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Mitigation of Climate Change and Role of Forest Management: A Short Review

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Abstract:

Climate change is the greatest global threat and long-term challenge, as it can significantly cause damage to water resources, land resources, ecosystem, food security and health. Current projections of climate change constitute a further increase in average global surface temperature, increase in atmospheric carbon dioxide concentrations and changes in precipitation as well as altered disturbance regimes. A change of 1.8-4°C by 2090-2099 relative to that of 1980-1999 has been projected by IPCC AR4. Developing countries are going to bear the brunt of climate change and suffer most from its negative impacts. Mitigation measures in the forestry sectors are generating much interest as a potential means of adaptation to climate change and also as a source for additional income to rural population. Forest ecosystems are one of the most efficient systems in reducing greenhouse gas emissions, capturing carbon in soil and biomass, and reducing the vulnerability of people and ecosystems to the detrimental impacts of climate change. Managing the loss of global forest should, therefore be incorporated into the framework for stabilizing the atmospheric concentrations of green house gases. Forest management strategies can prove to be promising tools to achieve this stabilization with social, economic and environmental goals. For forests, to fully achieve their potential to address climate change, their governance must be improved as forestry projects can provide low cost mitigation strategies for climate change as well as adequate standards of living by improved food security, reduced poverty and increased sources of income.

Keywords: Climate Change Mitigation, Forest Management, Ecosystem Services, Forest Degradation, Forest Ecosystems, Food Security

1.0 Introduction:

Earth's environment has been undergoing changes due to increasing human population and its activities; the most significant changes being the increase in concentration of carbon dioxide and other green house gases in the troposphere. There is a clear evidence for the changes that have occurred in the composition of greenhouse gases in the lower atmosphere during the last century (IPCC, 2001) and over the long time scales of glacial and interglacial periods (Barnola *et al.,* 1987, Petit *et al.,* 1999). Carbon dioxide is one of the main greenhouse gas, the level of which is continuously rising in the atmosphere since preindustrial times (Lal and Singh, 2000). Human-induced increase in atmospheric CO_2 over the past 140 years is thought to have contributed to average global temperature increase as well as other changes in climate and is attributable mostly to fossil fuel combustion and deforestation worldwide (Hamburg *et al.,* 1997). Fossil fuels combustion being the principle cause of increase in carbon dioxide, releases about 21 billion tons of CO_2 in the atmosphere annually, whereas deforestation is estimated to account for 15-30% of annual CO_2 emission (Singh *et al.,* 2006). Anthropogenic deforestation is converting the forest from being sinks of CO_2 to its sources. Paoli *et.al.,* 2010 has also reported 12-20% global anthropogenic carbon emissions annually from anthropogenic deforestation and forest degradation in the tropics during past decade.

Atmospheric CO_2 concentrations have increased by almost 100 ppm in comparison to its pre-industrial level, reaching 379 ppm in 2005. There has been an increase of almost 100ppm in CO_2 concentration from its preindustrial levels, reaching 379 ppm in 2005. Also, the total CO_2 equivalent concentration of all long-lived GHGs is

estimated to be about 455 ppm (Rogner *et al.,* 2007). A further increase in average global surface temperature (1.8-4°C change by 2090-2099 relative to 1980-1999) under different scenarios and atmospheric carbon dioxide concentrations, changes in precipitation as well as altered disturbance regimes has been projected by IPCC, 2007a. Approximately one fourth of mammals species (about 1125, IPCC, 2002) and about 20% of bird species (about 1800, IPCC, 2007b) are at risk of global extinction because of climate change.

2.0 Forest Ecosystems and Climate Change

Climate change is a multi-scalar environmental and social problem, which affects different sectors (Osbahr, 2007) and its impacts may be specific to individual sectors or regions. Ahenkan and Boon, 2010 have reported agriculture, biodiversity, water, health, forests and energy sectors as most vulnerable sectors towards climate change. Forests, being the significant natural assets, maintain a balance between earth and environmental systems and also provide livelihood for millions of forest dwellers. They play a key role in the conservation of ecosystems, in maintaining quality of water, and in preventing or reducing the severity of floods, avalanches, erosion, and drought. Forests ecosystems provide a wide range of economic and social benefits, such as employment, forest products, and protection of sites of cultural value (FAO, 2006). They are home to most of the world's biodiversity and sustain the livelihoods of over 1 billion of the world's poorest people.

Degradation of forest resources has a detrimental effect on soil, water and climate, which in turn affects human and animal life (Mathur and Sachdeva, 2003). As per the views of Richards, 1990, the long term process of forest loss is the result of conversion of landuse change by human kind that systematically converts forest land to agriculture. In the past decade (2000-2010), around 13 million hectares of forest have been converted to other uses or they have been lost through natural causes each year. The estimated 850 million hectares of global degraded forests can potentially be restored and rehabilitated to bring back lost biodiversity and ecosystem services and to contribute to climate change mitigation and adaptation (FAO, 2010).

The relationship between forests and climate change is intricate. The forest sector plays and important role in climate change. Forest can mitigate climate change by absorbing carbon, and also they can contribute to climate change if they are degraded or destroyed. Forestry, as defined by IPCC, accounts for around 17% global GHG emissions-the largest source of anthropogenic emissions after energy supply and industrial activity.

In present scenario of increasing concentration of CO_2, there is growing interest in the potential for increasing the storage of carbon in terrestrial vegetation through forest conservation, afforestation and land management. Several studies have indicated that the global potential for enhancing the C storage in forest and agricultural ecosystems may be as much as 60-90 Petagrams of C (Dixon et al., 1991, Brown et al., 1996). The wide variation in the estimated carbon (C) pools and fluxes is because of the uncertainty in biomass estimates of forests (Schroeder et.al., 1997) and the method for estimating the biomass (Detwiler and Hall, 1988).

3.0 Forest, Climate Change and Global Economy:

Forests are our most important terrestrial storehouses of carbon and play important role in regulation of climate. Deforestation and forest degradation release stored carbon into the atmosphere as CO_2 emissions. The global forest sector produces an estimated 5.8 $GtCO_2$ annually. Deforestation is occurring rapidly in the tropics, where an estimated 13 million hectares – an area the size of England – are converted to other land uses each year. Deforestation in tropical regions generally emits significantly more CO_2 than forests elsewhere in the world. Modelling for the Eliasch Review estimates that the global economic cost of the climate change impacts of deforestation will rise to around $1 trillion a year by 2100 if unabated. The total damage cost of forest loss for the global economy could be $12 trillion in net present value terms. These costs are additional to climate change damage caused by emissions from other sectors (Eliasch, 2008).

To address the global externality of CO_2 emissions, carbon needs to be valued to represent the price or penalty that would be paid by those who generate the emissions. This value can be imposed as carbon tax or can arise from a trading system.

Standing tropical forests may contain 300-400 tons CO_2 per hectare in biomass (Kindermann *et al.,* 2008). If carbon prices are $14 per ton CO_2, the annual rental value of carbon embodied in a standing tropical forest with average 350 tons CO_2 in measureable aboveground carbon is $245 per hectare per year (Sohgen, 2009). The scale of the forest carbon markets have climbed to 75 MtCO2e, valued at an estimated $432 million with projects impacting more than 7.9 million hectares in 49 countries from every region of the world (Diaz *et.al.,* 2011). These estimates imply that the forest conservation and avoided deforestation can prove to be a low cost option that is meaningfully applied to climate policy.

4.0 Forest Management Strategies:

Being the largest store of terrestrial store of carbon after coal and oil, forests have a vital role to play in the fight against global warming. The forestry sector can not only sustain its carbon but also has the potential to absorb carbon from the atmosphere (Lal and Singh, 2000). Sustainable forest management is a dynamic and evolving concept that aims to maintain and enhance the economic, social and environmental value of all types of forests, for the benefit of present and future generations. Effective forest management practices can result in sure survival of forest ecosystems and will also increase their potential to provide environmental, socio-cultural and economic services to mankind. It can also increase the contribution of these ecosystems to climate change mitigation, bringing up the livelihood of forest-dependent communities and helping them to adapt to new environmental conditions caused by climate change.

Community forest management can significantly contribute to reduce forest emissions and increase forest carbon stocks, while maintaining other forest benefits. Payments for ecosystem services may be useful in preserving, acknowledging and rewarding good community forest management practices. Forests can be net sinks or net sources of carbon, depending on their age, health and susceptibility to wildfires and other disturbances, as well as on how they are managed. Forest management interventions that result in carbon emission reductions or increased carbon sequestration could potentially be rewarded by REDD+ (FAO, 2010). Financial assistance for climate change adaptation of forests, forestry and forest-dependent people is provided by various funds managed by the Global Environment Facility.

Developing and managing agro forestry systems on agricultural lands and farms, urban and rural tree plantations, trees roads, rivers and human settlements can significantly contribute to environmental sustainability. They ensure enormous opportunities for providing income, a large number of goods and ecosystem services for rural households, food security and poverty eradication. FAO provides technical assistance to improve the management of agroforestry systems so as to enhance the potential of trees outside forests to address global challenges of poverty, land degradation, climate change and biodiversity loss.

5.0 Conclusion:

Forest restoration and sustainable forest management are considered important measures for mitigating climate change. They are not meant only for mitigating climate change but for providing various productive services like production of goods, protective services comprising protection of soil and water, environmental services including biodiversity conservation, and socio-cultural services by supporting the livelihood of people and poverty alleviation. Along with these services, forest ecosystems are a storehouse of various opportunities for uplifting the economic wellbeing of the nation (e.g. timber and non-timber products, employment etc.). Climate change mitigation and adaptation measures should, thus, be so defined as to provide the balance between local and national forest objectives with synergistic approach. Climate change adaptation strategies can be viewed as a risk management component of sustainable forest management plans. Bioenergy production from forestry and the substitution of fossil-fuel-intensive products by wood products could be important strategies for mitigating climate change. Planting forest rather than relying on natural regeneration can increase the rate of carbon accumulation in early years and increases the overall quantity of carbon on the site in long run (Sohgen, 2009). Hence, forestry is not just a bridge to the future; it should be an important part of any control strategy needed to mitigate climate change.

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