Climate change mitigation through forests in Bangladesh: A policy approach to forestry practice

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Anthropogenic emissions of greenhouse gases have been identified as the main cause of global warming and climate change. As one climate change mitigation option, the Clean Development Mechanism (CDM) under the Kyoto Protocol has created the global warming mitigation opportunities that allow Bangladesh to receive investments from developed countries wishing to offset their emissions of greenhouse gases. Bangladesh has a special interest in strategies for combating global warming because its large areas to be planted represent a potentially large carbon sink. The high rate of deforestation contributes a large carbon source. To properly assign carbon credits in the forestry sector of Bangladesh, a number of important issues and uncertainties need to be resolved. Definition of the accounting method and the means of crediting forest reserve establishment are two important issues. Reforestation offers opportunities for carbon credits for the uptake in forest biomass. Current accounting rules, however do not account for carbon stored in forest products. Forest management has been proposed as a global warming response option for the bigger benefits in the short-term while the afforestation/reforestation can give credits in the long-term. Reforestation can be the greatest option offered by Bangladesh for mitigating climate change in the first commitment period. Under the current rules, avoided deforestation does not give any credit in the same commitment period. Slowing deforestation also can be an important option in the second commitment period. The paper discusses the compatibility of the CDM and global response opportunities in Bangladesh; the opportunities of the Bangladesh Forestry Sector to mitigate the climate change; issues to be settled for carbon credits; the implications of the forestry options for different land uses as well as forest management with carbon benefits. The paper finally discusses the future policy options of the forestry sector of Bangladesh to mitigate the climate change and to obtain carbon credits.

Keywords: CDM, Climate change, Forest management, Land-use change

Introduction

Global warming has been identified as the cause of anthropogenic greenhouse gas (GHG) emissions, principally carbon dioxide (CO_2) in the atmosphere due to the industrial activities and other combustion of fossil fuels for non-industrial activities; deforestation and other land-use changes (Fearnside, 2006;Houghton, 2005;Nordell, 2003). Mayaux *et al.* (2005) and Achard *et al.* (2002) reported that world's humid tropical forests had been disappearing at a rate of about 5.8 (±1.4) m ha yr^{-1}, with a further 2.3 (±0.7) m ha yr^{-1} of forests visibly degraded between 1990 and 1997.

Kram *et al.* (2000) points out that the distribution of both income and GHG emissions is very unbalanced between various world regions. The relative importance of individual gases and sources of emissions differ from region to region. Kram *et al*. (2000) analyzed that currently developing countries account for about 46% of all emissions, but by 2100 no less they contribute 67-76% of the global total; while the total income generated in these countries reaches 58-71% from only 16% in 1990. But Kram *et al*. (2000) conclude that when population size and the levels of affluence in the developing countries confront with the potential severity of climate change induced damages, the scenarios are very different. Higher population densities and lower income make the countries more vulnerable for adverse climate change impacts, and that lower income create less favorable conditions for mitigation and/or adaptation measures. Domestic activity in developed countries must therefore receive priority, and the main emitters of CO_2 should assume their responsibility for tackling the causes. In the Protocol, which was adopted in Kyoto, Japan, in 1997, industrialized countries committed themselves to reduce their combined GHG emissions by more than 5% relative to the level in 1990, in the period between 2008 and 2012. The Kyoto Protocol recognizes forestry and land-use change activities as sinks and sources for atmospheric carbon. In a special report on land use, land-use change and forestry, the Intergovernmental Panel on Climate Change (IPCC) concludes that activities in the realm of land-use change and forestry provide an opportunity to affect the carbon cycle positively (IPCC, 2000). FAO (2001) proposes three possible strategies for the management of forest carbon. The first is to increase the amount or rate of carbon accumulation by creating or enhancing carbon sinks. The second is to prevent or reduce the rate of release of carbon already fixed in existing carbon sinks. The third strategy is to reduce the demand for fossil fuels by increasing the use of wood, either for durable wood products (i.e. substitution of energy-intensive materials such as steel and concrete) or for biofuel (carbon substitution). A number of carbon sequestration and carbon conservation initiatives have already been developed, including Activities Implemented Jointly (AIJ) under the UNFCCC and Land Use Change and Forestry carbon projects (FAO, 2001).

Carbon sequestered by the national forests and afforestation/reforestation (A/R) projects were well identified by Hansen *et al*. (2004), Cannell (2003), Pussinen *et al*. (1997), Karjalainen (1996), Ravindranath and Somashekhar (1995) and Ismail (1995), etc. The carbon sequestration potential of forests is specific to the species, site and management involved, and it is therefore very variable. Assuming a global land availability of 345 m ha for A/R and agroforestry activities, Brown *et al*. (1996) estimate that approximately 38 Gt of carbon could be sequestered over the next 50 years-i.e., 31 Gt by A/R and 7 Gt through the increased adoption of agroforestry practices.

The implication of the legal frameworks of the Clean Development Mechanism (CDM) on the Kyoto Protocol is important for creating CDM forests in Bangladesh and to achieve the ‘Certified Emission Reduction’ (CER). In addition to this, appropriate policy formulation is also critical to achieve the carbon credits in the country. Finding out the forestry options for mitigating global warming are critical to the reorientation of Bangladesh to participate in the international global warming mitigation initiatives. The study aims at the implications of the Kyoto Protocol and its CDM in Bangladesh; potentialities of Bangladesh forestry sector to combat the global warming with its different land uses. It also discusses the policy issues to expedite the development of the CDM forests in Bangladesh. The findings of this study would be useful for the policy makers, environmentalists and the investors to the CDM forests.

Kyoto Protocol to mitigate the climate change

To effectively address the anthropogenic climate change, GHG emission was recognized importantly by the Kyoto Protocol. It was the product of the COP3 (Conference of the Parties) of the UNFCCC (United Nations Framework Convention on Climate Change) with the target of ‘stabilization of GHG concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system’. The Protocol sets specific reduction targets and timetables for reducing net GHG emissions from the Annex I (Industrialized) countries. It calls for Parties to reduce their annual emissions 5% below 1990 emissions. The Protocol with the ratification of Russian Federation came into force on February 16, 2005. As of September 28, 2006, 166 states and regional economic integration organizations have deposited instruments of ratifications, accessions, approvals or acceptances (Error: Reference source not found). A total of 37 Annex I and 129 Non-Annex I Parties compose this Kyoto Protocol Parties. The total percentage of the Annex I Parties emissions is 61.6% (UNFCCC, 2006). Bangladesh remain in the Non-Annex I list of the Parties.

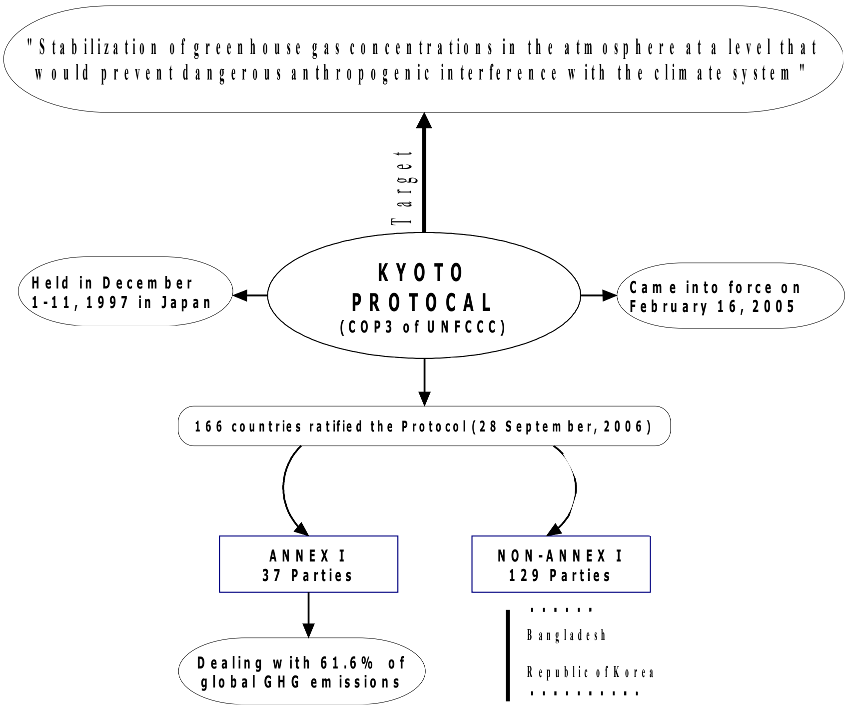


Figure 1. Adoption of Kyoto Protocol in response to the climate change

Several provisions in the UNFCCC and Kyoto Protocol allow nations to achieve GHG emission reductions or enhancement of sinks cooperatively. As a general matter, the UNFCCC commits the most highly developed nations, to give developing countries financial and technical assistance to implement the convention and deal with the effects of climate change. The Article 4 of the UNFCCC obligates the developed nations to assist developing nations through funding for emissions reductions, funding for adaptation to adverse effects and transfer of environmentally sound technology (Rosenbaum *et al.*, 2004). The Articles 4, 6, 12 and 17 of the Kyoto Protocol contemplate flexible mechanisms of compliance. The Article 4 deals with the possibility that a group of Annex I Parties or a regional economic integration organization could jointly fulfill their reduction commitment. The Article 6 allows Annex I Parties to transfer ‘emission reduction units’ generated through JI (Joint Implementation) projects and allows Parties to authorize ‘legal entities’ to participate in these transfers. Eligible JI projects include all ‘Land Use, Land-use Change and Forestry’ (LULUCF) activities allowed under Article 3.

CDM as a flexible mechanism

The Article 12 of the Kyoto Protocol introduces the CDM, originally a part of AIJ (Activities Implemented Jointly). The CDM is an instrument under the authority of the COP and supervised by an Executive Board. CDM projects typically involve Annex I countries as investors and Non-Annex I countries as hosts, essentially joint ventures between developed and developing countries (Figure 2).

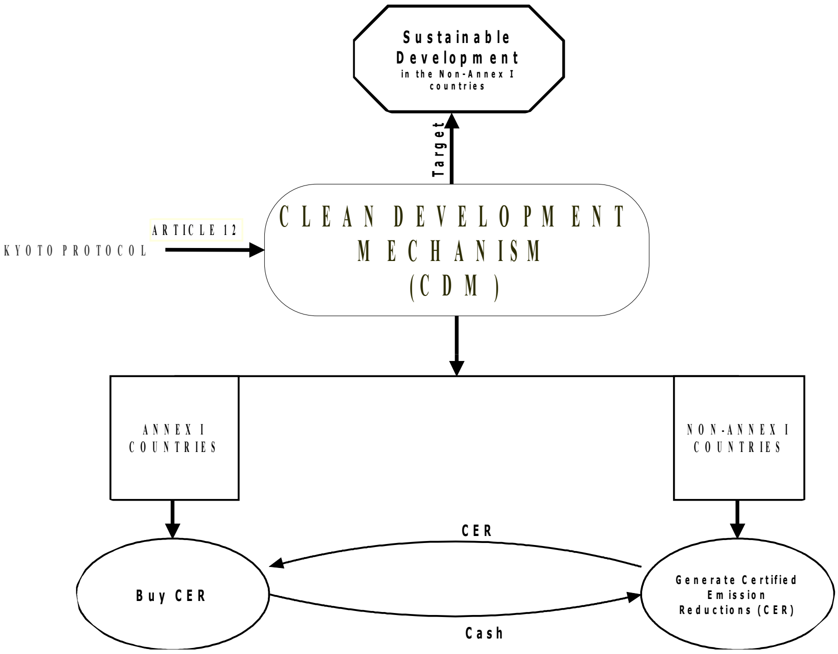


Figure 2. Target and procedures of CDM of the Kyoto Protocol

Reductions resulting from these projects, beginning in the year 2000, count towards satisfying an Annex I country's obligations to reduce aggregate emissions during the years 2008 to 2012 (First commitment period). An 'operational entity' accredited by the COP must validate the project before implementation and verify the project's emission reductions before the Executive Board can issue credits for the emission reductions achieved.

Silveira (2005) discusses the role of CDM in respect of sustainable development, formation of carbon markets, and promotion of bioenergy options. His study concludes that bioenergy projects are attractive and CDM provides a complementary bridge for international cooperation towards sustainable development. Ravindranath *et al*. (2006) and Reddy & Balachandra (2006) also conclude that a woodfuel stove project with the improvement of the traditional stoves can well be put on the international 'carbon market' at competitive cost for GHG emission reduction. Forest management and conservation as well as carbon sequestration in agriculture are not allowed in the first commitment period. Furthermore, the credit that a Party can claim from LULUCF projects under the CDM is 1% of the Party's base year (1990) emissions, times five (Rosenbaum *et al.*, 2004). The COP agreement means that over the five years, one-fifth of the reduction can come from CDM-LULUCF projects (Rosenbaum *et al.*, 2004). The negotiations are being continued how to treat CDM-LULUCF projects after 2012.

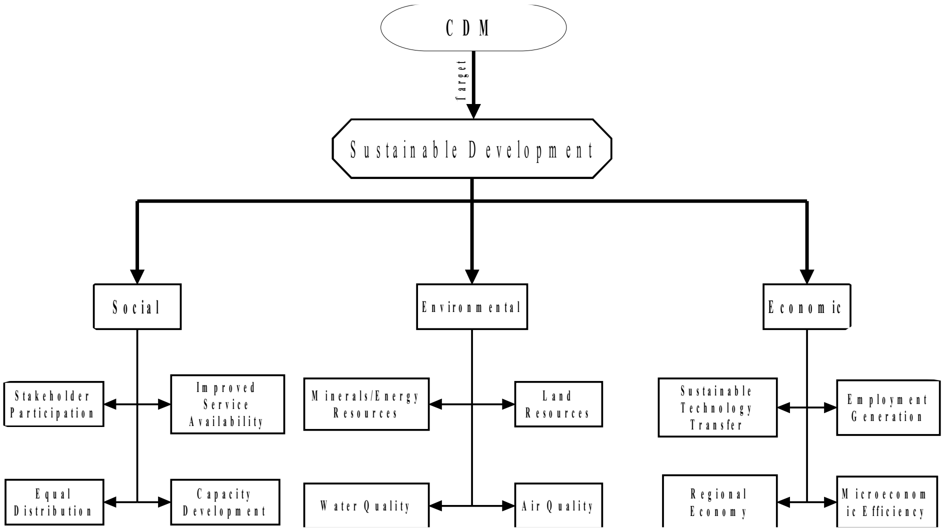


Figure 3. Sustainable development criteria of the CDM of the Kyoto Protocol

However, CDM projects are expected to derive the sustainable development in the Non-Annex I countries (Figure 3). The development must be in the social, environmental and economic arena of a country. The possible carbon sequestration, carbon combustion efficiency and carbon substitution projects are expected to derive lots of impacts on the overall of a host country (Figure 4).

Carbon sequestration in the CDM

Terrestrial ecosystems are clearly influencing the concentration of GHGs to the atmosphere (Lal, 2004) as it works both sinks and sources. Greenhouse gases are constantly entering and leaving the atmosphere. Actively growing trees and other plants uptake CO_2 from the atmosphere combines it with water through photosynthesis and creates sugars and more stable carbohydrates (Rosenbaum *et al.*, 2004). Through this process, trees capture and store atmospheric CO_2 in vegetation, soils and biomass products. Carbohydrates become the building blocks and energy supply for most of life on Earth. Eventually, when plants and animal die, CO_2 returns to the atmosphere. When wood products or other organic materials burn or decompose, they also release CO_2 (Figure 5).

The terrestrial ecosystem plays an important role in global carbon sequestration. It has been estimated that 1146 GtC is stored within the 4.17 b ha of tropical, temperate and boreal forest areas, about one-third of which is stored in forest vegetation (IPCC, 2000). Aboveground biomass in the tropical forests and belowground biomass of the savannas in the tropics have the greatest carbon storage as 212 GtC and 264 GtC, respectively (IPCC, 2000). Soil carbon represents the largest carbon pool of terrestrial ecosystems, and has been estimated to have one of the largest potentials to sequester carbon worldwide (García-Oliva and Masera, 2004). Soil stores about 80% of the total carbon sequestered by the terrestrial ecosystem, ranging from 50% in tropical forests to 95% in tundra (IPCC, 2000). The anthropogenic causes hamper this storage of carbon in the forests.

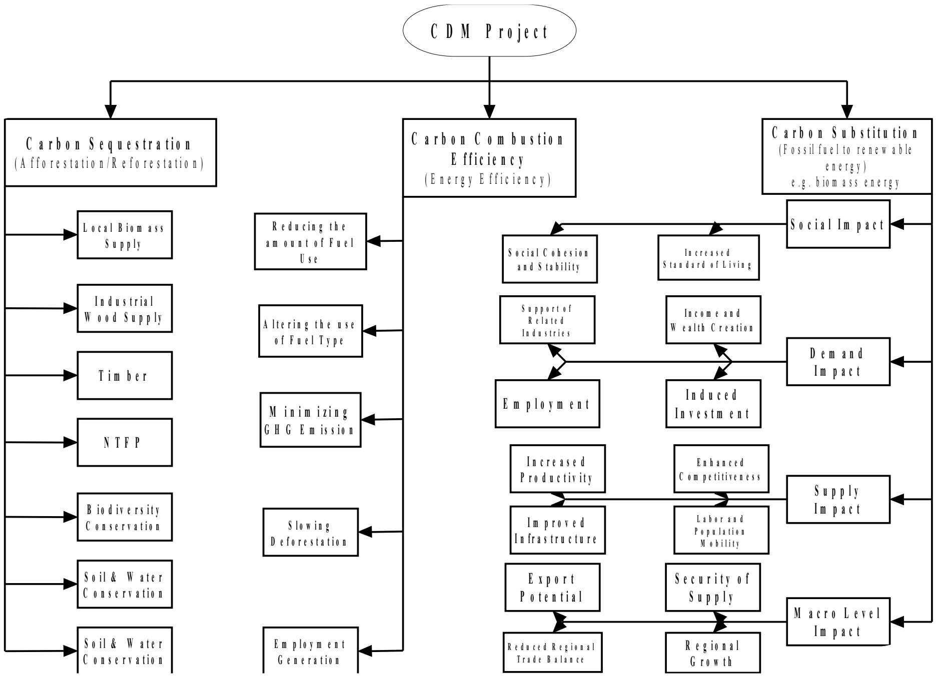


Figure 4. Possible projects in the first commitment period and their utility

The practice of sustainable forest management can enhance the sinking characteristics of forests (Rosenbaum *et al.*, 2004). Establishment, enhancement and protection of forest ecosystems can affect the GHG concentration in the atmosphere. A/R of non-forested or degraded forest lands can increase; and prevention of deforestation can maintain the amount of carbon held in forests (Rosenbaum *et al.*, 2004). The relative low-cost of A/R, compared with non-forest offset options, may make them economically attractive (Cannell, 2003;Niles *et al.*, 2002;Ravindranath and Somashekhar, 1995). Selective cutting schemes, lengthened rotations, reduced-impact logging, and species choice may achieve a higher average level of sequestered carbon (Rosenbaum *et al.*, 2004). Simply postponing or eliminating harvesting can sometimes be a short to medium term means to keep carbon sequestered (Schulze *et al.*, 2000).

Using wood in building and other long-lived objects effectively sequesters carbon for the life of the objects. Substituting essentially carbon-neutral wood for energy-intensive materials such as brick, aluminum or steel may significantly reduce the use of fossil fuels, which of course release CO_2 when burned (Rosenbaum *et al.*, 2004).

Sustainable production of wood fuel from forests can displace fossil fuels. Although burning of biomass fuels releases CO_2, the re-growth of a sustainably managed forest offsets that releases. Thus, forest fuels can supply energy virtually without net contribution to GHG levels (Rosenbaum *et al.*, 2004).

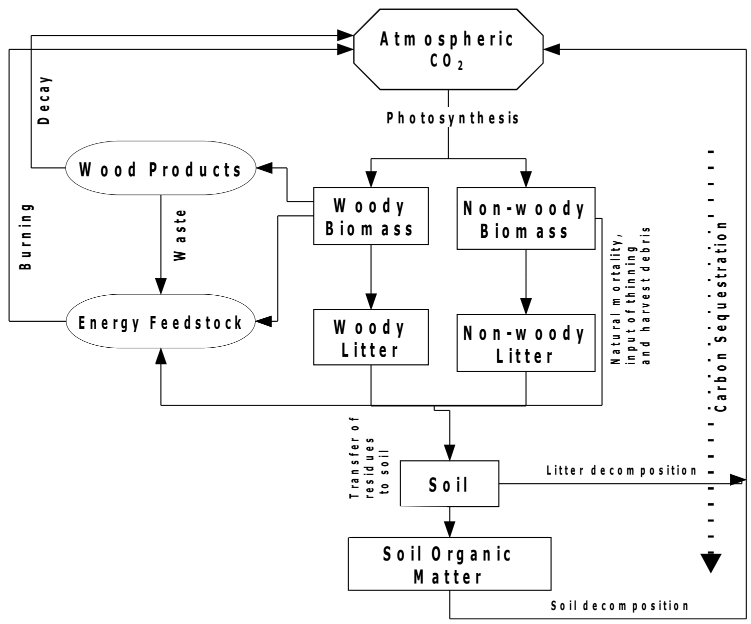


Figure 5. Carbon sequestration by the forests in the carbon cycle

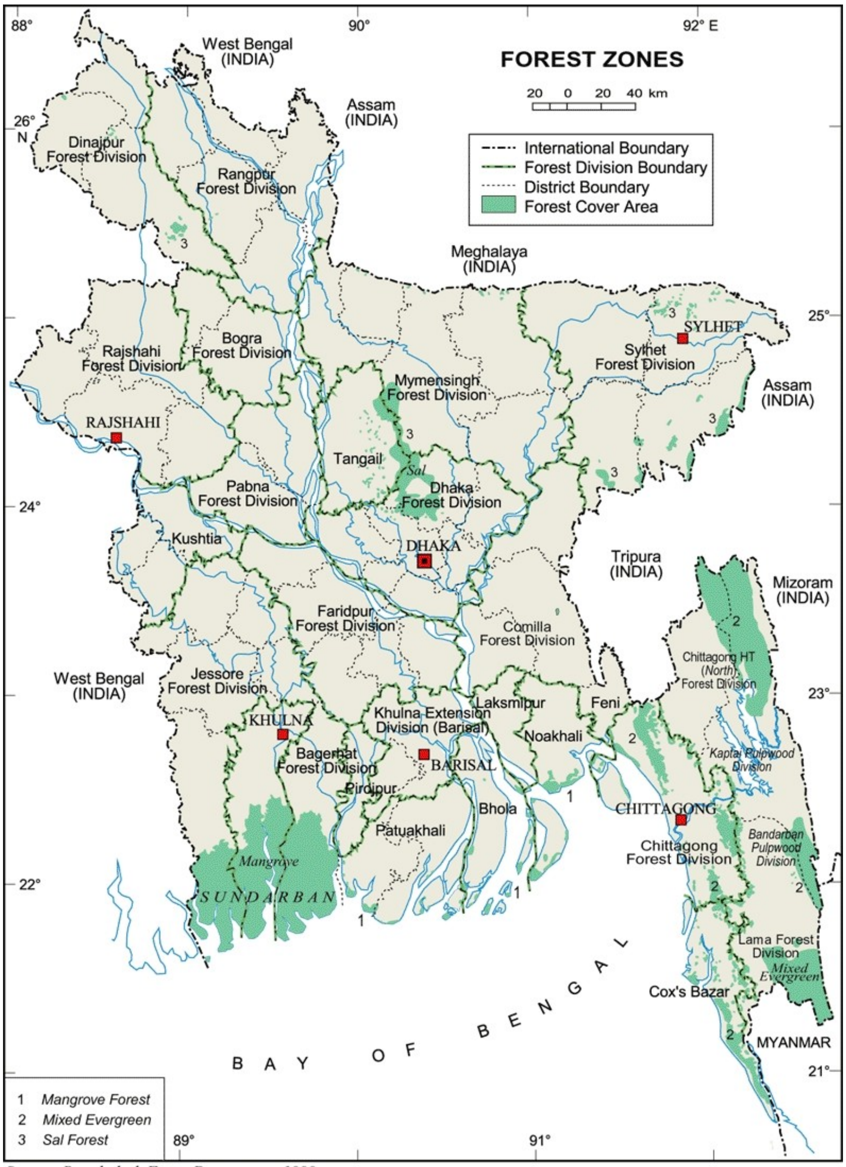
Bangladesh and its forestry sector

Bangladesh is located in the South Asia ranged between 20º34/ to 26º38/ N latitude and 88º01/ to 92º42/ E longitude with a geographical coverage of 14.76 m ha with three broad categories of land-hills, uplifted land blocks and alluvial plains. The country is characterized by low per capita gross national product; low natural resource base; high population density, and high incidence of natural disasters. The climate is subtropical, characterized by high temperature, heavy rainfall, often excessive humidity, and fairly marked seasonal variations. Though more than half of the area is located in the north of the tropics, the effect of the Himalayan mountain chain makes the climate more or less tropical throughout the year (MoEF, 2005). The country has an almost uniformly humid, warm, tropical climate. The mean annual rainfall varies widely within the country, according to geographical location, ranging from 1200 mm in the extreme west to 5800 mm in the east and northeast (MoEF, 2005).

In 2006, the population of the country was about 155 m (FAO, 2009) having 1198 people per km^2 in the country. Among the total population 74.5% of the population lives in rural areas. The primarily agricultural economy of Bangladesh has recorded around 5% annual growth rate over the last few years (ADB, 2001). The main crops grown in the country are rice and jute. Per capita GDP (ppp) was US$ 1155 in 2005 with the annual growth rate 6.6 (FAO, 2009).

Forestry is an important sector in Bangladesh's economy. It contributed about 1.84% of the country's GDP and 10.2% of the agriculture income in 2003/2004. The annual GDP of this sector in 2003/2004 was 4.48% (GOB, 2004). Iftekhar (2006) reports that 'if environmental services and contribution in people's livelihood could have been properly accounted for, then the share of the forestry sector would have been much more'. Forestlands make up almost 18%, agricultural lands 64% and urban areas 8% of the total lands in Bangladesh (FAO, 1998). The state owned forest land is shown in the figure 6. Other land uses account for the remainder. Total forestland area is 2.56 m ha, including officially classified and unclassified state lands, village forests and tea/rubber gardens. Most of the

state forestland is degraded. Classified and unclassified forestland signifies an administrative or legal category, not necessarily areas with forest cover. The natural forest accounts for about 31% and forest plantations 13% of total forest areas. Shifting cultivation, illegal occupation and unproductive areas account for the remaining forestland (FAO, 1998). Presently, protected areas represent just over 5% of forestland administering 65% of state forestland while the other forestlands are administered by local District Commissioners (DC). The better quality natural forests and plantations in the government forestlands, excluding parks and sanctuaries (medium to good density), makes up around 0.8 m ha, which is 5.8% of Bangladesh's total area. The area included in the present protected area network is 0.12 m ha, equal to 5.2% of state forestland or less than 1% of Bangladesh's total area (FAO, 1998). In 2005, forest area per 1000 people was 6 ha. The mean annual change rate between 2000 and 2005 was
-0.3%.



Source: *Bangladesh Forest Department, 1999*

Figure 6. Major three forest types in Bangladesh

Present forest land-use and its problems

More than 90% of the state owned forestland is concentrated in 12 districts in the eastern regions. Out of 64 districts in the country, there is no any national forestland in 28 districts (FAO, 1998). So, the national forestland in Bangladesh is eccentric. About 6,000 ha of forestland were believed to be lost each year due to various reasons. But recent observation by the Forest Resource Assessment Project suggests that the annual rate of forest destruction has exceeded 37,600 ha (FAO, 2000).

Ali (2002a) describes that illegal harvesting; encroachment and shifting cultivation are the important problems in forest land-use in Bangladesh. In Bangladesh, individual offences related to illegal harvesting are mostly for fuelwood, home, and farm implements or for the sale of goods in the market for personal daily livelihood requirements. Although per capita fuelwood consumption of Bangladesh is one of the lowest in the subcontinent, fuel wood supply from the state forests of Bangladesh has not been enough to meet the demand of the whole population (BBS, 1997). Official fuelwood supply from the forest (1985-90) was only 0.7 m m^3 yr^{-1}, whereas the demand was about 7.0 m m^3. The case for timber was similar. The average supply from the forest was 1.09 m m^3, whereas the demand was 2.42 m m^3. As the gap between supply and demand continued to grow, illegal harvesting was reported to be increased. As a result of forest clearance, encroachment is one of the worst problems of Bangladesh forest land-use. Once the forest is cleared and left un-forested, people start to invade and claim the land as their own. Ali (2002b) describes that about 62,000 ha of national forest land has been encroached up to December 1980, and more than 88,000 people were living inside forests. Moreover, there were about 5,000 forest villagers living inside forests legally, whose number was also increasing.

Shifting cultivation is an age-old practice in the hilly areas of Bangladesh. Although it is not the common practice of plain-land people, the way tribal people conduct shifting cultivation, particularly through the use of fire and terracing of hilly land, was considered highly detrimental to the forest environment (Ali, 2002b). According to GOB (1993) about 60,000 households were practicing shifting cultivation at the time on 85,000 ha of land with an average of only 1.3 ha land per household. Presently the numbers have been dramatically increased due to the increase of tribal population.

Bangladesh Forestry Sector to mitigate the climate change

Overall carbon sink

Owning diversified forest ecosystems, i.e., wet forest lands, rain forests, moist deciduous forest, semi-arid areas and mangroves, Bangladesh forestry sector is acting as an important carbon sink. It has been estimated that about 5000 species of higher plants with thick foliage and species diversity occur in Bangladesh.

On an average, 92 tC ha^{-1} (Table 1) is stored by the existing tree tissues in the forests of Bangladesh (Shin *et al.*, 2007). Among them, closed large-crown forests 121 tC ha^{-1}, closed small-crown forests 87 tC ha^{-1}, disturbed closed forests 110 tC ha^{-1} and disturbed open 49 tC ha^{-1}. ESSD (1998) reports that forest soils in Bangladesh store carbon at a rate of 115 tC ha^{-1},100 tC ha^{-1} and 60 tC ha^{-1} in moist, seasonal and dry soils, respectively. But Shin *et al.* (2007) commented that due to the over extraction of the forest resources and encroachment in the forests, soil carbon reduce fast.

Table 1. Biomass and carbon density in the forests of Bangladesh

Forest types	Aboveground biomass tdm ha^{-1}	Underground biomass tdm ha^{-1}	Total biomass tdm ha^{-1}	Carbon stock tC ha^{-1}
Closed large-crowns	206-210	32	242	121
Closed small-crowns	150	23	173	87
Disturbed closed	190	29	219	110
Disturbed open	85	13	98	49
Average				92

(Shin *et al.*, 2007)

Specific carbon sinks through A/R

According to the modalities of the CDM adopted at COP7 in Marrakesh, Morocco, in November 2001(Marrakesh Accords), it can allow projects both in LULUCF and energy sectors. In the first commitment period, CDM restricts the LULUCF projects only to A/R which comply with the SBSTA (Subsidiary Body for Scientific and Technological Advice) recommendations adopted in COP9 (Decision 19/CP.9). The recommendation of SBSTA includes the details of definitions, non-permanence, leakage, additionality, uncertainties and socio-economic and environmental impacts, including impacts on biodiversity and natural ecosystems (Rosenbaum *et al.*, 2004). Shin *et al.*(2007) estimated the carbon sinks through A/R including the 13 plantation tree species of ages ranging from 6 to 23 years in the tropical semi-evergreen forest zone in the Chittagong region of Bangladesh. It was found that 190 tC ha^{-1} exist in the forests including above-ground, under-ground tree tissues and soils through A/R. The average highest biomass carbon content (145 tC ha^{-1}, S.E[*]. 7.73) was found in the *Aphanamixis polystachya* stands, and the lowest (43 tC ha^{-1}, S.E. 7.70) was found in the *Swietenia mahagoni* stands. The average highest soil (including humus) carbon content (113 tC ha^{-1}, S.E. 5.39) was found in the *Lagerstroemia speciosa* stands, while the lowest was found in the *Pinus caribaea* plantation (83 tC ha^{-1}, S.E. 6.93). A net 4 (S.E. 0.31) tC $ha^{-1}yr^{-1}$ increment in the plantations was found, considering productivity and loss of litter and fuel wood from the plantation. The highest net mean annual increment (MAI) in carbon stock was found to be 9.83 (S.E. 1.50) tC $ha^{-1}yr^{-1}$ in the *Eucalyptus camaldulensis* stands, followed by *Acacia mangium* (7.48 tC $ha^{-1}yr^{-1}$, S.E. 0.66) while the lowest was in the *Gmelina arborea*, at 0.25 tC $ha^{-1}yr^{-1}$ (S.E. 0.64).

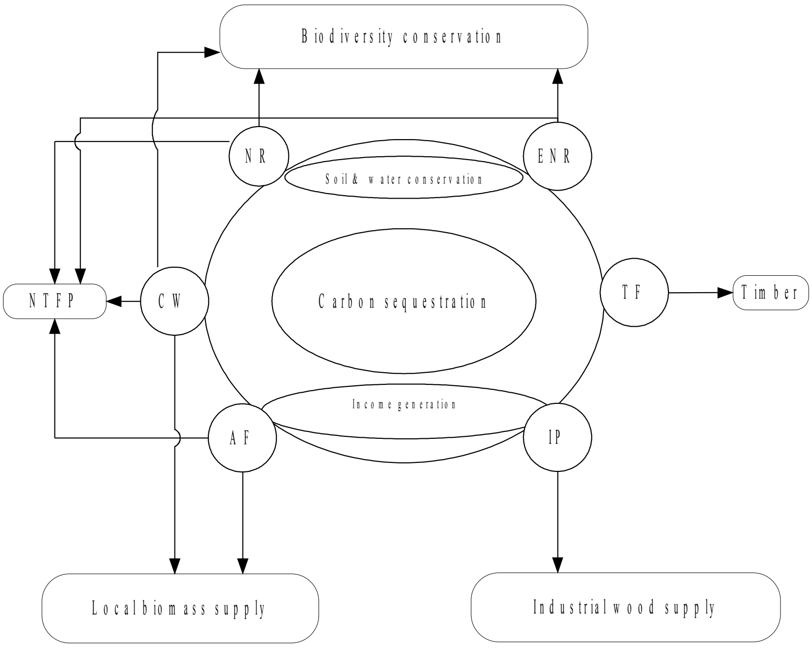
Reorienting forestry for increasing the carbon sinks

Different forest land uses

Different forestry options for different land categories should be targeted not only for sequestrating the carbon, but also for meeting the biomass needs of local communities and industries; conserving soil, moisture and biodiversity; generating employment for communities through the supply of non-timber forest products (NTFP). Shin *et al.* (2008) describe the different land uses for the expansion of carbon sink while emerging different forest goods and services (Figure 7). There can be four approaches increasing the carbon pool in the forests of Bangladesh; a) conservation of forests and carbon sinks; b) reforestation in previously forested barren lands and afforestation in newly accredited lands; c) enrichment of the existing "poor tree cover" forest lands with reforestation; and d) enforcement of the

[*] Standard error of mean

forestry acts and regulations. All of these approaches are expected to achieve the objectives of forest resources development and abatement of GHG emissions.



Notes: AF= Agroforestry; CW= Community Woodlot; ENR= Extended Natural Regeneration; IP=Industrial Plantation; NR= Natural Regeneration; NTFP=Non Timber Forest Products; TF=Timber Forestry

Figure 7. The utility of the forestry options while sequestering carbon

Reducing deforestation

For the forests with high standing biomass and low future growth rates, the best choice for the carbon emission reduction is simply to conserve the existing forest stand. Thus the 1.05 m ha of forestlands would fall in this category, simply requiring protection and enrichment. These lands include medium to good density natural forest areas (0.20 m ha), established and proposed protected areas (0.15 m ha), plantations (0.25 m ha) and other forest areas (0.45 m ha). A total of 15 formally protected forest areas in Bangladesh occupy about 0.75% of the total land area of the country. The situation of these protected areas is being quickly deteriorated as the pressure is being mounted from poaching, logging, and land conversion for shrimp farming. So, slowing down the deforestation is the most important issue to preserve the forests and enhance the carbon sinks.

Carbon sinks through A/R

Between 1974 and 1995, Bangladesh raised a total of 0.32 m ha of plantations of various types through A/R. Among these, hilly forests were 0.17 m ha, plain land *Sal* forests were 0.03 m ha, and coastal plantations were 0.13 m ha. By using a social forestry approach, the Forest Department is mobilizing a movement involving people from different communities to plant trees. A large number of trees have been planted in the community and private lands, e.g., on roadsides, embankments, school/institution premises and canal banks. Presently, the afforestation rate per year is about 0.02 m ha (FAO, 2000).

Issues to be settled for carbon credits

Crediting

Due to the leakage and non-permanence risks in the 'LULUCF' projects, parties agreed that credits arising from CDM-A/R projects should be temporary, but could be reissued or renewed every five years after an independent verification to confirm that sufficient carbon was still sequestered within the project to account for all credits issued (Pearson *et al.*, 2005). This is also assumed to be more flexible to the Non-Annex I countries in comparison to long-term crediting system (Võhringer, 2004). In the temporary crediting, carbon accounting should be implemented on a carbon tonne-year basis. Under a tonne-year system, credit would be given for the number of tonnes of carbon held out of the atmosphere each year. Under the tonne-year accounting system, delaying deforestation merits credit irrespective of the long-term fate of the forest, although the cumulative credit that can be earned from a given patch of forest is obviously greater as the forest remains standing longer.

Protected area establishment and crediting

Based on the current criteria of CDM, establishing a park in an area of forest that would not be cleared receives no credit, whereas one in an area experiencing rapid clearing is heavily rewarded (Fearnside, 1999). The park in the area with little clearing is likely to be cheaper to establish. How to allot carbon credits can, therefore, influence where to create parks.

In Bangladesh, the least protected and most threatened types of forest are in the Central and Southeastern part of Bangladesh where reserves may be established with little clearing (Salam *et al.*, 1999;Salam *et al.*, 2005).

Reduction of fossil fuel use or maintenance of the stock of forests

Creating and maintaining carbon stocks in the forests is an important climate change response options for Bangladesh. Although carbon stock maintenance through forest management and conservation in Non-Annex I countries are not included in the first commitment period, they are likely to be included in later commitment periods, but strong arguments are made regarding incorporating this form of environmental service into global warming mitigation policies.

If carbon stock maintenance is recognized as a form of mitigation measure, as distinguished from avoided deforestation, then monitoring needs would be much simpler from the point of view of countries contributing funds as carbon credits; only accompany of forest stock remaining each year would be necessary (Fearnside, 1999). Even though fossil fuel reduction is generally assumed much easier than maintaining the carbon stock in the forests, the value of forests for climatic functions other than carbon stocks and for maintaining biodiversity and indigenous cultures provide additional reasons to treat them differently from fossil fuel reserves (Meng *et al.*, 2003). Bangladesh as one of the least developed countries has not yet developed the appropriate biomass-based technology to substitute the fossil fuel and it is not likely to be achieved in the near future, so carbon stock creation and maintenance in the forests may be the relatively beneficial option (Baral and Guha, 2004;Huq, 2001).

Internal carbon credit allocation regimes

Under the Kyoto Protocol, credits earned for sequestering CO_2 would be allocated to the governments that have ratified the international treaty. The governments may allocate these credits and Kyoto obligations to domestic forest owners or retain them as they see fit. Since there is still much uncertainty over the mechanics of how credits will be allocated to growers, Guthrie & Kumareswaran (2003) introduced three alternative schemes, i.e., lump sum regime, the flows regime and the stocks regime. Among them the lump sum regime and the stocks regime seem to be appropriate for Bangladesh considering the existing socio-economic conditions. The lump sum regime entitles forest owners to a one-off lump sum payment for engaging in A/R, paid at the commencement of the first rotation. Growers retain these credits as long as replanting occurs immediately after harvest; if the forest is not replanted, deforestation has occurred, the owner incurs an obligation, and the lump sum allocation must be repaid in full. The stocks scheme, which is the one modeled by Sohngen & Mendelsohn (2003), rewards this temporary storage by giving forest owners credit not only for the quantity of carbon captured, but also for the duration of capture, effectively treating carbon credits as rent payments for the storage of carbon. Under this regime, credits are allocated to the owner annually in proportion to the size of the total carbon stock, which grows cumulatively through time. In order to increase carbon sequestration, forest owners must be encouraged to lengthen rotations, and be discouraged to convert forestland to alternative uses.

Future policy/approaches of the forestry sector

To mitigate the climate change through forestry practice the future policy/approach of the forestry sector should be oriented to reforest the degraded forestlands, and afforest the newly accredited lands as well as to retard the deforestation. The general objectives of the forestry sector should be the conservation of biodiversity; the mitigation of global warming; and the alleviation of poverty. To reorient the forestry sector in that way, both physical and institutional measures are needed. Development of coastal green belts, agro-forestry and social forestry may be included in the physical measures. Institutional measures may include integrated ecosystem planning and management, management of ecosystem in the reserved/protected areas, and reduction of habitat fragmentation. The participatory forestry approach should be re-oriented with proper benefit sharing by the local participants with clear land tenure and keeping the idea of sustainability and biodiversity.

Making political commitment is critical to both preserving the forests and eliminating the corruption in the forestry sector of Bangladesh. FAO (2001) addressed the illegal practices in the forest; i.e., illegal occupation of forestlands, illegal logging, illegal timber transport, trade and timber smuggling, transfer pricing and other illegal accounting practices; and illegal forest processing. To reduce these illegal activities, the following measures may be undertaken: (i) providing the rewards to the foresters for the integrity, (ii) increasing the probability of detection of forest crime and detection, (iii) increasing the penalties for the forest crime and corruption, (iv) reducing discretionary power of government official, (v) increasing the use of market mechanisms, (vi) involving the media, NGOs and the public in combating forest crime, and (vii) reinforcing the forest laws and legislation very strictly. A comprehensive awareness program should be extended to the general people, private forest owners, local and national politicians and so forth, aiming at showing the importance of forestry, environmental conservation, biodiversity and endangered ecosystems. Adequate and proper training should be provided to the officials in charge of enforcing various policies and regulations.

The National Forest Policy (1994) and the National Energy Policy (1995) for the first time specifically address the issue of woodfuel and have pledged government commitment to ameliorate the situation. The Forest Policy aims to increase the tree cover area upto 20% by the year 2015 through both government and private sector efforts. The Forest Policy further mentions that forests will be extended to rural areas, newly accreted chars, USF lands and other fallow private and community lands such as roadsides, railway sides, institution premises, embankment slopes and homesteads by public participation. The Energy Policy addresses the energy issues from the viewpoints of current status and future programs under renewable and non-renewable energy sources. It emphasizes the conservation of biomass fuel by introducing fuel saving technologies like improved cook stoves and their dissemination to both rural and urban households and commercial installations. Hence motivation has to be strengthened. The statements on biomass conversion to other energies are not clear. Although the government of Bangladesh is motivated to promote biomass energy with biased statements, it has not been fully approached to meet the criteria of CDM. So, the energy policy and national forest policy should be reviewed again to comply with the CDM framework.

To be involved with CDM A/R

Based on the issues discussed in this study, the following recommendations have been made to resolve the difficulties of Bangladesh's participation in the global warming mitigation program through CDM A/R:

Research should be undertaken to collect data on the quantity, distribution and partitioning of carbon, and any changes taking place over time in the different ecological zones of Bangladesh.

Species and site-specific carbon measurement models should be developed both for indigenous and exotic plant species.

Standard rules and procedures, for defining and quantifying carbon credits at the project level, must be developed to feasibly generate forestry offsets under the CDM.

Minimum standards for stakeholder consultations would go a long way towards addressing social risks, and may also be politically feasible, given that stakeholder consultations are mandatory for all CDM projects.

To solve the problems or obstacles for the inclusion of forestry activities in CDM projects, including baselines and additionality, leakage, monitoring, and accounting procedures, project requirements, vis-à-vis all of the above areas, must be standardized, straightforward and easy to apply to avoid excessive transactions costs.

Gundimeda (2004) recommended three important criteria for the sustainability of CDM projects in developing countries, which may conform to the Bangladeshi perspective. These criteria are: (a) balancing the short-term needs of the poor with the long-term requirement for carbon; (b) management of forestlands by the rural poor after the design of the CDM project; and (c) ensuring that maximum revenue is channeled to the poor. The first criterion implies that, while designing the CDM projects, care should be undertaken to ensure that the annual energy requirement of rural-dwellers, met by fuel wood and agricultural residues, are incorporated. The second important issue, in project design, is that concerns, about who are the poor participants in the project, should be well addressed.

Regarding the continuance of the CDM in Bangladeshi forests, user groups should be given responsibility for the management of government forests, with proper benefit-sharing mechanisms. Guidelines for codes of conduct and ethics, and other institutional arrangements, should be developed to assist the user groups. Although Bangladesh has some experience of social forestry programs, new location-specific revenue-sharing rules should be designed under the CDM. Further extensive research is required; nevertheless, Bangladesh can achieve sustainable development through appropriate economic policies and practices, which can address all uncertainties regarding the CDM projects.

Bangladesh can make an intergovernmental collaboration with the Government of the Republic of Korea to learn how a reforestation scheme can be successful.

To achieve the Certified Emission Reduction (CER) under CDM

Benítez *et al*. (2007) asserted that while investing into the Non-Annex I countries in the CDM projects, country particularities like institutions, government credibility, corruption, economic stability, inflation and terrorism must be considered as political, financial and economic risk factors. Bangladesh is overwhelmed by these risk factors (Zafarullah and Siddiquee, 2001), which may lead to the negative investment trend in the CDM projects. So, Bangladesh should take appropriate policy measures and actions to tackle these risk factors.

The inter-sectoral conflicts among forestry, agriculture, environment, land, wildlife and energy sectors should be resolved. There is a serious gap in terms of the coordination among economic and environmental objectives in Bangladesh. The gap is more serious in the case of the understanding and coordination of the linkages between GHG abatement activities and measures. Although Bangladesh emits less than 0.1% of global GHG emissions, she is one of the countries that would suffer adverse impacts from anthropogenic climate change (Huq 2001). To cope with the changes of climate, the country needs to develop a concerted plan of action to face the problems of climate change and the development challenges they will present. Huq (2001) asserted that this would require a well-coordinated policy for scientific research and development, focusing particularly on building an adaptive capacity. In particular, such a capacity needs to be developed in the fields of disaster management, agriculture, water resource management, and coastal zone management. The elements of the strategy specific to climate change also need to be incorporated into the national and sectoral planning to ensure that they are compatible with national sustainable development objectives. The policies should minimize the land-use and resource-management regimes. Issues relating to project permanence, leakage, and transaction costs should also be addressed (Kennett, 2002).

Bangladesh had repeatedly increased the trend of foreign investment in the industrial sector. But no investment was seen in the forestry sector. A part of the national degraded forestlands can be allotted to the national or multinational companies as a long-term lease for reforestation. Appropriate policies, benefit-sharing mechanism between the government and the companies, and share of the local communities, should be confirmed first in this regard. It could be a better alternative to gain the capability of dealing with the CDM forestry activities.

Conclusion

The discussion on the forest resources in Bangladesh indicates that forestlands are potential to sequester carbon to reduce the global warming. The study emphasizes both conservation of forests and carbon sinks and expansion of carbon sinks through A/R. It has figured out different forestry options aiming at carbon sequestration with other necessary utilities in Bangladesh. But the unsettled issues discussed should be settled along with appropriate policies indicated in this study. Policy changes are expected to have the greatest potential effect in this arena. As slowing down the deforestation is an important global warming response option that can gain potential carbon benefits as expected by the CDM in the second commitment period of the Kyoto Protocol, it is imperative that the needed effort would be made to develop this option by the Parties. A/R, which is much closer to offering eligible projects for investment, has the principal barriers, which are social in most cases in Bangladesh. Steps should be undertaken to ensure that unacceptable social impacts do not derive from the plantation expansion programs. The study shows that Bangladesh has a clear scenario of ‘additionality’ of CDM. Fuel substitution and energy efficiency based CDM projects can gain the momentum in the country. Socio-economic impacts of biomass energy promotion in Bangladesh show that it can provide the social cohesion and stability; and increased standard of living of the people, spreading positive flow to the whole economy of the country. Thus, the country can achieve the sustainable development. The study finds the most important constraint to Bangladesh’s participation in carbon trading as the lack of capacities to deal with the CDM projects. So, capacity building should be prioritized to host the CDM projects in the country as early as possible. The gross carbon content in the forests of Bangladesh, in general, and in the Chittagong hilly region, in particular, indicate that Bangladesh has a high capacity of carbon uptake. Due to adverse human dimensions like over extraction of the forest resources, on the plantations, however, the net annual carbon increment is lessened. Nevertheless, the content range of organic carbon in the stand-soils clearly shows the significant potential of the Chittagong hilly lands to sequester carbon. The participation of Bangladesh as a Non-Annex I country in the global warming mitigation program involves sharing with the international efforts to reduce global warming and developing the forestry sector, as well as to build up the capacity to combat the likely natural hazard due to the uncontrolled climate change.

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