# Climate Change and Forests

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Forests provide several goods and services that are crucial to human survival. They are one of the world's major carbon stores, containing about 80% of aboveground terrestrial biospheric carbon and 40% of terrestrial belowground carbon. The forestry sector is unique, in that it contributes significantly to global $CO_2$ emissions (about 20% of global $CO_2$ emissions) and also provides significant opportunities to not only reduce the current or projected emissions, but also to remove $CO_2$ accumulated from past emissions in the atmosphere, and sequester it in soil, vegetation and wood products. Finally, forest sector is highly vulnerable to climate change, adversely affecting the species composition, species dominance, biodiversity and ultimately to extinction. Further, forestry sector is closely linked to socio-economic systems, particularly the forest dwellers and rural communities and thus making them vulnerable to projected impacts of climate change.

## Greenhouse Gas Emissions from Forests

In 1990, the Land Use Change and Forestry (LUCF) sector accounted for 20% of the global $CO_2$ emissions of 7.1 GtC. GHG emissions and removals were estimated, by Indian Institute of Science, for India using the *IPCC (Intergovernmental Panel on Climate Change) Revised 1996 Guidelines* for the National Communications submitted to the UNFCCC (United Nations Framework Convention on Climate Change). A net marginal emission of 14.29 million tonnes of $CO_2$ was estimated for the forest sector for 1994. In India, $CO_2$ emissions from forest conversion or loss are largely offset by afforestation.

## Impact Of Climate Change On Forest Ecosystems In India:

IPCC Reports have concluded that even moderate warming and climate change will impact forest ecosystems and biodiversity adversely. A detailed

assessment of impacts of climate change on forests at national level for India by *Ravindranath et al, 2006* made using BIOME4 model, SRES scenarios A2 and B2 and Regional Climate Model of the Hadley Centre (HadRM3) outputs shows that in India 68 to 77% of the currently forested grids are likely to undergo change in forest type, adversely affecting biodiversity in the transient phase. The model outputs further show that the projected climate is likely to be not optimal for existing vegetation. The study also shows that Net Primary Productivity is likely to increase by 70-100 % due to $CO_2$ fertilization, assuming no nutrient limitation. Recent dynamic Global Vegetation Modeling Studies have also confirmed that majority of the currently forested grids are highly vulnerable to climate change even by 2050s.

**Mitigation potential of forest sector in India; national, regional, district and project level**

A comprehensive assessment of the $CO_2$ sequestration or mitigation potential of forest sector in India has been made and published in several papers. Contrary to the belief that forest sector in India has limited carbon mitigation potential, due to high human and livestock population density, mitigation studies carried out by the Indian Institute of Science at national, regional, district and project level shows the following. At the national level, economic mitigation assessment is carried out for the first time using AEZ (Agro-ecological Zone) classification of land. Economic mitigation potential assessment is carried out under baseline and mitigation scenarios, including the carbon price incentive using GCOMAP model. The incremental mitigation potential, over the baseline scenario afforestation is estimated to be in the range of 129 to 435 million tonnes of Carbon during the period 2005 to 2035 (*Ravindranath et al, 2007*).

The regional mitigation study focused on developing regional baseline and comparing with the project baseline, for the first time. The study adopted three-step approach namely; identification of likely baseline options for land-use, estimation of baseline rates of land-use change, and quantification of baseline carbon profile over time. The analysis showed that carbon stock estimates made for wastelands and fallow lands for project-specific as well as regional baseline are comparable. The study for the first time showed that conducting field studies for estimating carbon stock changes in biomass and soil, using regional baseline approach is about a quarter of developing a project baseline. The study demonstrated the reliability, feasibility and cost-effectiveness of adopting regional baseline for forest sector mitigation projects. A study at district level demonstrated the approach and methods to be adopted for estimating carbon mitigation potential of forestry projects.

A recent study by Indian Institute of Science, made an assessment of the implications of past and current forest conservation and regeneration policies and programs on forest carbon sink in India. The study concluded that if the current rate of afforestation continues the carbon stock in Indian forest is projected to increase from 8.79 GtC in 2006 to 9.75 GtC by 2030.

**Mitigation and adaptation synergy in forest sector**

Mitigation and adaptation are the two strategies to address climate change. Currently the two strategies are separately addressed. A preliminary attempt was made to conceptualize and explore the opportunity for synergy between mitigation and adaptation. Firstly, there is a need to ensure that mitigation projects and programmes do not increase the vulnerability of forest ecosystems and plantations. Secondly, several adaptation practices could be incorporated into mitigation projects to reduce vulnerability. The study has listed several adaptation activities which contribute to mitigation. The paper concluded that there is limited information about the synergy between mitigation and adaptation and highlighted the need for research and demonstration of synergy through field projects.