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The Carbon Sequestration Potential of Forestry Sector: Bangladesh Context

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ABSTRACT : Forests potentially contribute to global climate change through their influence on the global carbon (C) cycle. The Kyoto Protocol provides for the involvement of developing countries in an atmospheric greenhouse gas reduction regime under its Clean Development Mechanism (CDM). Carbon credits are gained from reforestation and afforestation activities in developing countries. Bangladesh, a densely populated tropical country in South Asia, has a huge degraded forestland, which can be reforested by CDM projects. To realize the potential of the forestry sector in developing countries like Bangladesh for full-scale emission mitigation, the carbon sequestration potential should be integrated with the carbon trading system under the CDM of the Kyoto Protocol. This paper discusses the prospects of carbon trading in Bangladesh, in relation to the CDM, in the context of global warming.

Keywords : Carbon sequestration, Carbon trading, CDM, Global warming, Climate change.

INTRODUCTION

There is a wide scientific consensus that global climate is changing in part as a result of human activities (IPCC, 2001; Ravindranath et al., 1997; Negi et al., 2002) and that the social and economic costs of slowing it down and of responding to its impacts will be large (OECD, 2000). Global changes are occurring in many ways: atmosphere, land-use and now also in climate (Mooney et al., 1999; Huang et al., 2000; IPCC, 1996, 2001, 2002; CPCB, 2002). In recent years, the few global issues that have received more attention of scientists, resource mangers, policy makers and public undoubtedly are climate change (Tiwari and Singh, 1987; Al-Amin, 2002; Alamgir, 2005). Climate change is one of the most pressing environmental concerns of the 21st century. It is now generally accepted that this climate change is the result of increasing concentrations of carbon dioxide, methane, nitrous oxide and other greenhouse gases (GHGs) in the atmosphere (IPCC, 2001; Schimel et al., 1995). Increasing carbon emission is one of today's major concerns, which was well addressed in Kyoto Protocol (Ravindranath et al., 1997) because it is the main causal factor for global warming (Lal, 2001). The per capita GHG emission by industrialized countries is about 6 times the world average emissions, while GHG emission from USA alone accounts for 20% of the total global emissions (Ahmed, 2006). Countries like Bangladesh are not big GHG emitters (Bankoff, 1999). Forests also play an important role in the climate system. Meanwhile, deforestation worldwide contributes 18% of all CO_2 emissions (Stern, 2006). Developing countries like Bangladesh are mostly affected by the consequences of "Global Warming" (Anon, 2000). If the increase of air temperature continues at the present rate, by the end of the year 2030, sea level will rise by 20 cm, and at the end of this century it will rise by one meter. As a result, low-lying countries of the world may go under water partly or wholly and consequently Bangladesh will be greatly affected (Bankoff, 1999; Miah, 2002).

Forests have the potential to be managed to reduce

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atmospheric concentrations of carbon and thus mitigate climate change (Houghton et al., 1992; Brown et al., 1996; Ravindranath et al., 1997; Williams, 2002; Matthews et al., 2000). So forests play multiple and significant roles in regulating atmospheric concentrations of carbon dioxide (Rotter et al., 2002). Active absorption of CO_2 from the atmosphere through photosynthesis, and its subsequent storage in the biomass of growing trees or plants is the carbon storage (Baes et al., 1977; Williams, 2002; Heath and Smith, 2004). It was reported that a hectare of actively growing forest can sequesters 2–5 tonne of carbon per year (Brown, 1996). This way forests play an important role in sequestration of carbon globally (Rawat et al., 2003). Importance of forested areas in carbon sequestration is already accepted, and well documented (Tiwari and Singh, 1987; Alamgir et al., 2009). Forest carbon sequestration is characterized as an increase in carbon stocks on the land base through such activities as afforestation, reforestation, agroforestry, forest restoration (WWF, 2002). Considering the carbon sequestration potential of forest, the forestry community needs to promote all forestry practices that can provide climate change mitigation benefits (UNFCCC, 2007a). Taking this view ahead, the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol have introduced a mechanism named CDM (Clean Development Mechanism) allowing for the development of carbon forestry activities in the developing world as means to mitigate climate change and promote sustainable development (UNFCCC, 2002). Therefore, the proper management of forest as a sink of carbon can provide two fold benefits, one it will help to mitigate the impact of climate change (Nabuurs et al, 2007) and two it will be a mean of potential profitable business (i. e. carbon trading) through the CDM (Sampson, 2004; Richards et al., 2006; Ruddell et al., 2006; Helms, 2007).

To protect world from climate change and the low lying country like Bangladesh management of forest with a vision of carbon sequestration is essential. Bangladesh was once densely forested but this has been cleared for timber, converted to agriculture or cut for firewood (Gain, 2002). Bangladesh has a total forest land of 2.53 million ha of which 1.11 million ha is under tree cover (Roy, 2004). So, there is a large scope to initiate new plantation in the degraded and denuded forest areas also in the area outside the forests (Unclassified State forest, road sides and canal banks). Furthermore the presence of trees and forests benefits communities in many ways such as: Adapting to climate change impacts, maintaining natural resources and promoting sustainable development (Nabuurs et al., 2007). Now it is high time to incorporate the existing forest management strategies with the climate change through the sequestration of carbon. Taking this view ahead, the present study explore the carbon sequestration potential of forestry sector in Bangladesh, in relation to the CDM and in the context of climate change, which ultimately help future forest management strategies for Bangladesh.

The Human Contribution to Climate Change

The increase in greenhouse gas in the atmosphere is now recognized to contribute to climate change (IPCC, 2000). It is now generally accepted that this change in global temperature is caused primarily by rising atmospheric concentrations of greenhouse gases, principally carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). The most important of these greenhouse gases, CO_2, accounts for some 65 percent of the "greenhouse effect" (IPCC, 2000) followed by methane (CH_4) (20%), nitrous oxide (N_2O) (6%) (Andrasko, 1990). The concentration of CO_2 in the atmosphere increased from 285 ppm at the end of the nineteenth centenary to about 366 ppm in 1998 as consequences of anthropogenic emissions of about 405 gigatonnes of carbon into the atmosphere (IPCC, 2001). The rise of atmospheric CO_2 concentrations has also been caused by the combustion of fossil fuels, cement manufacture and deforestation (IPCC, 2000). Deforestation is a significant source of carbon emissions; evidence suggests that deforestation in the 1980s may have accounted for one-fourth of all anthropogenic carbon emissions (Houghton, 1999). Between 1850 and 1980, more than 100 Gt of carbon were released into the atmosphere as a result of deforestation, representing about one-third of the total anthropogenic car-

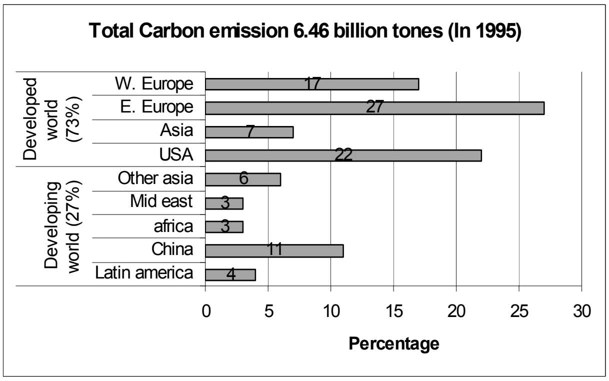
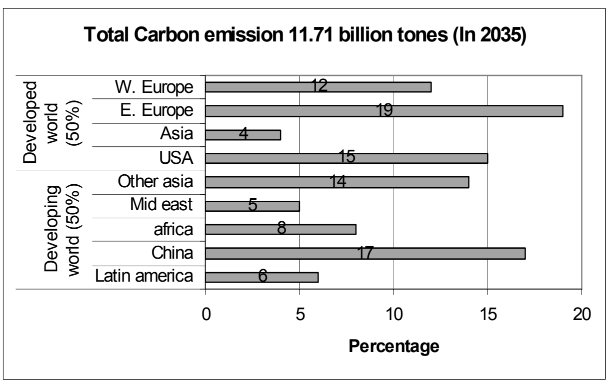


Fig. 1. (a). Total Carbon emissions in 1995 by different countries Source: (Mintzer and Trexler, 2000).



(b). Total Carbon emissions in 2035 by different countries Source: (Mintzer and Trexler, 2000).

bon emissions over this period (Houghton, 1996). Figure 1 (a, b) shows contribution of GHGs emissions by the developing and developed world.

Carbon sequestration potential of forestry sector: Global context

Forest can play a significant role in global carbon budget both by conserving and sequestering carbon from the atmosphere. Carbon sequestration is the strategy for the management of forest carbon to increase the amount or rate of carbon accumulation by creating or enhancing carbon sinks (carbon sequestration) (Bass et al., 2000). This strategy involves afforestation, reforestation and restoration of degraded lands, improved silvicultural techniques to increase growth rates and implementation of agroforestry practices on agricultural lands. Carbon sequestration has tended to be equated to tree planting both in natural forest and plantation contexts. Although there are many more options than simply afforestation and reforestation, estimates of the global potential of carbon sequestration have taken as their starting point the area of land available for afforestation (Bass et al., 2000). The world forest contains an estimated 340 Pg C in live and dead above and below ground vegetation and 618 Pg C in mineral soils and O horizon (Brown, 1996). Globally 700 million ha of land might be available for carbon conservation and sequestration programme, 345 million ha currently non forested or under stocked land for plantation and agroforestry, 138 million ha through slowed tropical deforestation and 217 million ha through natural and assisted regeneration of tropical forest (Trexler and Haugan, 1994; Nilson and Schopfhauser, 1995). This amount of land could conserve 60 to 87 Pg C by 2050 (Table 1). Table 1 shows global estimates of the potential amount of C that could be sequestered and conserved by forest management practices between 1995 to 2050. The tropics have the potential to conserve and sequester largest quantity of carbon (80%) followed by the temperate zone (17%) and the boreal Zone (3%), annual rate of carbon sequestration from all practices would increase overtime and reach about 202 Pg/yr by 2045 (Brown, 1996). Brown et al. (1996) estimate that approximately 38 Gt of carbon could be sequestered over the next 50 years – i.e. 30.6 Gt by afforestation/reforestation and 7 Gt through the increased adoption of agroforestry practices. Figure 2 shows potential contribution of afforestation/reforestation and agroforestry activities to global carbon sequestration from 1995-2050, where total carbon sequestration potential 38 Gt.

Anthropogenic changes in the earth's climate have been the focus of climate change policy since the signing of the United Nations Framework Convention on Climate Change (UNFCCC) at the 1992 Earth Summit. To date, this Convention has been ratified by 191 countries, including the United States (UNFCCC, 2007b). The objective of the UNFCCC was to stabilize GHG emissions, "at a level that would prevent dangerous anthropogenic interference with the climate system." A global carbon market has emerged as a result of the Kyoto Protocol (of the UNFCCC), which set GHG emission limitations for ratifying nations and established mechanisms for reducing overall GHG by at least 5% below 1990 levels by the end of 2012 (UNFCCC, 2002). As a result of this a concept arise named ‘carbon trading’. The concept of carbon trading is an opportunity for the developing countries. The Kyoto Protocol has developed a strategy by which the developed country will sponsor for the establishment of a new forest to the developing countries. On the basis of this several funds were established according to which project implementers will receive the forest credits (Schoene, 2002). To achieve this goal a mechanism name CDM develops. The purpose of the CDM is to assist developing countries in achieving sustainable development and at the same time to assist developed countries in fulfilling their commitments under the Kyoto Protocol (KP). However, in the first commitment period of the KP, there is an important restriction for inclusion of Carbon Sequestration (CS) in the CDM (FAO, 2003a; FAO, 2004). CDM was established to supervise the project of the establishment of the new forest (Schoene, 2002). By applying this CDM of carbon trading climate change can be mitigate. The mitigation cost through forestry can be quite modest, US$ 0.1- US$ 20/t C in some tropical developing countries and somewhat higher US$ 20-US$ 100/t C in developed countries (Hoogeveen, 2007).

Table 1. Global estimates of the potential amount of C that could be sequestered and conserved by forest management practices between 1995 to 2050

Latitudinal belt	Practice	Area (M ha)	Csequestered & conserved (Pg[3])
High	Forestation	95.21	2.4
Mid	Forestation	113	11.8
	Agroforestry	6.5	0.7
Low	Forestation	66.9	16.4
	Agroforestry	63.2	6.3
	Regeneration[2]	217	11.5-28.7
	Slow eforestation[1]	138	10.8-20.8
	Total	**700**	**60-87**

[1] Includes not satisfactorily restocked forest lands in Canada.
[2] Includes an additional 25% of aboveground C to account for C belowground in roots, litter, and soil (based on data in Nilsson and Schopfhauser, 1995 and Brown et al., 1993b); the range in values is based on the use of low and high estimates of biomass C density resulting from the uncertainty in these estimates
[3] 1 Pg = 10^{15} g or billion metric tons
Source: Brown et al., 1996

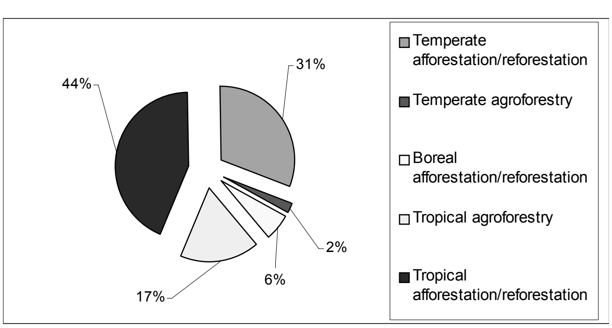


Fig. 2. Potential contribution of afforestation/reforestation and agroforestry activities to global carbon sequestration, 1995-2050 (Total carbon sequestration potential 38 gigatonnes (Gt).
Source: Brown et al., 1996.

State of Bangladesh forest

According to Forest Department (FD) and some other sources (Hossain, 2005; Khan et al., 2007; Mukul et al., 2008) the area of forest land is about 2.53 million ha representing approximately 17.5% of the country’s total surface area (Table 2.) but according to FRA 2005 this figure is only about 0.871 million ha (FAO, 2006; 2007). Officially, Bangladesh FD manages 1.53 million hectares of forest land of the country. Bangladesh has a total land area of 14.39 million hectares, of which 9.12 million ha is cultivated, 2.14 million ha public forests, 0.27 million ha village groves, and 1.64 million ha constantly under water. The remaining land area (1.22 million hectares) is occupied by tea gardens, uncultivable areas, rural and urban houses and ponds (Kibria et al., 2000). The area covered by government and village forests is about 16% of the total land area; however only 0.93 million ha (6.5%) is under tree cover, which is about 40% of the forests controlled by the government. The remaining 60% includes denuded lands (grassland, scrubland and encroached areas) (FAO, 2003b). About 24 000 ha of forest is lost annually as a result of homestead development, urbanization and deforestation (FAO, 2003a). But there is a controversy and another report shows that agricultural land makes up 64%

of Bangladesh's land area, forest lands account for almost 18%, and urban areas account for a further 8% (APFSOS, 1998). Water and other land uses account for the remaining 10%. Total forest land area totals 2.53 million ha, including officially classified and unclassified state lands and forest lands accounted for by village forests and tea/rubber gardens. This data shows that the natural forest accounts for almost 31% and forest plantations 13% of total forest areas (Table 3).Shifting agriculture plus illegal occupation cover 5% of forest lands while water (9%) and unproductive area (0.6%) and other areas (35%) account for almost 45% of forest land. Presently protected areas represent just over 5% of forest land. Bangladesh FD is responsible for administering 65% of state forest land (about 1.46 million ha). The balance comes under local District Commissioners (DC). Excluding parks and sanctuaries, but including the

Table 2. Forest types (ecosystem diversity) and areas in Bangladesh

Forest type		**Location**	**Area** (million ha)	**Remarks**
Hill forest	Managed reserved forest (evergreen to semi-evergreen)	Eastern part of the country (Chittagong, Chittagong Hill Tracts and Sylhet)	0.67	Highly degraded and managed by the Forest Department.
	Unclassed state forest (USF)	Chittagong Hill Tracts	0.73	Under the control of district administration and denuded mainly due to faulty management and shifting cultivation. Mainly scrub forest.
Plain land forest	Tropical moist deciduous Forest	Central and north-western region (Dhaka, Mymensingh, Tangail etc.)	0.12	Mainly *Sal* forest but now converting to exotic short rotation plantations. Managed by the Forest Department.
Mangrove	Sundarbans	Southwest (Khulna, Satkhira)	0.57	World's largest continuous mangrove forest and including 0.17 million ha of water.
	Coastal forest	Along the shoreline of twelve districts	0.10	Mangrove plantations along the shoreline of 12 districts. Managed by Forest Department.
Village forest		Homestead Forests all over the Country	0.27	Diversified productive system. Fulfill majority of country's domestic timber, fuelwood and bamboo requirements.
Plantation in tea and rubber gardens		Chittagong Hill Tracts and Sylhet	0.07	Plantations of various short rotation species (mainly exotics).
Total forest			**2.53**	17.49 % of country's total landmass

Source: Hossain, 2005; Mukul et al., 2008

Table 3. Classified and unclassified forest land by physical cover

Type of Land Cover Area	Area (Hectares)	Percentage
Natural Forest		
Medium-Good Density	460,700.0	20.5
Poor Density	82,200.0	3.7
Bamboo	71,200.0	3.2
Scattered Trees/Barren	95,900.0	4.3
Total	**710,000.0**	**31.7**
Plantations	303,000.0	13.5
Jhummed/Encroached	111,000.0	4.9
Total Productive	**1,124,000.0**	**50.1**
Unproductive	12,900.0	0.6
Parks/Sanctuaries	116,700.0	5.2
Water	9.0	-
Other*	786,600.0	44.1
Total Unproductive	**1,118,200.0**	**44.9**
Total	**2,242,300**	**100.0**

* Predominantly Unclassified State Forest (USF)

(Source: APFSOS, 1998; Alamgir, 2005)

better quality natural forest (medium to good density) plus bamboo areas and plantations gives a figure of 835,000 ha of reasonable quality forest vegetation on state forest land. This equals 5.8% of Bangladesh's total area. The area included in the present protected area network is 116,700 ha, equal to 5.2% of state forest land or less than 1% of Bangladesh's total area (APFSOS, 1998).

Potentials of Bangladesh forest for carbon sequestration

Carbon trading is an opportunity for the developing countries. The Kyoto Protocol has developed a strategy by which the developed country will sponsor for the establishment of a new forest to the developing countries. On the basis of this several funds were established according to which project implementers will receive the forest credits (Schoene, 2002). Bangladesh forests still absorb more carbon than the total carbon produced in the country. As a signatory party of 'Kyoto Protocol' the country can ask for compensation from the developed countries for this extra carbon absorbed by country's forest (Mukul, 2007). A study conducted by Jha et al. (2003) showed that national average of soil organic carbon content /ha was 182.94 tonne/ha. It has been estimated that that 367 tones of carbon per hectare is stored by the tree tissues in the forest of Bangladesh (Figure 3). According to Jha (2001) the soil organic carbon contents under different land use in India were found as 120 tonne/ha, 40 tonne/ha and 40 tonne/ha in forest, agriculture and pasture respectively. Khajuria and Chauhan (2003) reported that a project to restore 10,000 ha of degraded community land in Handia forest range of Madya pradesh, India has been estimated to earn US$ 300, 000. They also reported that the forest area of Panjab, India can sequester 1.5 million tones per year of organic carbon worth US$ 20-25 million. The forest area of Chittagong (South) forest division can sequester 1.9 million tones per year of organic carbon worth US$ 34.23 million at the rate of 18 US$ per tonne of organic carbon (Alamgir, 2005). As Bangladesh has 1.43 million ha of forest land without forest cover (Figure 4) can be use for plantation through CDM under Kyoto Protocol.

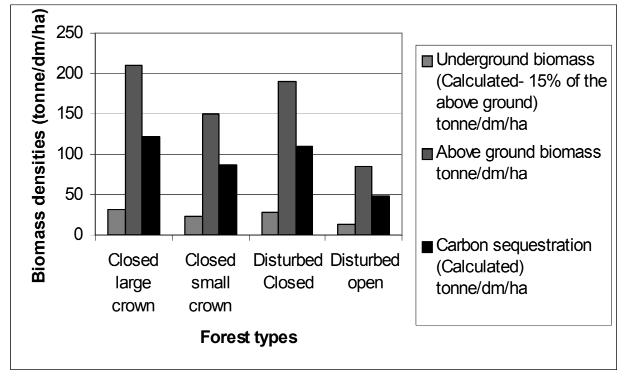


Fig. 3. Biomass densities in forest of Bangladesh (Adapted and modified from Alamgir et al., 2009).

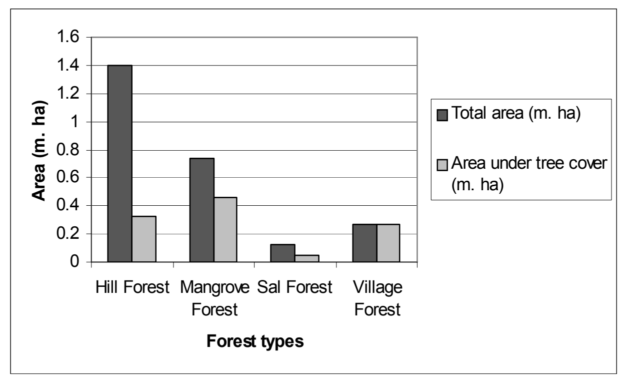


Fig. 4. Potential land available in different forest types for plantation (Adapted and modified from Roy, 2004).

CONCLUSION AND FUTURE ISSUES

Forests are an important component of the global carbon cycle. They both influence and are influenced by climate change and their management or destruction will have a significant impact on the course of global warming in the twenty-first century. Forest management can contribute towards emissions reductions and to carbon sequestration. By proper management of forest we can mitigate climate change impact. Climate change mitigation through carbon sequestration by forest is the low cost method and it will open a door for development activities because it's very easy and simple of getting fund for carbon sequestration. To increase forest capacity regarding carbon sequestration following steps should be considered: providing incentives for the maintenance of future and existing forest resource values in ways that discourage conversion of forests to other land uses, enhancing regeneration to increase species composition and stocks, increase people participation in forest management, decelerating hot spot for carbon sequestration and protected area, training program for government officials to develop skills to combat atmospheric carbon, formulate a separate institutional body for the management of carbon trading.

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