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Bishwa Nath Oli
Department of Forest Research and Survey, Kathmandu, Nepal

Kumud Shrestha
Nepal Foresters' Association, Kathmandu, Nepal

Satdobato, Lalitpur
PO Box: 12207, Kathmandu, Nepal
Contact number: +977 1 5552924; 5550631 **Fax:** +977 1 5535190
Email: forestaction@wlink.com.np; **URL:** www.forestaction.org

Carbon Status in Forests of Nepal: An Overview

Bishwa Nath Oli* and Kumud Shrestha**

*Department of Forest Research and Survey, Kathmandu, Nepal

**Nepal Foresters' Association, Kathmandu, Nepal

Corresponding author: bn_oli@yahoo.com

Abstract: Globally, climate change and mitigation issues have been receiving an increasing attention, and Nepal is no exception. Deforestation is the second single Greenhouse Gas (GHG) source, behind energy production, responsible for about a quarter of anthropogenic GHG emissions. Literature claims that forests have a paramount role in lowering the net GHG emissions to the atmosphere. Forests in Nepal cover nearly 40% of the total land areas and significantly contribute to mitigating the adverse impact of climate change. As no figures are available on biomass and carbon by development and physiographic regions in Nepal, this paper aims at providing information about the total carbon stock in the forests of Nepal. This paper strongly argues for maintaining reliable forestry sector statistics, such as forest cover, growing stock, biomass and carbon in the country.

Key words: global warming, carbon stock, carbon emission, deforestation, climate change

INTRODUCTION

Global warming and climate change are perhaps the most pressing global issues these days. Recent years have witnessed growing concern about the accumulation of GHGs[1] in the earth's atmosphere, which is significantly raising the global temperature. Nepal's contribution to the global annual GHG emission is 0.025% (MoPE 2004). The total GHG emission from Nepal is estimated at 39,265 Gega gram (Gg) and per capita emission is 1,977 kg (GoN 2008a). The world's forests and forest soils currently store more than 1 trillion tonnes of carbon, twice the amount floating free in the atmosphere. Thus, increasing storage and preventing stored carbon from being released back to the atmosphere are two of the most important measures for combating global warming and conserving the environment.

Melting glaciers, erratic global weather patterns, droughts, raging wildfires and creeping invasive species of flora and fauna in new localities are all unmistakably the effects of climate change. The Intergovernmental Panel on Climate Change (IPCC) estimates that the global temperature will most likely increase by up to 3.5°C by 2100. Over the last twenty-five years, the temperature in Nepal has also been increasing at the rate of 0.06°C per year (GoN 2008b). In high altitudes, it increased by 0.6°C over the last thirty years (Liau and Rasul 2007). Concentration of carbon dioxide was almost stable at 280 Parts Per Million (PPM) over hundred years or up to the pre-industrial stage, and which increased rapidly following the Industrial Revolution, reaching 380 PPM in 2005 (Banskota *et al.* 2007). In terms of percentage, between 1970 and 2004, global GHG emissions have increased by 70%; CO_2 emissions alone have grown by about 80%. Globally, forest destruction causes 24% of human-induced carbon emissions and 18% of all GHGs (Schoene and Netto 2005). Thus, it is the second single GHG source, behind energy production, responsible for about a quarter of anthropogenic GHG emissions (IPCC 2007). Reducing emissions from deforestation could significantly contribute to overall efforts to stabilize GHG concentrations in the atmosphere and to mitigate the climate change. In Nepal, the forest area decreased at an annual rate of 1.7%, whereas forest and shrub land together decreased at an annual rate of 0.5% during the period 1978/79-1994 (DFRS 1999). Some recent studies in twenty Terai districts suggest that the forest cover has decreased at an annual rate of 0.06% during the period 1990/91-2000/01 (DoF 2004). The above two figures clearly show that deforestation in Nepal has been in a decreasing trend, which will certainly mitigate the negative impact of climate change.

The carbon reservoir in the world's forests is higher than the one in the atmosphere (Stern 2006). The world's forests and forest soils currently store more than 1 trillion tonnes of carbon, twice the amount floating free in the atmosphere. Therefore, forestry projects can help to lower the net GHG emissions in several ways. The first is to prevent the carbon stored in standing forests from being released into the atmosphere. The second is to actively increase carbon stocks through tree planting, improved soil management or enhancement in natural regeneration of degraded forest lands. A tonne of fuel wood can save 400 litres of oil and prevent 0.3 tons of carbon emission. Similarly, substituting every cubic metre of construction timber with steel or aluminium could prevent 0.3 tonnes of carbon emission (Schoene and Netto 2005). The deforestation issue has been at the centre of international environmental debate for years. Despite national and international efforts to halt deforestation, it continues at a rate of about 13 million hectares (ha) per year (FAO 2006). The figure is alarming, at 14.6 million ha per year (Burger *et al.* 2005). Deforestation not only causes loss of carbon, but also results in loss of biodiversity, disturbed water regulation and destruction of livelihoods of a large number of the world's poorest (Williams 2003).

Nepal signed the United Nations Framework Convention on Climate Change (UNFCCC) on June 12, 1992, and ratified it on May 2, 1994, making it effective in the country from July 31, 1994. As a party to the Convention, Nepal is obliged and committed to acting against the earth's climate change and the adverse effects of human activities. It is also a signatory to the Kyoto Protocol and became party to the conference from December 2005. Emission reductions from avoided deforestation has been regarded as a key element of cost-effective future climate change policy (Stern 2007, Anger and Sathaye 2008). Therefore, inclusion of avoided deforestation and degradation to reduce GHG emissions has been deliberated since the Kyoto Protocol. Reducing Emissions from Deforestation and Forest Degradation (REDD) in developing countries is an instrument aimed at reducing deforestation, and providing important opportunity for developing countries to contribute significantly to emission reduction efforts under the international climate regime. In addition, many accompanying benefits, including environmental service from reducing deforestation, could be expected. Advanced remote sensing technologies for forest monitoring are not easily available in Nepal. Furthermore, individual and institutional capacities to estimate and monitor forest resources are not so strong. In order to capture the benefits from climate change scenario, there is an urgent need for maintaining reliable baseline statistics of the forestry sector.

CARBON STATUS IN FORESTS OF NEPAL

Carbon in Forests

Forests cover nearly 40% of the total land area of the country (DFRS 1999,) and the per capita forest area is 0.27 ha. The forest and shrub land together decreased at an annual rate of 0.5% during the period 1978/79-1994. The total stem volume (over bark) of forests in Nepal is 759 million cubic metres and the total biomass of stems, branches and leaves is 873 million tonnes (air dry). As of March 2007, the protected area system covers about 19.7% of the total area of the country. Carbon storage in the above-ground and below-ground biomass, deadwood and litter and forest soil is presented in table 1. The table shows that the forests of Nepal store 897 million metric tonnes of carbon in the year 2005.

Carbon in Different Categories of Forests

Carbon storage by legal categories of forest and shrub land in Nepal is presented in table 2. The figures on the growing stock and forest area given by DFRS (1999) were used to get the required information. The total carbon stock in the live and deadwood biomass in forests and shrub land is 890 million tonnes. The calculation excludes the carbon content in litter and forest soil. The default factors for estimating carbon on the basis of forest types have been adopted from Harmon *et al.* (2001) to estimate the below-ground and deadwood biomass. The below-ground biomass was calculated by multiplying the above-ground figures by 0.35. Similarly, the deadwood biomass was estimated by multiplying the total live biomass, both above and below-ground, by 0.15. The default factor of 0.5 has been used to convert the biomass stock into carbon stock. MoPE (2004) estimates that nearly 14,738 Gg of CO_2 are sequestrated due to biomass growth in forests. The figure of biomass presented in table 2 is high because it is difficult to differentiate the area of forest and shrub land for each category of forests. Thus, there can be some range. Moreover, the same value of biomass per ha (196.8) has been used to estimate the total biomass in both forest and shrub land.

Table 1: Status of Carbon in Forest and Shrub Land of Nepal

Category	Carbon (Million metric tonnes)		
	1990	2000	2005
Carbon in above-ground biomass	278	385	359
Carbon in below-ground biomass	97	135	126
Sub-total: Carbon in living biomass	375	520	485
Carbon in dead wood	56	78	73
Carbon in litter	17	13	13
Sub-total: Carbon in dead wood and litter	73	91	86
Soil carbon to a depth of 100 cm	432	350	326
Total Carbon	880	961	897

Source: FAO 2006

Table 2: Status of Carbon Forests in Nepal by Legal Classification

Category	Sub-category	Area in million ha	Above ground biomass in million tonnes	Below ground biomass in million tonnes	Dead wood biomass in million tonnes	Total biomass in million tonnes	Carbon in million tonnes
National Forest	Government-managed forest*	3.9[λ]	767.832	268.741	155.486	1192.059	596.0296
	Community forest**	1.2	236.256	82.689	47.841	366.7874	183.3937
	Leasehold forest***	0.014	2.75632	0.9647	0.558	4.279187	2.139593
	Religious forest+	0.000543	0.106906	0.0374	0.0216	0.165971	0.082986
	Protected forest@	0.71	139.7848	48.924	28.306	217.0159	108.508
Private Forest	Private forest#	0.0023	0.0115	0.00402	0.002329	0.017854	0.008927
Total		5.826	1146.748	401.361	232.216	1780.326	890.162

Sources: NFA 2008, **DoF 2008,***LFLP 2007, @HMG/MFSC 2002, #DoF 2005, [λ:] The area of government-managed forest has been calculated by subtracting all categories of forests from the total forest area of Nepal as per the National Forest Inventory data, including shrub land.

Carbon in Forests of Nepal by Development Regions

The carbon in above-ground biomass in the forests of Nepal is presented for two different years by development regions in table 3. The above-ground biomass for the year 1986 has been taken from HMG/ADB/FINNIDA (1988), whereas some calculations were done to estimate the biomass and carbon for the year 1994. The forest area and the mean stem volume of different development regions were used to calculate the total stem volume in the respective regions. A Biomass Expansion Factor (BEF) of 1.167 (considering the total biomass of 873 million tonnes and total growing stock of 759 million cubic metres) was used to convert the stem volume to the total above-ground biomass figure. Then, a default value of 0.5 was used to convert the biomass figure to the total carbon stock in the forests of Nepal.

The figures estimated in this study are presented in tables 2 and 3. Reliability of these figures can be discussed. Measurable, Reliable and Verifiable (MRV) figures are needed before Nepalese stakeholders go for carbon trading. All development partners and stakeholders have a big role in generating such figures.

Carbon in Forests of Nepal by Physiographic Regions

The carbon in above-ground biomass in the forests of Nepal is presented for two different years by physiographic regions in table 4. The above-ground biomass for the year 1986 has been taken from HMG/ADB/FINNIDA (1988), whereas no such disaggregated figures by physiographic regions are available for 1994.

Table 3: Carbon in Forests of Nepal by Development Regions

SN	Development Regions	Forest Area (in Million ha)		Above-ground Biomass (in Million Tonnes)		Carbon (in Million Tonnes)	
		1986	1994	1986	1994	1986	1994
1	Far Western	0.991	0.687	128.0	161.1	64.0	80.55
2	Mid Western	1.641	1.192	229.0	219.4	114.5	109.7
3	Western	0.900	0.734	81.0	143.5	40.5	71.75
4	Central	1.063	0.919	109.0	183.3	54.5	91.65
5	Eastern	0.923	0.736	81.0	165.7	40.5	82.85
	Total	5.518	4.268	628.0	873.0	314.0	436.5

Source: HMG/ADB/FINNIDA 1988, DFRS 1999

Table 4: Carbon in Forests of Nepal by Physiographic Regions

SN	Physiographic Regions	Forest Area in Million ha		Above-ground Biomass in Million Tonnes		Carbon in Million Tonnes	
		1986	1994	1986	1994	1986	1994
1	High Himal	0.155	NA	23.0	NA	11.5	NA
2	High Mountains	1.639	NA	247.0	NA	123.5	NA
3	Middle Mountains	1.811	NA	134.0	NA	67.0	NA
4	Siwaliks	1.438	NA	152.0	NA	76.0	NA
5	Terai	0.475	NA	72.0	NA	36.0	NA
	Total	5.518	NA	628.0	NA	314.0	NA

Source: HMG/ADB/FINNIDA 1988
Note: NA: Not Available.

FOREST CERTIFICATION AND CARBON CERTIFICATION

In order to receive any benefits from carbon trading we need internationally reliable data. Forest certification is internationally reliable system of sustainable forest management. This can establish a sound basis for carbon trading. Shrestha and Paudel (2008), a paper presented at the 5th National Community Forestry Workshop, provides comparative information on forest certification and forest carbon certification, as shown in Table 5.

FUTURE PRIORITIES

Although there are several policies related with GHG emissions, no identified national policies and instruments have been integrated in national development to deal with climate change and its mitigation options in the country. As the Ministry of Environment, Science and Technology is currently formulating a national climate change policy, it should focus on the pertinent issues of climate change and mitigation measures such as benefits of carbon conservation, discouraging onset of fire, research in additional carbon conservation in forests as well as forest certification. The government should promote sustainable management of all categories of forests, especially government-managed forests, community forests and private forests, and analyse the level of biomass to be maintained in the process of forest management relating to the level of carbon sequestration. Similarly, it should encourage afforestation and reforestation programmes to restore the ecosystem by rehabilitating degraded forestland in all categories of forest, in consultation with local communities, so that maximum amount of carbon is sequestrated from atmosphere in the form of biomass. Forestry and related statistics such as on growing stock, biomass and carbon stock should be regularly updated at national level to safeguard the estimation of carbon emission and carbon sequestration. This could be done through the use of advanced remote sensing technologies, which has also been recommended by Rome Workshop (UNFCCC 2006). Unless and until there is reliable baseline statistics, it will be difficult to tap financial resources from international conventions and mechanisms through carbon trading.

Table 5: Comparison of Climate Standards and Certification Standards

Features	FC Standards	Climate Standards
Objective	SFM	SFM + Carbon conservation
Initiation time	Mid nineties	Ten years later
Issues to be addressed	Social, ecological, economic	Social, ecological, climate
Awareness	New issues and low awareness	Less awareness than FC
Process	Independent verification	Ditto
Basis	Internationally reliable	Ditto
Certification agencies	Internationally accredited	Ditto
Monitoring	Internal and external	Internal, external and thematic NGO
Government Participation	Voluntary	Indirectly mandatory from UNFCCC / KP
Establishment of Umbrella system	Well established like FSC and PEFC	Not yet well established
Relationship between buyers and forest managers	Weak through label	Strong through direct payment. So, harsher certification mechanism

Source: Shrestha and Paudel 2008

CONCLUSION

This paper argues for maintaining reliable forestry sector statistics, such as forest cover, growing stock, biomass and carbon in the country. Forests in Nepal cover nearly 40% of the total land area and significantly contribute to mitigating the adverse impact of climate change. Forestry and related statistics such as growing stock, biomass and carbon stock should be updated regularly at national level to safeguard the estimation of carbon emission and carbon sequestration. This could be done through the use of advanced remote sensing technologies

REFERENCES

Anger, N. & Sathaye, J. 2008. Reducing Deforestation and Trading Emissions: Economic Implications for the post-Kyoto Carbon Market. Discussion Paper No. 08-016. Centre for European Economic Research.

Banskota, K., Karky, B.S. & Skutsch, M. 2007. Reducing Carbon Emission Linking Community Managed Forests in the Himalayas. Kathmandu: International Centre for Integrated Mountain Development.

Burger, D., Hess, J. & Lang, B. 2005. *Forest Certification: An Innovative Instrument in the Service of Sustainable Development.* Germany: GTZ, Programme Office for Social and Ecological Standards.

DFRS 1999. *Forest Resources of Nepal (1987-1998).* Kathmandu, Nepal: Department of Forest Research and Survey, Ministry of Forests and Soil Conservation.

Dhungana, S.P., Oli, B.N. & Mandal, R.A. 2007. Claiming a Bird in Hand: Economic Potential of Plantation in Nepal under Clean Development Mechanism. *Journal of Forests and Livelihood*, **6**(1): 18-27.

DoF 2004. *Forest Cover Change Analysis of the Terai Districts (1990/91-2000/01)*. Kathmandu, Nepal: Department of Forests.

DoF 2005. *Private Forest Statistics.* Kathmandu, Nepal: Department of Forests.

DoF 2008. *Community Forestry Database*. Kathmandu, Nepal: Department of Forests.

FAO 2006. Global Forest Resource Assessment 2005. Rome, Italy: Food and Agriculture Organization of the United Nations.

GoN 2008a. National GHG Inventory. Draft report prepared for Second National Communication, Ministry of Environment, Science and Technology, Government of Nepal.

GoN 2008b. National Climate Change Policy. Draft policy prepared for discussion by Ministry of Environment, Science and Technology, Government of Nepal.

Harmon, M.E., Krankina, O.N., Yatskov, M. & Matthew, E. 2001. Predicting Broad-scale Carbon Stock of Woody Detritus from Plot-Level Data. In: R. Lal, J. Kimble and B.A. Steward (Eds.), *Assessment Method for Soil Carbon*. New York: CRC press. [pp 533-552]

HMG/MFSC 2002. *Nepal Biodiversity Strategy.* Kathmandu, Nepal: Ministry of Forests and Soil Conservation.

HMGN/ADB/FINNIDA 1988. Master Plan for the Forestry Sector Nepal, Main Report. Kathmandu, Nepal: Ministry of Forests and Soil Conservation.

IPCC 2007. Summary for Policymakers. In: S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Millers (Eds.), *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge, UK and New York: Cambridge University Press.

LFLP 2007. *Leasehold Forestry Database.* Kathmandu, Nepal: Leasehold Forestry and Livestock Programme, Department of Forests.

Liau, J. & Rasul, G. 2007. Climate Change, the Himalayan Mountains and ICIMOD. *Sustainable Mountain Development,* **53**.

MFSC 2004. *Terai Arc Landscape-Nepal, Strategic Plan 2004-2014, Broad Strategic Document. Government of Nepal.* Kathmandu, Nepal: Ministry of Forests and Soil Conservation.

MoPE 2004. Nepal Initial National Communication to the Conference of the Parties of the United Nations Framework Convention on Climate Change. July, 2004. Kathmandu, Nepal: Ministry of Population and Environment.

NFA 2008. Feasibility Analysis of REDD Principles in Context of Nepal. A report submitted to WWF by Nepal Foresters' Association.

Schoene, D & Netto, M. 2005. The Kyoto Protocol: What Does it Mean for Forest and Forestry. *Unasylva,* 222(56).

Shrestha K. & Paudel, G. 2008. REDD, Forest Certification and Carbon Conservation: Relationship and Issues. *A paper presented in the Fifth National Community Forestry Workshop*, 9-11 November, 2008. Kathmandu, Nepal: Department of Forests.

Stern, N. 2006. The Economics of Climate Change: The Stern Review. Cambridge, UK: Cambridge University Press.

UNFCCC 2006. Report on a Workshop on Reducing Emissions from Deforestation in Developing Countries. Note by the Secretariat. FCCC/SBSTA/2006/10.

Williams, M. 2003. *Deforesting the Earth – from Prehistory to Global Crisis.* Chicago: The University of Chicago Press.

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[1] Carbon Dioxide (CO2), Methane (Ch4), Nitrous Oxide (N2O), Hydrofluorocarbon (HFC), Perfluorocarbon (PFC) and Sulphur Hexafluoroide (SF) are the principal GHGs responsible for global climate change. Carbon Dioxide is the major component of global climate change.