Chapter 3

Forests and Carbon Markets

Concerns over global warming have led to proposals for the establishment of markets for greenhouse gas emissions. Tree-based systems are a convenient way of sequestering carbon from the atmosphere to reduce net emissions. Through the process of photosynthesis, trees absorb carbon dioxide (CO2) which remains fixed in wood and other organic matter in forests or tree plantations for long time periods.

3.1 The Carbon Cycle

CO_2 is cycled through four main global carbon stocks: the atmosphere, the oceans, fossil fuels, and terrestrial biomass and soils (Figure 3.1). Over the period 1989 – 1998, activities in the energy and building sectors increased atmospheric carbon levels by 6.3 Giga tonnes[18] of carbon per year (Gt C yr^{-1})[19].

Land use change and forestry (LUCF) activities released 60 Gt C yr^{-1} into the atmosphere and absorbed 60.7 Gt C yr^{-1} with a net effect of decreasing atmospheric carbon levels by 0.7Gt C yr^{-1}. Oceans removed about 2.3 Gt C yr^{-1} from the atmosphere. The net result of these fluxes over the last 10 to 15 years is that atmospheric carbon levels have increased by about 3.3 Gt C yr^{-1}.

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[18] 1 Giga Tonne (1Gt) = 10^9 tonne

[19] Watson, R.T., Noble, I.R., Bolin, B., Ravindranath, N.H., Verardo, D.J. and Dokken, D.J. (eds.). 2000. *Landuse, Land-use Change, and Forestry, A Special Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, NY.

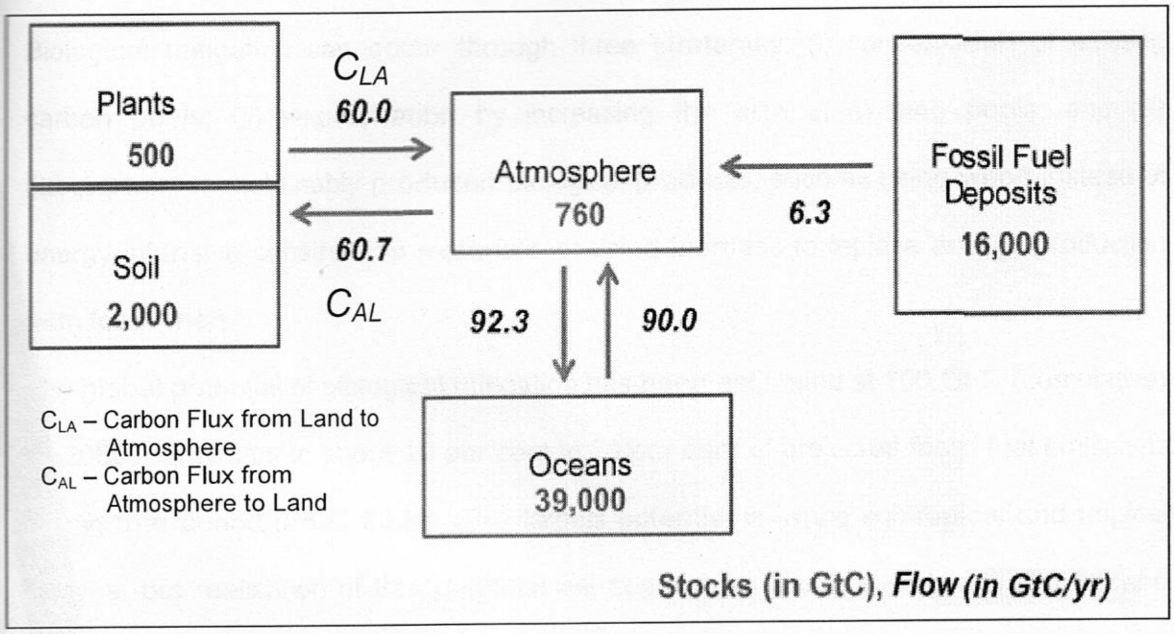

Fig 3.1 Carbon cycle through main global carbon stocks

Although the main contributor to mitigation of global warming is the energy sector and every effort should be undertaken to reduce GHG emissions from energy sector by way of increasing efficiency of energy use or switching over to renewable energy sources, it is the flow between terrestrial ecosystems and the atmosphere which will be the most effective strategy of carbon mitigation because of reasons such as low cost of abatement, vast scope and significant co-benefits. The rate C_{LA} includes emissions caused by respiration and deforestation, whereas C_{AL} includes carbon sequestered by afforestation and reforestation projects. Mitigation can be achieved by the LUCF sector by increasing C_{AL} or decreasing C_{LA} or both. The balance of these exchanges is referred to as *biological mitigation*.

3.2 Biomass Accumulation as a Carbon Sink

Biological mitigation can occur through three strategies: (i) conservation of existing carbon pools; (ii) sequestration by increasing the size of existing pools; and (iii) substitution of sustainably produced biological products, such as using wood instead of energy-intensive construction materials, or using biomass to replace energy production from fossil fuels.

The global potential of biological mitigation has been estimated at 100 Gt C (cumulative) by 2050, equivalent to about 10 per cent to 20 per cent of projected fossil fuel emissions during that period (IPCC 2001). The largest potential is in the subtropical and tropical regions, but realisation of this potential will depend on land and water availability and rates of adoption (Watson *et al.* 2000, IPCC 2001)[20]. The large opportunities for biological mitigation in tropical countries cannot be considered in isolation of broader policies in forestry, agriculture and other sectors. Barriers to reaching the potential level of mitigation include: (i) lack of funding and human and institutional capacity to monitor and verify mitigation efforts and outcomes, (ii) food supply requirements, (iii) people living off the natural forests, (iv) existing incentives for land clearing, (v) population pressure and (vi) switch from forests to pastures because of demand for meat (IPCC 2001). Brown *et al.* (1996) estimate that, by 2050, plantations in tropical countries have the potential to capture as much as 16.4 Gt C, whereas agroforestry has the potential to capture 6.3 Gt C[21].

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[20] Watson, R.T., Noble, I.R., Bolin, B., Ravindranath, N.H., Verardo, D.J. and Dokken, D.J. (eds.). 2000. *Landuse, Land-use Change, and Forestry, A Special Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, NY.

[21] Brown, S. 1997. Estimating biomass and biomass change in tropical forests: A primer. FAO Forestry Paper 134.FAO, Rome.

Forest carbon proponents argue that if an area of land can be converted to a forest or if increased carbon stores can be realized through improved management practices, then these actions provide a viable means of extracting additional carbon from the atmosphere. Moreover, important stimuli for such actions can be generated through the formation of forest carbon markets.

3.3 Emissions Trading & Forest Carbon

Carbon credits may be generated from activities that remove carbon dioxide already in the atmosphere, thus reducing the net amount of CO_2 in the air. This strategy qualifies forests and forest management practices to grow credits through carbon sequestration. Storing a ton of carbon in a new forest or through improved forestry techniques reduces the net amount of carbon in the atmosphere, in essence offsetting emissions from a power plant, industrial facility, or automobiles. Although intuitively appealing, it turns out to be much more complicated than trading other carbon commodities that are created from actual emission reductions. Turning forest-stored carbon into a tradable commodity introduces complexities and potentially prohibitive costs stemming from implementation, measurement and monitoring, and long-term enforcement of carbon stores and contracts for tradable credits.

3.4 Commodifying Forest Carbon

Of central importance to an effective emission cap-and-trade program is the accurate and cost-effective measuring, monitoring and enforcement of emissions, and changes in emissions, from regulated sources and, removals of carbon dioxide and changes in carbon storage. Since each commodity is to be backed by the amount of either avoided emissions (allowances or credits) or sequestered carbon (forest credits), inaccuracies in defining the commodity, or lack of enforcement in compliance, degrades the reliability and effectiveness of the program. Because each commodity, whether allowance, forest credit or other credit, is characteristically different, the transactions costs will determine its respective contribution, in practice, to reduce atmospheric CO2 levels since the corresponding costs will be reflected in the commodity's price. The measurement of point-source carbon emissions from power plants, production facilities, even residential use or transportation is relatively easy and therefore inexpensive compared to forest credits,

But forest carbon is different. A commodity backed by forest-stored carbon is subject to many of the same physical and biological influences that regulate the forest carbon cycle. Sequestration rates vary spatially and temporally and no two forests (or even trees) exhibit the same rates of carbon accumulation. Disturbances to a forest could release carbon back into the air. This complicates the measurement, monitoring, and long-term enforcement of carbon stores.

3.5 Costs Considerations in Generating Forest Carbon Credits

Growing a new forest has obvious costs—land, labor, seeds or saplings, maintenance, protection and other inputs. In addition, conversion of the land to forests forgoes some prior use, for example, agricultural production. A landowner's decision of whether or not to grow trees on his land is based on the expected costs and benefits. If the benefits—wood, ecosystem services etc exceed the expected costs, then one would raise tree plants. When the costs exceed the benefits to alternative use of the land and other resources, there is no reason to invest. Similarly, the decision to grow a forest with the intention of generating tradable carbon credits will be made based on expected costs and benefits. Forest carbon credits are not created by simply growing a forest or changing the way an existing forest is managed. Projects must be pre-approved, baselines established, and carbon stores or changes in carbon stocks must be determined before credits can be certified. Once the credits are created and certified, carbon stocks must be monitored for changes in carbon (additional sequestration or losses of carbon), and contracts enforced to ensure accurate accounting of carbon stores over time.

Some features of carbon markets indeed seem conducive to smallholder participation. Firstly, market exchanges of carbon sequestration services do not entail transport of those services. Given that smallholders typically reside in areas remote from commercial centres, transaction costs associated with transport often reduce significantly their ability to compete in national or international markets. Secondly, carbon sequestration is a service without scope for quality differences, so the relatively high production costs (abatement costs in this case) often faced by smallholders in meeting national or international quality standards do not arise in this arena. In this paper the focus is on agroforestry and tree plantations

3.6 Non-permanence Nature of Forest Carbon Credits

A concern about growing forests to store carbon is the risk of the carbon being re-released into the atmosphere. Unlike reductions in source emissions— which never get emitted at all—carbon stored in a forest is always at risk of natural or deliberate disturbances that can quickly release carbon back into the atmosphere, reversing any benefits from sequestration. Wildfires, insect infestations, illegal cutting of trees may release the stored carbon back to the atmosphere. Monitoring and protection from disturbances, and enforcement to ensure against possible catastrophic losses of carbon, will increase the costs of producing and transacting carbon credits as well as the risks of purchasing and holding these credits over time (assuming the buyer is held liable for losses). The problem of non-permanence, and the need for perpetual monitoring, measuring and enforcement against losses, has led to proposals for temporary and renewable forest carbon credits. Limiting carbon contracts to 5, 10, or even 20 years (potentially renewable) would reduce the risk of unaccounted carbon losses. However, this assumes that at the end of the contract period, the credits are replaced with other offsets to ensure that any future unaccounted losses of carbon from the original credits do not result in a net loss of carbon back into the air.

3.7 Additionality

Under the Kyoto Protocol, projects that qualify for credits have to satisfy the additionality requirement that "reductions in emissions must be additional to any that would occur in the absence of the project".

Additionality can be established by showing that tree planting would be less profitable than the land use systems it replaces in absence of the project, or by showing that there are barriers to tree plantation. In order to establish additionality, it is necessary to establish a baseline. Only those emission offsets above the baseline will be eligible in the CER market.

3.8 Baseline

Only carbon that would not otherwise have accumulated will count toward the generation of credits. Therefore, carbon baselines must be established and only carbon that accumulates above the baseline could generate tradable credits. Baselines require knowledge of past land use, an accurate measure of current carbon stores, knowledge of vegetation and soil capacities to sequester carbon over time, and accurate models and measurements to forecast changes in carbon. Each requirement translates into an added cost to the landowner.

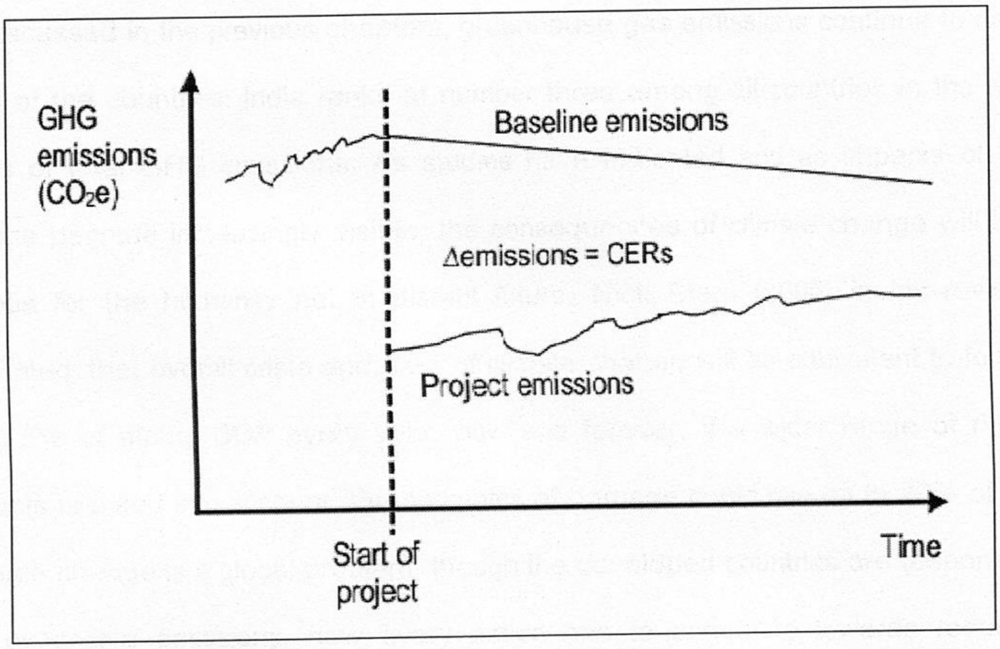

Figure 3.2 Illustration of Baseline and Additionality (Matthias Krey, 2004)

3.9 Measurement & Monitoring

Before carbon credits can be traded, they must be certified by an approved third party or government-appointed authority. The certification process should ensure that forest credits represent actual amounts of sequestered carbon. Accurate measurement of and accounting for changes in carbon stores are not only important for the certification and verification of carbon credits, but would help stabilize market prices for carbon credits.