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**Essays on Reducing Emissions from Deforestation and Forest  
Degradation in the Terai Arc Landscape of Nepal**

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A thesis  
submitted in partial fulfilment  
of the requirements for the Degree of  
Doctor of Philosophy

at  
Lincoln University  
by  
Mohan Babu Gurung

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Lincoln University

2014

Abstract of a thesis submitted in partial fulfilment of the requirements for the Degree of Doctor of Philosophy in Forestry.

## Essays on Reducing Emissions from Deforestation and Forest Degradation in the Terai Arc Landscape of Nepal

by

Mohan Babu Gurung

Opportunity costs of conserving forest for the purpose of greenhouse gas emissions reductions underpin economic sustainability of 'reducing emissions from deforestation and forest degradation (REDD+)' and are essential to ascertain before embarking into this newly proposed mechanism to mitigate climate change. Two major determinants of REDD+ opportunity costs are the drivers of deforestation and forest degradation and the carbon stock. These factors differ from place to place. Use of global land use models and of forest carbon stock estimates to design REDD+ at sub-national or national scale may be misleading if they do not reflect local socio-economic and agro-ecological conditions. This study examined the potential costs of emissions reductions in the Terai Arc Landscape of Nepal, one of the biodiversity hotspots of the world.

The first part of the thesis examines the underlying causes of deforestation and forest degradation. A synthesized econometric model of deforestation is prepared including rarely integrated part of forest degradation. A newly assembled panel data sets of 15 districts of Nepal over a 19-year period were used for the analysis. The results highlight that increased agricultural yield and promotion of community-based forest management regimes reduce deforestation. Fuel wood, the main source of energy used for cooking in the landscape, is the proximate cause of forest degradation along with timber extraction. Alternative energy sources like solar and biogas can be substituted for fuel wood to reduce forest degradation.

The second part of the study deals with carbon stock in the forests. The research estimated the distribution of C stock across the different pools and management regimes of tropical *Sal* forest. It applied a field measurement approach and collected biomass data from 113 sample plots. The estimated average total carbon stock was  $228.76 \pm 19.61 \text{ Mg ha}^{-1}$ . The value of total C stock, however, varied according to management regimes. The estimated carbon stocks differed from all earlier estimates based on biome-average dataset. Evidence of strong association of C stock with management regime provides valuable information for policy makers to make informed choice of management regime for the landscape.

The third part of the study is focused on estimation of opportunity costs of emissions reductions through avoided deforestation and forest degradation. A bottom-up approach is applied using time series data of agriculture, timber and fuel wood production and prices to estimate the opportunity costs. The estimated mean opportunity cost of emissions reductions from avoided deforestation on the Terai Arc Landscape is found to be US\$ 8.95 per Mg CO<sub>2</sub>e. The study reveals that emission reduction from avoided forest degradation is cheaper than emission reduction through avoided deforestation. The opportunity cost estimates are higher than those reported in earlier global studies and are attributed to higher agricultural returns and lower carbon density in the forest of the Terai Arc Landscape. The study suggests that the levels of funding needed for REDD+ based on the earlier global estimates may be insufficient for effective emissions reductions. Policy makers to be cautious when using global models and values to design any sub-national REDD+ scheme.

***Keywords:*** Drivers of deforestation and forest degradation, Carbon stocks, Opportunity cost, Emissions reductions, REDD+, Tropical *Sal* forest, *Terai Arc Landscape*

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# Table of Contents

<b>Abstract</b> .....	<b>ii</b>
<b>Acknowledgements</b> .....	<b>iv</b>
<b>Table of Contents</b> .....	<b>vi</b>
<b>List of Tables</b> .....	<b>ix</b>
<b>List of Figures</b> .....	<b>x</b>
<b>Acronyms, Symbols and Abbreviations</b> .....	<b>xi</b>
<b>Chapter 1 Introduction</b> .....	<b>1</b>
1.1 Background .....	1
1.2 REDD+ Discourse: Concepts and Designs .....	3
1.3 Motivation and research context .....	7
1.4 Research Objectives.....	9
1.5 Research Framework .....	9
1.6 Structure of the Thesis.....	11
<b>Chapter 2 Underlying causes of deforestation and proximate causes of forest degradation in the Terai Arc Landscape of Nepal</b> .....	<b>12</b>
2.1 Background .....	13
2.2 Introduction .....	14
2.3 Causes of deforestation and forest degradation.....	16
2.4 Materials and methods.....	21
2.4.1 Characteristics of the study area .....	21
2.4.2 The model description .....	23
2.4.3 Data and data sources.....	25
2.5 Results and Discussions .....	26
2.5.1 Deforestation .....	26
2.5.2 Forest degradation.....	30
2.5.3 Implications for REDD+ policy.....	32
2.6 Conclusion.....	34
<b>Chapter 3 Estimation of carbon stock under different management regimes of tropical forest in the Terai Arc Landscape, Nepal</b> .....	<b>36</b>
3.1 Introduction .....	37
3.2 Materials and Methods.....	38
3.2.1 Site description .....	38
3.2.2 Forest type and management regime.....	40
3.2.3 Measurement of carbon stocks .....	41
3.2.4 Sampling design .....	42
3.2.5 Data analysis .....	43
3.3 Results.....	46
3.3.1 Aboveground biomass (AGB) .....	47
3.3.2 Belowground biomass.....	48
3.3.3 Shrub and Litter pool .....	49
3.3.4 Soil organic carbon (SOC).....	49

3.3.5	Total Carbon Stock .....	49
3.3.6	Changes in C stocks and emission reduction potential.....	51
3.4	Discussion.....	52
3.5	Conclusion.....	54
<b>Chapter 4 Opportunity costs of reducing CO<sub>2</sub>e emissions from deforestation and forest degradation in the Terai Arc Landscape of Nepal .....</b>		<b>56</b>
4.1	Background .....	57
4.2	The Terai Arc Landscape of Nepal.....	59
4.3	Methodology.....	61
4.4	Results.....	63
4.5	Discussion.....	67
4.6	Conclusion.....	69
<b>Chapter 5 Feasibility of reducing emissions from deforestation and forest degradation in the Terai Arc Landscape, Nepal .....</b>		<b>71</b>
5.1	Rationale .....	72
5.2	Deforestation: drivers, CO <sub>2</sub> e emissions and opportunity cost .....	73
5.2.1	Forest and forest area change .....	73
5.2.2	Drivers of deforestation.....	74
5.2.3	Carbon stocks and emission factor .....	75
5.2.4	Opportunity cost of emissions reductions through avoided deforestation .....	76
5.3	Forest degradation: drivers, emissions factor and opportunity cost .....	78
5.3.1	Drivers of forest degradation.....	78
5.3.2	Emission factor.....	78
5.3.3	Opportunity cost of forest degradation.....	79
5.4	Conclusion.....	80
<b>Chapter 6 Overall Conclusions and Implications.....</b>		<b>82</b>
6.1	Conclusions .....	82
6.1.1	Policy Implications .....	84
6.1.2	Research Contributions.....	85
6.2	Limitations and directions for further research.....	86
<b>Appendix A Deforestation and forest degradation models .....</b>		<b>87</b>
A.1	Descriptions of deforestation variables.....	87
A.2	Descriptions of forest degradation variables.....	87
A.3	Study Districts .....	88
A.4	Multicollinearity test of deforestation variables .....	88
<b>Appendix B Carbon stock data .....</b>		<b>89</b>
B.1	Plot level carbon stock (Mg/ha) data of protected area forest.....	89
B.2	Plot level carbon stock (Mg/ha) data of community forest.....	90
B.3	Plot level carbon stock (Mg/ha) data of government-managed forest.....	91
B.4	Plot level carbon stock (Mg/ha) data of other forest .....	92

<b>Appendix C Opportunity Cost</b> .....	<b>93</b>
C.1 District wise opportunity costs of emissions reductions .....	93
C.2 Net Present Value (US\$/ha) from cattle ranching during the 30 years period .....	94
C.3 Net Present Value (US\$/ha) from agriculture during the 30 years period .....	95
C.4 Net Present Value (US\$/ha) from timber extraction during the 30 years period .....	96
C.5 Net Present Value (US\$/ha) from fuel wood extraction during the 30 years period .....	97
C.6 Net Present Value (US\$/ha) of revenue generated from Protected area during the 30 years period .....	98
C.7 Net Present Value (US\$/ha) of high yield agricultural crop production during the 30 years period .....	99
<b>References</b> .....	<b>100</b>

## List of Tables

Table 2.1 Descriptive statistics of deforestation variables by period 1990-99 and 1999-09 .....	26
Table 2.2 Panel analysis of deforestation in the Terai Arc Landscape of Nepal, 1990-1999 and 1999-2009 .....	28
Table 2.3 Descriptive statistics of forest degradation variables (% change per annum) selected in the study, by period 1990-99 and 1999-09 .....	30
Table 2.4 Panel analysis of forest degradation in TAL, 1990-99 and 1999-09, using Fixed Effects, Random Effects and OLS Models .....	31
Table 3.1 Ratio of belowground biomass to aboveground biomass .....	44
Table 3.2 Numbers of sample plots across the management regimes and carbon pools.....	47
Table 3.3 Estimates of carbon stock in belowground biomass, in $\text{mg ha}^{-1}$ .....	48
Table 3.4 Estimates of Soil Organic Carbon, in $\text{Mg ha}^{-1}$ .....	49
Table 5.1 Percentage changes (annual) in agricultural yield (weighted) during the two period .....	74

## List of Figures

Figure 1.1 Total Annual Anthropogenic GHG Emissions by Groups of Gases 1970-2010 .....	2
Figure 1.2 Conceptual model of multi-level REDD+ mechanism .....	4
Figure 1.3 An example of comparison between reference level and REDD+ scenario .....	5
Figure 1.4 Research Framework .....	10
Figure 2.1 Vegetation map of study area .....	22
Figure 2.2 Effects of underlying causes on deforestation and forest degradation .....	23
Figure 3.1 Location map of Terai Arc Landscape, Nepal.....	39
Figure 3.2 Distribution of Aboveground Biomass in different management regimes .....	48
Figure 3.3 Distribution of carbon stock in different carbon pools .....	50
Figure 3.4 Distribution of carbon Stock ( $\text{Mg ha}^{-1}$ ) across various forest management regimes.....	50
Figure 4.1 Distribution of forest sector NPV by district.....	65
Figure 4.2 Opportunity costs of $\text{CO}_2\text{e}$ emissions reduction by land use in the Terai Arc Landscape	66
Figure 5.1 Decline in forest area in the Terai Arc Landscape, 1990-2009 .....	73

## Acronyms, Symbols and Abbreviations

°C	Degree Celsius
ADB	Asian Development Bank
AFOLU	Agriculture, Forestry and Other Land Use
Ag	Agriculture
AGB	Aboveground Biomass
APMDD	Agribusiness Promotion and Marketing Development Directorate
AR	Assessment Report
BAU	Business-as-usual
bd	Bulk Density
BGB	Belowground Biomass
C	Carbon
CBS	Central Bureau of Statistics
CER	Certified Emission Reduction
CF	Community Forest
CFBZ	Community Forest and Buffer Zone
CI	Confidence Interval
cm	centimetre
cm <sup>3</sup>	Cubic centimetre
CO <sub>2</sub>	Carbon dioxide
CO <sub>2e</sub>	Carbon dioxide equivalent
COP	Conference of Parties
d	Diameter
dbh	Diameter at Breast Height
DD	Forest Degradation
DF	Deforestation
DFRS	Department of Forest Research and Survey
DIMA	Dynamic Integrated Model of Forestry and Alternative Land Use
DNA	Designated National Authority
DNPWC	Department of National Park and Wildlife Conservation
DoF	Department of Forest
DoR	Department of Road
EKC	Environmental Kuznets Curve
ER	Emission Reduction

ETM	Enhanced Thematic Mapper
FAO	Food and Agriculture Organization
FCGA	Free Common Good Attitude
FCPF	Forest Carbon Partnership Facility
FE	Fixed Effect
Fig	Figure
FINNIDA	Finnish International Development Agency
FS	Forest Size
FSISP	Forestry Sector Institutional Strengthening Programme
Fu	Fuel wood
GCOMAP	Generalized Comprehensive Mitigation Assessment Process Model
GDP	Gross Domestic Product
Gg	Giga gram
GHG	Greenhouse Gas
gm	Gram
GPS	Global Positioning System
Gt	Giga tonne
GTM	Global Timber Model
H	Height
Ha	Hectare
HMG/N	His Majesty's Government of Nepal
INSEC	Informal Sector Service Centre
IPCC	Inter-governmental Panel on Climate Change
Kg	Kilogram
Km	Kilometre
LM	Breusch and Pagan Lagrangian Multiplier
Lv	Livestock
M	Metre
m <sup>2</sup>	Square metre
MFSC	Ministry of Forest and Soil Conservation
Mg	Mega gram
Mha	million hectares
MoAD	Ministry of Agricultural Development
MPFS	Master Plan for Forestry Sector
MRV	Monitoring, Reporting and Verification
N	Number

NARC	National Agricultural Research Council
NPR	Nepalese Rupees
NPV	Net Present Value
ODA	Overseas Development Administration
OLS	Ordinary Least Square
OLU	Other Land Use
PA	Protected Area
PES	Payment of Environmental Services
Pg	Petagram
PG	Population Growth
PI	Political Instability
RE	Random Effect
RED	Reducing Emissions from Deforestation
REDD	Reducing Emissions from Deforestation and forest Degradation
REDD+	Reducing Emissions from Deforestation and forest Degradation, conservation, Enhancement of forest carbon stocks and sustainable management of forests
R-PIN	Readiness Plan Idea Note
RPP	Readiness Preparation Proposal
SOC	Soil Organic Carbon
Sq.	Square
t	tonne
TAL	Terai Arc Landscape
Tm	Timber
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
US\$	United States Dollar
VER	Verified Emission Reduction
WWF	Worldwide Fund for Nature
Yr	Year

