

Climate Change Adaptation and Mitigation Options through Strengthening Forest Management in Developing Country: A Case Study on Bangladesh

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Summary

Bangladesh is one of the most climate vulnerable countries in the world and will become even more so as a result of rapid climate change. Forests play an important role in the climate system. They are a major reservoir of carbon in soils. Forests also directly affect climate on the local, regional, and continental scales by influencing ground temperature, evapo-transpiration, surface roughness, albedo, cloud formation, and precipitation. Forest sector holds an excellent potential to halt climate change in at least two dimensions as forest plays a crucial role in maintaining ecological stability and it has gained importance for capturing carbon through which the country can be benefitted to earn money from the carbon market under the clean development mechanism (CDM). With increasing population, deforestation has increased with shrinkage of forest cover from 18% in 1927 to a mere 6% today. So, industrial contribution to global warming has been small but its contribution through deforestation has been large. A tropical or subtropical forest absorbs a lot more carbon dioxide into its leaves than a temperate one, typically from 100 to 600 ton per year, for every square kilometer. Potentialities of tree planting, forest protection and agro-forestry in Bangladesh to mitigate climate change have been discussed in this study and other benefits from forest sector were also highlighted. 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. Four major strategies to mitigate carbon emissions through forest related activities were highlighted for building community resilience in Bangladesh.

Key word: *adaptation, afforestation, carbon sequestration, climate change, mitigation.*

Introduction

Bangladesh is a developing country with an extremely limited resource base, facing the problems of fast growing population, low rate of development, depletion of the natural resource base, natural calamities and environmental degradation (Mahat, 1993). Climate change is a reality and its impacts are all about evident around the world. Many of the anticipated adverse effects of climate change, such as, sea level rise, higher temperature, enhanced monsoon precipitation, and an increase in cyclone intensity will aggravate the existing stresses that already impede development sector of Bangladesh, particularly by reducing water and food security (MoEF, 2005).

Forests are important for maintaining ecological balance. Forests contribute significantly to populations living through the provision of a wide range of forest products, recreational opportunities as well as environmental services. The potential contribution of forests to the mitigation of climate change is just one of many benefits forests provide for local communities. Sustainable forest management is a critical component of any policy and action programme that seeks to address the growing global concern about the impact of climate change. Forests and climate change are related in multiple ways. Proper management of forest resources can be a worth and can be seen as an integral part of climate change adaptation and mitigation efforts. Approximately, 30% of the world's land mass is occupied by forests which provide multiple benefits like economic, environmental, social and cultural services. More than one billion people live in or around forests and use forest resources for fuel, timber, food, medicine and income; of these, 70

million are indigenous people living in remote areas that depend completely on forest resources for their livelihoods (Patosaari, 2007). Forests and trees are important carbon sinks. It is widely recognized that forests play an important role in the global carbon cycle by sequestering and storing carbon (Stainback and Alavalapati, 2002). The main objective of this paper was to highlight the forest management initiatives to cope with climate change impacts and to highlight the mitigation options by strengthening the forest management in Bangladesh.

Study Approach

The whole study has been carried out through an explorative way to identify the impacts of climate change and its possible adaptation and mitigation options through forest management. Literature related to forest management, climate change adaptation and mitigation were reviewed to conceptualize and understand the overall situation and to define the exact adaptation and mitigation options for a developing country, Bangladesh. Several case studies about national and international contexts have been reviewed to suggest adaptation and mitigation options for strengthening the forestry management of Bangladesh. Data associated with this research were collected from the Forest Department, published books, journals, periodicals and bulletins. Outcomes of the several studies were analyzed to depict the climate change adaptation and mitigation options strengthening forestry management in Bangladesh.

Climate Change and Forests in Bangladesh

Forests are globally important reservoirs, sources and sink of carbon, store carbon in the leaves, branches, trunks and roots of trees and in forest soils (ETFRN, 2009). Bangladesh has a diverse range of forest ecosystems. The Sundarbans of Bangladesh, a world heritage site, is the single largest mangrove area in the world, comprising an area of 57700 ha, and housing one of the richest natural gene pools (Huq and Ayers, 2008). Climate change is reflecting a detrimental impact on all of the forest ecosystems in Bangladesh, and the Sundarbans are likely to be the worst affected (Rahman and Alam, 2003). Depletion of forest resources has created serious environmental and economic problems in Bangladesh and the people have been adversely affected both economically and environmentally (Mahat, 1993).

Bangladesh has options for getting on a low-carbon economy track that may also help with adaptation. Identifying effective adaptation options and examining the economic incentives that would make such strategies successful. Initiation of flood and salinity-resistant rice species is an effective measure in reducing flood and salinity-induced relocation. Afforestation could be more effective in reducing vulnerability to floods. There is also a need to understand the role of ecosystems in managing disasters. There is strong evidence that mangroves played a role in mitigating the impact of the Orissa Super-Cyclone in 1999. The cost-benefit analysis of previous events including human casualties, damages infrastructure and losses of lives etc. summarizes the importance of preservation of mangroves. Large-scale mangrove plantations are currently being developed and ecosystem based adaptation is another useful tool to fight against climate change associated environmental problems. Coastal afforestation (with mangroves or other tree species) can be act as a barrier to resist the impacts of storm surges. In urban planning, floods, appropriate drainage planning is imperative to check the future vulnerability. Though regulation can be a highly effective means to combat deforestation and promote the use of sustainable forest management, lack of capacity in monitoring and lack of resources for law enforcement are inhibiting factors in many developing countries.

Forest sector is considered as an important resource base that provides environmental services, including habitats for wildlife, ecology and biodiversity, as well as employment and livelihoods. In climate change perspective, this sector is a significant source of carbon stock also. Considering the climate change issues, in 1992, the Government of Bangladesh signed the United Nations Framework Convention on Climate Change (UNFCCC) and ratified in 1994. The Ministry of

Environment and Forest (MoEF) is responsible for coordinating the UNFCCC process in Bangladesh. In 2005, Bangladesh has completed a National Adaptation Plan of Action (NAPA), in which the management and protection of forests had been identified as a significant initiative to fight against climate change impacts. The costs of reducing emissions from deforestation and degradation (REDD) appears as low compared to alternatives for reducing carbon emissions (Chomitz, 2007). Achieving climate change mitigation through forestry requires that forests should be managed in the ways that fundamentally reduce carbon emissions (ETFRN, 2009).

Forest Management for Climate Change Adaptation Options

Adaptation to climate changes refers to adjustments in ecological, social and economic systems in response to the effects of changes in climate (Smit and Pilifosova, 2001). In general, management to help forests adapt to climate change will involve maintaining forest health and ecosystem diversity and resilience; forest monitoring to quickly detect and tackle outbreaks of pests and diseases; effective fire management; restoration of forest functions after disturbances; reduced impact logging; increases in the number of locations where specific habitats are managed and efforts to connect habitats and landscapes (ETFRN, 2009). So, an effective adaptation policy must be responsive to a wide variety of economic, social, political, and environmental circumstances (Spittlehouse and Stewart, 1993).

Climate change adaptation strategies can be viewed as a risk management component of sustainable forest management plans and requires planning for change so that a suite of options is available whenever needed (Spittlehouse and Stewart, 1993). Forest managers have many options for mitigating the effects of climate change and adapting to that change (Spittlehouse, 1997; Stewart *et al.*, 1998), although forest policy needs to be assessed to ensure it encourages adaptation (Duniker, 1990; Parker *et al.*, 2000; Burton *et al.*, 2002). Numerous adaption measures against climatic impacts can be resulted in a sustainable forest management, thus forests do have the potential to contribute to national adaptation strategies. Tree plantation and their management in a sustainable fashion can aid in the protection of soil being eroded during flooding and rainfall. Forests can be used in restoring and rehabilitation of degraded or disturbed lands. They have the ability of trapping sediments and immobilization of toxic compounds thus purifying water. Moreover, the role of forest resources against natural calamities is well-known.

Forest Management for Climate Change Mitigation Options

In general, the term mitigation refers to all the activities aimed at lowering the emissions of green house gases and removal of CO₂ from the atmosphere in order to stabilize CO₂ concentration. The Kyoto Protocol to the United Nations Framework Convention on Climate Change (1997) has established the principle that carbon sequestration can be used by participating nations to meet their respective net emission reduction targets for carbon dioxide (CO₂) and other greenhouse gases (Parks *et al.*, 1997). The forestry sector has a huge potential to contribute at global to regional scales (Malhi *et al.*, 2002) as it ameliorates greenhouse gas emissions and sequester carbon, thereby lessening the human impact on climate (Constance *et al.*, 2007). Forest-related mitigation activities often have a cost advantage over other mitigation strategies (Patosaari, 2007). According to some estimates, forests can store from 20-100 times more carbon than other vegetation on the same land area, which means around 30-60 tons of carbon per hectare. There are three pathways along which carbon sequestration is of relevance for atmospheric concentrations of carbon dioxide: carbon storage in biological ecosystems, carbon storage in durable wood products and substitution of biomass fuels for fossil fuels (Richards and Stokes, 1995).

Carbon Sequestration and Conservation: Forest management strategies designed to achieve goals of removing CO₂ and storing carbon are diverse, and include avoiding deforestation, promoting afforestation and reforestation, manipulating vegetation to favor rapid growth and long-

term site retention, and sequestering carbon after harvest in wood products (Harmon and Marks, 2002). There are several ways by which carbon sequestration and conservation can be improved. Some of them include increasing carbon sinks by proper vegetation or land management, reforestation and afforestation of degraded. The conservation of destroyed forests that can be referred to as 'avoided deforestation' is another mean to conserve forest carbon. Once wood is removed from the forest, its further use greatly affects its sequestration status and to avoid or minimize the return of carbon to the atmosphere is possible by storing carbon in wood products, or using it as biomass to fuel electricity production, thereby providing alternative forms of energy to replace fossil fuels (Constance *et al.*, 2007). Carbon sequestration can be enhanced through afforestation, reforestation and restoration of degraded lands, agro-forestry, silviculture etc. Carbon conservation is possible through improved forest management practices, conservation of biomass and soil carbon in protected areas in Bangladesh.

Options for Carbon Sequestration in Forests

Afforestation: Afforestation refers to converting barren land into forests and is the most recognized and studied option for mitigation. It has estimated that a forest that is growing can remove 5-11 tons CO₂ per hectare per year, depending on location and productivity. Over the years numerous estimates about the sequestration potential for afforestation have been made. Sedjo (1989) reported that world plantations could sequester up to 10.7 billion tons CO₂ per year, while Sohngen and Mendelsohn (2007) suggested that 0.7 – 2.2 billion tons CO₂ can be sequestered globally per year. One of the most thorough reviews of the literature to date, Richards and Stokes (2004), find that 7.0 billion tons CO₂ per year may be sequestered globally.

Reductions in deforestation: According to IPCC (2007), deforestation causes about 5 billion tons CO₂ emissions per year, or around 17% of total global emissions. Tropical forests contain 300- 400 tons of CO₂ per hectare in biomass and around 2.8 billion tons CO₂ emissions per year could be reduced in tropical regions by avoiding deforestation. These estimates show that there is great scope to avoided deforestation at a relatively low cost option that can be applied in climate change mitigation policy.

Forest management: There are a number of options to increase the carbon storage through forest management. Some of them provide long-term carbon storage while some others provide short-time benefits. In managed forests, the quickest way to increase carbon on the landscape is to increase the forest rotation age and could be an important component of any carbon policy that values carbon stored on the landscape. Planting forests rather than relying on natural regeneration after harvest or any other disturbance can increase the overall quantity of carbon on the site in the long run (Hoehn and Solberg, 1994). Alternatively, shifting forests from one type to another can increase total carbon sequestration across the landscape (Sohngen and Brown, 2006). A study conducted by the Copenhagen Consensus Center under Copenhagen Business School showed that it is possible to obtain around 6.7 billion tons CO₂ per year, with around 40% of this arising from avoided deforestation, 31% from forest management activities, and the rest from afforestation.

Reduce Emissions: Forest management and forest operations have a long term effect on human-generated emissions. It has been estimated that tropical deforestation accounts for about 20 percent of human generated CO₂ emissions (House *et al.*, 2006). The Intergovernmental Panel for Climate Change (IPCC) estimates that about 65% of the total mitigation potential in the forest sector is located in the tropics and about 50% of this total could be achieved by reducing deforestation (IPCC, 2007). The emissions of stored carbon from forests can be reduced by some strategy, such as, improving forest resistance to natural calamities like storms, flooding, drought, rainfall and many others usually by reducing the density of small trees and one way to accomplish the density reductions is by mechanical thinning (Stephens and Moghaddas, 2005).

Carbon Substitution: Another important factor in mitigation effort is bio-energy, an alternate source of renewable energy. This energy are being made from wood products is carbon neutral and moreover, forestation and bio-energy plantations can lead to land restoration that has been degraded by over-extensive agriculture, manage water runoff, retain soil carbon and benefit rural economies by providing employment and income (Patosaari, 2007). Carbon substitution can be eased through increased transfer of forest biomass into durable wood products.

Forest Management and Climate Change Adaptation and Mitigation Options in Bangladesh

In rural areas of Bangladesh, there is a good scope for social and coastal afforestation. Farmers will be provided with *khas* (fallow) land for planting trees. Non-Governmental Organizations (NGOs) can also be involved in the local and indigenous group formation process and planting. Through plantation in rural areas, especially in *khas* lands, forest coverage can be increased. The poor landless people are very much interested in plantation and appropriate management while offering cash money as their daily earnings. It has been observed in many villages through years that the villagers are good local forest managers if they are trained and aware enough about the importance of forests and forestry for our ecosystem and national economy. Afforestation are possible mainly in *khas* lands, *char* area, beside the newly made roads, around the ponds, river and canal sides, through *ails* (divider) of two different lands. An appropriate mix of high-yielding and quick-growing tree species will be selected as an effort to increase canopy coverage and capturing carbon. These plantations can be a worth in such that the economic wellbeing of the farmers and the poor's engaged in management, protection of bank erosion of rivers, canals and ponds and the trees will provide valuable timber.

In the southwestern coastal area of Bangladesh, the large mangrove forest provides wellbeing of the national economy. This area (Sundarbans Mangrove Forest) is quite vulnerable due to storm surges, tropical cyclones etc. One of the most immediate and useful adaptation strategies should be to protect the mangrove forest from denudation and implement a massive afforestation program all along the coastal belt. In fact, Bangladesh has a couple of ongoing projects aiming afforestation to stabilize the land, create more accretion leading to more land and also raise the level of topography that will reduce inundation by sea level rise (SLR). Mangroves play a prominent role in maintaining the coastal ecosystem with a variety of environmental supports. These help to buffer the land against storm surges, strong winds and sea level rise. They also provide a protective barrier for the community and their homes. It serves as a protection for a myriad of juvenile aquatic species, functioning as a habitat for a variety of terrestrial fauna and a source of nutrients that helps to sustain many complex food chains. Mangroves shield coastline from storm surge, cyclone and other natural calamities by reducing the wave energy and deposition of sediments. Large scale involvement of communities in coastal afforestation provides a new option for income generation and livelihood security in Bangladesh. An important impact is that the coastal communities who were previously considered a threat to coastal forests become the protectors of these vegetative shelter belts due to sharing of ownership. Salinity is another problem in Bangladesh particularly in the south-western region where the agricultural lands are going to barren continuously as a result of sea water intrusion. The situation has turned to more severe stage due to shrimp cultivation and day by day the salinity intrusion is affecting also the uplands areas. Although various initiatives have been undertaken to solve the salinity intrusion problem, nothing found effective to halt the salinity penetration to the uplands. A number of salt tolerant tree species can be practiced to overcome the problem at these areas. Salt tolerant tree plantation can minimize the problem which in turns may change the soil condition to make favorable for the crop production and to increase rainfall which will have its importance to hitch the groundwater salinity intrusion.

In drought-prone areas of Bangladesh, plantation holds a great adaptation strategy to overcome this situation and to make the lands enable for crop production. Tree components through their deep roots explore a large soil volume of water and nutrients which help to maintain the production during drought seasons. For this purpose, the selection of plant variety is very important and that

variety of trees is adapted here, those require lower amount of water to sustain. Through participatory forest management (PFM), joint forest management, co-management and community-based forest management, forest-dependent communities are at the centre of climate change adaptation efforts, which must focus on strengthening people's adaptive capacity and resilience to fight against frequent climate change. The most successful example of community forest management is the "*Betagi Community Forestry Model Farm*" as in the hilly forest areas of Chittagong.

Agro-forestry is another mode of forest management which is practiced throughout the country. It is a mixed farming system where people raised together trees, crops and animals in the same farm. Being a mixed farm, the yield is relatively higher and it offers a good option to adapt with the adverse climatic conditions. The urban areas are quite vulnerable terms of air pollution, noise pollution, drainage congestion etc. The plantation in the urban cities can be a worth to adapt and moderate those conditions very effectively.

Under UNFCCC, developing countries are negotiating REDD (reducing emissions from deforestation and forest degradation) as an instrument that would provide incentives to developing countries to carry out forest-based climate change mitigation actions. Forest management practices are quite important to reach the ultimate goal of curbing emissions from deforestation and forest degradation and to conserve and enhance forest carbon stocks on the ground. Forest management is imperative behind the successful implementation REDD. Trees absorb carbon dioxide from the atmosphere and store it as carbon. Carbon sequestration by forests has gained much interest as a principal means of mitigation effort. It is a relatively inexpensive ways to mitigate climate change impacts. Participatory forest management, joint forest management, co-management and community-based forest management can significantly contribute to reduce forest emissions and increase forest carbon stocks, while maintaining other forest benefits.

Conclusion

Forest management is an effective tool in response to climate change through proper adaption and mitigation measures. In Bangladesh, various forest management practices are going on and can be undertaken in future through which the adverse climatic events can be managed either by cope with or by controlling them. All the forestry management initiatives are found effective both in economic as well as their environmental sustainability. Forest management programme must satisfy the environmental requirement and adequate planning is necessary to achieve future management goals. Thus, in this management we have to make a framework in which all aspects of forestry activities will be considered and climate change will be in the core concern to make the programme sustainable. The management framework must coincide with the dynamic and changing climate so that ecosystems remain resilient against stress overlying by climate change and other anthropogenic activity; ecosystems continue to provide all the necessary benefits and services.

Forests have huge potentiality to serve as an effective tool capable in combating climate change, providing protecting for people and livelihoods, and form a baseline for more sustainable economic and social development. Sustainable forest management provides the framework for international and national level planning for confronting the challenging issues of climate change specially while to be adapted or mitigated. Finally, considering the multiple services and benefits provided by forests, it is urgent that policy makers can better evaluate the value of forests and the importance of allowing access to forest resources, in a way that facilitates the long-term sustainability of this important natural resource in response to the upcoming climatic pressure.

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