

Traditional Ecological Knowledge in the REDD+ Strategies in Bangladesh

Project ID: 9912-1

Final Report

By

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Background of the work

Forestry is an important sector in Bangladesh's economy. Forest lands make up almost 18% of the total lands in Bangladesh where natural forest accounts for about 31%. REDD+ is now a central topic of research and discussion in the arena of climate change mitigation and forest conservation. The financial incentives for REDD+ in many pilot projects established in several countries have been found to alter drivers of land use changes by reducing opportunity costs of retaining forest cover, and as multipartite solutions that not only generate profit and reduce carbon emissions, but also provide benefits for human development and biodiversity. The importance of Traditional Ecological Knowledge (TEK), usufructs of the forest dependent peoples, has been emphasized for the successful implementation of REDD+. Bangladesh had no pilot project on REDD+. Tropical semi-evergreen forests in the Chittagong Hill Tracts (CHTs) of Bangladesh are severely deforested and degraded. REDD+ can potentially retard deforestation and degradation. So, it concerns a research question what is TEK regarding natural forests of the local peoples living inside the forests which can be incorporated while planning for the REDD+ projects in the CHTs of Bangladesh. The present study aims at answering this research question.

General objectives of the study

The general objective of this research project is to find out the TEK of the forest dependent peoples living inside the tropical semi-evergreen forests in the CHTs of Bangladesh.

Specific objectives of the study

- Shorting out TEK of the forest dependent peoples regarding biodiversity conservation
- Identification of TEK for vulnerability reduction in their livelihood
- Shorting out the alternative livelihood practices which can be used while implementing REDD+
- Identification of tradeoffs between forest biodiversity use and expected carbon benefits of the peoples

Study area and method of sampling

The *Chakma* ethnic community living inside the forests is the dominant tribal group in Bangladesh. TEK of a tribal community, especially *Chakma* living inside the tropical semi-evergreen forests was sampled purposively as a case study in the Rangamati Sadar Upazila (Local government unit under a district) at Rangamati District in Bangladesh (Figure 1). A stratified random sampling technique was applied to locate the forest dependent households in two strata. Two Unions were selected randomly from the Upazila based on two strata (severely deforested and degraded). The name of the selected two unions are Balukhali and Sapchori. From each union, 3 villages were selected randomly making a total of 6 villages for the study. The names of the villages are Headmanpara, Maddhapara, Bodhipur, Sapchoripara, Kainda and Harekkhang. From each selected village, 15 households were selected randomly. It made a total of 90 households as the ultimate sampling units.

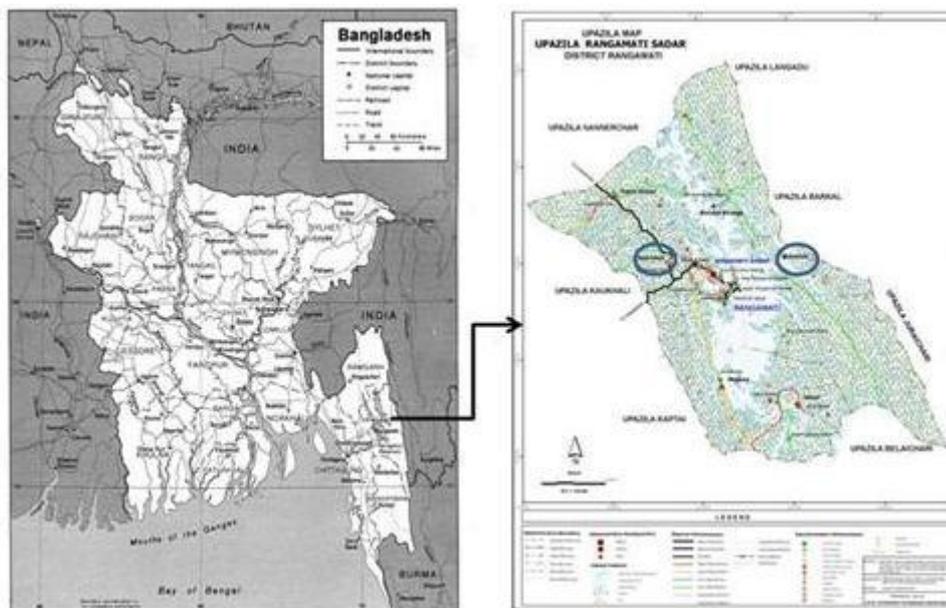


Figure 1. The selected Unions, Balukhali and Sapchori, are shown in the map of Rangamati Sadar Upazila of Rangamati District, Bangladesh

Project activities

A reconnaissance survey in Rangamati Sadar Upazila was performed on July 2011 to obtain an overview of the forests and the *Chakma* community in the CHTs of Bangladesh. And then, a planning meeting was organized with the participation of all data investigators and prominent naturalists. For better understanding and pin-pointed methodology, the planning meeting appeared as a stakeholders' consultation. In this consultation, we had an

academic discussion with Professor M. Kalimuddin Bhuiyan, Professor Dr. Kamal Hossain and Dr. Jarin Akhter of Institute of Forestry and Environmental Sciences, University of Chittagong; and Professor S.M. Monirul Hasan of the Department of Sociology of University of Chittagong. In our meeting, Dr. Shalina Akther, a free lancer consultant in tribal usufructs and society mobilization dynamics, was also present. Mr. Sheeladitya Chakma, Mr. Pipir Pipir Chakma and Ms. Dipannita Chakma also were present in our planning meeting as the nearest stakeholder of the Chakma community in the CHTs. We had a very effective adjustment in our planning of research after this meeting. We adjusted the pre-made semi-structure questionnaire and re-oriented our approach of data collection after this meeting. Finally, the data collection by semi-structured questionnaire has been completed for 90 forest dependent households at due time.

Local elites, community leaders and other key persons provided us significant opinion on the forest conservation and REDD+ implementation. We were partially successful to make a network of volunteers such as students, environmentalists who contributed with data collection and monitoring of the forest dependent peoples' perception and their traditional ecological knowledge. Taking the hypothesis that REDD+ program might improve the livelihood practices and their income of the forest dependent peoples, I took initiatives to have a couple of awareness campaigns in the Rangamati Sadar Upazila. The campaigns took place on 21 June 2012 and 28 June 2012. Significant numbers of both male and female participants were present in the campaigns. Based on the study findings, we extended our ideas to make aware the Chakma forest dependent households on the need of forest conservation and extending their present alternative livelihoods practices. The expected benefits of the REDD+ was also discussed pro-actively. A good awareness feedback was received from the respondents. The contribution of the Rufford Small Grants Foundation towards nature/forest conservation was also discussed positively. The forest dependent peoples demanded more extension of the ideas we discussed there.

PROJECT REPORT

Summary

Reducing emissions from deforestation and forest degradation, and enhancing forest carbon stocks (REDD+) can generate cost-effective quick reductions in global greenhouse

gas (GHG) emissions. It can simultaneously address climate change and rural poverty, while conserving biodiversity and sustaining vital ecosystem services. Traditional Ecological Knowledge (TEK) of the forest dependent peoples can be an important tool to implementation of the REDD+ in Bangladesh. The research aims to find out the TEK of the forest dependent peoples living inside the tropical semi-evergreen forests in Chittagong Hill tracts (CHTs) of Bangladesh. Adopting a stratified random sampling technique, the study was carried out in the Rangamati Sadar Upazila with a total of 90 sample households from the Chakma community. It was found that average number of people gathering products from the forests was 2 day⁻¹ household⁻¹ and the mean distance of the forests from the households was 1.31 km. The average time required for extracting forest products was 2 hours. The land resources owned by each household were 6291 m², of which 460 m² were in the homestead, 2944 m² were under jhum (shifting) cultivation and 2887 m² were under non-jhum cultivation for agriculture. The average revenue per household from selling forest products in the study area was 13473 tk year⁻¹ including the revenues from timber, firewood, bamboo, medicinal plants, mammals and nuts where the largest generated from the timber selling. The study found that from the total harvests of the forest products, 92% of the firewood is consumed directly by the households, followed by timber and bamboo 33%, medicinal plants 22%, mammals 3% and nuts 2%, respectively. The study finds that at the strategy point of the REDD+ implementation in the CHTs of Bangladesh, the alternative livelihoods of the forest dependent peoples may be raising plantation, agricultural intensification, extending small business, etc. It was found that dependence on the forests for their medicinal, religious and foods services were in the hardcore while they could sacrifice timber, bamboo and vegetable collection from the forests. The present study confirms that for the REDD+ implementation in the CHTs, an appropriate cash compensation of the traditional forest use should be provided to the forest dependent peoples. Along with this, alternative jobs provided to the Chakma households will be crucial. The study will be useful to the policy makers relevant to the REDD+ strategies and natural forest conservation in Bangladesh.

Results and discussions

Socio-economic background of the forest dependent households

The forest dependent households had mostly semi-illiterate family members with only primary level education. The unavailability of educational institutions and long distance of

the households from the municipality areas along with other causes may be the possible reasons for not receiving sufficient education. In all the six villages, the family size was five members (Table 1). Analysis of households' income indicates that the average income of the households was 99289 tk year⁻¹ where Sapchoripara had the highest, 106133 tk year⁻¹ and Harekkhang had the lowest, 85867 tk year⁻¹. In most of the households, 2 members per household were found income-earners.

Table 1. Socio-economic background of the forest dependent Chakma households in the Rangamati Sadar Upazila, Rangamati, Bangladesh.

Villages	Family size	Literacy score	Number of earning members	Total income tk year ⁻¹
Bodhipur	4±0.32	1.52±0.25	2±0.19	89000±9696
Harekkhang	5±0.36	4.50±0.52	2±0.15	85867±7337
Headmanpara	5±0.40	4.03±0.48	2±0.27	95733±9014
Kainda	5±0.51	3.85±0.68	2±0.27	105467±12149
Maddhapara	5±0.31	4.20±0.74	2±0.21	113533±14293
Sapchoripara	5±0.29	5.36±0.64	1±0.13	106133±12473

Note: Figure next to ± sign refers to standard error of means

The average number of people gathering products from the forests per day per household was 2 and the mean distance of the forests from the households was 1.31 km. The average time required for extracting forest products was 2 hours with the minimum 2.30 hours and maximum 5.13 hours (Table 2).

Table 2. Access to forests of the forest dependent Chakma households in the Rangamati Sadar Upazila, Rangamati, Bangladesh.

Villages	Household's persons foraging in the forests (persons day ⁻¹)	Time required for extracting forest products (hours)	Distance of the forests from the households (km)
Bodhipur	2±0.18	5.13±0.41	1.80±0.33
Harekkhang	2±0.14	3.60±0.24	0.90±0.09
Headmanpara	2±0.19	4.47±0.32	1.07±0.13
Kainda	2±0.14	2.30±0.33	1.27±0.22
Maddhapara	2±0.20	4.40±0.43	1.27±0.19
Sapchoripara	2±0.15	3.97±0.37	1.53±0.29

Note: Figure next to ± sign refers to standard error of means

The land resources owned by each household were 6291 m², of which 460 m² were in the homestead, 2944 m² were under jhum (shifting) cultivation and 2887 m² were under non-jhum cultivation for agriculture (Table 3). The study determined that the majority of the lands used for jhum cultivation were hilly in nature. This is due to the geographical location of the area. Most of the lands were government-owned land leased to the local community for longer term.

Table 3. Distribution of land resources of the forest dependent households in the Rangamati Sadar Upazila, Rangamati, Bangladesh.

Villages	Homestead land (m ²)	Total <i>jhum</i> land for agriculture (m ²)	Total non <i>jhum</i> land for agriculture (m ²)	Total land (m ²)
Bodhipur	450±68.51	3798±798.38	2361±359.49	6609±1029.35
Harekkhang	436±62.92	2875±463.95	2509±309.41	5821±514.48
Headmanpara	704±158.15	2989±481.17	2395±394.50	6088±553.48
Kainda	583±248.88	2641±172.58	3513±622.01	6737±792.62
Maddhapara	256±34.54	2965±290.07	2945±553.64	6166±653.04
Sapchoripara	329±60.14	2394±220.23	3600±533.72	6322±648.40
Mean	460±53.70	2944±186.55	2887±196.35	6291±287.24

Note: Figure next to ± sign refers to standard error of means

The Lorenz curve and its gini coefficient show the inequality measurement for the forest dependent chakma community in the study area. The highest unequal distribution of the resources under the respondent households was in the homestead lands with the gini coefficient 0.41 followed by non-jhum lands for agriculture, gini 0.3 and jhum lands agriculture, gini 0.28 (Figure 2). However, the inequality of the total income per year of the household was found comparatively lower as gini 0.24.

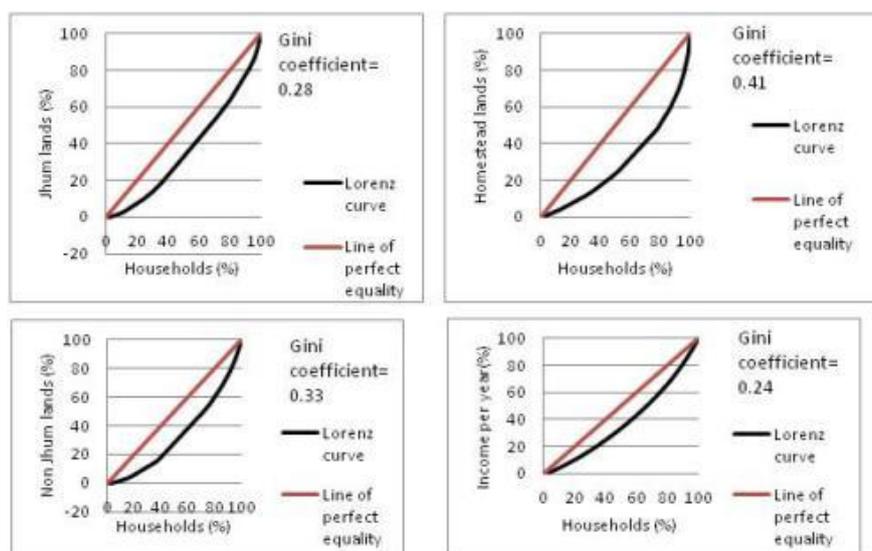


Figure 2. Inequality measurement in the resources owned by the forest dependent peoples in the Rangamati Sadar Upazila, Rangamati, Bangladesh.

Households' revenues from the forests

The average revenue per household from selling forest products in the study area was 13473 tk year⁻¹ including the revenues from timber, firewood, bamboo, medicinal plants, mammals and nuts where the largest generated from the timber selling (Table 4). The largest revenues, 19065 tk year⁻¹ were recorded from Headmanpara while the lowest, 11037 tk year⁻¹ was from Sapchoripara. The distance of the forests from the homestead and time required for extracting forest products and the total revenues received from selling the forest products were not found significantly correlated each other.

Table 4. Revenues received from the forest products by the forest dependent households in the Rangamati Sadar Upazila, Rangamati, Bangladesh.

Villages	Revenues received from selling forest products (tk year ⁻¹)						
	Timber	Firewood	Bamboo	Medicinal plants	Mammals	Nuts	Total
Bodhipur	3800	1733	1053	1353	2127	1333	11400
	±1269.42	±725.17	±555.91	±422.45	±705.79	±544.82	±2130.44
Harekkhang	7200	3133	1000	1233	1747	677	15090
	±1993.32	±2095.04	±1000.00	±472.14	±795.52	±1330.00	±3585.78
Headmanpara	7333	6067	1200	1603	1500	1362	19065

	±2361.73	±2219.97	±781.94	±691.42	±832.38	±505.71	±4244.60
Kainda	3067	1367	1707	733	1733	2697	11304
	±1798.06	±629.56	±635.35	±556.06	±934.61	±886.90	±2772.85
Maddhapara	4867	1753	1453	467	3420	983	12943
	±2162.16	±400.34	±347.08	±466.67	±1030.36	±411.67	±2801.98
Sapchoripara	3667	1755	1667	1819	1167	963	11037
	±1855.92	±270.39	±451.42	±818.77	±427.25	±432.56	±1935.53
Mean	4989	2635	1347	1201	1966	1336	13473
	±789.05	±551.84	±265.17	±238.60	±330.26	±228.24	±1235.32

Note: Figures next to ± indicates standard error of means

Literature shows that millions of South African derive direct benefits from forests, as they contribute approximately 20% to their livelihood (Shackleton et al. 2007). It has been also confirmed that forest resources are not a means of alleviating poverty for millions of people, but rather that they provide resilience in their livelihoods, thus preventing intensification of poverty. Higher levels of forest resources and suitable agroforestry are also associated with higher community welfare in the rural areas of Kalimantan, Indonesia (Dewi et al. 2005). Kamanga et al. (2009) stated that the poorest segment depends more on forest income than the least poor group in Chiradzulu of Malawi. However, forest income contributed around 15% of their total income.

Households' direct consumption and sustainability of the harvesting

The study found that from the total harvests of the forest products, 92% of the firewood is consumed directly by the households, followed by timber and bamboo 33%, medicinal plants 22%, mammals 3% and nuts 2%, respectively (Table 5). However, almost all the households opined that firewood harvests was sustainable followed by timber 94%, forage and mushroom 53%. The sustainability was analyzed lower for nuts 3%, mammals 4%, rattan 4%, lianas and vines 6%, etc (Table 6).

Table 5. Consumption of the forest products from the total harvests by the forest dependent households in the Rangamati Sadar Upazila, Rangamati, Bangladesh.

Villages	Consumption of the forests products from the total harvesting (%)					
	Timber	Firewood	Bamboo	Medicinal plants	Mammals	Nuts
Bodhipur	64.33	96.67	21.33	13.33	.00	.00
Harekkhang	55.33	82.00	28.00	13.33	5.33	.00
Headmanpara	55.33	73.33	42.67	20.00	4.00	1.33
Kainda	84.67	98.00	71.33	56.00	10.00	8.00
Maddhapara	45.33	100.00	20.00	8.00	.00	.00
Sapchoripara	65.33	100.00	14.00	20.00	.00	.00
Mean	32.89±4.46	91.67±2.36	32.89±4.82	21.78±4.29	3.22±1.64	1.56±1.14

Table 6. Sustainability perception of the forest products by the forest dependent households in the Rangamati Sadar Upazila, Rangamati, Bangladesh.

Forest products	Percentage of the households						Mean (%)
	Villages						
	Bodhipur	Harekkhang	Headmanpara	Kainda	Maddhapara	Sapchoripara	
Timber	100	100	100	100	80	87	94
Firewood	100	93	100	100	100	100	99
Bamboo	27	33	53	80	20	20	39
Rattan	0	7	0	20	0	0	4.4
Forage	53	67	47	47	60	47	53.3
Thatching grass	13	7	0	20	0	0	6.7
Lianas and vines	0	20	0	13	0	0	5.6
Medicinal plants	13	13	20	60	13	20	23.3
Mammals	0	7	7	13	0	0	4.4
Wild fruits	53	67	67	73	27	0	47.8
Mushroom	53	47	93	80	47	0	53.3
Nuts	0	0	7	13	0	0	3.3

Obviously, forest degradation hampered the sustainability of the forest products harvesting in most of the cases. The present study found that the natural forests in the study areas was degraded 88% perceived by the forest dependent households followed by 8% almost barren. Only 4% households from a few villages perceived that the natural forests are well stock (Figure 3). However, the observation of the degradation of natural forests in the

CHTs of Bangladesh did not reveal any such deep insights into the factors involved. To the naked eye, it appeared to be caused by the peoples' overdependence on them due to overpopulation and the lack of alternative income generation (Biswas & Choudhury 2007; Nath & Inoue 2009). This can be supported by the principle of 'the tragedy of the commons' (Hardin 1968). The present study found that overharvesting was the largest, 77% cause for forest degradation and denudation followed by the invasion of plainland peoples 14% and lack of proper forest policy 7%, etc (Figure 4).

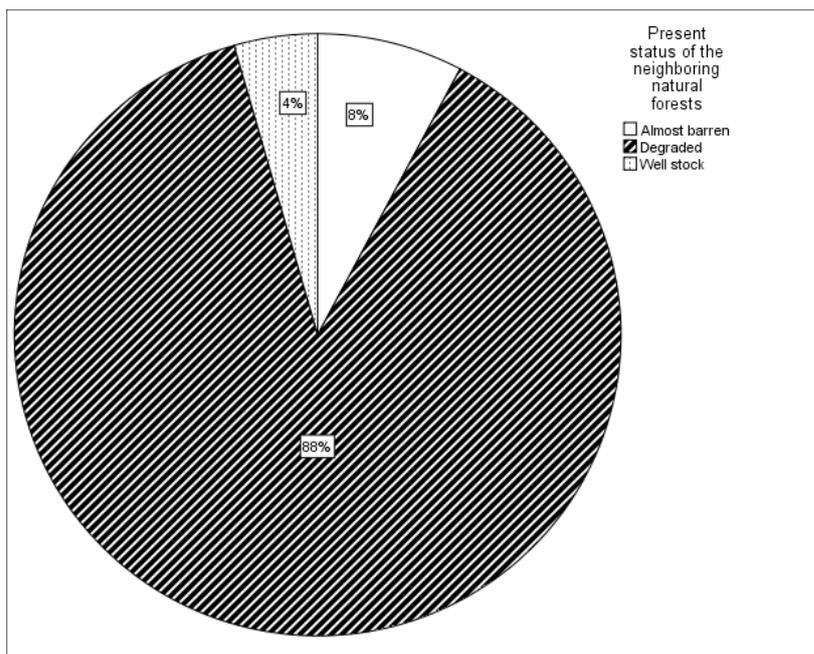


Figure 3. Present status of the natural forests in Rangamati Sadar Upazila perceived by the forest dependent households.

Salam et al. (1999) indicated that deforestation and degradation in the hill forests of Bangladesh are influenced by infrastructural problems related to the country's underlying socioeconomic features. The negligence of the customary use and management rights of the forest of the indigenous peoples in the CHTs has accelerated the deforestation (Thapa & Rasul 2005), and this further intensified by government policy encouraging the migration of plain land people to the CHTs, the militarisation of the CHTs, and the construction of both a hydroelectric project and a large dam as development intervention (Ahmed 2008; Iftekhar & Hoque 2005; Thapa & Rasul 2005). If appropriate measures are not taken within a short

period of time, all of these causes are expected to accelerate the further loss of forest cover in the CHTs.

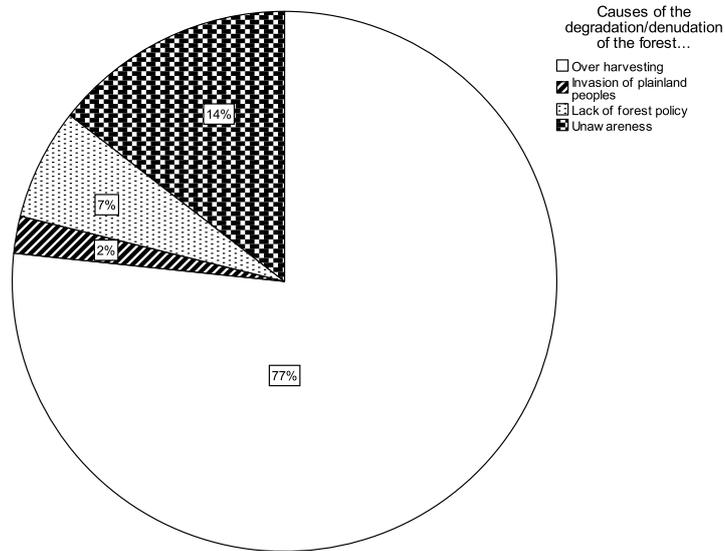


Figure 4. Causes of the degradation of the forests Rangamati Sadar Upazila perceived by the forest dependent households.

About half of the respondents reported that forest degradation made the forest dependent households poorer day by day. Reduced harvesting was reported by around 40% households (Figure 5).

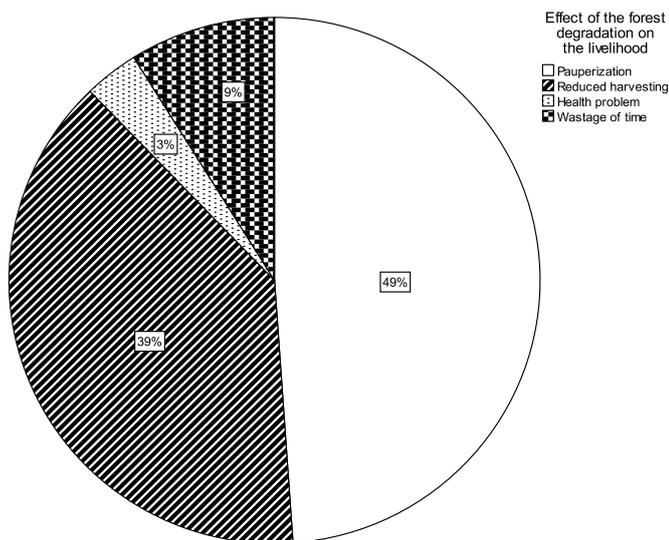


Figure 5. Effect of the forest degradation on the livelihoods of the forest dependent households in Rangamati Sadar Upazila, Rangamati, Bangladesh.

Alternative livelihood practices

Due to the forest degradation and the anticipated REDD+ program in the study area, the prohibition of the neighbouring natural forests returned the responses from the forest dependent households that plantation activities in the blank spaces of the homesteads might be the largest alternative forest practice perceived by almost half of the respondents (Figure 6). The other practices were reported as agricultural intensification, extending small business, working as day labourers, jobs in different organization and weaving etc.

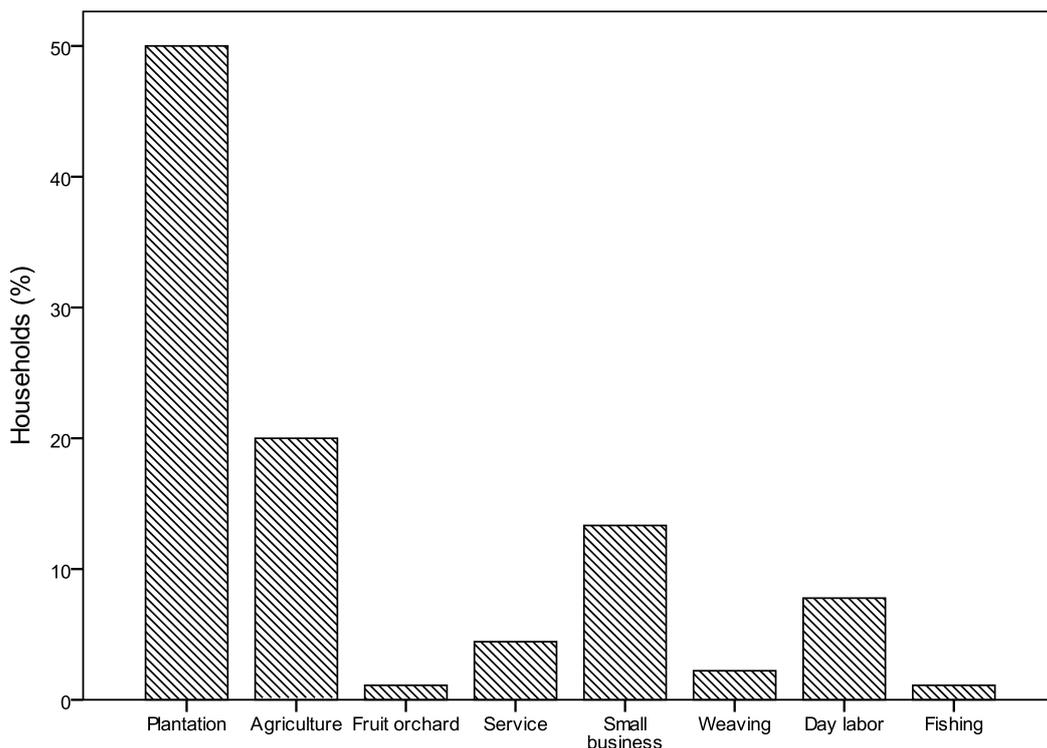


Figure 6. Alternative livelihood practices when the forests will be totally barren and kept reserved for the REDD+ program in the Rangamati Sadar Upazila of Rangamati, Bangladesh.

More than half of the studied households responded that if the specific forest becomes banned for them they would buy the firewood from the market, some 25% households opined that they would collect firewood from the other forests which would not be under the REDD+ program (Figure 7). Around 10% households were confident to collect firewood from their own plantation area. A few households thought that biogas program in the area might be useful to compensate their firewood needs.

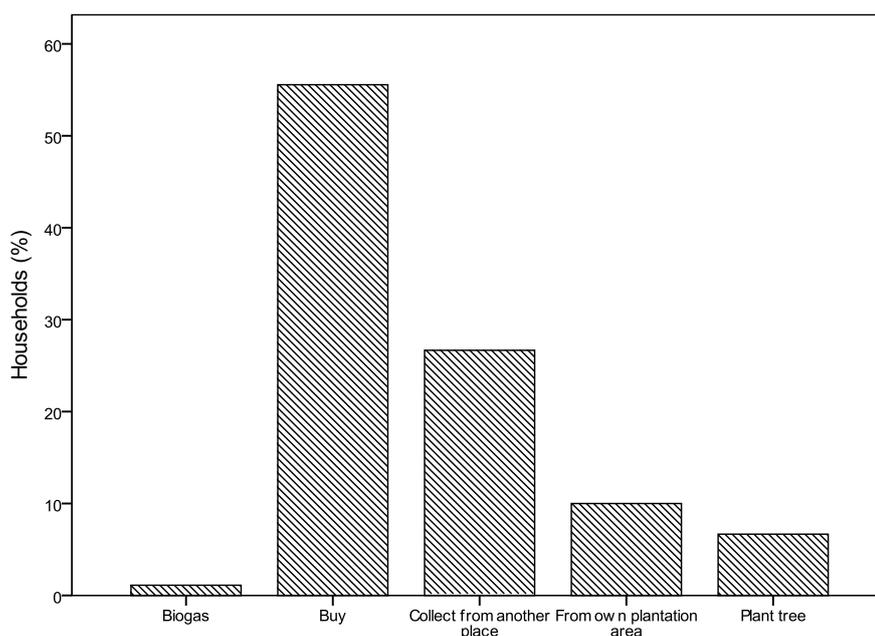


Figure 7. Fuels gathering alternative when forests will be banned for the forest dependent households in Rangamati Sadar Upazila of Rangamati, Bangladesh.

The trade-offs between forest use and anticipated REDD+

The studied households at around 35% responded that they could sacrifice the collection of timber from the neighbouring natural forests followed by the vegetable collection from the forests by around 30%, bamboo collection by around 20% and firewood collection by around 15% households (Figure 8). However, most of the households at around 85% reported that sacrificing firewood would be a harder experience to them (Figure 9). Accordingly, they responded that food service, religious or cultural use of forest, medicinal plants and animal collection from the forests could not be sacrificed in anyway.

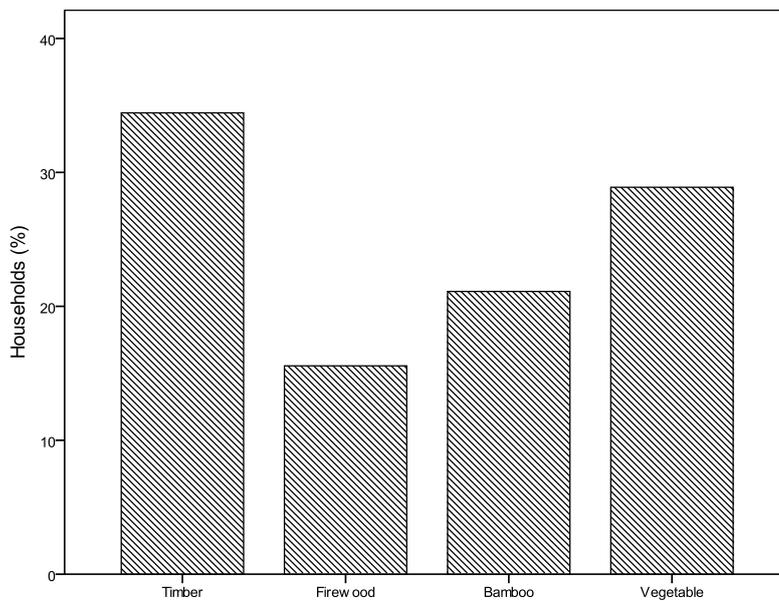


Figure 8. Forest service which may be sacrificed perceived by the forest dependent households in Rangamati Sadar Upazila of Rangamati, Bangladesh.

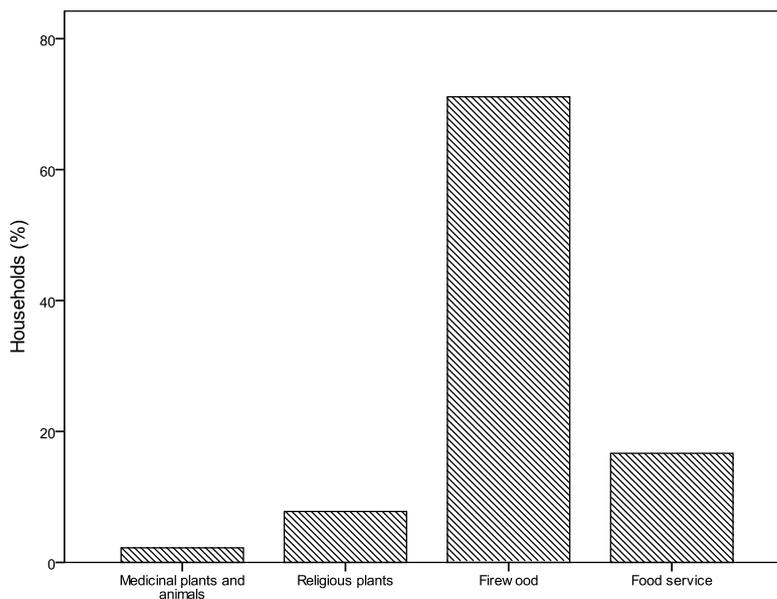


Figure 9. Forest service which cannot be sacrificed by the forest dependent households in Rangamati Sadar Upazial of Rangamati, Bangladesh.

More than 40% of the households responded that if the forests will be prohibited to the forest dependent households monetary compensation will be crucial to them. Around one

third of the households expected alternative jobs from the government if let they keep away from using their neighbouring forests. Biogas for cooking was another expectation of the households.

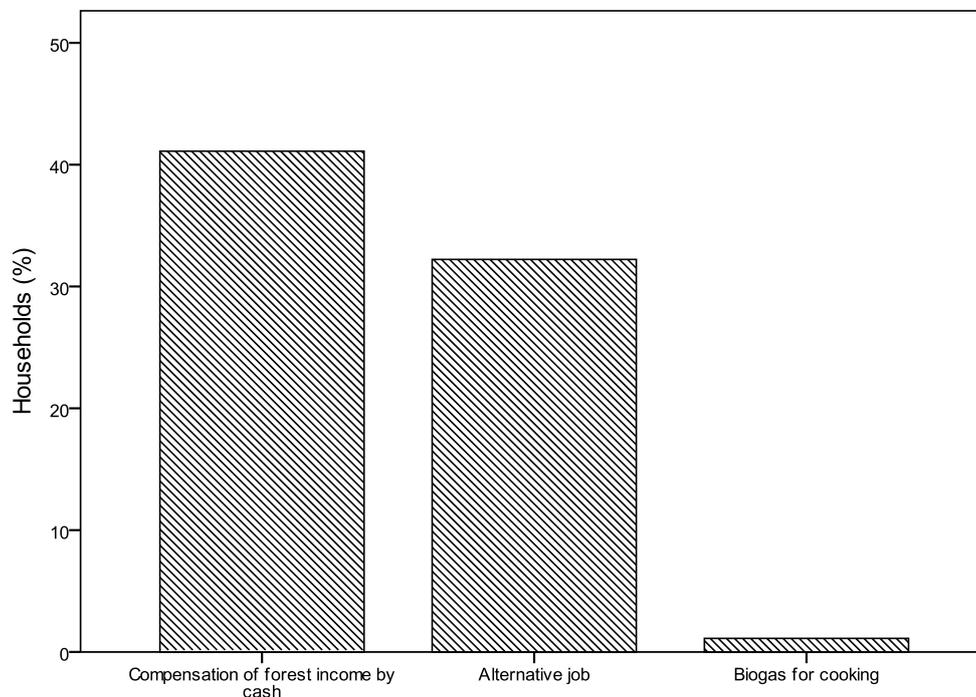


Figure 10. Expectation from the government when forests will be prohibited to the forest dependent peoples in Rangamati Sadar Upazila of Rangamati, Bangladesh.

Traditional use of forests

The forest dependent households firmly opined that sacrifice of using forests for the purposes of medicinal and religious uses would be difficult to them. In addition to this, collecting firewood and food service from the natural forests would be crucial to them. This traditional uses of the forests are described as below;

Medicinal, religious and other uses

The study reveals that *Azadirachta indica*, *Calotropis procera*, *Adhatoda vasica*, *Bambusa vulgaris*, *Centela asiatica*, *Ocimum sanctum*, and *Moringa oleifare* were used as medicinal plants and *Azadirachta indica* was given high priority as medicine by the families (Table 7). Conversely, *Melocanna beccifera*, *Thysanolaena maxima*, *Bambusa vulgaris*,

Agaricus bisporus, *Calamus guruba*, *Bambusa tulda*, and *Imperata cylindrica* were used for other purposes. Around two-thirds of the households were found to use *M. beccifera* for various agricultural implements in their shifting cultivation; around half were found to use *T. maxima* for their cultural events.

Table 7. Plants used as medicine and others by the forest dependent Chakma households in Rangamati Sadar Upazila of Rangamati, Bangladesh.

Species used as medicine	Households (%)	Species with other usage	Households (%)
<i>Adhatoda vasica</i>	56.78	<i>Agaricus bisporus</i>	15.90
<i>Azadirachta indica</i>	66.50	<i>Bambusa tulda</i>	12.60
<i>Bambusa vulgaris</i>	2.58	<i>Bambusa vulgaris</i>	42.90
<i>Calamus tenuis</i>	6.78	<i>Calotropis procera</i>	11.90
<i>Calotropis procera</i>	23.6	<i>Calamus guruba</i>	12.76
<i>Centela asiatica</i>	5.78	<i>Imperata cylindrica</i>	4.78
<i>Moringa oleifera</i>	24.8	<i>Melocanna beccifera</i>	82.90
<i>Ocimum sanctum</i>	34.78	<i>Thysanolaena maxima</i>	45.00
<i>Rawfolia serpentina</i>	22.56	<i>Tamarindus indica</i>	24.89

Note: Multiple responses present in the second and fourth column

The households were found obliged to use the different parts of plants as offerings to different Goddesses and to the souls of the lately departed persons. The different plant parts were used in the religious festival namely ‘Boudha puja’, ‘Shibuli puja’, ‘Ganga puja’ and ‘Alapaloni’ etc. The fruits of the myrobalans (*Terminalia chebula*, *Terminalia belirrica* and *Emblica officianlis*) are collected from the forests to sacrifice to the Goddesses in the above religious festivals. In the festivals, the hunting of wild boar (*Sus scrofa*) and Jungle fowl (*Gallus gallus*) is mandatory to use it in the above festivals. It is used as a special food in those occasion. Hunting wildlife was found important for the livelihoods and culture of the forest dependent Chakma households. Hunting *S. scrofa* was practiced frequently by the 46% households followed by the Bullfrog, *Rana tigrina*, 42% and the Monitor lizard, *Varanus benghalensis*, 36%, and so on. The other wildlives hunted from the neighbouring natural forests were Cricket (*Tarbinskiellus portentosus*), Porcupine (*Hystrix indica*), Barking deer

(*Muntiacus muntjak*), Sambar deer (*Cervus unicolor*), Squirrel (*Ratufa bicolor*), Tree frog (*Rana bimaculatus*), Python (*Python reticulatus*), Terrestrial tortoise (*Melanochelys tricarinata*) etc.

The Chittagong Hill tracts in Bangladesh is considered a center of bio-cultural diversity because of its richness in natural resources and cultural diversity (Halim et al. 2007). It is particularly rich in herbal medicine resources (Khan & Rashid 2006). Some earlier studies regarding herbal medicines undertaken in the CHTs also indicated the dependence of the various tribes on medicinal plants. Miah & Chowdhury (2003) for the Mro tribe and Alam (2002) for the Marma tribe reported the use of medicinal plants for different ailments. Haque (2000) reveals that the CHTs people are more malaria-resistant than the 'non-hill' people and have developed indigenous cures from medicinal plants that grow locally. Use of plants for medicinal purposes is also observed in various cultures throughout the world. To cope with certain small ailments, people of west-central Bhutan depend upon a number of plants occurring in local forests for relief and treatment of pain (Namgyel & Ghimiray 1998). Maikhuri et al. (2000) reported that 37 plant species are in common medicinal use among the Tolchhas, Marchhas and Jadhhs of Central Himalyas, India. Among them, the Tolchhas are the most dependent on herbal treatment, and they also have a greater understanding of medicinal plants. Hunting and harvesting of forest products by the indigenous peoples are considered as an integral part of the forest ecosystem (Miah & Chowdhury 2004; Mustafa et al. 2002; Saxena 1986). Sene (2000) reports that subsistence hunting accounts for more than 90% of the bushmeat supply in Africa. Cultural attachment of hunting is also important. The tribal people of Orissa in India practice hunting for sport and cultural pastime rather than securing income. This is reported as crucial for communal feeling (Mohapatra 1997).

Firewood

The study found that *Albizia odoratissima* was used by 78% households as firewood followed by *Macaranga denticulate* by 75% (Table 8). It was also found that the *Albizia procera*, *Grewia microcos*, *Anogeiss acuminatus*, *Terminalia belerica*, *Bursera serrata* tree species were moderately used (ranging from 32% to 54%) as firewood and a very small percentage (ranging from 6 to 7%) of *Artocarpus chaplasha* and *Duabanga sonneratioides* were used for fuelwood.

Table 8. Tree species used as firewood by the forest dependent Chakma households in Rangamati Sadar Upazila of Rangamati, Bangladesh.

Species used as firewood	Households (%)
<i>Albizia odoratissima</i>	78.00
<i>Albizia procera</i>	54.00
<i>Anogeiss acuminatus</i>	46.89
<i>Artocarpus chaplasha</i>	5.89
<i>Bischofia javanica</i>	5.00
<i>Bursera serrata</i>	33.80
<i>Dillenia pentagyna</i>	12.00
<i>Duabanga sonneratioides</i>	6.80
<i>Ficus hispida</i>	23.60
<i>Gariga pinnata</i>	32.00
<i>Grewia microcos</i>	46.00
<i>Macaranga denticulata</i>	75.00
<i>Shima wallichii</i>	8.90
<i>Syzygium cumini</i>	23.90
<i>Terminalia belerica</i>	23.40
<i>Vitex peduncularis</i>	11.89

Note: Multiple responses present in the second column

Rodriguez et al. (2009) for a montane village in East China confirmed that forest management has been gradually shifting from a focus on forest production based on bamboo to a multipurpose orientation in which conservation to promote tourism becomes increasingly important. However, despite income from bamboo remaining the controlling factor of inequality in the society, different forest products are providing it opportunities to move along its development ladders.

Food services

It was found that using forest for harvesting wild fruits and vegetables was important to the Chakma households living in the forest areas. The households reported that *Bixa orellana*, *Bursera serrata*, *Phyllanthus emblica*, *Syzygium cumini*, *Solanum torvum*, *Terminalia belerica* were the important plant species used as fruits and *Amonum subulatum*, *Centela asiatica*, *Colocasia esculanta*, *Dioscorea bulbifera*, *Melocanna beccifera*, *Musa*

sepientum, *Pteris cretica* were the species used as vegetables by the Chakma households. Among these, the greatest percentage of families used *Bixa orellana* (87%) and *Syzygium cumini* (81%) as fruit, while another two species, *Melocanna beccifera* (90%) and *Amonum subulatum* (86%), were given high priority as vegetables by the Chakma community (Table 9).

Table 9. Plant species used as fruit and vegetables by the Chakma Community in Rangamati Sadar Upazila, Rangamati, Bangladesh.

Species used as fruits	Households (%)	Species used as vegetables	Households (%)
<i>Bixa orellana</i>	87.00	<i>Agaricus bisporus</i>	3.68
<i>Bursera serrata</i>	16.70	<i>Amonum subulatum</i>	85.60
<i>Calamus spp.</i>	8.00	<i>Calamus spp.</i>	9.00
<i>Cassia fistula</i>	6.00	<i>Centela asiatica</i>	54.32
<i>Emblica officinalis</i>	10.50	<i>Colocasia esculanta</i>	32.12
<i>Ficus hispida</i>	3.45	<i>Curcuma zeodaria</i>	12.00
<i>Ficus nervosa</i>	23.80	<i>Dioscorea bulbifera</i>	8.90
<i>Garcinia cowa</i>	25.00	<i>Melocanna beccifera</i>	92.00
<i>Mangifera sylvatica</i>	5.76	<i>Moringa oleifera</i>	13.45
<i>Phyllanthus emblica</i>	55.00	<i>Musa paradisiaca</i>	25.90
<i>Solanum torvum</i>	7.80	<i>Musa sepientum</i>	32.56
<i>Syzygium cumini</i>	81.45	<i>Pteris cretica</i>	45.60
<i>Terminalia bellirica</i>	30.87	<i>Solanum torvum</i>	31.87

Note: Multiple responses present in the second and fourth columns

The consumption of fruit and vegetable species by the Chakma tribe was almost the same as the Mro tribe in the CHTs (Miah & Chowdhury 2004). Khisa (1998) reported that there are 50 or more tree species in the CHTs with edible fruits and that many of these are exceedingly sweet. In times of need and scarcity, tribal communities rely mostly on forest produce for their subsistence, and that even in normal times their diet includes seeds together with other plants collected from forests (Shroff 1997). Samal (1997) reveals that the Kandha tribe of Koraput, India extracts tamarind seeds and mango stones to eat. Mango stones and

tamarind seeds are powdered and then made into gruel with other food items. Agreeing with this, Jana & Chauhan (2000) noted that roasted seeds of *Tamarindus indica* are edible and eaten by the Nepales tribe of Sikkim. They also eat pulp made of the pod of the plant *Cassia fistula*. The Bhotiya tribe of India depends to a large extent on wild resources of plant and animal origin for food security (Maikhuri et al. 2000). The consumption of bamboo (*Melocanna beccifera*) shoots by the tribal communities in the CHTs was highlighted by Banik (1998) due to its nutritional values. According to his report, bamboo shoot is comprised of 4.5% carbohydrates, 2.6% protein, 0.3% fat and 0.9% ash, making it a valuable, nutrient-rich source of sustenance. He also reports that young shoots of several species of bamboo are an important vegetable in daily diets in Japan, China, Taiwan and Thailand.

Conclusions

The core dependence of the Chakma households on forests for their culture, food security and livelihood support in the CHTs has been clearly determined by this study. The traditional use of the neighbouring natural forests shows some factors at some points where the forest dependent peoples thematically obliges to conserve the forests. The findings of the study highlight the relative importance of revenues from forests by different categories of products. It was found that most of the products harvested from the neighbouring natural forests was used for their subsistence livelihoods. However, due to the continuous degradation of the forests, the sustainability of the forest products harvesting has been lowering gradually with the non-timber forest products drastically. The study finds that at the strategy point of the REDD+ implementation in the CHTs of Bangladesh, the alternative livelihoods of the forest dependent peoples may be raising plantation, agricultural intensification, extending small business, etc. These alternative livelihoods can reduce the vulnerability of the forest dependent Chakma households in the face of the severe forest degradation or adopting the REDD+. In the trade-offs issues between the REDD+ and the forest use by the Chakma households, it was found that dependence on the forests for their medicinal, religious and foods services are in the hardcore while they could sacrifice timber, bamboo and vegetable collection from the forests. The present study confirms that for the REDD+ implementation, an appropriate cash compensation of the traditional forest use should be provided to the forest dependent peoples. Along with this, alternative jobs provided to the Chakma households will be crucial.

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