Forest Management strategies for carbon management functions in context of climate change

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Abstract

It has been almost established that it is the accumulation of Green House Gases (GHGs), which constitute predominantly carbon dioxide, is the prime cause of the global climate change through the phenomenon of global warming. In spite of the uncertainties about the extent, impact and outcome of global warming, it is unequivocally accepted that reduction of Green House Gases is the direction in which concerted efforts from the global community should be focused. Forests, as the carbon sinks, play a major role in removal of the GHGs from the atmosphere. Forest management has thus attained an exclusive additional dimension and responsibility in context of atmospheric carbon management.

Forests have been recognized as simple but effective means of carbon sequestration where ultra modern technological advances are not required. However, several factors determine the feasibility of role of forests as carbon sinks and enhancing their utility in carbon sequestration. As wood is the most important carbon storage system of the forest biomass, the strategy for carbon management must include wood management as an important component. Consequently forest productivity and wood management become most important factors of carbon management.

Key words: *Carbon sequestration; carbon management; Forest profile; productivity; growing stock; biodiversity value; demand side management*

This paper attempts to analyse the costs and concerns involved, the opportunities and the issues needed to be addressed while accounting the role of forests as carbon sinks, among the different roles and functions the forests play in the ecological and socio-economic paradigms of human life, in the Country. The present notion of conservation, trades off required in optimizing the carbon sink efficiency of forests and need of a new perspective in the forest management have been presented. Some of the management imperatives and options that would be required to be internalized in forest management planning and administration in this context have been discussed.

Introduction

The phenomenon of climate change is ascribed to global warming predominantly known to be caused by accumulation of green house gases (GHGs) in earth's atmosphere. The uncertainties linked to the phenomenon render it perhaps the most debated concern of the humanity today. The Inter-governmental Panel on Climate Change (IPCC)[1] has been working on the trends and its fourth assessment report (AR4) indicates that the Earth's surface temperature has risen by 0.6±0.2°C over the twentieth century. In the last 50 years, the rise has been of the order of 0.13 ± 0.07°C per decade. The fact of global warming is declared unequivocal and sufficient evidences have indicated that this is due to anthropogenic reasons.

The current level of atmospheric CO_2 is estimated as 379 parts per million (ppm) compared with only 280 ppm of pre-Industrial level. The annual growth rate of CO_2 concentration has been greater in last 10 years (1.9 ppm/yr) compared to the average of last 40 years (1.4 ppm/yr).

Since warming depends upon the total stock of GHG in the atmosphere, continued emissions result into gradual rise in temperatures. If emissions continue to increase as at present, a warming of about 0.2°C per decade is predicted by IPCC. Even if emissions are stabilized at 2000 levels, the warming trend is expected be about 0.1°C per decade. The Special Report on Emission Scenarios (SRES) predicts that the world's surface air temperature could rise by between 1.1 and 6.4^0C over the twenty-first century. In the scenarios with GHG concentrations ranging between 600 ppm and 1550 ppm, the temperature rise is projected between 2 to 4^0C. The sea level is projected to rise by 18 to 59 cm.

Accumulation of GHGs in atmosphere being the prime cause of this climatic change, the responses to it need to primarily aim at minimizing the GHG concentration in the atmosphere. In the present circumstances, the option of reducing emissions has been the subject of global debate with various positions being taken by various countries in this respect. Nevertheless, every possible step is needed to minimise atmospheric carbon in the existing circumstances. While technological solutions for large scale carbon capture and storage are being worked on, the scope of available simpler solutions in contributing to carbon removal from the atmosphere can not be undermined. Forestry is one of such sectors which offers significant scope of cleaning the world's atmosphere from excess carbon dioxide.

Global perspective

Recognizing the potential of forestry in carbon management, various options within the sector have been discussed and recognized by the world community. Thus among the existing natural resource

management systems, forestry has emerged as the most important sector which can support strong response to climate change with least deviation from the existing management.

The Kyoto Protocol is scheduled to come to an end in 2012 and negotiations on the successor regime commenced in Bali, Indonesia, in December 2007. Further roadmap for post Kyoto Protocol measures is expected to be worked out in the days to come. In Bali conference in December 2007, decision of COP 13[2] on the action on forestry side of response to climate change is as follows:

1(b)(iii) Policy approaches and positive incentives on issues relating to reducing emissions from deforestation and forest degradation in developing countries; and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries;

G8 countries on 8th July 2008, at Hokkaido Toyako, Japan, resolved, in their leaders declaration, to take up action in forestry sector as follows[3]:

"36. We encourage actions for Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (REDD) including the development of an international forest monitoring network building on existing initiatives. Recognizing the urgent need to curb illegal logging and its associated trade, we welcome the G8 Forest Experts' Report on Illegal Logging. We will follow up, as appropriate, its preliminary list of options. We will make all possible efforts by ensuring close coordination among various fora and initiatives with a view to promoting effective forest law enforcement and governance and sustainable forest management worldwide. We will also consider ways to enhance our cooperation to combat forest fires."

It is estimated that the world's forests store 283 Gigatonnes (Gt) of carbon in their biomass alone, and that the carbon stored in forest biomass, deadwood, litter and soil together is roughly 50 percent more than the amount of carbon in the atmosphere[4]. Further capacity of more than 100 Gt has been estimated in world forests[5]. In FAO, Wulf Killmann, chair person of the interdepartmental working group, climate change FAO has stated as follows:

"We need to stop deforestation and expand the land area covered by forests, certainly, but we also need to substitute fossil fuels with biofuels,— like wood fuels from responsibly managed forests — in order to reduce carbon emissions, and we should use more wood in long-lasting products to keep trapped carbon out of the atmosphere for longer periods of time."

UK Forestry Commission Policy line on the f**orestry policies in response to climate change[6] indicates that while p**rotective measures would guard existing forests from degradation or from climate related damage, adaptation initiatives would help managers prepare forests and woodlands for the anticipated additional stresses from a changing climate and the resulting extremes in weather. Mitigation measures include not only capturing carbon in forest biomass, soils and wood products but also substituting wood products for energy-intensive materials, such as concrete or steel.

Forests as carbon sinks

Such recognition to forest management as a promising option for dealing with GHG reduction puts an additional responsibility on the forest management, for internalizing this aspect in the management.

Forests as carbon sinks are not only needed to be maintained, but also should continue to sequester carbon at significant rate. This function of the forests needs to be maintained with all the other existing social, economic and environmental functions intact. Similarly, this function of the forests also needs to be monitored in terms of their contribution in the total measures for carbon sequestration. This becomes much more important in view of the fact that forest conservation has been agreed to be made a part of the post Kyoto mechanisms. In such circumstances, it is imperative that forest management is not only reviewed with these new roles in mind, but the ways to measure and monitor the performance are also worked out.

Wood as carbon storage device

The importance of trees to store carbon lies in the fact that wood, the most dominant forest produce, can be used in a variety of uses, which eventually help further conservation of environment. Thus, wood being a direct outcome of harnessed solar energy and atmospheric carbon, is capable of providing not only energy, but also structural materials which can store carbon for long period; which are biodegradable; require relatively smaller energy inputs for fashioning compared to their metal counterparts; more aesthetic; better insulators; least hazardous and accessible to all citizens – rural or urban. Finally and foremost, it is sourced from a growing resource, which can continue harnessing carbon if over mature growth is harvested to give way to new growth.

On the other hand, owing to the pressure on forests for products and services, the state of forests has been deteriorating. Thus with a policy reorientation in 1980s, harvesting of wood has been considered as an undesirable activity linked to commercial concerns. In spite of the inherent concepts of sustainability in the principles of harvesting of wood, these principles are not relied upon in favour of conservation, thanks to the earlier focus on economically important species and policy of large scale conversion of natural forests into plantations. Looking in totality, if the present alternatives to wood are viewed in sustainability and specifically climate change perspectives, it can be seen that the substitutes, mainly metals and plastics, have largely been energy intensive, hazardous, non biodegradable with high environmental costs.

Considering the virtues of wood, there is a case for a review of utility of wood and policy of discouraging its use. For maintaining carbon sink function of forests, the wood needs to be harvested and put for uses that can ensure long term storage of carbon. Demand management of the wood harvested from the forests would be critical for ensuring sustained demand/utility of carbon traps in this perspective.

Cost of creating carbon sinks

Focus on the role of forests as carbon sinks is a new development. Due to the facts mentioned above, preparing forest management for this function involves a change of paradigm from protectionism to conservationism. The changeover from timber resource to ecological resource has imparted several dimensions to the objectives of forest management. This includes multiple products, ecological services, non invasive benefits, community needs with community resource status and genetic resources. The Kerala forests are specifically considered important for their biodiversity and watershed services. Any additional function of the forests therefore must not infringe upon the biodiversity and watershed services roles.

The concept of dedicated carbon sink forests in some countries is based on the availability of areas where separate stands can be maintained for this purpose. Working on the principles of dedicated forests for carbon sinks, the economic cost has been worked out in some studies. In such a study in United States, it has been indicated to be within the range of $ 30-90/ ton of carbon[7]. Compared to this cost, the average market rate of CERs in CDM market is about $ 17. The worked out cost of dedicated carbon sinks include the cost of land, cost of inputs for creating the sinks, cost of the resources or activities which would be ultimately replaced by the carbon sinks. Nevertheless, option of maintaining forests as carbon sinks has been considered economically desirable in USA[8].

However, considering the variety of management objectives for our forests, this concept of dedicated carbon sinks may not be feasible. The existing extent under forest land use interspersed with habitations does not allow a compartmentalized forest budgeting for different designated uses. Therefore, there is a need to look for feasible options for GHG mitigation especially ways and means of carbon management in forests. The strategy needs to ensure offsetting the costs of factors enumerated above.

Opportunities for offsetting costs:

In the prevailing circumstances in the Country in general and Kerala in particular, an analysis of our forestry environment provides clues to the factors which can be utilized to leverage the costs of carbon sequestration. A significant 23% of the land area of the Country is under the recognized forestry land use. In Kerala, about 29% of the land area is recorded under the forest land use[9]. This extent provides ample scope for maintaining this area as an important carbon bank. Thus optimum use of the existing forests itself can offset the requirement of earmarked land for specific carbon sinks.

The tropical climate of this region sets the productivity potential at very high level. Most of the forests naturally contain large proportion of tree dominated profile, which provides to these forests a capability of holding much higher biomass than they actually hold presently. High biomass volume provides higher resilience and adaptability to change. The present estimations of gap between the productivity potential and existing productivity are huge[10]. It can be claimed that productivity of forests in the Country can be doubled by appropriate management strategies. It is more so feasible in Kerala due to prevalence of tropical moist climate. Thus an investment for optimizing forest productivity in Kerala has a potential of boosting carbon stocks in the forests substantially.

Wood is the most dominant component of the forest biomass. It is a common knowledge that in forests higher age is associated with low growth rate and diminishing mean annual increment leading to nil to low net carbon sequestration[11]. As such, forests with predominantly higher age classes accumulate low biomass, and thus limit the new growth by occupying the growing space. For maintaining the forests as vibrant carbon sinks, it is imperative that prime growth rate is maintained and post prime biomass is harvested and utilized in carbon efficient ways. Therefore, any strategy for carbon management in forests needs to incorporate wood management as its integral component.

Wood is the only major natural building material that is renewable. Concerns about the environmental impact of the materials in structural use are increasingly important for protecting the environment and are in

favour of wood. Thus long term carbon trap uses of wood can offset further costs by substituting metal and plastics, which are less environment-friendly and more energy intensive.

Management concerns

While considering carbon management as an added facet of forest management, the management policies and strategies need to be looked into from this new perspective. Present National Forest Policy and state strategies mostly aim at expanding forest areas to the maximum possible extent. However, it is the standing volume - which forms the growing stock within the forests that will determine the carbon capturing capacity of the forests. Thus the notion that a large extent of forests connotes larger carbon stock alone would not be sufficient for driving carbon management to optimum. It needs to be appreciated that optimizing the standing volume within the existing extent itself can make a big difference in the carbon stock of the forests.

However, several factors need to be addressed while maintaining forests as carbon banks. First need in this context will be taking the natural forests bearing tree growth into active management domain. While the forests with almost monotypic tree growth like teak, sal or pine forests are managed like plantation forests, those with a higher diversity of species are at present outside active management domain since conversion of natural forests was stopped in early 1980s. It is almost three decades since then and any assessment of impact of this decision on the forest profile has not yet been done. It is high time that the state of the forests, capable of bearing tree growth, is assessed for their potential to bear trees and wood as carbon deposits. The use of natural forests for production functions is supported by the fact that most of the important plantation species grown in Kerala are natives of these forests.

It will be desirable that the extent of forests is leveraged by volume or biomass. Present state of productivity in the forests of India can be doubled if appropriate management inputs are provided. Doubling of growth rate can not only double the existing carbon stock within the same area, but also can improve the resilience of the forests against the shocks of changing climatic conditions. It is a fundamental biological principle that growth shows a sigmoid curve against time (age). Wood biomass constitutes the largest share in a tree dominated forest and so the growth rate of wood biomass can be maintained by harvesting the wood soon after peaking of growth rate, and replacing it by the new regeneration to take over with high growth rate.

However, any consideration in this direction will have to be linked to redressal of the factors which, in the past, resulted in degradation of the forests in spite of the inbuilt fundamentals of sustainable yield. Other designated roles of the forests will need to be interwoven in the assessments and analysis for management planning. The strategy shall have to be oriented towards sustainable use. Biodiversity profile and other ecological values will have to be understood and managed better e.g. for environmental services, protocols will have to be worked out for identification of critical attributes for maintaining services, "Optimum values" of these attributes and management actions for attaining these optimum values while maintaining healthy carbon sinks.

Management of Change

There have been several paradigm shifts in forestry during the last one and half centuries wherein timber oriented forestry gave way to community oriented principles. Present focus on environmental services and the ultimate objective of carbon management in forests indicate trend towards wood management again. But multiple resource management imperatives govern the objectives now. This requires a strong back up from scientific understanding of forests and ecology. Among the major shifts in forestry paradigm, following can be said as most critical.

- Species level timber centered stock assessments to be reoriented towards habitat/ stand/ecosystem level inventories and assessment.
- Compartmentalized budgeting of forests into specific functions to give way to the need of understanding landscapes and forest profiles for working towards multiple resource management approach.
- Incorporating carbon management objectives in the forest management processes with wood management to replace the earstwhile timber production strategies. Thus felling cycles and plantation managements would be substituted by sustainable harvesting models in tune with ecological profiles and growth rates in stead of economic rotations.
- Technological orientation to community empowerment has become essential when the legal provisions have incorporated technical terminologies such as sustainable use and critical habitats.

These changed circumstances need to be followed by scientific back up in terms of protocols for inventories and assessments, modeling of dynamics of ecosystems with many more attributes than ever before and expressing the facts in terms of measurable and verifiable data. Thus, along with the removal of wood from higher maturity class stands based on the forest profile, the concerns of viable populations of the component species, vulnerability of the soil and water regime of the area and thresholds for sustaining these would be integral part of the management planning.

Research and development support will need to focus on developing regimes for internalizing the following principles in the management of forests:

- Inventory systems for assessment of biodiversity profile as main component of stock mapping.
- Assessment systems for environmental services, vulnerability assessments and threshold values of the attributes required to maintain the environmental services in the identified vulnerable areas.
- Yield assessment and prescriptions for harvesting based on the principle of maintaining the existing profile of the forest rather than increment rate of individual species.
- As yield predictions would be based on the profile of forests, adequate allowance would be needed to be provided in the harvesting volume prediction models to accommodate data errors, climatic variations and natural stresses in view of climatic uncertainties.

- High productivity should not mean plantations of a species or removal of "economically important" species. Ultimate forest left to grow should have proportionate representation of species. The species not desirable economically but could interfere in maintaining normal profile should be removed.

Conclusion

Keeping in view the above facts, it is desirable to recognize the renewability of the forest resources and their vast potential to capture and store much larger quantity of carbon than at present. The demand side management of wood, the most prevalent and usable component of the forests should be evolved as an important aspect of forest management. At the same time, for ensuring that the ecological and social roles of the forests are maintained as such, scientific back up should be strengthened for developing protocols for assessment, planning and monitoring the attributes related to these aspects. These aspects of management would be required to be internalized in the forest management. To begin with, it will be desirable to launch an assessment of the impact of the moratorium on felling from natural forests of the state during early 80s, on the forest profile and environmental services.

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