CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM FOR AFFORESTATION AND REFORESTATION
PROJECT ACTIVITIES (CDM-AR-PDD) Version 03

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PROJECT DESIGN DOCUMENT FOR AFFORESTATION AND REFORESTATION PROJECT ACTIVITIES (CDM-AR-PDD)

Annexes

SECTION A. General description of the proposed A/R CDM project activity

A.1. Title of the proposed A/R CDM project activity

Title : Chunoti CDM Reforestation Program : Mitigation of Greenhouse Gas Emissions Through Co-Management of Chunoti Wildlife Sanctuary

Version : 1

Date : 1 May 2008

A.2. Description of the proposed A/R CDM project activity

PROJECT CONTEXT

Although climate change, as a public good, is global in its causes and consequences, its adverse impacts are being borne inequitably in different regions and communities. Bangladesh, a riparian country very near to sea level, and coastal poor dependent on neighboring biodiversity are being particularly affected adversely. Co-management of Chunoti Wildlife Sanctuary (WLS) offers an excellent opportunity for achieving global environmental goals by mitigating Green House Gas (GHG) emissions while conserving biodiversity and alleviating rural poverty locally. Greening of the Sanctuary by reforesting through block plantations and enrichment plantation activities to be implemented by the existing Co-Management Committees (CMCs) will result in empowering local communities including the members of Community Patrolling Groups (CPGs) and Forest User Groups (FUGs) and thereby contribute in improved governance. The project proposals are cost effective, efficient and equitable with large employment and income gains expected to accrue to local communities. In the process local surplus labor resources will be utilized in restoring the degraded forest landscape of the Sanctuary.

Although Bangladesh is a low-carbon emitting country due mainly to low level of industrialization, its vulnerability to climate changes is very high as a sea rise of 1-2 meter would inundate a substantial area thereby affecting a large coastal population. In Bangladesh the per capita carbon dioxide (CO_2) emission is estimated to be as 0.2 ton/year which is much lower when compared to 1.6 ton/year in other developing countries and 20 ton/year in USA (Enayetullah *et al*, 2004). However, the consumption of fossil fuels in the country is growing by more than 5% per year and motor traffic is increasingly causing environmental pollution. Natural resources including forests are getting severely degraded due mainly to heavy biotic interference. Carbon offset projects can negate or

neutralize carbon dioxide in one place by avoiding the release of carbon dioxide elsewhere or sequestering carbon dioxide that would have otherwise remained in the atmosphere.

The neglect of natural forests due mainly to lack of effective management and inadequate funds have resulted in the severe degradation of semi-evergreen forests located in the hilly region of Bangladesh. Chuntoti Wildlife Sanctuary covering seven reserved forest (RF) blocks of hill forests is located in the country's south-eastern region. It represents a fragile forest landscape near the Bay of Bengal, which if not conserved soon, may be lost for the future generation. In order to arrest deforestation and conserve wildlife the Government of Bangladesh gazetted Chunoti forests (7,764 ha) as Wildlife Sanctuary in 1986.

No effective reforestation efforts are planned in Chunoti by the Government as on-going projects such as Nishorgo Support Project (NSP) focus mainly on building co-management organizations and upscaling their skills through capacity building and motivation. However, the existing co-management organizations can be gainfully involved in implementing reforestation activities under climate change mitigation efforts being finalized at international level. Green House Gas mitigation projects in the least developing countries such as Bangladesh can generate carbon credits that are in demand in the industrialized countries for reducing their carbon footprints.

Reforestation and afforestation activities under land use, land use change and forestry (LULUCF) sector have been identified for the mitigation of climate change under Kyoto Protocol. The Sanctuary degraded before January 1990 as assessed from the interpretation of imageries and so reforestation activities in Chunoti qualify for the funds under Clean Development Mechanism and other similar initiatives. A variety of wildlife including micro-organisms and important ecological processes are still noticed in the Sanctuary that encompasses important terrestrial, aquatic and forest ecosystems.

The country's forests including protected areas (PAs) have traditionally been intimate interspersion of human habitations with dependency on neighboring forests for their livelihood in a largely agrarian economy. Community forestry projects have been implemented in Bangladesh, particularly since 1981 when donor support was provided to the Forest Department (FD) for establishing short-rotation plantations mainly on unutilized public land not covered under forest category. As a result, natural forests including PAs could not get the benefits of enhanced funding and participation of local community. Although natural forests were included in Forestry Sector Project (FSP, 1999-2006), main emphasis continued on raising plantations as more than two-third of the total budget was spent for planting activities mainly on non-forest land.

The neglect of existing forests due to lack of funding and inadequate management resulted in natural forests degradation, particularly in the semi-evergreen and evergreen forests located in the country's hilly region. Anthropogenic pressures including increased commercial extraction of forest produce, brought by manifold increase in human population, led to widespread shrinkage and deforestation of hill forests. Keeping in view of deforestation that took place earlier, the Government of Bangladesh gazetted Chunoti forests (7,764 ha) in 1986 as Wildlife Sanctuary mainly to conserve degraded forest land as elephant movement corridors. However, the situation did not improve even after its gazetation as the management of Sanctuary was not included under either FSP or any other forestry development projects.

The Forestry Master Plan, completed in 1993 with the assistance from Asian Development Bank, led to the promulgation of the people-oriented Forestry Policy of 1994. The Policy *inter-alia* emphasized peoples' participation in the sustainable management of forests. Accordingly, the emphasis of forests management gradually shifted from timber production to meeting bonafide consumption needs of local people. As a result, social forestry was included in the revised Forest Act of 2000 and Social Forestry Rules, 2004 were formulated in order to implement the policy recommendations. In 2004 the FD launched the Nishorgo Program that aimed to improve the conservation of forests and other biodiversity in the PAs managed by FD across the country.

At the heart of Nishorgo Program is a focus on building gainful partnerships between the Forest Department and key stakeholders, who assist in PA conservation efforts. Co-management activities in Chunoti have recently (2006) been intensified by establishing co-management organizations (co-management councils, co-management committees, forest user groups/ community patrolling groups and their federations) under a USAID supported initiative (Nishorgo Support Project, NSP). The GHG project proposal builds on the activities of NSP by proposing additional biodiversity conservation interventions that will be implemented in the Sanctuary by leveraging the roles and responsibilities being currently shouldered by the existing co-management organizations. Co-management Councils and Co-management Committees have been formed for Chunoti and Jaldi Forest Ranges by the Government of Bangladesh (through a 2006 gazette notification) for co-managing Chunoti Wildlife Sanctuary.

This project document is developed by referring to the relevant guidelines of the Intergovernmental Panel on Climate Change (IPCC), Clean Development Mechanism (CDM), the Climate, Community and Biodiversity Alliance (CCBA) and other international organizations working in the important field of climate change.

Carbon sequestration estimates and the proposed area for reforestation have been estimated based on the analyses of forests inventory data and soil surveys as conducted by Bangladesh Forest Research Institute (BFRI). Intensive training to FD staff and the members of co-management committees (CMCs) is planned before implementing the project. The project report contains a brief description of appropriate tools and techniques implemented and field tested in Chunoti. Relevant leakage (diverted emissions beyond the project boundaries) and permanence (release of stored carbon before or after project interventions) issues have adequately been addressed. The project proposal includes suitable guidelines for delineating project boundaries, identifying land-use systems and mitigation options, establishment of baseline carbon stocks, projection of carbon stock in different project scenario, risk management plan to monitor non-permanence (e.g. illicit felling) and leakage (e.g. forest fires and forest grazing), and a participatory monitoring strategy.

PROJECT JUSTIFICATION

Rising temperatures have already altered Earth's climate, with consequences for: hydrology and water resources; agriculture and food security; terrestrial and freshwater ecosystems; coastal zones and marine ecosystems; and human health (Llewellyn, 2007). Land Use, Land Use Change and Forestry (LULUCF) sector has been identified as an important land-based sector that mitigates climate change as defined in the Climate Convention. Forestry, broadly included under LULUCF sector, provides low cost mitigation opportunities to combat climate change either by increasing the removal of green house gases from the atmosphere through forests/plantations as carbon sinks or by reducing GHG emissions through avoided deforestation. Reforestation and afforestation are eligible CDM activities under the Article 12 for non-Annex-I countries such as Bangladesh. The definition of forest as per the Marrakesh Accord is, "a minimum area of land 0.05 – 1.0 ha with tree crown cover of more than 10-30% with trees with the potential to reach a minimum height of 2-5 meters at maturity *in-situ*." The proposed reforestation activity is an A/R CDM activity wherein reforestation is defined as the direct human-induced conversion of non-forested land to forested land through planting, seeding and/or the human-induced promotion of natural seed sources on land that was forested but has been converted to non-forested land. Under CDM's first commitment period (2008-2012) reforestation activities are limited to reforestation being implemented on those lands that did not have forests on or before 31 December 1989. This has been demonstrated by analyzing that the Sanctuary area was having below 10% tree cover before this deadline.

The formal ownership of the Sanctuary is with the FD as a representative organization of the Government of Bangladesh. By conserving forests and developing plantations in Chunoti, forest landscape degradation can be halted, biodiversity and water conserved *in-situ*, and reforestation needs met by utilizing

surplus labor. The proposed reforestation activity would help restore the severely degraded forests of the Sanctuary and also generate income locally from the sale of carbon credits. It will sequester carbon dioxide and generate GHG emission reductions that can be measured, monitored and certified. In the process, the vulnerability of Chunoti WLS to climate variability will be reduced. Besides, forests-based mitigation opportunities would have significant potential to transfer investment funds and technology, and upgrade institutional capacity of FD field staff and co-management organizations for biodiversity conservation, forest landscape restoration and bio-energy. The revenue generated by carbon trade will help re-vegetate the degraded landscape of Chunoti for *in-situ* biodiversity conservation and also secure long-term income for the local communities residing in and around the Sanctuary. The proposed reforestation activity would, therefore, have beneficial effect on biodiversity, environment and local community, both within and beyond the project boundary. It will greatly contribute to sustainable development, poverty alleviation, soil and water conservation, biodiversity conservation, good governance and empowerment of local community.

Given the present precarious financial situation, the Government of Bangladesh has been unable to plan taking up adequate reforestation in the Sanctuary. Even the reforestation targets under NSP are very meager (not more than 100 ha enrichment plantations annually for the last two years). Under the circumstances, the proposed reforestation activity will be an additionality as defined under CDM. The proposed species for reforestation are mainly indigenous as identified by the CMCs based on their suitability for the Sanctuary area. No genetically modified organisms or invasive alien species will be used. Similarly no chemical fertilizers are planned to be used while taking up planting activities.

The role of forests in carbon cycle is vital as they account for approximately 80% of CO_2 exchanged between land and atmosphere through the process of photosynthesis. As trees grow the carbon is stored in biomass by converting CO_2 and water (by using solar energy) into sugars and oxygen (released through the leaves). Forests also release CO_2 during the process of respiration. However, a forest that is growing (i.e. increasing in biomass) will absorb more CO_2 than it releases. So the sequestration and storage potential of a biodiversity carbon project depends on growing and sustaining forests. In addition, biodiversity projects in densely populated Bangladesh would have high socio-environmental benefits for local communities, who are mainly subsistence farmers and laborers. So the development of forest carbon sinks will benefit local community by contributing to poverty alleviation through their enhanced income generation and better quality of life. Moreover, forest products as renewable resources can be substituted for different materials (e.g. steel) that are produced in energy-intensive industries producing greenhouse gases. Both bottom-up and top-down studies indicate that there is substantial economic potential for the mitigation of

global GHG emissions over the coming decades, that could offset the projected growth of global emissions or reduce emissions below current levels (IPCC, 2007).

This project is in line with the Poverty Reduction Strategy Paper (PRSP) of the Government of Bangladesh and especially with the measures envisaged in the Partnerships for the Global Environment; it supports the Millennium Development Goal No. 7, Ensuring Environmental Sustainability, and the Millenium Development Goal No. 1 by addressing rural poverty alleviation. Scaling up flows of carbon finance to developing countries to support effective policies and programs for reducing emissions would accelerate the transition to a low-carbon economy (Stern, 2007). The project will sequester GHG emissions and generate global environmental benefits. It would conserve biodiversity and alleviate rural poverty in and around the Sanctuary. Being the first of its kind, the project will help develop a suitable methodology that would in future have significant demonstration effects in natural resources sector in Bangladesh. It will engage in capacity building through training and technical assistance to FD field staff and the two CMCs. The environmental and socio-economic impacts of the proposed reforestation activity will be monitored and assessed during the project implementation period.

PROJECT OBJECTIVES

The project development document (PDD) seeks to develop a CDM biodiversity carbon project in Bangladesh by enriching the Sanctuary through reforestation technologies to be implemented jointly by the FD and two CMCs. Chunoti and Jaldi CMCs as representatives of local resource poor villagers in the identified landscape will be jointly involved in the project implementation, particularly for participatory monitoring and implementation of alternative income generation (AIG) activities by using the proposed revolving fund. In the process the degraded landscape will be re-vegetated, natural resources including soil and water conserved, local stakeholders' income enhanced and rural poverty alleviated.

The proposed reforestation and livelihoods interventions under the project will be implemented by FD and CMCs respectively as strategic seller of carbon credits in response to global demand. A suitable mechanism for conserving biodiversity in and around the Sanctuary is suggested by involving the co-management organizations (Co-Management Councils, Co-Management Committees, Nishorgo Clubs, Forest User Groups and Community Patrolling Groups) that have been organized under NSP. The project thus combines the global environment objective with the local governance objective focusing on community empowerment. The project will help explore and demonstrate technical and methodological approaches related to an appropriate carbon offset process for co-management of PAs in Bangladesh.

The project focuses training and capacity building of FD staff and co-management organizations for developing and implementing biodiversity carbon projects, sustainable biodiversity management, and strengthening of social capital locally. The project design and implementation would contribute to the development of methodological tools to monitor and verify future biodiversity carbon offset projects in Bangladesh.

Specifically the following objectives will be achieved through the project implementation:

- To sequester and store GHG emissions through reforestation activities required for forest landscape restoration in the severely degraded Chunoti WLS,
- To measure, monitor and verify GHG emission removals through co-management organizations,
- To reforest Chunoti WLS based on the technical recommendations as contained in the Government approved management plans,
- To demonstrate technical and methodological approaches for design and implementation of carbon offset projects for biodiversity conservation and livelihoods for the rural poor, and
- To build capacity of co-management organizations and FD field staff

A.3. Project participants

Name of Party involved ((host) indicates a host Party)	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as a project participant (Yes/No)
Bangladesh (host)	Forest Department and Co-management Committees	No

A.4. Technical description of the A/R CDM project activity

A.4.1. Location of the proposed A/R CDM project activity

A.4.1.1. Host Part(ies)

Bangladesh

A.4.1.2. Region/State/Province etc.

Chunoti Wildlife Sanctuary covering Chunoti Forest Range and Jaldi Forest Range in Chitagong and Cox's Bazar Districts of Bangladesh

A.4.1.3. City/Town/Community etc.

The following villages are located in and around the Chunoti Wildlife Sanctuary

Interface Villages/*Paras* having stakes in Chunoti Range of Chunoti Wildlife Sanctuary

Sl No	Village	Total HHs No	Beat	Location	Level of Stake
1	Khalifer Para	70	Chunoti	Inside	Major
2	Rashider Ghona	500	Chunoti	inside	Major
3	Bangha Pahar	200	Chunoti	Adjacent	Major
4	Sultan Mouluvi para	200	Chunoti	inside	Major
5	Munshi para	250	Chunoti	inside	Major
6	Damir Ghona	200	Chunoti	inside	Major
7	Mirikhil	500	Chunoti	inside	Major
8	Hindhu para-1	100	Chunoti	Inside	Major
9	Boro Miazi Para	200	Chunoti	Adjacent	Major
10	Baghan Para	100	Chunoti	Adjacent	Moderate
11	Sikder Para	800	Chunoti	Near to Adjacent	Moderate
12	Kathuria Para	300	Chunoti	Near to Adjacent	Moderate
13	Deputy Para	100	Chunoti	Near to Adjacent	Moderate
14	Hindhu Para-2	30	Chunoti	Adjacent	Moderate
15	Kalu Sikder Para	30	Chunoti	Adjacent	Moderate
16	Kumudiaduri	70	Chunoti	Adjacent	Moderate
17	Moulana Para	200	Chunoti	Near to Adjacent	Moderate
18	HutKholaMura	80	Chunoti	Adjacent	Major
19	Rosainga Ghona	30	Chunoti	Adjacent	Major
20	Barua para	40	Chunoti	Near to Adjacent	Major
21	Null Bonia	40	Chunoti	Adjacent	Moderate
22	Munshi para	250	Chunoti	Inside	Major
23	Sufri Nagar	400	Chunoti	Inside	Major
24	Gucchagram/ Ashrayan (Shelter)	100	Chunoti	Inside	Major

Sl No	Village	Total HHs No	Beat	Location	Level of Stake
25	RatarKul	40	Chunoti	Inside	Major
26	hasainna kata	15	Chunoti	Inside	Major
27	TeenGhoria para	10	Chunoti	Inside	Major
28	Bon Pukur	50	Chunoti	Adjacent	Major
29	Kolatoli	20	Aziznagar	Inside	Major
30	Aziz nagar	50	Aziznagar	Inside	Major
31	Gainna Kata	50	Aziznagar	Inside	Major
32	Jungle basti Area	70	Aziznagar	Inside	Major
33	West Villager Para	300	Aziznagar	Inside	Major
34	Nayapara	50	Aziznagar	Inside	Major
35	Purba Villagerpara	250	Aziznagar	Inside	Major
36	Ichachari	30	Aziznagar	Adjacent	Major
37	Taillar bill (Goyal mara Villager para)	800	Herbang	Inside + Adjacent	Major
38	Vandari Dhoba	200	Herbang	Adjacent	Moderate
39	Hormudhi para	1000	Herbang	Adjacent	Moderate
40	barua para	40	Herbang	Inside	Major
41	West Charpara	10	Herbang	Inside	Major
42	Napiter Chita	5	Herbang	Inside	Major

Level of stake was determined on the basis of distribution of different resource users and people having land within the sanctuary.

Interface Villages/*Paras* having stakes in Jaldi Range of Chunoti Wildlife Sanctuary

Sl. No.	Village	Total HHs No.	Beat	Location	Level of Stake
1	Nazira Market	250	Jaldi	Inside	Partial
2	Badalia	387	Jaldi	Inside	Partial
3	Harunbazar (East)	150	Jaldi	Inside	Partial
4	Imar Para	100	Jaldi	Inside	Partial
5	Guratuni Para	156	Jaldi	Inside	Moderate
6	Khalilshah Para	200	Jaldi	Inside	Moderate
7	Baruapara	300	Jaldi	Inside	Moderate
8	Noapara	150	Jaldi	Inside	Moderate
9	Neajor Para (Part)	450	Jaldi	Inside	Moderate
10	Baharullah Para (Part)	250	Jaldi	Inside	Moderate
11	(North) Bonik Para	85	Jaldi	Inside	Partial
12	Monki Para	55	Jaldi	Inside	Major
13	Neajor Para (Part)	275	Jaldi	Inside	Moderate
14	(South) Bonik Para	52	Jaldi	Inside	Partial

Sl. No.	Village	Total HHs No.	Beat	Location	Level of Stake
15	Laskar Para	150	Jaldi	Adjacent	Major
16	Shil Para	45	Jaldi	Inside	Moderate
17	Maldar Para	75	Jaldi	Inside	Moderate
18	Chhumma Para (Part)	80	Jaldi	Adjacent	Major
19	Talukdar Para	75	Jaldi	Inside	Moderate
20	Hungkari Para	110	Jaldi	Inside	Moderate
21	Teli Para	150	Jaldi	Inside	Moderate
22	Baharullah Para (Part)	100	Jaldi	Inside	Moderate
23	Sikder Para	80	Jaldi	Adjacent	Moderate
24	East Miar Para	45	Jaldi	Adjacent	Moderate
25	Bagicha Para	25	Jaldi	Adjacent	Major
26	Daria Para	25	Jaldi	Adjacent	Major
27	East Para	20	Jaldi	Adjacent	Major
28	Chhumma Para (Part)	22	Jaldi	Adjacent	Major
29	Jungle Jaldi (Part)	15	Jaldi	Adjacent	Major
30	Narichamura	12	Jaldi	Adjacent	Major
31	Komolyaghona	10	Jaldi	Adjacent	Major
32	Dullyajhiri	20	Jaldi	Adjacent	Major
33	Kebol Krishna Mohajan Para	120	Jaldi	Inside	Partial
34	Brahman Para	75	Jaldi	Inside	Partial
35	Karmakar Para	35	Jaldi	Inside	Major
36	Jaldas Para	35	Jaldi	Inside	Moderate
37	Acharjya Para	90	Jaldi	Inside	Major
38	Rudra Para	50	Jaldi	Inside	Moderate
39	Dutta Para	40	Jaldi	Inside	Moderate
40	Rolla Para	125	Jaldi	Adjacent	Major
41	Kajir Para	85	Jaldi	Adjacent	Major
42	Natun Dighir Para	35	Jaldi	Adjacent	Major
43	Airaghona	28	Jaldi	Adjacent	Major
44	Muhuri Para	69	Jaldi	Inside	Partial
45	Dhopa Para	150	Jaldi	Inside	Partial
46	Askoria Road	80	Jaldi	Inside	Partial
47	Askoria (North) Para	84	Jaldi	Inside	Partial
48	Askoria (Middle) Para	85	Jaldi	Inside	Partial
49	Askoria (East)	88	Jaldi	Inside	Partial

Sl. No.	Village	Total HHs No.	Beat	Location	Level of Stake
	Para				
50	Askoria (South) Para	87	Jaldi	Inside	Partial
51	Askoria Teli Para	95	Jaldi	Inside	Partial
52	Mohajan Para	275	Jaldi	Adjacent	Partial
53	Sreeram Mohajan Para	150	Jaldi	Adjacent	Partial
54	Master Para	65	Jaldi	Adjacent	Moderate
55	Talukdar Para	25	Jaldi	Adjacent	Moderate
56	Villager Para	165	Jaldi	Adjacent	Major
57	Adarshagram	72	Jaldi	Adjacent	Major
58	Biswas Para	55	Jaldi	Adjacent	Partial
59	Dushari Para	325	Jaldi	Adjacent	Major
60	Roidia Ghona	350	Jaldi	Adjacent	Major
61	Barua Para	45	Jaldi	Adjacent	Major
62	Sikder Para	55	Jaldi	Adjacent	Major
63	Dighir Par	32	Jaldi	Adjacent	Major
64	Nomo Para	21	Jaldi	Adjacent	Major
65	Jungle Jaldi (Part)	30	Jaldi	Adjacent	Major
66	North Para	205	Jaldi	Inside	Partial
67	South Para	195	Jaldi	Inside	Partial
68	Jalia Para	240	Jaldi	Inside	Partial
69	Toily Para	150	Jaldi	Inside	Partial
70	Shapla Para	50	Jaldi	Inside	Partial
71	Shil Para	60	Jaldi	Inside	Partial
72	Ashar Babar Para	50	Jaldi	Inside	Partial
73	Mollah Para	140	Jaldi	Inside	Partial
74	Sikder Para	95	Jaldi	Inside	Partial
75	Chairman Para	85	Jaldi	Inside	Partial
76	Shapla Para	75	Jaldi	Inside	Partial
77	Jele Para	200	Jaldi	Inside	Moderate
78	Muddar Para (Part)	130	Jaldi	Inside	Moderate
79	Mahabbat Ali Sikder Para	50	Jaldi	Inside	Moderate
80	Muddar Para (Part)	20	Jaldi	Inside	Moderate
81	Ali Sikder Para	140	Jaldi	Inside	Moderate
82	Kanucherang Para	50	Jaldi	Inside	Moderate
83	Shianna Para	95	Jaldi	Inside	Moderate
84	Moazzin Para	145	Jaldi	Inside	Moderate

Sl. No.	Village	Total HHs No.	Beat	Location	Level of Stake
85	Maiz Para	560	Jaldi	Inside	Major/Moderate
86	Nuruddin Sikder Para	50	Jaldi	Inside	Partial
87	Mohammadia Para	100	Jaldi	Inside	Moderate
88	Charitya Para	75	Jaldi	Inside	Moderate
89	Shil Para	20	Jaldi	Inside	Moderate
90	Jalia Para	75	Jaldi	Inside	Moderate
91	Teli Para	20	Jaldi	Inside	Moderate
92	Shoily Babar Para	25	Jaldi	Inside	Moderate
93	Das Para	75	Jaldi	Inside	Moderate
94	Mahabbat Ali Para	220	Jaldi	Adjacent	Moderate
95	Rustom Ali Majheer Para	40	Jaldi	Adjacent	Moderate
96	Barua Para	140	Jaldi	Adjacent	Moderate
97	Sheyanat Ali Para	50	Jaldi	Adjacent	Moderate
98	(East) Barua Para	170	Jaldi	Adjacent	Major
99	Matbbar Para	75	Jaldi	Adjacent	Major
101	Noa Para	80	Jaldi	Adjacent	Major
102	Ismail Sikder Para	55	Jaldi	Adjacent	Major
103	Moulvi Para	30	Jaldi	Adjacent	Major
104	Adarshagram	60	Jaldi	Adjacent	Major
105	Jalar Para	50	Jaldi	Adjacent	Major
106	Badla Para	30	Jaldi	Adjacent	Major
107	Deputy Ghona	300	Chambol	Outside	Partial
108	Jele Para	66	Chambol	Outside	Partial
109	Joy Nagar	350	Chambol	Outside	Partial
110	Patla Bibir Para	70	Chambol	Outside	Partial
111	Surma Sikder Para	100	Chambol	Outside	Partial
112	Chartia Para	90	Chambol	Outside	Partial
113	Baralia Para	60	Chambol	Outside	Partial
114	Gourhori Chowdhury Para	50	Chambol	Outside	Partial
115	Sikder Para	70	Chambol	Outside	Partial
116	Afia Baper Para	127	Chambol	Outside	Partial
117	Maddham Para	100	Chambol	Outside	Partial
118	Ahmadia Para	177	Chambol	Outside	Partial
119	Jailla Para	50	Chambol	Outside	Partial
120	Chowdhury Para	100	Chambol	Outside	Partial
121	Moulvi Para	150	Chambol	Outside	Partial
122	Muhuri Para	150	Chambol	Outside	Partial

Sl. No.	Village	Total HHs No.	Beat	Location	Level of Stake
123	Napit Para	50	Chambol	Outside	Partial
124	Shindhu Para	415	Chambol	Adjacent	Partial
125	Azani Para	200	Chambol	Adjacent	Partial
126	Sadeq Fakir Para	200	Chambol	Adjacent	Partial
127	Saleh Ahmad Member Para	103	Chambol	Adjacent	Partial
128	Satghat Para	60	Chambol	Adjacent	Partial
129	Nath Para	70	Chambol	Adjacent	Partial
130	Hindu Para	100	Chambol	Adjacent	Major
131	Barmauttar	100	Chambol	Adjacent	Major
132	Sonarkhil	220	Chambol	Adjacent	Major
133	Duillyar Jhiri	87	Chambol	Adjacent	Major
134	Churanto Mura	100	Chambol	Adjacent	Major
135	Jungle Chambol	50	Chambol	Adjacent	Major
136	Rudra Para	80	Chambol	Adjacent	Major
137	Nath Para	150	Chambol	Adjacent	Major
138	Karmakar Para	100	Chambol	Adjacent	Partial
139	Khalifar Para	170	Chambol	Adjacent	Major
140	Moinuddin Talukdar Para	100	Chambol	Adjacent	Major
141	Azani Para	150	Chambol	Adjacent	Major
142	Teli Para	100	Chambol	Adjacent	Major
143	Hazi Para	250	Chambol	Outside	Adjacent
144	Bokakanir Para	100	Chambol	Outside	Adjacent
145	Mowlar Baper Para	150	Chambol	Outside	Adjacent
146	Mita Para	50	Chambol	Outside	Adjacent
147	Sider Para	100	Chambol	Outside	Adjacent
148	Moulvi Para	60	Chambol	Outside	Adjacent
149	Sikder Para	60	Chambol	Outside	Adjacent
150	Hindu Para	300	Chambol	Adjacent	Adjacent
151	Hydori Para	200	Chambol	Adjacent	Major
152	Peskar Para	30	Chambol	Adjacent	Major
153	Bera Para	120	Chambol	Adjacent	Partial
154	Jungle Chambol	700	Chambol	Adjacent	Major
155	Bahaddar Hat Para	57	Puichhari & Partial Napora	Outside	Partial
156	Koibotto Para	100	Puichhari	Outside	Partial
157	Jaldas Para	104	Puichhari	Outside	Partial
158	Bahona Kata	121	Puichhari	Outside	Partial
159	Pairanga Kata	75	Puichhari	Outside	Partial

Sl. No.	Village	Total HHs No.	Beat	Location	Level of Stake
160	Sikder Para	40	Puichhari	Outside	Partial
161	Noqpara	08	Puichhari	Outside	Partial
162	Mowlar Para	325	Puichhari	Outside	Partial
163	Abdar Para	93	Puichhari	Outside	Partial
164	Miah Ghona	78	Puichhari	Outside	Partial
165	North Para	229	Puichhari	Outside	Partial
166	Majhhar Para	113	Puichhari	Outside	Partial
167	Tek Para	100	Puichhari	Outside	Partial
168	Roai Para	300	Puichhari	Outside	Partial
169	Arabshah Ghona	220	Puichhari	Outside	Partial
170	Telia Kata	100	Puichhari	Outside	Partial
171	Pandit Kata	178	Puichhari	Outside	Partial
172	Haidar Ghona	240	Puichhari	Outside	Partial
173	Sikder Para	105	Puichhari	Outside	Partial
174	Napit Para	28	Puichhari	Outside	Partial
175	Nurar Baper Para	110	Puichhari	Outside	Partial
176	Monjan Para	117	Puichhari	Outside	Partial
177	Fakir Para	67	Puichhari	Outside	Partial
178	Saiyer Para	180	Puichhari	Outside	Partial
179	Sachiar Para	83	Puichhari	Outside	Partial
180	Naya Para	14	Puichhari	Adjacent	Major
181	South Para	275	Puichhari	Inside/ Adjacent	Major
182	Khali Para	20	Puichhari	Inside/Adjacent	Major
183	Office Tila	34	Puichhari	Inside	Major
184	Master Para	08	Puichhari	Adjacent	Major
185	Das Para	42	Puichhari	Adjacent	Major
186	Noa Para	33	Puichhari	Adjacent	Major
187	Sikder Para	57	Puichhari	Adjacent	Major
188	Raittya Para	23	Puichhari	Adjacent	Major
189	Konar Para	71	Puichhari	Adjacent	Major
190	Maiz Para	115	Puichhari	Adjacent	Major
191	Gozonnya Para	68	Puichhari	Adjacent	Major
192	Barua Para	11	Puichhari	Adjacent	Major
193	Shia Para	310	Puichhari	Inside	Major
194	Bohira Bari	64	Puichhari	Inside	Major
195	Napita Beal Para	42	Puichhari	Inside	Major
196	North Para	188	Puichhari	Near to Adjacent	Moderate
197	Das Para	43	Puichhari	Near to	Moderate

Sl. No.	Village	Total HHs No.	Beat	Location	Level of Stake
				Adjacent	
198	Napit Para	27	Puichhari	Near to Adjacent	Moderate
199	Naya Para	13	Puichhari	Near to Adjacent	Moderate
200	Chowdhury Para	22	Puichhari	Near to Adjacent	Moderate
201	Mia Para	10	Puichhari	Near to Adjacent	Moderate
202	Sikdar Para	50	Puichhari	Near to Adjacent	Moderate
203	West Para	97	Puichhari	Near to Adjacent	Moderate
204	Naya Para	13	Napora	Adjacent	Major
205	Hater Chhora	324	Napora	Inside	Major
206	Master Mura	165	Napora	Inside	Major
207	East Chhalia Para	334	Napora	Inside/Adjacent	Major
208	Sikder Para	27	Napora	Adjacent	Major
209	Hindu Para	76	Napora	Adjacent	Moderate/ Major
210	Office Para	54	Napora	Inside	Major
211	Pal Para	18	Napora	Near to Adjacent	Moderate
212	Greater Hindu Para	400	Napora	Near to Adjacent	Moderate
213	Kantabar Para	53	Chambol	Adjacent	Major
214	Villager Para	162	Chambol	Inside	Major
215	Shamsia Ghona	186	Chambol	Inside	Major
216	Mirpara	170	Chambol	Neat to Adjacent	Moderate
217	North Para	97	Napora	Outside	Moderate
218	North Koibottor Para	55	Napora	Outside	Moderate
219	Majhhar Koibottor Para	79	Napora	Outside	Moderate
220	Rustom Kata	180	Napora	Outside	Moderate

A.4.1.4. Detailed geographic delineation of the project boundary, including information allowing the unique identification(s) of the proposed A/R CDM project activity

The proposed reforestation project's boundary is the core zone of Chunoti Wildlife Sanctuary with an area of 7,764 ha. Hill forests previously covered virtually all of eastern Bangladesh, but are now highly fragmented and degraded (GOB, 1999). As per the approved management plans the entire gazetted area has been assigned as core zone, around which an interface landscape zone has been delineated within 5 km radius from the periphery (GoB, 2007).

Chunoti Wildlife Sanctuary, located ($21^0$40' North latitude and $92^0$07' East longitude) in the country's south-eastern region (Figure 1), falls within Banshkhali and Lohagara Upzilas of Chittagong District, and Chakoria Upzila of Cox's Bazar District. It covers 7 Union Parishads : Chunoti, Adhunagar, Herbang, Puichari, Banskhali, Borohatia and Toitong (Figure 2). The Sanctuary, established in 1986 as a representative of hill forests bio-geographic zone, comprises 7 RF blocks (Chambal, Jaldi, Napura, Puichari, Goyalmara, part Satgarh and part Chunoti). It is bordered on the north by RFs of Chunoti Range, and in the south-east and south by RFs of Chunoti and Barabakia Ranges.

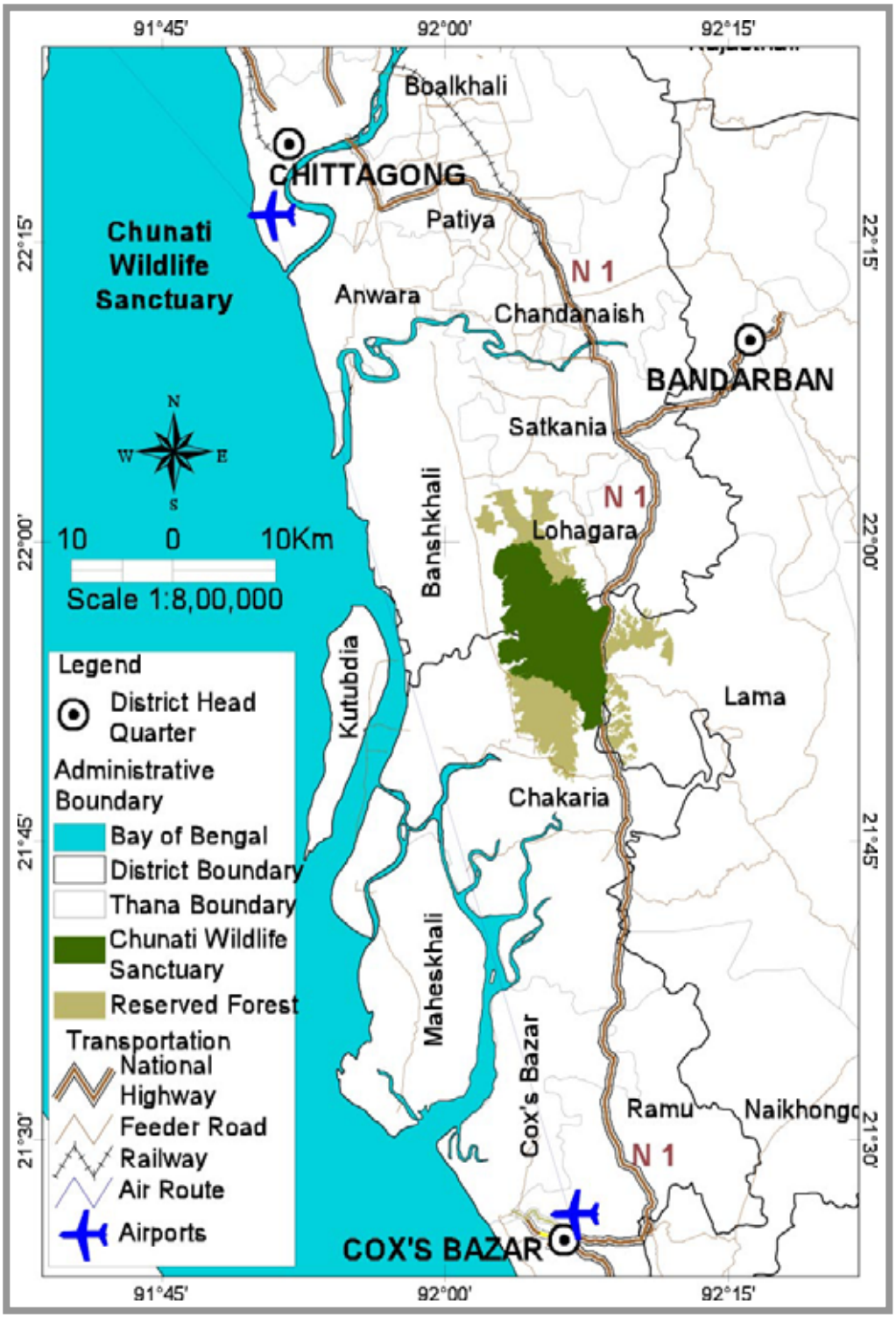

FIGURE 1: Location of Chunoti Wildlife Sanctuary in Bangladesh

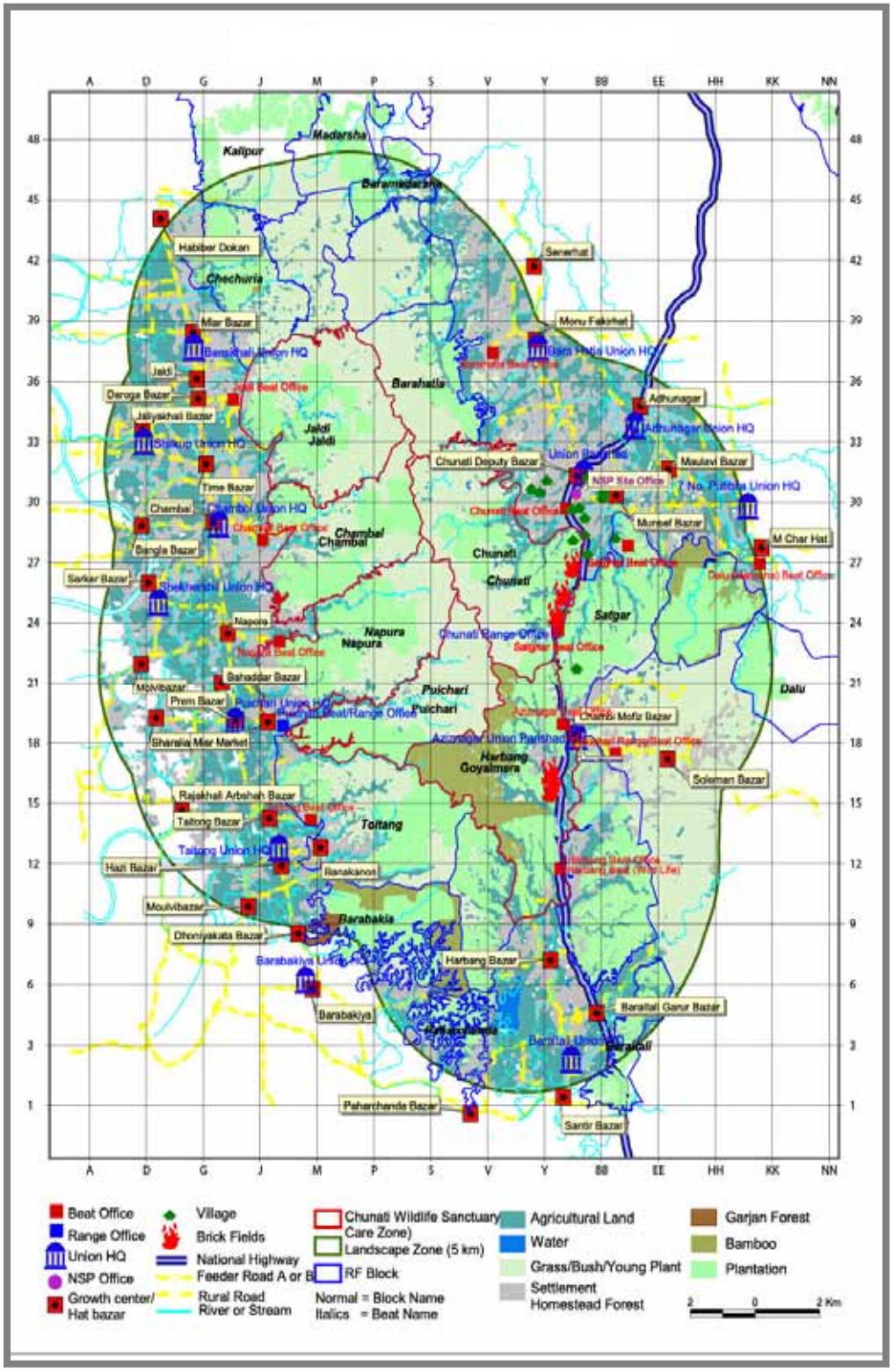

FIGURE 2: Landscape Map of Chunoti Wildlife Sanctuary

The Sanctuary is accessible from Chittagong city via the national highway (to Cox's Bazar), which borders the eastern boundary over a distance of nearly 15 km. It lies halfway in between Chittagong and Cox's Bazar – nearly 70 km south of Chittagong. Another metalled road leading south from Chittagong runs parallel to the western boundary (at an average of 3-5 km away). The Sanctuary is well connected with Dhaka through air and road via Chittagong and Cox's Bazar. A narrow railway gauge connects the nearest railway station (nearly 25 km from the northern boundary) Dohazari to Chittagong main railway line. Although the Sanctuary is not presently popular as eco-tourism spot, its good connectivity through road, railway and air makes it a potential future candidate for community-based eco-tourism - the existing trail system can in future be developed as nature trails for hiking by eco-tourists.

A.4.1.5. Description of the present environmental conditions of the area planned for the proposed A/R CDM project activity, including a brief description of climate, hydrology, soils, ecosystems (including land use)

ECOSYSTEMS

A variety of wildlife including plants and micro-organisms and important ecological processes that govern their functions are noticed in the Sanctuary that encompasses the following terrestrial, aquatic and forests ecosystems:

- Remainder patches of secondary forests;
- Plantations (short rotation and long rotation);
- Bamboo and other grasslands;
- Waterbodies;
- Settlements; and
- Cultivated fields.

The first three ecosystems are the largest in extent and also important from the Sanctuary management point of view. The cultivated fields (mainly of paddies) and grasslands harbor mammals and reptiles. The waterbodies harbor important fish species, water birds and amphibians that are food to local communities. A large amount of water is drained from the surrounding hills as a result of high rainfall. In the absence of steep gradient required for carrying huge monsoon rainfall, the rain water gets collected in depressions and valleys through small streams, locally known as *chera* (e.g. Puichara and Bamerchara in Jaldi Range). In all four main streams and a number of small streams are supported by the surrounding hill ranges of Chunoti and so the restoration of degraded forest landscape is important for the sustenance of existing waterbodies. They provide good habitats, drainage and drinking water both for wild animals and local people. The waters are surcharged with materials brought from surrounding hills and a large portion of silt is deposited in the immediate neighborhood of the streams. The water recedes during dry season, enabling local people to cultivate

the rich land with winter crops. The surface level of waterbodies is, however, being raised due to siltation.

FORESTS

The strong influence of socio-economic, micro-climatic and edaphic factors including dense population residing in proximity, good rainfall and humidity, and sunshine is predominant on the Sanctuary's secondary forests. The hill forests (mixed tropical evergreen, semi-evergreen and bamboo) of Chunoti were reserved in early nineteenth century under Section 20 of the Forest Act 1927. The administration and management of the Sanctuary have recently been transferred from Chittagong (South) Forest Division to the newly created Chittagong Wildlife Management and Nature Conservation Division; there are two Forest Ranges (Chunoti and Jaldi) that cover the core zone of the Sanctuary.

Evergreen and semi-evergreen forests of Chunoti WS, located in the high rainfall bio-geographic zone, were in past biologically rich. The predominant influence of edaphic and favorable microclimatic factors led to the development of rich forests. These forests represented several features of the biodiversity of north-eastern subcontinent, which is one of the mega biodiversity region with many endemic floral and faunal species. They played important role in regulating water flows and checking soil erosion in the undulating terrain. Indeed the forests conservation within the Sanctuary is important as the restored forests will form important catchments for the existing water bodies, some of which flow down to the neighboring Bay of Bengal. In addition to providing a sanctuary to the wildlife, the restored forests will, therefore, be part of water sanctuaries to be maintained in future by following sound practices for soil and moisture conservation.

Natural regeneration in different forest blocks of Chunoti was largely good up to sixties as documented in old Working Plans. Unfortunately the forests of Chunoti have subsequently been subjected to heavy biotic interference and there was hardly any high forest left by eighties; few scattered patches of *garjan* and *sal* trees are remnants of the plantations raised earlier (mainly in sixties) by converting natural forests of great biodiversity value.

The forests have become fragmented with reduced extent of wildlife habitat and ensuing adverse effects on biodiversity. This has affected the ecological boundaries of the Sanctuary with limited wildlife corridors and breeding space. However, at places natural growth of secondary vegetation including bamboo and other grasses has come up, thereby enhancing the Sanctuary's *in-situ* conservation values, especially as elephant movement corridor. A number of fodder and fruit plants regenerate naturally but do not get established due to biotic influences, often giving way to a process of regression to a drier scrubby or savannah type of vegetation. Sungrass (as seen in the *Sunkholas*) has invaded particularly in dry areas as a result of site degradation. Local people collect

sungrass after burning the area each year. Few cane clumps occur sporadically, and bamboo regenerate naturally along the moist banks of streams.

FAUNA

The high forests are no more present and the conservation value of the Sanctuary currently stems mainly from the fact that Chunoti is still a good habitat for elephants (nearly 20-30 in number). Elephants as large mammals use the Sanctuary as movement corridors for visiting forests of the Chittagong Hill Tract (CHT) and neighboring areas of Myanmar. A diversity of other faunal groups such as reptiles, vertebrates, macques, fishes, frogs and amphibians is present in Chunoti.

Many animal species (mammals, birds, reptiles and amphibians), both forest-dwelling and wetland-species, of different genera and families have been reported in the Sanctuary. Elephants as large mammals use the Sanctuary as movement corridor. A viable population of many small and medium-sized mammal species that can survive in limited forest areas and/or disturbed or secondary habitats (e.g. small cats, wild pigs) are found in the Sanctuary. A diversity of other faunal groups such as reptiles, vertebrates, macques, fishes and amphibians is present. Aquatic species including turtles and frogs are found in water bodies.

The Sanctuary provides good scope for wildlife education and research, nature interpretation and conservation awareness. It represents a fragile forests landscape adjoining the Bay of Bengal, which if not conserved timely, may be lost for future generation. It is also a potential source of eco-tourism, aesthetic values, cultural values and scenic beauty.

GEOLOGY

The Sanctuary area is generally hilly with shallow gullies and gentle slopes. In some areas narrow valleys wind around hills and are blocked by ridges connecting the hills. The low and rolling hills of Chunoti are composed of upper tertiary rocks in which soft sandstone predominates. It has four main geological formations : Pleistocene, Pliocene, Mio-pliocene and Miocene. Pleistocene is a complex of alluviums, terraces and old terraced fans with unconsolidated sediments of sand, sand loam, loamy clay and others resulting from erosion of Duptila and Tipam formations. Pliocene is Duptila formation which mainly consists of folded, fine to course sandstone, interbedded with mottled siltstones and shales, plinthitic and lateritic layers. These sediments are strongly erodible. Mio-pliocene is Tipam formation composed of a succession of consolidated, folded and fine garined sandstones, interbedded with folded sandy shales, siltstones and shales. Miocene is the oldest surma formation, and is situated in the centre of the anticlines and surfaces at the bottom of valleys.

SOILS

The soils developed on unconsolidated sandstone of the low hills are brown, loamy and acidic (Typic or Orthic Hapludult). These soils permit deeper penetration of tree roots, unless obstructed by the presence of lateritic, plinthitic or placic horizons at shallow depths. The high hill soils are Lethic or Orthic Dystrocrepts or Hablotthent; these are developed usually on consolidated or semi-consolidated sandstone or stratified shale beds. Deeper penetration of tree roots is hindered on steep slopes and stratified hard shale or consolidated sandstone, wherever present at shallow depth. The soils on the alluvial plains and valleys are mainly silt loam to silty clay loam, moderately to strongly structured and neutral to medium acid sunsoil. The soils in valleys are imperfectly drained alluvial soils – these are Typic Haplaquent or Aeric Haplaquept. Some of the higher valley soils are moderately well drained and have brown, loamy, moderately structured and very strong acid subsoils. The narrow valley soils, usually with imperfect to poor drainage, are relatively greyer and less developed than the piedment plain soil. Locally sandy loams on ridges and silty clays in basins occupy small areas having strongly acid reactions. Locally, where seepage water keeps the valley wet throughout the dry season, very poorly drained soils occur; organic soils sometimes occur in such areas.

Soils on the hills with unconsolidated rocks are moderately well to excessively drained and mainly deep. They are yellowish brown to yellowish red, sandy loam to clay loams. Moderate to strong blocky and strongly to very strongly acid and have few to many iron-mangnese concretions. Locally some soils contain hard concretionary or indurated lateritic layer at a depth close to the surface. Solid on the hills with consolidated rocks are mainly developed on weathered sandstones, shales and locally siltstones. The soils developed in weathered sandstones are mainly sandy loams to clay loams. The soils developed in shales are silty clay loams. They are well to excessively drained, pale brown to yellowish brown, mainly sandty loams to silt clay loams, weak to strong blocky and medium to strongly acid in subsoil.

The banks of rivers and creeks are severely eroded in Chunoti area. The concave sections of rivers are severely cut by cascading discharge during the monsoon season; they are silted during the rainy season.

HYDROLOGY

In the southern part of the Sanctuary a range of low hills form important micro-watersheds with a number of streams through which a large amount of water is drained from the surrounding undulating terrain. The surface water hydrology is regulated by local rainfall, run off from adjacent uplands and the relief pattern of plain land. The valleys and coastal areas that occur above normal flood level are subjected to periodic flash flood following heavy rains on the adjacent uplands (GOB, 2003). The important features related to hydrology of Chunoti hilly lands

are local rainfall, slope gradient and soil porosity. Close proximity to the sea (Bay of Bengal) and gradient of the hill slopes provide a fairly efficient surface drainage system.

CLIMATE

The Sanctuary is subject to humid megathermal (MAT > 22 degrees) climate with little or no water deficit in the root zone at any part of a year. The climate is in general warm and humid but the weather is cool and pleasant during winter. The climate of the Sanctuary can be classified into 3 main seasons: summer (March-May), monsoon (June-October) and winter (November-February).

Relative humidity is the amount of moisture in the atmosphere at any given time. It affects atmospheric temperature, cloud formation and sun light intensity. Low relative humidity occurs during summer season and ranges from 28.6% (average minimum) to 98.2% (average maximum). Medium relative humidity during winter season ranges from 27.8% (average minimum) to 98.8% (average maximum). High relative humidity is experienced during the monsoon season and ranges from 41% (average minimum) to 100% (average maximum).

Temperature is an important climatic factor that affects forest growth. Temperature efficiency in Chunoti is normal that favors tree growth throughout a year. Sunshine, an important growth factor for plants and animals, is in abundance in Chunoti. It enables photosynthesis in plants and generates heat required for physiological processes in all living organisms. Very sunny period (24-30 days/month) is experienced during winter season. Sunny period (24-27 sunny days/month) occurs during the summer season. Clouds are seen during the monsoon period when only 9-21 days are sunny in a month.

The moisture control section does not become biologically dry for more than 90 consecutive days after the summer solstice at 50 cm depth. Rains, in terms of both duration and frequency, are heavy during monsoon season. But a large part of total rainfall particularly in hills is presently drained off and so soils become draughty even for a longer period at the tree root zone (50 mm). Pre-monsoon Nor'westerly and cyclonic storms are accompanied by high speed winds and rains, which do considerable damage to large trees. The valleys that occur above normal flood level are subjected to periodic flash flood during heavy rains.

Main elements of climate are summarized as below:

Rainfall (mean monthly) in April, July and October: 112, 588 and 216 mm
Rainfall (mean monthly) in November, January and March: 112, 588 and 216 mm
Maximum (monthly average) temperature in May: 32.2^0C
Minimum (monthly average) temperature in January: 13.8^0C

Mean annual rainfall:	2,914 mm
Mean annual evaporation:	1,466 mm
Mean annual temperature:	27.9^0C

A.4.1.6. Description of the presence, if any, of rare or endangered species and their habitats

Chunoti Wildlife Sanctuary supports 20-30 elephants that are considered to be flagship and conspicuous species. Elephants are listed in the Third Schedule of Bangladesh Wildlife (Preservation) (Amendment) Act, 1974, implying thereby their full protection from hunting, killing and capture from the wild. The Asian Elephant is included in the CITES Appendix I, and so completely interdicting international trade. It also is included in the IUCN Redbook and so categorized as a critically endangered species.

As an umbrella species elephants are important ecological part of Chunoti forest ecosystem and are indeed an indicator of good biodiversity health. A suitable forest habitat for elephants simultaneously ensures protection of a number of other species in view of broad habitat requirements for elephants. As large hervibore mammal elephants require huge amount of forage and waterbodies mainly for drinking and bathing. They prefer a mosaic of habitat types including patches of forests, scrub forests, bananas, bamboo, forest clearings and intermittent open spaces, and succulent grasslands. Chunoti forests meet these requirements in terms of good amount of palatable grasses, scrub forests with open spaces, bamboo and herbs, and a number of streams flowing through the Sanctuary.

A.4.2. Species and varieties selected for the proposed A/R CDM project activity

The following species and practices for reforestation were identified after holding consultations with the CMCs and other local stakeholders:

- Suitable species for reforestation are mainly indigenous species that (in mixture) may include siris, sisoo (*Dalbergia sissoo*), simul (*Bombax ceiba*), chikrasi (*Chikrassia tabularis*), jarul (*Lagerstroemia speciosa*), gamar (*Gmelina arborea*), tetul (*Tamarindus indica*), dumur (*Ficus hispida*), garjan (*Dipterocarpus spp*.), telsur, koroi (*Albizia spp*.), champa, mahogany, kadam (Anthocephalus chinensis), arjun, haritoki, pitali, chapalish (*Artocarpus chaplasha*), boilam, agar, hargoja, padauk, jam (*Syzgium cumini*), dhakijam (*Syzgium grande*), civit (*Swintonia floribunda*), toon, bazna (*Zanthoxylum rhetsa*), jalpai (*Eleocarpus longifolia*), chalta (*Dillenia spp*.), amla, bahera (*Terminalia bellirica*), amloki (*Phyllanthus emblica*), ficus species, bamboo, etc. Monoculture will not be allowed and canes will not be under-planted.

- Exotic tree species such as acacia, eucalyptus and mangium will not be planted inside the core zone.
- Palatable grasses for wildlife fodder plantations may include *Typha angustifolia, Alpimia nigra, Themeda arundinacea, Saccharum arundinaceum, Sacharum longisetosum, Sacharum narenga, Sacharum hookeri, Phragmites karka, Arundo donax, Impreta cylinder, Sacharum spontaneum, Cymbopogan flexuosus* and *Setaria palmafolia*. These grasses may also be used for gully plugging in case soil erosion takes place due to gradient and run off in hillocks.
- Planting of fruit bearing and wide crown tree species such as chapalish and artocarpus will particularly be suitable for arboreal fauna.
- Plantation of shrubs and vegetables may be taken up around waterbodies (e.g. *charas*, ponds) by involving local stakeholders.
- Subsidiary silvicultural operations such as cleaning of weeds, climber cutting and freeing of natural regeneration from suppression will be taken up for encouraging natural regeneration. In coppicing species stump dressing and stool thinning (retaining 2-3 shoots per stool) will be carried out. Existing bamboo and cane clumps will be decongested and managed by employing CPGs.

A.4.3. Description of legal title to the land, current land tenure and rights to tCERs/lCERs issued for the proposed A/R CDM project activity

The land category of Chunoti WLS is reserved forest land (comprising 7 reserved forest blocks) with the legal title of land ownership held by the Government of Bangladesh through Forest Department. In 1986 the GOB declared the area as Wirldlife Sanctuary under the provisions of Bangladesh Wildlife (Preservation) (Amendment) Act, 1974.

A.4.4. Technology to be employed by the proposed A/R CDM project activity

The forest landscape of the Sanctuary can be restored by reforestation through block and enrichment plantations of indigenous species by attracting revenue generated in carbon offset trading. By conserving forests through reforestation, biodiversity and water can be conserved *in-situ*, and rural poverty alleviated by utilizing surplus labor and land resources locally. Mitigation opportunities in the Sanctuary have significant potential to transfer investment funds and technology to Bangladesh. A climate change mitigation project for biodiversity conservation in Chunoti is, therefore, developed by following international guidelines relevant for financing the carbon offset projects that are now developing in LULUCF sector. The PDD is developed for potential investments, generating carbon credits by conserving biodiversity in a dense agrarian economy characterized by food deficit and low per capita income.

Climate mitigation projects suitable for Chunoti WLS focuses on reforestation and enrichment efforts required for the re-vegetation of severely degraded forest areas. Reforestation in climate change literature is defined as the direct human-induced conversion of non-forested land to forested land through planting, seeding and/or human-induced promotion of natural seed sources, on land that was forested but converted to non-forested land. Enrichment of existing vegetation is required in those areas where natural regeneration can be accelerated by adopting appropriate silvicultural techniques for assisted natural regeneration.

Keeping in view the results of land-use assessmentsm, both reforestation and enrichment plantations are required to be taken in Chunoti for restoring its degraded forest landscape. Suitable areas for reforestation are those where currently neither plantations exist nor natural regeneration comes up adequately. Based on field observations, suitable areas for taking up reforestation through block plantations are areas that are presently covered under grass land-use and where seedlings of indigenous tree species (mainly of slow growing and fruit-bearing species suitable for wildlife) can be planted by the FD. Of the total area of 3,000 ha as estimated under grass land-use category, nearly 2,000 ha can thus be brought under block plantations (2500 seedlings/ha) of indigenous species during initial phase of the project implementation period of 5 years.

Enrichment plantations of indigenous species of trees and shrubs can be taken in those areas where some vegetation exist mainly due to either natural processes of forest regeneration or areas that have earlier been planted but are presently degrading due to biotic pressure including illicit felling. Suitable areas, as identified during the field inventory works, will include the land-uses categorized as long rotation plantations, short rotation plantations, and bamboo. Of the total area of 1,200 ha available under long and short rotation plantations, nearly 1,000 ha will be taken for establishing enrichment plantations of indigenous species (1250 seedlings/ha). In bamboo areas, nearly 2,000 ha forest land will be reforested and so enriched by planting only 650 seedlings per ha in the identified gaps. Detailed technological prescriptions for establishing block plantations and enrichment plantations, and managing natural regeneration and bamboo clumps are discussed as below (based on the management prescriptions of the approved management plans for Chunoti WLS).

REFORESTATION TECHNOLOGIES

The simplified plantations guidelines, as discussed below, are applicable for establishing and managing enrichment plantations and block plantations for reforestation in the core zone of Chunoti WLS. The following main objectives will be achieved by raising and managing enrichment and block plantations through adequate protection and conservation of the constituent biodiversity of Chunoti:

i) Encourage natural processes for regeneration and rehabilitation of forests ecosystem by providing effective protection against biotic interference (illicit removals of forest produce, encroachment, poaching, grazing and forest fire),
ii) Conserve the constituent biodiversity by developing and maintaining enriched forests as good habitat favoring wildlife, and
iii) Establish and manage plantations of local species through stakeholders' consultations and participation.

Enrichment Plantations

Enrichment plantations of indigenous species (e.g. garjan, sal, siris, sissoo, simul, chikrasi, chapalish, dhakijam, jarul, chalta, amla, bahera, ficus species, jackfruit, jam, dumur, dheua, etc. – see the approved management plans for full species list with scientific names) will be taken up in identified blank areas (or gaps) of the core zone. These plantations will enrich the existing vegetation by supplementing/complementing the existing natural regeneration that will be encouraged by following the guidelines as presented below. No PBSA (participatory benefit sharing agreement) are envisaged to be signed with local stakeholders as the plantations will not be managed on benefit sharing basis. As appropriate, due help of co-management committees will be taken for putting in place suitable measures for the control of illicit felling as required. The following reforestation activities will be taken up for enrichment plantations both by the FD field staff and the two CMCs:

- Identification of suitable areas for enrichment planting.
- Advance closure (suitable protection measures against hacking, betel leaf cultivation, forest land encroachment, grazing and forest fires) of identified areas.
- Collection and treatment of seeds, and development and maintenance of nursery of indigenous species.
- Cutting of unwanted bushes (say around 1 meter radius of the pits in which seedlings are to be planted in identified gaps), climbers and tall weeds (bushes not hindering natural regeneration will be retained as biodiversity but also for creating moist conditions locally).
- Cutting back of old, high and malformed stumps, and faulty coppice shoots for encouraging coppice regeneration.
- On an average 1250 seedlings per ha mainly of indigenous species (multi-species plantations to optimize species and habitat heterogeneity) will be planted in the identified gaps (of more than 0.5 ha).
- In bamboo areas only 650 seedlings of indigenous species will be planted in the identified gaps where existing bamboo clumps will aggressively managed by associating the members of CPGs and FUGs.
- One kg of cowdung and/or farm yard manure will be applied in the pits of size 45m x 45m x 45m (dug in the month of Feb. – March).

- No burning and clear cutting of existing vegetation will be taken up in order to conserve biodiversity. In case of weeds a circular area of 1 m radius around the pit can be cleared before taking up planting on the onset of monsoon rains (in the month of June-July).
- The dead and hollow trees suitable for wildlife will not be removed.
- Half-moon trenches around the planted seedlings along the contours are suggested in the slopes as an integral part to conserve and trap soil, and retain soil moisture locally in the identified micro-watersheds.
- Weeding, beating up and cleaning will be taken up as and when required. Normally 3 weeding are taken up in the 2nd financial year and 2 weeding in the 3rd financial year. Vacancy filling, if required, will be done during the first year along with weeding.
- Singling of coppice shoots leaving 2-3 shoots per stool will be taken during 2nd year for the regenerating coppice stumps that are to be dressed during the first year.
- Suitable species for enrichment plantations are mainly indigenous species that (in mixture) may include siris, sisoo (*Dalbergia sissoo*), simul (*Bombax ceiba*), chikrasi (*Chikrassia tabularis*), jarul (*Lagerstroemia speciosa*), gamar (*Gmelina arborea*), tetul (*Tamarindus indica*), dumur (*Ficus hispida*), garjan (*Dipterocarpus spp*.), telsur, koroi (*Albizia spp*.), champa, mahogany, kadam (Anthocephalus chinensis), arjun, haritoki, pitali, chapalish (*Artocarpus chaplasha*), boilam, agar, hargoja, padauk, jam (*Syzgium cumini*), dhakijam (*Syzgium grande*), civit (*Swintonia floribunda*), toon, bazna (*Zanthoxylum rhetsa*), jalpai (*Eleocarpus longifolia*), chalta (*Dillenia spp*.), amla, bahera (*Terminalia bellirica*), amloki (*Phyllanthus emblica*), ficus species, bamboo, etc. Monoculture will not be allowed and canes will not be under-planted.
- Exotic tree species such as acacia, eucalyptus and mangium will not be planted inside the core zone.
- Palatable grasses for fodder plantations may include *Typha angustifolia, Alpimia nigra, Themeda arundinacea, Saccharum arundinaceum, Sacharum longisetosum, Sacharum narenga, Sacharum hookeri, Phragmites karka, Arundo donax, Impreta cylinder, Sacharum spontaneum, Cymbopogan flexuosus* and *Setaria palmafolia*. These grasses may also be used for gully plugging in case soil erosion takes place due to gradient and run off in hillocks.
- Planting of fruit bearing and wide crown tree species such as chapalish and artocarpus will particularly be suitable for arboreal fauna.
- Plantation of shrubs and vegetables may be taken up around waterbodies (e.g. *charas*, ponds) by involving CPGs and FUGs.
- Subsidiary silvicultural operations such as cleaning of weeds, climber cutting and freeing of natural regeneration from suppression will be taken up for encouraging natural regeneration. In coppicing species stump

dressing and stool thinning (retaining 2-3 shoots per stool) will be carried out. Existing bamboo and cane clumps will be decongested and managed.

Block Plantations

The following guidelines will be adopted while raising block plantations in the identified areas of core zone of the Sanctuary:

- Block plantations of indigenous species (list as in case of enrichment plantations as described above) will be taken in mixture at 2m×2m (2500 seedlings/ha) by associating local stakeholders (e.g. members of community patrolling groups and forest user groups).
- The fruit bearing trees suitable for wildlife will be planted in mixture with other tree species.
- Two kg of cowdung and/or farm yard manure will be applied in the pits of size 45m x 45m x 45m (dug in the month of Feb. – March).
- Other guidelines will be applicable as described above for enrichment plantations.

Natural Regeneration Management

Main factors responsible for habitat degradation will be identified by holding stakeholders' consultations before taking up reforestation activities. Protection against the identified causal factors including illicit felling, forest fires and grazing, encroachment and poaching will be ensured by involving CPGs and FUGs. The following natural regeneration management practices will be implemented for enriching the existing growing stock in and around the core zone:

- Salvage of dead, dying and diseased trees will be done after leaving some dead trees suitable for wildlife nesting.
- Subsidiary silvicultural operations including cleaning, coppicing, stump cutting and dressing, and stool thinning will be carried out, preferably along with the raising of enrichment and block plantations.
- Bamboo clumps decongestion required for improving habitat for wildlife movement and elephant corridors.
- Habitat improvement works including rehabilitation of degraded forest areas, planting of fruit bearing shrubs and trees, development of palatable grasses, cleaning and thinning of existing plantations, maintenance of glades and waterholes, replacement of exotics by gradual canopy opening, eradication of weeds from glades and wetlands, soil and water conservation, micro-watershed development, etc. will be taken up.
- Gradual opening of top canopy in the existing exotic plantations will be taken up mainly to encourage natural regeneration of indigenous species to come up and get established.

- Waterbodies (e.g. streams/*charas*, ponds) present in the core zone will be maintained for use of wildlife and also local people whose participation will be ensured in their restoration and maintenance.

Bamboo Management

Bamboo forests in the core zone have come up in degraded sites as a part of plant succession in the areas affected by illicit felling and forest fires. Given protection through CMCs the bamboo areas will develop and so mature clumps would need decongestion for better growth. Participating households of CPGs and FUGs will be involved in intensively managing mature bamboo clumps, failing which they may hamper the growth of both natural and artificial regeneration of indigenous species. In doing so the participating households will be allowed intermittent yields obtained through a regular working of mature bamboo clumps. Depending upon site conditions, the first harvest of mature clumps will be available from year 5 to 7 based on usual bamboo harvesting practices to be followed meticulously. A cutting cycle of 3 years may be followed till the bamboo clumps flower/die. Old Culms will be removed first from the centre of a clump (and not from the periphery of the clump)-this will help regenerate new culms coming out from the periphery.

Enrichment plantations in bamboo areas will be taken up in identified gaps. In addition to enhancing forests productivity, bamboo will afford protection to young seedlings, provided bamboo clumps are managed through cut back so that the clump canopy is manipulated suitably. Over a period of time bamboo will form as a middle-storey in Chunoti forests and will provide good soil cover, thereby enhancing moisture retention capacity of forest soils. Natural regeneration would get a protective umbrella and so upcoming seedlings will flourish underneath, free from danger of being trampled, grazed and browsed.

Grass (*Sunkhola*) Management

Grasslands have evolved in Chunoti under an unplanned system of forest fires, forest grazing and site deterioration due to deforestation in past. The existing grasslands continue to be maintained due to heavy biotic pressure, particularly burning in most of the areas. The grasses are the most evolved species of plants and have short life cycle (take a short time from germination to reach maturity). But they have a long life as, unlike trees, when cut they sprout back almost instantaneously. They can support a rich diversity of fauna, and are also efficient in absorbing rain water. Indeed most of our cereals have originated from wild grasses and so the *sunkholas* in Chunoti can be conserved as gene banks as well.

Protection, development and sustainable use of the grasslands (*sunkholas*) patches in Chunoti are very important as a large number of poor people depend on them for their livelihood (sungrass being sold in local markets as thach roof

material). In addition, sporadic patches of grasslands are good for elephants that regularly use them as their movement corridors. However, excessive exploitation of the *sunkholas* have made them unsustainable and immediate interventions are required for restoring the degraded sites. A controlled use of grasslands (for personal consumption) through rotational harvesting will be put in place by the two CMCs in order to avoid unsustainable exploitation of *sunkholas*. So special groups of grass users will be formed and linked with the CMCs. The grassland patches, interspersed with enrichment and block plantations, will attract bird species and other fauna. Two CMCs will employ the existing CPGs and FUGs in controlling forest fire, forest grazing and illicit felling of both timber and grasses.

Regenerating Forests

The Chunoti Wildlife Sanctuary is presently in a severely degraded stage with less than 10% vegetation cover. There is hardly any natural forest left presently and few scattered patches of *garjan* and *sal* trees are the plantations that were raised earlier by converting high forests of great biodiversity value. A successful implementation of this project would result in regenerating forests both through plantations and natural regeneration of indigenous tree species. Given protection by the CMCs by employing the existing CPGs, the regenerating forests would over the maturity period develop as mixed forests of indigenous species. The forests restoration would result in a rich assemblage of vegetation in which the top canopy of trees will be accompanied by semi-evergreen flora in middle storey and the ground flora of grasses, herbs, shrubs. Even block plantations of indigenous species will over a period are expected to develop a multi-storey structure that will mimic natural vegetation.

Nursery Development and Planting

As almost all the recommended tree species are slow growing indigenous species, nursery preparations should be started at least one year in advance of planting season. Seed collection from the identified plus trees will be initiated timely in order to develop nurseries for producing one year old quality seedlings for planting. The participatory management plans for Chittagong Forest Division (GOB, 2003) provide detailed guidelines on : possible sources of plus trees, seed collection methods and calendar, storage and treatment of seeds, seed testing, seed sowing, potting media, filling and staking of polybags, watering of seedlings, grading and hardening of seedlings, and record keeping including plantation journals. Suitable guidelines on appropriate planting practices such as site preparation, planting of potted seedlings, weeding, casuality replacement, and maintenance of plantations will be followed as provided in the management plans.

COSTS

Of the total Sanctuary area of 7,764 ha, suitable areas available for reforestation through block plantations and enrichment plantations are estimated to be as

2,000 ha and 3,000 ha respectively. So the proposed project interventions for GHG mitigation in terms of reforestation through enrichment and block plantations would be focused over 5,000 ha. Simultaneously the remainder areas (2,764 ha) will be brought under effective protection by the CMCs for encouraging natural regeneration.

Costs Stream and Financing Plan

The following plausible costs for reforestation by raising block plantations and enrichment plantations have been collected from the approved management plans and FD cost norms as approved by the GOB. Based on these norms the costs for the proposed reforestation interventions are estimated as below:

Cost (@Tk. 28,000/ha) for establishing block plantations over 2,000 ha = Tk. 56 million
Cost (@Tk. 14,000/ha) for enrichment plantations over 1,000 ha = Tk. 14 million

Cost (@Tk. 10,000/ha) for enrichment plantations over 2,000 ha (cost for bamboo clump management included)
= Tk. 20 million

So the total cost for the proposed reforestation interventions is estimated to be as Tk. 90 million (or USD 1.3 million only).

Two CMCs will assist FD in the implementation of the proposed reforestation activity and will be responsible for the implementation of the entire monitoring mechanism over the project period period of 42 years. A revolving fund will be set up at the CMC level by depositing a part of the amount accrued through carbon sale. The proposed revolving fund will be managed by CMCs in extending micro-credit to the poor members of FUGs and CPGs for their livelihood development. The amount will be used as a revolving fund by the CMCs for implementing livelihood activities for the members of the FUGs and CPGs who will be responsible for the protection of forests. The proposed revolving fund will be managed by the two CMCs for extending soft micro-credit (with 5% service charge) to the members of CPGs and FUGs for their livelihood development. Some remuneration in terms of per *dium* is envisaged for the staff of FD. They will continue to receive their salaries which will be treated as the Government's contribution for community development and biodiversity conservation.

The total cost is thus estimated around USD 2m which is quite reasonable when compared internationally. According to the IPCC (2001), abatement costs through forestry could be quite modest, from USD 0.1 – 20 per ton of carbon in developing countries, and somewhat higher (USD 20 – 100/tC) in developed countries. An additional fund is earmarked for the monitoring of project outputs

by the two CMCs, and for capacity building of FD field staff and the members of CMCs and CPGs.

A five year financing plan as below may be adopted for the proposed reforestation activities:

Financing plan for project implementation (over a period of five years)

Reforestation Options	Physical Targets (in ha)						Financial Targets (in m Tk.)					
	Y1	Y2	Y3	Y4	Y5	Total	Y1	Y2	Y3	Y4	Y5	Total
Block Plantations	250	450	600	450	250	2000	7	12.6	16.8	12.6	7	56
Enrichment Plantations	100	200	400	200	100	1000	1.4	2.8	5.6	2.8	1.4	14
Enrichment Plantations (bamboo areas)	250	450	600	450	250	2000	2.5	4.5	6	4.5	2.5	20
TOTAL	600	1100	1600	1100	600	5000	10.9	19.9	27.4	19.9	10.9	90

The total project cost of USD 2 m is distributed among the seven components as presented in Table 11.2.

Total project cost

Item	Cost in Takas	Cost in USD
Reforestation	90,000,000	1,300,000
Revolving Fund	17,250,000	250,000
Per Dieum Charge	6,900,000	100,000
Consultant and Certification fees	6,900,000	100,000
Monitoring Expenses	13,800,000	200,000
Contingencies	3,450,000	50,000
Total	**138,300,000**	**2,000,000**

A.4.5. Approach for addressing non-permanence

The approach for addressing non-permanence of the proposed A/R CDM activity is selected in accordance with the para 38 under section K of the CDM A/R modalities and procedures : Issuance of tCERs for the net anthropogenic greenhouse gas removals by sinks achieved by the project activity during each verification period, in accordance with paragraphs 45-50 of the CDM A/R modalities and procedures in "Decision-CMP 1 – Modalities and procedures for afforestation and reforestation project activities under the clean development mechanism in the first commitment period of the Kyoto Protocol."

Gainful involvement of local communities including forest dependent households and women is necessary not only for the successful implementation of the proposed reforestation activities but also for addressing non-permanence and reducing leakage. FD and the Co-management committees of Chunoti and Jaldi (as the sellers of carbon credits will be jointly implementing the proposed project activity) will jointly take the vital responsibility for providing effective community protection to the reforested areas in particular and the Sanctuary in general. A risk management plan will be prepared by the CMCs for the control of non-permanence (illicit felling, poaching, and forest land encroachment) and leakage (forest fires and grazing) occurences. The plan will be implemented by involving the existing FUGs and CPGs. Currently there are five CPGs (with 188 members) in Chunoti Range and five CPGs (with 187 members) in Jaldi Range. They in association with Forest Gaurds and Beat Officers will provide community protection jointly on rotation basis by following the community patrolling guidelines as developed under NSP. In addition, there are presently 38 FUGs (with 921 members, majority of them being female) in Chunoti Range and 28 FUGs (with 610 members, a majority of them are female groups) in Jaldi Range. Each patrolling group will be assigned specific reforested areas for their protection through rotational joint patrolling. Empowerment and active involvement of these groups will contribute to sustaining carbon credits and providing employment for their income generation. The members of CPGs will be provided livelihood opportunities by setting up a revolving fund.

A.4.6. Estimated amount of net anthropogenic GHG removals by sinks over the chosen crediting period

The mitigation scenario includes the proposed project interventions required for reforesting the core area through block plantations and enrichment plantations. The proposed reforestation activity would lead to changes in carbon stock during the project period. The carbon stock changes in mitigation scenario can be projected by using multiple methods that may be employed for estimating growing stock in Chunoti. For example, carbon sequestration rates can be

projected based on default values for growing stock - in forestry this can be achieved by using mean annual increment (MAI) values as published in forestry literature. Alternatively, growing stock can be estimated based on cross-sectional field studies. In this project document both the methods have been employed in estimating the growing stock and thence carbon sequestration rates.

Carbon stock and changes as estimated both in baseline (without project) and mitigation (with project) scenario for each of the proposed management options are summarized as below:

Total carbon stock changes (in ton) over a 42-year maturity period (2009-2050)

Sl. No.	Project Interventions	Proposed Area (in ha)	Carbon Stock under base-line scenario	Carbon Stock under mitigation scenario	Total Carbon Stock changes
1	Block Plantations	2000	56,360 (=28.18x2000)	366,400	310,040
2	Enrichment Plantations (degraded plantation areas)	1000	36,290 (=36.29x1000)	183,200	146,910
3	Enrichment Plantations (bamboo areas)	2000	64,900 (32.45x2000)	366,400	301,500
4	TOTAL	5000			758,450

A.4.7. Public funding of the proposed A/R CDM project activity

No public funding from parties included in Annex 1 is involved.

SECTION B. Duration of the project activity/crediting period

B.1. Starting date of the proposed A/R CDM project activity and of the crediting period

Ist January, 2009

B.2. Expected operational lifetime of the proposed A/R CDM project activity

31 December, 2050

B.3. Choice of crediting period and related information

B.3.1. Renewable crediting period, if selected

N/A

B.3.2. Fixed crediting period, if selected

N/A

SECTION C. Application of approved baseline and monitoring methodology

C.1. Assessment of eligibility of land

The proposed reforestation activity in Chunoti provides evidence that the land within the planned project boundary is eligible as a CDM project activity as per the definition of reforestation and eligibility of land under CDM. For the first commitment period, reforestation activity will be limited to reforestation being implemented on the land that did not contain forests before or on 31 December 1989. The eligibility of land for forestry projects under LULUCF depends mainly on its legal status, its forest cover prior to 1990 and also the present tree crown cover.

In order to examine the CDM suitability of forest land for reforestation in Chunoti, two imageries (Figure 3 and Figure 5) of Chunoti for the periods before and after the cut off date (1 January 1990) were obtained and interpreted by the Resource Information and Management Section (RIMS) of FD. The land-use maps prepared for discerning change patterns for the core zone are presented in Figure 4 and Figure 6.

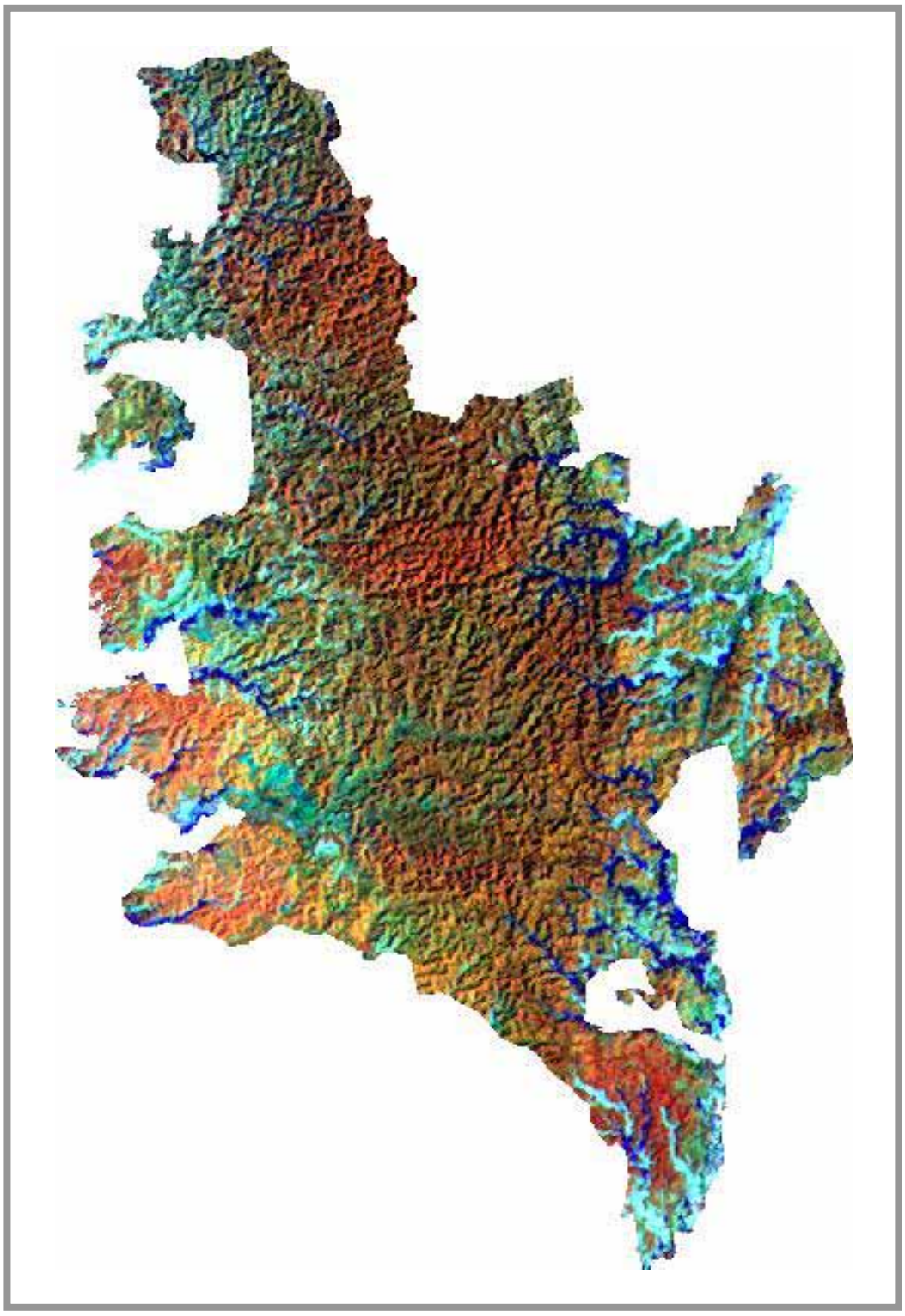

Figure 3 : Image 1989 of Chunoti Wild Life Sanctuary

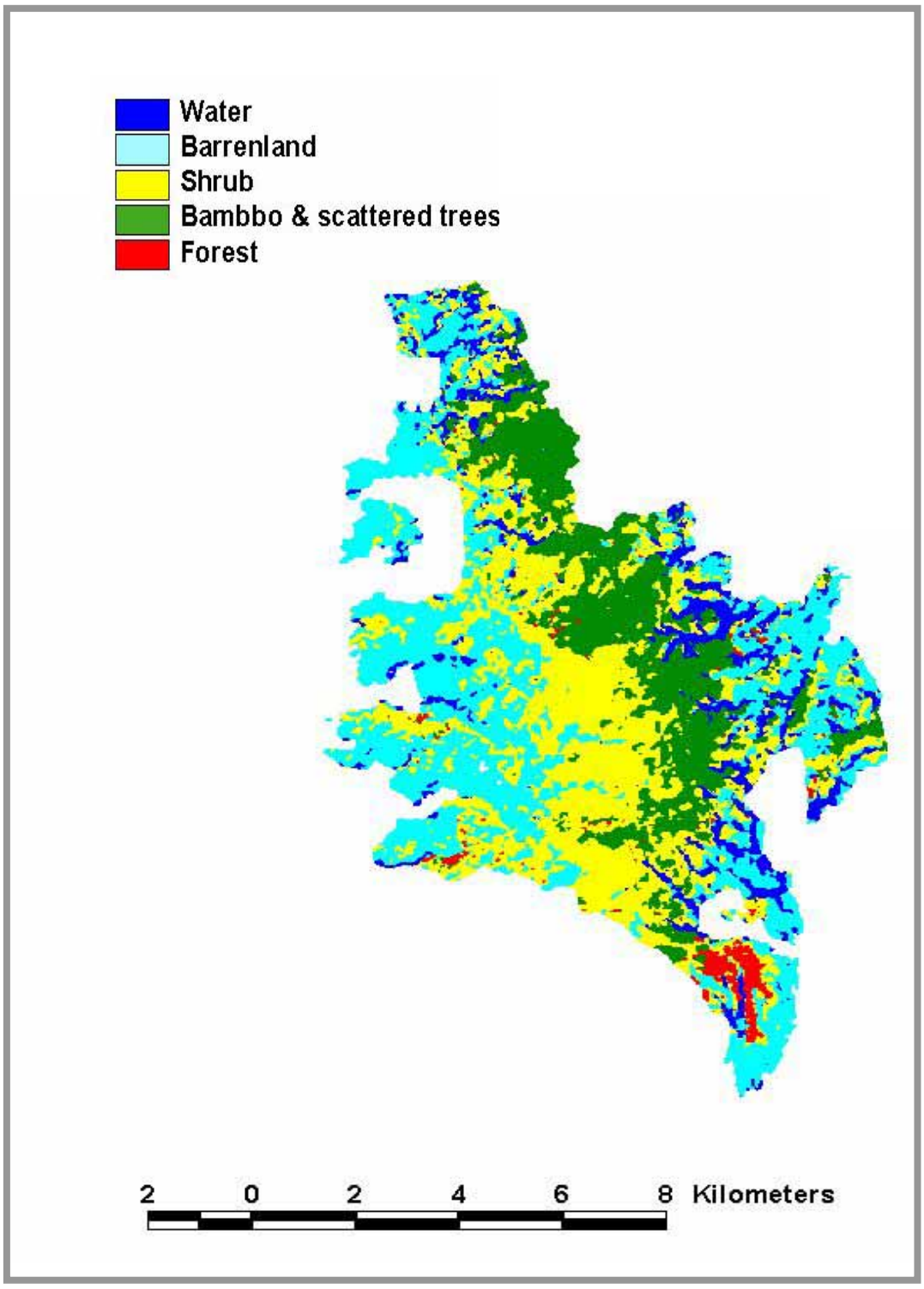

Figure 4 : Map of Chunoti Wild Life Sanctuary (1989)

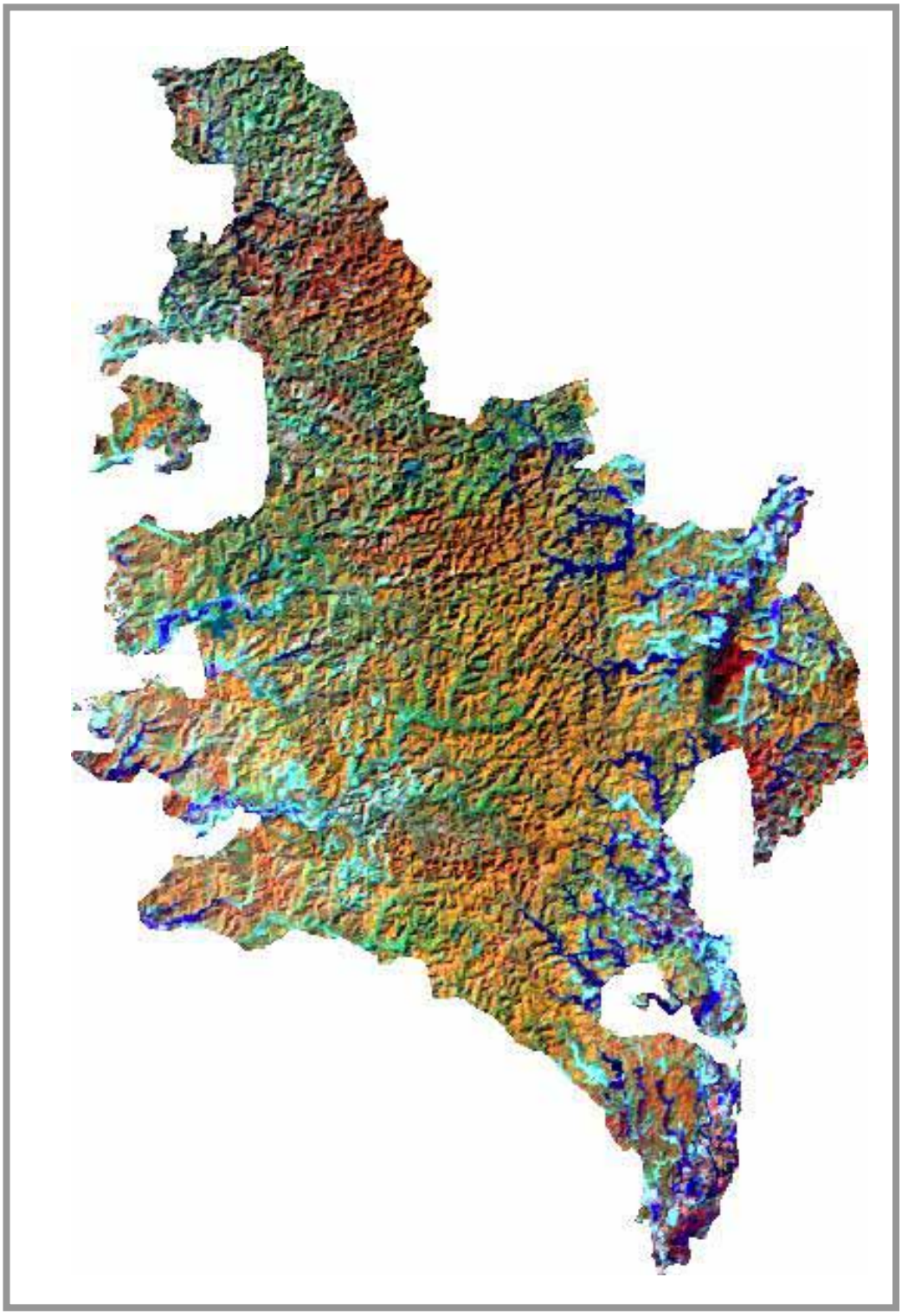

Figure 5 : Image 2006 of Chunoti Wild Life Sanctuary

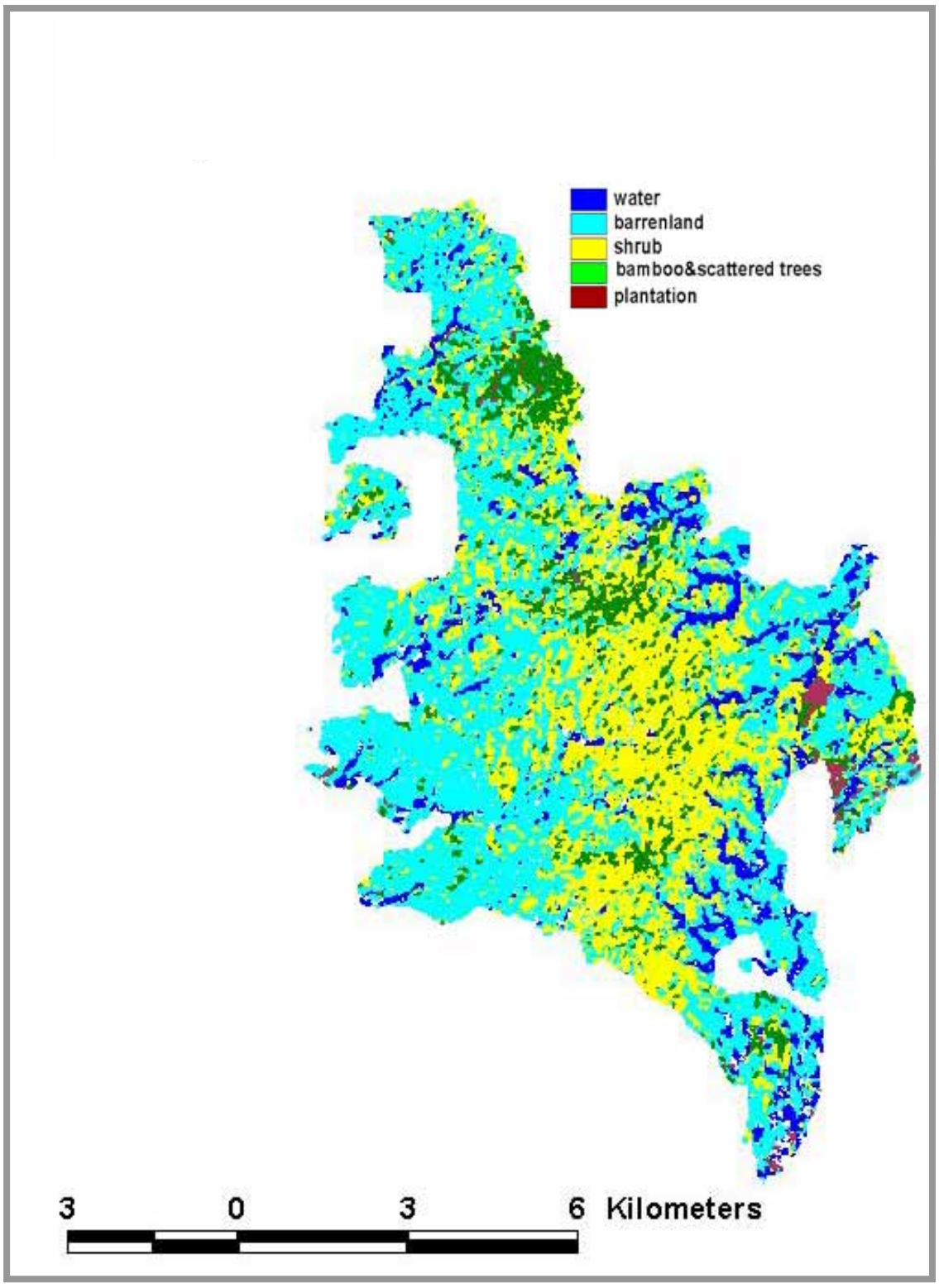

Figure 6 : Map of Chunoti Wild Life Sanctuary (2006)

The land-use information interpreted from the maps is presented in two tables as below:

Land-use classification based on 1989 Imagery

Land-use category	Area (Hectare)	%
Forests including Plantations	172.7656	2.06
Grass including Bamboo	1666.818	19.84
Grass-Shrub	2833.615	33.73
Barren land	2889.173	34.39
Water	839.5416	9.99
TOTAL	8401.914	100.00

Land-use classification based on 2006 Imagery

Land-use category	Area (Hectare)	%
Forests including Plantations	101.711	1.21
Grass including Bamboo	773.0871	9.20
Grass-Shrub	2562.534	30.50
Barren land	4138.305	49.25
Water	826.277	9.83
Total	8401.914	100.00

It is evident from the above-referred tables that even before January 1990 the forests were severely degraded, and grasses and barren lands dominated the Chunoti WLS. So the forest land is below the forest thresholds as per the forest definition under CDM. This means that the land, where the proposed reforestation activity is planned to be implemented, is eligible as an A/R CDM project. Without the planned project interventions the land will in short term not be able to revert back to forest cover.

The above-discussed temporal analysis of imagery complemented by ground truthing shows beyond doubt that the proposed project area was not covered as "forest" since 1989 till to date. Therefore, additional testimony produced by following a participatory appraisal methodology is not needed as the above-mentioned evidences are considered adequate.

C.2. Title and reference of the approved baseline and monitoring methodology, applied to the proposed A/R CDM project activity

AR-AM0001 version 2 of 19th May, 2006

The selected baseline and monitoring methodology is approved one and is an integral part of the PDD.

C.3. Assessment of the applicability of the selected approved methodology to the proposed A/R CDM project activity and justification of the choice of the methodology

The chosen methodology is applicable to the proposed A/R CDM project activity for the following main reasons:

- The proposed project activity does not lead to a shift of pre-project activities outside the project boundary. This means that the land under the proposed A/R CDM project activity can continue to provide at least the same amount of goods and services as in the absence of project activity. The proposed reforestation on the degraded forest land would indeed lead to an increase in goods and services.
- The proposed project activity will be implemented in degraded forest land where long rotation species that are native to the area will be planted.
- Forest land will be reforested through direct planting, augmented with aided natural regeneration.
- Site preparation does not cause significant longer term net emissions from soil carbon. Grazing is not a significant problem in the area.

Technical description of the proposed project including listing of existing land-use systems, land tenurial status, and potential mitigation options and their technical description are presented for different management categories. Possible carbon pools in Chunoti are identified and assessed. A participatory mechanism is suggested for monitoring the identified carbon pools during the implementation of the project interventions. A cost effective monitoring strategy is worked out by focusing on possible roles of the existing co-management organizations. Suitable methods for carbon inventory in baseline (without project situation) and mitigation (with project situation) scenario are reviewed and applied by following an inexpensive sampling strategy. The estimation of growing stock changes in volume, biomass and carbon contents is attempted both for the establishment of baseline and mitigation scenario for each of the identified mitigation options for reforestation. Possibilities for leakage and non-permanence are examined and suitable measures suggested in order to reduce ensuing risks.

C.4. Description of strata identified using the ex ante stratification

A broad stratification with few created strata will result in higher heterogeneity within each stratum and so requires an increase in field plots. On the other a detailed stratification may allow achieving better precision, but field plot intensity can seldom be reduced; the increased use of stratification may actually increase the need for field data. Stratification should, therefore, be optimized for cost effectiveness. Stratified random sampling was adopted in order to account for large variations in growing stock.

The core zone of Chunoti WLS and its interface landscape zone are identified on the maps. Depending upon the suitability of existing land-uses for different reforestation categories, the core zone is stratified into nine land-use categories. Within the core zone all the intersection points on the 2cm x 2cm grid (laid on 1 : 30,000 map of Chunoti) were counted as 218. As each intersection point on the map represents 36 ha (2 x 300m x 2 x 300m) on the ground, the total gazetted area of the Sanctuary is estimated as 7,848 (=218x36) ha.

The entire gazetted area was divided into 3 broad strata comprising a *garjan* forest patch, *sal* forest patch, and the remainder degraded forest land (that was further stratified into 7 land-use strata). The area plot (each representing 0.5cm x 4cm on the map and so 0.5x300m x 4cmx300m = 18ha on the ground) details as collected during forest carbon inventory were analyzed for each of the nine identified land-uses/strata with the following results:

1. Area of Plantations (Long Rotation)	648 ha (=36x18 ha)
2. Area of Plantations (Short Rotation)	576 ha (=32x18 ha)
3. Area under Bamboo	2754 ha (=153x18 ha)
4. Area under Grass	2988 ha (=166x18 ha)
5. Area under Agriculture	630 ha (=35x18 ha)
6. Area under Water-body	90 ha (=5x18 ha)
7. Area under settlement (village / *para*)	126 ha (=8x17 ha)
8. Area under Garjan Forest Patch at Bon Pukur	8 ha
9. Area under Sal Forest Patch at Aziznagar	2 ha
TOTAL	7,822 ha

Total enumeration was found necessary in the last two land-use categories as these two forest patches stiil have good forests with standing trees of Garjan and Sal. A complete tree enumeration was, therefore, done in *garjan* and *sal* patches whereas systematic random sampling was adopted in the remainder areas. A middle line passing through the Chunoti Range Office was taken as a reference point for field inventory works by employing two field parties of Forest Inventory Division of the Bangladesh Forest Research Institute. Every second grid line was traversed by field crews on which volume, biomass and area sample plots were located by using ranging rods, measuring tapes and compass. Based on the field level land-use area assessments it was concluded that block plantations of indigenous species (2500 seedlings/ha) can be taken over an area of 2000 ha whereas two models of enrichment plantations can be implemented over 1000 ha (with 1250 seedlings/ha) and 2000 ha (with 650 seedlings/ha).

C.5. Identification of baseline scenario

C.5.1. Description of the application of the procedure to identify the most plausible baseline scenario (separately for each stratum defined in C.4., if procedures differ among strata)

The procedure adopted for identification of the most plausible baseline scenario included stakeholders' consultations, review of maps and management plans, and intensive field visits to the core zone. Based on a review of the management plans, maps and other FD documents, due consultations were subsequently held with local stakeholders including members of CMCs, CPGs, FUGs, and FD field staff. The core area of the Sanctuary was visited intensively in order to cover all the 9 strata as described in Section C.4.

C.5.2. Description of the identified baseline scenario (separately for each stratum defined in Section C.4.)

Plantations of long rotation tree species such as *teak*, *garjan*, *sal* and *chapalish* have been raised mainly in sixties by removing natural forests of slow growing species. Plantations of short rotation tree species such as *acacia, eucalyptus* and *gamar* have been raised under different projects implemented since early 80s. Although bamboo and cane have been under-planted in some areas under the Bamboo, Cane and Murta Project of FD, most of the bamboo in core zone has come up naturally, particularly in degraded sites and near streams having moisture. Sun grass has invaded as pioneer species in areas where site degradation has been severe. Local people collect sun grass as thach material for their houses and so sometimes resort to fire to encourage fresh grasses.

A number of water bodies including streams and ponds exist inside the core zone. Some paddy fields have been developed by local people, particularly in the valleys having water bodies. A patch of mature garjan forest existing at Bon Pukur (near the main Chittagong-Cox's Bazr Hightway) was fully enumerated. Similarly another patch of forests with sal as main species exist near Aziznagar Beat Office and has been fully enumerated. Both of these patches represent old plantations of garjan and sal that were raised after cleafelling natural forests.

The most plausible scenario is that the project areas would retain status quo or degrading in the absence of any reforestation activity that inlcudes effective protection. In the absence of proposed activity the severely degraded forests of Chunoti are not expected to improve as there are no substantial reforestation activities that are scheduled to be implemented by FD in the coming years. Funds from the GOB for reforestation or wildlife management are not forthcoming. Only plantation targets that are earmarked annually for the coming two years under NSP are in the order of 200 ha - this will not have measurable impacts given the vast areas in need of reforestation in Chunoti. Except NSP, no other donor funded project is in operation in forestry sector.

C.6. Assessment of demonstration of additionality

The approach as recommended under CDM guidelines for demonstration of a proposed reforestation activity as additional and not the baseline scenario is followed. Main steps as outlined in the EB additionality tool are followed to demonstrate that the proposed A/R CDM project activity is additional and not the baseline scenario, taking into account the conditions under which AR-AM0001 is applicable. The chosen approach is:

- Step 0: Preliminary screening based on the starting date of the project activity;
- Step 1: Identification of alternatives to the A/R project activity (the possible baselines) consistent with current laws and regulations;
- Step 3: Barrier analysis – determine whether the proposed activity faces barriers that i) prevent the implementation of this type of proposed project activity, and ii) do not prevent the implementation of at least one of the alternatives; and
- Step 4: Impact of registration of the proposed afforestation or reforestation (A/R) project activity as an A/R CDM project activity.

Step 0: Preliminary screening based on the starting date of the project activity

This step is not applicable. The credit period will begin after registration. So the preliminary screening based on a specific starting date of the project activity is not applicable at this stage as an exact start of the crediting period has not yet been decided.

Step 1: Identification of alternatives to the A/R project activity (the possible baselines) consistent with current laws and regulations

Sub-step 1a: Define alternatives to the project activity

The project area is severely degraded forest land owned by FD. The proposed reforestation activity is an additionality to the existing forest scenario and is in compliance with all relevant legal and regulatory requirements. The only alternative option in the absence of proposed reforestation activity is not doing any plantations and hence the continuation of the existing degraded forest land. Although natural regeneration comes up in the project area, it does not get established in the absence effective community protection. Given the current financial health of the country in general and FD in particular it is not possible to take up significant plantations under normal GOB operations. Thus the continuation of the current situation represents the only baseline alternative.

Sub-step 1b: Enforcement of applicable laws and regulations

The alternative described as above is in compliance with all applicable legal and regulatory requirements. The Government of Bangladesh is signatory to almost all the international environmental conventions and so the relevant policies of FD are not expected to change during the course of implementation of the proposed reforestation activity. However, technological issues including the availability of quality seedlings of indigenous species will carefully be planned by the FD and CMCs, and adequate technical and organizational support will be made available under NSP.

Externally funded participatory forestry projects have been implemented in Bangladesh since 1981 when a community forestry project was taken up by FD. Sectoral forestry projects (e.g. Forestry Sector Project) were subsequently implemented with a major policy shift in favor of a participatory management of the country's forests and PAs. The country in this process witnessed a major policy shift (Forest Policy, 1994), towards a more participatory and less

regulatory approach to the management of forests. Local people and communities participated in developing, protecting and managing plantations and forests *in lieu* of usufructury rights granted as participatory benefit sharing agreements signed between user groups of local stakeholders and land owning agencies such as FD as per the amended Forest Act of 2000 and the Social Forestry Rules, 2004. Donor support for forestry sector has of late declined drastically and except NSP no other project is either under implementation or in pipeline.

Step 3: Barrier analysis: A barrier analysis is presented in the following Table:

Sl. No.	Barrier that would prevent the implementation of the type of proposed project activity from being carried out if the project activity was not registered as an A/R CDM activity	Sub-step 3a: How it prevents the implementation of this type of proposed project activity. How it would prevent potential project proponents from carrying out the proposed project activity if it was not expected to be registered as an A/R CDM project activity.	Sub-step 3b: How it does not prevent the implementation of the alternative.	Source of transparent and documented evidence
1	Investment barrier 1: Debt funding is not available for this type of project activity	Banks including agricultural banks have never in past extended loans to FD for long gestation reforestation projects, and this situation is not expected to change in near future.	The most likely alternative of leaving the forest land in degraded conditions costs nothing to FD.	FD documents and discussions
2	Investment barrier 2: No access to international capital markets due to real or perceived risks associated with domestic or foreign direct investment in the country where the project activity is to be implemented	It is not possible to raise funds in the international or domestic capital markets for long gestation investments in reforestation projects on degraded forest land managed	The present scenario of funds availability matches the baseline situation characterized by	FD documents and discussions

		by FD, a hierarchical institution known for its inflexibility and bureaucracy.	degraded forest land.	
3	Investment barrier 3: Lack of access to credit	Implementing long gestation reforestation projects by taking credits has not been done by FD and this is likely to continue in future.	Baseline scenario will continue in the absence formal credit. Informal credit for a large reforestation project is not available.	FD documents and discussions
4	Institutional barrier 1: Risk related to changes in government policies or laws	Carbon credits will have security with FD as forest land rights are secure with them. Moreover environmental benefits of reforestation projects are well appreciated by the Govt. of Bangladesh.	As forestry laws do not permit private ownership rights on govt. forest land, the baseline situation in terms of degraded forest land will continue.	Forest Acts and Forest Policy
5	Institutional barrier 2: Lack of enforcement of forest or land-use related legislation	A close involvement of CMCs would help FD in enforcing their rights on forest land.	Degraded status of forest land will not change due mainly to financial constraints	FD discussions
6	Technological barrier 1: Lack of access to planting material	Indigenous tree species as recommended for reforestation are comparatively slow growing and so would require at least one year old seedlings to be planted. FD will develop and maintain central nurseries	FD has historically maintained central nurseries but of late this practice has faced problems due to funds constraints. This means	Field inspections

		by using project funds.	degraded forest lands will not be planted with local tree species.	
	Technological barrier 2: Lack of infrastructure for implementation of the technology	Reforestation efforts at the recommended scale would require facilities for developing nurseries and establishing plantations and that is not possible in the absence of adequate funds.	Degraded forest land will continue as FD lacks adequate infrastructure, and private facilities are not allowed as per the existing rules and procedures.	Field visits
7	Barrier related to local tradition 1: Traditional knowledge or lack thereof laws and customs, market conditions, practices	As local stakeholders are involved in the design and planning of the project, relevant issues related to local traditions have been accounted for. Similarly local stakeholders shall be closely associated with the project activity implementation through CMCs, CPGs and FUGs.	Local stakeholders are largely resource poor and so will not be able to implement any alternative activity, thereby resulting in the status quo and hence continuance of baseline scenario.	Field discussions with local stakeholders
	Barrier related to local tradition 2: Traditional equipment and technology	Technology required for the proposed activity is understood locally both by the FD and stakeholders but cannot be implemented without adequate financial resources and equipments. Voluntary labor contribution from the local	As adequate resources are neither available with FD nor with CMCs the baseline scenario will continue.	Socio-economic survey

		stakeholders is not expected in view of rural poverty widespread in the project area.		
8	Barrier due to prevailing practice: The project activity is the first of its kind. No project activity of this type is currently operational in the host country or region.	Reforestation of degraded forest land has been taken up by FD in past but not as a CDM activity.	Baseline scenario is expected to continue.	FD discussions
9	Barrier due to local ecological conditions 1: Degraded soil (e.g. water/wind erosion, salination, etc.).	Ecological conditions prevailing in the project area favour reforestation.	Existing biotic pressure and lack of adequate resources would mean the continuation of baseline situation.	Field visits
	Barrier due to local ecological conditions 2: Catastrophic natural and/or human-induced events (e.g. land slides, fire, etc.).	Landslides do not exist and forest fires will be controlled by the two CMCs by associating CPGs.	The base line situation is not affected.	Field visits
	Barrier due to local ecological conditions 3: Unfavorable conditions such as drought.	Drought does not occur in the project area.	Drought does not occur in the project area.	Field visits and discussions
	Barrier due to local ecological conditions 5: Biotic pressure in terms of grazing, fodder collection, etc.	Except fuelwood collection other biotic pressures are minimal. CMCs will be responsible for ensuring protection to the reforested area.	Forest degradation will continue in the absence of proposed reforestation activity.	Field visits
10	Barrier due to social conditions 1: Demographic pressure on the land (e.g. increased demand on land due	Of the total 7,764 ha, only 5,000 ha is planned to be reforested. CMCs having local	Some forest land may come under encroachment in the	Field visits

	to population growth.	leaders will ensure that the demographic pressure on forest land is controlled.	absence of the proposed reforestation activity.	
	Barrier due to social conditions 2: Social conflict among interest groups in the region where the project takes place.	CMCs resolve local conflicts in their regular monthly meetings.	Baseline situation will continue.	Field visits and discussions with CMCs
	Barrier due to social conditions 4: Lack of skills locally	Adequate skills for reforestation are available locally.	In the absence of adequate financial resources, skills cannot be applied to improve the existing degraded forests.	Field discussions
	Barrier due to social conditions 5: Lack of organization of local communities	Local community organization are functioning under NSP.	In the absence of adequate financial resources, local community organizations are not able to improve the existing degraded forests.	Discussions with CMCs
11	Barriers relating to markets, transport and storage 3: Possibilities of large price risk due to the fluctuations in the prices of timber and non-timber products over the project period in the absence of efficient markets and insurance mechanisms	As no harvesting of either timber or fuelwood is planned, this barrier is not applicable.	No formal harvesting takes place as it is a wildlife sanctuary.	FD discussions

	Barriers relating to markets, transport and storage 4: Absence of facilities to convert, store and add value to production from CDM activities, limits the possibilities to capture rents from the land use under A/R CDM project activity.	As no harvesting of either timber or fuelwood is planned, this barrier is not applicable.	No formal harvesting takes place as it is a wildlife sanctuary.	Discussions with FD staff

Being a long gestation activity and the current orientation of Forest Department, reforestation in Bangladesh is neither covered under any debt funding nor it has access to international or domestic capital markets. As no harvesting of forest produce is envisaged, marketing barriers are not relevant. Under the circumstances the above-discussed barrier analysis for the reforestation activity favors its implementation through the proposed carbon offset funding.

Step 4: Impact of CDM registration

The approval and registration of the proposed reforestation activity as A/R CDM activity will help achieve all the objectives as described in Section A.2. In addition to sequestering carbon through greening the Sanctuary and thereby improving wildlife habitat, the activity also will help alleviate rural poverty, restore the forest landscape, empower the local communities and build capacity locally. Being the pioneer project in Bangladesh forestry sector, it will help open the door for similar projects in natural resources sector.

C.7. Estimation of the ex ante baseline net GHG removals by sinks

In the absence of any mitigation project activity (without project scenario), some carbon emissions would sink in the existing land-uses that include vegetation. Therefore, baseline assessments are necessary for forecasting change patterns for carbon stocks and land-uses that would occur in case no mitigation efforts are taken in the Sanctuary area. The carbon stocks in above-ground, below-ground and on-ground were estimated in core zone that was stratified in to 9 land-use strata. The baseline net GHG removals are estimated by sinks as below by employing the following formula:

$$\Delta C_{BSL, j} = \Sigma \Sigma \Delta C_{ij, baseline, t}$$

Where, i = strata (land-use category),
j = tree,
$\Delta C_{BSL, j}$ = the sum of changes in carbon stocks in the living biomass of trees for year t, and
$\Delta C_{ij, baseline, t}$ = average annual carbon stock changes in living biomass of trees for
stratum i, and trees j, in the absence of project activity (in t CO_2/year for year t)

The estimation of the *ex ante* baseline net GHG removals by sinks is done by implementing the following 4 main phases:

i) design phase,
ii) field data collection phase,
iii) analyses phase, and
iv) document development (report writing) phase.

The field work design began in mid 2007 by field testing suitable tools and methods required for developing a CDM project that is in line with emerging international procedures and financing mechanisms for facilitating carbon trading. The project targets forest lands in the core zone of Chunoti Wildlife Sanctuary

that have degraded (to less than 10% forest cover) prior to 1 January 1990 (the cut off date as defined under international agreements). The physical location and relevant boundaries for proposed biodiversity mitigation project are identified based on existing information and consultations with local stakeholders. The project boundaries consist of both temporal and geographic domain within which carbon stock changes and other attributes of the project are estimated and will in future be monitored. The geographical boundaries for proposed reforestation activities are delineated on the maps. The project boundaries encompass GHG emissions and removal of CO_2 that are attributable to the proposed project interventions.

A literature review focusing on the latest GHG issues concerning LULUCF sector was done to update understanding on the subject. The approved management plans and other related documents on Chunoti were referred to. As a part of the design phase, reconnaissance visits were made to the Sanctuary and its surrounding landscape by referring to the management plan maps and other official records. Stakeholders consultations were held with local people to understand land status, physical location and boundary of project activities. Possible management options including reforestation and enrichment technologies were discussed and finalized in consultation with FD and co-management organizations. The nature of carbon pools (e.g. soil organic carbon, above-ground biomass, below-ground biomass, and on-ground biomass) was assessed and monitoring parameters were discussed with FD and co-management organizations of Chunoti and Jaldi.

FIELD INVENTORY

Field data collection phase was very important for arriving at precise estimates of carbon pool and so adequate preparations were taken in the identification of a suitable inventory organization. In view of long experience, the Bangladesh Forest Research Institute (BFRI), Chittagong was selected for carrying out field works. Field formats for collecting field data were developed after field testing and validation. The field inventory was conducted in partnership with the BFRI, NSP and FD. A counter part officer (Assistant Conservator of Forest, from the RIMS of FD) was designated by FD, particularly for the coordination with the FD field staff. Two Divisional Officers (from Forest Inventory Division and Soil Sciences Division) were designated by the BFRI for carrying out forest inventory and soil inventory works. In-house project development capacity is targeted within FD and the members of two CMCs in order to ensure sustainability. On the job trainer's training was imparted to the ACF, who was tasked to coordinate with other FD staff and co-management organizations. Two crew teams of Forest Inventory Division of BFRI were formed and dispatched for field works after proper field training for forest inventory (laying out sample plots, and assessing height, basal area, girth, species, etc.). An additional team from the Soil Science Division of BFRI was designated and briefed on soil field surveys.

ANALYSES

Field inventory data was computerized in spreadsheets as a data base for future use. Growing stocks were estimated for each of nine identified land-use categories by using the field data and growing stock models as developed by the Forest Inventory Division of BFRI. Carbon sequestration rates were then estimated by following the methods as developed under CDM/IPCC procedures. Soil carbon analyses were done in the laboratory of the Soil Sciences Division of BFRI.

CARBON STOCK ASSESSMENT

The forest inventory data was analysed for estimating growing stock in terms of volume, biomass and carbon stock changes in baseline and mitigation scenario for different reforestation technologies. The use of volume equations for different tree species as developed by BFRI was examined for their application. Soil profiles were studied in the field. Soil samples were collected from the surface soil (0-30 cm) for estimation of soil organic matter and bulk density. The aggregated soil samples were brought for laboratory analyses to BFRI HQs at Chittagong for assessing soil organic carbon contents.

SOIL CARBON STOCK ASSESSMENT

Forest soils of Chunoti and Jaldi Forest Ranges occur with different soil associations under the Agro-Ecological Zone-29. Textural class is sandy loam to clay loam, and the reactions of all the soil profiles are moderately to strongly acidic. Soil colour in the field conditions is light yellowish brown to yellowish red and topsoil is mostly brown. Land capability classes of the sites are poor to moderate.

Justification

Biological factors contribute in the rapid breakdown of litter. Organic matter, a carbonaceous substance, is the remains of plants, animals and microorganisms, which are continuously assimilated / decomposed into the soil by other microorganisms. The decomposition of organic matter starts increasing from the onset of monsoon, reaches its peak during October-November and then continues declining up to April when it stabilizes. Organic matter acts as depository of plant nutrients and increases water holding capacity of soils, thereby enhancing water availability to plants. Over a period, organic matter is gradually lost from the soil as carbon dioxide, produced by microbial respiration. To compensate that loss the soil needs repeated addition of new plant and/or animal residues. Sequestered CO_2 in plant tissue eventually becomes part of soil organic matter. If biological sequestration does not take place then more CO_2 would accumulate in the environment, causing warming of climate.

Methodology

The grid map of Chunoti Wildlife Sanctuary was used in carrying out the soils survey in the core zone. Soils were checked for finding out variations across the grid lines and along the grid lines. Soil profiles (1m x 1m x 1.3m) were dug out in the core zone. Composite samples (5-10 core samples) were collected from the representative land-uses by accounting variation of organic matter in the upper, middle and lower hill slopes. Approximately 100 composite samples (core of 5-10 nos.) were collected (see Annexure-IV and Annexure-VI) from the soil depth of 0-30 cm. Considering morphological properties, texture and color, the samples were processed and analyzed for organic carbon determination and bulk density assessment.

Organic carbon was determined by wet oxidation method. The air-dried samples were used for carbon determination. Organic matter content was determined by multiplying organic carbon by the constant factor 1.724. Per hectare organic carbon/matter was estimated by employing the furrow slice soils quantity per hectare (i.e. 2.2×10^6 kg/ha). Bulk density (g/cm^3) was assessed from oven dried (OD) weight (at 105^{o}C over 24 hours) - O.D weight of the soil divided by the volume of the core sampler. Soil texture was determined by finger feelings and color by standard color chart.

Assessment

Bulk density relates to the combined volumes of the solids and pore spaces. Soils with a high proportion of pore space to solids have lower bulk densities than more compact soils having less pore space. So any factor that influences soil pore space will affect bulk density. Increase in bulk density usually indicates a poorer soil environment for root growth, and reduced aeration and infiltration. Fine textured surface soils such as silt loams clays, and clay loams generally have lower bulk densities than sandy soils. The solid particles of the fine textured soils land are organized in porous grains or granules, especially if adequate organic matter is present. This condition assures high total pore space and a low bulk density. In sandy soils, however, organic matter contents are generally low, the solid particles lie close together, and the bulk densities are commonly higher than in the finer textured soils.

The analytical results of soil texture and bulk density of the samples of Jaldi and Chunoti Forest Ranges under different land-use categories are presented in Table 7.1. The average bulk density was found in surface, sub-surface and sub-stratum as 1.39, 1.48 and 1.49 g/cm^3 respectively. In the topsoil many fine roots were found, which might have effect in lowering bulk density. The analysis showed that surface soils contain more organic matter and pore space than that of sub-surface and sub-stratum soils. The soils of same location showed different bulk density. Even in soils of same profile, significant differences in bulk density

were found. This means that bulk density varies from soil to soil, and also with soil depth (the bulk density is higher in lower strata of the profile).

Heavy rainfall in monsoon influences the eluviations of finer soil particles that might cause higher bulk density of lower strata of the soil profiles. Bulk density values for the crop combinations of paddy, paddy and other cereals, banana, and forests showed the values as 1.45, 1.52, 1.39 and 1.53 g/cm^3 respectively. The study areas have similar bulk densities as in case of the depleted shifting cultivation (locally known as *jhum*) fields of hilly areas. Very compact sub soils have bulk density of 2 or more, whereas a typical arable surface soil may have bulk density as 1.3 g/cm^3. The bulk density values estimated in this soil study indicate the stage in between the 2 and 1.3g/cm^3.

Soil texture and bulk density of the soil samples of different land-uses

Profile code	Soil depth (cm)	Particulars	Texture	B.D. (g/cm^3)
NNB-12	0-21 21-88 88-120+	East site of Napura Beat office, Banshkhali	Sandy Loam Loam Sandy Clay Loam	1.29 1.52 1.48
NPB-29	0-23 23-68 68-120+	Puichari Beat Office, Banshkhali	Sandy Loam Ditto Ditto	1.45 1.58 1.49
NJB-42	0-20 20-60 60-120+	Jaldi Beat Office, Banshkhali	Sandy Clay Loam Sandy Loam Ditto	1.40 1.46 1.43
N-27	0-7 7-15 15-60 60-110+	East site of Chunoti Range Office, Acacia plantation, mid slope of the hill	Sandy Loam Ditto Ditto Ditto	1.21 1.42 1.47 1.59
N-39	0-20 20-62 62-115+	South hill summit, 24 BB grid line, acacia, & amloki plantation	Sandy Loam Ditto Ditto	1.49 1.41 1.48

* NNB = Napura beat of Nishorgo Support Project, NPB = Pui Chhari beat of Nishorgo Support Project
NJB = Jaldi beat of Nishorgo Support Project, N = Nishorgo Project at Chunoti

Three soil profiles in Chunoti Range and four in Jaldi Range were excavated and analysed. Particulars of profiles environment and their carbon contents are presented in Table 7.2. The organic matter (OM) distribution pattern attributes in the profiles indicates the characteristics of typical profiles. The OM content

declines with the increase of soil depths. The average OM content in the surface soil of Chunoti (1.5%) is higher than in Jaldi (1.3%). This proves that more depletion of OM has occurred in Jaldi Range due mainly to over exploitation of above-ground vegetation.

Organic carbon and organic matter assessment for the soil profiles of Chunoti and Jaldi.

Profile Code	Soil depth (cm)	Profile Environment	O.C. (%)	O.C. (t/ha)
N-2	0-13 13-32 32-67 68+	Chunoti, Line- Z-24, CRO's western site, 0-30 cm, N 21º55'48'4" L and 92º03'41'4"E latitude, line no-Z-24, Forest Inventory Division plot (FID) no-1, Acacia auriculiformis plantation (10%), shrub-80%, herb-10% and litter coverage-98%.	0.89 0.63 0.44 0.40	19.52 13.91 9.70 8.81
Average				
NNB-5	0-18 18-43 43-90 90-125+	Gridline Q-23, location: ghaittar jhum, upper part of slope, slope 45-60%, encroacher's plantation: gamar in lower middle slope, vegetative coverage – 100%; bamboo and reeds dominating.	1.01 0.67 0.25 0.06	22.20 14.80 5.49 1.28
Average				
NNB-12	0-21 21-88 88-120+	K-23, east side of Napura Beat Office, eucalyptus coppice plantation, 8-10 m height, under growth kali bamboo batna, mangium, etc. Core samples BD were collected	0.78 0.21 0.10	17.10 4.59 2.17
Average				
NPB-29	0-23 23-68 68-120+	Hill top, 5 ha. Nishorga Buffer zone plantation – 2005-6, species: acacia, amloki, champa, eucalyptus coppice, Pui Chhari Beat (east side), undergrowth as grid line-2	0.40 0.29 0.25	8.81 6.38 5.49
Average				
NJB-42	0-20 20-60 60-120+	Gridline: M-37-38, New plantation site 15 ha (41), foot hill, paddy field to the south of the profile, a betel leaf field in near by, now the side is naked, weeds coverage, mottles found in sub-stratum.	0.82 0.63 0.32	17.99 13.02 7.02
Average				

N-27	0-7 7-15 15-60 60-110+	Chunoti, acacia plantation, 6-8 years, ht. 50-60 ft., girth: 15-25 inch, middle slope, slope: 40-45%, Location – Kripa ghona, 1200 m east from CRO*; Weeds ht. and %: 6 inch (20%), 1 ft. (20%), 3-4 ft. (40%) and reeds 4-6 ft. (20%).	1.05 0.86 0.44 0.44	23.10 18.89 9.70 9.70
Average				
N-39	0-20 20-62 62-115+	Chunoti, location: 24BB, mixed plantation of acacia (20%), and amloki (10%), average ht. of both species: 8-12ft., upper slope, evidence of erosion in to soil, thorny bush and reeds 50%, unknown weeds 20%, Kuruch seedlings abundance.	0.66 0.53 0.22	14.42 11.61 4.85
Average				

*Chunoti Range Office

Organic carbon contents of composite samples are presented in Table 7.3 for Chunoti Range. A total of 43 soil samples were analyzed for organic carbon assessment. Samples covered depths of 0-15 cm, 0-30 cm and 15-30 cm. Particulars of the sampling spots are presented in Appendix-VI. Average, maximum and minimum organic carbon in the surface of Chunoti were found as 0.82%, 1.05% and 0.29% respectively, and 0.65%, 0.86% and 0.48% in the sub soil. Estimated quantity of organic carbon stands about 18 ton/ha for surface soil, which gradually declines in the lower strata.

Analytical result of soil organic carbon and organic matter of the composite samples of Chunoti Range

Sl No	Code No.	Soil depth (cm)	O.C. (%)	O.M t/ha)	Sl No.	Code No.	Soil depth (cm)	O.C. (%)	O.M (t/ha)
1	N-1	0-30	0.67	14.80	23	N-23	0-15	0.74	16.33
2	N-2	0-30	0.86	18.89	24	N-24	15-30	0.78	17.10
3	N-3	0-30	0.63	13.91	25	N-25	0-15	1.05	23.10
4	N-4	0-30	0.70	15.44	26	N-26	15-30	0.86	18.89
5	N-5	0-30	0.78	17.10	27	N-27	0-7	1.05	23.10
6	N-6	0-30	0.93	20.42	28	N-28	7-15	0.86	18.89
7	N-7	0-30	0.70	15.44	29	N-29	15-60	0.44	9.70
8	N-8	0-30	0.55	12.12	30	N-30	60-110+	0.44	9.70
9	N-9	0-30	0.70	15.44	31	N-31	0-15	0.89	19.52
10	N-10	0-30	0.63	13.91	32	N-32	15-30	0.48	4.79
11	N-11	0-30	0.67	14.80	33	N-33	0-15	0.82	17.99
12	N-12	0-30	0.59	13.02	34	N-34	0-15	0.78	17.10
13	N-13	0-30	0.93	20.42	35	N-35	15-30	0.48	10.59
14	N-14	0-30	0.63	13.91	36	N-36	0-15	0.97	21.31
15	N-15	0-30	0.70	15.44	37	N-27	0-15	0.29	6.38
16	N-16	0-30	0.51	11.23	38	N-38	0-15	0.97	21.31
17	N-17	0-30	0.63	13.91	39	N-39	0-20	0.36	7.91
18	N-18	0-30	1.01	22.20	40	N-40	20-62	0.13	2.81
19	N-19	0-30	0.82	17.99	41	N-41	62-115+	0.02	0.38
20	N-20	0-30	1.05	23.10	42	N-42	0-15	0.89	19.52
21	N-21	0-15	0.86	18.89	43	N-43	0-15	0.74	16.33
22	N-22	15-30	0.67	14.80					

Organic carbon contents of composite samples are presented in Table 7.4 for Jaldi Range. A total of 44 soil samples were collected by covering variable soil depths. The specifications of sampling areas are shown in Appendix-V. Average, maximum and minimum organic carbon in the surface were found as 0.75%, 1.16% and 0.48% respectively whereas

these values were 0.69%, 1.08% and 0.32% in the sub soil. Estimated quantity of organic carbon stands about 16.5 ton/ha for surface soil, which gradually declines in the lower strata.

Analytical result of soil organic carbon and organic matter of the composite samples of Jaldi Range

Sl No.	Code No.	Soil depth (cm)	O.C. (%)	O.C. (t/ha)	Sl No.	Code No.	Soil depth (cm)	O.C. (%)	O.C. (t/ha)
1	NNB-1	0-15	0.89	19.47	23	NPB-23	0-15	0.70	15.44
2	NNB-2	15-30	0.70	15.44	24	NPB-24	15-30	0.59	13.02
3	NNB-3	0-15	0.74	16.33	25	NPB-25	0-15	0.93	20.42
4	NNB-4	15-30	0.86	18.89	26	NPB-26	15-30	1.08	23.74
5	NNB-5	0-18	1.01	22.20	27	NPB-27	0-15	0.89	19.52
6	NNB-6	18-43	0.67	14.69	28	NPB-28	15-30	0.82	17.99
7	NNB-7	43-90	0.25	5.49	29	NPB-29	0-23	0.40	8.81
8	NNB-8	90-125+	0.06	1.28	30	NPB-30	23-68	0.29	6.38
9	NNB-9	0-30	1.05	23.10	31	NPB-31	68-120+	0.25	5.49
10	NNB-10	0-30	0.48	10.59	32	NJB-32	0-15	0.48	10.59
11	NNB-11	0-30	0.63	13.91	33	NJB-33	15-30	0.32	7.02
12	NNB-12	0-21	0.78	17.10	34	NJB-34	0-15	1.16	25.52
13	NNB-13	21-88	0.21	4.59	35	NJB-35	15-30	0.93	20.42
14	NNB-14	88-120+	0.10	2.17	36	NJB-36	0-15	0.82	17.99
15	NPB-15	0-15	0.40	8.81	37	NJB-37	15-30	0.78	17.10
16	NPB-16	15-30	0.44	9.70	38	NJB-38	0-15	0.78	17.10
17	NPB-17	0-15	0.48	10.59	39	NJB-39	15-30	0.59	13.02
18	NPB-18	15-30	0.44	9.70	40	NJB-40	0-15	0.97	21.31
19	NPB-19	0-15	0.55	12.12	41	NJB-41	15-30	0.82	17.99
20	NPB-20	15-30	0.59	12.99	42	NJB-42	0-20	0.82	17.99
21	NPB-21	0-15	0.74	16.35	43	NJB-43	20-60	0.63	13.91
22	NPB-22	15-30	0.63	13.91	44	NJB-44	60-120+	0.32	7.02

Specification of soil samples collected from Chunoti Forest Range

Code	Specification
N-1	Line- Z-24, Soils of Chunoti, soil depth 0-30 cm, spot near the western site of Chunoti Range Office (CRO), nearly level land, tree coverage 40%, shrub 50% and herb 10% and litter coverage 100%.
N-2	Line- Z-24, CRO's western site, 0-30 cm, N 21º55'-48'4" L and 92º03'-41'4"E latitude, line no-Z-24, Forest Inventory Division plot (FID) no-1, Acacia auricoliformis plantation (10%), shrub-80%, herb-10% and litter coverage-98%.
N-3	Teak copies, new plantation of teak in foothill, height of teak 4-5 m, undergrowth and sun grass dominating, spot located south of Dairy Farm of Mustafa Group, north of E to W footpath, gridline same as N-2.
N-4	Bamboo plot, mid slope (20-25%), dense bamboo bush, west site of the Range Office, south side of chapalish plantation, soil depth 0-30 cm.
N-5	Top of the spot no N-4, north side of the footpath, bamboo plot, height 8-12 ', natural kali bamboo, clump distance 5-10, soil depth 0-30 cm.
N-6	A. auricoliformis and A. mangium plantation of six month old, dense grass coverage (100%), north side of the Dairy Farm of Mustafa Group, seedlings height 3-5', line no of FID-25, FID plot no-2, 35-40% slope located at west hill to brick field.
N-7	Paddy field, south of acacia plantation, location: Baraghona, Shurmara, soil depth 0-30 cm.
N-8	A. auricoliformis dominating mahogany, eucalyptus plantation of Goni Miah, 1990 belongs to Amir Ahmed Khan, average height 25-26 m, undergrowth-nil, slope 15-20%, heavy litter fall, soil depth 0-30 cm.
N-9	Gridline Z-23; Natural bamboo covered zone, height 8-10', hill top, slope 45-50%, litter fall few, east of a large garjan tree and west side of Ctg. to Cox's Bazar highway, location Kolabagan, few 8 years old garjan tree.
N-10	Aziz Nagar Beat, Chunoti Avayarannaya Range 2003-04, area 20 ha, mixed plantation of acacia, mahogany, champa, dhakijam, block-Goyalmara, west side of highway, average ht of acacia is 20-25', soil depth 0-30 cm.
N-11	Hill top, sample no-10, almost flat top, poor survival of garjan (height 10) plantation, nearly naked hill, soil depth 0-30 cm.
N-12	Private Plantation (PT) of Barkatullah; minjiri, chatin, acacia, jack fruit, plantation of 1990, undergrowth few, litter fall medium, slope 10%; PT is opposite to 1998-99 plantation of wildlife, species: amloki, horitaki, bohera, jam, etc, by near Harbang Beat Office, depth 0-30 cm
N-13	Trees above avg. ht-50', gorjan trees of about 20-25 yrs old, dense under growth (shrub and herb)

Code	Specification
N-14	Buffer zone, plantation: 2002-03, 90 ha, share holder nos: 90, 7 team, species: A. hybrid, sal, garjan, chapalish, telsore under Harbang Beat, Slope-10%, ht. of acacia: 45-50', spacing : 6'x6', under plantation: pineapple, soil depth. 0-30 cm.
N-15	Top of the same hill, location: Alipur, Harbang, Eastside of the highway and south side of Harbang Beat, mixed plantation, heavy litter fall.
N-16	Gridline Z-27, acacia plantation of 2005-06, mixed with garjan, avg. ht of acacia: 4' and garjan-5', dhakijam copice, old garjan plantation in the hilltop. Medicinal plantation: 2004-05, west side of highway, movement route of elephant herd, Bonapukur, Hafjakhana, Chunoti Beat.
N-17	Top of the same hill (16), medicinal plantation: arjun, bohera, amloki, 35% slope, sungrass dominating, top flat, litter medium, soil depth: 0-30 cm.
N-18	Gridline AA-24.plantation (1997) of champa, acacia, undergrowth bamboo bush, and shrub and herb, location: east side of Chunoti range office, Avg. ht. of champa 25', slope-35%, bamboo bush dense;Avg. ht – 6'
N-19	Top of the same hill, mainly acacia, ht : 50', bamboo bush and baidal, litter dense.
N-20	Gridline AA-24 and Z-24, near and south to Chunoti Range office, West of the highway, Acacia of 1991, dense litter, plain land was grass covered, depth: 0-30 cm.
N-21	BB-25, GPS-92º03'54" East, 21º55'54" N, acacia plantation, lower slope, 1200 m east of Ctg to Cox's Bazar Road, 30% slope, medium undergrowth, location: Krepaghona, soil depth: 0-15 cm
N-22	As above, soil depth: 15-30
N-23	As above, soil depth 0-15 cm, middle slope.
N-24	As above, soil depth 15-30 cm
N-25	Top of the same hill, 0-15 cm, undergrowth – bamboo bush, baidal, monakata, mahuna, etc, ht of acacia – 50'
N-26	As above, soil depth 15-30
N-27	Profile 6, acacia plantation, participatory Forestry plot, middle slope, weeds coverage, dominant height trees have been pilferaged, evidence available. Encroachment occurring, kheda (2) for elephant protection on 30-40 ht. Trees to save rice field.
N-28	As above, soil depth 7-15 cm
N-29	As above, soil depth 15-60 cm
N-30	As above, soil depth 60-110+
	10, 11, 12, 13 - core sample for bulk density determination.
N-31	Gridline 24C, 92º03'54" E, 21º55'49"N, soil depth: 0-15 cm, paddy

Code	Specification
	field, west side of canal, elephant foot print noted.
N-32	As above, soil depth: 15-30 cm
N-33	24(A), subplot, 92º3'54"E, 21º55'39"N, acacia plantation 2004-05,foot hill
N-34	Gridline BB-24, south side of the ghona, height of acacia –7.5 m, dia – 20 cm-23.3 cm. Batna has also been found. Bamboo bush: ht - 10'
N-35	As above, 15-30 cm.
N-36	BB-23, Tribula, Chunoti, acacia plantation of collaborating farmer, south side of ghona, lower slope of hill, avg. ht: 35', soil depth: 0-15 cm
N-37	0-15 cm, middle part of the same hill
N-38	0-15 cm, top of the hill, mixed plantation of acacia, amloki, under growth mainly sun grass, poor growth, avg. ht. of acacia : 10'
N-39	Profile, location: 24BB, mixed plantation of acacia (8-12ft), and amloki, age 3-4 years, natural growing reeds, vegetative coverage 100%, hill (150-160 ft.) top, 40-45% slope, iron manganese concretions found on eroded spot. On 17/04/07 elephant herd appeared there, footprints of them assumed about 1-1.5 ft. in the harvested paddy field.
N-40	Ditto, Soil depth: 20-62 cm
N-41	Ditto, soil depth: 62-115 cm
N-42	Gridline AA-22, acacia plantation, 2003-04, Forest sector projector, Buffest zone, short rotation plantation: 60 ha. Participant: 60 CF, 4 team. Species: acacia hybrid, sal, gorjan, chapalish, neem, amloki, horitoki, bohera, gamar, arjun, kadam, jarul, jalpai, chichkrashi, spacing – 2m x 2m: under Satghar beat, Chunoti range, undergrowth asam lata, ht of acacia: 40-45'. Soil depth: 0-15 cm.
N-43	Gridline AA-21-22, forestry sector project satgar beat, Chunoti, dense forest, undergrowth, asam lata, east site of Ctg to Cox's Bazar Road, soil depth 0-15 cm, Buffer zone, short rotation plantation, area: 80 ha, participant 80 men, team – 6, species: A. hybrid, sal, garjan, chapalish, telsur, segun, bokain, bohera, horitoki, amloki, gamar, arjun, kadam, jarul, spacing: 2 m x 2 m.

Specification of soil samples collected from Jaldi Forest Range

Sample No**	Specification
NNB-1	Gridline Q-23, 21º55'36"N-S: Hill top, bamboo bush, slope - 45%, bamboo height - 2-2.5 m.
NNB-2	Ditto, 15-30 cm
NNB-3	Ditto, 0-15 cm, Mid slope, bamboo bush, no tree species.
NNB-4	Ditto, 15-30 cm
NNB-5	Gridline Q-23, profile-2: soil depth: 0-18 cm, (6) 18-43 cm, (7) 43-90 cm, (8) 90-125+cm, Gridline Q-23, location

Sample No**	Specification
	ghaittar jhum, upper part of slope, slope 45-60%, encroacher's plantation: gamar in lower and middle slope, vegetative coverage – 100; bamboo and reeds dominating.
NNB-9	0-30 cm, dense grass cover, under growth kurup tree, location to of the west hill
NNB-10	0-30 cm, foot hill, North side of the chhara, plot of Abdur Rahim (Sher Ali)
NNB-11	0-30 cm, beside the foot path, north side of beat office
NNB-12	Gridline K 23-24, 21º55'25" N and 91º58'20" E, profile: 3 East side of the Napura Beat Office, eucalyptus coppice plantation 8-10 m height, under growth kali bamboo, batna, mangium, etc.NNB-12: 0-21 cm, (13) 22-88 cm (14) 89-120+ cm;
NNB-15	Gridline L-19, 0-15 cm, old natural garjan plantation, lower slope, dense under growth, south side of the beat office, slope-30%, mottling on the surface soil noted, plantation-10 ha, fruit and fodder plantation: 2002-3. Puichhari Beat (PB)
NPB-16	Ditto, 0-15 cm
NPB-17	Ditto, 0-15 cm, hill top, under growth same as (15) but slope 10%, encroachment near office tila (hill)
NPB-18	0-30 cm, Ditto
NPB-19	Gridline M-17, 0-15 cm, top of the mini sal plantation, natural under growth, pacca lata, bamboo, acacia, eucalyptus, etc. Area of social forestry plantation-2003, slope-25%, Jhum para.
NPB-20	As above, 15-30 cm
NPB-21	0-15 cm, as above dense under growth, few sal coppice
NPB-22	As above, 15-30 cm
NPB-23	Nacked hill, mid slope, a proposed plantation site of 2007, area-15 ha. at Pui chhari, weeds: batna, paccalata, ghuicha, monakata, batali etc. 0-15 cm
NPB-24	As above, 15-30 cm
NPB-25	0-15 cm, East pui chhari, 20 ha ecopark plantation 2005-5, A. hybrid, Amloki, horitoki, jalpai, etc. Mid slope 25-30%, acacia avg. ht.1.5-2 m, under growth medium: batna, bamboo bush, mottling found, arhar has been planted.
NPB-26	As above, 15-30 cm
NPB-27	0-15, as above, hill top. Slope: 30%, conoretions visible.
NPB-28	15-30 cm. As above
NPB-29	Gridline O-19, profile-4, hill top, 5 ha. Nishorga Buffer zone plantation – 2005-6, species, acacia, amloki, champa, eucalyptus coppice, Pui chhari Beat (east side),

Sample No**	Specification
	undergrowth as grid line-2
NJB-32	Gridline J-36, village para, eucalyptus plantation of a Professor plantation 2002-3, Avg. ht: 30-35' poor under growth – grass, laggabati, an acacia plantation near by plain land, soil depth: 0-15 cm
NJB-33	15-30 cm, as above
NJB-34	Acacia plantation of Jaldi Beat: 2002, Lower part of hill, under growth poor, slope 25-30%, tree ht: 30-35 ft. Location: villager para, concretions noted, 0-15 cm
NJB-35	As above, 15-30 cm
NJB-36	Mid of the same hill, 0-15 cm, under growth very, few, grass covered area, medium litter fall, tree growth as (34), slope-30%
NJB-37	As above 15-30 cm
NJB-38	Top of the same hill, species; titi gam, amloki, guava, acacia hybrid, dense undergrowth, tree growth poorer than mid slope, concretions noted
NJB-39	As above, 15-30 cm
NJB-40	0-15 cm, Saika jhiri, nacked hill, Jaldi Beat Office, south site, north side of a pond, top of the hill, slope. 40-45%,, dense weeds and creeper coverage, sai lata dominating, proposed side of Nishorga: 15 ha.
NJB-41	As above, 15-30 cm
NJB-42	Gridline M 37-38, profile-5, New plantation site: 15 ha foot hill, paddy field to the south of the profile, a betel leaf field in near by, now the side is naked, weeds coverage, mottles found in sub.-stratum.

**NNB= Nishorga Project area of Napura beat, NPB=Nishorga project area of Puichhari beat, NJB=Nishorga project of Jaldi beat.

FOREST CARBON STOCK ASSESSMENT

The following biomass inventory works were taken up by the technical staff of the NSP, FD and Forest Inventory Division of the BFRI.

Preparatory Works

The Management Plan for Chunoti Wildlife Sanctuary was used for the study of land-use details in the core zone. The GIS data base developed under NSP was used in generating base maps (at a scale 1 : 30,000) required for carrying out field works. In view of large variations in growing stock in the core zone a stratified random sampling was found suitable. The entire gazetted area was, therefore, divided into 3 broad strata, comprising a *garjan* forest patch at Bonpukur, a *sal* forest patch at Aziznagar and the remainder degraded areas

categorized into 7 land-use strata : Plantations (long rotation), Plantations (short rotation), Bamboo, Grass, Agriculture, Water-body, Settlement, *Garjan* Forests, and *Sal* Forests. A complete tree enumeration was done in both the forest patches whereas the remainder area was inventoried based on systematic random sampling as described below.

The volume plots were to be located without bias in order to maintain statistical rigour. If plots follow a road or trail, then all locations in the project site will not have an equal chance of selection and a systematic bias will get introduced. So the location of sampled plots was done by using a fixed grid that covered the entire core zone. The maps were, therefore, developed with grid lines at a spacing of 2 cm x 2cm (representing 600m x 600m on ground). The grid lines were numbered in order to provide a unique number to each of the volume and biomass plots where measurements were to be recorded. The maps, in addition to land-use, show the details of the Sanctuary administration and management units, and some other relevant socio-economic details. Each crew carried a copy of the grid map for field use and so two copies were used for field works.

A middle line passing through the Chunoti Range Office (in East-West direction) was taken a reference line for starting the field inventory works by two field parties (one responsible for north direction and another for south direction). A reference line (in N-S direction) and a reference point were identified near Chunoti Range Office by using the map details and field measurements. Every second line was traversed by field crews on which all the sample plots were located by using ranging roads, measuring tapes and compass. This means that the sample plots were located in the field, based on the grid lines drawn on the maps at 2m x 4m (representing 600m x 1200m on ground). The resulting intersection of grid lines were the locations of volume plots (each of area 0.01 ha with 5.64 m radius circle) and biomass plots (each of area 1 m^2 with 0.564 m radius circle). Thus two circular plots were laid as concentric plots based on systematic random sampling. Because all carbon measurements are to be reported on a horizontal-projection basis, plots on sloping land were laid by using a correction factor. This correction factor accounts for the fact that when distances measured along a slope are projected to the horizontal plane, they are smaller.

Field Formats

Three formats were developed and validated after a field visit to Chunoti Wildlife Sanctuary. Discussions were held with members of CMCs, and the field staff of both FD and NSP. The draft formats were finally discussed with the senior officials of the BFRI and FD. The following field formats were finalized after incorporating all the relevant comments made by the technical staff.

A. VOLUME, BIOMASS AND SOIL DETAILS

I (i). Volume Plot Details (5.64 m radius plot of area 0.01 ha)

Range		Beat		Zone/Sub-Zone	
Land-Use Class		Species		Line #	
Forest Fire Occurrence		Dominant Height		Plot #	
Terrain		Slop		RF Block	
% of Plot		Aspect		Union Council	
Way point		Latitude		Longitude	

II. Ground Vegetation (plants/regeneration, bamboo/grass, leaf litter, dead wood, etc.) (0.564 m radius plot of area 1 m^2)

Sample No. (same as plot No.)		Remarks
Green weight		
Air dry weight		
Oven dry weight		

III. Forest Soil Profile Details

Sample No.		Remarks
Soil type		
Soil profile (in cm.)		

B. LAND-USE AREA DETAILS

Possible Land-Use Types:

1. Grass/Bush
2. Bamboo
3. Plantations
4. Forest
5. Agriculture (paddy, betel leaves, etc.)
6. Water body (*chara*, *pukur*, lake, etc.)
7. Settlement/Village
8. Brick Kilns
9. Others (specify)

a. Area Plot Details (17.84 m radius plot)

Range		**Beat**		**Zone/ Sub-Zone**	
Land-Use Class		Species		Line #	
Forest Fire Occurrence		Dominant Height		Plot #	
% of Plot		Union Council		RF Block	

b. Area Plot Details (17.84 m radius plot)

Range		**Beat**		**Zone/ Sub-Zone**	
Land-Use Class		Species		Line #	
Forest Fire Occurrence		Dominant Height		Plot #	
% of Plot		Union Council		RF Block	

c. Area Plot Details (17.84 m radius plot)

Range		**Beat**		**Zone/Sub-Zone**	
Land-Use Class		Species		Line #	
Forest Fire Occurrence		Dominant Height		Plot #	
% of Plot		Union Council		RF Block	

C. TREE VOLUME DETAILS

I (ii). Volume Plot (Individual Trees) Details (5.64 m radius plot)

Number	Tree Species	GBH (cm)	Total height (m)	Remark

Distance and direction to the nearest tree from the plot centre ………………..…

Date …………………   Signature ……………..

Field enumerators recorded the data in the above-presented formats about volume (in a 0.01 ha circular plot of radius 5.64m), biomass (in a 1 m^2 circular plot of radius 0.564m) and area (in a 0.1 ha circular plot of radius 17.84m).

Field Instruments

The equipment used for field work should be accurate and durable in order to withstand the rigors of use under adverse forest field conditions. Each crew carried the following field instruments/equipments, the use of each one was demonstrated during the crew training:

- Germin GPS (Global Positioning System)
- Compass
- Maps with Grids
- Weighing Scales
- Haga Altimeter/Clinometer
- Distance Measuring Tape
- Diameter/Girth Measuring Tape
- *Dau* for vegetation harvest
- Spade (*Kudal* /*Belcha*)
- Iron Rings
- Soil Augar
- Ropes
- Ranging Roads
- Jute Bags, and
- Soil Sampling Probes

For collecting soil samples and vegetation samples, cloth/jute bags were used; paper bags may be ripped and plastic bags do not allow the samples to dry.

Forest Inventory

Two field inventory groups (each comprising a crew leader, two enumerators, one Field Organizer, two labor and two Forest Gaurds) were employed simultaneously under the overall supervision of a senior technical staff (the Division Head of Forest Inventory Division of the FRI). A one-day training program was implemented for the crew members before proceeding for taking up field measurements. The design of formats, the collection of data and the use of equipments were explained in detail during the field demonstrations. The transect lines and the centres of concentric plots were laid out in the field by using compass, ranging rods and distance measuring tapes (50m). Horizontal distances were measured and so in undulating terrain a slope correction factor was used for converting slant distance in to horizontal distance. Three circles (of radius 17.84m, 5.64m and 0.564m) were laid in the field by using tapes, ropes of fixed radius and iron rings.

Three types of inventory forms (see Formats A, B and C in Annexure-IV) were used. The enumerators recorded the data about volume and biomass in Forms A and C. The Form C was designed to record tree measurements for estimating tree volume. The area details of each identified land-use type (in the 0.1 ha plots of radius 17.84 m) were recorded in Form B. The latitude and longitude readings were taken for all the plot centres by using a GPS. The ground vegetation in each of the 1 m^2 plot was collected in gunny bags after harvesting (an iron ring of 0.564 radius was placed in the field for harvesting biomass) and green weight measured by using a scale (weighing machine). The biomass gunny bags were air dried for a week at the NSP site office for taking their dry weight. The samples were then transported to the BFRI's laboratory for estimating oven dry weight.

Land-use Area Plots

Area plots were recorded with the same number as the volume plot with suffixes a, b and c. Three area plots (each of 0.1 ha with 17.84 m radius) were laid in between two volume plots for estimating the total land-use areas in each identified land-use category. Each volume plot also acted as an area plot for recording land-use type. An area sample plot represented an area of 0.5cm x 4cm on the map and so 18 ha (=0.5 x 300m x 4 x 300m) in the field.

Volume Plots

Area plot particulars were also recorded on top of the form No. I(i)) used for volume plot measurements. All the trees equal or more than 5cm diameter at breast height (DBH - 1.3m above the ground) or 15cm girth at breast height (GBH) were measured for their diameter/girth. Two fattest trees were measured for height in the sampled plot. If tree centre is within the circular plot then it was included for measurements. Each measured tree in a plot represented several hundred trees when extrapolated to per ha and so adequate precautions were taken during field measurements. If a tree was located on a slope, it was measured while standing on the uphill side. If the tree was found forked at or below the GBH, it was measured just below the fork point. If it was not possible to measure below the fork, then it was measured as 2 trees. A volume plot represented an area of 2cm x 4cm on the map (of scale 1 : 30,000) and so 72 ha (=2 x 300m x 4 x 300m) in the field.

Biomass Plots

The above-ground biomass (including litter layer) was harvested in the concentric biomass plots laid out by following the above-described methodology (Section 7.2.1). The ground vegetation (herbaceous vegetation including leaf litter, dead wood, grass/bamboo, seedling/sapling, etc.) was harvested (by clipping all vegetation within the circular iron frame to ground level) from 0.564 radius plots (of area 1m^2) for estimating above-ground biomass. The harvested biomass from each plot was weighed in the field as green/wet biomass. The samples of

harvested biomass were collected in jute bags and air dried (for 7 days) in the site offices for estimating dry-to-wet biomass ratio. Some air dry samples from each of the 7 land-use types were then transported to BFRI for estimating oven dry biomass (at 70^0C).

BASELINE SCENARIO AND ESTIMATION OF EX-ANTE NET GHG REMOVALS BY SINKS

The detailed methodology adopted for the estimation is present as below:

ABOVE-GROUND FOREST BIOMASS AND CARBON ASSESSMENT

The volumes (in m^3) for all the trees inventoried in the laid out volume plots (of 0.01 ha) in plantation land-use were calculated by using two volume models (the first model estimates V_1 based on the measurements of girth at breast height, and the second model estimates V_2 based on the measurements of both girth at breast height and tree height) as developed by the BFRI for different tree species. For example, the following two volume equations were used in estimating the volumes for *garjan*:

$$\log_e V_1 = f(GBH) = -9.9621407 + 2.08627 \times \log_e GBH$$
$$\log_e V_2 = f(GBH, H) = -10.15963 + 1.59316 \times \log_e GBH + 0.940025 \times \log_e H$$

Per ha volumes were estimated by multiplying by 100 to the tree volumes calculated for each volume plot (of 0.01 ha). Total volumes for both long rotation and short rotation plantations were finally estimated by multiplying per ha volumes by the plantations land-use area as estimated in Section 8. The volume estimates of biomass were converted to ton (t)/ha by using the wood density value (0.67). Based on average density volume, 0.67 of the total above-ground volume was, therefore, considered as above-ground biomass (B). Carbon storage (C) in the above-ground vegetation was finally estimated by taking 50% of the forest biomass as carbon (IPCC, 2003).

Above-ground Forest Biomass and Carbon for Plantations (Long Rotation)

Based on the inventoried trees in the enumerated plots, per ha volumes (V_1 and V_2) for long rotation plantations were estimated as :

$$V_1 = 49.94 \text{ m}^3\text{/ha and } V_2 = 37 \text{ m}^3\text{/ha}$$

Per ha above-ground biomass (AGB), based on V_1 and V_2, were estimated as below :

$$AGB_1 = 33.46 (=49.94 \times 0.67) \text{ t/ha and } AGB_2 = 25.17 (=37.56 \times 0.67) \text{ t/ha.}$$

The following above-ground carbon (AGC) storage values in the above-ground vegetation were estimated by multiplying the forest biomass by 0.5:

AGC_1 = 16.73 t/ha, and AGC_2 = 12.59 t/ha

Total carbon in the long rotation plantations over an estimated area of 648 ha will, therefore, be as 10,841 t/ha and 8,158 t/ha.

Above-ground Forest Biomass and Carbon for Plantations (Short Rotation)
Per ha volumes ($V_{1'}$ and $V_{2'}$) for short rotation plantations are estimated to be as below :

$V_{1'}$ = 41.34 m^3/ha and $V_{2'}$ = 34.29 m^3/ha

Per ha above-ground biomass, based on $V_{1'}$ and $V_{2'}$, were estimated as:

$AGB_{1'}$ = 27.70 t/ha and $AGB_{2'}$ = 22.97 t/ha.

The following carbon storage in the above-ground vegetation were estimated by multiplying the forest biomass by 0.5:

$AGC_{1'}$ = 13.85 t/ha, and $AGC_{2'}$ = 11.49 t/ha

Total carbon in the long rotation plantations over an estimated area of 576 ha will, therefore, be as 7,978 t/ha and 6,718 t/ha.

Above-ground Forest Biomass and Carbon for *Garjan* Forests
Complete enumeration in Bon Pukur stratum of the *garjan* forest patch was done for assessing the total volume.

Total volumes for *garjan* (TV_{1g} and TV_{2g}) for all the enumerated trees in garjan forest patch are estimated to be as below:

TV_{1g} = 1901 m^3 and TV_{2g} = 1626 m^3

Total above-ground biomass (TAGB), based on TV_{1g} and TV_{2g}, were estimated as:

$TAGB_{1g}$ = 1274 t and $TAGB_{2g}$ = 1090 t.

Total above-ground carbon (TAGC) storage in the above-ground vegetation were finally estimated as below by multiplying the forest biomass by 0.5 :

$TAGC_{1g}$ = 637 t, and $TAGC_{2g}$ = 545 t

Total area of the *garjan* patch was estimated in the field as 8 ha where 110 trees were enumerated. Elderly people from the locality and the FD field staff were interviewed for assessing the average age of the *garjan* patch as nearly 50 years. This means that on an average volume per ha is 238 (=1901/8) m^3/ha and the mean annual increment (MAI) works out to be as 4.8 (=238/50) m^3/ha/year.

Above-ground Forest Biomass and Carbon for *Sal* Forests

The total volume of the *sal* forest patch was estimated based on the complete enumeration in Aziznagar *sal* stratum with an estimated area of 2 ha and 557 trees.

Total volumes (TV_{1s} and TV_{2s}) for all the enumerated trees in *sal* forest patch were estimated to be as below:

$$TV_{1s} = 308\ m^3 \text{ and } TV_{2s} = 295\ m^3$$

Total above-ground biomass (TAGB), based on TV_{1s} and TV_{2s}, were estimated as:

$$TAGB_{1s} = 206\ t \text{ and } TAGB_{2s} = 198\ t.$$

The following total above-ground carbon (TAGC) storage in the above-ground vegetation were estimated by multiplying the forest biomass by 0.5 as below:

$$TAGC_{1s} = 103\ t, \text{ and } TAGC_{2s} = 99\ t$$

Total area of the *sal* patch was estimated in the field as 2 ha. Elderly people from the locality and the FD field staff were interviewed for assessing the average age of the *sal* forest patch as 30 years approximately. This means that on an average volume per ha is 154 (=308/2) m^3/ha and the mean annual increment (MAI), therefore, works out to be as 5.1 (=154/30) m^3/ha/year.

BELOW-GROUND FOREST BIOMASS AND CARBON ASSESSMENT

A default conversion factor of 0.26 (Murthy *et al*, 2006) was used for converting above-ground biomass to below-ground biomass (BGB) as discussed below.

Below-ground Forest Biomass and Carbon for Plantations (Long Rotation)

For long rotation plantations the estimated values for below-ground biomass were estimated as :

$$BGB_1 = 8.70\ t/ha \text{ and } BGB_2 = 6.54\ t/ha.$$

The estimated values of below-ground carbon (BGC) were found as:

BGC_1 = 4.35 t/ha, and BGC_2 = 3.27 t/ha

Total below-ground carbon in the long rotation plantations over an estimated area of 648 ha will, therefore, be as 2,819 t/ha and 2,119 t/ha.

Below-ground Forest Biomass and Carbon for Plantations (Short Rotation)
For short rotation plantations the estimated values for below-ground biomass were estimated as:

$BGB_{1'}$ = 7.20 t/ha and $BGB_{2'}$ = 5.97 t/ha.

The estimated values of below-ground carbon will, therefore, be :

$BGC_{1'}$ = 3.60 t/ha, and $BGC_{2'}$ = 2.99 t/ha

Total below-ground carbon in the long rotation plantations over an estimated area of 576 ha will, therefore, be as 2074 t and 1772 t.

Below-ground Forest Biomass and Carbon for Bamboo Areas
For bamboo areas the estimated value for below-ground biomass was estimated as below:

BGB_{1b} = 9.72 t/ha.

The estimated value of below-ground carbon will, therefore, be:

BGC_{1b} = 4.86 t/ha.

Below-ground Forest Biomass and Carbon for Grass Areas
For grass areas the estimated value for below-ground biomass was estimated as:

BGB_{1g} = 4.14 t/ha.

The estimated value of below-ground carbon will, therefore, be:

BGC_{1b} = 2.07 t/ha.

ON-GROUND BIOMASS ASSESSMENT
Green measurements (weight) of the collected biomass samples (from each of the circular plot measuring an area of 1 m^2) were taken in the field. Green biomass samples were dried in the project office for one week after which air dry weights were taken.

On-ground Biomass and Carbon for Plantations (Long Rotation)
An average of 19.62 t/ha of green on-ground biomass was estimated based on the measurements taken in field for the biomass samples collected from long rotation plantation areas. Based on the conversion factor of 0.81 (estimated

based on field measurements) the air dry weight of on-ground biomass (OGB) was estimated to be as 15.89 t/ha and hence on-ground carbon works out as 7.95 t/ha. Total on-ground carbon for long rotation plantations over an estimated area of 648 ha was so estimated as 5,152 t.

On-ground Biomass and Carbon for Plantations (Short Rotation)
An average of 16.64 t/ha of green on-ground biomass was estimated based on the measurements taken in field for the biomass samples collected from short-rotation plantation land-use category. Based on the conversion factor of 0.80 (estimated based on field measurements) the air dry weight of on-ground biomass is estimated as 13.31 t/ha and on-ground carbon as 6.66 t/ha. Total on-ground carbon for short rotation plantations over an estimated area of 576 ha was estimated as 3,836 t.

On-ground and Below-ground Biomass and Carbon for Bamboo Areas
An average of 21.76 t/ha of green on-ground biomass was estimated based on the measurements taken in the field for the biomass samples collected from bamboo areas. Based on the conversion factor of 0.86 (estimated based on field measurements) the air dry weight of on-ground biomass was estimated as 18.71 t/ha and on-ground carbon as 9.36 t/ha. In order to get the below-ground biomass we multiplied the on-ground biomass of bamboo with 0.26 thereby getting a figure of 4.86 t/ha. Total biomass of bamboo is therefore 23.57 t/ha and total carbon as 11.79 t/ha. For bamboo over an estimated area of 2754 ha total carbon stocks will be as 32,470 t.

On-ground and Below-ground Biomass and Carbon for Grass Areas
An average of 20.38 t/ha of green on-ground biomass is estimated based on the measurements taken in the field for the biomass samples collected from the grass land-use areas. Based on the conversion factor of 0.78 (estimated based on field measurements) the air dry weight of on-ground biomass was estimated to be as 15.90 t/ha and on-ground carbon as 7.95 t/ha. By applying a conversion factor of 0.26 below-ground biomass and carbon for bamboo are estimated as 4.13 t/ha and 2.07 t/ha respectively. Total carbon stock for bamboo over an estimated area of 2,754 ha is estimated as 27,595 t.

On-ground Biomass and Carbon for Agricultural Areas
An average of 14.17 t/ha of green on-ground biomass was estimated based on the measurements taken in the field for the biomass samples collected from the cultivated areas. Based on the conversion factor of 0.67 (estimated based on field measurements) the air dry weight of on-ground biomass in agricultural areas was estimated as 9.49 t/ha and on-ground carbon as 4.75 t/ha. Total on-ground carbon in agricultural areas over an estimated area of 630 ha is so estimated as 2,993 t.

On-ground Biomass and Carbon for Settlement Areas

An average of 0.03 t/ha of green on-ground biomass is estimated based on the measurements taken in the field for the biomass samples collected from village/*para* areas. Based on the conversion factor of 0.52 (estimated based on field measurements) the air dry weight of on-ground biomass in settlement areas was estimated as 0.02 t/ha and on-ground carbon as 0.01 t/ha. Total on-ground carbon for settlement areas over an estimated area of 126 ha is so estimated as 1.26 t.

TOTAL CARBON STOCK

Above-assessed total carbon stocks for Chunoti Wildlife Sanctuary are summarized as below for each land-use types:

Carbon Stock Assessment (in t/ha) in Baseline Scenario

Sl. No.	Land-use	Above-ground Carbon	Below-ground Carbon	On-ground Carbon	Soil Carbon	Total Carbon Stock
1	Plantations (long rotation)	12.59	3.27	7.95	13.48	37.29
2	Plantations (short rotation)	11.49	2.99	6.66	14.86	36
3	Bamboo		4.86	9.36	18.23	32.45
4	Grass		2.07	7.95	18.16	28.18
5	Agriculture			4.75	12.16	16.91
6	Settlement			1.26		1.26

Total carbon in the Bon Pukur *garjon* patch and Aziznagarar *sal* patch are estimated as 637 t and 103 t respectively.

C.8. Date of completion of the baseline study and the name of person(s)/entity(ies) determining the baseline

20 December 2007

Bangladesh Forest Department

Bangladesh Forest Research Institute

Nishorgo Support Project

Co-Management Committee, Chunoti

Co-Management Committee, Jaldi

SECTION D. Estimation of *ex ante* actual net GHG removals by sinks, leakage and estimated amount of net anthropogenic GH removals by sinks over the chosen crediting period

D.1. Estimate of the *ex ante* net GHG removals by sinks

The above-ground MAIs for *sal* forest patch and *garjan* forest patch in the Sanctuary have been estimated as 5.1 and 4.8 m^3/ha/year (see Sections 9.1.3 and 9.1.4) based on the field measurements for growing stock. This indicates that for reforestation of indigeneous species we can expect an average MAI of 4.95 m^3/ha/year (or biomass of 4.95x0.67 t/ha/year). This compares closely with the MAI value (4.8 m^3/ha/year) of the BFRI, estimated based on the data regularly collected from the Sample Plots maintained by them in Chittagong Division. In another study (Dmeldo and Ahmad, 1985) the values of MAI have been estimated as 4.8 and 5.4 m^3/ha/year in Chittagong for teak and dhakijam plantations respectively. Also the estimated MAI value for Chunoti compares well with the MAI value (4.66 m^3/ha/year) for similar reforestation efforts in India (Sharma and Pandey, 1989).

The above-ground forest carbon sequestration rate will work out to be as 1.7 (=4.95x0.67x0.5) t/ha/year. The below-ground forest carbon sequestration rate will, therefore, be as 0.44 (=1.7x0.26) t/ha/year.

For estimating on-ground forest carbon sequestration rates two biomass sample plots (see AA24 and BB24 plots on the grid map as presented in Figure 1) were laid out (adjoining to the core zone boundary) in Satghar Beat where plantations raised earlier (12 years old plantations) have developed ground vegetation. Harvested biomass samples were weighed both for green weight in field and air dry weight in project office after one week. Based on field data, the air dry biomass is estimated as 34.50 t/ha and so total on-ground forest carbon works out to be as 17.50 t/ha. This, over a period of 12 years, gives an on-ground forest carbon sequestration rate of 1.46 t/ha/year.

Total forest carbon sequestration rate is, therefore, worked out as average carbon tonnage of 3.6/ha/year (by adding above-ground, below-ground and on-ground carbon sequestration rates as estimated above). So for a medium term plan for 42 years (2008-2050) the total carbon sequestration would be 151.20 t/ha.

The BFRI, Chittagong has conducted soil organic carbon studies in the forests of Chittagong Division and the results have been published (BFRI, 1996). Based on

these empirical estimates the soil carbon in the Chunoti forests of indigenous species is estimated by the Soil Science Division of BFRI as 32 t/ha.

Above-assessed total carbon stocks for Chunoti Wildlife Sanctuary are summarized as below for the proposed reforestation activities:

Carbon stock assessment (in t/ha) in mitigation scenario

Sl. No.	Reforestation Activity	Proposed Area	Forest Carbon	Soil Carbon	Total Carbon Stock
1	Block Plantations	2000	302,400	64,000	366,400
2	Enrichment Plantations (degraded plantation areas)	1000	151,200	32,000	183,200
3	Enrichment Plantations (bamboo areas)	2000	302,400	64,000	366,400
4	TOTAL	5000			

Carbon Stock Changes

The following summary Table is presented (by using the above-discussed estimates) for discerning the carbon stock change patterns as a result of reforestation activities.

Total carbon stock changes (in ton) over 42-years period

Sl. No.	Project Interventions	Proposed Area (in ha)	Carbon Stock under base-line scenario	Carbon Stock under mitigation scenario	Total Carbon Stock changes
1	Block Plantations	2000	56,360 (=28.18x2000)	366,400	310,040
2	Enrichment Plantations (degraded plantation areas)	1000	36,290 (=36.29x1000)	183,200	146,910
3	Enrichment Plantations (bamboo areas)	2000	64,900 (32.45x2000)	366,400	301,500
4	**TOTAL**	5000			758,450

The total carbon stock changes are estimated as 758,450 t over the project period of 42 years. The annual carbon stock change, therefore, works out as 18,058 t.

D.2. Estimate of the *ex ante* leakage

No significant leakage is expected during the project implementation as the two CMCs are tasked to prevent forest fires and illicit felling by mobilizing existing CPGs and FUGs. As chemical fertilizers will not be used, no significant emission of N_2O is envisaged.

SECTION E. Monitoring plan

E.1. Monitoring of the project implementation

E.1.1. Monitoring of the project boundary

1.1.1. The boundary of Chunoti WLS, within which the proposed reforestation activity will occur, is defined both on the map and in the field as per the Government of Bangladesh gazette notification. Both the core zone and the interface landscape zone have been shown on the maps developed under NSP. However, the GPS readings will be taken both for the core zone where reforestation activity is planned to be implemented.

1.1.2 Within the Sanctuary area the boundaries of the planned three categories of reforested patches will be located through GPS (longitude and latitude) and mapped by using the existing GIS data base as developed under NSP. Each category of reforested patches will be monitored by establishing unique reference numbers as assigned by the two CMCs and shown in the plantations maps as included in the plantations journals.

1.1.3. The project boundary in terms of reforested patches shall be cross-checked and monitored annually by the CMCs and FD field staff all through the crediting period. In case of deforestation or seedling mortality taking place within the project boundary, the area will be excluded from the project and suitable corrective action will be taken for accounting carbon credits as a result of loss of vegetation. An updated GIS will be maintained for monitoring the area under each of the proposed reforestation category.

ID number	Data variable	Data unit	Measured (m), calculated ©, estimated (e), or default (d)	Recording frequency	Number of data points/Other measure of collected data	Comment
1.1.1.	Latitude and Longitude of core zone	Lat. Long.	(m)	once	Main corners of natural physical features, and other main mid points	

1.1.2.	Latitude and Longitude of each patch planned for reforestation	Lat. Long.	(m)	once	Four corners of the patch to be reforested, and other main mid-points	
1.1.3.	Latitude and Longitude of each reforested patch	Lat. Long.	(m)	annual	All patches that are reforested and assigned a unique reference no. by CMCs	

E.1.2. Monitoring of forest establishment

1.2.1. The nursery development for the timely production of quality seedlings of indigenous species will be monitored monthly in order to ensure quality planting stock. Site preparations for planting will follow biodiversity conservation principles and so will not cause net emissions from soil carbon in longer term. For example, no burning and clearfelling of existing vegetation will be done inside the Sanctuary. Site preparations including pitting and stacking along contours will particularly be supervised by FD technical staff in order to minimize soil erosion.

1.2.2. The planting will be done in blocks of 10 ha and the survival of planted seedlings and area details will be recorded by CPG members annually for the first three years based on sound field inventory methods. The quality and quantity of seedlings will be monitored by the CMCs at the time of planting and subsequently for 3 years. The initial survival rate of planted seedlings will be estimated after the planting, and beating up operation will be done in case of seedling mortality during the first year.

1.2.3. Annual checking of plantations will be done by the CMC. Circular sample plots of 0.01 ha (with 5.64 m radius) will be laid out over the planting grid for counting the surviving saplings, checking plantation area details, and recording growth of planted seedlings.

1.2.4. Annual monitoring will continue during the carbon crediting period when area and surviving trees details will be cross-checked for each strata by the two CMCs who will be responsible for the maintenance of monitoring records.

ID number	Data variable	Data unit	Measured (m), calculated ©, estimated (e), or default (d)	Recording frequency	Number of data points/Other measure of collected data	Comment
1.2.1.	Nursery seedling quality and quantity	Nos. Species Height Collar diameter	(c) (e) (m) (m)	Monthly in each nursery bed	Quantitative and qualitative assessments for each nursery bed	
1.2.2.	Survival of planted seedlings and mortality replacement	Planted seedling's survival	(c)	Quarterly for the first 3 years	Percentage survival estimated based on 0.01 ha sample plots (1% sampling intensity).	
1.2.3.	Survival of saplings/trees and area check	No. of planted, and established saplings and trees after 3 years	(m)	annual	Percentage survival estimated based on 0.01 ha sample plots (1% sampling intensity).	
1.2.4.	Check for each strata	Species and area	(e)	annual	0.1 ha sample plots with 10% sampling intensity.	

E.1.3. Monitoring of forest management

As cowdung and/or farm yard manure is recommended to be applied, no fertilizer application monitoring is required. Similarly no final harvesting is planned as the future growth will be retained as per the principles of Sanctuary management as described by GOB (2007). Suitable silvicultural operations such as weeding, mulching, cleaning and climber cutting will be taken up by employing members of CPGs and FUGs.

E.2. Sampling design and stratification

a) Stratification and sampling for ex-post calculations

Stratification of the project area into relatively homogeneous units is done in accordance of the chosen methodology – AR-AM0001 version - in order to increase the accuracy and precision of measuring and monitoring in a cost-effective manner.

Step 1 : The project area is stratified into 9 land capability classes based on an assessment of the key factors influencing carbon stocks in the above- and below-biomass pools.

Step 2 : Local information about main factors including land-use maps, socio-economic data and soils details has been collected.

Step 3 : Preliminary stratification - The entire gazetted area is divided into 3 broad strata comprising a *garjan* forest patch, *sal* forest patch, and the remainder degraded forest land (that is further stratified into 7 land-use strata). So the stratification of the project area is done into nine relatively homogeneous land-use types/strata and this classification will be used for monitoring in order to increase the accuracy of periodic assessments in a cost-effective manner. Relevant information for each of the land-use strata was collected during the forest inventory.

Step 4 : A supplementary sampling survey on site specifications for each preliminary stratum will be carried out as below:

- Existing trees, if any, will be measured for species, estimated age class, number of trees, mean girth at breast height, height, etc. in randomly selected circular plots of 0.1 ha (17.84 m radius plot) each.
- Non-tree vegetation will be estimated by laying out plots of size 1 m^2 each (with radius 0.0564 m).

- Variation analysis will be done for key factors considered for the analyses. In case of large variations, intense field works will be taken up and further stratification will be planned as discussed below.

Step 5 : Based on the supplementary information as collected from step 4 above, a further stratification will be done by considering as to whether each preliminary stratum is sufficiently homogeneous or not. The degree of homogeneity will be assessed based on stratum size, natural variability and its significance to the project and baseline scenario. A stratum having significant variation in vegetation type will be divided into two or more strata. Similarly strata with similar attributes will be merged into one stratum. Distinct strata will differ significantly in terms of their baseline and/or project carbon calculation.

Step 6 : Sub-stratification will be created based on the planting type and/or the year of planting as described in CDM-AR-PDD.

Step 7 : A stratification map will be developed by using the GIS/MIS (available with RIMS and NSP) for integrating the data from different sources. Post-stratification and sub-stratification of the area into homogenous units will be examined during the first monitoring, keeping in view of measurement precision and costs. The following factors shall be considered in the post-stratification:

- Data from monitoring of forest establishment and project boundary;
- Data from monitoring of forest management;
- Variation in carbon stock changes for each stratum and sub-stratum after the first monitoring event;
- Strata and sub-strata shall be grouped 9into one strata or sub-strata if they have similar carbon stock, carbon stock change and spatial variation.

b) Sampling

As forest area of Chunoti is relatively large, appropriate sampling techniques are required in order to save cost and time. A representative sample of the total population may statistically be withdrawn where various tree parameters and forest characteristics can be measured for periodic assessments. The sample estimates can then be extrapolated to arrive at total area and population estimates. The sampling design to be selected should be statistically and technically adequate in order to generate reliable and cost-effective data. The sampling may be random or systematic, stratified or unrestricted and simple, multi-phase or multi-stage.

The sampling design for monitoring will be systematic random sampling using mainly permanent sampling plots (and in some cases temporary sampling plots) installed in grid nets of different spacing to measure and monitor changes in carbon stocks of above-, on- and below ground biomass. In view of a high

covariance between observations at successive sampling events, permanent sample plots are generally considered as statistically efficient in estimating changes in forest and soil carbon stocks. The plots will be given the same treatment as other forest lands within the project boundary and the monitoring field team will not be informed about the location of monitoring plots.

i) Determining sample size

The systematic distribution of the sample units over the survey areas using dot grid designs will be planned. The number of plots will depend on a number of factors including species variation, accuracy and monitoring interval. The total number of sample plots (n) will be estimated by using the following formula as per the approved methodology:

$$N = (t/E)^2 (\Sigma W_h S_h \sqrt{C_h}) (\Sigma W_h S_h / \sqrt{C_h})$$

$$n_h = n (W_h S_h / \sqrt{C_h} / (\Sigma W_h S_h / \sqrt{C_h})$$

(the summation from h=1 to L)

Where, L = total no. of strata

t = t value for a confidence level (95%)

E = allowable error (+ - 10% of the mean)

S_h = standard deviation of stratum h

n_h = number of samples per stratum that is allocated proportional to

$W_h S_h / \sqrt{C_h}$

$W_h = N_h / N$

N = no. Of total sample units (all stratum), $N = \Sigma N_h$

N_h = no. of sample units for stratum h, calculated by dividing the area of stratum h by area of each plot

C_h = cost to select a plot of the stratum h

Permanent sample plots (of 0.1 ha with 17.84 m radius) will be established evenly based on systematic random sampling (locating systematically with a random start) in all the three categories of the proposed reforestation activity for temporal assessments of soil carbon stocks and forest carbon stocks (above-ground, below-ground and on-ground). These plots will be treated in the same way as other lands for taking up reforestation within the project boundary. Periodic monitoring of the forests through permanent field plots will require accurate location of the plots on the ground. The geographical position (GPS coordinates), administrative location, stratum and series no. of each of the permanent plots will, therefore, be recorded and archived.

The appropriate sample size for each category of the three planting models will be established by following the relevant guidelines as approved under CDM. The

sample size will be determined based on the mean standard deviation of carbon stock and carbon stock changes during the monitoring period for each stratum. For each sample plot a register will be maintained with all relevant details of growth and location. The frequency of monitoring will be every 5 years.

ii) Randomly locating sampling plots

In order to avoid subjective choice of permanent sampling plot locations (e.g. plot centres, plot reference points, movement of plot centres to more convenient positions), the plots will be located systematically with a random start by using GPS. It will be ensured that the sampling plots are distributed as evenly spread as possible. Records will be maintained about geographical position, administrative location, stratum and sub-stratum series, no. of plots, etc.

E.3. Monitoring of the baseline net GHG removals by sinks

E.3.1. Monitoring of the baseline net GHG removals by sinks (before start of the project), if required

See Section C.7.

E.3.2. Monitoring of the ex post baseline net GHG removals by sinks (after start of the project), if required

The proposed reforestation activity will not lead to a shift of pre-project activities outside the project boundary. For example, the forest land under the proposed reforestation with indigenous species will continue under the Sanctuary management and so will continue to provide enhanced level of goods and services as there will be no curtailment to the legitimate rights and access of local people for subsistence consumption.

The carbon stock changes in the baseline scenario have been estimated both for soil carbon content and forest carbon content. In case of the without project scenario, the existing vegetation status is not expected to improve. The baseline net GHG removals by sinks need not to be measured and monitored over time.

E.4. Monitoring of the actual net GHG removals by sinks

E.4.1. Data to be collected in order to monitor the verifiable changes in carbon stock in the carbon pools within the project boundary resulting from the proposed A/R CDM project activity

Unlike energy sector mitigation projects, co-management projects for biodiversity conservation are characterized by a number of complex factors including long gestation period, non-linear rates of carbon accumulation in vegetation and soil,

varying harvesting rates of forest products, emissions from forest soil and floor, and forest fire. Monitoring of carbon sequestration and storage is, therefore, necessary for biodiversity projects (Ravindranath and Bhat, 1997). However, an appropriate mechanism in Chunoti should not only be cost effective but need to be implemented by the concerned CMCs by involving community stakeholders. The following monitoring strategy to be implemented by the two CMCs is suggested for the proposed reforestation activity.

Forest processes are generally measured over periods of 5-year intervals. As verification and certification must occur every 5 years for reforestation activities, it is reasonable that at least the dominant biomass pool (trees) should be measured at the same frequency. The carbon pools that respond more slowly (e.g. forest soil carbon content) can be measured even 10 (or even 20) years or at the end of the project activity.

Different accounting and measurement methods have been described in the Special Report of IPCC (Watson *et al*, 2000) along with associated implications for costs and accuracy. Main institutional responsibility for monitoring key parameters will be of Chunoti and Jaldi CMCs. They will seek due help from the members of Forest User Groups and Community Patrolling Groups that are operating under their jurisdiction. For example, all the field measurements will be entrusted to the selected members of FUGs and CPGs who will be trained locally. A trainers training will, however, be provided to the identified members of CMCs and Federations (of CPGs and FUGs) who will in turn impart training to FUGs and CPGs. Soil samples will be collected locally and sent to BFRI, Chittagong for soil organic carbon analyses in the laboratory. Deforestation and plantation failure areas, if any, will be identified and documented. Suitable methods and institutional arrangements that may be adopted in co-management monitoring are presented as below:

Monitoring methods and institutional arrangements

Parameter	Methods	Data to be monitored	Frequency	Institutional arrangements
Plant survival rate	Counting in the samples (of circular plot of 5.64m radius)	No. of seedlings and saplings	Annual	CMCs employ FUGs and CPGs
On-ground biomass growth	Weight measurements of the biomass in the samples (circular plot of 0.564m radius)	Green and air dry weights	Once in five years	CMCs employ FUGs and CPGs

Parameter	Methods	Data to be monitored	Frequency	Institutional arrangements
Above-ground volume growth	Growth measurements in the samples (circular plot 5.64m radius)	Tree girth (at breast height), tree height	Once in five years	CMCs employ FUGs and CPGs
Soil Carbon	Soil sampling and field methods	Soil organic carbon	Once in five years	Collection by CMCs, Soil analyses by Forest Research Institute

Varifiable Indicators

ID no.	Data variable	Source of data	Data unit	Measured (M), Calculated ©, Estimated (E), or Default (D)	Recording frequency	No. of sample Plots at which the data will be monitored	How will the data be archived (electronic/ paper)	Comment
4.1.1.01	Stratum ID	Stratification map	Alphan-umeric		Before the start of the project	100%	Electronic & paper	
4.1.1.02	Sub-stratum ID	Stratification map	Alpha-numeric		Before the start of the project	100%	Electronic & paper	
4.1.1.03	Confid-ence level		%		Before the start of the project	100%	Electronic & paper	For QA/ QC
4.1.1.04	Precisi-on level		%		Before the start of the project	100%	Electronic & paper	For QA/ QC
4.1.1.05	Sample plot ID	Project & plot map	Alpha-numeric		Before the start of the project	100%	Electronic & paper	Numeric series ID
4.1.1.06	Plot locat-ion	Project & plot map, and GPS location		M	5 years	100%	Electronic & paper	Using GPS
4.1.1.07	Tree Species	Project design map			5 years	100%	Electronic & paper	As in PDD

4.1.1.08	Age of plantation	Plot Measurement	Year	C	5 years	100%	Electronic & paper	Counted since the planting year
4.1.1.09	No. of trees	Project area & plot Measurement	No.	C	5 years	100%	Electronic & paper	
4.1.1.10	Dia. at Breast Height (DBH)	Plot measurement	cm	M	5 years	100% trees in plot	Electronic & paper	Measurement at monitoring time
4.1.1.11	Mean DBH	Plot measurement	cm	E	5 years	100% trees in plot	Electronic & paper	Estimated via 4.1.1.10
4.1.1.12	Tree Height	Plot measurement	m	M	5 years	100% trees in plot	Electronic & paper	Measurement at monitoring time
4.1.1.13	Mean tree height	Plot measurement	m	E	5 years	100% trees in plot	Electronic & paper	Estimated via 4.1.1.12
4.1.1.14	Tree Vol-ume	Plot measurement	m^3/ ha	E	5 years	100% samp-ling plot	Electronic & paper	Volume equat-ions of BFRI
4.1.1.15	Wood density fractor	IPCC		D	5 years	100% samp-ling plot	Electronic & paper	Default value

4.1.1.16	Biomass expansion factor	IPCC		D	5 years	100% samp-ling plot	Electronic & paper	Default value
4.1.1.17	Carbon fraction	IPCC		D	5 years	100% samp-ling plot	Electronic & paper	Default value
4.1.1.18	Below-ground/ Above - ground forest carbon ratio	IPCC		D	5 years	100% samp-ling plot	Electronic & paper	Default value
4.1.1.19	Above-ground forest carbon stock of plots	Volume Equations & conversion factors	t C /ha	E	5 years	100% samp-ling plot	Electronic & paper	Via 4.1.1.14 to 4.1.1.17
4.1.1.20	Below-ground forest carbon stock of plots	Estimated from 4.1.1.19	t C /ha	E	5 years	100% samp-ling plot	Electronic & paper	Via 4.1.1.19 and 4.1.1.18
4.1.1.21	On-ground forest carbon stock of plots	Weight meausreme nt	t C /ha	E	5 years	100% samp-ling plot	Electronic & paper	Biomass weight in $1m^2$ sample plots

4.1.1.22	Soil carbon stock of plots	Soil analysis	t C /ha	E	5 years	Soil profiles in sample plots	Electronic & paper	Soil analysis of samples in BFRI laborat-ory
4.1.1.23	Total carbon stock of plots	Add values from 4.1.1.19 to 4.1.1.22	t C /ha	E	5 years	100% samp-ling plot	Electronic & paper	Via 4.1.1.19 – 4.1.1.22
4.1.1.24	Total carbon stock of stratum	Values from 4.1.1.23 multiplied by stratum area	t C	E	5 years	100% stratum	Electronic & paper	

E.4.2. Data to be collected in order to monitor the GHG emissions by the sources, measured in units of CO2 equivalent, that are increased as a result of the implementation of the proposed A/R CDM project activity

Given the difficult terrain, vehicles are not planned to be used in the project area during the project implementation. So no significant vehicular emissions are expected as a result of project activity. Similarly nitrogen fertilizers will not be used for establishing plantations and so there will not be any significant Nitrous oxide emissions. Farmyard manure and/or cowdung containing very less N content (0.5%) will be used for raising plantations.

E.5. Leakage

E.5.1. If applicable, please describe the data and information that will be collected in order to monitor leakage of the proposed A/R CDM project activity

Leakage represents the increase in GHG emissions by sources which occurs outside the boundary of a reforestation CDM project activity which is measurably attributable to the project activity. Primary leakage occurs when the baseline activity is shifted to other areas due to reforestation. In view of severe forest degradation, this type of leakage is not possible in and around the Sanctuary. Moreover, as a result of reforestation local community including members of CPGs and FUGs will be able to get some benefits in terms of fallen leaves, twigs and branches over a period of time. As most of the forest lands fall within the interface landscape zone, the planned protection of forests in and around Chunoti will control any further encroachment of forest land both in core zone and interface landscape zone. Secondary leakage is caused by market effects and this possibility is not foreseen as no harvesting for commercial purposes is allowed in the Sanctuary. So there is neither a necessity of monitoring primary and secondary leakage nor taking any measures for minimizing them.

Reforestation works will be carried out mainly by the members of CPGs and FUGs, and the transportation of seedlings and manures will be done locally without using any motor transport. So no GHG emission is envisaged due to fossil fuel combustion from vehicles.

E.5.2. Please specify the procedures for the periodic review of implementation of activities and measures to minimize leakage

Leakage will not be monitored and significant measures are not required for minimizing leakage.

E.6. Quality control (QC) and quality assurance (QA) procedures undertaken for data monitored

A quality assurance and quality control procedure will be followed based on Good Practice Guidance of IPCC (2003). A manual for field measurements will be prepared and the personnel responsible for field works will be trained in the relevant aspects of field data collection, storage and analyses. All field measurements will be checked by a technical staff in randomly sampled plots in order to ensure the consistent measurements and monitoring of carbon stock over time. Any errors found during cross-checking will be corrected and recorded. Data entry will be done electronically and maintained in spreadsheets for future use. Given the long time frame of 42 years it would be advisable to revise the data sheets by using updated software versions.

E.7. Please describe the operational and management structure(s) that the project operator will implement in order to monitor actual GHG removals by sinks and any leakage generated by the proposed A/R CDM project activity

The two CMCs (Chunoti and Jaldi co-management committees with the following details) established as per the Government Order (No. Pa Ba Ma/Parisha-4/Nishorgo-64/(Part-4)/112 dated 15/5/2006) will be responsible for implementing the monitoring plan.

Co-Management Committee : Chunoti Range

A. Summary Information:

Name of the Organization:	**Co-Management Committee** Chunoti Range Chunoti Wildlife Sanctuary
Address :	Chunoti Wildlife Sanctuary PO: Chunoti Upazila: Lohagora Dist: Chittagong Bangladesh
Telephone:	01716-089632
Contact Person:	Mr. Sanajit Mandol
P**osition with the Organization:**	Range Officer and Member-Secretary
Contact person Address :	Chunoti Wildlife Sanctuary Po: Chunoti Upazila: Lohagora Dist: Chittagong,Bangladesh
Telephone:	01716-089632

B. Organizational Information:

1. **Registration Status:**
   The GoB issued a Gazette Notification (May 15, 2006) for Co-Management Council & Co-Management Committee of Chunoti Range, Chunoti Wildlife Sanctuary.

   The 19 member Co-Management Committee is the executive body

which is derived from the 56 member Co Management Council.

2. **Constitution**, **Charter or Bylaws Status**:
   The Co-Management organization has its own constitution, staff policy and procurement policy.

3. **Organization Foundation Time**:
   Functioning since 25 June 2005.

4. **Members' Information:**
   - Co-Management Council members: 56; and
   - Co-Management Committee members: 19.

   The members of the Council are the representatives of different stakeholder groups of the locality:
   a. civil society members:13 (Union Parishad/municipality chairpersons and councilors), reputed personalities, teachers, doctors, social workers, journalists, religious leaders & freedom fighters: 6-8;

   b. local administration: 4 (Upazila Nirbahi Officer, Assistant Conservator of Forests/Range Officer, Police, BDR, Ansar, VDP, etc.);

   c. community people viz. resource user groups who are dependent on forest resources: 9, resource owning group viz. owners of brick field, saw mill, furniture & timber business: 6, ethnic minority group-3, local youths: 2, other concerned persons:1;

   d. local NGOs & CBOs: 2-4; and

   e. other government officials: 4-6 (department of agricultural extension, livestock, fisheries, land administration, health & family welfare, social welfare, youth & BRDB).

5. **Summary of past and current activities:**
   The Co-Management Committee performed many social mobilization activities *inter alia* conducted several Focus Group Discussions with different stakeholders including Forest User Group (FUG) , made contact with local government officials and local influential people as a part of social mobilization activities**.** The organization implemented 10-kilometer strip plantation project with a budget outlay of BDT 389,000.

C. Accounting System and Internal Control:

1. **Bank account information:**
   Savings Bank Account No: 1188
   Sonali Bank, Lohagora Branch, Chittagong

Signatories Name	Designation in CMC
Md.Sanajit Kr. Mandol	Member Secretary
Md.Nurul Absar Sikdar	Vice Chairman
Md. Alhaj Shafiq Ahmed	Treasurer

2. **Responsibility for Financial Accounting & Reporting :**
   The Co-Management Committee's employee "Accountant Cum Administrative Assistant" is assigned to help in accounts operations. The Treasurer and Member-Secretary are accountable for financial accounting and reporting.

3. **Capacity for Donor Funds**
   Co-Management Committee has been dealing with the USAID funds and so have capacity for dealing with the funds of other donors

4. **Inventory Control System:**
   The Co-Management Committee has got inventory form, register book and monitoring instruments.

5. **System of Keeping Asset Security** (Safe, locked office, security system):
   The Co-Management Committee has got locked office and there are locked Almirah and file cabinet for keeping important documents of the office.

D. Additional information:

1. **Expectation of Getting Other Sources of Financing from USAID or other Donor:**
   The Co-Management Committee endeavors to get financial support from other sources.

2. **Current Auditing Process**
   The Co-Management Committee has not yet faced any formal audit as the projects are ongoing. However, the internal auditing system is proactive in this regard.

Co-Management Committee : Jaldi Range

A. Summary Information:

Name of the Organization:	**Co-Management Committee** Jaldi Range Chunoti Wildlife Sanctuary
Address :	Village: Monsuriabazar PO: Monsurabazar Upazila : Bashkhali Dist: Chittagong Bangladesh
Telephone:	01819-332193
Contact Person:	Mr. Md. Alamgir Kabir Choudhury
Position with the Organization:	Chairperson
Contact person Address :	Village: Monsuriabazar PO: Monsurabazar Upazila : Bashkhali Dist: Chittagong Bangladesh
Telephone:	01819-332193

B. Organizational Information:

1. **Registration Status:**
   The GoB has issued a Gazette Notification for the Co-Management Council & Co-Management Committee of Jaldi Range, Chunoti Wildlife Sanctuary under the Ministry of Environment and Forests (dated May 15, 2006).

   The 19 member Co-Management Committee is the executive body which is derived from the 83 member Co Management Council.

2. **Constitution**, **Charter or Bylaws Status**:
   The Co-Management organization has its own constitution, staff policy and procurement policy.

3. **Organization Foundation Time**:
   Started functioning in June 2005.

4. **Member's Information:**
   As in case of Chunoti

5. **Summary of past and current activities:**
   The Co-Management Committee performed many social mobilization activities, and conducted several Focus Group Discussions with different stakeholders including Forest User Group (FUG). They made contact with local government officials and local influential people as a part of social mobilization activities thereby accomplishing the project objectives. The organization has implemented a Nishorgo Library Project amounting BDT 361,200.

C. Accounting System and Internal Control:

6. **Bank account information:**

   Savings Bank Account No: 1261
   Sonali Bank, Banshkhali Branch, Chittagong

Signatories Name	Designation in CMC
Md.Liakat Ali Mollah	Member Secretary
Md.Kamrul Islam Hossaini	Vice Chairman
Md. Akhter Hossain	Treasurer

7. **Responsibility for Financial Accounting & Reporting :**
   The Co-Management Committee's employee "Accountant Cum Administrative Assistant" is assigned to help in accounts operations. The Treasurer and Member Secretary are accountable for financial accounting and reporting.

8. **Capacity of Keeping Donor wise Accounts Separately**
   Co-Management Committee has been dealing with USAID funds and is eager to solicit funds from other donors as well.

9. **Inventory Control System:**
   The Co-Management Committee has got inventory form, register book and monitoring instruments.

10. **System of Keeping Asset Security** (Safe, locked office, security system):
    The Co-Management Committee has got locked office and there are

locked Almirah and file cabinet for keeping important documents of the office.

D. Additional information:

1. Expectation of Getting Other Sources of Financing from USAID or other Donor:

The Co-Management Committee is trying to get financial support from USAID or any other sources.

2. Current Auditing Process

The Co-Management Committee has not yet faced any formal audit as the projects are ongoing. However, the internal auditing system is proactive in this regard.

E.8. Name of person(s)/entity(ies) applying the monitoring plan

Chunoti Co-Management Committee

Jaldi Co-Management Committee

SECTION F. Environmental impacts of the proposed A/R CDM project activity

F.1. Documentation of the analysis of the environmental impacts, including impacts on biodiversity and natural ecosystems, and impacts outside the project boundary of the proposed A/R CDM activity

Main purpose of the environmental analysis is to ensure that the plantation/forests management options under the proposed reforestation project are environmentally sound and sustainable. Environmental consequences of the proposed reforestation activity should be recognized early and taken into account while making important decisions. The environmental analysis was, therefore, designed to: i) identify and assess the potential impacts of main forests restoration activities proposed to be undertaken, ii) interpret and communicate the information about such impacts, and iii) recommend appropriate measures for strengthening the environmental management in the project design. A check list of questions enabled covering main issues related to land, water, air and biota. Possible beneficial and adverse environmental impacts from the proposed reforestation activity have been screened with regards to the location, planning and technical design, and the operations of the proposed reforestation project.

The project location in Chunoti will induce the following significant beneficial environmental impacts:

- Reforestation activities in the identified micro-watersheds would help control soil erosion in the undulating terrain of Chunoti,
- Community patrolling by CPGs will control illicit felling, forest fires, poaching and grazing thereby reducing biotic pressure on the forests in and around the Sanctuary,
- Plantations coupled with natural regeneration along the western side of the Sanctuary will help conserve coastal areas, and
- Restoration of forests will increase the aesthetic and eco-tourism value of the Sanctuary.

It is expected that the following beneficial environmental impacts related to planning and design will accrue:

- Biodiversity and environmental conservation through appropriate measures as included in the project design,
- Natural regeneration through aided regeneration techniques,
- Multi-storey natural and enriched vegetation,
- Retention of ground flora as no clear felling and burning during planting,
- Retention of dead or hallow trees suitable for wildlife habitat,

- Bush thinning in place of bush cutting during planting and weeding,
- Wildlife fruit species as included in the species mix,
- Micro-watershed identification and waterbody management by associating local community,
- Water and soil conservation through natural grass and bamboo management,
- Forests restoration, aesthetic and recreation values, environmental improvement, and pollution abatement,
- Poverty alleviation, improved governance, community empowerment, and women welfare

The following beneficial environmental impacts will result from the project operation:

- Better forests and constituent biodiversity,
- enhanced forest land productivity,
- enhanced soil fertility and efficient nutrient cycling,
- effective community protection,
- improved drainage,
- protected coasts with less siltation,
- livelihood support for local people,
- environmental amelioration,
- enhanced community participation in the Sanctuary management, and
- enhanced adaptability and reduced vulnerability to climate change,

No significant adverse environmental impacts are foreseen as adequate measures have been taken in the design of the project. For example, no exotic species are included in the plantation design and use of chemical fertilizers, pesticides and herbicides has been excluded. Burning of vegetation has been prohibited before taking up any planting activities. Contour planting has been suggested wherever appropriate. As per the Wildlife (Amendment) Act, 1974 no commercial harvesting is allowed in the Sanctuary and so no felling related damage is envisaged. Conflicts among the local community, if any, will be managed by the CMCs by putting in place an appropriate conflict resolution mechanism. The visitation to the Sanctuary is currently very less and so no significant eco-tourist related activities will take place in near future. In future, however, the tourists management need to be strengthened by involving the CMCs.

It can, therefore, be concluded that the project implementation will induce beneficial environmental impacts, and no significant adverse environmental impact is foreseen. The limited impact of eco-tourists can be offset through appropriate mitigation measures to be implemented by the CMCs. Thus the

environmental analysis concludes that the project is not only environmentally sound but also very beneficial.

The implementation of reforestation activity would have significant impacts in the adaptation of climate change impacts through alleviation of rural poverty.

F.2. If any negative impact is considered significant by the project participants or the host Party, a statement that project participants have undertaken an environmental impact assessment, in accordance with the procedures required by the host Party, including conclusions and all references to support documentation

No significant negative impacts have been envisaged by the project activity.

F.3. Description of planned monitoring and remedial measures to address significant impacts referred to in section F.2. above

No required as no significant impacts are projected.

SECTION G. Socio-economic impacts of the proposed A/R CDM project activity

G.1. Documentation of the analysis of the major socio-economic impacts, including impacts outside the project bounadry of the proposed A/R CDM project activity

The core and interface landscape of the Sanctuary has a number of villages, paddy land, settlements and forest. The area is densely populated (see Section 4.1.3. for the details of paras/villages) and a majority of population depend on agriculture for earning their livelihood. A socio-economic survey was conducted in 2007 and the following impact analysis is based on the survey results. A two-stage sampling was followed keeping in view the spread of villages in and around the Sanctuary. A purposive sampling was done for selecting 15 representative villages (8 villages from Chunoti Range and 7 villages from Jaldi Range) covering different categories of villages spread in the interface landscape. From each selected village, ten households were sampled by following systematic random sampling. The socio-economic information was collected by using five different tools of data collection: formal questionnaire, village profiling sheet, focus group discussions, micro-enterprise information sheet and National Socio-economic Situationer. Main information captured through the survey included demographic profile, education, health, profession, sanitation, resource extraction and flow, employment, etc. The relevant data were collected for analysing both community/village level patterns and household level characteristics.

Surveyed Villages in Chunoti Wildlife Sanctuary

Sl. No.	Village	Union	Upzila	Total no. of households	Total population
1	Jangal Puichari	Puichari	Banskhali	2000	13000
2	Jangal Napura	Puichari	Banskhali	1000	7000
3	Jangal Chambol	Chambol	Banskhali	70	500
4	Shilkup Barua Para	Shilkup	Banskhali	400	2000
5	Shilkupdarsha Gram	Shilkup	Banskhali	45	250
6	Jaldi Villager Para	Jaldi	Banskhali	500	3000
7	Purba Napura	Puichari	Banskhali	1000	6000
8	Goyal Mara	Harbang	Chakaria	300	2400
9	Brindabankhil	Harbang	Chakaria	500	3000
10	Villager Para	Harbang	Chakaria	1500	12000
11	Gainkata	Harbang	Chakaria	85	600
12	Banpukur	Chunoti	Lohagora	500	3500
13	Hindupara	Chunoti	Lohagora	70	500
14	Mawlana Para	Chunoti	Lohagora	120	1000
15	Barua Para	Chunoti	Lohagora	70	500
				8160	55250

The overall ratio of men and women is found almost same (1.09) in the surveyed villages. The average size of a household is 6.2 with most of the population aged 25-34 years (16%) and 15-24 years (20%). This population profile of surveyed villages matches closely with the national statistics. These two categories of local population will especially be focused during the project implementation by involving them gainfully. The age-dependency ratio is the ratio of persons in the “dependent” ages (under 15 and over 64 years) to those in the “economically productive” ages (15-64 years) in a population. The age-dependency ratio is used as an indicator of the economic burden the productive population must carry in order to support dependent population. The age-dependency ratio in Chunoti is estimated as 80%, which indicates a higher dependent-aged population in comparison to economically productive population residing in and around the Sanctuary.

The survey on religious configuration indicates a slightly higher representation of Hindu (13%), Buddhist (8%) and Christian (7%) population when compared with the national averages of 9% for Hindu and less than 1% for Buddhist and Christians. Nearly one-third (35%) of the present population in Chunoti have migrated from other parts of the country during last 7 years (since 2000). As a result, biotic pressure on both forest produce and forest land has increased

manifold. There are 96 Primary Schools, 30 Madrassas, 26 High Schools and 2 Colleges in the interface landscape. Male (79%) and female (77%) literacy rates in Chunoti are higher than the national averages. A large no. of children discontinue schools mainly to support their families by working in household activities but also as labor. The female children drop out due to distance and early marriage.

The patron-client relationship is complex in the studied villages. Only one-third of total population is literate. Only one-quarter of total population have sanitation facilities. The biotic pressure on forest resources is increasing steadily, especially due to rapid population growth, increased urbanization, industrialization and agricultural demand for land and forest produce. Nearly one-third of the local population remains unemployed, particularly during agriculture lean season when loans are taken and credit is most needed. During the months of February and March, before the paddy harvest, local people go through a hard time, when food shortage is experienced. Only accessible natural resources available to common people are indeed common pool resources such as forests and wetlands. Grass, bamboo and fuelwood are collected by local people from the nearby forests for meeting their demand for subsistence consumption. The predominantly agrarian economy of local people, therefore, puts a heavy demand on Chunoti's forests that have in past been unsustainably harvested. Betel leaf cultivation is practiced and crop damages by elephants have been reported by local people. In ranking people's needs for forest produce, fuel, timber and non-timber forest products come at priority.

Village society in Chunoti is divided into a few small samaj (community groups) with its informal (e.g. Imams) and formal (elected representatives of Union Parishads) leaders. They play an important role in the motivation of local people and so have been consulted before introducing the reforestation activity. Local people are aware of the depletion of forest resources in their vicinity and the effects of deforestation on their life. They want to plant more trees and understand about different plantation models including block and enrichment plantations due mainly to the efforts made in different forestry projects including FSP and NSP. Their awareness and motivation regarding forestry programs enhances the absorptive capacity of the resource users such as FUGs and CPGs. Accordingly they are to be involved in the design, implementation and other important decision-making processes of the reforestation activity.

Local people were found conservative when assessed on gender issues. Women folks, particularly from rich families, are not allowed to work outside and are so mainly housewives, keeping themselves busy in doing household works. The existing socio-economic conditions, traditions and lack of suitable skills and opportunities have restrained women from participation in economic activities. But poor women are engaged in self-employment in household-based income

generation activities such as poultry, duck and cattle rearing, pond fishing, etc. The male members of a family earn money, control the resources and generally dominate in decision-making. Some ethnic groups settled near to forest areas, however, have working women, particularly in forest related activities. Nearly one-tenth of the female population aged 10 years and above is classified as widow or divorced to whom the benefits of reforestation activity will be directed. Women showed preference for nursery development and to plant fruit trees in their homestead and so female FUGs will particularly be focussed. Many NGOs organize poor women into groups and provide credit and technical support for income generation activities.

The population density in the interface landscape is higher than the national average. Agriculture is the main source of income for nearly one-quarter of the households, the remainder being engaged in small and medium business, labour, fishing, trade and service. Landlessness is increasing due to rapid population growth, inheritance pattern, natural calamities, river erosion and the inability of the indebted poor to recover their mortgaged land. Landless households generally have homesteads and practice share cropping but also work as labour. All expenses for producing agriculture crop are borne by the share-cropper and the share paid to the land owner is generally 50% of the total production. The share-cropping agreement is on a year tenancy basis but no formal deeds are signed. As a consequence, no planting of trees are allowed by the land-owners on rented lands. The informal sector is very active and petty trading in food and forest products grown on private land, or homesteads or simply collected from forest areas is sizeable.

Rural farm households are stratified as small, medium and large, according to land holding size. Among land owning households, nearly two-third are small farms with less than 1 ha, one-fifth are medium farms with land holdings varying from 1 to 3 ha and the remainder are large farms of more than 3 ha. Land ownership of farm holdings is unevenly distributed; two-third of total small farmers own less than half (40%) of the land, whereas one-fifth of total medium farmers own nearly half of the land, and the large farms take up the remainder land holdings. Among the rural households, about half have bovine livestock, one-quarter have sheep and goat, and two-third raise poultry.

The proposed reforestation activities are labour-intensive and so a large number of local people will get wage employment opportunities during the project implementation period. In addition, livelihood opportunities are planned for the members of CPGs and FUGs who will help protect forests through community patrolling. A revolving fund has been proposed for implementing various income generation activities for the members of FUGs and CPGs. It is expected that the farmers of nearby private land will be benefited due to water and soil conservation in the Sanctuary. Improved environment will positively contribute

for the good health of local people. Forward and backward linkages of eco-tourism will be beneficial for local community. Some NTFPs such as orchids, fruits and medicinal herbs may be allowed to local people residing in and around the Sanctuary.

A conflict resolution mechanism will be established by the CMCs in order to resolve socio-economic issues during the project implementation.

G.2. If any negative impact is considered significant by the project participants or the host Party, a statement that project participants have undertaken a socio-economic impact assessment , in accordance with the procedures required by the hsot Party, including conclusions and all references to supporting documentation

No significant negative impacts are envisaged due to the implementation of the proposed A/R CDM project activity

G.3. Description of planned monitoring and remedial measures to address significant impacts referred to in section G.2. above

None are required.

SECTION H. Stakeholders' comments

H.1. Brief description of how comments by local stakeholders have been invited and complied

This PDD has been prepared in consultation with the key stakeholders including the staff of FD, CMCs, BFRI and NSP. Formal presentations were made to the senior FD and BFRI staff, and CMCs at various stages of the project development. The final document incorporates their valid suggestions and comments.

Stakeholders's consultation in Chunoti started with the implementation of Nishorgo Support project in 2003 when PRA/RRA exercises were taken up by the project staff. Participatory management planning during the 2005-06 further strengthened the process of stakeholders' consultation on relevant reforestation technologies and methods that were finally included in the Government approved plans. Chunoti and Jaldi co-management committees held stakeholders' consultations by involving FD field staff, FUGs, CPGs, co-management councils, Nishorgo clubs, etc. Stakeholders' consultations were then held with local people to understand land status, physical location and management options.

The physical location and relevant boundaries for the biodiversity mitigation project were identified based on the maps as prepared for the management plans and updated (maps of 1: 30,000 scales with 2mx2m grid lines) under NSP by making field visits. The project boundaries consisted of both temporal and geographic domain within which carbon stock changes were estimated and will in future be monitored. Possible management options for reforestation were finalized in consultation with the FD staff and the members of two CMCs. The nature of carbon pools (forest carbon in above-ground biomass, below-ground biomass, on-ground biomass, and soil carbon) was assessed and monitoring parameters were finalized during field visits. Technological options for restoring the degraded forest landscape of Chunoti and their potential for the mitigation of carbon dioxide (CO_2) were discussed in monthly meetings of the two CMCs.

H.2. Summary of the comments received

During participatory discussions the stakeholders' comments related mainly to the tree species, maintenance of plantations, protection mechanism, number of weeding in the first three years of planting, revolving fund, project boundary, alternative income generation activities, etc.

H.3. Report on how due account was taken of any comments received

All the relevant suggestions made by the stakeholders have been included in the design of the recommended reforestation technology package and methods.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROPOSED A/R CDM PROJECT ACTIVITY

Organization	Bangladesh Forest Department
Street/P.O. Box	Agargaon
Building	Ban Bhaban
City	Dhaka
State/Region	
Postfix/ZIP	1212
Country	Bangladesh
Telephone	
FAX	00880 2 811 9453
E-Mail	cf-wnc@bforest.gov.bd
URL	
Represented by	
Title	Project Director
Salutation	Mr.
Last Name	Ahmad
Middle Name	Uddin
First Name	Ishtiaq
Department	Forest Department
Mobile	01712085944
Direct FAX	
Direct tel:	00880 2 8127222
Personal E-Mail	ahma002@umn.edu

Annex 2

INFORMATION REGARDING PUBLIC FUUNDING

No funding will be diverted from the Official Development Assistance

Annex 3

BASELINE INFORMATION

Data/Parameters	Description	Vintage	Resolution	Sources
Historical land use data	- Demonstrating eligibility of land -Determining baseline approach	1989 & 2006 Satellite imageries	1 : 250,000	Department of Space (SPARSO), GOB
Land use cover map	- Demonstrating eligibility of land -Stratification	2006 Satellite imageries and 1998 Aerial Photographs	1 : 30,000	NSP (various sources including IRS, LISS-III and Aerial Photographs)
National and sectoral policies	-Forest Policy, 1994 -Poverty Reduction Strategy Paper	1994 2007		Govt. of Bangladesh
UNFCC	UNFCC decisions and guidelines			UNFCC website
IPCC	IPCC guidelines on LULUCF projects	1996, 97, 2001, 2003, 2007		IPCC website and reports
V	Above-ground Volume	2007		Volume equations of BFRI
MAI	Mean annual increment	2007		Estimates of BFRI
B	Above-ground biomass	2007		Estimated from V by using density value
C	Above-ground carbon	2007		Estimated from B by using carbon factor

Annex 4

SUMMARY MONITORING PLAN

Monitoring of the baseline net GHG removals

Baseline carbon stocks for forests and soils have been estimated for all the nine strata spread over the study area of 7,764 ha. The project activity in terms of reforestation is planned over an area of 5,000 ha only. The baseline net GHG removals by sinks do not need to be measured and monitored over time.

Monitoring of the proposed project activity

1. Monitoring project boundary and project implementation

a). Monitoring the boundary of the proposed A/R CDM project activity
The boundaries of the Sanctuary are marked on the map and are identified by the CMC and FD on ground. The boundary of the proposed reforestation patches for all the three categories will be marked both on the map and in the field (through GPS) before taking up plantation activities. These measured GPS locations will be entered into the GIS system to be maintained in the RIMS of FD and made available locally to the CMCs. The project boundary will subsequently be monitored periodically (after every 5 years) by the CMCs all through the carbon credit period. Any deviations (e.g. deforestation, plantation failures) in project boundary will be notified to all concerned in order to take corrective actions.

b). Monitoring of forest establishment
The following monitoring activities shall be conducted for monitoring the forest establishment:

- The quantity and quality of seedlings of the proposed tree species will be closely monitored by the CMCs while developing nurseries of both indigenous and other fruit/fodder species.
- Site preparations before taking up planting will be monitored as per the technical prescriptions. For example, no clearfelling of existing vegetation and burning will be allowed. Similarly, no tillage will be done to cause long-term net emissions from forest soils.
- Initial planting survival rate will be assessed through field surveys to be mounted within 3 months by the CMCs by employing the members of CPGs and FUGs. This monitoring will subsequently be repeated annually in permanent sample plots laid out in all the 3 categories of plantation areas.

c). Monitoring of forest management

The application of cowdung and farm yard manure during planting will be monitored and records kept for inspection. As thinning and harvesting are not planned, no monitoring is envisaged for resource extraction. However, the regeneration status and the growth of forest stock will be monitored every 5 years in the identified permanent sample plots.

2. Stratification and sampling for ex-post calculations

a). Stratification

Based on the study of relevant documents including management plans, imageries and maps, and field visits/inventories, the forest area is pre-stratified into 9 strata as discussed in detail in Section B. The ex-post stratification will be done based on the tree species planted, year of planting, protection mechanism, cost, etc.

b). Sampling

i) Sample size

Permanent sample plots will be laid out for measuring and monitoring forest carbon and soil carbon stocks. The sample size for each stratum will be estimated based on the methodology given in version 2 of AR-AM0001 (as detailed in Section C.3.1.). This will require an estimation of mean standard deviation of carbon stock and carbon changes during the monitoring period.

ii) Random sample plots

The permanent sample plots (circular plots of 0.1 ha with 17.84 m radius) will be selected by following the systematic random sampling methodology (locating plots systematically with a random start) that is considered a good practice for LULUCF projects. An effort will be made to ensure that the sample plots are evenly distributed as far as possible. The GPS coordinates, forest beats and other administrative locations will be recorded for each of the identified plots.

iii) Monitoring frequency

The reforestation is planned to start by rainy season next year (June-July 2009) and will continue over a period of 5 years as per the financing plan (see Section A.4.4.). The frequency of monitoring will be every five years.

3. Measuring and estimating carbon stock changes over time

The methods as explained in Section E.4.1. will be followed.

4. Monitoring GHG emissions by sources as the results of the A/R CDM project activity

The procedures as explained in Section E.4.2. will be meticulously followed.

5. Quality assurance and quality control (QA/QC)

The procedures as recommended in the IPCC (20030 will be followed for ensuring quality (Section 4.3.4).

Procedures to ensure reliable field measurements

Field formats will be field validated and field crew will be trained before start of field works. All field data will be checked by a technically qualified staff in cooperation with field staff. A Standard Operating Procedure (SOP) for each step of the planned field measurements will be prepared and adhered to.

Procedures to verify field data collection

Selected plots (say 1% of total no. of plots) will be re-measured by other members of a field team and the results will be compared to check for errors. Any errors will be recorded and corrected.

Procedures to verify field data entry and analysis

Data entry will be made for preparing spreadsheets that can be subsequently used for carrying out different analyses. Errors will be minimized by exercising field checks, cross-checking and making plausible judgments.

Data maintenance and storage

As the project activity is long-term by nature, the data collected during the project implementation will be archived for future use. Both electronic and paper copies of data will be stored in safe places and updated regularly.

6. Uncertainty assessment

The uncertainty in each species in each stratum can be estimated from re-measurement of randomly selected plots and/or from the measurement of replicate plots by employing the following equations:

Us = (½) x {(95% confidence level interval width)/μ}x 100
Where, μ = mean value

$Uc = (\sqrt{(Us1 \times Cs1)^2 + (Us2 \times Cs2)^2 + \ldots\ldots\ldots\ldots + (Usn \times Csn)^2})/(Cs1+Cs2+\ldots.+Csn)$

Where, Uc = combined percentage uncertainty of sub-stratum,
Csi = mean carbon stock of species in the sub-startum

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