

## CLIMATE CHANGE AND ITS RISK REDUCTION BY MANGROVE ECOSYSTEM OF BANGLADESH

Prabal Barua\* , Md. Shah Nawaz Chowdhury and Subrata Sarkar

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### Abstract

Climate change is amongst the most dreaded problems of the new millennium. Bangladesh is a coastal country bounded by Bay of Bengal on its southern part and here natural disasters are an ongoing part of human life. This paper discusses about the possible impact of climate change through tropical cyclones, storm surges, coastal erosion and sea level rise in the coastal community of Bangladesh and how they cope with these extreme events by the help of mangrove ecosystem. Both qualitative and quantitative discussions are made by collected data from different research work those are conducted in Bangladesh. Mangrove ecosystem provides both goods and services for coastal community, helps to improve livelihood options and protect them from natural disaster by providing variety of environmental support.

**Keywords:** climate change, Bay of Bengal, mangrove ecosystem, natural disaster, coastal community, livelihood

### Introduction

Bangladesh is a coastal country bounded by Bay of Bengal on its southern part and here natural disasters are an ongoing part of human life. Impacts of climate change alter the function, diversity and productivity of ecosystem and livelihood. Climate change keeps the coastal community in risk and destroys property. Facilities of sanitation, home and drinking water are damaged. Food crisis arise and disease out break. With a population of 130 million, Bangladesh is already facing the impacts of climate change. No people of other country know about the impact of climate change better than Bangladesh, where millions of people are already suffering. The life and livelihoods of coastal people are more vulnerable than any other non coastal area of Bangladesh, because they are facing continuously natural calamities especially cyclone, storm surge and flood and becoming a victim of it. To reduce the impact of climate change Mangrove forest are playing an important role, which are also vital for our socio economic development. A large portion of population of Bangladesh lives in coastal area and depends on local natural resources for their livelihood. Mangroves play an important role for maintaining the coastal ecosystem and provide a variety of environmental supports. 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. In Mangrove ecosystem area of Bangladesh economic, social and cultural life is closely related with

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\*Corresponding Author, Email: [prabalims@gmail.com](mailto:prabalims@gmail.com)

Institute of Marine Sciences and Fisheries, University of Chittagong, Chittagong, Bangladesh

Mangrove flora and fauna, its lunar and tidal and seasonal cycles and their associated fish, shrimp and crab. Mangrove vegetation shield coastline from cyclone, storm surge and other natural disaster by reducing the wave energy and stabilize sediment.

## Methodology

### *Data Collection and analysis*

Semi-structured interview with five stakeholders groups e.g. fishing community, forest officers and staffs, local administrators (chairman & members of union parishad), local residents, and elite persons (school teacher, respectable elders) were done in the study period for collection the information about the state of forest and status of dwellers livelihood. The collected data were synthesized and the useful data were extracted for study,

Participatory appraisal involves a series of qualitative multidisciplinary approaches to learn about local level conditions and local peoples' perspectives. Rapid Participatory Rural Appraisal (RRA/PRA) was carried out using field observations and community level group meeting with different stakeholder groups in the adjacent forest areas from March to October, 2008 in order to gather primary information following the approaches of Pido (1995), Pido *et al.* (1996), Townsley (1996), IIRR (1998) and Hossain *et al.* (2004) and also to know the available resources of the mangrove areas as well as their importance for community livelihoods. Direct observation prevents rapid appraisal from being misled by myth (Chambers, 1980) and it often provides more valid and less costly information than other research methods (KKU, 1987). Group meetings with local communities are the important way of learning about local conditions and resources (Pelto and Pelto, 1978).

## Results and Discussion

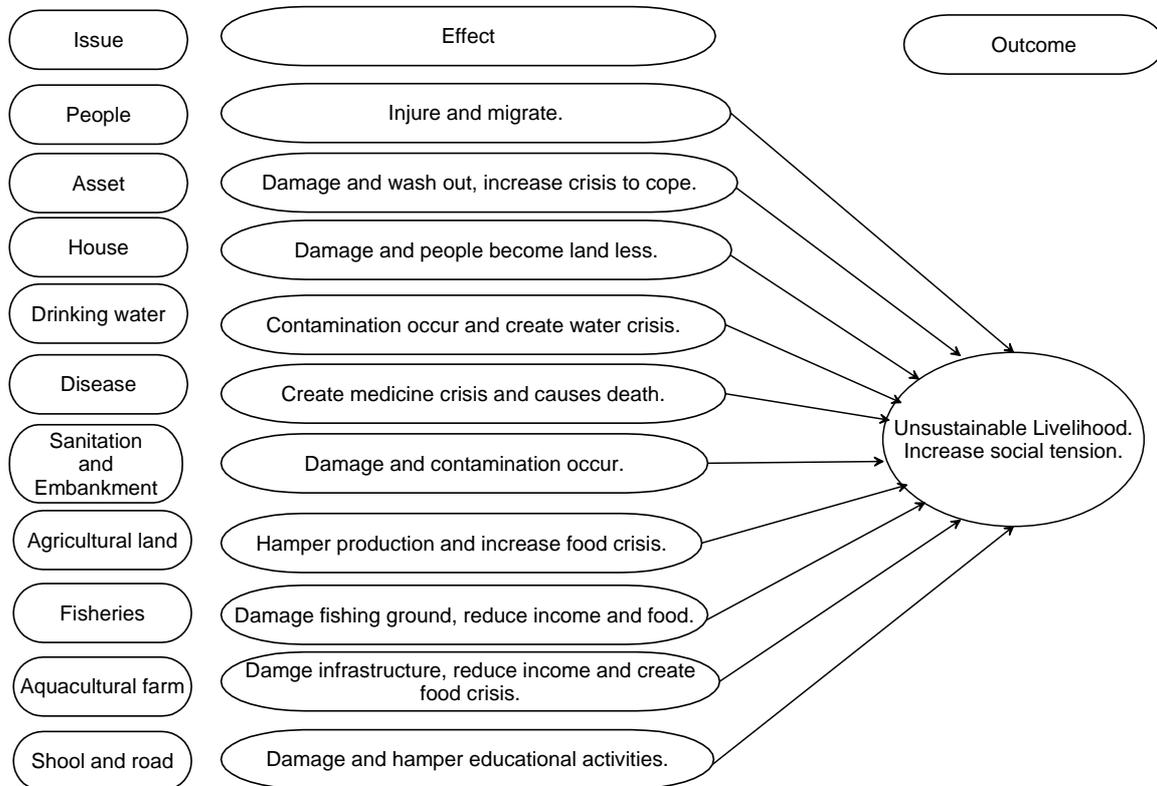
Mangrove is a type of forest growing along tidal mudflats and along shallow water coastal area extending inland along rivers, streams and their tributaries where the water is generally brackish. The mangrove ecosystem is dominated by mangrove trees and act as primary producer. About 587,380 ha of natural mangroves and 100,000 ha planted mangroves are supported by the coastal area of Bangladesh and locally known as *Perabon*. The Sundarban, major continuous block of mangroves, is situated at the southern part of Khulna, Bagerhat and Satkhira district of Khulna civil division, covering an area of 577,040 ha. It is the world largest mangrove forest ecosystem. Sundarbans have a considerably high floral diversity and supports 245 genera and 334 plant species. It is known that there are 289 terrestrial faunal species of 185 genera and 219 aquatic faunal species of 146 genera in the Sundarbans forests. The Sundarbans mangrove ecosystem produce a huge amount of fish for the community and many people from near and far from the forest area do fishing in and around Sundarbans round the year. The leaves of golpata (*Nipa fruticans*) are harvested by local community for thatching purpose. The Sundarban mangrove reserve has a great economic importance for Bangladesh and provides livelihood options for 300,000 people.

Another natural mangrove forest of Bangladesh is the hundred years old Chakaria Sunderbans. It is one of the oldest mangrove forests in the subcontinent and has been subjected to heavy human interference. This mangrove ecosystem situated in Cox's Bazar district, southeastern Bangladesh along the northeastern coast of the Bay of Bengal. Due to excessive human interference and extension of shrimp farming the entire forest has been cleared, except a remnant of only 11 sundari trees (*Heritiera fomes*). Clearance of mangrove in this area causes loss of

coastal habitat and aquatic resources, increase erosion and vulnerability to natural disaster.

**Climate change in Bangladesh**

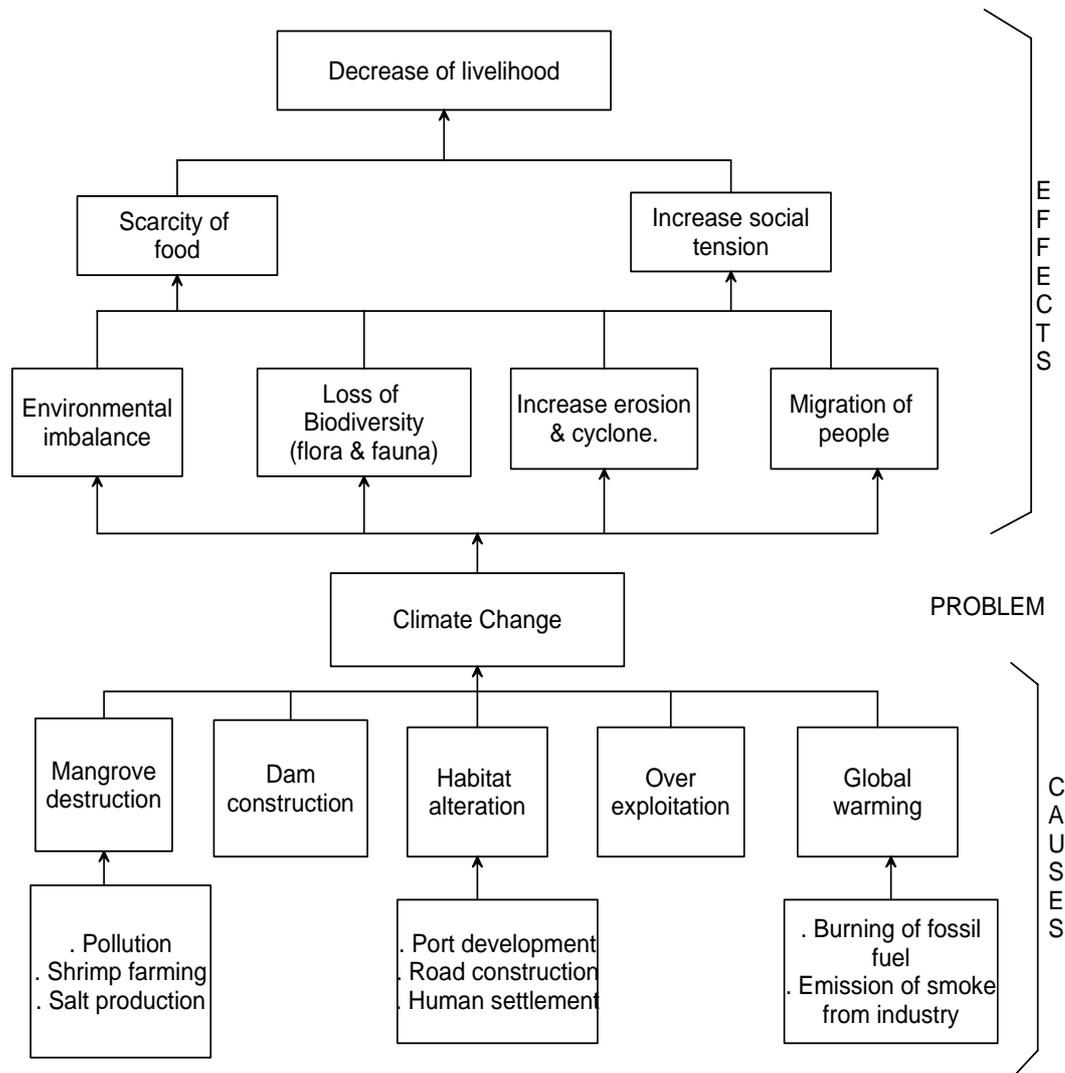
Bangladesh is located between two different settings. Himalayas in north and Bay of Bengal in south. These two setting regulate and modify the climate of this region. Bangladesh is one of the countries which are suffering from adverse impact of climate change. The geographical location of Bangladesh makes the country vulnerable to climate change. Threats of climate change are sea level rise, droughts, floods, cyclones, land erosion, salinity intrusion and epidemic disease. As Bangladesh is a disaster-prone country and population density is high, the abovementioned types of disasters make the life of people more complicated. Due to increase of greenhouse gases in atmosphere for combustion of fuel, fossil and from industrial source global warming causes sea level rise. Sea-level rise as a consequence of global warming is caused by increase in seawater temperatures resulting to thermal expansion of water and melting of glacier and polar land ice (Kennedy et al., 2002). Two estimates of potential future sea level rise for Bangladesh are 0.30-1.5 m and 0.3-0.5 m for 2050 (DoE, 1993). These estimates show that a rise of 1.0 and 1.5 m would inundate 10% and nearly 16% of the country, respectively. Most of the impact of climate change comes to the country from Bay of Bengal and adjacent Indian Ocean. Bay of Bengal is a place of cyclone generation. Gray (1968) estimated that 10% of the world's tropical cyclones form in this bay. About 14% of Cyclones that formed in Bay of Bengal between 1881 and 1990 (110 years) hits in Bangladesh and 49% of world death occur in this country occur due to cyclones.



**Figure 1.** Impact of climate change on the coastal ecosystem of Bangladesh

Between 1991 and 2000, 93 major disasters were recorded in Bangladesh. The impacts of climate change effect community badly and the coastal community of Bangladesh first felt in 1970 and 1991, when two super cyclones hit the country and caused death of about 500,000 and 138,000 people respectively. In Bangladesh south west part of the country was affected by Category 4

Cyclone, Cyclone Sidr, in November 2007. Cyclone Nargis also occurred in 2007 and causes loss of forest in Myanmar. Cyclone AILA began as a disturbance on 21 May in the Bay of Bengal, strengthened as Category 1 cyclone, causes death of about 200 people and left hundreds of thousands more homeless. The flood-affected area of Bangladesh has also undergone significant increase. From 1954 onwards, flood record exists. Significant peak flooding occurred in 1955, 1974, 1987, 1988, 1998 and 2004; in 1988 and 1998 about two-thirds of the country was flooded, which cause significant loss of life and property (Fig 2)

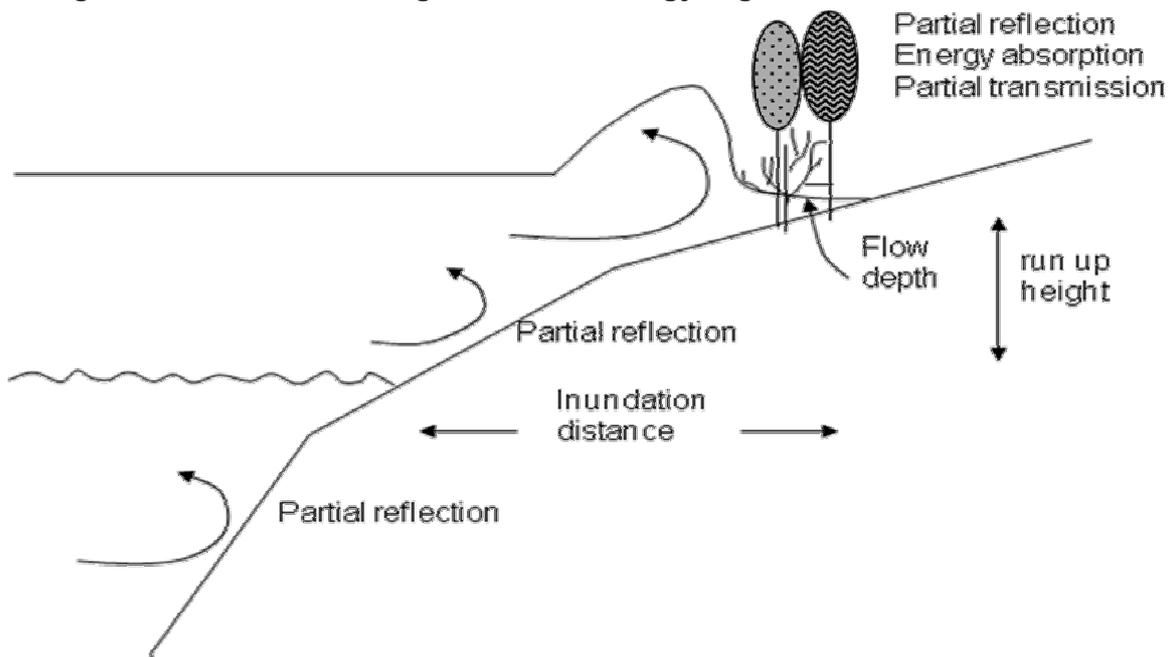


**Figure 2.** Problem tree analysis for climate change

### ***Mangrove and risk reduction of Climate change***

Climate change constitutes a significant impact on the coastal areas of Bangladesh. Mangrove provides economic and environmental benefits that extend well beyond the function served in reducing impacts from climate change. Mangroves can fix greater amounts of CO<sub>2</sub> per unit area than in tropical ocean, where fixed by phytoplankton. Mangroves are also capable to accumulate and store carbon in the soil in huge amounts. A 20 year old mangrove stores 11.6 kg m<sup>-2</sup> of carbon with C burial rate of 580 g m<sup>-2</sup> yr<sup>-1</sup> and hence, plantation of mangroves provides great benefits to control global climate change by stabilizing atmospheric carbon (Fugimoto, 2000). The mangrove foliage produces flavonoids that serve as UV-screen compounds (Moorthy and kathiresan, 1997 a, b). Mangroves protect the environment by protecting coastal

areas and communities from storm surges, waves, tidal currents and typhoons. Mangrove acts as a buffer against wave energy (Fig- 2).



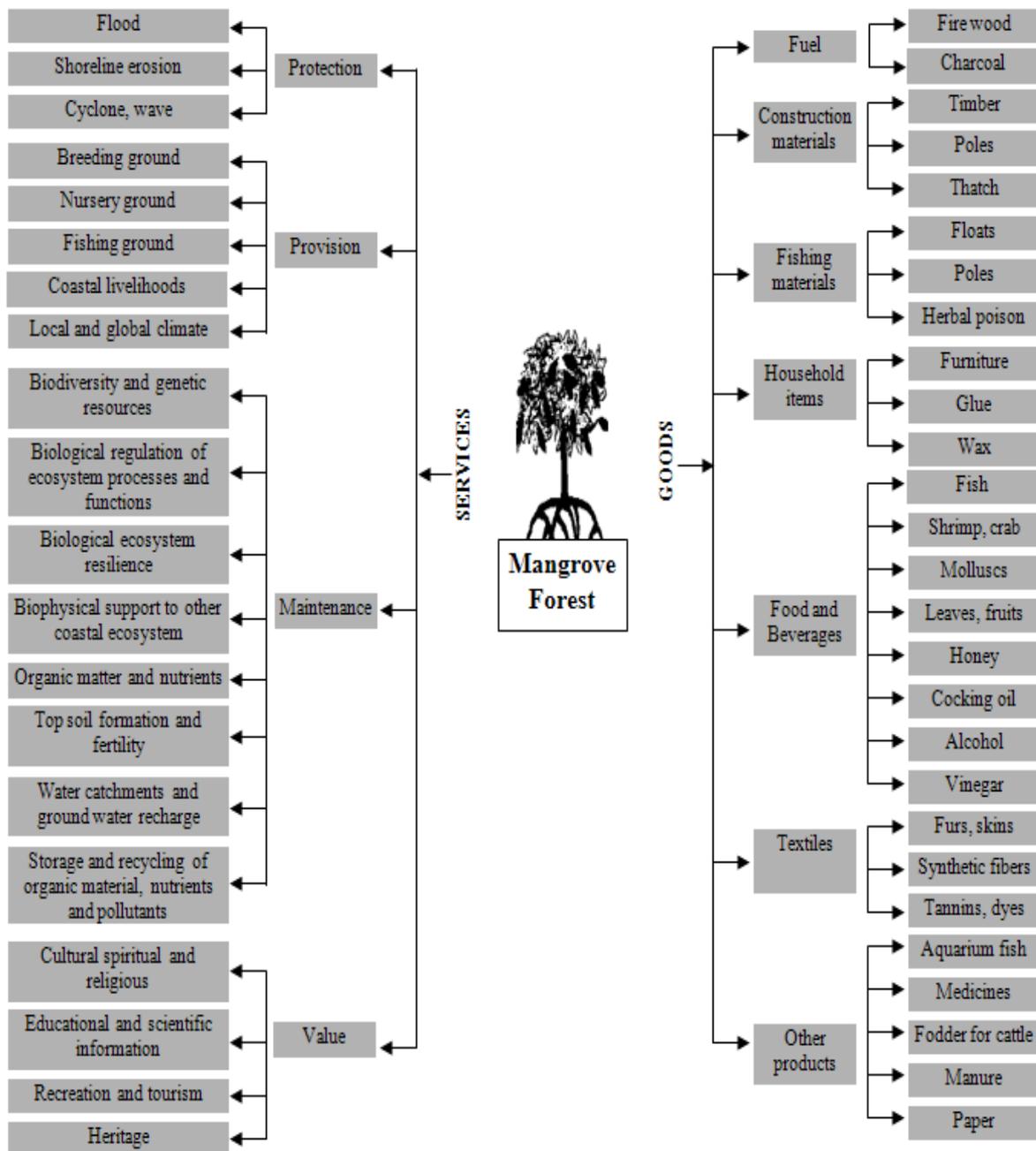
**Figure 3.** Tsunami wave run-up with mangroves forest barrier (source: Forbes, 2007)

The structures of the trees enable them to withstand rare heavy wave impacts and help to dissipate wave action from severe storms. Analytical models show that 30 trees per 100 m<sup>2</sup> in a 100 m wide belt may reduce the maximum tsunami flow pressure by more than 90 % (Hiraishi and Harada, 2003). The crown and stem of mangroves serve as physical barriers against wind action. Mangrove forest, a network of coastal defenses, is capable of absorbing 30 to 40 per cent of the total force of a tsunami or typhoon and ensuring waves before they swirl over inhabited areas by the shore. Their specialized fringes like root system traps and holds sediments and reduce coastal erosion. The accumulation of sediment by the roots in mangrove forests also helps build land mass. Mangrove vegetation can alter topography and bathymetry through the process of sedimentation; reduce the vulnerability of the landscape to inundation due to sea level rise. Further, mangroves promote clear water by filtering and assimilating pollutants. It seems clear that in regions of the coast where extensive mangrove forests exist, they will help ameliorate the impacts of the climate change (Hossain, 2008). For example, in November 2007, coastal community of southwest region of Bangladesh was less affected when Category 4 Cyclone, Cyclone Sidr, hit in this region due to presence of Mangrove. But the impact of destruction of mangrove forest in southeast coastal region of the country first felt in April 1991, when a super cyclone hit the country and caused death of 138,000 people. That cyclone reminds the importance of mangrove forest as a 'bio-shield' to safeguard the coastal people. Rapid rate of emissions of greenhouse gases such as carbon dioxide, methane, nitrous oxide, ozone and chlorofluorocarbons from anthropogenic sources such as burning of fossil fuels, tropical deforestation and other human activities resulted to increase in global temperature, otherwise known as global warming and responsible for sea level rise. A 1 m rise in sea level would inundate 16% of Bangladesh's total land and 15% of the country's population will be landless. Mangrove trees produce peat from decaying leaf litter fall while the growth of pneumatophore, root, rhizome and stem trapped sediment in the water including leaf litter. The process of building peat and

accumulation of sediment helps coastal area to keep up with sea level rise. Mangroves function in flood control by decreasing the velocity of excess water during heavy rainfall. As water flows into mangrove forests, it naturally loss velocity as it collects and continues to spread out. Mangrove vegetation provides another natural barrier to fast moving water and therefore aids in flood speed reduction. The result of mangroves activity during floods is often decreased damage of surrounding areas (Hossain, 2009). Thus, mangroves are a part of the solution to climate change in the coastal community of Bangladesh by stabilizing and protecting coastal regions and providing environmental resources.

**Mangrove and livelihood**

The environmental benefits of mangroves, as well as their commercial uses, have made mangrove forests very important ecosystems. The benefits of mangrove ecosystem in terms of goods and services are shown in figure 4.



**Figure 4.** The productive and protective role of mangrove forest as goods and services (Source: Hossain, 2009)

Mangrove forests serve as diverse habitat for many species, including fish, birds, reptiles, amphibians, mollusks, crustaceans and many other invertebrates. Mangroves act as root of sea and, if there is no mangrove along the coast, there will be no or fewer fish in the sea and the sea will act as tree without its root. Mangroves provide nursery grounds for fish, prawns and crabs, and support fisheries production in coastal waters. The exposed prop roots and pneumatophore provide ample hiding places for fish. Many commercial shrimp and fish species are commonly available here. Mangroves produce leaf litter and detritus matter, from the leaf of mangrove trees which are valuable sources of food for animals in coastal waters. Up to 80% of global fish catches are directly or indirectly dependant on mangroves. From Sundarbans mangrove forests, an average of 6000 ton/ha is released per year provide a great source of natural food. Mangroves serve as recreational grounds for bird watching and observation of other wildlife by providing shelter for local and migratory wildlife. Mangroves are a good source of wood, timber and housing materials, firewood, charcoal, and of poles for fish traps. Fish, crustaceans and mollusks can be harvested from mangroves. Aquaculture and commercial fisheries also depend on mangroves for juvenile and mature fish species. Last but not the least; mangroves are sources of tannin, alcohol and medicine. The annual economic value of mangroves, estimated to be US\$ 200,000- \$900,000 per ha (Wells, 2006). Mangrove forests offer good opportunities for ecotourism and economic benefits to local coastal communities of Bangladesh. The mangrove forests have been shown to sustain more than 70 direct human activities, ranging from fuel-wood collection to fisheries. For the coastal dwellers of mangrove ecosystem area, the value of mangrove is not surprising. Local community has long recognized the socioeconomic values of mangrove ecosystems for their lives and livelihoods. These resources help to eliminate poverty. The local people are depending largely on the natural resources of mangrove forest for their living.

Major activities in mangrove forest area are shrimp farming, salt production, collection of fuel wood, fry collection, cattle grazing and human settlement. Mollusc shells are collected from mangrove by fishermen for lime preparation. Mangrove twigs are used as firewood to the local people due to the high caloric value. The mangrove wood with high content of tannin is used as timber for its durability. The pneumatophores of mangrove trees are used by local fishermen for stopper and float making. Mangrove extracts as indigenous medicine; for example, *Avicennia* species have tonic effect. The fruits of *Sonneratia* species are used for beverage preparation. Extracts from mangroves seem to have a potential for human, animal and plant pathogens and for the treatment of incurable viral diseases like AIDS (Kathiresan, 2000).

## Conclusion

Climate change has created significant impact on coastal rural people of Bangladesh, changes the life style and destroys the livelihood options. A well developed mangrove forest ensures different goods and services for local people and attracts mangrove dependent species to enhance biodiversity. As the natural disasters are increasing around the globe it is essential to protect mangrove for human welfare to improve protection against typhoons, storm tides, tsunamis and other ensuing catastrophic consequences.

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