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Ministry of Environmental Conservation and Forestry
Forest Department

Carbon Stock Determination in Peat Soil of Heho Valley Peatland Area

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ဟဲဟိုးလွင်ပြင်ရှိသစ်ဆွေးမြေ၏ကာဗွန်သိုလှောင်မှုကိုလေ့လာတွက်ချက်ခြင်း

သီတာဆွေ
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စာတမ်းအကျဉ်း

ရေတိမ်ဒေသများအတွင်း သေကြေပျက်စီးနေသော အပင်များ ကျေပျက်မှုနှုန်းထား အမျိုးမျိုးဖြင့် စုစည်းနေသည့်မြေကို သစ်ဆွေးမြေဟုခေါ်ပြီး ၎င်းတွင် အော်ဂန်နစ် ကာဗွန် ပမာဏ အနည်းဆုံး ၁၂ မှ ၁၈ ရာခိုင်နှုန်းထိပါဝင်ပြီး အနိမ့်ဆုံးသစ်ဆွေးမြေအထူမှာ ၅၀ စင်တီမီတာ ရှိပါသည်။ သစ်ဆွေးမြေများသည် များပြားသောပမာဏရှိသည့် ကာဗွန် များကိုသိုလှောင် ထိန်းသိမ်းရာ ကန်ကြီးသဖွယ် ဆောင်ရွက်ပေးခြင်းကြောင့် သစ်ဆွေးမြေများ ထိန်းသိမ်း စောင့်ရှောက်ခြင်းသည် ရာသီဥတုပြောင်းလဲမှု လျော့ချခြင်းလုပ်ငန်းစဉ်များတွင် အဓိက အရေးကြီးသောအခန်းကဏ္ဍတွင် ပါဝင်လာပါသည်။ အရှေ့တောင်အာရှနိုင်ငံ များအတွင်း အင်ဒိုနီးရှားနိုင်ငံသည် သစ်ဆွေးမြေဧရိယာအများဆုံးပိုင်ဆိုင်ပြီး မလေးရှားနှင့် ပါပူးဝါး နယူးဂီနားနိုင်ငံတို့ကဒုတိယနှင့် တတိယအများဆုံးနိုင်ငံများဖြစ်ကြပါသည်။ မြန်မာနိုင်ငံ၏ သစ်ဆွေးမြေများမှ ကာဗွန်သိုလှောင် ထားရှိမှုကိုလည်းခန့်မှန်း တွက်ချက် နိုင်ခြင်း မရှိသေးပါ။ ထို့ကြောင့် SEA peat project အတွက် မြန်မာနိုင်ငံမှ တာဝန်ယူ ဆောင်ရွက်သည့် FREDA အဖွဲ့သည် ရှမ်းပြည်တောင်ပိုင်းဒေသရှိဟဲဟိုး၊ အင်းလေးနှင့် ပင်းတယဒေသများရှိ သစ်ဆွေးမြေဧရိယာများကို အတည်ပြု သတ်မှတ်နိုင်ခဲ့ကြပြီး ၎င်းဒေသများအနက် ဟဲဟိုး လွင်ပြင်တွင် သစ်ဆွေးမြေဧရိယာများမှ ကာဗွန်သိုလှောင် ထိန်းသိမ်းမှုသိရှိရန် သုတေသနလုပ်ငန်း ဆောင်ရွက်ခဲ့ပါသည်။ လေ့လာတွေ့ရှိချက်အရ ဟဲဟိုးလွင်ပြင်ဒေသရှိ သစ်ဆွေး မြေနေရာတွင် သိုလှောင်ထားသော စုစုပေါင်း ဩဂဲနစ် ကာဗွန်ပမာဏသည် အရှေ့တောင်အာရှ နိုင်ငံများရှိသစ်ဆွေးမြေများတွင် သိုလှောင်ထားသော ကာဗွန်ပမာဏကဲ့သို့ မများရခြင်းမှာ ခေတ်အဆက်ဆက် သစ်ဆွေးမြေ အသုံးပြုမှု နည်းစနစ်နှင့် လက်ရှိမြေအသုံးချမှု အခြေအနေတို့ကြောင့် ဖြစ်နိုင်ပါသည်။ သို့သော် ၎င်းဒေသရှိ သစ်ဆွေးမြေများအားယခုကဲ့သို့ ရေသွင်းရေထုတ်ပြုလုပ်၍ စိုက်ပျိုးမြေအဖြစ် ကြာရှည်စွာ အသုံးပြုပါက သိုလှောင်ထားသော ကာဗွန်များသည် လေထုထဲသို့ ကာဗွန်ဒိုင်အောက်ဆိုဒ်ဓါတ်ငွေ့ အမြောက်အများ ပြန်လည် ပြောင်းလဲထုတ်လွှတ် ပေးလိမ့်မည်ဖြစ်ပါသည်။ သို့ဖြစ်ပါ၍ သစ်ဆွေးမြေများအား ကာဗွန်ထုတ်လွှတ်မှု နည်းပါးစေသည့် စီမံအုပ်ချုပ်မှုများဆောင်ရွက်ရန် အရေးတကြီး လိုအပ်လျှက်ရှိနေပါကြောင်း သုံးသပ်တင်ပြထားပါသည်။

Carbon Stock determination in Peat Soil of Heho Valley Peatland Area

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Abstract

Peat soil forms from the accumulation of remnants of dead prehistoric vegetation, part of which has undergone decomposition. It has a minimum organic Carbon content of 12-18% and a minimum thickness of 50 cm (Adinugroho et al., 2005). Peatlands are becoming increasingly important in the context of climate change since they act as sinks and stores of huge amounts of carbon. The majority of peatland in Southeast Asia is located in Indonesia, followed by Malaysia and Papua New Guinea. However, the peatland areas in Myanmar have not been adequately and exactly explored and identified yet. As a consequence, information regarding the exact amount of carbon storage in peatlands in Myanmar is also limited. To this account, peat land areas from Heho, Inlay Lake and Pintaya regions from Southern Shan state have been confirmed as a first attempt by the groups of Forest Resource Environment Development and Conservation Association (FREDA) which is the SEApeat project partner from Myanmar. This study provides the consistent estimates of carbon stocks for the peatland in Heho valley. Total organic carbon (TOC) contents were relatively lower than that of peatlands in other SE Asia countries, which may be due to the historical (peat extraction, drainage) and current land uses. The higher bulk density and lower organic carbon in this study area may be due to the lowering of the water table and the subsequent increased aeration of the peat due to drainage preparations for agriculture purposes. Although carbon stocks of the peatland on Haho valley are relatively low, they can be a significant source of vulnerable carbon which will be able to be transformed to carbon dioxide to release into the atmosphere if the peatland is drained or converted to agriculture for a long period. In this account, planning the wise use of the peatland with low carbon emissions is urgently needed.

Keywords: peatland, total organic carbon, TOC, carbon storage, carbon dioxide, carbon emission

Contents

Carbon Stock determination in Peat Soil of Heho Valley Peatland Area

1. Introduction

Peat soil forms from the accumulation of remnants of dead prehistoric vegetation, part of which has undergone decomposition. It has a minimum organic Carbon content of 12-18% and a minimum thickness of 50 cm (Adinugroho *et al.*, 2005). Peatlands are becoming increasingly important in the context of climate change since they act as sinks and stores of huge amounts of carbon. Page *et. al.* (2011) estimated that 88.6 Pg C are stored in tropical peatlands worldwide, with 68.5 Pg C (77%) occurring in Southeast Asia. The majority of peatland in Southeast Asia is located in Indonesia, followed by Malaysia and Papua New Guinea.

The areas of peatlands in Myanmar were estimated as 500 km^2 by Kivinen & Pakarinen (1981); 3,410 km^2 by Van Engelen & Huting (2002), 1228 km^2 by Verwer *et. al.* (2010) and World Energy Council (2013) a with peat thickness of 1.5 m. Lo and Parish (2013) has modified the data from Page *et. al*., (2011) as the peatland area in Myanmar as 122,800 ha.However, the peatland areas in Myanmar have not been adequately and exactly explored and identified yet. As a consequence, information regarding the exact amount of carbon storage in peatlands in Myanmar is also limited. To this account, peat land areas from Heho, Inlay Lake and Pintaya regions from Southern Shan state have been confirmed as a first attempt by the groups of Forest Resource Environment Development and Conservation Association (FREDA) which is the SEA peat project partner from Myanmar. A case study for the determination on the carbon storage of peatland was carried out in Heho valley in order to provide the useful information on the carbon storage capacity of peatlands in Myanmar.

2. Objective

The main objective of this study, therefore, is to assess the carbon storage and density of peatland area of Heho Valley.

3. Materials and Methods

3.1 Site description

Study area was selected based on availability of Peatland information and Landsat coverage. Heho valley has assessed as the peatland area according to the peatland vegetation observed, information gathered from local people, collected soil samples based on the remote sensing map conducted by Dr. Le Phat Quoi, a Vietnamese soil expert.

The Heho valley peatland is 1684 ha in area and located in Kalaw Township, Southern Shan State, which lies from 20° 40" to 20° 43" North latitude and from 96° 46" to 96° 50" East longitude and elevation is 1320masl. It is situated in the watershed areas of Yepai stream flowing into Inlay Lake. It is a plain gradually slope down from west to east. In the past, the area was a great peatland which supported the regular flow of Yepai stream. Since the area, however, was hidden underneath a layer of mineral soil, it is used as an agriculture land for growing cabbage, garlic, onion, potato, corn, cauliflower, etc.

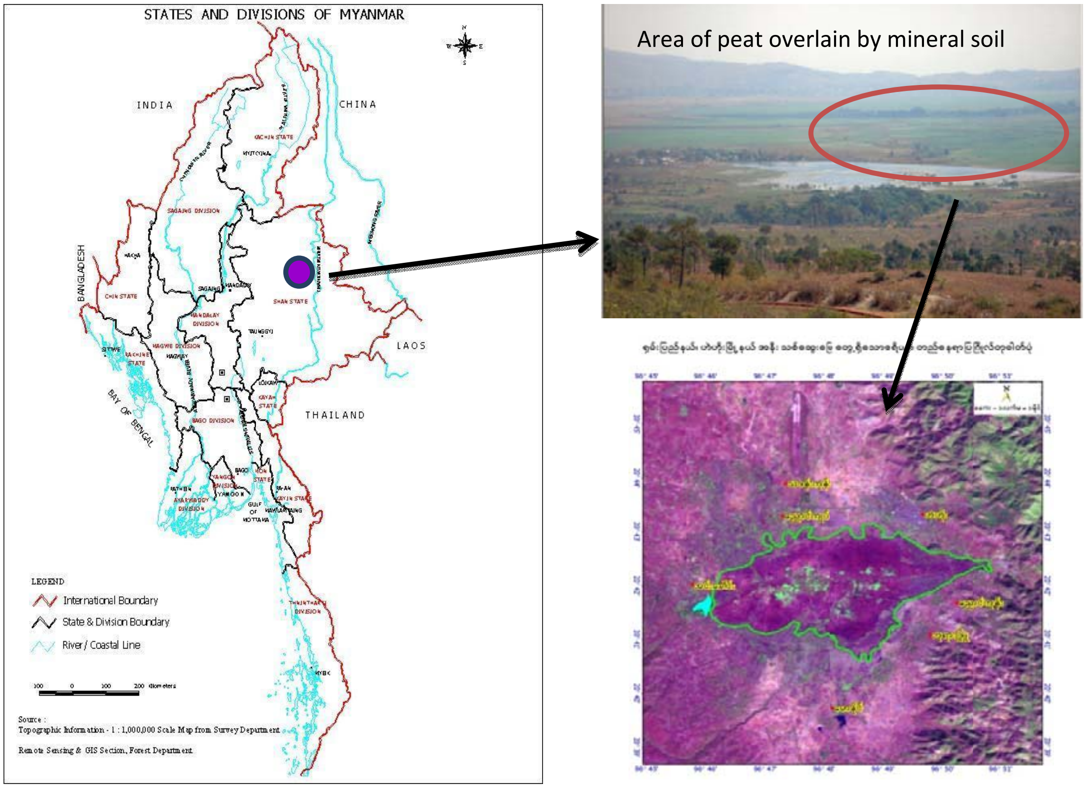

Figure (1) Location of the study area

3.2 Data Collection

3.2.1 Sampling point determination

Sample collections occurred at points distributed on a grid system of transects across the area. A base-line transect was surveyed on the long axis of the Peatland, and side-line transects surveyed at right angle in order to properly distribute coverage across the Peatland. The coordinates of each point of measurement were recorded by using a global positioning system (GPS). Sample points were surveyed at 400 ± 5m interval along the base-line and the side-line transects. Peatland information such as peat depth, land use and drainage were also recorded in every point (Appendix I).

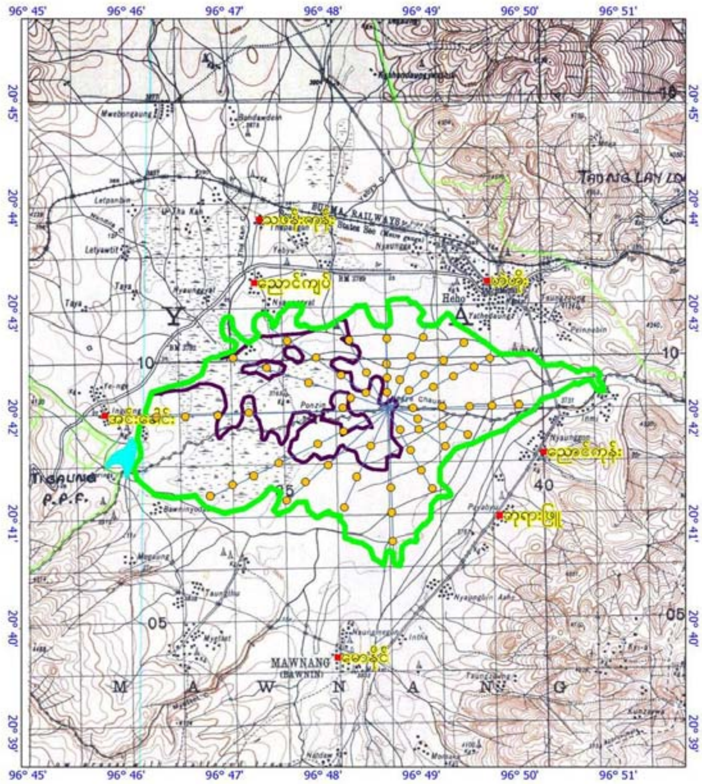

Figure (2) Sampling points within a peat dome using transect methods for the study area

3.2.2 Peat Depth

Since ground measurement of peat thickness is essential to estimate peat carbon store, peat depth was recorded by using a long metallic probe. This was carried out by gentle pushing by using a long metallic probe into the peat and measured the depth of the peat when the probe hit the mineral layer. Peat samples from each point were collected at the peat depth of 1 m increment. A total of 91 peat samples were collected by using Edelman auger. These cores of peat samples at each layer (with 1 m depth increment) from each point were later taken to the laboratory for analysis of variables such as carbon concentration (organic carbon), bulk density and peat maturity using methods described in Augus*et al.*, (2011).

3.3 laboratory methods

3.3.1 Determination of peat maturity

Peat maturity observation is useful for assessing peat fertility and carbon content. The more mature the peat, the generally more fertile (Agus*et al.*, 2011), although many other factors also determine fertility, including clay or ash mixture.

Peat maturity test was performed in the laboratory as follows:

a) First, a 25 ml syringe was filled with peat sample from each depth from each sampling point;
b) Then the sample in the syringe was pressed using the syringe pump and record the volume, *Vol 1*, when the sample can no longer be compressed;

c) This sample was transferred into a 150 µm or 0.0059 inch sieve;
d) The fine materials from the sample were washed out by using a rinsing bottle;
e) After the fine materials have been thoroughly washed out of the sieve, the coarse fibres were transferred again into the syringe and then press. When the sample cannot compressed anymore, the volume, *Vol 2*, was recorded;
f) The fibre content was calculated by using the following equation;

$$Fibre\ content\ = {}^{Vol\ 2}/_{Vol\ 1} \times 100\%$$

g) Then peat maturity was estimated based on the following criteria:
    - Sapric peat or well decomposed peat with a fibre content less than 15%
    - Hemic peat or half-decomposed peat with fibre content 15-75 %
    - Fibric peat or immature peat with fibre content greater than 75 %

3.3.2 Bulk density

Peat BD was determined in the laboratory by a gravimetric method. The wet soil samples were weighed, then left to dry at 105°C in an oven for 5 or 7 days depending on the moisture content of the samples. The dry samples were then reweighted when the constant weight was achieved, and BD was calculated as described in Augus *et. al*., (2011):

$$BD\ = {}^{M_{ds}}/_{V_s}$$

Where $M_{ds}$is dry weight (g) of sample and V_s is the sample volume (cm^3).

3.3.3 Moisture content determination

Moisture content was determined by drying a peat soil sample at 105°C as described by ASTM standard. The moisture content is expressed as a percent of the oven dry mass of the sample and calculated as the following equation.

$$Moisture\ Content\ \%\ = {}^{[(A-B)\ \times 100]}/_{A}$$

Where:
A= mass of the as-received test specimen, g, and
B = mass of the oven-dried specimen, g

3.3.4 Peatland organic carbon stocks

The carbon concentration was measured as a proportion of organic matter content by using loss-on-ignition method. Five gram peat soil sample from each layer was placed in a crucible and weighed, then oven dried at 105°C overnight. The dried samples were re-weighed and put in the furnace at 550°C for 2 hr. Samples were then re-weighed and the mass of soil loss expressed on a dry weight basis was determined by the following equation (Konare *et al.*, 2010; UCL Department of Geography, 2011) (cited in Weissert and Disney, 2013)

$$LOI\ \left({}^{g}/_{kg}\right) = {}^{\left(Weight_{dry}\ -\ Weight_{ignition}\right)}/_{Weight_{dry}}\ .\ 100 \qquad (1)$$

The TOC content was then determined, using a conversion factor of 1.724, based on the assumption that the TOC content of soil organic matter is on average 58% (Agus*et al.*, 2011; Liu Zigang*et al.*, 2012). Depending on the type of soil and organic matter the conversion factor can vary between 1.724 and 2.500 (Schumacher, 2002) (cited in Weissert and Disney, 2013). The value of 1.724 is the same as that used by Zigang *et. al.* (2012) and Jaenike *et. al.* (2008) to calculate TOC contents of peat soils in China and Indonesia.

Based on the survey and laboratory data, peatland organic carbon stock (POCS) was estimated using the following equation.

$$Peatland\ Organic\ Carbon\ Stock\ (kg\ C\ m^{-2}) = Cg/_{kg} \times BD \times D_s \times A \quad (2)$$

Where:

$Cg/_{kg}$ = carbon concentration on gravimetric basis (gkg^{-1})

BD = bulk density (g soil cm^{-3} or kg soil m^{-3})

D_S = peat depth (m)

A = area (m^2)

The peatland carbon density (POCD) was calculated based on the measured soil layer thickness, organic carbon content, soil volume weight according to the following equation.

$$\text{POCD} = \overline{BD} \cdot \overline{TOC} \cdot D_s \quad (3)$$

Tone of carbon dioxide equivalent per hectare (t CO_2-e/ha) is calculated by multiplying the carbon stock by 3.67*(IPCC, 2006).*

4. Results and Discussions

4.1 Peat depth

Peat layer is in large variation from 15 cm to 295 cm in depth. Small areas of deeper peat were found in the area. Only12% of the sampling points were deeper than 2 m and were concentrated in the centre of the peatland. Peat depth variability around the mean was fairly large standard deviations of 0.77 m.

4.2 Peat Maturity

Three basic kinds of organic soil materials are distinguished as fibric, hemic and sapric, according to the degree of decomposition of the original plant material. Fibric, least decomposed peat contains fragment of wood larger than 2 cm in cross section or in the smallest dimension. Hemic soil materials are intermediate in degree of decomposition, they partly altered both physically and biochemically. Sapric soil materials are mostly decomposed of their organic materials (*USDA, 2010*) (cited in *Wahyunto et. al., 2010*).

It was found that the peatland of Heho valley belongs to the order of Hemist indicating the intensive management on peat lands could significant influence on the rate of decomposition process.

4.3 Moisture content

The average moisture content of peat soils of the study area has 71% with the rage from 52 % to 86 % which fall the normal moisture content for peat soils.

4.4 Bulk density and total organic carbon

The bulk density (BD) of peat soil is likely the most important parameter. The BD of peat is lower than that of a mineral soil and it can vary considerably for different peat types and even within one peat type (*Wahyunto et. al., 2010*).BD of peatland in Heho valley ranged from 0.12 to0.34 gcm^{-3} and was on average 0.27 gcm^{-3}. These values are higher than the rate of BD of Hemist for Kalimatan (0.01-0.33 g cm^{-3}). It may be due to topogenous effect from surrounding mountains and the admixture of clay with the peat samples at some points in the study area. The peat samples had a Total organic carbon (TOC) content of 161 g kg^{-1} with a wide range from 75 g kg^{-1}to 452 g kg^{-1}.

4.5 Organic carbon storage (OCS) and organic carbon density (OCD)

The total OCS of Heho Valley peatland, calculated by equation (2), is 0.48 Mt (1000000 ton = 1 Megaton), which ranges from 0.06 to 1.35 Mt. According to the findings in this study, the OCD of Heho Valley, calculated by equation (3), is mostly between 11 kg m^{-3} to 121 kg m^{-3}. It is similar to the results (40.22 kg m^{-3}) of Hemist peatland under annual crop cultivation in Kalimatan, Indonesia, but much lower than the OCD of buried peatland in China. However, the OCS per unit area is far higher than the other soil types in Myanmar due to high organic matter content in peat.

Peat thicknesses for carbon stock of peat soils are also split up into two groups and these are: (1) peat thickness <2 m and (2) peat thickness > 2 m. Resulted calculation of organic carbon stocks of peat soil for the study area is presented in the following Table.

Table (1) Total Carbon stored at the study area (TOC, peat depth and BD are means ± SD, and total carbon stocks are shown with total uncertainties)

Parameters	Range	Average
Peat thickness (cm)	15-295	110 (77)
Bulk Density (g cm^{-3})	0.11- 0.34	0.23 (0.06)
Moisture Content (%)	52-86	71 (8)
Carbon density (kg m^{-2})	3.9 –80.2	29 (17)
Total Carbon stock (t ha^{-1}) of thickness; < 200 cm > 200 cm	 60 - 817 217 - 476	 268 (168) 285(97)
Total Carbon stock (t ha^{-1})		287 (214)
Total Carbon stock (M tons per area)		0.48 (0.35) *
tCO_2e (t ha^{-1})		1053
tCO_2e (M tons per area)		1.8 *

(1000000 ton = 1 Megaton)*

5. Conclusion and Recommendations

Peat soils are formed naturally from prolong period of water submergence and used for different purposes worldwide. Peatlands are unique natural resources forming distinct ecosystems of importance for biodiversity for the maintenance of genetic, species and habitat levels (IPS, 2010). Un-drained peatlands are valuable environments for a wide range of biodiversity and using for ecosystem services and many are managed as nature reserves. Drained peatlands are used mostly for agriculture and forestry but also for peat extraction to provide energy, growing media and other products. In Heho valley, cultivation of seasonal crops such as some vegetables is the major use for peatland. Production of peat for fuel-wood was not observed in recent times, except artificial drainage for land preparation for growing agricultural crops was observed. IPS (2010) stated that after-use plans for peat extraction, forestry, agriculture and other uses should include best practice measures for the restoration of an optimal range of biodiversity and ecosystem services.

The organic carbon stock of peatland in Heho Valley was within the range from 0.06 Mt to 1.35 Mt. According to the findings in this study, the OCD of the study area ranged from 11 k gm^{-3} to 121 kgm^{-3}.This study provides the consistent estimates of C stocks for the peatland in Heho valley. TOC contents were relatively lower than that of peatlands in other SE Asia countries, which may be due to the historical (peat extraction, drainage) and current land uses. The higher bulk density and lower organic carbon in this study area may be due to the lowering of the water table and the subsequent increased aeration of the peat due to drainage preparations for agriculture purposes. Although carbon stocks of the peatland on Haho valley are relatively low, they can be a significant source of vulnerable C which will be able to be transformed to carbon dioxide to release into the atmosphere if the peatland is drained or converted to agriculture for a long period. In this account, planning the wise use of the peatland with low carbon emissions is urgently needed.

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APPENDIX I

List of sampling points where peat samples were collected in Heho Valley Area

Point No.	Land cover	Peat layers									Total Thickness	No. of Peat simple (begs)	Soil between Peat layers	Depth of ground water (ft)	Flood		Drainage	Fire	Remark
		1st layer			2nd layer			3rd layer											
		From	To	Thickness	From	To	Thickness	From	To	Thickness					Duration (month)	Depth (ft)			
1	To Plant Paddy	3.3'	5.3'	**2'**	-	-	-	-	-	-	**2'**	1	Mud Soil	2'	2	1.6'	Y	N	
2	To Plant Paddy	1'	3'	**2'**	-	-	-	-	-	-	**2'**	1	Mud Soil	2'	2	2'	Y	N	
3	Potato Plantation	0.6'	3'	**2.6'**	-	-	-	-	-	-	**2.6'**	1	Mud Soil	2'	2	1.6'	N	N	
4	Potato Plantation	3'	6'	**3'**	6'	8.2'	**2.2'**	-	-	-	**5.2'**	2	Mud Soil	6'	2	1'	Y	N	
5	Potato Plantation	3'	4.6'	**1'**	-	-	-	-	-	-	**1'**	1	Mud Soil	3.6'	2	1'	Y	N	
6	Potato Plantation	3.3'	5.3'	**2'**	-	-	-	-	-	-	**2'**	1	Mud Soil	4.3'	2	0.6'	Y	N	
7	Potato Plantation	-	-	-	-	-	-	-	-	-	-	0		-	-	-		-	no peat found
8	Cabbage Plantation	1.5'	4.11'	**3.6'**	-	-	-	-	-	-	**3.6'**	1	Mud Soil	3'	2	1.6'	Y	N	
9	Corn Plantation	1'	4'	**3'**	4'	7'	**3'**	7'	8.4'	1.4'	**7.4'**	3	Mud Soil	3'	2	1.6'	Y	N	
10	Potato Plantation	6.3'	6.11'	**0.8'**	-	-	-	-	-	-	**0.8'**	1	Mud Soil	2.9'	2	1'	Y	N	
11	Cabbage Plantation	6'	6.1'	**10"**	-	-	-	-	-	-	**10"**	1	Mud Soil	4'	2	1'	Y	N	
12	Potato Plantation	4.2'	7.2'	**3'**	7.2'	9'	**1.1'**	-	-	-	**4.1'**	2	Mud Soil	7'	2	0.6'	Y	N	
13	Corn Plantation	3.3'	6.3'	**3'**	6.3'	7.1'	**1.7'**	-	-	-	**4.7'**	2	Mud Soil	-	2	0.6'	Y	N	

List of sampling points where peat samples were collected in Heho Valley Area (Contd.)

Point No.	Land cover	Peat layers									Total Thickness	No. of Peat simple (begs)	Soil between Peat layers	Depth of ground water (ft)	Flood		Drainage	Fire	Remark
		1st layer			2nd layer			3rd layer											
		From				To	Thickness								Duration (month)	Depth (ft)			
14	Pasture	2.3'	3.3'	**1'**	-	-	-	-	-	-	**1'**	1	Mud Soil	-	2	1.6'	N	N	
15	Bean	0.6'	1.2'	**0.8'**	-	-	-	-	-	-	**0.8'**	1	Mud Soil	-	2	0.6'	N	N	
16	Bean	-	-	-	-	-	-	-	-	-	-	0		-	-	-	-	-	no peat found
17	Corn Plantation	3.2'	6.2'	**3'**	6.2'	9.2'	**3'**	-	-	-	**6'**	2	Mud Soil	-	2	1'	N	N	
18	Cabbage Plantation	1.1'	4.1'	**3'**	4.1'	6.1'	**2'**	-	-	-	**5'**	2	Mud Soil	-	2	0.6'	N	N	
19	To Plant Paddy	1.1'	4.1'	**3'**	4.1'	7.1'	**3'**	7.1'	8.1'	1'	**7'**	3	Mud Soil	7'	2	1.6'	N	N	
20	Tornato Plantation	0.6'	1.6'	**1'**	-	-	-	-	-	-	**1'**	1	Mud Soil	2.6'	2	1'	N	N	
21	Potato Plantation	1.5'	4.5'	**3'**	-	-	-	-	-	-	**3'**	1	Mud Soil	2'	2	1'	Y	N	
22	Potato Plantation	0.9'	1.1'	**1.1'**	-	-	-	-	-	-	**1.1'**	1	Mud Soil	3'	2	1.6'	Y	N	
23	To Plant Paddy	0.6'	1'	**0.6'**	-	-	-	-	-	-	**0.6'**	1	Mud Soil	1'	2	1.6'	Y	N	
24	Garlic Plantation	2.6'	5.6'	**3'**	5.6'	8.6'	**3'**	-	-	-	**6'**	2	Mud Soil	2'	2	1'	N	N	
25	Flower Plantation	2.6'	5.6'	**3'**	5.6'	8.6'	**3'**	-	-	-	**6'**	2	Mud Soil	3'	2	0.6'	Y	N	

List of sampling points where peat samples were collected in Heho Valley Area (Contd.)

Point No.	Land cover	Peat layers									Total Thickness	No. of Peat simple (begs)	Soil between Peat layers	Depth of ground water (ft)	Flood		Drainage	Fire	Remark
		1st layer			2nd layer			3rd layer							Duration (month)	Depth (ft)			
		From				To	Thickness												
27	Potato Plantation	2.3'	5.3'	**3'**	5.3'	8.3'	**3'**	8.3'	9.3'	1'	**7'**	3	Mud Soil	5'	2	1'	Y	N	
28	Soya bean Plantation	4'	7'	**3'**	7'	10'	**3'**	-	-	-	**6'**	2	Mud Soil	5'	2	0.6'	N	N	
29	Cabbage Plantation	0.4'	0.1'	**0.6'**	-	-	-	-	-	-	**0.6'**	1	Mud Soil	4.6'	2	1.6'	Y	N	
30	Corn Plantation	3.4'	6.4'	**3'**	-	-	-	-	-	-	**3'**	1	Mud Soil	5.6'	2	1.6'	Y	N	
31	Corn Plantation	2.3'	5.3'	**3'**	5.3'	7.3'	**2'**	-	-	-	**5'**	2	Mud Soil	4.6'	2	0.6'	Y	N	
32	Potato Plantation	3'	6'	**3'**	6'	9'	**3'**	-	-	-	**6'**	2	Mud Soil	4'	2	1'	Y	N	
33	Potato Plantation	1.2'	3.2'	**2'**	-	-	-	-	-	-	**2'**	1	Mud Soil	4.6'	2	1'	Y	N	
34	Garlic	0.6'	1.4'	**0.1'**	-	-	-	-	-	-	**0.1'**	1	Mud Soil	-	2	0.6'	-	-	
35	Pigeon Pea Plantation	2.7'	5.7'	**3'**	5.7'	7.5'	**1.1'**	-	-	-	**4.1'**	2	Mud Soil	-	2	0.6'	N	N	
36	Potato Plantation	1.1'	4.1'	**3'**	-	-	-	-	-	-	**3'**	1	Mud Soil	4.6'	2	0.6'	N	N	
37	Potato Plantation	0.6'	2'	**1.6'**	-	-	-	-	-	-	**1.6'**	1	Mud Soil	1.3'	2	1.6'	Y	N	
38	Potato Plantation	0.6'	1.6'	**1'**	-	-	-	-	-	-	**1'**	1	Mud Soil	4.3'	2	0.6'	Y	N	

List of sampling points where peat samples were collected in Heho Valley Area (Contd.)

Point No.	Land cover	Peat layers									Total Thickness	No. of Peat simple (begs)	Soil between Peat layers	Depth of ground water (ft)	Flood		Drainage	Fire	Remark
		1st layer			2nd layer			3rd layer											
		From				To	Thickness								Duration (month)	Depth (ft)			
39	Potato Plantation	0.4'	1.3'	**1.1'**	-	-	-	-	-	-	**1.1'**	1	Mud Soil	3.6'	2	1'	Y	N	
40	Corn Plantation	1.4'	2.4'	**1'**	-	-	-	-	-	-	**1'**	1	Mud Soil	-	2	1'	Y	N	
41	Potato Plantation	0.6'	1.6'	**1'**	-	-	-	-	-	-	**1'**	1	Mud Soil	3'	2	1'	Y	N	
42	Potato Plantation	1'	1.6'	**0.6'**	-	-	-	-	-	-	**0.6'**	1	Mud Soil	3.1'	2	2'	N	N	
43	Cabbage Plantation	1.1'	4.1'	**3'**	4.1'	5.8'	**0.1'**	-	-	-	**3.1'**	2	Mud Soil	-	2	1'	Y	N	
44	Potato Plantation	0.7'	1.7'	**1'**	3.7'	5.7'	**2'**	-	-	-	**3'**	2	Mud Soil	3.7'	2	1.6'	Y	N	
45	Potato Plantation	1'	2.2'	**1.2'**	-	-	-	-	-	-	**1.2'**	1	Mud Soil	3'	2	0.6'	Y	N	
46	Pasture	0.6'	1.6'	**1'**	-	-	-	-	-	-	**1'**	1	Mud Soil	7'	3	3'	N	N	
47	Corn Plantation	1.5'	4.5'	**3'**	-	-	-	-	-	-	**3'**	1	Mud Soil	5'	2	1'	N	N	
48	Cabbage Plantation	3.3'	6.3'	**3'**	6.3'	9.3'	**3'**	-	-	-	**6'**	2	Mud Soil	3.8'	2	0.6'	Y	N	
49	Potato Plantation	0.1'	3.1'	**3'**	3.1'	6.1'	**3'**	-	-	-	**6'**	2	Mud Soil	3'	2	1'	Y	N	
50	Flower Plantation	0.3'	0.9'	**0.6'**	-	-	-	-	-	-	**0.6'**	1	Mud Soil	1'	2	0.6'	Y	N	
51	Pasture	0.6'	2.6'	**2'**	-	-	-	-	-	-	**2'**	1	Mud Soil	-	2	2'	N	N	

List of sampling points where peat samples were collected in Heho Valley Area (Contd.)

Point No.	Land cover	Peat layers									Total Thickness	No. of Peat simple (begs)	Soil between Peat layers	Depth of ground water (ft)	Flood		Drainage	Fire	Remark
		1st layer			2nd layer			3rd layer											
		From				To	Thickness								Duration (month)	Depth (ft)			
52	Potato Plantation	1'	1.1'	**0.3'**	-	-	-	-	-	-	**0.1'**	1	Mud Soil	-	2	1.6'	Y	N	
53	Corn Plantation	2'	5'	**3'**	5'	8'	**3'**	-	-	-	**6'**	2	Mud Soil	5'	2	2'	Y	N	
54	Potato Plantation	2.3'	5.3'	**3'**	5.3'	7'	**1.9'**	-	-	-	**4.9'**	2	Mud Soil	-	2	0.6'	Y	N	
55	Potato Plantation	1.8'	4.8'	**3'**	4.8'	7.8'	**3'**	-	-	-	**6'**	2	Mud Soil	3.3'	2	0.6'	Y	N	
56	Potato Plantation	1.3'	4.3'	**3'**	4.3'	7.3'	**3'**	7.3'	10.3'	3'	**9'**	3	Mud Soil	n.a	2	1.6'	Y	N	
57	Potato Plantation	2.9'	5.9'	**3'**	5.9'	8.9'	**3'**	-	-	-	**6'**	2	Mud Soil	n.a	2	2'	Y	N	
58	Potato Plantation	2.8'	5.8'	**3'**	5.8'	7.8'	**3'**	-	-	-	**6'**	2	Mud Soil	n.a	2	1.6'	Y	N	
59	Potato Plantation	1.7'	3.7'	**2'**	3.7'	6.7'	**3'**	6.7'	8.7'	2'	**7'**	3	Mud Soil	n.a	2	1'	Y	N	
60	Potato Plantation	1.6'	4.6'	**3'**	4.6'	6.6'	**2'**		-	-	**5'**	2	Mud Soil	n.a	2	1'	Y	N	
CPO	Potato Plantation	1.8'	4.8'	**3'**	4.8'	7.8'	**3'**	7.8'	10.8'	3'	**9'**	3	Mud Soil	n.a	2	0.6'	Y	N	