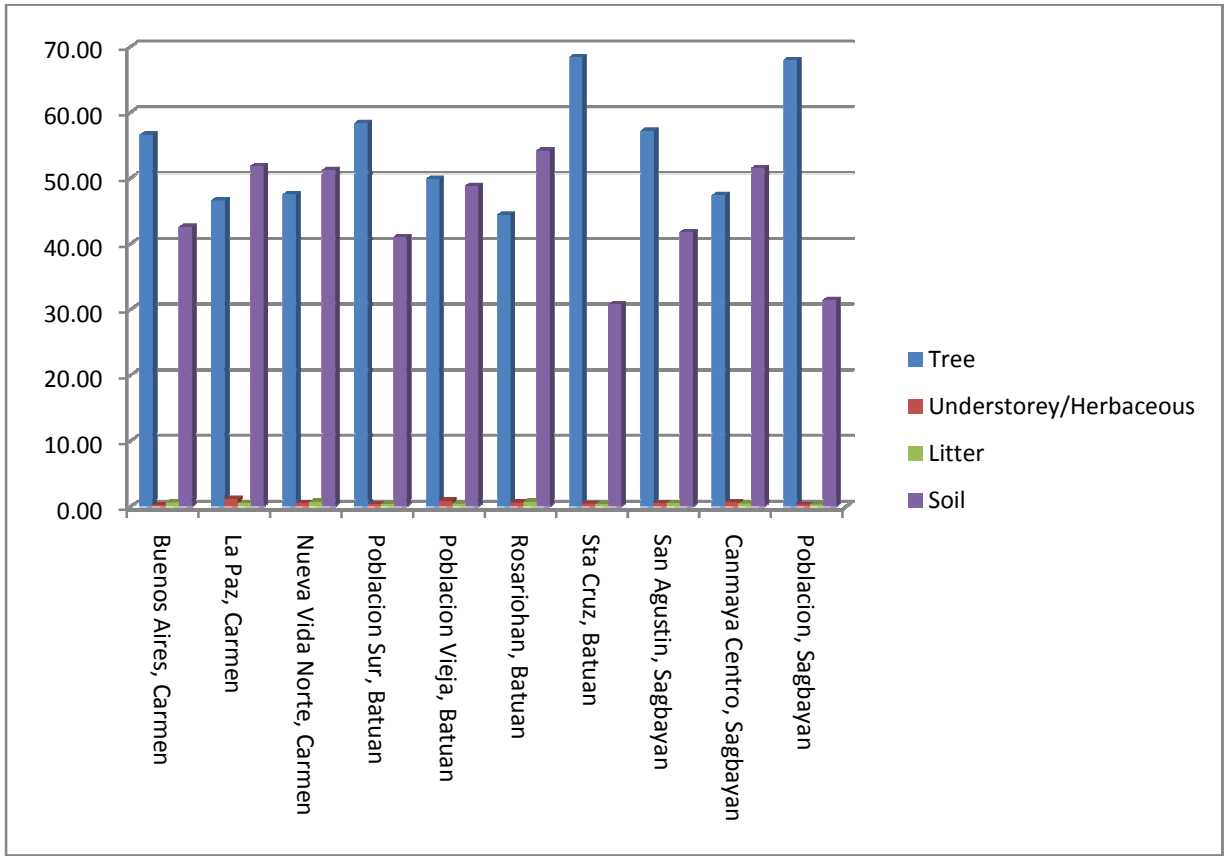


Figure 10. Percent contribution of the different carbon pools in hills with 100% trees.

Hills with 100% grass

Hills with 100% grass have carbon densities ranging from 0.91 t/ha to 4.03 t/ha or an average of 2.40 t/ha (Figure 11). Highest carbon density value is observed at Nueva Vida, Carmen while the lowest value has been noted in Buenos Aires, Carmen. This value is 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.

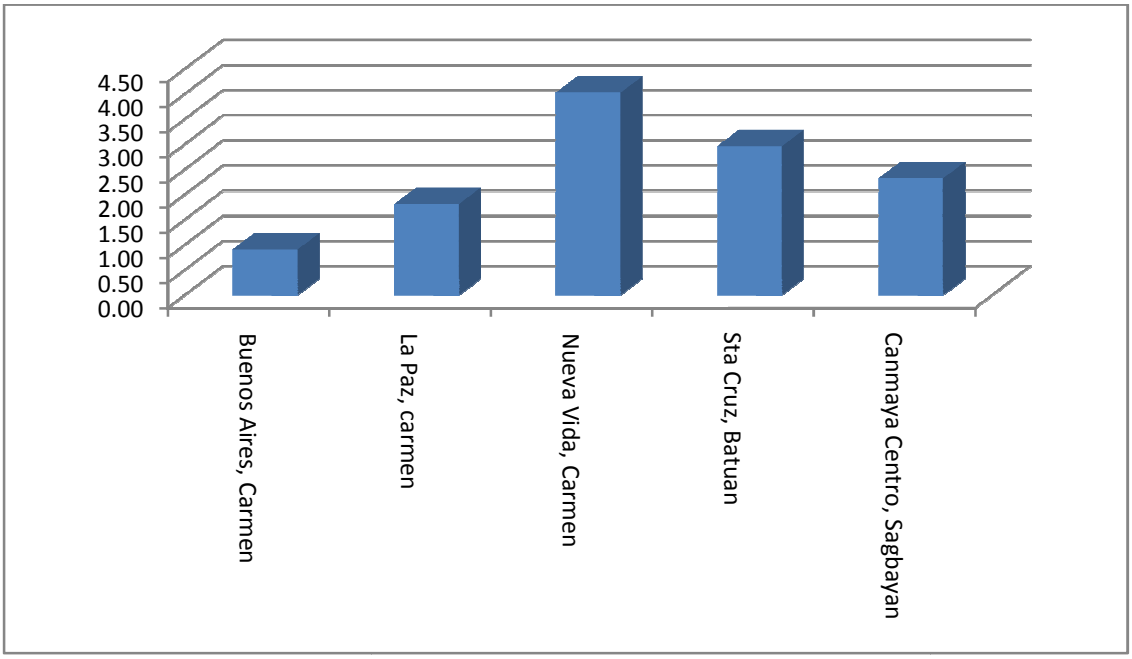


Figure 11. Carbon densities of hills with 100% grass

Using the values obtained, average carbon dioxide emission per hill per year amounts to 9.38 tons. Assuming that there will be 300 hills that will be maintained under grass vegetation for tourism purposes, 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/yr, a total of 153 ha needs to be established as a carbon offset project.

Hills with 20% trees

Carbon densities of hills with 20% trees range from 18.46 t/ha to 131.78 t/ha. On the average, carbon density of hills with 20% trees is about 68.42 t/ha (Figure 12). The large carbon density observed in one of the hills in Buenos Aires is attributed to the presence of a good number of trees. This hill has been densely planted with *Swieteniamacrophylla* with dbh range of 5-26 cm. In one small plot alone, 44 trees are included in the carbon assessment. Considering that only 20 meters from the base has been planted, trees were planted at quite close spacing.

The relative capacity of the different carbon pools in the hills with 20% trees is in the following order: tree> SOC > grass. Around 85% of the total carbon stored is found in the trees whileabout 11% and 4% are in the soil and grass, respectively.

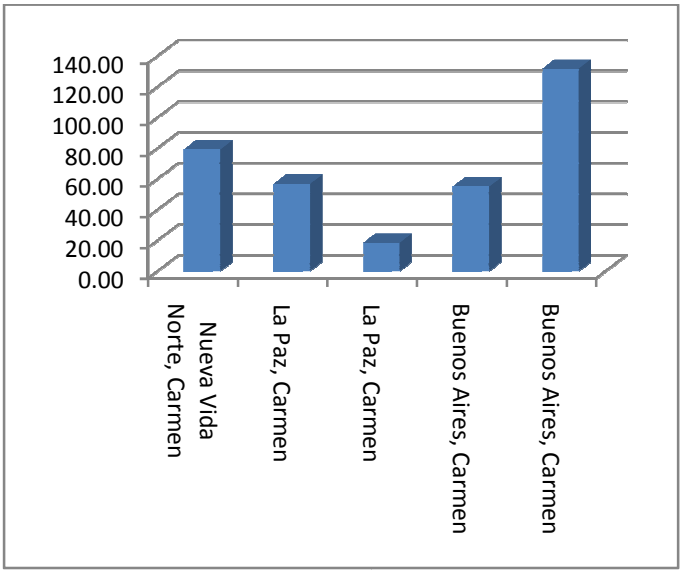


Figure 12.Carbon densities of hills with 20% trees.

Comparing the hills with different cover, results show that carbon density of hills with 100% trees do not differ much with the carbon density value of hills with 20% trees. Carbon density of hills with 100% trees is 74.34 t/ha while that of the hills with 20% trees is valued at 68.32 t/ha (Figure 13).

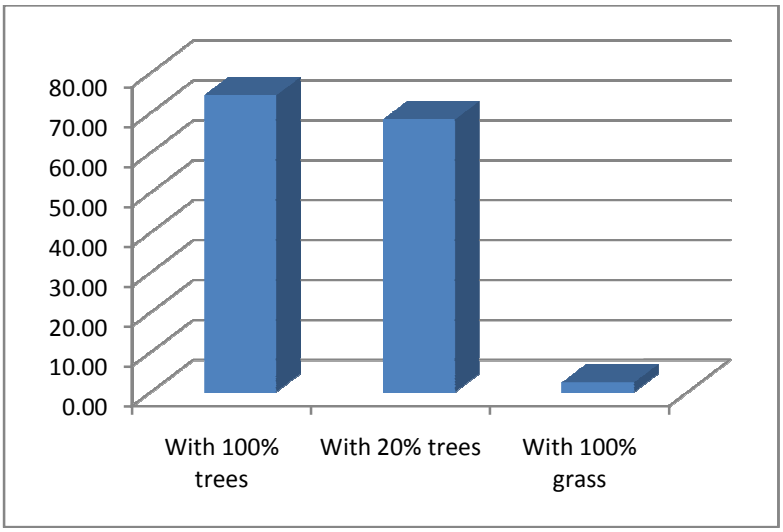


Figure 13. Carbon density of hills with different covers

4.3 Socio-economic Assessment

4.3.1 HouseholdSurvey

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

There were 100 male and 150 female respondents, 84% of whom were married. In terms of educational attainment, 35% were elementary graduates, 22% were HS 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. A high proportion 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 PP 1037 excluding lands that are alienable and disposable in flat and rolling lands below 18% slope) (Table 10). It appears that more respondents were aware of PP 333 (56%) than PP 1037 (25%), possibly because PP 333 is the more recent proclamation and the one being referred to by the barangay council during meetings. It is worth noting that a major reason for non-awareness was poor information dissemination of both policy issuances, although some respondents said 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 about major policy issuances regarding the Chocolate Hills.

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***
PoblacionVieja	18	10
Garcia	11	2
Santa Cruz	27	6
Sagbayan	***69***	***29***
San Agustin	17	8
CanmayaDiot	30	8
Canmaya Centro	22	13
Total	**175**	**75**

There were 25 respondents who said they owned hills, and they were asked whether they received advice from the government regarding the land use practices that were allowed after the Chocolate Hills was declared a protected area. There were more respondents who said 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 about Allowed Land Use Practices (%,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

*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 are 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 P18,546, P12,507, and P8,754 for the year, respectively.

More than half (15) respondents said that trees such as mahogany (*Swieteniamacrophylla),* yemane*(Gmelinaarborea),* and molave*(Vitexparviflora)* and coconut 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

*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 (P/yr)**
	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 they would just leave the hills alone as the land is not productive. Only a few respondents said they wanted to plant agricultural crops on the hills. The apparent decision not to use the hills for farming can be a result of the low incomes 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 and 2009 at 81% and 86%, respectively. Other Asian and European countries were also major origins of visitors to the Chocolate Hills.

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 (P)	**8,925,975**		**20,791,650**	

The highest monthly tourist arrivals for both years were recorded in May and April, 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 is still quite high (Figure 14). Other than the peak months of April and May, the monthly number of visitors to the Chocolate Hills Complex difference 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 P10 per person to P25 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 P50/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 P8.926 million to P20.791.

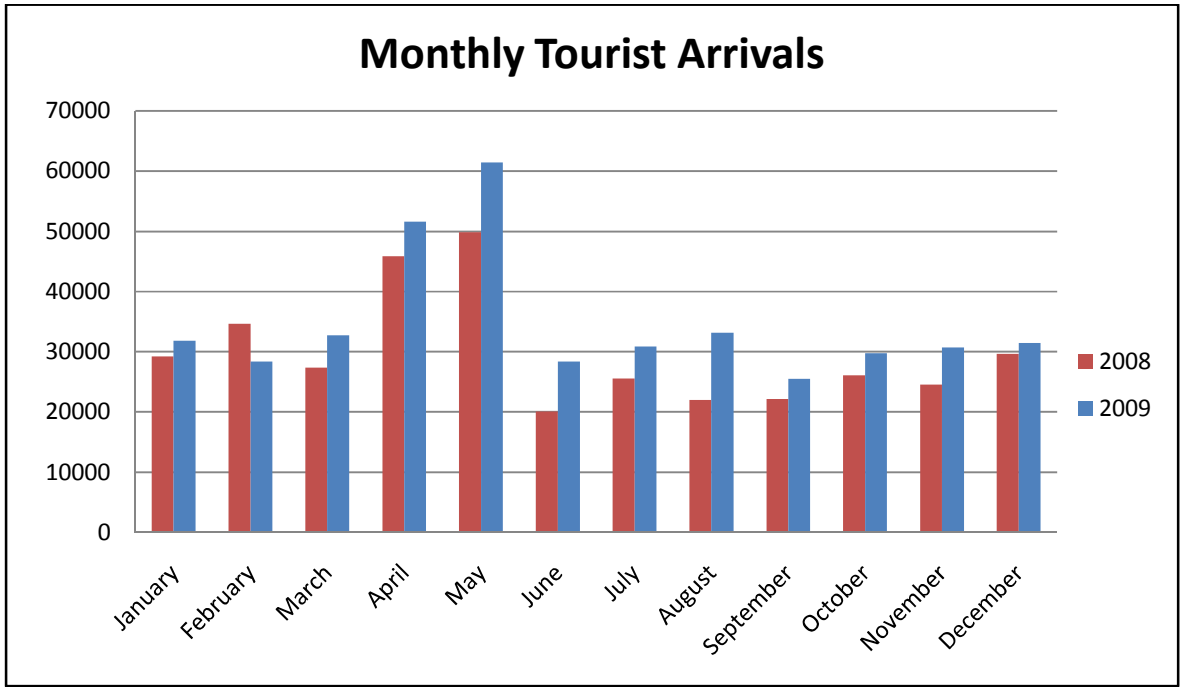


Figure 14. Monthly tourist arrivals

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 spend at the Chocolate Hills Complex was limited. The research team also tried to approach foreign tourists,but was not able to interview any because of the above reason, together with 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, and 82% expressed satisfaction with the appearance of the Chocolate Hills. Almost half of the respondents (49%) were most interested to see the Chocolate Hills, while 12% had the Loboc River Cruise as their top priority. In terms of 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 the 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 cannot 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 Chocolate Hills

Statement	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

*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 and disposable and were 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, burning is no longer allowed, and this has deprived the farmers of fodder source for their livestock. Consequently, the livestock population, especially carabaos, has dwindled. This has adversely affected many local residents whose source of livelihood is livestock raising as well as the farmers who used the carabaos as work animals in their farms.

Before the proclamation, some hills were allowed to be quarried for the gravel needs of the municipalities and the Department of Public Works and Highways. This is no longer allowed, and this has also caused a problem to the local governments because they no longer have sources for backfilling materials. 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 SangguninagPanlalawigan 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 SangguniangPambarangays concerned to enact an ordinance prohibiting destruction of the "Chocolate Hills" located in their respective areas of jurisdiction

Consequently, 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 those of the hills.

Urich (2001) reported that 93% of the hills is privately owned but this figure is difficult to verify with the concerned municipalities. In fact, GIS analysis from available map data on CHNM showed that 77% are privately owned (Figure 6b). 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.

The study learned from the Protected Area Superintendent (PASu) Forester MarcialUgay and the planning officers of the three municipalities of Sagbayan, Batuan and Carmen that current records are incomplete and do not identify owners of specific hills. The titles of the privately owned hills are not segregated in the registry of hills. Moreover, the hills included in the proclamation were merely identified from the topographic map without ground validation. Even the PASu does not know which hills are included in the proclamation.

In 1997, before the inception of the area into the protected area system of 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 which results from the 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 programme intensified.

The ownership of the area has since been abrogated to government and current management practice now rests with the Protected Area Management Board (PAMB) as a result of Presidential Proclamation No. 1037 in 1997 designating the one thousand seven hundred seventy six (1,776) hills, more or less, and areas around and surrounding them located in the

municipalities of Carmen, Batuan, Sagbayan, Bilar, Velencia and Sierra Bullones, Province of Bohol as 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 OffsetProject

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. Such carbon offset project can be aforestation project where an open area is developed by planting trees. Forests have been regardedas a significant sink of carbon because of their ability to absorb large amounts of carbon dioxide fromthe atmosphere through the process of photosynthesis. Trees use carbon dioxide for their growth byfixing it in their biomass. In the Philippines, several studies assessing carbon stored in tree plantationshave been conducted. Results of such studies showed that on the average, tree plantations have a carbondensity of 59 t/ha.

In the case of the chocolate of hills of Bohol, the research team discussed with the PAMB the possibility of setting up a carbonoffset project to compensate for the carbon emissions due to the burning of the hillswithin the Chocolate Hills Complex. This scheme is similar to the concept of the Clean DevelopmentMechanism (CDM) where a developed country can invest in a project in a developing country to getcarbon credits. The amount of carbon generated by the project in the developing country shall formpart 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. Can be a boon to tourism since the study showed the strong feeling of tourists 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 that will be developed should cover a total of 166 ha to offset the carbonemissions from the burning of the proposed 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. 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 shall be managed by the PAMB.

As shown by the cost benefit analysis (see section 4.6), the cost of the status quo will be higher considering reduced biodiversity, increased carbon emission, degraded microclimate and reduced hydrologic functions. There will be a positive improvement on these aspects with a carbon offset project.

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 Annex 7.3, and 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, and 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 30-32 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 0-2, and the plantation maintenance costs from year 1 until year 30. 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. The data and assumptions used in the cost-benefit analysis are presented in Annex 7.2. 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 US$5, US$10 and US$20. For example, the NPV for the initial rotation under the business as usual case at the lowest carbon price of US$5/tC and 10% discount rate is P208,061,040, which is lower than the NPV with carbon offset of P215,625,619. 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, 10 and 20/tC and discount rates of 10% and 15%.

Option	Net Present Value (NPV, PhP)					
	US$5/tC		US$10/tC		US$20/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 (Annex 7.3) 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 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	
-US$ 5/tC	1,627,232
-US$ 10/tC	3,254,463
-US$ 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 and the larger community as well. 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 will also benefit the community that will be directly involved in the carbon offset project, including those from other municipalities and barangays. The global community will also benefit from the reduction in carbon emission.

Moreover, this project has a high acceptability rating for the LGU, the tourists and the PAMB. For the tourists, the proposed alternative will allow burning during the dry months, which in turn will give the Chocolate Hills their “chocolate” appearance. For the PAMB, the proposed alternative will likewise be preferable because it will entail the development of carbon

offsets, which will neutralize the carbon emissions that will result from controlled burning of some hills.

From the economic aspect, the carbon offset project will generate more benefits and reduce costs, especially environmental costs. However, the political acceptability of the status quo is perceived to be higher than the proposed alternative, mainly because it will result in the sharing of benefits among the three municipalities that have jurisdiction over the Chocolate Hills, unlike in the present setup where only the municipality of Carmen benefits from tourism revenues. Consequently, the adoption of the proposed alternative can enhance transparency in management activities.

Table 20. Comparison of 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 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 sequestered; Environmental conservation; Biodiversity conservation; Maintenance of microclimate; Maintenance of hydrologic functions
Political Acceptability	High	Medium
Administrative	Less transparency about management activities	Greater transparency about management activities

5.0 CONCLUSIONS and RECOMMENDATIONS

5.1 Conclusions

The study developed a carbon offset project based on scientific information and then did an economic analysis of this project for possible consideration by the PAMB of the Chocolate Hills Natural Monument (CHNM) in Bohol, Philippines. The study found that CHNMis dominated by agriculture. Historically, 77% of the area was privately-ownedeven though the proclamation recognized the land titles and prior claims of the residents especially on the lowlands devoted to agriculture. Only the hills were reverted to government ownership. However, delineation and demarcation on the ground have yet to start and actual areas have yet to be determined. 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. Accordingly, the study found that the area is exhibiting signs of natural regeneration. From a total of 123 randomly selected hills in the towns of Carmen, Batuan and Sagbayan, the vegetation analysis results show that more hills are forested than are covered with grass. In terms of diameter (i.e. DBH) and height, the plants mostly belong to the low diameter 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 P8,934 for the year.

Comparing the hills with different cover, results show that carbon density of hills with 100% trees do not differ much with the carbon density value of hills with 20% trees. Carbon density of hills with 100% trees is 74.34 t/ha while that of the hills with 20% trees is valued at 68.32 t/ha.

At alternative discount rates of 10% and 15%, 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 US$5, US$10 and US$20. The NPV for the initial rotation under the business as usual case at the lowest carbon price of US$5/tC and 10% discount rate is P208,061,040, and is lower than the NPV with carbon offset of P215,625,619. Furthermore, a 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 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 (Annex 7.8) dated June 4, 2010 indicated that they will 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 Carmen LGU. However, they had no scientific basis for the clearing. They proposed an arbitrary scheme where some 300 hills would be cleared of vegetationup to 80% from the top while leaving the bottom 20% vegetated (80-20 scheme).The results of the carbon study was able to show 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 needs to be established. We have included a draft resolution for the PAMB in order to initiate a carbon offset project for CHNM (Annex 7.9).

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Annex 7.1
Household Survey Questionnaire

Enumerator: _____ Date: _____
Time Started: _____ Time Ended: _____

Introductory Remarks

Good morning/afternoon. I am _____, a student from _____ and a member of a research team from the University of the Philippines Los Baños. We are undertaking a study on alternative management regimes for Bohol's Chocolate Hills, and one of the components of our study is a survey among residents to determine land use practices and benefits from the CHNM. I would like to ask whether you are willing to participate in our survey? If yes, please sign this consent form.
Enumerator lets respondent sign the consent form.

Thank you for agreeing to participate in our survey. We will now begin the interview. I would like to request you to think carefully about the following questions. Your answers will help us a lot in our study.

I. General Information about the Respondent
Name: _____
Address: _____

1. Age: _____
2. Gender: _____ Male _____ Female
3. Civil Status: _____ Single _____ Married _____ Widow/er
4. Educational attainment: _____

5. Occupation
   _____ Unemployed
   _____ Self-employed
   _____ Government employee
   _____ Private sector employee
   _____ Others, please specify _____

6. Household Size:
   _____ Adults (15 years and above)
   _____ Children (14 yrs and below)

7. How many in your family, including yourself, is/are gainfully employed? _____

Household Member	Income			
	Main		Other Source	
	Type*	Amount (₱/month)	Type*	Amount (₱/month)

* Employee, Business, etc.

8. Ownership of House:
   _____ Owned
   _____ Rented
   _____ Living with relative

II. Property Ownership and Land Use Practices within CHNM

1. Do you own a piece of property/land? _____ Yes _____ No

   a. If yes, please fill up the following table:

Location (Indicate if within CHNM)	**No. of Parcels**	**Area (ha)**	**Current Land Use/s**	**Basis of Ownership (title, tax dec)**	**Estimated Annual Income (P/yr)**

2. Which of the following policy issuances about the CHNM are you familiar with?

Policy Issuance	✓ **If aware**	✓ **If NOT,why?**
Presidential Proclamation 1037 declaring the Chocolate Hills Natural Monument and putting the hills under government control and supervision		
Presidential Proclamation 333 amending Presidential Proclamation 1037 excluding lands that are alienable and disposable (A&D) in flat and rolling lands below 18% slope		

Questions 3-6 are for respondents who own hills in the CHNM:

3. What benefits do you and your family derive from the CHNM?

Benefit	**Pls describe (indicate kind, amount/u.t.)**
Income from land, agricultural	

crops	
Income from land, tree crops	
Income from tourism (homestay, tour guide, sale of souvenirs, sari-sari store	
Support from government because land use is controlled	
Others, pls specify	

4. Have you been informed of the land use practices that you may or may not do?
_____Yes _____No

a. If Yes, which of the following have you been advised about?

Practice	✓ **If advised**	**Remarks** (description, compliance)
Agricultural crops that can be planted (indicate what)		
Maximum elevation of the hills where you can plant		
Need to burn hills regularly (indicate frequency, time of year)		
Need to cut down trees that grow on hills		
Others, pls specify		

III. Details for Income Profile (for the period Jan-Dec 2009)

1. Are you and your other household members engaged in farming for the period Jan-Dec 2009?

[ ] Yes. [ ] No.

2. How many farm parcels do you and other household members cultivate? _____

3. Where are your farm parcels located?	4. * What is the tenure status in (parcel)?	5. How many hectares is (parcel)?	6. ** What were the crops planted in (parcel) last year (Jan-Dec 2009)?	7. What is the area planted to (crop)? (in ha.)
Parcel 1:				

Parcel 2:				
Parcel 3:				
Parcel 4:				
Parcel 5:				

*1-owned, 2-partly-owned, 3-amortizing owner, 4-tenanted, 5-leased
**1-coconut, 2-banana, 3-rice, 4=corn, 5-sweet potato, 6-cassava, 6-yautia

Location of parcel (Copy from Q#3)	Name of Crops (copy from Q#6)	8. How much of (crop) have you harvested [Jan-Dec 2009]?	9. How many times did you harvest (crop) [Jan-Dec 2009]?	10. Prevailing market price of (crop) [Jan-Dec 2009]	11a. Estimated Cost of Prodn in (crop)	11b. Estimated Income [Jan-Dec 2009] (in PhP)
Parcel 1:						
Parcel 2:						
Parcel 3:						
Parcel 4:						

Parcel 5:						

1. What crops/trees grow well on the hills?

2. What crops/trees do not grow well on the hills?

3. If it were all up to you, what do you want to do with the hills you own?
   _____ Totally plant them with agricultural crops
   _____ Totally plant them with trees
   _____ Plant a combination of agricultural and tree crops
   _____ Leave them alone as the land is not productive
   _____ Others, pls specify _____

Thank you for participating in our survey.
As a token of our appreciation, please accept this simple gift.

Information for Respondent's Consent Form

Good morning/afternoon/evening. I belong to a research team from the University of the Philippines Los Baños that is undertaking a study on the management of the Chocolate Hills. I hope you can help us by participating in this survey. This survey will take about 30 minutes to complete. I would like to assure you that the information you will reveal will be used only for the purpose of this study, and we will keep your identity confidential. Are you willing to participate in this survey? ***(If willing, request the respondent to sign the consent form).***

If you have any question about our study or the research team, please feel free to contact Dr. Enrique L. Tolentino, Jr., Director, Institute of Renewable Natural Resources, University of the Philippines Los Baños, College, Laguna at 63 49 536 2557.

Thank you.

_____

Name and signature of enumerator

(Note to enumerator: detach this part and give to respondent)

Respondent's Consent Form

This is to certify that _____, a member of the University of the Philippines Los Baños research team, explained to me the objectives of their study on the management of the Chocolate Hills. I hereby agree to participate in the survey, with the assurance that:

1. The information I will reveal will be used solely for research purposes;
2. I have the option to discontinue my participation at any point in the survey should I feel uncomfortable about it;
3. My identity will be kept confidential; and
4. I can verify the study and the identity of the research team from Dr. Enrique L. Tolentino, Jr., Director, Institute of Renewable Natural Resources, University of the Philippines Los Baños, College, Laguna at 63 49 536 2557.

_____ _____

Name and Signature of Respondent **Date**

Annex 7.2

The data and assumptions used in the cost-benefit analysis.

Parameter	Value	Unit
Biomass accumulation rates for native species		
Year 1-15	5.7	t/ha
Year 16-30 (decline by 10%)	5.1	t/ha
Timber volume (30 years)	60	t/ha
Wood density native species	0.6	t/cu.m.
Establishment cost	30,000.00	PhP per ha
Rotation length	30	years
Maintenance cost	1,500.00	PhP per ha/yr
Total emission from burned grassland vegetation (CO2)	2,813.00	tCO2/year
Conversion factor from CO2 to C	0.27	unitless
Total emission from burned grassland vegetation (C) for 300 hills	767.18	tC/year
Harvesting cost	2,410.00	PhP/cu.m.
Stumpage Value	7,108.00	PhP/cu.m.
Rate of establishment		
Year 1	50	ha
Year 2	50	ha
Year 3	66	ha
Entrance	50	per visitor
Discount rate	10%; 15%	
Price of carbon		
Low	20	USD/tC
Medium	10	USD/tC
High	20	USD/tC
Currency conversion	45	PhP/USD

Annex 7.3 Table 1. Cost-benefit analysis results for the current (business as usual) and the proposed management regime for CHNM at the discount rate of 10% and carbon price of US$ 10/tC.

Base Case: Business As Usual (With Burning)
Discount rate = 10% Carbon price = 10 US$/tC

	Benefits			Costs		
Year	Entrance Fee Revenue	Business Revenue	Total	Carbon Emission	Total	Net Benefit
0	0		0	0	0	0
1	17,851,950	1,620,000	19,471,950	7,672	7671.818	19,464,278
2	20,791,650	1,620,000	22,411,650	7,672	7671.818	22,403,978
3	21,572,277	1,620,000	23,192,277	7,672	7671.818	23,184,606
4	20,200,999	1,620,000	21,820,999	7,672	7671.818	21,813,327
5	23,141,576	1,620,000	24,761,576	7,672	7671.818	24,753,905
6	21,013,137	1,620,000	22,633,137	7,672	7671.818	22,625,465
7	20,074,671	1,620,000	21,694,671	7,672	7671.818	21,687,000
8	16,668,125	1,620,000	18,288,125	7,672	7671.818	18,280,454
9	24,048,276	1,620,000	25,668,276	7,672	7671.818	25,660,604
10	20,319,867	1,620,000	21,939,867	7,672	7671.818	21,932,195
11	19,420,578	1,620,000	21,040,578	7,672	7671.818	21,032,906
12	18,844,000	1,620,000	20,464,000	7,672	7671.818	20,456,329
13	16,740,254	1,620,000	18,360,254	7,672	7671.818	18,352,582
14	15,568,773	1,620,000	17,188,773	7,672	7671.818	17,181,101
15	19,552,610	1,620,000	21,172,610	7,672	7671.818	21,164,938
16	26,757,423	1,620,000	28,377,423	7,672	7671.818	28,369,751
17	24,231,966	1,620,000	25,851,966	7,672	7671.818	25,844,294
18	24,101,986	1,620,000	25,721,986	7,672	7671.818	25,714,314
19	23,350,955	1,620,000	24,970,955	7,672	7671.818	24,963,283
20	23,309,490	1,620,000	24,929,490	7,672	7671.818	24,921,819
21	18,876,648	1,620,000	20,496,648	7,672	7671.818	20,488,977
22	20,459,704	1,620,000	22,079,704	7,672	7671.818	22,072,032
23	15,738,595	1,620,000	17,358,595	7,672	7671.818	17,350,924
24	22,151,700	1,620,000	23,771,700	7,672	7671.818	23,764,029
25	18,840,638	1,620,000	20,460,638	7,672	7671.818	20,452,966
26	21,173,889	1,620,000	22,793,889	7,672	7671.818	22,786,217
27	22,164,979	1,620,000	23,784,979	7,672	7671.818	23,777,307
28	20,355,823	1,620,000	21,975,823	7,672	7671.818	21,968,151
29	21,368,082	1,620,000	22,988,082	7,672	7671.818	22,980,410
30	23,662,750	1,620,000	25,282,750	7,672	7671.818	25,275,078
31						
32						
				NPV (initial rotation)		**208,024,880**
				NPV (perpetual)		**219,946,483**

Proposed Management Regime: (Burning with Carbon Offsets)
Discount rate = 10% Carbon price = 10 US$/tC

	Benefits					Costs				
Year	Entrance Fee Revenue	Business Revenue	Carbon Offsets	Timber Revenue	Total	Estab Cost	Maint Cost	Carbon Emission	Total	Net Benefit
0	0	0	0	0	0	1,500,000		0	1,500,000	-1,500,000
1	17,851,950	1,620,000	67,950	0	19,539,900	1,500,000	75,000	7,672	1,582,672	17,957,228
2	20,791,650	1,620,000	200,700	0	22,612,350	1,980,000	150,000	7,672	2,137,672	20,474,678
3	21,572,277	1,620,000	417,600	0	23,609,877	0	249,000	7,672	256,672	23,353,206
4	20,200,999	1,620,000	633,150	0	22,454,149	0	249,000	7,672	256,672	22,197,477
5	23,141,576	1,620,000	847,800	0	25,609,376	0	249,000	7,672	256,672	25,352,705
6	21,013,137	1,620,000	1,061,550	0	23,694,687	0	249,000	7,672	256,672	23,438,015
7	20,074,671	1,620,000	1,274,850	0	22,969,521	0	249,000	7,672	256,672	22,712,850
8	16,668,125	1,620,000	1,487,700	0	19,775,825	0	249,000	7,672	256,672	19,519,154
9	24,048,276	1,620,000	1,700,550	0	27,368,826	0	249,000	7,672	256,672	27,112,154
10	20,319,867	1,620,000	1,912,500	0	23,852,367	0	249,000	7,672	256,672	23,595,695
11	19,420,578	1,620,000	2,124,450	0	23,165,028	0	249,000	7,672	256,672	22,908,356
12	18,844,000	1,620,000	2,336,400	0	22,800,400	0	249,000	7,672	256,672	22,543,729
13	16,740,254	1,620,000	2,547,900	0	20,908,154	0	249,000	7,672	256,672	20,651,482
14	15,568,773	1,620,000	2,759,400	0	19,948,173	0	249,000	7,672	256,672	19,691,501
15	19,552,610	1,620,000	2,970,450	0	24,143,060	0	249,000	7,672	256,672	23,886,388
16	26,757,423	1,620,000	3,160,350	0	31,537,773	0	249,000	7,672	256,672	31,281,101
17	24,231,966	1,620,000	3,350,250	0	29,202,216	0	249,000	7,672	256,672	28,945,544
18	24,101,986	1,620,000	3,539,700	0	29,261,686	0	249,000	7,672	256,672	29,005,014
19	23,350,955	1,620,000	3,729,150	0	28,700,105	0	249,000	7,672	256,672	28,443,433
20	23,309,490	1,620,000	3,918,600	0	28,848,090	0	249,000	7,672	256,672	28,591,419
21	18,876,648	1,620,000	4,108,050	0	24,604,698	0	249,000	7,672	256,672	24,348,027
22	20,459,704	1,620,000	4,297,500	0	26,377,204	0	249,000	7,672	256,672	26,120,532
23	15,738,595	1,620,000	4,486,500	0	21,845,095	0	249,000	7,672	256,672	21,588,424
24	22,151,700	1,620,000	4,675,500	0	28,447,200	0	249,000	7,672	256,672	28,190,529
25	18,840,638	1,620,000	4,864,500	0	25,325,138	0	249,000	7,672	256,672	25,068,466
26	21,173,889	1,620,000	5,053,500	0	27,847,389	0	249,000	7,672	256,672	27,590,717
27	22,164,979	1,620,000	5,242,500	0	29,027,479	0	249,000	7,672	256,672	28,770,807
28	20,355,823	1,620,000	5,431,500	0	27,407,323	0	249,000	7,672	256,672	27,150,651
29	21,368,082	1,620,000	5,620,050	0	28,608,132	0	249,000	7,672	256,672	28,351,460
30	23,662,750	1,620,000	5,808,600	35,540,000	66,631,350	0	249,000	7,672	256,672	66,374,678
31				35,540,000	35,540,000	0	150,000	0	150,000	35,390,000
32				46,912,800	46,912,800	0	75,000	0	75,000	46,837,800
							NPV (initial rotation)			**223,662,468**
							NPV (perpetual)			**236,480,240**

Annex 7.3 Table 2. Cost-benefit analysis results for the current (business as usual) and the proposed management regime for CHNM at the discount rate of 10% and carbon price of US$ 20/tC.

Base Case: Business As Usual (With Burning)
Discount rate = 10% Carbon price = 20 US$/tC

	Benefits			Costs		
Year	Entrance Fee Revenue	Business Revenue	Total	Carbon Emission	Total	Net Benefit
0	0		0	0	0	0
1	17,851,950	1,620,000	19,471,950	15,344	15343.64	19,456,606
2	20,791,650	1,620,000	22,411,650	15,344	15343.64	22,396,306
3	21,572,277	1,620,000	23,192,277	15,344	15343.64	23,176,934
4	20,200,999	1,620,000	21,820,999	15,344	15343.64	21,805,655
5	23,141,576	1,620,000	24,761,576	15,344	15343.64	24,746,233
6	21,013,137	1,620,000	22,633,137	15,344	15343.64	22,617,794
7	20,074,671	1,620,000	21,694,671	15,344	15343.64	21,679,328
8	16,668,125	1,620,000	18,288,125	15,344	15343.64	18,272,782
9	24,048,276	1,620,000	25,668,276	15,344	15343.64	25,652,932
10	20,319,867	1,620,000	21,939,867	15,344	15343.64	21,924,523
11	19,420,578	1,620,000	21,040,578	15,344	15343.64	21,025,234
12	18,844,000	1,620,000	20,464,000	15,344	15343.64	20,448,657
13	16,740,254	1,620,000	18,360,254	15,344	15343.64	18,344,910
14	15,568,773	1,620,000	17,188,773	15,344	15343.64	17,173,430
15	19,552,610	1,620,000	21,172,610	15,344	15343.64	21,157,267
16	26,757,423	1,620,000	28,377,423	15,344	15343.64	28,362,080
17	24,231,966	1,620,000	25,851,966	15,344	15343.64	25,836,622
18	24,101,986	1,620,000	25,721,986	15,344	15343.64	25,706,642
19	23,350,955	1,620,000	24,970,955	15,344	15343.64	24,955,611
20	23,309,490	1,620,000	24,929,490	15,344	15343.64	24,914,147
21	18,876,648	1,620,000	20,496,648	15,344	15343.64	20,481,305
22	20,459,704	1,620,000	22,079,704	15,344	15343.64	22,064,360
23	15,738,595	1,620,000	17,358,595	15,344	15343.64	17,343,252
24	22,151,700	1,620,000	23,771,700	15,344	15343.64	23,756,357
25	18,840,638	1,620,000	20,460,638	15,344	15343.64	20,445,295
26	21,173,889	1,620,000	22,793,889	15,344	15343.64	22,778,545
27	22,164,979	1,620,000	23,784,979	15,344	15343.64	23,769,635
28	20,355,823	1,620,000	21,975,823	15,344	15343.64	21,960,480
29	21,368,082	1,620,000	22,988,082	15,344	15343.64	22,972,738
30	23,662,750	1,620,000	25,282,750	15,344	15343.64	25,267,406
31						
32						
				NPV (initial rotation)		**207,952,558**
				NPV (perpetual)		**219,870,017**

Proposed Management Regime: (Burning with Carbon Offsets)
Discount rate = 10% Carbon price = 20 US$/tC

	Benefits					Costs				
Year	Entrance Fee Revenue	Business Revenue	Carbon Offsets	Timber Revenue	Total	Estab Cost	Maint Cost	Carbon Emission	Total	Net Benefit
0	0	0	0	0	0	1,500,000		0	1,500,000	-1,500,000
1	17,851,950	1,620,000	135,900	0	19,607,850	1,500,000	75,000	15,344	1,590,344	18,017,506
2	20,791,650	1,620,000	401,400	0	22,813,050	1,980,000	150,000	15,344	2,145,344	20,667,706
3	21,572,277	1,620,000	835,200	0	24,027,477	0	249,000	15,344	264,344	23,763,134
4	20,200,999	1,620,000	1,266,300	0	23,087,299	0	249,000	15,344	264,344	22,822,955
5	23,141,576	1,620,000	1,695,600	0	26,457,176	0	249,000	15,344	264,344	26,192,833
6	21,013,137	1,620,000	2,123,100	0	24,756,237	0	249,000	15,344	264,344	24,491,894
7	20,074,671	1,620,000	2,549,700	0	24,244,371	0	249,000	15,344	264,344	23,980,028
8	16,668,125	1,620,000	2,975,400	0	21,263,525	0	249,000	15,344	264,344	20,999,182
9	24,048,276	1,620,000	3,401,100	0	29,069,376	0	249,000	15,344	264,344	28,805,032
10	20,319,867	1,620,000	3,825,000	0	25,764,867	0	249,000	15,344	264,344	25,500,523
11	19,420,578	1,620,000	4,248,900	0	25,289,478	0	249,000	15,344	264,344	25,025,134
12	18,844,000	1,620,000	4,672,800	0	25,136,800	0	249,000	15,344	264,344	24,872,457
13	16,740,254	1,620,000	5,095,800	0	23,456,054	0	249,000	15,344	264,344	23,191,710
14	15,568,773	1,620,000	5,518,800	0	22,707,573	0	249,000	15,344	264,344	22,443,230
15	19,552,610	1,620,000	5,940,900	0	27,113,510	0	249,000	15,344	264,344	26,849,167
16	26,757,423	1,620,000	6,320,700	0	34,698,123	0	249,000	15,344	264,344	34,433,780
17	24,231,966	1,620,000	6,700,500	0	32,552,466	0	249,000	15,344	264,344	32,288,122
18	24,101,986	1,620,000	7,079,400	0	32,801,386	0	249,000	15,344	264,344	32,537,042
19	23,350,955	1,620,000	7,458,300	0	32,429,255	0	249,000	15,344	264,344	32,164,911
20	23,309,490	1,620,000	7,837,200	0	32,766,690	0	249,000	15,344	264,344	32,502,347
21	18,876,648	1,620,000	8,216,100	0	28,712,748	0	249,000	15,344	264,344	28,448,405
22	20,459,704	1,620,000	8,595,000	0	30,674,704	0	249,000	15,344	264,344	30,410,360
23	15,738,595	1,620,000	8,973,000	0	26,331,595	0	249,000	15,344	264,344	26,067,252
24	22,151,700	1,620,000	9,351,000	0	33,122,700	0	249,000	15,344	264,344	32,858,357
25	18,840,638	1,620,000	9,729,000	0	30,189,638	0	249,000	15,344	264,344	29,925,295
26	21,173,889	1,620,000	10,107,000	0	32,900,889	0	249,000	15,344	264,344	32,636,545
27	22,164,979	1,620,000	10,485,000	0	34,269,979	0	249,000	15,344	264,344	34,005,635
28	20,355,823	1,620,000	10,863,000	0	32,838,823	0	249,000	15,344	264,344	32,574,480
29	21,368,082	1,620,000	11,240,100	0	34,228,182	0	249,000	15,344	264,344	33,963,838
30	23,662,750	1,620,000	11,617,200	35,540,000	72,439,950	0	249,000	15,344	264,344	72,175,606
31				35,540,000	35,540,000	0	150,000	0	150,000	35,390,000
32				46,912,800	46,912,800	0	75,000	0	75,000	46,837,800
							NPV (initial rotation)			**239,736,167**
							NPV (perpetual)			**253,475,098**

Annex 7.3 Table 3. Cost-benefit analysis results for the current (business as usual) and the proposed management regime for CHNM at the discount rate of 15% and carbon price of US$ 5/tC.

Base Case: Business As Usual (With Burning)
Discount rate = 15% Carbon price = 5 US$/tC

	Benefits			Costs		
Year	Entrance Fee Revenue	Business Revenue	Total	Carbon Emission	Total	Net Benefit
0	0		0	0	0	0
1	17,851,950	1,620,000	19,471,950	3,836	3835.909	19,468,114
2	20,791,650	1,620,000	22,411,650	3,836	3835.909	22,407,814
3	21,572,277	1,620,000	23,192,277	3,836	3835.909	23,188,442
4	20,200,999	1,620,000	21,820,999	3,836	3835.909	21,817,163
5	23,141,576	1,620,000	24,761,576	3,836	3835.909	24,757,740
6	21,013,137	1,620,000	22,633,137	3,836	3835.909	22,629,301
7	20,074,671	1,620,000	21,694,671	3,836	3835.909	21,690,835
8	16,668,125	1,620,000	18,288,125	3,836	3835.909	18,284,289
9	24,048,276	1,620,000	25,668,276	3,836	3835.909	25,664,440
10	20,319,867	1,620,000	21,939,867	3,836	3835.909	21,936,031
11	19,420,578	1,620,000	21,040,578	3,836	3835.909	21,036,742
12	18,844,000	1,620,000	20,464,000	3,836	3835.909	20,460,164
13	16,740,254	1,620,000	18,360,254	3,836	3835.909	18,356,418
14	15,568,773	1,620,000	17,188,773	3,836	3835.909	17,184,937
15	19,552,610	1,620,000	21,172,610	3,836	3835.909	21,168,774
16	26,757,423	1,620,000	28,377,423	3,836	3835.909	28,373,587
17	24,231,966	1,620,000	25,851,966	3,836	3835.909	25,848,130
18	24,101,986	1,620,000	25,721,986	3,836	3835.909	25,718,150
19	23,350,955	1,620,000	24,970,955	3,836	3835.909	24,967,119
20	23,309,490	1,620,000	24,929,490	3,836	3835.909	24,925,655
21	18,876,648	1,620,000	20,496,648	3,836	3835.909	20,492,812
22	20,459,704	1,620,000	22,079,704	3,836	3835.909	22,075,868
23	15,738,595	1,620,000	17,358,595	3,836	3835.909	17,354,760
24	22,151,700	1,620,000	23,771,700	3,836	3835.909	23,767,864
25	18,840,638	1,620,000	20,460,638	3,836	3835.909	20,456,802
26	21,173,889	1,620,000	22,793,889	3,836	3835.909	22,790,053
27	22,164,979	1,620,000	23,784,979	3,836	3835.909	23,781,143
28	20,355,823	1,620,000	21,975,823	3,836	3835.909	21,971,987
29	21,368,082	1,620,000	22,988,082	3,836	3835.909	22,984,246
30	23,662,750	1,620,000	25,282,750	3,836	3835.909	25,278,914
31						
32						
				NPV (initial rotation)		**144,309,484**
				NPV (perpetual)		**146,488,997**

Proposed Management Regime: (Burning with Carbon Offsets)
Discount rate = 15% Carbon price = 5 US$/tC

	Benefits					Costs				
Year	Entrance Fee Revenue	Business Revenue	Carbon Offsets	Timber Revenue	Total	Estab Cost	Maint Cost	Carbon Emission	Total	Net Benefit
0	0	0	0	0	0	1,500,000		0	1,500,000	-1,500,000
1	17,851,950	1,620,000	33,975	0	19,505,925	1,500,000	75,000	3,836	1,578,836	17,927,089
2	20,791,650	1,620,000	100,350	0	22,512,000	1,980,000	150,000	3,836	2,133,836	20,378,164
3	21,572,277	1,620,000	208,800	0	23,401,077	0	249,000	3,836	252,836	23,148,242
4	20,200,999	1,620,000	316,575	0	22,137,574	0	249,000	3,836	252,836	21,884,738
5	23,141,576	1,620,000	423,900	0	25,185,476	0	249,000	3,836	252,836	24,932,640
6	21,013,137	1,620,000	530,775	0	23,163,912	0	249,000	3,836	252,836	22,911,076
7	20,074,671	1,620,000	637,425	0	22,332,096	0	249,000	3,836	252,836	22,079,260
8	16,668,125	1,620,000	743,850	0	19,031,975	0	249,000	3,836	252,836	18,779,139
9	24,048,276	1,620,000	850,275	0	26,518,551	0	249,000	3,836	252,836	26,265,715
10	20,319,867	1,620,000	956,250	0	22,896,117	0	249,000	3,836	252,836	22,643,281
11	19,420,578	1,620,000	1,062,225	0	22,102,803	0	249,000	3,836	252,836	21,849,967
12	18,844,000	1,620,000	1,168,200	0	21,632,200	0	249,000	3,836	252,836	21,379,364
13	16,740,254	1,620,000	1,273,950	0	19,634,204	0	249,000	3,836	252,836	19,381,368
14	15,568,773	1,620,000	1,379,700	0	18,568,473	0	249,000	3,836	252,836	18,315,637
15	19,552,610	1,620,000	1,485,225	0	22,657,835	0	249,000	3,836	252,836	22,404,999
16	26,757,423	1,620,000	1,580,175	0	29,957,598	0	249,000	3,836	252,836	29,704,762
17	24,231,966	1,620,000	1,675,125	0	27,527,091	0	249,000	3,836	252,836	27,274,255
18	24,101,986	1,620,000	1,769,850	0	27,491,836	0	249,000	3,836	252,836	27,239,000
19	23,350,955	1,620,000	1,864,575	0	26,835,530	0	249,000	3,836	252,836	26,582,694
20	23,309,490	1,620,000	1,959,300	0	26,888,790	0	249,000	3,836	252,836	26,635,955
21	18,876,648	1,620,000	2,054,025	0	22,550,673	0	249,000	3,836	252,836	22,297,837
22	20,459,704	1,620,000	2,148,750	0	24,228,454	0	249,000	3,836	252,836	23,975,618
23	15,738,595	1,620,000	2,243,250	0	19,601,845	0	249,000	3,836	252,836	19,349,010
24	22,151,700	1,620,000	2,337,750	0	26,109,450	0	249,000	3,836	252,836	25,856,614
25	18,840,638	1,620,000	2,432,250	0	22,892,888	0	249,000	3,836	252,836	22,640,052
26	21,173,889	1,620,000	2,526,750	0	25,320,639	0	249,000	3,836	252,836	25,067,803
27	22,164,979	1,620,000	2,621,250	0	26,406,229	0	249,000	3,836	252,836	26,153,393
28	20,355,823	1,620,000	2,715,750	0	24,691,573	0	249,000	3,836	252,836	24,438,737
29	21,368,082	1,620,000	2,810,025	0	25,798,107	0	249,000	3,836	252,836	25,545,271
30	23,662,750	1,620,000	2,904,300	35,540,000	63,727,050	0	249,000	3,836	252,836	63,474,214
31				35,540,000	35,540,000	0	150,000	0	150,000	35,390,000
32				46,912,800	46,912,800	0	75,000	0	75,000	46,837,800
							NPV (initial rotation)			**144,437,895**
							NPV (perpetual)			**146,619,348**

Annex 7.3 Table 4. Cost-benefit analysis results for the current (business as usual) and the proposed management regime for CHNM at the discount rate of 15% and carbon price of US$ 10/tC.

Base Case: Business As Usual (With Burning)
Discount rate = 15% Carbon price = 10 US$/tC

	Benefits			Costs		
Year	Entrance Fee Revenue	Business Revenue	Total	Carbon Emission	Total	Net Benefit
0	0		0	0	0	0
1	17,851,950	1,620,000	19,471,950	7,672	7671.818	19,464,278
2	20,791,650	1,620,000	22,411,650	7,672	7671.818	22,403,978
3	21,572,277	1,620,000	23,192,277	7,672	7671.818	23,184,606
4	20,200,999	1,620,000	21,820,999	7,672	7671.818	21,813,327
5	23,141,576	1,620,000	24,761,576	7,672	7671.818	24,753,905
6	21,013,137	1,620,000	22,633,137	7,672	7671.818	22,625,465
7	20,074,671	1,620,000	21,694,671	7,672	7671.818	21,687,000
8	16,668,125	1,620,000	18,288,125	7,672	7671.818	18,280,454
9	24,048,276	1,620,000	25,668,276	7,672	7671.818	25,660,604
10	20,319,867	1,620,000	21,939,867	7,672	7671.818	21,932,195
11	19,420,578	1,620,000	21,040,578	7,672	7671.818	21,032,906
12	18,844,000	1,620,000	20,464,000	7,672	7671.818	20,456,329
13	16,740,254	1,620,000	18,360,254	7,672	7671.818	18,352,582
14	15,568,773	1,620,000	17,188,773	7,672	7671.818	17,181,101
15	19,552,610	1,620,000	21,172,610	7,672	7671.818	21,164,938
16	26,757,423	1,620,000	28,377,423	7,672	7671.818	28,369,751
17	24,231,966	1,620,000	25,851,966	7,672	7671.818	25,844,294
18	24,101,986	1,620,000	25,721,986	7,672	7671.818	25,714,314
19	23,350,955	1,620,000	24,970,955	7,672	7671.818	24,963,283
20	23,309,490	1,620,000	24,929,490	7,672	7671.818	24,921,819
21	18,876,648	1,620,000	20,496,648	7,672	7671.818	20,488,977
22	20,459,704	1,620,000	22,079,704	7,672	7671.818	22,072,032
23	15,738,595	1,620,000	17,358,595	7,672	7671.818	17,350,924
24	22,151,700	1,620,000	23,771,700	7,672	7671.818	23,764,029
25	18,840,638	1,620,000	20,460,638	7,672	7671.818	20,452,966
26	21,173,889	1,620,000	22,793,889	7,672	7671.818	22,786,217
27	22,164,979	1,620,000	23,784,979	7,672	7671.818	23,777,307
28	20,355,823	1,620,000	21,975,823	7,672	7671.818	21,968,151
29	21,368,082	1,620,000	22,988,082	7,672	7671.818	22,980,410
30	23,662,750	1,620,000	25,282,750	7,672	7671.818	25,275,078
31						
32						
				NPV (initial rotation)		**144,284,297**
				NPV (perpetual)		**146,463,430**

Proposed Management Regime: (Burning with Carbon Offsets)
Discount rate = 15% Carbon price = 10 US$/tC

	Benefits					Costs				
Year	Entrance Fee Revenue	Business Revenue	Carbon Offsets	Timber Revenue	Total	Estab Cost	Maint Cost	Carbon Emission	Total	Net Benefit
0	0	0	0	0	0	1,500,000		0	1,500,000	-1,500,000
1	17,851,950	1,620,000	67,950	0	19,539,900	1,500,000	75,000	7,672	1,582,672	17,957,228
2	20,791,650	1,620,000	200,700	0	22,612,350	1,980,000	150,000	7,672	2,137,672	20,474,678
3	21,572,277	1,620,000	417,600	0	23,609,877	0	249,000	7,672	256,672	23,353,206
4	20,200,999	1,620,000	633,150	0	22,454,149	0	249,000	7,672	256,672	22,197,477
5	23,141,576	1,620,000	847,800	0	25,609,376	0	249,000	7,672	256,672	25,352,705
6	21,013,137	1,620,000	1,061,550	0	23,694,687	0	249,000	7,672	256,672	23,438,015
7	20,074,671	1,620,000	1,274,850	0	22,969,521	0	249,000	7,672	256,672	22,712,850
8	16,668,125	1,620,000	1,487,700	0	19,775,825	0	249,000	7,672	256,672	19,519,154
9	24,048,276	1,620,000	1,700,550	0	27,368,826	0	249,000	7,672	256,672	27,112,154
10	20,319,867	1,620,000	1,912,500	0	23,852,367	0	249,000	7,672	256,672	23,595,695
11	19,420,578	1,620,000	2,124,450	0	23,165,028	0	249,000	7,672	256,672	22,908,356
12	18,844,000	1,620,000	2,336,400	0	22,800,400	0	249,000	7,672	256,672	22,543,729
13	16,740,254	1,620,000	2,547,900	0	20,908,154	0	249,000	7,672	256,672	20,651,482
14	15,568,773	1,620,000	2,759,400	0	19,948,173	0	249,000	7,672	256,672	19,691,501
15	19,552,610	1,620,000	2,970,450	0	24,143,060	0	249,000	7,672	256,672	23,886,388
16	26,757,423	1,620,000	3,160,350	0	31,537,773	0	249,000	7,672	256,672	31,281,101
17	24,231,966	1,620,000	3,350,250	0	29,202,216	0	249,000	7,672	256,672	28,945,544
18	24,101,986	1,620,000	3,539,700	0	29,261,686	0	249,000	7,672	256,672	29,005,014
19	23,350,955	1,620,000	3,729,150	0	28,700,105	0	249,000	7,672	256,672	28,443,433
20	23,309,490	1,620,000	3,918,600	0	28,848,090	0	249,000	7,672	256,672	28,591,419
21	18,876,648	1,620,000	4,108,050	0	24,604,698	0	249,000	7,672	256,672	24,348,027
22	20,459,704	1,620,000	4,297,500	0	26,377,204	0	249,000	7,672	256,672	26,120,532
23	15,738,595	1,620,000	4,486,500	0	21,845,095	0	249,000	7,672	256,672	21,588,424
24	22,151,700	1,620,000	4,675,500	0	28,447,200	0	249,000	7,672	256,672	28,190,529
25	18,840,638	1,620,000	4,864,500	0	25,325,138	0	249,000	7,672	256,672	25,068,466
26	21,173,889	1,620,000	5,053,500	0	27,847,389	0	249,000	7,672	256,672	27,590,717
27	22,164,979	1,620,000	5,242,500	0	29,027,479	0	249,000	7,672	256,672	28,770,807
28	20,355,823	1,620,000	5,431,500	0	27,407,323	0	249,000	7,672	256,672	27,150,651
29	21,368,082	1,620,000	5,620,050	0	28,608,132	0	249,000	7,672	256,672	28,351,460
30	23,662,750	1,620,000	5,808,600	35,540,000	66,631,350	0	249,000	7,672	256,672	66,374,678
31				35,540,000	35,540,000	0	150,000	0	150,000	35,390,000
32				46,912,800	46,912,800	0	75,000	0	75,000	46,837,800
							NPV (initial rotation)			**148,714,965**
							NPV (perpetual)			**150,961,014**

Annex 7.3 Table 5. Cost-benefit analysis results for the current (business as usual) and the proposed management regime for CHNM at the discount rate of 15% and carbon price of US$ 20/tC.

Base Case: Business As Usual (With Burning)
Discount rate = 15% Carbon price = 20 US$/tC

	Benefits			Costs		
Year	Entrance Fee Revenue	Business Revenue	Total	Carbon Emission	Total	Net Benefit
0	0		0	0	0	0
1	17,851,950	1,620,000	19,471,950	15,344	15343.64	19,456,606
2	20,791,650	1,620,000	22,411,650	15,344	15343.64	22,396,306
3	21,572,277	1,620,000	23,192,277	15,344	15343.64	23,176,934
4	20,200,999	1,620,000	21,820,999	15,344	15343.64	21,805,655
5	23,141,576	1,620,000	24,761,576	15,344	15343.64	24,746,233
6	21,013,137	1,620,000	22,633,137	15,344	15343.64	22,617,794
7	20,074,671	1,620,000	21,694,671	15,344	15343.64	21,679,328
8	16,668,125	1,620,000	18,288,125	15,344	15343.64	18,272,782
9	24,048,276	1,620,000	25,668,276	15,344	15343.64	25,652,932
10	20,319,867	1,620,000	21,939,867	15,344	15343.64	21,924,523
11	19,420,578	1,620,000	21,040,578	15,344	15343.64	21,025,234
12	18,844,000	1,620,000	20,464,000	15,344	15343.64	20,448,657
13	16,740,254	1,620,000	18,360,254	15,344	15343.64	18,344,910
14	15,568,773	1,620,000	17,188,773	15,344	15343.64	17,173,430
15	19,552,610	1,620,000	21,172,610	15,344	15343.64	21,157,267
16	26,757,423	1,620,000	28,377,423	15,344	15343.64	28,362,080
17	24,231,966	1,620,000	25,851,966	15,344	15343.64	25,836,622
18	24,101,986	1,620,000	25,721,986	15,344	15343.64	25,706,642
19	23,350,955	1,620,000	24,970,955	15,344	15343.64	24,955,611
20	23,309,490	1,620,000	24,929,490	15,344	15343.64	24,914,147
21	18,876,648	1,620,000	20,496,648	15,344	15343.64	20,481,305
22	20,459,704	1,620,000	22,079,704	15,344	15343.64	22,064,360
23	15,738,595	1,620,000	17,358,595	15,344	15343.64	17,343,252
24	22,151,700	1,620,000	23,771,700	15,344	15343.64	23,756,357
25	18,840,638	1,620,000	20,460,638	15,344	15343.64	20,445,295
26	21,173,889	1,620,000	22,793,889	15,344	15343.64	22,778,545
27	22,164,979	1,620,000	23,784,979	15,344	15343.64	23,769,635
28	20,355,823	1,620,000	21,975,823	15,344	15343.64	21,960,480
29	21,368,082	1,620,000	22,988,082	15,344	15343.64	22,972,738
30	23,662,750	1,620,000	25,282,750	15,344	15343.64	25,267,406
31						
32						
				NPV (initial rotation)		**144,233,924**
				NPV (perpetual)		**146,412,296**

Proposed Management Regime: (Burning with Carbon Offsets)
Discount rate = 15% Carbon price = 20 US$/tC

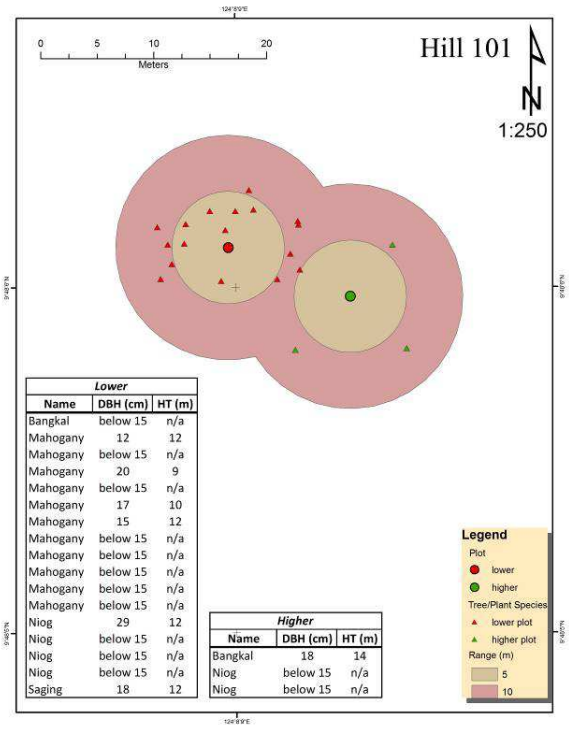
	Benefits					Costs				
Year	Entrance Fee Revenue	Business Revenue	Carbon Offsets	Timber Revenue	Total	Estab Cost	Maint Cost	Carbon Emission	Total	Net Benefit
0	0	0	0	0	0	1,500,000		0	1,500,000	-1,500,000
1	17,851,950	1,620,000	135,900	0	19,607,850	1,500,000	75,000	15,344	1,590,344	18,017,506
2	20,791,650	1,620,000	401,400	0	22,813,050	1,980,000	150,000	15,344	2,145,344	20,667,706
3	21,572,277	1,620,000	835,200	0	24,027,477	0	249,000	15,344	264,344	23,763,134
4	20,200,999	1,620,000	1,266,300	0	23,087,299	0	249,000	15,344	264,344	22,822,955
5	23,141,576	1,620,000	1,695,600	0	26,457,176	0	249,000	15,344	264,344	26,192,833
6	21,013,137	1,620,000	2,123,100	0	24,756,237	0	249,000	15,344	264,344	24,491,894
7	20,074,671	1,620,000	2,549,700	0	24,244,371	0	249,000	15,344	264,344	23,980,028
8	16,668,125	1,620,000	2,975,400	0	21,263,525	0	249,000	15,344	264,344	20,999,182
9	24,048,276	1,620,000	3,401,100	0	29,069,376	0	249,000	15,344	264,344	28,805,032
10	20,319,867	1,620,000	3,825,000	0	25,764,867	0	249,000	15,344	264,344	25,500,523
11	19,420,578	1,620,000	4,248,900	0	25,289,478	0	249,000	15,344	264,344	25,025,134
12	18,844,000	1,620,000	4,672,800	0	25,136,800	0	249,000	15,344	264,344	24,872,457
13	16,740,254	1,620,000	5,095,800	0	23,456,054	0	249,000	15,344	264,344	23,191,710
14	15,568,773	1,620,000	5,518,800	0	22,707,573	0	249,000	15,344	264,344	22,443,230
15	19,552,610	1,620,000	5,940,900	0	27,113,510	0	249,000	15,344	264,344	26,849,167
16	26,757,423	1,620,000	6,320,700	0	34,698,123	0	249,000	15,344	264,344	34,433,780
17	24,231,966	1,620,000	6,700,500	0	32,552,466	0	249,000	15,344	264,344	32,288,122
18	24,101,986	1,620,000	7,079,400	0	32,801,386	0	249,000	15,344	264,344	32,537,042
19	23,350,955	1,620,000	7,458,300	0	32,429,255	0	249,000	15,344	264,344	32,164,911
20	23,309,490	1,620,000	7,837,200	0	32,766,690	0	249,000	15,344	264,344	32,502,347
21	18,876,648	1,620,000	8,216,100	0	28,712,748	0	249,000	15,344	264,344	28,448,405
22	20,459,704	1,620,000	8,595,000	0	30,674,704	0	249,000	15,344	264,344	30,410,360
23	15,738,595	1,620,000	8,973,000	0	26,331,595	0	249,000	15,344	264,344	26,067,252
24	22,151,700	1,620,000	9,351,000	0	33,122,700	0	249,000	15,344	264,344	32,858,357
25	18,840,638	1,620,000	9,729,000	0	30,189,638	0	249,000	15,344	264,344	29,925,295
26	21,173,889	1,620,000	10,107,000	0	32,900,889	0	249,000	15,344	264,344	32,636,545
27	22,164,979	1,620,000	10,485,000	0	34,269,979	0	249,000	15,344	264,344	34,005,635
28	20,355,823	1,620,000	10,863,000	0	32,838,823	0	249,000	15,344	264,344	32,574,480
29	21,368,082	1,620,000	11,240,100	0	34,228,182	0	249,000	15,344	264,344	33,963,838
30	23,662,750	1,620,000	11,617,200	35,540,000	72,439,950	0	249,000	15,344	264,344	72,175,606
31				35,540,000	35,540,000	0	150,000	0	150,000	35,390,000
32				46,912,800	46,912,800	0	75,000	0	75,000	46,837,800
							NPV (initial rotation)			**157,269,104**
							NPV (perpetual)			**159,644,346**

Annex 7.4

Projected annual tourist arrival using a 1-period moving average forecast

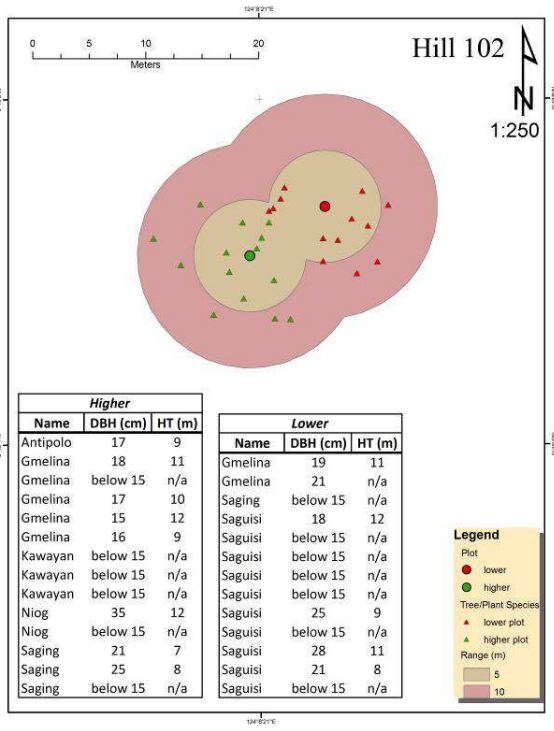
Year	Annual Visitor	Income at P50/person
1	357,039	17,851,950
2	415,833	20,791,650
3	431,446	21,572,300
4	404,020	20,201,000
5	462,832	23,141,600
6	420,263	21,013,150
7	401,493	20,074,650
8	333,363	16,668,150
9	480,966	24,048,300
10	406,397	20,319,850
11	388,412	19,420,600
12	376,880	18,844,000
13	334,805	16,740,250
14	311,375	15,568,750
15	391,052	19,552,600
16	535,148	26,757,400
17	484,639	24,231,950
18	482,040	24,102,000
19	467,019	23,350,950
20	466,190	23,309,500
21	377,533	18,876,650
22	409,194	20,459,700
23	314,772	15,738,600
24	443,034	22,151,700
25	376,813	18,840,650
26	423,478	21,173,900
27	443,300	22,165,000
28	407,116	20,355,800
29	427,362	21,368,100
30	473,255	23,662,750
Total	12,447,069	622,353,450

Annex 7.5
Sample maps of individual plots



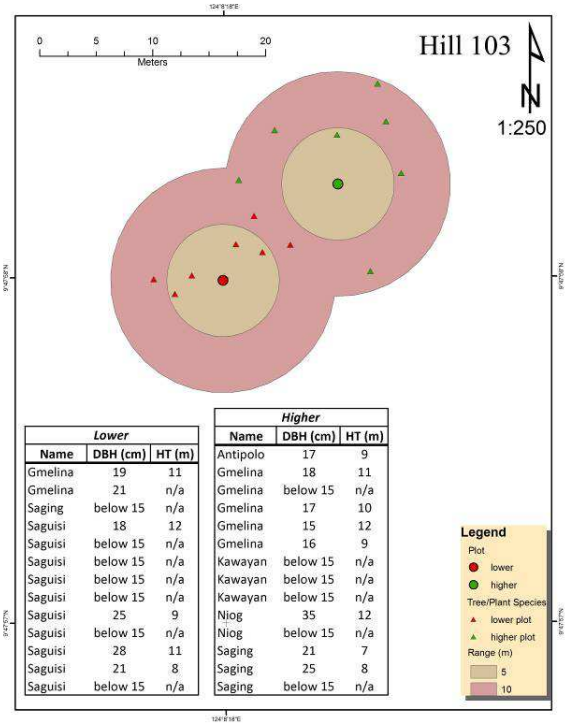
Lower		
Name	DBH (cm)	HT (m)
Bangkal	below 15	n/a
Mahogany	12	12
Mahogany	below 15	n/a
Mahogany	20	9
Mahogany	below 15	n/a
Mahogany	17	10
Mahogany	15	12
Mahogany	below 15	n/a
Mahogany	below 15	n/a
Mahogany	below 15	n/a
Mahogany	below 15	n/a
Mahogany	below 15	n/a
Niog	29	12
Niog	below 15	n/a
Niog	below 15	n/a
Niog	below 15	n/a
Saging	18	12

Higher		
Name	DBH (cm)	HT (m)
Bangkal	18	14
Niog	below 15	n/a
Niog	below 15	n/a



Higher		
Name	DBH (cm)	HT (m)
Antipolo	17	9
Gmelina	18	11
Gmelina	below 15	n/a
Gmelina	17	10
Gmelina	15	12
Gmelina	16	9
Kawayan	below 15	n/a
Kawayan	below 15	n/a
Kawayan	below 15	n/a
Niog	35	12
Niog	below 15	n/a
Saging	21	7
Saging	25	8
Saging	below 15	n/a

Lower		
Name	DBH (cm)	HT (m)
Gmelina	19	11
Gmelina	21	n/a
Saging	below 15	n/a
Saguisi	18	12
Saguisi	below 15	n/a
Saguisi	below 15	n/a
Saguisi	below 15	n/a
Saguisi	below 15	n/a
Saguisi	25	9
Saguisi	below 15	n/a
Saguisi	28	11
Saguisi	21	8
Saguisi	below 15	n/a



Lower		
Name	DBH (cm)	HT (m)
Gmelina	19	11
Gmelina	21	n/a
Saging	below 15	n/a
Saguisi	18	12
Saguisi	below 15	n/a
Saguisi	below 15	n/a
Saguisi	below 15	n/a
Saguisi	below 15	n/a
Saguisi	25	9
Saguisi	below 15	n/a
Saguisi	28	11
Saguisi	21	8
Saguisi	below 15	n/a

Higher		
Name	DBH (cm)	HT (m)
Antipolo	17	9
Gmelina	18	11
Gmelina	below 15	n/a
Gmelina	17	10
Gmelina	15	12
Gmelina	16	9
Kawayan	below 15	n/a
Kawayan	below 15	n/a
Kawayan	below 15	n/a
Niog	35	12
Niog	below 15	n/a
Saging	21	7
Saging	25	8
Saging	below 15	n/a

Annex 7.6
Photos of project activities


a

b

c

d

Meetings with the municipal mayor of Carmen, Bohol, Hon. Manuel R. Molina on July 5, 2009 (Plate a); the Chocolate Hills Complex Hotel and Restaurant Operations Manager, Mrs. Jocelyn Lagare on July 5, 2009 (Plate b); the municipal mayor of Batuan, Bohol, Hon. Gregoria D. Pepito on March 5, 2010 (Plate c); and the Municipal Planning and Development Officer of Sagbayan, Bohol, Mr. Maximo G. Lomosbog on July 5, 2009 (Plate d)


a

b


c

Meetings with Municipal Planning and Development Officer of Batuan, Bohol, Mr. Rizalino S. Canda on July 5, 2009 (Plate a); with the faculty of Bohol Island State University on July 5, 2009 (Plate b); and presentation of the project's preliminary results to the Protected Area Management Board (PAMB) (Plate c).

Biophysical survey in the municpaplities of Batuan, Carmen, and Sagbayan Bohol on March – May, 2010

Household survey in the municpaplities of Batuan, Carmen, and Sagbayan Bohol (March – May, 2010)

Household survey in the municpaplities of Batuan, Carmen, and Sagbayan Bohol (March – May, 2010)

Annex 7.7
List of Species Found in the Study Area

Species **Local Name**	**Scientific Name**	**Family Name**
American kapok	**Ceibapentandra*(L.) Gaertn.	MALVACEAE *Juss.*
Amugis	*Koordersiodendronpinnatum*(Blanco) Skeels	ANACARDIACEAE *Lindl.*
Anislag	*Securinegaflexuosa*Muell.-Arg.	EUPHORBIACEAE *Juss.*
Antipolo	*Artocarpusblancoi*(Elmer) Merr.	MORACEAE *Link*
Atchuete	**Bixaorellana*L.	BIXACEAE *Link*
Bago	*Gnetumgnemon*L.	GNETACEAE *L.*
Balete	*Kingiodendronalternifolium*(Elmer) Merr. & Rolfe	FABACEAE: CAESALPINIODEAE
Balimbing	**Averrhoacarambola*L.	OXALIDACEAE *R. Br.*
Bangkal	*Naucleaorientalis*(L.) L.	RUBIACEAE *Juss.*
Big leaf Mahogany	**Swieteniamacrophylla*King	MELIACEAE *Juss.*
Bolon	*Platymitraarborea*(Blanco) Kessler	ANNONACEAE *Juss.*
Cacao	**Theobroma cacao* L.	MALVACEAE *Juss.*
Caimito	**Chrysophyllumcainito*L.	SAPOTACEAE *Juss.*
Cassava	*Manihotesculenta*Crantz	EUPHORBIACEAE
Chico	**Manilkarasapota*(L.) royer.	SAPOTACEAE *Juss.*
Cogon	*Imperatacylindrica*(L.) Beauv.	POACEAE *Barnhart*
Corn	*Zea mays L.* ssp. *mays*	POACEAE
Dalingdingan	*Hopeafoxwothyi*Elmer	DIPTEROCARPACEAE *Blume*
Dao	*Dracontomelondao*(Blanco) Merr.	ANACARDIACEAE *Lindl.*
Datiles	**Muntigiacalabura*L.	MUNTIGIACEAE *A. DC.*
Gabi	**Colocasiaesculentum*(L.) Schott	ARACEAE *Juss.*
Gmelina	**Gmelinaarborea*Roxb.	LAMIACEAE *Lindl.*
Guava	**Psydiumguajava*L.	MYRTACEAE *Juss.*
Gubas	*Endospermumpeltatum*Merr.	EUPHORBIACEAE *Juss.*
Hauili	*Ficusseptica*Burm. f.	MORACEAE *Link*
Ipil-ipil	*Leucaenaleucocephala*(Lam.) de Wit	FABACEAE: MIMOSOIDEAE
Is-is	*Ficusulmifolia*Lamk	MORACEAE *Link*
Kakauate	**Gliricidiasepium*(Jacq.) Kunth ex Walp.	FABACEAE: FABOIDEAE
Kalios	*Streblusasper*Lour.	MORACEAE *Link*
Kalubkob	*Syzygiumcalubcob*(C.B. Rob.) Merr.	MYRTACEAE Juss.
Kamachile	**Pithecellobiumdulce*(Roxb) Benth.	FABACEAE: MIMOSOIDEAE
Kawayankiling	*Bambusa vulgaris* Schrad.	POACEAE *Barnhart*
Lamog	*Planchoniaspectabilis*Merr.	LECYTHIDACEAE *Poit*

Species **Local Name**	**Scientific Name**	**Family Name**
Magabuyo	*Celtisluzonica*Warb.	CANNABACEAE *Martynov*
Makahiya	*Mimosa pudica L.	FABACEAE: MIMOSOIDEAE
Malaisis	*Malaisiascandens*(Lour.) Planch.	MORACEAE *Link*
Malapapaya	*Polysciasnodosa*(Blume) Seem.	ARALIACEAE *Juss.*
Malugai	*Pometiapinnata*Forst. &Forst.	SAPINDACEAE *Juss.*
Mangga	**Mangiferaindica*L.	ANACARDIACEAE *Lindl.*
Molave	*Vitexparviflora*Juss.	LAMIACEAE *Lindl.*
Nangka	*Artocarpusheterophyllus*Lam.	MORACEAE *Link*
Neem tree	**Azadirachtaindica*A. Juss.	MELIACEAE Juss.
Niog	*Cocosnucifera*L.	ARECACEAE *C.H. Schultz - Schulztzenstein*
Pako	*Diplaziumesculentum*(Retz.) Sw.	WOODSIACEAE *Herter*
PandanDagat	*Pandanustectorius*Soland.	PANDANACEAE *R. Br.*
Papaya	**Carica papaya* L.	CARICACEAE *Dumort.*
Para rubber	**Heveabrasiliensis*(HBK.) Muell.-Arg.	EUPHORBIACEAE *Juss.*
Pineapple	*Ananascomosus*	BROMELIACEAE
Pugahan	*Caryotacumingii*Lodd.	ARECACEAE *C.H. Schultz - Schulztzenstein*
Rain tree	**Samaneasaman*(Jacq.) Merr.	FABACEAE: MIMOSOIDEAE
Rice	*Oryza sativa*	POACEAE
Sagingmatsing	*Musa acuminata*Colla	MUSACEAE *Juss.*
Saguisi	*Heterospatheelata*Scheff.	ARECACEAE *C.H. Schultz - Schulztzenstein*
Santol	*Sandoricumkoetjape*(Burm. f.) Merr.	MELIACEAE *Juss.*
Smooth narra	*Pterocarpusindicus*Willd. Forma *indicus*	FABACEAE: FABOIDEAE
Sweet potato	*Ipomeabatatas*(L.) Lamk.	CONVOLNULACEAE *Juss.*
Takipan	*Caryotarumphiana*Mart. *var. philippinensis*Becc.	ARECACEAE *C.H. Schultz - Schulztzenstein*
Talisai	*Terminaliacatappa*L.	COMBRETACEAE *R. Br.*
Talisaigubat	*Terminaliafoetidissima*Griff.	COMBRETACEAE *R. Br.*
Tamayuan	*Strombosiaphilippinensis*	OLACACEAE *Mirb. Ex DC.*
Tambalau	*Knemaglomerata*(Blanco) Merr.	MYRISTICACEAE *R. Br.*
Tanguile	*Shoreapolysperma*(Blanco) Merr.	DIPTEROCARPACEAE *Blume*
Teak	**Tectonagrandis*L. f.	LAMIACEAE *Lindl.*

Species **Local Name**	**Scientific Name**	**Family Name**
Toog	*Petersianthusquadrialatus*Merr.	LECYTHIDACEAE *Poit*
Tuai	*Bischofiajavanica*Blume	PHYLLANTHACEAE *Martynov*
Umbrella grass	**Cyperusflabelliformis*Rottb.	CYPERACEAE *Juss.*
White lauan	*Shoreacontorta*Vidal	DIPTEROCARPACEAE *Blume*
Yabnob	*Horsfieldiacostulata*(Miq.) Warb.	MYRISTICACEAE *R. Br.*
Yautia	*Xanthosomaviolaceum*Schott	ARACEAE *Juss.*

Annex 7.8
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.

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- 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

Annex 7.9 Draftresolution 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 Banos (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 areforestation 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 fromthe atmosphere through the process of photosynthesis. Trees use carbon dioxide for their growth byfixing 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 carbondensity 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 hillswithin the Chocolate Hills Complex.

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

WHEREAS, to ensure high survival rate oftheplanted seedlings, indigenous species will be selected.

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

WHEREAS, the carbon offset project be developed using the incomefrom 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 corret:

MARCIAL B. UGAY
PASu

Attested and concurred by:

FELIPE L. RAMO SR.
President Officer

Approved/affirmed:

LEONARDO R. SIBBALUCA
Regional Executive Director