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Rice Terrace Farming Systems
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Assessment on the feasibility of REDD+ in Nagacadan Rice Terraces of Ifugao and its *muyong* forest

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Rice Terrace Farming Systems
This working paper series share findings produced as part of the research activities under the Rice Terrace Systems in Rural Asia, a research project of the United Nations University Institute for the Advanced Study of Sustainability (UNU-IAS). The project aims to address dual challenges of both excessive runoff and water scarcity due to climate change by providing ecosystem based adaptation measures to strengthen resilience of the Hani Rice Terraces and Ifugao Rice Terraces.

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ABSTRACT

Muyong is one of the indigenous forest management practices of the Ifugaos that play a crucial role in the watersheds of the Ifugao rice terraces and supplementary food source. This study attempts to assess the feasibility of implementing a REDD+ in the Nagacadan rice terrace cluster of the Ifugao Rice Terraces. A carbon study was conducted by measuring four different carbon pools of the local forests: the forest carbon stock, non-tree vegetation, forest floor litter layer, and soil carbon at 10 cm depth. A qualitative assessment was also carried out in order to assess the potential for REDD+ implementation in the area through focus group discussion and key informant interviews.

INTRODUCTION

The Ifugao's muyong system stands out among indigenous silviculture, horticulture and soil and water conservation methods in Ifugao. Through an efficient Assisted Natural Regeneration (ANR) system, the Ifugao managed forestlands as watersheds and agro-forests ensuring sustainable water supply for the rice fields (Martin, 2013). According to Butic and Ngidlo (2003) *muyungs*, which was derived from their local dialect as forest or woodlot and is also called *Pinugo*, made up of clan- owned woodlots (forests) directly above the rice terraces, and its values, are based on the cultural ways and practices of the Ifugao people. *Muyong* has four separate meaning: 1). A privately owned woodlot in an elevated area that is managed by the indigenous people; 2). A socio-political structure of collective management; 3). Water rehabilitation technique, and 4). Assisted natural regeneration strategies for the forest according to Jang and Salcedo (2013) and Camacho et al. (2012).

STUDY AREA AND METHODOLOGY

The selected study site is located in the Barangay of Nagacadan located along the western border of the municipality of Kiangan, Ifugao Province. Nagacadan is approximately 600 hectares in size and is comprised of five hamlets: Bayninan, Wingyon, Onnop, Pau, and Bilong. A carbon study was conducted by measuring four different carbon pools of the local forests: the forest carbon stock, non-tree vegetation, forest floor litter layer, and soil carbon at 10 cm depth. A qualitative assessment was also carried out in order to assess the potential for REDD+ implementation in the area through focus group discussion and key informant interviews.

Two classifications of forest that are native to the area were used in the carbon study, the *muyong* and the *bilid*. The *muyong*, as explained earlier, refers to the private woodlots that are maintained by residents of the area. The *bilid* is the other forest land use in the area. In the context of the local community, the *bilid* refers to the forested area along the mountain ridge. It is usually distant from the homestead and unlike the *muyong*, is communally managed. Because of the different management regimes, the *bilid* exhibits different characteristics from that of the *muyong*, most notably: forest species composition, tree density and average diameter at breast height.

For the forest carbon component, 11 *muyong* and 8 *bilid* sites were sampled; species, tree DBH and height were recorded and their respective locations were marked on GPS. Due to the sleep slope of the terrain in the study site, the size of the plots in the study were limited to 10 square meters. The following equation was used for the estimation of aboveground biomass, it was developed specifically for

Figure 1: Muyong and the rice terraces below

forest biomass estimation in moist tropical forests. The equation was selected because it accounts for the large variety in species found in tropical forests. This equation is reliable for trees with DBH as large as 148 cm.

$$Biomass = exp(-2.289 + 2.649 \times ln(dbh) - 0.021 \times ln(dbh^2))$$

Source: Brown (1997)

With the remote sensing aspect of this study, the 10 square meter plots correlated to the size of approximately one pixel from JAXA's AVNIR-2 satellite data. However, because of the high slope, the size of the plots was slightly smaller than that of the pixel. An expansion factor was used to adjust for the slope in the biomass density calculations of the forest plots.

The forest floor layer analysis examined two carbon pools, non-tree vegetation and forest floor litter. This component sampled the two carbon pools from the five land use types: *muyong* (9), *bilid* (7), *habal* (5), short fallow (4) and long fallow (4). Samples were obtained and oven-dried to calculate biomass and carbon sequestration.

The analysis of soil carbon used a similar stratification of land use classes, looking at the *muyong*, *bilid*, short fallow, long fallow and *habal*. Three representative samples were taken from the muyong, two from the bilid and one from short fallow, long fallow, and habal, respectively. These samples were taken from the top 10 cm topsoil layer. Soil carbon content was determined by analyzing soil samples from the different land use classes under laboratory conditions.

RESULTS AND DISCUSSION

The first notable finding of this study was that there are significant differences in diameter at breast height and tree density in the *muyong* and in the *bilid*. The *muyong* exhibited a higher average DBH and lower tree density while the bilid exhibited a lower DBH and high tree density.

This below histogram charts the frequency of trees found in the 19 sample sites. The histogram illustrates that the *muyong* allows for the growth of larger trees, either because of the protection offered by the private ownership or as a result of the maintenance activities that are performed in *muyong*. Diameter at breast height (DBH) is the most important factor for biomass estimation. According to the equation developed by Sandra Brown (1997) the diameter at breast height increases the tree biomass at an exponential rate. Up to 40% of the total biomass in moist tropical forests can be found in trees of diameter of 70 cm or more, despite trees of this size typically accounting for less than 5% of the forest population (Brown and Lugo, Brown 1992). The only entry omitted from the above histogram was a 109 cm *Balete* tree that was observed in the *muyong*.

Forest carbon stock was calculated by using a proportion (0.47) of the total estimated biomass. This was added to the estimated carbon sequestered in the other three carbon pools to get the total carbon stock of the different land uses. Comparing the estimated aboveground biomass of the muyong to tropical forests featured in other studies, the muyong that were studied measure to be generally above-average. The FAO's 2010 FRA implies that an

Figure 2: DBH Histogram

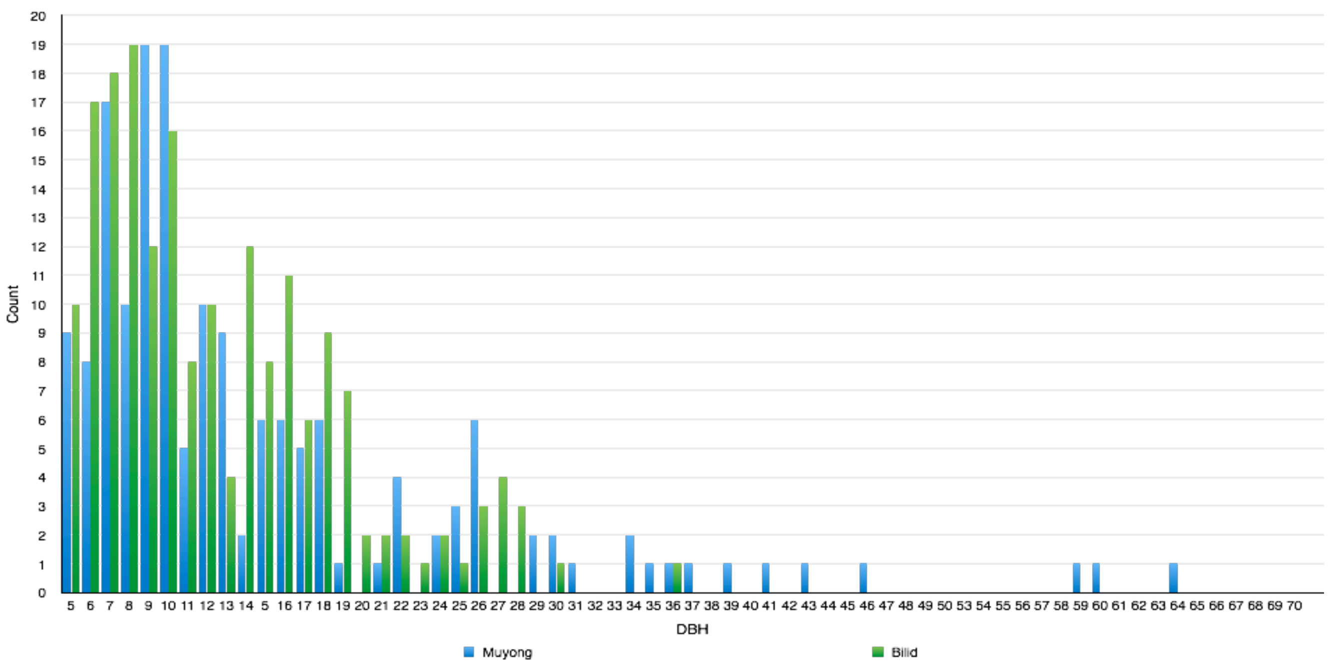


Table 1: Muyong Forest Carbon Stock Calculations

Muyong	AGB		BGB		AGB+BGB		C Stock	
	kg	tons/ha	kg	tons/ha	kg	tons/ha	kg	tons/ha
M01	666.22	70.1	133.30	14.0	799.52	84.1	375.78	39.5
M02	2,345.49	246.6	417.87	43.9	2,763.36	290.6	1,298.78	136.6
M03	3,167.92	333.1	535.70	56.3	3,703.62	389.4	1,740.70	183.0
M04	1,066.22	112.1	209.00	22.0	1,275.21	134.1	599.35	63.0
M05	2,465.64	259.3	515.15	54.2	2,980.79	313.4	1,400.97	147.3
M06	1,008.68	106.1	191.53	20.1	1,200.21	126.2	564.10	59.3
M07	1,500.47	157.8	291.27	30.6	1,791.74	188.4	842.12	88.5
M08	1,965.55	206.7	375.16	39.4	2,340.72	246.1	1,100.14	115.7
M09	5,421.45	570.0	834.79	87.8	6,256.24	657.8	2,940.43	309.2
M10	1,248.71	131.3	240.64	25.3	1,489.35	156.6	699.99	73.6
M11	1,723.20	181.2	322.56	33.9	2,045.76	215.1	961.51	101.1
Average	2,052.7	215.8	369.7	38.9	2,422.41	254.7	1,138.5	119.7

Table 2: Bilid Forest Carbon Stock Calculations

Bilid	AGB		BGB		AGB+BGB		C Stock	
	kg	tons/ha	kg	tons/ha	kg	tons/ha	kg	tons/ha
B01	1,383.0	145.4	264.6	27.8	1,647.6	173.2	774.4	81.4
B02	1,243.6	130.8	252.9	26.6	1,496.5	157.3	703.3	74.0
B03	1,324.9	139.3	273.2	28.7	1,598.1	168.0	751.1	79.0
B04	915.9	96.3	196.6	20.7	1,112.5	117.0	522.9	55.0
B05	1,542.0	162.1	303.1	31.9	1,845.1	194.0	867.2	91.2
B06	2,389.5	251.2	464.9	48.9	2,854.4	300.1	1341.5	141.1
B07	1,589.8	167.2	346.3	36.4	1,936.2	203.6	910.0	95.7
B08	2,262.8	237.9	443.6	46.6	2,706.3	284.6	1272.0	133.7
Average	1,581.4	166.3	318.1	33.5	1,899.6	1597.9	892.8	93.9

average hectare of Philippine forest contains about 148.50 tons of biomass while the muyong in this study exhibited a much higher biomass of 215.8 tons/hectare.

Forest Floor Area

Table 3: Average sample collected per square meter for each land use type

Land Use	Fresh Sample (g)	Litter Sample (g)	Total Sample (g)
Bilid	673±447	1,776±412	2,449±608
Fallow	1,714±1,220	1,702±1531	3,416±1,958
Muyong	419±188	1,075±446	1,494±481
Habal	1,134±501	316±261	1,450±565

From the 1 square meter plots, the largest samples of fresh and litter were collected in the 'fallow' land use classification, followed by the 'bilid'. Oven-drying the samples collected yielded the following dry masses:

Table 4: Average Dry Mass per square meter for each land use type

	Average Dry Mass			Proportion of Dry Mass		
Land Use	Fresh	Litter	Total	Fresh	Litter	Total
	(grams /sqm)	(grams /sqm)	(grams /sqm)			
Muyong	0.94	2.99	3.93	0.24	0.76	1.00
Bilid	1.57	5.39	6.96	0.23	0.77	1.00
Habal	1.56	1.18	2.73	0.57	0.43	1.00
Fallow	1.90	2.69	4.59	0.41	0.59	1.00

This shows that despite the fallow land housing the greatest amount of raw material, the forest floor in the bilid actually contains the most biomass. The oven-dried weight was then used to calculate the biomass density of the forest floor layer (non-tree vegetation and litter):

Table 5: Average Biomass Density per square meter for each land use type

Land Use	Average Biomass Density			Proportion of Biomass Density	
	Fresh	Litter	Total	Fresh	Litter
	(tons/ ha)	(tons / ha)	(tons/ ha)		
Muyong	935.4	2,991.9	3,927.3	0.238	0.762
Bilid	1,572.2	5,680.9	7,253.1	0.217	0.783
Habal	1,555.1	1,176.2	2,731.3	0.569	0.431
(Short Fallow)	776.9	2,968.0	3,744.9	0.207	0.793
(Long Fallow)	2,498.7	2,606.3	5,105.0	0.489	0.511
Fallow	1,637.8	2,787.1	4,424.9	0.370	0.630

'Short fallow' and 'Long fallow' were combined to make up the 'Fallow' land use classification. The above table shows that in the non-tree vegetation and litter layers, the *habal* and the fallow land exhibited the highest amount of total biomass. The long fallow as expected, contains a higher biomass density due to the greater amount of plant growth.

Among the four stratifications of land use types, the bilid is estimated to have the highest density of carbon in the forest floor layer.

Table 6: Average Carbon Density per square meter for each land use type

Land Use	Average Carbon Density			Rank		
	Fresh	Litter	Total	Fresh	Litter	Total
	(tC/ha)	(tC/ha)	(tC/ha)			
Muyong	4.21± 1.87	13.46± 6.04	17.67± 6.34	4	3	3
Bilid	7.07± 4.69	24.25± 7.69	31.33± 9.01	2	1	1
Habal	6.99 ± 3.37	5.29± 3.71	12.29± 5.01	3	4	4

Soil Component

In the soil analysis, samples taken from the 10 cm topsoil layer were obtained and oven-dried at 70 degrees Celsius for 48 hours. They were then subject to carbon content analysis under laboratory conditions.

Table 7: Average Bulk Density per square meter for each land use type

Land Use	Average Bulk Density	Mean % OC	Avg. Carbon Stock (tC/ha)
Open field	0.7±0.24	3.35±1.80	68.3±43.36
Bilid	0.73+0.04	3.26±0.90	63.6±6.23
Muyong	0.73±0.24	3.88±0.09	80.1± 52.3

The soil samples exhibited similar bulk densities, but differed in the percentage of organic carbon (%OC) found in the soil. The muyong was found to have the highest %OC that contributed to it's higher estimated soil carbon sequestration. It is also worth mentioning that the high variation in the open field classification is a result of using different representative samples for the classification.

Total Carbon Stock

Based on the results, the muyong is expected to have the highest carbon stock among the land use classes that were sampled. Furthermore, there is reason to suspect that the actual carbon stock of the muyong may be higher, based on the understanding that the initial estimates were adjusted down to avoid bias. The carbon sequestration capacity of the old abandoned rice fields is unnaturally high, though this is likely caused by bias of the representative soil sample, which was taken from a waterlogged plot. The open land classification is the average of the habal, abandoned and old abandoned land use categories.

The total carbon stock per hectare was estimated to be highest in the muyong. The carbon sequestration capacity of the old abandoned rice fields is unnaturally high, though this is likely caused by bias of the representative soil sample which was taken from a waterlogged plot. The open land classification is the average of the habal, abandoned and old abandoned land use categories.

Figure 3: Total C Stock

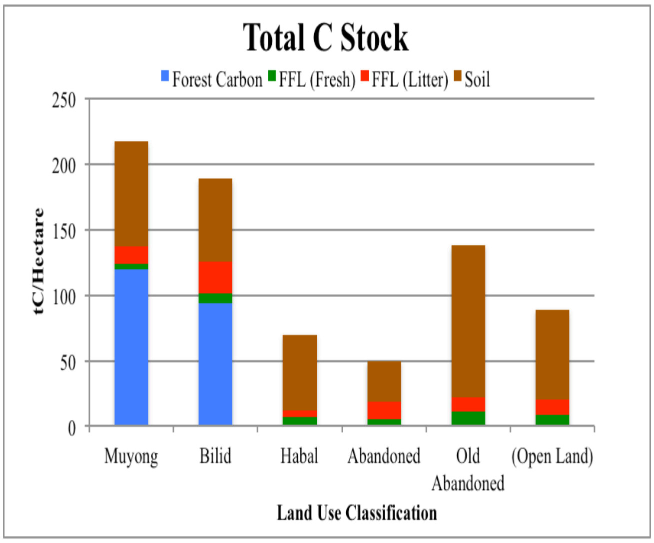


Table 8: Total Carbon Stock per square meter for each land use type

Land Use	Forest C Stock	Forest Floor Layer		Soil	Total C Stock
	(tC/ha)	Fresh	Litter	(tC/ha)	(tC/ha)
Muyong	119.7	4.21	13.46	80.1	217.47
Bilid	93.9	7.07	24.25	63.6	188.82
Habal	N/A	6.99	5.29	57.6	69.88
Abandoned	N/A	4.97	13.36	31.3	49.63

Challenges and Opportunities

The qualitative aspect of the study looked to assess the potential for REDD+ in the study site using key informant interviews and focus group discussions. While the carbon study attempted to address the technical feasibility of REDD+ in the area, the qualitative component looked to identify the key challenges and opportunities towards a REDD+ intervention. Attention was paid to the REDD+ safeguards that are stipulated in Annex I/CP16. Safeguards are policies and mechanisms that exist to reduce the risk of undesirable outcomes from an intervention. If not properly established, the lack of safeguards increases the risks of increasing in the carbon emissions of the area. The REDD+ safeguards follow five core themes: good governance, social aspects, environmental aspects, non-carbon benefits and GHG emissions integrity.

In order for an appropriate strategy to be devised, an intervention must also take into account the relevant stakeholders and societal conditions that are specific to the project site. Safeguards must take into account the existing situation within the area and within the country.

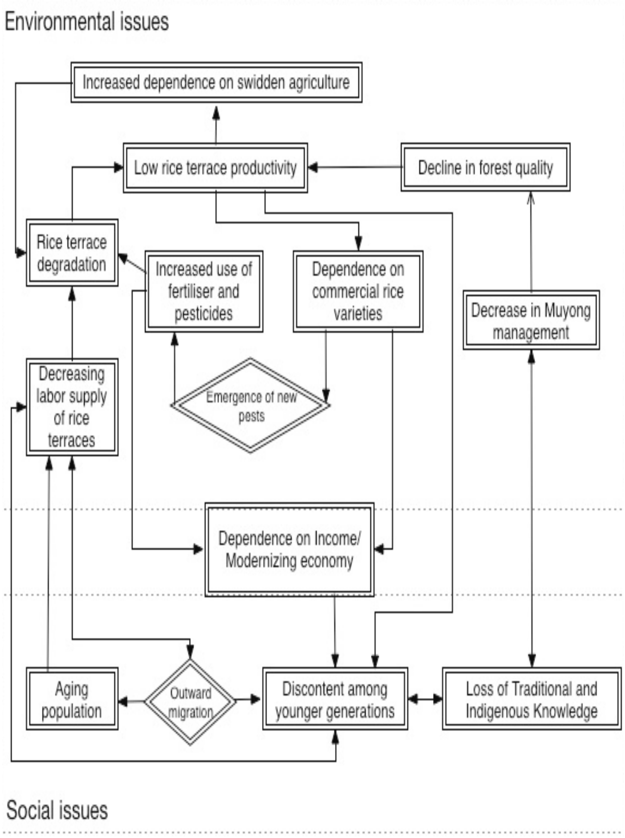
In the area of good governance, the Philippines actually has quite a robust body of legislation designed to protect the forest. That being said, there are issues with the lack of enforcement capacity and verification mechanisms particularly within the forestry sector. The Community Based Forest Management (CBFM) Agreement system has been a national policy in the Philippines since 1996, yet there is no currently existing agreement in the area, which is evidenced by the lack of a People's Organization in the Barangay. However, this looks to change as there are plans to install one in the near future. The question still remains as to whether the local community will actively use and participate in such a program, given their past experiences with government initiatives.

The study also revealed that there is a knowledge gap between the national government and the local communities when it comes to the question of local land tenure. At the moment, the only method of verification for *muyong* ownership is tax registration forms; however, these have a tendency to lack reliability. In reality, the community is well aware of *muyong* boundaries of different owners, however, this gap in knowledge between government legitimacy and local legitimacy to claims on the land represents a potential leakage that must be addressed before a REDD+ intervention can be possible.

Addressing the social and environmental issues of the area is also an extremely complex issue to address. The primary environmental problems in the area are largely a result of economic pressures. The change to the intensive use of commercial rice, in particular, has been a large factor in contributing to this change.

A result of the key informant interviews and the focus group discussions, it is feasible to argue that the change from the strains of traditional rice varieties to commercial rice is exerting a large impact on the agricultural system in the area. One of the most notable changes that the commercial rice brings is the possibility of having two crops of rice per year as opposed to the one offered by the native variety. Intensive use of the commercial rice, rather than the native rice, can serve to degrade the rice terraces over time. Although there are already international initiatives in the area such as the GIAHS program and the UNESCO inscription, REDD+ can make a positive impact if it can manage to find a way to reduce the outward flow of migration and to incentivize continued maintenance of the *muyong* system over the long run.

The creation of non-carbon benefits associated with a REDD+ initiative looks for an intervention to actually improve the livelihood of the local communities in addition to sequestering carbon. The promotion of the concept of the *muyong* seeks to do just that as the muyong provides essential ecosystem services that enhance the livelihood of its users. Addressing the integrity of GHG emissions seeks to avoid the risks of displacing such emissions.



Although the *muyong* is currently employed in the study site, the promotion of the *muyong* in other areas of the province and in the Philippines could potentially improve the quality of livelihood and carbon sequestration simultaneously. The question still remains as to how to transplant the values that have allowed the *muyong* to exist and how to incentivize such behavior. More research and thought needs to be put into how benefits can be adequately distributed so that an appropriate and sustainable outcome can be achieved.

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