REDD+ and ecosystem services trade-offs and synergies in community forests of central Himalaya, Nepal

Eak Rana
Masters in Sustainable Resource Management (MSc), Technical University of Munich, Germany,
Master of Arts (MA), Tribhuvan University, Nepal,
Bachelor of Forestry Sciences (BSc Forestry), Institute of Forestry,
Tribhuvan University, Nepal

March 2016

A thesis submitted in fulfilment of the requirements for the degree of Doctor of Philosophy

Charles Sturt University
Faculty of Science
School of Environmental Sciences
Albury, NSW 2640
Australia

Supervisors: Dr. Rik Thwaites
Professor Gary W Luck
# Table of Content

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table of Content</td>
<td>iii</td>
</tr>
<tr>
<td>List of Appendices</td>
<td>ix</td>
</tr>
<tr>
<td>List of Figures</td>
<td>xi</td>
</tr>
<tr>
<td>List of Tables</td>
<td>xiv</td>
</tr>
<tr>
<td>List of Boxes</td>
<td>xvii</td>
</tr>
<tr>
<td>Certificate of authorship</td>
<td>xviii</td>
</tr>
<tr>
<td>Dedication</td>
<td>xix</td>
</tr>
<tr>
<td>Acknowledgements</td>
<td>xx</td>
</tr>
<tr>
<td>Ethics approval</td>
<td>xxii</td>
</tr>
<tr>
<td>English language editor statement</td>
<td>xxii</td>
</tr>
<tr>
<td>Abstract</td>
<td>xxiii</td>
</tr>
<tr>
<td>Publication arising from this research</td>
<td>xxv</td>
</tr>
<tr>
<td>List of Abbreviations</td>
<td>xxvi</td>
</tr>
</tbody>
</table>

### Chapter 1- Introduction .............................................................................. 1
1.1 Research context ...................................................................................... 1
1.2 Research questions ................................................................................... 2
1.3 Research approach and framework .......................................................... 3
1.4 Thesis structure ....................................................................................... 5

### Chapter 2- Ecosystem service trade-offs and REDD+ in community forestry ....7
2.1 Introduction ............................................................................................... 7
2.2 Introduction to ecosystem services and biodiversity conservation ......... 7
   | 2.2.1 Introduction to ecosystem services ................................................... 7
   | 2.2.2 Linking biodiversity and ecosystem services .......................................... 14
   | 2.2.3 Linking forest biodiversity and ecosystem services .............................. 17
   | 2.2.4 Linking forest biodiversity, carbon storage and tangible forest products .. 18
2.3 Ecosystem services in community forestry ................................................. 19
   | 2.3.1 Historical overview of community forestry ............................................ 19
   | 2.3.2 Historical overview of forest management in Nepal ............................... 20
   | 2.3.3 Evolution and current status of community forestry in Nepal .................. 21
   | 2.3.4 Institutional aspects of community forestry .......................................... 23
   | 2.3.5 Socio-ecological characteristics of community forestry ....................... 24
      | 2.3.5.1 Community forestry as a common property regime ................................ 25
      | 2.3.5.2 Community forestry and collective actions ......................................... 26
2.3.5.3 Factors influencing collective actions and outcomes of community forestry .......................................................... 27
2.3.6 Social and ecological outcomes in community forestry .......................................................... 28
  2.3.6.1 Community forestry and ecosystem services .......................................................... 28
  2.3.6.2 Community forestry and biodiversity conservation .................................................. 29
  2.3.6.3 Community forestry and local livelihoods .......................................................... 29
2.4 REDD+ and ecosystem services in community forestry .......................................................... 30
  2.4.1 Historical background of REDD+ .............................................................................. 30
  2.4.2 Overview of REDD+ co-benefits .............................................................................. 32
  2.4.3 REDD+ and biodiversity conservation ....................................................................... 34
  2.4.4 REDD+, ecosystem services, and local livelihoods .................................................. 36
  2.4.5 REDD+ initiative in Nepal ......................................................................................... 37
  2.4.6 Opportunities for REDD+ in community forestry ...................................................... 41
    2.4.6.1 Biophysical scope of community forestry for REDD+ ........................................ 41
    2.4.6.2 Institutional opportunities of community forestry for REDD+ ............................ 42
  2.4.7 Challenges to REDD+ in community forestry .......................................................... 43
  2.4.8 Factors associated with REDD+ in community forestry ............................................. 44
    2.4.8.1 Forest dependency and REDD+ in community forestry ...................................... 44
    2.4.8.2 Factors affecting forest products extraction .......................................................... 45
    2.4.8.3 Institutional arrangements for REDD+ ................................................................. 46
  2.4.9 REDD+ benefit sharing and ecosystem services in community forestry ................. 49
    2.4.9.1 Overview of REDD+ benefit sharing ..................................................................... 49
    2.4.9.2 Dimensions of REDD+ benefit sharing .................................................................. 50
    2.4.9.3 Elements of REDD+ benefit sharing .................................................................... 51
  2.4.10 REDD+ benefit sharing in community forestry ......................................................... 52
    2.4.10.1 Equity in REDD+ through community forestry .................................................. 52
    2.4.10.2 Effectiveness of REDD+ through community forestry ........................................ 53
    2.4.10.3 Efficiency in REDD+ in community forests .......................................................... 56
2.5 Reflection on critical questions ......................................................................................... 56
2.6 Chapter summary .............................................................................................................. 57

Chapter 3- Research methodology: General overview ..................................................... 60
3.1 Introduction ....................................................................................................................... 60
3.2 General overview of research approaches and methods .................................................. 60
3.3 Country background ........................................................................................................ 63
3.4 Selection of research location, units and participants ..................................................... 65
Chapter 4- Status of carbon stocks, removal of forest products and forest biodiversity

4.1 Introduction ............................................................................................................ 71
4.2 Methodology .......................................................................................................... 72
  4.2.1 Description of community forest user groups .................................................. 72
  4.2.2 Data collection .................................................................................................. 75
    4.2.2.1 Collection of carbon stocks data ................................................................. 75
    4.2.2.2 Collection of forest products data ............................................................... 77
    4.2.2.3 Collection of vegetation data for assessing bias of data 2010 and 2013 .... 77
  4.2.3 Analysis of data ............................................................................................... 78
    4.2.3.1 Carbon stocks ............................................................................................ 79
    4.2.3.2 Timber ....................................................................................................... 79
    4.2.3.3 Fuelwood .................................................................................................... 80
    4.2.3.4 Fodder and grass ....................................................................................... 80
    4.2.3.5 Plant species diversity and richness ............................................................ 80
    4.2.3.6 Stem density .............................................................................................. 80
  4.2.4 Result of bias analysis ...................................................................................... 81
  4.2.5 Change in carbon stock, plant diversity, and removal of forest products ...... 81
4.3 Results of change between 2010 and 2013 ......................................................... 82
  4.3.1 Change in carbon stocks .................................................................................. 83
  4.3.2 Change in plant species diversity, richness and plant-stem density .......... 84
  4.3.3 Change in removal of forest products ............................................................. 87
4.4 Discussion ............................................................................................................. 91
  4.4.1 Change in carbon stocks ............................................................................... 91
  4.4.2 Change in plant species diversity, richness, and stem density ...................... 93
  4.4.3 Change in extraction of forest products ......................................................... 95

Chapter 5- Relationships between carbon stocks, forest biodiversity, and forest products extraction .................................................................................................................. 97
5.1 Introduction .......................................................................................................... 97
5.2 Collection and analysis of data .......................................................................... 98
5.3 Results .................................................................................................................. 101
5.3.1 Correlations across carbon stocks, forest biodiversity and forest products .......................................................... 101
5.3.2 Trade-offs and synergies across carbon stocks, forest biodiversity and removal of forest products .......................................................... 101
  5.3.2.1 Trade-offs and synergies between carbon stocks and forest biodiversity .......................................................... 102
  5.3.2.2 Trade-offs and synergies between carbon stocks and forest products .......................................................... 104
  5.3.2.3 Trade-offs and synergies between plant species diversity and forest products .......................................................... 105
  5.3.2.4 Trade-offs and synergies between species richness and forest products .......................................................... 106
  5.3.2.5 Trade-offs and synergies between stem density and forest products .......................................................... 107

5.4 Discussion .................................................................................................................................................. 108
  5.4.1 Relationships between carbon stocks and forest biodiversity attributes .......................................................... 108
  5.4.2 Relationships between carbon stocks and forest products extraction .......................................................... 109
  5.4.3 Relationships between forest biodiversity attributes and forest products .......................................................... 111
    5.4.3.1 Relationships between plant species diversity and forest products .......................................................... 111
    5.4.3.2 Relationships between stem density and forest products .......................................................... 113

Chapter 6- Research methodology for social study .......................................................... 114

6.1 Introduction .................................................................................................................................................. 114
6.2 Theoretical basis of this research design ................................................................................................. 114
6.3 Associated research paradigms and approaches to research design .......................................................... 116
    6.3.1 Quantitative research approach ........................................................................................................... 116
    6.3.2 Qualitative research approach ........................................................................................................... 117
    6.3.3 Mixed methods approach ................................................................................................................. 118
6.4 Research design- intensive case study and ecological study .................................................................. 120
6.5 Research context and researcher’s identity ............................................................................................. 121
6.6 Field work procedures .......................................................................................................................... 124
6.7 Selection criteria of case study CFUGs for in-depth interview ................................................................. 126
6.8 Techniques for collection of qualitative socio-economic data .................................................................. 130
    6.8.1 Individual in-depth interviews ........................................................................................................... 130
    6.8.2 Focus group discussion ....................................................................................................................... 133
    6.8.3 Participant observation ....................................................................................................................... 135
    6.8.4 Email and telephone interview ......................................................................................................... 137
6.9 Collection of quantitative socio-economic data ......................................................................................... 137
6.10 Collection of secondary data ................................................................................................................ 138
6.11 Analysis of data........................................................................................................... 139
  6.11.1 Analysis of qualitative data....................................................................................... 139
  6.11.2 Analysis of socio-economic quantitative data ......................................................... 142
  6.11.3 Estimation of importance value index (IVI).......................................................... 142
6.12 Validity and reliability ............................................................................................... 142
6.13 Ethical consideration .................................................................................................. 143
6.14 Possible biases and limitations of qualitative research .............................................. 144
6.15 Scope of study ........................................................................................................... 145

Chapter 7- Understanding the factors affecting removal of forest products and their effects on carbon stocks and forest biodiversity.............................................. 146
7.1 Introduction ................................................................................................................ 146
7.2 Existing practices and change in extraction of forest products ..................................... 148
  7.2.1 Change in extraction of timber ................................................................................. 148
  7.2.2 Change in extraction of fuelwood ......................................................................... 159
  7.2.3 Change in extraction of fodder ............................................................................. 167
7.3 Synthesis of factors affecting extraction of forest products ......................................... 177
7.4 Discussion .................................................................................................................. 179
  7.4.1 Biophysical characteristics provide options for forest products extraction .. 179
    7.4.1.1 Distance to forests from settlement reduces fuelwood and fodder removal ................................. 179
    7.4.1.2 Forest product extraction approaches vary across different size CFUGs ............................................. 180
    7.4.1.3 Distribution of different tree species with different use value influences forest products removal ............................................................................................................. 182
  7.4.2 Influence of socio-economic circumstances on forest products removal .......... 183
    7.4.2.1 Tree growing on private farmlands reduces fuelwood and fodder extraction ........................................................................................................................................ 183
    7.4.2.2 Change in agriculture practices reduces fuelwood and fodder removal 185
    7.4.2.3 Temporary outmigration reduces fuelwood and fodder collection ...... 186
    7.4.2.4 Improved road access increases timber removal .............................................. 187
    7.4.2.5 Development of wood-based factories increases timber extraction...... 189
  7.4.3 Institutional arrangements mediate the demand and supply condition of forest products............................................................................................................................................... 190
7.5 Chapter conclusion..................................................................................................... 191

Chapter 8- REDD+ pilot and practice changes ................................................................. 194
# Chapter 8 - Change in forest management

## 8.1 Introduction

8.1 Introduction .......................................................................................................................... 194

## 8.2 Change in group management and participation

8.2 Change in group management and participation ............................................................... 200

## 8.3 Distribution of funds within and across CFUGs

8.3 Distribution of funds within and across CFUGs ............................................................... 215

#### 8.3.1 Change in priority for fund distribution within CFUGs

8.3.1 Change in priority for fund distribution within CFUGs ............................................. 215

#### 8.3.2 Has the REDD+ pilot fund improved livelihoods of the poor?

8.3.2 Has the REDD+ pilot fund improved livelihoods of the poor? ................................. 223

## 8.4 Changes in forest management approaches

8.4 Changes in forest management approaches ...................................................................... 227

#### 8.4.1 Forest conservation: minimising risks, restricting extraction of forest products and reducing demand

8.4.1 Forest conservation: minimising risks, restricting extraction of forest products and reducing demand ................................................................. 228

#### 8.4.2 Forest improvement activities

8.4.2 Forest improvement activities ..................................................................................... 236

## 8.5 Coherence between REDD+ pilot, climate change and forest policies

8.5 Coherence between REDD+ pilot, climate change and forest policies .......................... 240

## 8.6 Discussion

8.6 Discussion .......................................................................................................................... 245

#### 8.6.1 REDD+ strengthens institutional capacity, but increases implementation costs

8.6.1 REDD+ strengthens institutional capacity, but increases implementation costs ........... 246

#### 8.6.2 REDD+ provides enhanced access to benefits for the poor, but can reduce motivation of non-recipients

8.6.2 REDD+ provides enhanced access to benefits for the poor, but can reduce motivation of non-recipients .......................................................... 249

#### 8.6.3 REDD+ supports forests conservation, but can undermine customary rights

8.6.3 REDD+ supports forests conservation, but can undermine customary rights ............. 253

#### 8.6.4 REDD+ presents both policy opportunities and challenges for carbon, biodiversity and livelihoods

8.6.4 REDD+ presents both policy opportunities and challenges for carbon, biodiversity and livelihoods ............................................................. 256

## 8.7 Chapter conclusion

8.7 Chapter conclusion ........................................................................................................... 258

# Chapter 9 - Synthesis and conclusion

## 9.1 Introduction

9.1 Introduction ....................................................................................................................... 261

## 9.2 Synthesis of key findings

9.2 Synthesis of key findings .................................................................................................... 262

#### 9.2.1 Changes in carbon stocks, forest biodiversity and removal of forest products are variable

9.2.1 Changes in carbon stocks, forest biodiversity and removal of forest products are variable ................................................................................... 264

#### 9.2.2 Both trade-offs and synergies between carbon, biodiversity and forest products are possible in community forests

9.2.2 Both trade-offs and synergies between carbon, biodiversity and forest products are possible in community forests .............................................. 266

#### 9.2.3 Factors associated with forests products extraction are multi-dimensional

9.2.3 Factors associated with forests products extraction are multi-dimensional ................. 267

#### 9.2.4 REDD+ results in both positive and negative effects for community forests

9.2.4 REDD+ results in both positive and negative effects for community forests ............... 268

#### 9.2.5 Policy reforms can expand the scope of REDD+ for carbon, biodiversity and livelihoods

9.2.5 Policy reforms can expand the scope of REDD+ for carbon, biodiversity and livelihoods ...................................................................................... 271

## 9.3 Implications to policy and practices

9.3 Implications to policy and practices .................................................................................. 272

## 9.4 Limitations and suggestions for future research

9.4 Limitations and suggestions for future research ............................................................... 273

# Reference

Reference .................................................................................................................................. 275

# Appendices

Appendices ............................................................................................................................... 324
List of Appendices

Appendix 1- Source of data of carbon stocks, plant diversity, and forest products......324
Appendix 2- Calculation of carbon stocks in community forests.........................325
Appendix 3- Details of carbon stocks in community forests in 2010 and 2013 ........328
Appendix 4- Estimation of plant species diversity index.....................................329
Appendix 5- Calculation of species richness using rarefaction ............................330
Appendix 6- Illustration of carbon, forest biodiversity and forest product removal in
2010, 2013 and leakage plot in 2013 .................................................................331
Appendix 7- Distribution of carbon stocks in community forests in 2010 and 2013 ...332
Appendix 8- Distribution plant diversity index (top left), species richness (top right),
and stem density (bottom) in 2010 and 2013 ......................................................333
Appendix 9- Extraction of timber (top left), fuelwood (top right), and fodder (bottom) in
2010 and 2013 ...................................................................................................334
Appendix 10- Standardised value of carbon stock, forest biodiversity attributes and
forest product extraction ......................................................................................335
Appendix 11- Steps used in producing graphs showing relationships....................336
Appendix 12- Association (Spearman’s rank order correlations) between carbon stocks,
forest biodiversity attributes, and forest products extraction in 2010.................337
Appendix 13- Community forests having trade-offs and synergies between carbon
stocks and forest biodiversity attributes and forest products, and changes from 2010 to
2013 ............................................................................................................338
Appendix 14- Community forests with trade-offs and synergies between carbon stocks,
plant species diversity, richness, and stem density in 2010..............................340
Appendix 15- Community forests with trade-offs and synergies between carbon stocks
and extraction of timber, fuel wood and fodder in 2010....................................341
Appendix 16- Community forests with trade-offs and synergies between plant species
diversity and extraction of timber, fuelwood and fodder in 2010.....................342
Appendix 17- Community forests with trade-offs and synergies between species
richness and extraction of timber, fuelwood and fodder in 2010......................343
Appendix 18- Community forests with trade-offs and synergies between stem density
and extraction of timber, fuelwood and fodder in 2010..................................344
Appendix 19- Local criteria adopted for well-being in CFUG households............345
Appendix 20- Checklist of in-depth interview ......................................................346
Appendix 21- Interview guide for focus group discussion .................................350
Appendix 22- Checklist for mail survey with central level stakeholders ................. 354
Appendix 23- Household questionnaire survey .................................................. 355
Appendix 24- Approved human research ethics by CSU ........................................ 359
Appendix 25- Consent form for research participants ........................................... 360
Appendix 26- Basic information of Sitakunda and Thansadeurali community forest
users groups........................................................................................................ 361
Appendix 27- Prioritisation of forest products by participants of focus group discussion
with Dalit (right) and Indigenous Peoples (left) in Sitakunda CFUG ...................... 362
Appendix 28- Prioritisation of forest products by participants of focus group discussion
with Women’s group (right) and Dalit group (left) in Thansadeurali Community forest
user group ............................................................................................................. 363
Appendix 29- Incidences of forest fires in Sitakunda community forests .................. 364
Appendix 30- Trust fund governing structure of the REDD+ pilot project .............. 365
Appendix 31- Criteria of seed grant defined in carbon trust fund guidelines under pilot
REDD+ initiative .................................................................................................... 366
Appendix 32- Comparison of the areas of fund mobilisation between the REDD+ trust
fund guidelines and community forestry guidelines .............................................. 367
Appendix 33- Income (In NRs.) from different sources in Sitakunda and Thansadeurali
community forest user group ............................................................................. 368
List of Figures

Figure 1.1- Overview of socio-economic and ecological influences of REDD+ under a socio-ecological system .................................................................4
Figure 1.2- Overview of thesis structure and chapters ..........................................................6
Figure 2.1- Linkage between group and forest management in community forestry system ......................................................................................................................25
Figure 2.2- Interrelationship between REDD+ and non-carbon benefits (dark blue circles are environmental co-benefits whereas orange circles are social co-benefits) ....32
Figure 2.3- Major opportunities and risks for biodiversity conservation from the five REDD+ activities ........................................................................................................35
Figure 2.4- Institutional structure of REDD+ governance in Nepal ..................................39
Figure 2.5- Simplified diagram of REDD+ benefit flows at international, national, sub-national, and local level ........................................................................................................49
Figure 2.6- Conceptual framework of REDD+ benefit distribution and its contribution to livelihood and carbon stock (forest conservation) ........................................51
Figure 3.1- Inter-disciplinary research approach for social-ecological study ..............61
Figure 3.2- Explanatory design of mixed methods design in socio-ecological system ..63
Figure 3.3- Major physiographic regions of Nepal .............................................................64
Figure 3.4- Map of research sites ..........................................................................................65
Figure 3.5- Key features of Charnawati watershed .............................................................68
Figure 3.6- Illustration of linking group level ecological changes with individual level perception and feeling .................................................................................................70
Figure 4.1- Map showing permanent plots in community forests ........................................76
Figure 4.2- Composite sampling designs for carbon data collection ..................................77
Figure 4.3- Map showing forest inventory plots for vegetation survey ................................78
Figure 4.4- Carbon stocks change across community forests in 2010 and 2013 ........83
Figure 4.5- Mean and standard error of plant species diversity in different community forest in 2010 and 2013 ..................................................................................85
Figure 4.6- Mean and standard error of plant species richness in different community forests in 2010 and 2013 ..................................................................................85
Figure 4.7- Mean and standard error of stem density in different community forests in 2010 and 2013 ..................................................................................86
Figure 4.8- Mean and standard error of timber harvest in different community forests in 2010 and 2013 ..................................................................................88
Figure 4.9- Mean and standard error of fuelwood harvest in different community forests in 2010 and 2013 ......................................................................................................................... 89
Figure 4.10- Mean and standard error of fodder extraction in different community forests in 2010 and 2013 .......................................................................................................................... 89
Figure 5.2- The number assigned to each community forest ........................................... 100
Figure 5.1- Illustration of associations between two variables ........................................ 100
Figure 5.3- Community forests with trade-offs and synergies between carbon stocks, plant species diversity, species richness, and stem density 2013 ................................................. 103
Figure 5.4- CFs with trade-offs and synergies between carbon stocks, and forest products extraction in 2013 .............................................................................................................................. 104
Figure 5.5- Community forests with trade-offs and synergies between plant species diversity and forest products extraction in 2013 ................................................................. 105
Figure 5.6- Community forests with trade-offs and synergies between species richness and forest products in 2013 ....................................................................................................................... 106
Figure 5.7- Community forests with trade-offs and synergies between stem density and forest products extraction in 2013 ......................................................................................... 107
Figure 6.1- The QUAN – Mixed – QUAL continuum ........................................................ 119
Figure 6.2- Interplay of REDD+ with social and ecological elements of CFs ............ 123
Figure 6.3- An overview of research methods and socio-economic data collection technique ......................................................................................................................... 126
Figure 6.4- Selected CFUGs for case study ...................................................................... 128
Figure 6.5- Illustration of process of qualitative data analysis according to hierarchical themes ........................................................................................................................................ 140
Figure 7.1- Hierarchy of institutional, biophysical and socio-economic factors affecting extraction of forest products in community forests ......................................................... 147
Figure 7.2- Importance value index of tree species in Thansadeurali CFUG for 2010 and 2013 ................................................................................................................................. 152
Figure 7.3- Importance value index of tree species in Sitakunda CFUG for 2010 and 2013 ................................................................................................................................. 152
Figure 7.4- Change in per ha extraction of timber (cubic feet) in Sitakunda and Thansadeurali ................................................................................................................................. 157
Figure 7.5- Change in per capita timber harvest (Cft) in Sitakunda and Thansadeurali community forest user groups ........................................................................................................ 157
Figure7.6- Percentage of households (n = 175 for Sitakunda and n = 382 for Thansadeurali) using different cooking energy schemes ................................................................. 164
Figure 7.7- Changes in per ha extraction of fuelwood (one headload or Bhari = 35 kg) in Sitakunda and Thansadeurali community forest user groups ................................................. 166
Figure 7.8- Change in per capita fuelwood extraction (one headload or Bhari = 35 kg) in Sitakunda and Thansadeurali community forest user groups ................................................. 167
Figure 7.9- Change in per ha fodder (bhari) extraction in Sitakunda and Thansadeurali community forest user groups .................................................................................................. 176
Figure 7.10- Change in per capita fodder extraction (one headload or Bhari = 35 kg) in Sitakunda and Thansadeurali community forest user groups ................................................. 177
Figure 7.11- Factors associated with the extraction of timber, fuelwood and fodder and their linkage with carbon stocks and forest biodiversity................................................. 178
Figure 8.1- Perceived changes in forest and group management practices with REDD+ pilot ....................................................................................................................................... 200
Figure 9.1- Social and ecological changes across community forests under REDD+.. 262
List of Tables

Table 2.1- Mapping and analysing the trade-offs across ecosystem services .................. 10
Table 2.2- Studies on analysing the relationships between biodiversity and provision of ecosystem services ......................................................................................................................... 15
Table 2.3- Historical overview of forest management in Nepal ........................................... 20
Table 2.4- Status of community forests in Nepal as of August, 2015 .............................. 22
Table 2.5- Distribution of community forests in ecological zones of Nepal as of August, 2015 ................................................................................................................................................................. 23
Table 2.6- Co-benefits and potential negative impacts of REDD+ ................................. 33
Table 2.7- Evolution of REDD discourses in Nepal ......................................................... 38
Table 2.8- Major REDD+ Initiatives being practiced in Nepal ....................................... 39
Table 2.9- Carbon potential of total forests and community forests in Nepal ............... 41
Table 2.10- Creditable activities in REDD+ and their relevance to community forestry ........................................................................................................................................................................... 41
Table 2.11- Forest management activities and relevancy to carbon stocks enhancement and REDD+ ................................................................................................................................................................. 54
Table 3.1- Summary of research components .................................................................. 62
Table 3.2- Overview of data collection and analysis methods and techniques .............. 62
Table 4.1- Main characteristic of community forests ....................................................... 73
Table 4.2- Illustration of results of Wilcoxon rank sum test (Mann-Whitney test) of difference value of carbon, forest biodiversity in forest inventory between ICIMOD and new plots (at significance level $\alpha = 0.05$, in two-tailed tests) ................................. 81
Table 4.3- Summary of changes in carbon stocks, plant diversity and removal of forest products in different community forest types between 2010 and 2013 .................... 82
Table 4.4- Carbon stocks across different categories of community forests ................. 83
Table 4.5- Change in carbon stocks in different community forest types between 2010 and 2013 (changes were positive for all community forests) ................................. 84
Table 4.6- Change in plant species diversity, species richness and stem density between 2010 and 2013 ................................................................................................................................................................. 84
Table 4.7- Changes in plant species diversity in community forests between 2010 and 2013 ................................................................................................................................................................. 86
Table 4.8- Changes in plant species richness in community forests between 2010 and 2013 ................................................................................................................................................................. 86
Table 4.9- Changes in stem density in community forests between 2010 and 2013 ..... 87
Table 4.10 - Change in removal of timber, fuelwood, and fodder in community forests between 2010 and 2013 ................................................................. 88
Table 4.11 - Change in timber harvest in different community forests in 2010 and 2013 ........................................................................................................ 90
Table 4.12 - Change in fuelwood extraction in different community forests in 2010 and 2013 ........................................................................................................ 90
Table 4.13 - Change in fodder extraction in different community forests in 2010 and 2013 ........................................................................................................ 91
Table 5.1 - Details of carbon stocks, plant diversity and forest products removal from 2010 to 2013 ........................................................................................................ 98
Table 5.2 - Categorisation of strength of pairwise correlation among forest attributes... 99
Table 5.3 - Association (Spearman’s rank order correlations) between carbon stocks, and plant diversity, species richness and stem density in 2013 ......................... 101
Table 5.4 - CFs with trade-offs and synergies between carbon stocks and forest biodiversity attributes and forest products in 2013 ................................................. 102
Table 6.1 - Highlights of strength and challenges of mixed methods approach ............ 119
Table 6.2 - Summary of key activities followed in the field ........................................ 124
Table 6.3 - Information of 19 community forests and selection of 2 community forests for case study ........................................................................................................ 127
Table 6.4 - Number of total households in case-study CFUGs with different well-being status ........................................................................................................... 130
Table 6.5 - Strengths and weaknesses of in-depth interview ...................................... 132
Table 6.6 - Households selected for semi-structured in-depth interview at CFUG level ....................................................................................................................... 132
Table 6.7 - District and central level participants for in-depth interview ..................... 133
Table 6.8 - Strengths and weaknesses of focus group discussion ................................. 134
Table 6.9 - Number of participants in focus group discussion organized with different interest groups ..................................................................................................... 135
Table 6.10 - Number of household (hh) for questionnaire survey ................................ 138
Table 6.11 - Code assigned for interviewees from different levels ............................... 140
Table 6.12 - Approaches applied to ensure reliability and validity in this research ..... 143
Table 7.1 - Proportional distribution of households of well-being groups extracting timber in Sitakunda and Thansadeurali CFUGs in 2013 ............................................. 154
Table 7.2 - Fuelwood dependency of different well-being households in Sitakunda and Thansadeurali community forest user groups in 2013 ............................................. 162
Table 7.3 - Number of households of different well-being groups and amount of fodder harvested in Sitakunda and Thansadeurali community forest user groups in 2013...... 169
Table 7.4 - Number of households with different landholding sizes that extracted fodder from Sitakunda and Thansadeurali community forests in 2013 ............................................. 171
Table 7.5 - Change in average per household number of cattle, buffalo and goats in Sitakunda community forest user group from 2009 to 2013 ................................................. 174
Table 7.6 - Change in average per household number of cattle, buffalo and goats in Thansadeurali community forest user group from 2009 to 2013 ............................................. 174
Table 7.7 - Percentage of households practicing different livestock feeding strategies in Sitakunda and Thansadeurali community forest user groups in 2013 (parentheses are percentage of households surveyed) .................................................................................. 175
Table 7.8 - Summary of factors associated with and their effects on the extraction of timber, fuelwood and fodder in community forests.............................................................................. 178
Table 7.9 - Illustration of factors affecting extraction of timber, fuelwood and fodder and their effects (P– Positive and N- Negative) on carbon stocks and forest biodiversity.. 192
Table 8.1 - Seed grants amount (in USD) distributed from REDD+ pilot to CFUGs of three watersheds of Nepal ........................................................................................................ 197
Table 8.2 - Seed grants amount (USD) distributed from REDD+ pilots to CFUGs of Charnawati watershed, Dolakha district .............................................................................. 198
Table 8.3 - Agenda items discussed and frequency of executive committee meetings of Sitakunda and Thansadeurali community forest user groups (Parenthesis is the number of meetings held in Thansadeurali) .................................................................................. 204
Table 8.4 - Average percentage of attendance of committee members of different ethnic and gender groups in Sitakunda community forest group ................................................. 206
Table 8.5 - Average percentage of attendance of committee members of different ethnic and gender groups in Thansadeurali community forest group ................................................. 206
Table 8.6 - Participation of forest users in general assembly in Sitakunda community forest user group (Parentheses are percentage of participation) ................................................. 209
Table 8.7 - Participation of forest users in general assembly in Thansadeurali community forest user group (Parentheses are percentage of participation) ................................................. 209
Table 8.8 - Percentage of fund allocation to different activities in Sitakunda CFUG (Parentheses are percentage of fund allocation) ................................................................. 217
Table 8.9 - Percentage of fund allocation to different activities in Thansadeurali CFUG (Parentheses are percentage of fund allocation) ................................................................. 218
Table 8.10 - Number of households directly benefitting from seed grants from 2011 to 2013 (parenthesis is percentage of households benefiting from seed grants with reference to total households of respective category of each ethnic group) ...............227
Table 8.11 - Trees planted in Sitakunda and Thansadeurali community forests per year ...........................................................................................................................................237
Table 8.12 - Thinning and pruning activity in Sitakunda and Thansadeurali community forests ........................................................................................................................................240
Table 8.13 - Illustration of reconciliation between climate change adaptation and biodiversity conservation policies with reference to REDD+ and their effects in local practices ........................................................................................................................................244

**List of Boxes**

Box 2.1 - Elinor Ostrom’s design principles for robust institutions and collective actions, (1990): ........................................................................................................................................27
Box 2.2 - Chronological development of REDD+ initiative ........................................31
Certificate of authorship

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person, nor material which to a substantial extent has been accepted for the award of any other degree or diploma at Charles Sturt University or any other educational institution, except where due acknowledgement is made in the thesis.

Any contribution made to the research by colleagues with whom I have worked at Charles Sturt University or elsewhere during my candidature is fully acknowledged. I agree that this thesis be accessible for the purpose of study and research in accordance with normal conditions established by the Executive Director, Library Services or nominee, for the care, loan and reproduction of theses.

Signature:

Name: Eak Rana
Date: 23 March 2016
Dedication

THIS THESIS IS DEDICATED
TO
MY MOTHER KARIMINA RANA
WHO PASSED AWAY
(16 DECEMBER 2013)
Acknowledgements

This thesis is the outcome of the support and guidance of many people and organisations. I would therefore like to express my immense gratitude and indebtedness to all of them. I am profoundly indebted to my principal research supervisor Dr. Rik Thwaites (Senior Lecturer, CSU) and co-supervisor Professor Gary Luck (Head, Research Professional Development Programmes, CSU). Thank you – Rik and Gary, for your consistent supervision, encouragement and intellectual and personal supports provided in every step of the thesis development. Your constructive comments and generous allocation of time to read my numerous drafts greatly assisted me to keep on track during the difficult time of thesis writing.

I am deeply grateful to Charles Sturt University (CSU) for providing a scholarship from the Faculty of Sciences to undertake this research. My especial thanks go to Mr. Simon McDonald (Spatial Analysis Officer, CSU), who provided support for statistical analysis of quantitative data and production of maps. I sincerely thank Professor Max Finlayson (Director, Institute for Land, Water and Society, CSU), who supported the establishment of institutional collaboration between CSU and the International Centre for Integrated Mountain Development (ICIMOD) for accessing data for this thesis. I am also indebted to Dr. Ben Wilson, Dr. Peter Spooner, Dr. Joanne Millar, Mr. Greg Fry, Ms Cathy Garbuio, Ms Frances Baker, Ms Rebecca Cartledge, Ms Angie Goodfellow and Ms Suzanne Skate for their support. I would like to thank Ms Jane Fowler for editing and proof-reading this thesis.

I would like to thank Dr. Bhaskar S Karky of ICIMOD for his cooperation in providing access to raw forest inventory data of community forests for this research. Thanks also go to Mr. Hammad Gilani of ICIMOD and Dr. Nabin Joshi of the Asia Network for Sustainable Agriculture and Bioresource (ANSAB) for their technical support in designing forest inventory and analysing data. I also thank Mr. Deepak Charmakar and Mr. Purna Khatri for assistance during the forest inventory.

I had a fruitful interaction with many postgraduate students at the School of Environmental Sciences, CSU Albury. I would like to thank all seniors and friends including Dr. Popular Gentle, Dr. Mohan Poudel, Dr. Binod Devkota, Dr. Kuenga Namgay, Mr. Buddi Poudel, Dr. Prajwol Gyawali, Dr. Patrick Cobbah, Ms Erika Cross, Mr. Adrian Clements, Mr. Karma Tenzing, Ms SaiDeepa Kumar, Mr. Paul Amoateng and Mr. Chaka Chirozva for their support and encouragement.

I offer my special thanks to many professionals and friends including Dr. Thakur Bhattarai, Dr. Rajan Kotru, Dr. Eklaya Sharma, Mr. Krishna Acharya, Mr. Resham Dangi, Dr. Bhisma Subedi, Dr. Kalyan Gauli, Mr. Birkha Shahi, Mr. Bhim P Khadka, Mr. Dil Raj Khanal, Dr. Narendra Chand, Dr. Him Lal Shrestha, Mr. Keshab Goutam, Dr. Basundhara Bhattarai, Dr. Himlal Baral, Dr. Punam Yadav, Mr. Sunil Pariyar, Ms. Pabitra Jha and Ms Bharati Pathak, all of whom offered valuable support and encouragement.

I am also highly indebted to all my research participants, especially those from Sitakunda and Thansadeurali and the other 17 community forest user group members of Dolakha district, for their valuable time, information and hospitality. I would like to thank many professionals of Dolakha district- Mr. Rabindra Maharjan, Mr. Ram Krishna KC, Mr. Chandra B Thapa, Mr. Sher B Shrestha, Ms Sita KC, Mr. Uddav
Pokharel, Mr. Dhan B. Tamang, Ms. Kamala Bashnet, Mr. Harihar Neupane and Mr. Sagar Godar Chhetri.

Most importantly, I would like to express my immense gratitude to my late mother, who passed away during this study (December 2013), for her encouragement and enormous struggles to bring me to this stage – this thesis is dedicated to her. I offer appreciation to my father Mr. Shreeman Rana for his inspiration and motivation. I thank my sister Mrs. Prema Thapa for her encouragement, and for her care of our father following the loss of our mother. Thanks also go to my cousins Dr. Ram Rana and Mr. Som Rana for their inspiration and support. Finally, a word of gratitude and appreciation goes to my beloved wife Shree, son Bibek and daughter Binu for their love, care and inspiration throughout the study.
Ethics approval

The research propose and field work scheme, including methods used for data collection for this research, were approved by the Ethics in Human Research Committee, School of Environmental Science, Charles Sturt University, Elizabeth Mitchell Drive, Thurgoona NSW, 2640 on 12 June 2013, in a letter to Mr. Eak Rana from Ms. Catherine Garoni, Admin Assistant, School of Environmental Sciences, Ethics in Human Research Committee (see Appendix 24). The protocol number issued with respect to this research project was 410/2013/07.

English language editor statement

A professional English editor, Ms. Jane Fowler, was engaged for the sole purpose of improving the use of English language in this thesis. The editor did not change the academic content of this thesis.
Abstract

There is a growing consensus internationally that REDD+ offers an effective approach to reduce emissions and enhance carbon, improve local livelihoods and conserve biodiversity. Yet, questions remain whether REDD+ can generate simultaneous positive outcomes, particularly in community managed forests in developing countries, where forest management objectives are primarily linked to local livelihoods. My research undertakes an integrated assessment of ecological and social changes arising from a REDD+ pilot established in community forests in Nepal.

Guided by an interdisciplinary research approach within a socio-ecological systems framework, my research employs a mixed methods research design applied to the collection of quantitative and qualitative data. Using primary research and existing data from forest inventories and local group records, I first assess short-term temporal changes in carbon stocks, forest biodiversity (plant species diversity, species richness, and stem density), and extraction of forest products (timber, fuelwood and fodder) in 19 REDD+ piloted community forests. I then analyse trade-offs and synergies between protecting carbon stocks, biodiversity and provision of forest products in these forests. The results highlight that carbon stocks have increased and biodiversity attributes have decreased following the implementation of REDD+, coinciding with a decrease in fuelwood and fodder extraction and an increase in timber removal. There were both trade-offs and synergies in protecting carbon stocks, biodiversity and provision of forest products, though trade-offs were generally prevalent for carbon stocks (e.g. forests with high carbon stock value had relatively low biodiversity value).

The sociological analysis involved in-depth assessment of two case study community forest user groups (CFUGs) to: (i) understand the factors affecting forest products removal, and (ii) analyse how REDD+ has influenced local forest and group management practices. Qualitative social data covered perceptions and experiences of respondents from local communities and district and national stakeholders, and were obtained through in-depth interviews and focus group discussions. Quantitative data derived from household surveys and group records were used to substantiate the qualitative results. The results reveal that the factors influencing extraction of forest products are multi-dimensional, local and non-local, and include institutional arrangements and socio-economic and biophysical characteristics. Changed access regulations, growing of trees on private farmlands, transformation of agriculture from traditional crops to vegetable farming, outmigration and introduction of alternative energies led to a decrease in fuelwood and fodder extraction, while development of road networks and wood-based factories were associated with an increase in timber extraction.

REDD+ strengthens institutional capacity, promotes pro-poor and equitable benefit sharing and increases the representation of marginalised households in decision-making. However, REDD+ may increase costs of CFUGs and the time commitment of forest users, reduce motivation of forest users to engage in REDD+, and exclude poor members from decision-making. REDD+ implementation sought to restrict forest products access and emphasise protection-oriented activities, leading to an increase in carbon stocks, but in practice it undermines the customary rights and livelihoods of poor households, and destabilises the customary practices of forest activities of self-regulated CFUGs.
I concluded that consideration of socio-economic and institutional factors is essential for future REDD+ designs. A combination of pro-poor and contribution-based criteria for benefit sharing and recognition of customary resource access rights and the distribution of sufficient funds from REDD+ to local people, could enhance equitable benefit sharing, efficiency and effectiveness for REDD+, leading to greater synergies between protecting carbon stocks, biodiversity and livelihoods.
Publication arising from this research

Journal article

Conference presentation from this study
### List of Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGSB</td>
<td>Above Ground Sapling Biomass</td>
</tr>
<tr>
<td>AGTB</td>
<td>Above Ground Tree Biomass</td>
</tr>
<tr>
<td>ANSAB</td>
<td>Asia Network of Sustainable Agriculture and Bioresources</td>
</tr>
<tr>
<td>CBD</td>
<td>Convention on Biological Diversity</td>
</tr>
<tr>
<td>CBS</td>
<td>Central Bureau of Statistics</td>
</tr>
<tr>
<td>CCBA</td>
<td>Climate, Community and Biodiversity Alliance</td>
</tr>
<tr>
<td>CDM</td>
<td>Clean Development Mechanism</td>
</tr>
<tr>
<td>CF</td>
<td>Community Forestry</td>
</tr>
<tr>
<td>CFs</td>
<td>Community Forests</td>
</tr>
<tr>
<td>CFUG</td>
<td>Community Forest User Group</td>
</tr>
<tr>
<td>CoP</td>
<td>Conference of Parties</td>
</tr>
<tr>
<td>CSO</td>
<td>Civil Society Organisation</td>
</tr>
<tr>
<td>DBH</td>
<td>Diameter at Breast Height</td>
</tr>
<tr>
<td>DDC</td>
<td>District Development Committee</td>
</tr>
<tr>
<td>DFO</td>
<td>District Forest Office (Officer)</td>
</tr>
<tr>
<td>DFRS</td>
<td>Department of Forest Research and Survey</td>
</tr>
<tr>
<td>DoF</td>
<td>Department of Forests</td>
</tr>
<tr>
<td>EC</td>
<td>Executive Committee</td>
</tr>
<tr>
<td>ER-PD</td>
<td>Emissions Reduction Project Document</td>
</tr>
<tr>
<td>ER-PIN</td>
<td>Emissions Reduction Project Idea Note</td>
</tr>
<tr>
<td>ESs</td>
<td>Ecosystem Services</td>
</tr>
<tr>
<td>FAO</td>
<td>Food and Agriculture Organisation of the United Nations</td>
</tr>
<tr>
<td>FCPF</td>
<td>Forest Carbon Partnership Facility</td>
</tr>
<tr>
<td>FECOFUN</td>
<td>Federation of Community Forestry Users, Nepal</td>
</tr>
<tr>
<td>FGD</td>
<td>Focus Group Discussion</td>
</tr>
<tr>
<td>FoP</td>
<td>Forest Operational Plan</td>
</tr>
<tr>
<td>GA</td>
<td>General Assembly</td>
</tr>
<tr>
<td>GCA</td>
<td>Gaurishankar Conservation Area</td>
</tr>
<tr>
<td>HREC</td>
<td>Human Research Ethics Committee</td>
</tr>
<tr>
<td>ICIMOD</td>
<td>International Centre for Integrated Mountain Development</td>
</tr>
<tr>
<td>ICS</td>
<td>Improved Cooking Stove</td>
</tr>
<tr>
<td>I/NGOs</td>
<td>International Non-Government Organisations</td>
</tr>
<tr>
<td>InVEST</td>
<td>Integrated Valuation of Ecosystem Services and Trade-offs</td>
</tr>
<tr>
<td>IPCC</td>
<td>Intergovernmental Panel on Climate Change</td>
</tr>
<tr>
<td>IPs</td>
<td>Indigenous Peoples</td>
</tr>
<tr>
<td>IVI</td>
<td>Importance Value Index</td>
</tr>
<tr>
<td>LAPA</td>
<td>Local Adaptation Plans for Action</td>
</tr>
<tr>
<td>LFP</td>
<td>Livelihood Forestry Programme</td>
</tr>
<tr>
<td>LHG</td>
<td>Leaf litter, Herbs and Shrubs</td>
</tr>
<tr>
<td>MEA</td>
<td>Millennium Ecosystem Assessment</td>
</tr>
<tr>
<td>MFSC</td>
<td>Ministry of Forests and Soil Conservation</td>
</tr>
<tr>
<td>MPFS</td>
<td>Master Plan for Forestry Sector</td>
</tr>
<tr>
<td>MRV</td>
<td>Monitoring, Reporting and Verification</td>
</tr>
<tr>
<td>NAPA</td>
<td>National Adaptation Plan of Action</td>
</tr>
<tr>
<td>NPC</td>
<td>National Planning Commission</td>
</tr>
<tr>
<td>NPP</td>
<td>Net Primary Productivity</td>
</tr>
<tr>
<td>NRs</td>
<td>Nepali Rupees</td>
</tr>
<tr>
<td>NSCFP</td>
<td>Nepal-Swiss Community Forestry Project</td>
</tr>
<tr>
<td>PDD</td>
<td>Project Design Document</td>
</tr>
<tr>
<td>RED</td>
<td>Reducing Emissions from Deforestation</td>
</tr>
<tr>
<td>REDD</td>
<td>Reducing Emissions from Deforestation and Forest Degradation</td>
</tr>
<tr>
<td>Acronym</td>
<td>Full Form</td>
</tr>
<tr>
<td>---------</td>
<td>-----------</td>
</tr>
<tr>
<td>REDD+</td>
<td>Reducing Emissions from Deforestation and Forest Degradation and Enhancement of Carbon Stocks</td>
</tr>
<tr>
<td>REL</td>
<td>Reference Emissions Level</td>
</tr>
<tr>
<td>RIC</td>
<td>REDD Implementation Centre</td>
</tr>
<tr>
<td>R-PIN</td>
<td>Readiness Project Idea Note</td>
</tr>
<tr>
<td>RPP</td>
<td>Readiness Preparation Proposal</td>
</tr>
<tr>
<td>SoC</td>
<td>Soil Organic Carbon</td>
</tr>
<tr>
<td>UNDP</td>
<td>United Nations Development Programme</td>
</tr>
<tr>
<td>UNEP</td>
<td>United Nations Environment Programme</td>
</tr>
<tr>
<td>UNFCCC</td>
<td>United Nations Framework Convention on Climate Change</td>
</tr>
<tr>
<td>UNFF</td>
<td>United Nations Forum on Forests</td>
</tr>
<tr>
<td>UN-REDD</td>
<td>United Nations Programme on Reducing Emissions from Deforestation and Forest Degradation</td>
</tr>
<tr>
<td>USAID</td>
<td>United States Agency for International Development</td>
</tr>
<tr>
<td>USD</td>
<td>The United States Dollar</td>
</tr>
<tr>
<td>USDA</td>
<td>United States Department of Agriculture</td>
</tr>
<tr>
<td>VDC</td>
<td>Village Development Committee</td>
</tr>
</tbody>
</table>
Chapter 1- Introduction

1.1 Research context

Reducing emissions from deforestation and forest degradation, and enhancement of carbon stocks (REDD+), is an international policy mechanism that aims to avoid further carbon dioxide emissions by providing developing countries with financial incentives to reduce forest loss. While increasing carbon stocks and reducing carbon emissions are major objectives of REDD+, the scheme is also expected to generate several non-carbon benefits, including biodiversity conservation and improvement in local livelihoods (Lee et al., 2011; Potts et al., 2013).

REDD+ is also seen as a value-laden policy instrument that has the potential to induce changes to business-as-usual local management practices (Korhonen-Kurki et al., 2014). Hence, REDD+ may change existing forest management strategies, forest product use, benefit sharing and on-ground decision-making, as a consequence of local people trying to meet the requirements of the scheme (Bryan & Crossman, 2013; Ojija, 2015).

The emphasis of REDD+ on protecting forests for carbon storage enhancement can undermine the livelihoods of forest-dependent people. For example, some studies (e.g. Maraseni et al., 2014; Pandey, Cockfield, et al., 2014; Poudel, Thwaites, et al., 2014; Robinson et al., 2013) have observed negative impacts on the livelihoods of forest-dependent people when the implementation of REDD+ imposes restrictions on access to forest products. Yet positive outcomes are also possible, including synergies between protecting carbon stocks and biodiversity (e.g. see Gamfeldt et al., 2013; Haase et al., 2012; Thompson, Okabe, et al., 2011), although these synergies may not always be present (e.g. Panfil & Harvey, 2015; Phelps, Friess, et al., 2012; Visseren-Hamakers, McDermott, et al., 2012).

Conservation of biodiversity and carbon stocks can be undermined by the extraction of forest products by local communities, and forest managers need to navigate a complex path in attempting to achieve multiple objectives (Chopra & Kumar, 2004; Manhas et al., 2006; Persha et al., 2011; Skutsch, Balderas-Torres, et al., 2011; Ximenes et al., 2012). Removal of forest products may also vary across local communities owing to variations in socio-economic status (Adhikari et al., 2004; Robinson & Kajembe, 2009; Sapkota & Odén, 2008), biophysical characteristics (Adhikari & Lovett, 2006a; Pichancourt et al., 2014; Pokharel, 2013) and institutional regimes (Andersson &
Agrawal, 2011; Coleman, 2009; Poteete & Ostrom, 2002). This adds a further level of complexity to understanding how REDD+ may impact on local conservation and resource use approaches.

REDD+ has been initiated through several forest management regimes including community forestry systems in developing countries such as Nepal. Failure to manage potential trade-offs emanating from the REDD+ scheme, between enhancing carbon stocks and protecting biodiversity, and supporting local livelihoods can jeopardise the future prosperity of forest-dependent people (Lusiana et al., 2014; Maraseni et al., 2014; Neupane & Shrestha, 2012). The success of REDD+ will largely depend on its capacity to support local livelihoods while meeting the global objective of carbon enhancement and biodiversity conservation (Atela et al., 2015; Chhatre & Agrawal, 2009; Visseren-Hamakers, McDermott, et al., 2012).

Supporting local livelihoods through sustainable use of forest products and conservation of forests are overarching objectives of pre-existing community forestry in Nepal (Gilmour et al., 2004; Mahanty et al., 2009). Forest conservation initiatives have traditionally focused on improving forests for the continued support of subsistent livelihoods of forest-dependent people (Atela et al., 2015; Blom et al., 2010). However, this conservation focus has recently shifted to include meeting climate change mitigation objectives of potential benefit to the global community (Agrawal et al., 2013; Murdiyarso & Skutsch, 2006). This sets up a tension between managing forests to provide benefits to both local and global communities. Among different climate change mitigation options, the United Nations Framework Convention on Climate Change (UNFCCC) has selected REDD+ as the preferred incentive based mechanism to be implemented in developing countries. However, without knowledge of the potential on-ground effects of this initiative, the implementation of REDD+ may lead to perverse incentives and exacerbate existing socio-economic problems.

1.2 Research questions

Given the above, it is critical to understand the juxtaposition between enhancing carbon stocks, protecting biodiversity and supporting local livelihoods in forest-dependent communities subject to REDD+ management activities. There is limited information on the synergies or trade-offs that may exist in meeting carbon enhancement and biodiversity conservation goals, and how local people may have changed their decision-making, benefit sharing and forest activities in response to REDD+. My study aims to
undertake an integrated assessment of the spatial and temporal variability of carbon stocks, biodiversity and forest products extraction in community forests (CFs) in Nepal. It also assesses changes in forest management practices as a result of the implementation of REDD+, and the implications these changes may have for local livelihoods and meeting the broader objectives of the REDD+ scheme. The specific research questions addressed were as follows:

1. How have carbon stocks, forest biodiversity, and forest products removal (i.e. timber, fuelwood, fodder) changed in community forests in Nepal following the implementation of REDD+?
2. Are there trade-offs or synergies in protecting carbon stocks, forest biodiversity, and the provision of forest products to local communities across community forests (CFs)?
3. What factors likely affect the extraction of forest products from community forests in Nepal, and what implications does this have for carbon stocks and forest biodiversity?
4. How has REDD+ changed local management practices in CFs?

1.3 Research approach and framework

This interdisciplinary research aims to understand interactive relationships between socio-economic and institutional arrangements and forest ecosystems, in generating ecosystem services (ESs) such as carbon stocks and forest products. My research involved community forest users groups (CFUGs) of Charnawati watershed in Dolakha district, located in the mid-hills to lower mountain regions of the central part of Nepal, which have been involved in a REDD+ pilot project since 2009. Community forestry in this district has been institutionalised for over two decades through the collaborative efforts of local communities and government, supported by international agencies, particularly the Swiss government.

Guided by an interdisciplinary research approach under a socio-ecological systems framework, my research employs mixed methods research design applied for the collection of biophysical information and quantitative and qualitative data of socio-economic circumstances. Quantitative biophysical data were collected on forest carbon stocks, plant species diversity (as a surrogate for biodiversity), and the volume of forest products removed from CFs in the form of timber, fuelwood and fodder. These data were obtained through field collection, previous forest inventories and from project
organisations and local CFUGs. Qualitative social data were collected in the field, and covered the perceptions and experiences of respondents of different class, gender, caste and ethnicity involved in CFUGs. These data were obtained through a combination of in-depth interview, focus group discussion and participant observation.

I adapted a relevant conceptual framework (Figure 1.1) to explore how REDD+ influences both the social and biophysical aspects of community forestry in Nepal. The framework illustrates that biophysical resource systems such as carbon stocks and forest biodiversity are interrelated and influenced by forest product extraction, which is further governed by forest ecosystem characteristics and socio-economic circumstances and institutional arrangements. The implementation of REDD+, which focuses on one of these forest ecosystem services (i.e. carbon stocks), can influence local communities to change their forest management practices and forest product extraction, and modify existing institutional arrangements (i.e. distribution rules) which can further change the status of biophysical outcomes (i.e. carbon stocks and forest biodiversity). This suggests that social and biophysical systems are strongly interdependent and can mutually affect each other.

Figure 1.1- Overview of socio-economic and ecological influences of REDD+ under a socio-ecological system

(Adapted from Agrawal & Gibson, 1999; Ostrom, 2009a)
1.4 Thesis structure

My thesis consists of nine chapters. This chapter (Introduction) provides a brief background to the study, research questions and conceptual framework (Figure 1.2). Chapter 2 reviews the literature on relationships between ecosystem services and forest biodiversity; the contribution of CFs to carbon stocks, local livelihoods and forest biodiversity; and potential opportunities and challenges of REDD+ to the management of CFs. Chapter 3 introduces the interdisciplinary research approach and provides a general overview of research methods. Chapter 4 responds to research question 1, and provides a detailed account of carbon stocks, removal of forest products (i.e. timber, fuelwood, and fodder) and forest biodiversity attributes (i.e. plant species diversity, plant species richness and stem density) in CFs in the study region, and quantifies how these forest characteristics change following implementation of REDD+. Chapter 5 quantifies trade-offs and synergies among carbon stocks, forest biodiversity attributes and removal of forest products across CFs in response to question 2. In Chapter 6, I detail the methods that have been used for conducting the qualitative social study, including the selection of two case study CFUGs, data collection and analysis. A detailed review of the methodological approach is typical of similar qualitative research. Chapter 7 explores the factors associated with changes in the extraction of forest products, and relates these changes to implications for carbon stocks and forest biodiversity. Chapter 8 describes the changes in local practices for group management, benefit sharing and forest activities following the implementation of REDD+. This chapter also considers the alignment between REDD+ and existing forest management policies, and potential opportunities and challenges for enhancement of carbon stocks and conservation of biodiversity. Chapter 9 synthesises the major findings across the thesis and details the implications of these findings to theory, policy and practices in forest management.
Figure 1.2- Overview of thesis structure and chapters
Chapter 2- Ecosystem service trade-offs and REDD+ in community forestry

2.1 Introduction
REDD+ has emerged as a prominent climate change mitigation approach due to the potential to provide multiple benefits to local and global communities. However, enhancement of carbon stock and reduction of carbon emissions for successful REDD+ implementation will pose challenges for the generation of non-carbon forest ecosystem services (ESs) and conservation of forest biodiversity, thus trade-offs may take place between carbon and other non-carbon ecosystem services and forest biodiversity. Such challenges will be more prominent in community managed forests, where poor and forest-dependent people rely on forest resources for their subsistence. This chapter presents a review of current scientific knowledge of ESs trade-offs, features of REDD+, and their implications on non-carbon ESs (e.g. timber, fuelwood, fodder) and local livelihoods through CFs.

This chapter is divided into three sections with several sub-sections. A chapter summary has been presented at the end of the chapter. Section one introduces the concept of ESs and discusses relationships across ESs and forest biodiversity. Section two discusses the CF system in Nepal in relation to the generation of ESs and conservation of forest biodiversity. Section three presents an overview of REDD+ implementation and its implications for the generation of ESs and forest biodiversity in CFs.

2.2 Introduction to ecosystem services and biodiversity conservation
2.2.1 Introduction to ecosystem services
ESs are the benefits that people obtain from ecosystems (MEA, 2005, p. 1), including, for example, water provision, carbon storage, genetic resources, spiritual benefits, timber, fibre and food. The concept of ESs is anthropocentric since it deals with the contribution of nature to human wellbeing (MEA, 2005) and is often used to demonstrate the interrelations between human beings, nature and natural resources (Brauman et al., 2007; Tallis et al., 2008).

The Millennium Ecosystem Assessment (MEA) has classified ESs broadly into four categories: provisioning services, regulating services, cultural services, and supporting services. Provisioning services include tangible goods and products such as food, fibre,
genetic materials, timber, and fresh water (Vira et al., 2012). Regulating services include climate regulation, pollination, and water regulation, and these often support the production of tangible goods (Vira et al., 2012). Cultural services are non-material benefits and include recreational, aesthetic, and spiritual outcomes that humans obtain from contact with ecosystems (Butler & Oluoch-Kosura, 2006). Soil formation, photosynthesis, and nutrient cycling are examples of supporting services, which are considered to be the underlying ecosystem functions required to generate the more ‘direct’ provisioning, regulating and cultural services (Brauman et al., 2007; MEA, 2005; Zhang et al., 2007).

The delivery of ESs is the result of a series of interactions between biotic (living) and abiotic (non-living) elements in ecosystems (Farley & Costanza, 2010; Swift et al., 2004). Several ESs are interdependent and interact with each other in either unidirectional or bidirectional ways (Bennett et al., 2009; Heal et al., 2001; McCauley, 2006; Pereira et al., 2005). In the case of a unidirectional interaction, the level of provision of service A affects the level of provision of service B but not vice versa. An example of a positive unidirectional interaction is the retention of forest patches (e.g. for biodiversity protection and/or carbon storage) near crop fields, which increases pollination services (because the forest provides habitat for pollinators) and crop production. A bidirectional interaction involves reciprocal effects between two or more ESs. For example, a negative bidirectional interaction occurs with land degradation where over-extraction of biomass reduces soil organic matter and increases soil erosion, leading to lower crop yields, which in its turn leads to increased pressure on land (Bennett et al., 2009). In unidirectional and bidirectional interaction, the effect of service A on B (or vice versa) can be either positive (enhancing service provision) or negative (disrupting service provision).

Interactions between ESs can result in trade-offs or synergies, which correspond to win-lose and win-win outcomes respectively (Haase et al., 2012; Raudsepp-Hearne et al., 2010). Trade-offs are the enhancement of one ES to the detriment of the provision of other ESs at the same location (Bennett et al., 2009; Hall et al., 2012) and often occur as a result of management practices emphasising the provision of a particular ES (Maass et al., 2005). For example, extraction of timber from a forest may disrupt water filtration or soil retention services provided by the forest or decrease the value of the forest for recreation. Conversely, synergistic outcomes are the simultaneous enhancement of more
than one ES (Bennett et al., 2009; Haase et al., 2012). For example, the conservation of mangrove forests along coastlines may yield multiple benefits to local communities through, for example, protection of the coastline from storm surges and enhancement of fish nurseries (improving fish stocks and food provision).

Synergistic outcomes across ESs are desirable for any development strategy that aims to increase the supply of ESs for the well-being of human society. However, trade-offs between ESs are often inevitable when attempting to manage multiple ESs at a time (Bai et al., 2011; Phelps, Friess, et al., 2012; Polasky et al., 2011; Vira et al., 2012). Therefore, knowledge of the relationships between ESs is essential to translate policy decisions into effective outcomes and for designing ecosystem management activities to minimise the impact of trade-offs (Elmqvist et al., 2011).

Trade-offs among ESs may be interpreted from a variety of perspectives. Rodriguez et al. (2006) suggested that trade-offs occur at three scales namely: spatial scale, temporal scale and the scale of ability to reverse. Spatial scale refers to whether the effects of the trade-offs occur locally and/or outside local areas. Temporal scale refers to whether the trade-offs occur relatively rapidly or slowly. Reversibility refers to whether the provision of an ES will return to its original state after a perturbation (Seppelt et al., 2011). Similarly, Elmqvist et al. (2010) highlighted three types of ES trade-offs namely: temporal trade-offs (benefits now, costs later), spatial trade-offs (benefits here, costs there or vice versa), and trade-offs among potential beneficiaries (who win and who lose).

Spatial trade-offs occur between two different communities (Elmqvist, Tuvendal, et al., 2010). For example, the application of agriculture fertilisers to increase food provision by upstream communities can have negative impacts on water quality that are detrimental to downstream communities (Tilman et al., 2001). Forest clearance for timber harvest by local communities may have negative impacts on regional and global communities through the disruption of the climate regulation service of the forests. Temporal trade-offs involve benefits accruing to present generations at the cost of potential future benefits for future generations (Kumar, 2010).

Trade-offs sometimes take place due to explicit choices, but in many cases they arise unintentionally because of complex ecological interactions within the ecosystem. Consequently, a new set of challenges is emerging among policy makers and managers
to identify and acknowledge the trade-offs that are involved in ecosystem management (McShane et al., 2011). Many authors suggest that promoting provisioning services results in negative impacts on other ESs, particularly regulating services (Elmqvist, Tuvendal, et al., 2010; Haase et al., 2012; Kraqt & Robertson, 2012; Lee & Lautenbach, 2015). In particular, food related provisioning services are favoured at the expense of other ESs (MEA, 2005; Schneiders et al., 2012; West et al., 2010). For example, Raudsepp-Hearne et al. (2010) mapped the relationships between 12 different ESs in Quebec, Canada. They found that the supply of provisioning services (crop and pork production) negatively correlated with the supply of regulating services (carbon sequestration and phosphorous retention) and cultural services (forest recreation and tourism) (see other examples in Table 2.1).

Trade-offs can occur also within the same category of ESs. For example, Dymond et al. (2012), Egoh et al. (2008) and Qin et al. (2015) found strong trade-offs between carbon sequestration and fresh water flow, which are both regulating ESs. In a study in Australia, Baral et al. (2012) observed negative association between production of timber and forage (both provisioning ESs). Similar results were reported by Kandziora et al. (2013) between production of fodder and crops based on their study conducted in northern Germany.

Table 2.1- Mapping and analysing the trade-offs across ecosystem services

<table>
<thead>
<tr>
<th>Location</th>
<th>Scale</th>
<th>Method and objectives</th>
<th>ES mapped and trade-offs analysed</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green Triangle region of Victoria, Australia</td>
<td>Catchment</td>
<td>Quantitative and qualitative appraisal of timber production, carbon stock, provision of water, water regulation, biodiversity, and forage production</td>
<td>• -Ve association between provisioning services (timber and forage production) and cost of regulating service</td>
<td>Baral et al. (2012)</td>
</tr>
<tr>
<td>Northern Minnesota, US</td>
<td>Landscape</td>
<td>Examination of two long-term forest management experiments spanning several decades of stand (forest tree community) development</td>
<td>• -Ve association between carbon cycling and ecological objectives</td>
<td>Bradford and D’Amata (2012)</td>
</tr>
<tr>
<td>Leipzig-Halle, Germany</td>
<td>Forest landscape</td>
<td>Easy-to-apply concept based on a matrix linking spatially explicit biophysical landscape to ecological integrity and ES</td>
<td>• -Ve association between increment of energy crop cultivation and regional food production.</td>
<td>Burkhard et al. (2012)</td>
</tr>
<tr>
<td>North Florida, USA</td>
<td>Forest landscape</td>
<td>Use United States Department of Agriculture (USDA) data collected in permanent plots</td>
<td>• -Ve association between above ground carbon and volume of timber removal</td>
<td>Cademus et al. (2014)</td>
</tr>
<tr>
<td>Location</td>
<td>Scale</td>
<td>Landscape</td>
<td>Impact assessment of afforestation of <em>Pinus radiata</em> on carbon and water</td>
<td>Quality association</td>
</tr>
<tr>
<td>----------</td>
<td>-------</td>
<td>-----------</td>
<td>-----------------------------------------------------------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>Fynbos biome of South Africa</td>
<td>Landscape</td>
<td>Impact assessment of afforestation of <em>Pinus radiata</em> on carbon and water</td>
<td>-Ve association between carbon sequestration and water provision</td>
<td>Chisholm, (2010)</td>
</tr>
<tr>
<td>New Zealand</td>
<td>National</td>
<td>Using national models, 3 ESs were monetised as commodities and a national map of the net benefit was produced</td>
<td>+Ve association between soil erosion regulation and carbon sequestration (both regulating services) and -Ve correlation between carbon and fresh water provision</td>
<td>Dymond et al. (2010)</td>
</tr>
<tr>
<td>South Africa</td>
<td>Landscape</td>
<td>Used statistical distribution of proxy indicators to quantify and assess the relationship and spatial congruence between primary productivity and ES</td>
<td>+Ve association between soil retention and soil accumulation, carbon stock, and water flow regulation, -Ve association between carbon and soil retention water flow regulation, primary productivity</td>
<td>Egoh et al. (2008)</td>
</tr>
<tr>
<td>Ewaso Ngiro Catchment, Kenya</td>
<td>Local</td>
<td>Mapped bundles of ESs at the catchment scale to understand the effects of land use planning and management in Kenya</td>
<td>-Ve association between forage production and water provision, -Ve association between wildlife and number of livestock</td>
<td>Erickson et al. (2012)</td>
</tr>
<tr>
<td>Bornhoved lake, Schleswig-Holstein, Northern Germany</td>
<td>Local</td>
<td>Analysed provisioning services such as crops and fodder using spatial data with information from ATKIS/InVeKos/Landsat</td>
<td>-Ve association between use of fodder and production of crops, which are influenced by locally made decisions</td>
<td>Kandziora et al. (2013)</td>
</tr>
<tr>
<td>Eastern German Leipzig, Halle</td>
<td>Forest landscape</td>
<td>Mapped trade-offs between ES and assessed the supply/demand ratio of ES</td>
<td>Increasing supply/demand ratio of food and water impact decreasing supply/demand ratio of energy</td>
<td>Kroll et al. (2012)</td>
</tr>
<tr>
<td>Global watersheds</td>
<td>Global watersheds</td>
<td>Spatial distribution of multiple ecosystem services for reconciling conservation and human development goals</td>
<td>+Ve association between water provision and carbon storage, -Ve association between carbon storage and flood mitigation</td>
<td>Luck et al., (2009)</td>
</tr>
<tr>
<td>European union</td>
<td>Regional</td>
<td>Mapped relationship between 4 provisioning, 5 regulating and 1 cultural services and with biodiversity (proxy – tree diversity, mean species abundance)</td>
<td>-Ve association between crop production and regulating services</td>
<td>Maes et al. (2012)</td>
</tr>
<tr>
<td>Distribution of biodiversity</td>
<td>Global</td>
<td>Mean per unit area ecosystem service outcomes</td>
<td>-Ve association between water provision, grass</td>
<td>Naidoo et al. (2009)</td>
</tr>
<tr>
<td>&amp; ecosystem ESs outcomes</td>
<td>Production for livestock and carbon stock, and biodiversity</td>
<td>Willamette Basin, Oregon Landscape</td>
<td>Used InVEST (Integrated valuation of ecosystem service trade-offs)</td>
<td>-Ve association between biodiversity conservation and ecosystem services</td>
</tr>
<tr>
<td>Guanzhong-Tianshui Economic region, China Landscape</td>
<td>Analysed trade-offs and synergies between ecosystem services by developing trade-offs and synergies index using R software</td>
<td>-Ve relationships between carbon sequestration and water interception</td>
<td>Qin et al. (2015)</td>
<td></td>
</tr>
<tr>
<td>Tibetan plateau, China Landscape</td>
<td>Analysing relationships between provisioning and regulating ESs</td>
<td>-Ve association between meat provision and production and carbon sequestration and water provision</td>
<td>Pan et al. (2014)</td>
<td></td>
</tr>
<tr>
<td>Quebec, Canada Regional</td>
<td>Mapping and trade-offs analysis between provisioning and regulating services</td>
<td>-Ve association between provisioning services (crop and pork production) and regulating services (carbon sequestration, soil phosphorous retention)</td>
<td>+Ve correlation between water supply, and crop and pork production (both provisioning services) -Ve association between regulating services (water quality and soil phosphorous retention)</td>
<td>Raudsepp-Hearne et al. (2010)</td>
</tr>
<tr>
<td>Global Global scale</td>
<td>Used global data to map relationships between terrestrial biodiversity and carbon storage</td>
<td>Positive association between species richness (biodiversity) and carbon stock but unevenly distributed across regions</td>
<td>Strassburg et al. (2009)</td>
<td></td>
</tr>
</tbody>
</table>

Elmqvist et al. (2010) have found linear and non-linear patterns of trade-offs between ESs. Linear trade-offs exist when the rate of increase of a particular ES is directly proportional to the rate of decrease of another ES. Convex non-linear trade-offs arise when the consistent increase of one ES produces a sharp decrease in other ESs, whereas concave non-linear trade-offs occur when the supply of a particular ES can increase to a relatively high level before other ESs decrease (Elmqvist, Maltby, et al., 2010; Lester et al., 2011).
Studies that examine patterns in ES trade-offs are often undertaken at global or regional scales (Table 2.1). For example, Naidoo et al. (2008), Luck et al. (2009) and Strassburg et al. (2010) mapped ES trade-offs at a global scale, and Nelson et al. (2009), Egoh et al. (2008), Baral et al. (2012), and Maes et al. (2012) analysed trade-offs at regional scales. Only a few assessments have been carried out at smaller, local scales (Ericksen et al., 2012; Kandziora et al., 2013; La Notte, 2012). The majority of studies are undertaken in mosaic landscapes, which include multiple land use systems such as agriculture, forests, and grassland.

Measurement of relationships between ESs is often difficult, and authors often use land cover as a proxy for quantifying service delivery (Bennett et al., 2009). For example, Baral et al. (2012) analysed relationships among ESs using information related to land-cover, landscape structure, and management systems. However, simple land cover proxies alone might not adequately capture crucial information about ES supply or who benefits from service provision. More detailed measurements are required, such as socio-ecological surveys at local scales that measure service provision by particular ecosystems and links these directly to specific beneficiaries.

Trade-offs and synergies among ESs vary across ecosystems (Egoh et al., 2009; Haase et al., 2012) and management regimes (Hicks et al., 2014; Vira et al., 2012). The magnitude of these relationships can also differ within different geographic regions due to distinct ecosystem processes, policies, management systems and socio-economic features (Bennett et al., 2009; Power, 2010). Additionally, patterns of demand, prices, institutional arrangements for ecosystem management, market access, and scientific knowledge are likely to result in some services being considered more valuable than others (Locatelli et al., 2014; Takeda & Røpke, 2010; Vira et al., 2012).

Win-win or synergistic relationships among ESs are always desirable for ecosystem managers. However such outcomes can only be obtained through the management of ecosystem that reduces the trade-offs among ESs. The reduction of ESs trade-offs requires a clear understanding of the nature and magnitude of these trade-offs and the interactions among ESs (Elmqvist et al., 2011; Raudsepp-Hearne et al., 2010). It is also essential to understand the interactions among ecosystem processes, social-economic attributes and policy arrangements that affect trade-offs (Balvanera et al., 2012; Rodríguez et al., 2006; Vira et al., 2012).
2.2.2 Linking biodiversity and ecosystem services

Biodiversity plays a vital role in supporting the provision of most ESs (Haase et al., 2012; Harrison et al., 2014; Reyers et al., 2012). Different components of biodiversity, such as the variety of genes, species and ecosystems regulate ecological processes, buffer environmental variation, and sustain the generation of ESs (Balvanera et al., 2006; Hooper et al., 2005; Polasky et al., 2011).

The relationships between biodiversity and ESs are interdependent and complex (Costanza et al., 2007; Harrison et al., 2014; Mace et al., 2012). Several authors have suggested that biodiversity has direct positive effects on the stability of ecosystem functions and the provision of ESs (Bai et al., 2011; Bastian, 2013; Haase et al., 2012; Maes et al., 2012). However, it is not necessarily true that the protection of biodiversity will always lead to greater provisions of ESs, or that increasing the provision of a particular ES will yield biodiversity conservation gains. Hence, both ‘win-win’ and ‘win-lose’ relationships can exist between biodiversity and ESs (Onaindia et al., 2013).

A positive association (synergy or win-win) between biodiversity (e.g. species richness) and the provision of particular ESs is relatively common. For example, some authors have reported a positive correlation between biodiversity and water yield, soil retention and carbon sequestration (Bai et al., 2011; Haase et al., 2012). Conversely, trade-offs (win-lose) may exist between biodiversity and some ESs such as phosphorous retention and pollination in certain circumstances (Bai et al., 2011).

Trade-offs are quite common between biodiversity and some provisioning services (Table 2.2) (MEA, 2005; Naidoo et al., 2008; Nelson et al., 2009). For example, Schneiders et al. (2012) observed a negative association between biodiversity and food and non-food related provisioning services. Similar results were reported by Chan et al. (2006) between species richness and forage production. This could be due to some provisioning services, such as timber, fibre, fuelwood, forage, and food, which generally have high use value, and are directly available to forest-dependent communities (Turner et al., 2007).

The pattern of relationships between biodiversity and provision of ecosystem services varies across the various design elements such as location, size or scale and land use
system of the ecosystems or region chosen for analysis. For example, a spatial association between biodiversity and ecosystem services is mostly observed in large-scale ecosystems (Anderson et al., 2009). In regards to land use systems, Naidoo et al. (2008) have shown that negative relationships are mostly noted between biodiversity and ecosystem services in human-dominated forests and agriculture lands where lands are generally managed for the provision of particular ecosystem services. The variation in relationships between biodiversity and ecosystem services based on the location, scale and land-use system chosen for study and analysis underscores the critical importance of multi-scale, location and land use system management decisions.

Table 2.2 shows that studies have focused mainly on terrestrial ecosystem services while the majority of the studies used floral biodiversity and vegetation for analysis of relationship between ecosystem services. Most of the studies have used species richness as a proxy of floral biodiversity while a few have employed spatial overlays of biodiversity priority areas and the production of ecosystem services (e.g. food production, carbon stocks) as an approach to understanding the relationships between them. This suggests that there are not specific biodiversity aspects (attributes) used for the analysis.

In addition to win-win and win-lose, win-neutral relationships are also possible between biodiversity and ESs (Hicks et al., 2014). These occur when the conservation of biodiversity does not change the net benefits from ESs received by society, or the enhancement of an ES does not adversely affect biodiversity (Reyers et al., 2012). Examples could include conservation of biodiversity that affects pollination functions where there are no pollination-dependent agricultural crops.

<table>
<thead>
<tr>
<th>Location</th>
<th>Scale of mapping</th>
<th>Method and objectives</th>
<th>ES mapped analysed relationship with biodiversity</th>
<th>Reference</th>
</tr>
</thead>
</table>
| Baiyangdian watershed, China | Watershed       | Used InVEST (Integrated valuation of ecosystem services and trade-offs) and application of correlation, overlap and principal component analysis and analysed spatial characteristics between biodiversity and ESs. | • +Ve association between biodiversity and soil retentions, water yield and carbon sequestration.  
• -Ve association between biodiversity and nitrogen/phosphor | Bai et al. (2011) |
<table>
<thead>
<tr>
<th>Location</th>
<th>Scale</th>
<th>Methodology</th>
<th>Association</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central Coast eco-region, California, USA</td>
<td>Regional</td>
<td>Used spatially explicit conservation planning framework to explore the trade-offs and opportunities for aligning conservation goal for biodiversity and ES</td>
<td>-Ve association between biodiversity and agricultural focused services (pollination and forage production)</td>
<td>Chan et al. (2006)</td>
</tr>
<tr>
<td>North America</td>
<td>Eco-region scale</td>
<td>Used multiple regression analysis and estimated the relationships between biodiversity (using plant species richness as a proxy) and net primary productivity (NPP) (as a proxy for ecosystem services)</td>
<td>-Ve association between biodiversity with net primary productivity (NPP) at low temperature (~2.1°C average) and synergy correlation of biodiversity with NPP at high temperatures (13 °C average)</td>
<td>Costanza et al. (2007)</td>
</tr>
<tr>
<td>Central African rainforests</td>
<td>Four countries</td>
<td>Used Shannon-Wiener index for biodiversity and IPCC guidelines for biomass calculation</td>
<td>Varied and weak relationships between tree diversity and above ground biomass</td>
<td>Day et al. (2014)</td>
</tr>
<tr>
<td>NewZeland</td>
<td>Two woody vegetation landscape</td>
<td>Assessed consequences of woody succession above and below ground taxa richness (plants, nematodes, mites, microbes, and fungi) in carbon stock, soil ecosystem function</td>
<td>-Ve association between (non-congruent pattern) between carbon sequestration and biodiversity</td>
<td>Dickie et al. (2011)</td>
</tr>
<tr>
<td>South Africa biomes</td>
<td>Biomes</td>
<td>Analysed coincidence, overlap and correlation between ESs (surface water supply, water flow regulation, carbon storage, soil accumulation and soil retention), and species richness (plants and animals), and vegetation diversity hotspots</td>
<td>+Ve association (but low) between species richness and vegetation diversity hotspots, and ESs in grassland and Savannah biomes</td>
<td>Egoh et al. (2009)</td>
</tr>
<tr>
<td>Sweden</td>
<td>Landscape</td>
<td>Assessment of forest biodiversity and its consequences on multiple ESs</td>
<td>+Ve association between tree species richness and forest biomass, soil carbon storage, and berry production.</td>
<td>Gamfeldt et al. (2013)</td>
</tr>
<tr>
<td>Leipzig-Halle, Germany</td>
<td>Landscape</td>
<td>Used multi-scale framework and analysed temporal and spatial integration of ESs (food supply, climate regulation, carbon storage and recreation) and biodiversity (bird as proxy of biodiversity)</td>
<td>+Ve association between above ground carbon and biodiversity (bird)</td>
<td>Hasse et al. (2012)</td>
</tr>
<tr>
<td>Europe (Germany, Italy)</td>
<td>Regional</td>
<td>Used multi-nominal logistic regression model, principal component analysis. Assessed spatial relationships between biodiversity, ESs</td>
<td>+Ve association between biodiversity and supply of ESs (regulating and cultural services)</td>
<td>Maes et al. (2012)</td>
</tr>
</tbody>
</table>
and conservation status of protected habitats

<table>
<thead>
<tr>
<th>Global map</th>
<th>Global</th>
<th>Compared ES maps with the global distributions of conventional targets for biodiversity conservation</th>
<th>Biodiversity conservation goal does not conserve optimal levels of ES and vice versa</th>
<th>Naidoo et al. (2007)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flanders, Belgium</td>
<td>Landscape</td>
<td>Used grid cells (4km×4km) to assess the relations between biodiversity, ecosystem services and land use intensity</td>
<td>• -Ve association between biodiversity and ecosystem services in relation to land use intensity • -Ve association between food production (provisioning service) and biodiversity</td>
<td>Schneiders et al. (2012)</td>
</tr>
<tr>
<td>South coast China</td>
<td>Landscape</td>
<td>Shannon-Wiener index for biodiversity and IPCC guidelines for biomass calculation</td>
<td>-Ve association between plant diversity and above ground biomass</td>
<td>Zhang et al. (2012)</td>
</tr>
</tbody>
</table>

Relationships between biodiversity and ESs can vary owing to the type of ESs and geographic location. For example, in a study in China, Bai et al. (2011) found a substantial overlap between biodiversity hotspots and three ESs hotspots namely: water yield, carbon sequestration and soil retention. In contrast, in their study in coastal California USA, Chan et al. (2006) observed a weak association between biodiversity and forage production and crop pollination. Similarly, Dickie et al. (2011) found a weak positive relationship between carbon sequestration and biodiversity conservation in weedy vegetation in New Zealand.

### 2.2.3 Linking forest biodiversity and ecosystem services

There is increasing focus on the role of forest ecosystems in providing ESs. Forests support approximately 80% of the world’s terrestrial biodiversity (Balvanera et al., 2014; Schneiders et al., 2012) and are an important form of natural capital, mediating ecosystem functions and providing key ESs to humanity such as timber, fuelwood, fibre, food, recreation, carbon sequestration, and water regulation. Livelihoods of over 1.6 billion people directly rely on these forest ESs and forest biodiversity including non-timber forest products (CBD, 2011).

Several authors have used species richness as a proxy of forest biodiversity more generally, to assess the relationships between forests and the provision of ESs (Dickie et
Plant diversity has been shown to have a positive correlation with carbon storage (regulating ES) and tangible forest products such as timber, fuelwood and fodder (provisioning ESs) (Gamfeldt et al., 2013; Isbell et al., 2011; Maestre et al., 2012; Quijas et al., 2010; Shirima et al., 2015; Thompson, Okabe, et al., 2011). This is mainly because different plant species in the forest ecosystem use different resources or the same resources in different ways (complementary effect), resulting in reduced competition and maximising the productivity of forest ecosystems (Gamfeldt et al., 2008; Hector & Bagchi, 2007; Hicks et al., 2014).

Forests with greater numbers of plant species do not always produce a greater level of ESs because in certain circumstances, even a small number of plant species with higher productivity can provide a greater delivery of some particular services. For example, Day et al. (2014) and Zhang et al. (2011) reported a negative correlation between above ground carbon storage and tree diversity in their studies in central African rainforests and in South-West China respectively. Similar results were observed by Slik et al. (2009) and Murphy et al. (2008) between soil carbon and plant diversity. Hence, species richness is not always the most critical factor in the delivery of particular services. Factors such as plant functional traits and forest age (Lepš & van der Maarel, 2005; Thompson et al., 2012), site quality, forest size, management practices, and policy arrangements are all important elements that determine the delivery of forest ESs (Cademus et al., 2014; Cadotte et al., 2011).

2.2.4 Linking forest biodiversity, carbon storage and tangible forest products

Understanding the interrelationships among forest biodiversity, carbon storage and tangible forest products such as timber, fuelwood, fodder and food has emerged as an important ecological and management concern (Elmqvist et al., 2011). Such understanding is particularly important in biomass-related ESs such as carbon storage and tangible forest products that include timber, fuelwood and fodder, because the status of carbon storage is directly related to the status of these tangible forest products.
(Perrings, 2010; Suwal et al., 2015; Yapp et al., 2010). That is, protecting forests to store carbon often means limiting the extraction of timber and fodder.

Current debates on the conflict between carbon storage, forest products important for local livelihoods, and their association with forest biodiversity are becoming more prominent as most of the tropical developing countries implement global climate initiatives such as the REDD+ scheme (Phelps, Webb, et al., 2012). It is generally agreed that international and national initiatives can conflict with the local priorities of forests management, since global initiatives focus on particular ESs, which are not necessarily of equal importance to local communities (Ingalls & Dwyer, 2016; Visseren-Hamakers, McDermott, et al., 2012).

Implementation of the REDD+ scheme in forest ecosystems has raised several concerns including the possibility of modifications to forest management activities, change in access to forest products, and changes in the structure of forest biodiversity (Parrotta et al., 2012b; Pistorius et al., 2011). Questions further arise about how local communities can maintain plant species richness while managing multiple ESs simultaneously.

2.3 Ecosystem services in community forestry
This section provides a general overview of community forestry (CF) in Nepal in relation to forest ecosystem services, biodiversity and local livelihoods. Sub-section one provides a historical overview of CF across the world. Sub-sections two and three describe forest management in Nepal with reference to CF. Sub-section four considers the socio-ecological characteristics of CF, with reference to property rights and collective actions. Sub-section five discusses factors related to CF outcomes and sub-section six demonstrates the links between CF and ecosystem services, biodiversity and local livelihoods.

2.3.1 Historical overview of community forestry
Community-based forest management, which gained prominence at the 1978 World Forestry Congress (Gilmour & Fisher, 1997), seeks to empower and engage local communities in forest management, and improve decision-making in regards to the use of forest resources (Arnold, 1991; Kanel & Acharya, 2008). It emerged under the premise that local communities have a greater interest and capacity in the sustainable management of forest resources than do the state or corporate sectors (Brosius et al., 1998). Indeed, some authors argue that CF can serve to combine forest conservation
with rural development, community empowerment, and poverty reduction, and that the scope of CF is now expanding to encompass environmental protection, climate change mitigation, and ESs (Agrawal & Angelsen, 2009; Hobley, 2007; Staddon, 2009).

### 2.3.2 Historical overview of forest management in Nepal

Forest management approaches in Nepal have been reformed over time, and can broadly be divided into four periods (Table 2.3) namely; privatisation before 1950; transition between 1950 and 1957; nationalisation from 1957 to 1988; and populism from 1988 to now (Gautam et al., 2004; Hobley & Malla, 1996). Prior to the mid 1950s, forest resources in Nepal were managed under a feudal system ruled by the Rana family, under which larger parts of forests were granted as *Birta* to Rana families and as *Jagir* to influential officials with the intention of prolonging the tenure of the Rana regime (Gilmour & Fisher, 1991; Mahat et al., 1986). Although the intent of the *Birta* system was to increase state revenue through collection of land tax, over 75% of forests under this system were converted to farmlands (Gautam et al., 2004).

#### Table 2.3- Historical overview of forest management in Nepal

<table>
<thead>
<tr>
<th>Period</th>
<th>Forest management focus</th>
<th>Type of forest ownership</th>
</tr>
</thead>
<tbody>
<tr>
<td>Privatisation before 1950</td>
<td>Before 1846: Era of forest conversion to agriculture land 1846 - 1950 Privatisation of forest by autocratic regimes</td>
<td>Private property</td>
</tr>
<tr>
<td>Period of transition 1950-1956</td>
<td>Period of transition to convert forest as private property to state property</td>
<td>Private property</td>
</tr>
</tbody>
</table>

Source: Hobley & Malla (1996); Pokharel et al. (2005) and Gautam et al. (2004)

1 A hereditary dynasty of Rana prime ministers who ruled in Nepal from 1846 to 1950 AD.
2 Land grants formally made by rulers from state to individuals, on a tax free and heritable basis (Gilmour & Fisher, 1991). Originally *Birta* lands were provided by the state to the individuals as a reward for bravery, especially in military action (Talbott & Khadka, 1994).
3 A form of land tenure in which land is assigned to government employees and functionaries, usually for their lifetime to stay in power and for collecting and or accruing to the state in lieu of (or in addition to) cash remuneration (Regmi, 1978).
Major policy changes in the forestry sector in Nepal were introduced by the democratic government after the autocratic Rana regime was overthrown in 1950 (Mahat et al., 1986). The government nationalised all private forests by introducing the Private Forest Nationalisation Act of 1957 and Birta Abolition Act of 1959 (Kanel & Acharya, 2008). Although nationalisation was effective in reclaiming Birta lands from the Rana families, it was criticised for demolishing indigenous management systems such as kipat4, practiced in the eastern mid-hills mainly for subsistence livelihoods (Arnold & Campbell, 1986; Messerschmidt et al., 1994).

With the realisation that there were insufficient human resources to control further deforestation across Nepal, the government introduced the Forest Preservation Act of 1967, which provided special provisions to forest department officials such as the capacity to issue severe penalties to any persons who entered into the forest without official permission (Pokharel et al., 2005). However, centralised control and mismanagement of bureaucracy led to further destruction of forests (Kanel & Acharya, 2008; Wallace, 1982). As a result, several environmental problems such as soil loss, landslides and flooding appeared in the 1970s (Mahat et al., 1986). In 1978, the World Bank stated that the hills and Terai (plain) forests of Nepal would be entirely depleted within 15 to 25 years (Devkota, 2005). In 1988, the Master Plan for Forestry Sector (MPFS) (1988) indicated a loss of over 0.5 million ha of forest across Nepal between 1964 and 1985. The consequences of this compelled the government to review the effectiveness of the centralised approach.

2.3.3 Evolution and current status of community forestry in Nepal

The idea of community based forest management in Nepal emerged with the realization of the need for participation of local communities in forest management. Community involvement in forest management came into practice in the late 1970s when the government revised the Forest Act, 1961 with a provision for delivering forest management responsibilities to the local political body – called Panchayat (Hobley & Malla, 1996). The amended Act introduced the Panchayat and Panchayat-protected forests, a semi-government management approach, retaining ownership and utilisation decisions with the government (Shrestha, 1996). Despite the positive initiation in devolving centralized management roles to local institutions, Panchayat forests could

4A form of land tenure in which land was regarded as the common property of the local ethnic group and was managed from within the ethnic tribal’s organisations (Fisher, 1989).
achieve little for forest conservation due to the lack of genuine representation of local communities.

The importance of people’s participation in forest management evolved when the government endorsed the provision of local participation in the seventh, five-year plan (1985-1990) (Pokharel, 1997). Likewise, the concept of “user group” was promoted in a national forestry workshop held in 1987, to address the intent of the five-year plan (Hobley & Malla, 1996). The MPFS developed in 1988 was a turning point in the development of CF (Bartlett & Malla, 1992), that provided the foundations for the formulation of the Forest Act in 1993 and Forest Regulation in 1995, as the most inclusive forest legislations in the country (Hobley & Malla, 1996; Pokharel et al., 2007). These two legislations outline the provisions of transferring management rights of forests, whereby accessible forests are given to local communities to manage through a CFUG.

As of July 2015, nearly 29% of the total forests of Nepal have been managed as community forests (CFs) with over 17,000 CFUGs under CF (DoF, 2015). Although CF is recognised as a promising approach to forest management, only around 52% of the total potential forests in Nepal are managed by local communities (Table 2.4), mainly because the government has restricted the handover of forests in low land Terai, where commercially valuable tree species are found (Kanel, 2004).

<table>
<thead>
<tr>
<th>Table 2.4 Status of community forests in Nepal as of August, 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total land area of Nepal</td>
</tr>
<tr>
<td>Total forest area</td>
</tr>
<tr>
<td>Potential CF area</td>
</tr>
<tr>
<td>Forest under CF</td>
</tr>
<tr>
<td>Total number of CFUGs</td>
</tr>
<tr>
<td>Household involved</td>
</tr>
</tbody>
</table>

Source: DoF (2015)

The geographic priority of the government for handing over forests has resulted in differences in the distribution of CFs across ecological zones; i.e. CFs cover much greater area in the mid-hills region compared to the mountain and Terai and Inner Terai (Table 2.5). The area of CFs per household is largest in the high mountain and lowest in the Terai region, and this discrepancy is because the handover of forests is not dictated by the number of households in CFUGs, and also because they have less population compared to accessible forest area.
### Table 2.5- Distribution of community forests in ecological zones of Nepal as of August, 2015

<table>
<thead>
<tr>
<th>Ecological zone</th>
<th>Number of CFUGs</th>
<th>CFs area (ha)</th>
<th>Number of household involved</th>
<th>Average household area (ha)</th>
<th>CFs</th>
</tr>
</thead>
<tbody>
<tr>
<td>High mountain</td>
<td>2,875</td>
<td>270,370</td>
<td>294,532</td>
<td>0.918</td>
<td></td>
</tr>
<tr>
<td>Middle hills</td>
<td>13,606</td>
<td>1,166,545</td>
<td>1,490,898</td>
<td>0.782</td>
<td></td>
</tr>
<tr>
<td>Terai/Inner Terai</td>
<td>2,479</td>
<td>361,819</td>
<td>607,325</td>
<td>0.595</td>
<td></td>
</tr>
<tr>
<td>Nepal (total)</td>
<td>18,960</td>
<td>1,798,733</td>
<td>2,392,755</td>
<td>0.751</td>
<td></td>
</tr>
</tbody>
</table>

Source: DoF (2015)

### 2.3.4 Institutional aspects of community forestry

Institutional arrangements for CF are aggregates of operational and collective choice rules (local level), and constitutional rules (central level) (Thomson & Schoonmaker, 1997). Constitutional rules such as the Forest Act of 1993 and Forest Regulation of 1995 recognise CFUGs as self-governed autonomous institutions, and provide the foundations for making and modifying basic operational rules through collective decision-making processes (Charnley & Poe, 2007). According Ojha (2011) and Agrawal (2001) CFUGs act as discrete institutions and can make decisions independently for forest management, based on the needs and context of CFUG members.

The general assembly (GA) of CFUGs is a collective forum, where forest users exercise collective decisions-making processes and formulate operational rules for their own use and management of forest resources. The decisions made in the GA are implemented through the EC, which is led by a chairperson, and is comprised also of a vice-chairperson, secretary, treasurer and members. EC members engage in day to day administrative activities, and often play dominant roles in the decision-making processes (Shrestha, 2005). Thus, decision-making is often influenced by so called local elites and EC members of CFUGs, and hence the decisions may not represent the concerns of all forest users, especially those who do not have a voice in the process (Yadav et al., 2008).

Elite capture is a well-known phenomenon, generally described as local tyranny, associated with the institutional viability of community forestry system in Nepal. Local elites are individuals or groups with disproportionate influence over a collective actions process because of their higher level of social, economic and political status and power (Andersson & Ostrom, 2008; Dasgupta & Beard, 2007; Schmidt & Theesfeld, 2012). As
noted by Wong (2010), Malla et al. (2003) and Theesfeld (2011), elite capture occurs when some opportunistic or self-interested and dominant individuals or group of people manipulate the resource distribution and decision-making process of community forests to serve their personal interest. This practice typically leads to the disproportionate access to resources and misappropriation or illegitimate re-distribution of forest resources mainly by local elites (Platteau, 2004). The domination of rule-making processes by the local dominant people or elites ignores the interests and needs of resource-poor and marginalised forest users, which eventually leads to the weakening of underlying institutional sprit such as equity within the community forestry (Andersson & Agrawal, 2011; Taylor, 2010).

To address the issues of participatory decision-making and coordination among CFUGs, the federation of community forestry users of Nepal (FECOFUN) was established in 1995. However, FECOFUN is often criticised for overlooking the role of CFUGs in improving forest management and the federation mostly acts as a watch dog and advocates for community rights (Baral et al., 2004).

2.3.5 Socio-ecological characteristics of community forestry

A socio-ecological system is a coherent system of biophysical and social factors that regularly interact in a resilient and sustained manner (Berkes et al., 1989; Folke, 2007). According to Ostrom (2009a), socio-ecological systems consist of natural resources (i.e. ecosystem), socio-economic factors, and institutions, which are interdependent and integrated. Outcomes of these elements are regulated by a feedback mechanism that occurs between social and ecological processes. Berkes et al. (2000), Anderson et al. (2008), Bodin & Tengo (2012), and Coleman (2009) argue that socio-economic and institutional processes are critical elements in this system, and these drive ecological process and influence biophysical outcomes.

CF is a socio-ecological system, based on the interactions that occur between user group characteristics and forests resources (McDougall et al., 2008). User group characteristics include the group size, heterogeneity, and social and economic conditions of forest users. These characteristics are usually dynamic and provide the foundations for devising rules related to the management and removal of forest resources. Forest resources include the physical characteristics of forests such as size,
condition and vegetative composition, which provide the basis for defining management options.

Socio-economic factors, institutional arrangements, and forest resources are interdependent (Ostrom, 2006). For example, a well-functioning CFUG can deliver appropriate forest management options leading to sustainably managed forests that provide perpetual benefits to forest users (Coleman, 2009; Pagdee et al., 2006). In CF, people and forests are managed in an integrated manner with a set of operational rules and management activities (Figure 2.1). The scope of these rules and the identification of forest activities are governed by the biophysical status of the forest, institutional arrangements, and the socio-economic condition of forest users (Chand, 2011; Nightingale, 2003a; Poteete & Ostrom, 2004). Hence, effective forest conservation may require an understanding of the socio-economic system in which these forests management activities are designed.

---

**Figure 2.1- Linkage between group and forest management in community forestry**

Source: Adapted from Yadav (2004)

**2.3.5.1 Community forestry as a common property regime**

CF characterises a common property regime, and a set of rights such as access, withdrawal or use, management, and exclusion rights, whereby responsibilities are transferred to a specific user group (Arnold, 1998; Schlager & Ostrom, 1992). Such rights are granted by the government to local people through agreed forest operational
plans and group constitution renewed for every 5 or 10 years. The rights and duties of CF members are formalised via commonly agreed rules related to the extraction and management of forest resources and reflected in forest operational plan and group constitution.

CF illustrates how well-defined property rights enhance ownership and regulate forest resource use. Local communities with land-use rights can better adapt management policies that consider local ecological and social conditions (Barsimantov & Kendall, 2012). However, property rights derived from government legislations may undermine traditional practices of forest management (Campbell et al., 2001). Therefore, property rights are necessary but not sufficient conditions for local forest management. The success of local forest management relies also on the congruence between biophysical and socio-economic boundaries of the CFs, provision of local rule making autonomy, common interest among community members, and recognition of traditional values (Agrawal & Ostrom, 2001; Pagdee et al., 2006).

2.3.5.2 Community forestry and collective actions

Collective actions refer to “action taken by a group (either directly or on its behalf through an organisation) in pursuit of member’ perceived shared interest” (Marshall, 1998, p. 32) and are common features of CF (Meinzen-Dick & Knox, 1999; Varughese & Ostrom, 2001). The participation of forest users in forest management, benefits distribution, and decision-making processes are common forms of collective actions in CF. These actions are mostly unpaid and rely on the readiness of members to co-operate and act collectively.

Collective action is a necessary condition for achieving a common goal in forest management. However, problems are frequently encountered due to different perceptions, values and needs among forest users (McCulloch et al., 1998; Pandit & Bevilacqua, 2011b). Likewise, collective actions can be problematic, when the costs of actions are differently borne by various groups (Nagendra, 2011). The success of collective actions is largely influenced by the way in which institutional arrangements are designed to address the diversified needs of forest users (Matta & Alavalapati, 2006; Ostrom et al., 1994).
Ostrom (1990) in her seminal work “Governing the commons: The Evolution of Institutions for Collective Action” has highlighted that collective actions are governed by institutional arrangements in common property resources management. As shown in Box 1-, Ostrom produced eight design principles as conditions for robust institutions and successful collective actions (Ostrom, 1990, p. 294).

**Box 2.1- Elinor Ostrom's design principles for robust institutions and collective actions, (1990):**

- Clearly defined boundaries (effective exclusion of non-users) of users and resources;
- Congruence between appropriation, access rules and local condition;
- Collective choice arrangements to allow resource users to participate in the decision-making process;
- Effective monitoring and management system accountable to the resource users;
- Graduated sanctions for resource users who violate locally developed rules;
- Mechanism of conflict resolution;
- Self-determination: secured management rights of local users well recognised by external authorities;
- Organisation in the form of multiple layers of nested enterprises.

outcomes. Several studies have indicated that a smaller group size with socio-economic homogeneity is more effective for collective actions and forest maintenance mainly because of smaller implementation and operation costs for formulating rules and implementing activities (Anh & Pretzsch, 2006; Ostrom, 1990; Poteete & Ostrom, 2004). Some studies have also observed better management and greater forest regeneration with lower levels of dependency on forest resources (Chhatre & Agrawal, 2008), strong institutions (local rules) (Coleman, 2009; Tucker et al., 2007) and market access (Baland & Platteau, 1996).

Small group size and homogeneity are; however, not essential conditions for better collective actions and forest management. For example, Heltberg (2001) observed effective collective actions and forest improvement in large groups while Yang et al. (2013) reported the same for intermediate sized groups. Also, social and economic heterogeneous groups may formulate innovative rules and strategies that result in better outcomes for forests (Varughese & Ostrom, 2001). These findings suggest that there are not consistent relationships between group size, heterogeneity and forest outcomes; however, factors such as institutional arrangements and households characteristics and forest resource characteristics may have a strong influence on CF outcomes (Engida & Mengistu, 2013; Gautam, 2007).
Some studies have reported that biophysical characteristics of forests such as forest size and distribution should influence the formulation of resource extraction rules and management strategies (Pagdee et al., 2006). Resource scarcity and forest degradation may occur when forest size is small relative to the user group size (Heltberg, 2001; Pokharel et al., 2011). However, some authors claim that resource scarcity and small per household forest size encourage people to co-operate, enforce rules, and identify better management strategies such that forest conditions improve (Chhatre & Agrawal, 2008; Wade, 1987).

Institutional arrangements and rules influence the ways that forest users manage and use forest resources. Likewise, locally devised rules can determine forest outcomes, since they mediate exogenous factors such as market pressures, and internal dynamics such as the social and economic inequalities of forest users (Agrawal & Yadama, 1997; Hayes & Persha, 2010).

2.3.6 Social and ecological outcomes in community forestry

CF can provide socio-economic, ecological, and environmental benefits, which can be categorised into ecosystem services (ESs), biodiversity and livelihoods improvement.

2.3.6.1 Community forestry and ecosystem services

Community forests generate a range of ESs available to local and global communities. Local communities rely on forests for timber, fuelwood and fodder, while the global community benefits from, for example, the carbon storage services of forests (MEA, 2005; Paudyal et al., 2015; Thompson, Okabe, et al., 2011). Indeed, the role of CFs has gradually been expanded from just the provision of forest products, to providing a viable means of carbon sequestration (Charnley & Poe, 2007; Máren et al., 2014; Wiersum, 2009). The latter service was recognised globally when the United Nations Framework Convention on Climate Change (UNFCCC) introduced the REDD+ mechanism to promote the carbon storage potential of forests in developing regions (Bowler et al., 2010; Murdiyarso & Skutsch, 2006). Policy makers in Nepal have seized on this opportunity and the National Planning Commission (NPC) of Nepal has emphasised the need to explore economic opportunities from CF based on the Payment for Ecosystem Services framework (GoN, 2010b).
2.3.6.2 Community forestry and biodiversity conservation

The National Biodiversity Strategy Plan of Nepal has recognised CF as an effective approach for biodiversity conservation (Acharya, 2004; Birch et al., 2014; GoN/MFSC, 2014; HMGN, 2002; Khadka & Schmidt-Vogt, 2008). Consequently, provisions for biodiversity conservation were incorporated into CF policy in 2009 (Shrestha et al., 2010), and this has encouraged CFUGs to include biodiversity conservation as an objective in their forest operational plans (Jha & Acharya, 2008).

Management strategies such as the restoration of degraded forests and reductions in forest degradations can help promote biodiversity conservation in CFs. However, species diversity varies greatly across CFs due to different perceptions of the value of biodiversity among forest users (Kharal & Oli, 2008; Nagendra & Gokhale, 2008; Schusser, 2012), the type of forest activities CFUGs implement, and the selection of plant species for plantation development (Acharya, 2004; Baral & Katzensteiner, 2009; Gilmour, 1997). The effectiveness of CF for forest biodiversity conservation is limited while the major focus remains on using forest products and improving local livelihoods (Persha et al., 2010).

2.3.6.3 Community forestry and local livelihoods

CF has improved the livelihoods of rural people in Nepal through an increased supply of forest products (such as fuelwood, fodder and timber) for meeting daily needs. Also, CF has become a viable source of collective funds, collected from various sources such as the sale of surplus forest products, membership fees, and donations from the external agencies. CFUGs can use these funds for income generating activities (Mahanty et al., 2009; Pokharel, 2008b). In a study of 1,788 CFUGs in 2002, Kanel & Niraula (2004) found that nearly 3% of the total income (11 million USD) of CFUGs was invested for further income generating activities.

In a longitudinal study in 26 CFUGs in eastern Nepal, Chapagain & Banjade (2009) found that nearly 46% of very poor and poor households had their status upgraded to well-off over a five-year period with the support of CF. Similar findings were observed in a study of 137 CFUGs in 47 districts in Nepal (MFSC, 2013; Ojha et al., 2009). Consequently, the government has widened the scope of CF to livelihood improvement by emphasising a need to identify the poorest users and allocate at least 35% of the total income of CFUGs to their livelihood (Chapagain & Banjade, 2009; GoN, 2009, 2012b).
However, balancing livelihood improvement and forest conservation is a major challenge. Thoms (2008) argues that forest conservation is potentially detrimental to the livelihoods of the poor, and others suggest that while CF has achieved conservation gains it has made a limited contribution to improving local livelihoods (Malla et al., 2003; Persha et al., 2011).

This is mainly because of inequitable distribution and less investment in pro-poor activities, and benefits that are captured by so-called “elite” members of CFUGs (Lamichhane & Parajuli, 2014; Yadav et al., 2008). Hence, a critical emerging issue is how CF can promote equity in resource distribution such that livelihood and conservation needs are addressed simultaneously.

2.4 REDD+ and ecosystem services in community forestry

2.4.1 Historical background of REDD+

"As we deliberate on the post-2015 development agenda, let us acknowledge the vital role of forests and pledge to work together to protect and sustainably manage these vital ecosystems." Secretary-General Ban Ki-moon Message for the 2014 International Day of Forests

Reducing emissions from deforestation and forest degradation (REDD) is recognised as a forest-based global climate mitigation initiative (Hiraldo & Tanner, 2011a; Wertz-Kanounnikoff & Angelsen, 2009). The United Nations introduced REDD in 2007, although the concept was originally conceptualised in 2005 during the 11th meeting of the conference of parties (CoP) of the United National Framework Convention on Climate Change (UNFCCC) (Parker et al., 2008).

The emphasis on REDD was strengthened when the IPCC (2007) and Stern report (2006) highlighted that deforestation alone contributes nearly 18% of anthropogenic carbon dioxide emissions, and claimed that avoiding deforestation can be the cheapest and most efficient means of climate change mitigation (Cadman & Maraseni, 2012; Crossman et al., 2011; Stern & Britain, 2006).

REDD+ evolved from the clean development mechanism (CDM), a forest based climate change mitigation initiative introduced in 1997, under the Kyoto Protocol at the 3rd meeting of the CoP (Bluffstone et al., 2013). Reducing emissions from deforestation (RED) was expanded to REDD at the 13th meeting of the CoP of UNFCCC by considering the contributions of forest degradation to carbon emissions (Box 2).
(Lawlor, 2010; Pistorius, 2012). The current form of REDD+ included three additional forest activities namely: conservation of carbon stock, sustainable management of forests, and enhancement of carbon stock (Cuypers et al., 2011).

REDD+ aims to avoid further carbon emissions through sustainable management of forests that establishes a permanent incentive mechanism to transfer payments from developed to developing countries (den Besten et al., 2014; Matzdorf et al., 2013). Such payments are made based on the success of developing countries in reducing carbon emissions and enhancing carbon stock. Hence, REDD+ is a performance based scheme that involves conditional requirements to regulate the payments (Lawlor et al., 2013; Wilson Rowe, 2015).

Box 2.2- Chronological development of REDD+ initiative

<table>
<thead>
<tr>
<th>Year</th>
<th>CoP</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>3</td>
<td>UNFCCC adopted clean development mechanism (CDM) forest based climate change mitigation approach under the Kyoto Protocol</td>
</tr>
<tr>
<td>2005</td>
<td>11</td>
<td>Papua New Guinea and Costa Rica submitted a country proposal for incentivizing the reducing emissions from deforestation (RED)</td>
</tr>
<tr>
<td>2007</td>
<td>13</td>
<td>UNFCCC adopted REDD as a new forest based climate change mitigation policy. With the integration of second “D” forest degradation.</td>
</tr>
<tr>
<td>2008</td>
<td>14</td>
<td>REDD was officially expanded to REDD+ with three additional forest activities namely: sustainable management of forest, conservation of carbon stock, and carbon stock enhancement</td>
</tr>
<tr>
<td>2009</td>
<td>15</td>
<td>Copenhagen accord – enabled mobilization of financial resources from development countries to materialize REDD+ and provide positive incentive to actions</td>
</tr>
<tr>
<td>2010</td>
<td>16</td>
<td>introduced social and environmental safeguard known as “Cancun agreement”. Methodological guidance – reference level and forest reference level</td>
</tr>
<tr>
<td>2011</td>
<td>17</td>
<td>Design of Green Climate Fund, effective environmental, social, governance and safeguard, reference level</td>
</tr>
<tr>
<td>2012</td>
<td>18</td>
<td>Concept of incentivizing and reporting non-carbon benefits</td>
</tr>
<tr>
<td>2013</td>
<td>19</td>
<td>REDD+ framework is agreed upon. Result based finance for REDD+ that constitutes: national forest monitoring system, safeguards, forest reference emissions level, monitoring, reporting and verification (MRV) and the drivers of deforestation and forest degradation, decision for incentivizing non-carbon benefits for the long-term sustainability</td>
</tr>
<tr>
<td>2014</td>
<td>20</td>
<td>“Lima call for climate actions” – both developed and developing countries agreed to set the targets of emission reductions with “Intended Nationally Determined Contributions” a non-binding option. Parties are obliged to submit country proposal to UNFCCC secretariat by CoP 21(2015)</td>
</tr>
<tr>
<td>2015</td>
<td>21</td>
<td>Paris agreement- Paragraph 25 decision and paragraph 23 urge to operationalise REDD+ as a result-based payment mechanism</td>
</tr>
</tbody>
</table>
and bilateral pilot projects in some tropical developing countries (Caplow et al., 2011; Fisher, 2014; Norman & Nakhooda, 2014; Sunderlin et al., 2014).

2.4.2 Overview of REDD+ co-benefits

While the main aim of REDD+ is to mitigate climate change through reducing emissions and enhancing carbon stocks, REDD+ activities may yield several additional benefits, mostly to local communities. These additional benefits are known as REDD+ co-benefits (Cuypers et al., 2011; Joshi et al., 2013), which are broadly grouped into social and environmental benefits over the short or long term (Brown et al., 2008; Chhatre et al., 2012). Social co-benefits include improvement of local livelihoods and forest governance while environmental benefits include improved forest condition, biodiversity conservation and protection of non-carbon ESs (Figure 2.2) (Karousakis, 2009; Lee et al., 2011).

Environmental co-benefits derive directly from maintaining and/or improving the forest ecosystem, and are often positively related to protecting carbon stocks (Ojea et al., 2016; Potts et al., 2013). Social co-benefits are related to the policy changes that enhance REDD+ implementation, such as clarification of land tenure, improved forest governance, and greater participation in decision-making (Cromberg et al., 2014; Mant, 2013). These non-carbon benefits are an important means of improving local livelihoods, forest governance, and the conservation of forest ESs.

Figure 2.2- Interrelationship between REDD+ and non-carbon benefits (dark blue circles are environmental co-benefits whereas orange circles are social co-benefits)

Adapted from Lee et al. (2011) and Brown et al. (2008)

The co-benefits associated with REDD+ can have positive and negative impacts that are influenced by the implementation of the scheme (Table 2.6). Some co-benefits such as biodiversity conservation, livelihood improvement, and securing the rights of
indigenous peoples are the major benefits that motivate local, national and global communities to support REDD+. Hence, some authors e.g. Elias et al. (2014), Epple et al. (2012), and Visseren-Hamakers et al. (2012) have underscored that achieving such benefits is important for several reasons, including acceptance of the scheme by stakeholders meeting social and environmental safeguards that have been agreed to under the UNFCCC, and for promoting environmental sustainability.

Social and environmental safeguards emerged as an integral component of REDD+ to prevent REDD+ activities causing adverse social (i.e. through protection of individual human rights, improvement of forest governance, land tenure security) and environmental (i.e. protection of biodiversity) consequences beyond emissions reduction and carbon stock enhancement. The idea of safeguards was laid down under the Cancun Agreement decided by the 17th conference of parties held in Cancun, Mexico in 2010), which provides broad guiding principles (Arhin, 2014; Pelletier et al., 2016; Rey et al., 2013; Roe et al., 2013). The safeguards promote the respect for, and protection of individual human rights and secure land tenure while also protecting biodiversity and delivering other ecological outcomes. Some authors (e.g. Jagger et al., 2014; McDermott et al., 2012; Visseren-Hamakers, McDermott, et al., 2012) have argued that co-benefits and safeguards under the REDD+ scheme are complementary approaches in response to both potential positive and negative effects of REDD+. For example, co-benefits describe the broader social and environmental benefits that arise from REDD+ beyond the carbon emission objectives, while safeguards seek to reduce the potential negative social and environmental effects that might arise (Chhatre et al., 2012; Visseren-Hamakers, McDermott, et al., 2012).

<table>
<thead>
<tr>
<th>Potential co-benefits</th>
<th>Potential positive impacts</th>
<th>Potential negative impacts</th>
</tr>
</thead>
</table>
| Biodiversity conservation | • Maintenance of diverse forest species, mitigation of forest loss and degradation  
• Conservation of forest habitats  
• Enhancement of native forest species  
• Enhancement of forest connectivity  
• New forest production options—such as agro-forestry enhance forest diversity  
• Increased tree diversity through mixed and enrichment plantations | • Introduction of invasive and alien species  
• Replacement of native species with exotic species  
• Prioritisation of high net-carbon sequestration species—monoculture |

Table 2.6: Co-benefits and potential negative impacts of REDD+
<table>
<thead>
<tr>
<th>Supply basic needs of forest resources</th>
<th>Income and employment</th>
<th>Governance and rights</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Improved availability of forests products—timber, fuelwood, and fodder when forests are restored and managed sustainably</td>
<td>• Additional income to poor and local communities</td>
<td>• Strengthening of institutions and rules</td>
</tr>
<tr>
<td>• More effective and inclusive forest management policies maintain and sustain the availability of forest products</td>
<td>• Financial benefits can be used for income generating activities that diversify livelihood options</td>
<td>• Inclusive and pro-poor policies—benefit sharing</td>
</tr>
<tr>
<td></td>
<td>• Employment opportunities</td>
<td>• Enhancement of collective actions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Risks of recentralised forest rights</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Lack of tenure security</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Problem with collective actions in forest management as benefits are not distributed equitably with a pro-poor approach</td>
</tr>
</tbody>
</table>

Source: Adapted from Joly (2009), Alexander et al. (2011) and Parrota et al. (2012a)

### 2.4.3 REDD+ and biodiversity conservation

REDD+ presents opportunities and risks for biodiversity. Several authors claim that REDD+ can generate synergies between biodiversity conservation and climate change mitigation (Gardner et al., 2012; Grainger et al., 2009; Joly, 2009; Sajwaj et al., 2008). Long-term incentives through REDD+ can also motivate local communities to avoid human induced causes of forest degradation such as fire, illegal logging and overgrazing, and this may yield biodiversity benefits (Alexander et al., 2011; Harvey et al., 2010; Phelps, Webb, et al., 2012).

Different forest management activities associated with REDD+ can have different biodiversity outcomes (Figure 2.2). The restoration of degraded forest, and sustainable management practices including reduced impact logging can contribute to improving the status of biodiversity (Edwards et al., 2010; Grussu et al., 2014; Miles & Dickson, 2010; Putz & Redford, 2009; Putz et al., 2008; Sangermano et al., 2012). Biodiversity conservation can also result from the improved forest governance, more secure land tenure and more accountable forest management that accompany the desire to successfully implement REDD+ (Swan & McNally, 2011).
Some authors have reported that the conservation of biodiversity can help achieve the key objectives of REDD+ (Ehara et al., 2013; Entenmann & Schmitt, 2013; Panfil & Harvey, 2015). For example, Miles et al. (2010), Parrota et al. (2012a), and Thompson et al. (2009) have highlighted that improved biodiversity conservation can increase overall ecological resilience and improve ecosystem functional stability, thereby leading to greater carbon storage and promoting other ESs central to REDD+. However, the benefits of a synergistic relationship between biodiversity and carbon storage are less appreciated by local communities who rely on forest biodiversity for their livelihoods (Campbell et al., 2008; Lindenmayer et al., 2012).

REDD+ could also have a negative impact on biodiversity conservation (Figure 2.3). For example, Karousakis, (2009) and Lindenmayer et al. (2012) have highlighted that problems emerge when local communities focus on increasing carbon stocks by replacing native plants with one or a few exotic plant species, converting natural forests to monoculture stands. Another risk is that the protection of forests with high carbon storage capacity in one area can lead to greater demand for forest resources being placed on bio-diverse forests in other areas (Harrison & Paoli, 2012; Harvey et al., 2010; Swan & McNally, 2011).

![Figure 2.3- Major opportunities and risks for biodiversity conservation from the five REDD+ activities](image_url)

Source: Adapted from Miles & Dickson (2010)
Biodiversity outcomes associated with REDD+ depend on a variety of factors, including how policies are designed and implemented (Parrotta et al., 2012b; Venter et al., 2013), and the types of forest management strategies applied (Busch, 2013; Dickson & Kapos, 2012; Peterson et al., 2012; Venter et al., 2009). The contribution of local communities to biodiversity conservation is often not compensated for as it is for carbon storage and water provisions (Cerbu et al., 2011), and this may shift local community motivations to activities that yield immediate monetary gains. This suggests that careful attention is required to the design and implementation of forest activities associated with REDD+.

2.4.4 REDD+, ecosystem services, and local livelihoods

REDD+ presents an opportunity to conserve several non-carbon ESs when forests are protected for carbon storage enhancement. For example, in Indonesia, Lu et al. (2012) observed that the implementation of REDD+ contributed to the prevention of soil erosion through improvement in forest connectivity, while Stringer et al. (2012) found that REDD+ contributed to watershed conservation in Sub-Saharan Africa.

REDD+ can also be a source of additional income for local communities. Equitable distribution of this income may support the livelihood of forest-dependent people who are partners in safeguarding the forests (Bayrak et al., 2014; Groom & Palmer, 2012). Likewise, payment systems for carbon storage provide a means for developing compensation mechanisms for several non-carbon ESs (e.g. water provision). This can expand the sources of additional income and create employment opportunities for local communities (Nasi et al., 2011; Nayak, 2012).

Some authors e.g. Anderson & Zerriffi, (2014), Thompson et al. (2011), and Luttrell et al. (2012) claim that REDD+ can provide opportunities to improve national and local forest governance systems, such as inclusive decision-making processes, if implemented in compliance with international standards and agreements. Better forest governance can improve security of access rights of local communities to forest resources, strengthen institutional arrangements, and promote equitable sharing of benefits, which eventually contribute to enhanced local livelihoods (Schroeder & McDermott, 2014).

However, REDD+ may also have negative impacts on the protection of other ESs and on local livelihoods. One of the major criticisms of REDD+ is that it has a narrow focus on carbon enhancement activities, which reduces the capacity for local communities to
use non-carbon forest ESs, especially tangible forest products (Huettner, 2012; Leggett & Lovell, 2012; Visseren-Hamakers, McDermott, et al., 2012). Restriction on access to forest resources negatively affects poor and forest-dependent people through reduced capacity to meet subsistence livelihoods and participate in non-timber forest markets (Mutabazi et al., 2014; Poudel, Thwaites, et al., 2014; Ratsimbazafy et al., 2011; Tacconi et al., 2010; Vatn et al., 2009).

The introduction of a new financial stream from REDD+ can add extra value to forested land, making it attractive to private investors and government agencies (Baraloto et al., 2014). This may encourage central governments to recentralise the forest management authority from local communities by assigning some forest conservation pre-conditions (Phelps et al., 2010; Springate-Baginski & Wollenberg, 2010). Adoption of strict forest protection and recentralisation of the management authority can exclude local communities especially poor, forest-dependent and indigenous people, from using traditional rights over forests, which leads to adverse impacts on forest conservation (Mutabazi et al., 2014).

There is also a risk of inequitable distribution of REDD+ payments when elite members at local level may control the distribution (Mustalahti et al., 2012; Resosudarmo et al., 2012). Bayrak et al. (2014) and To et al. (2012) have warned that since poor people have difficulty in taking part in decision-making processes elite members can monopolise REDD+ benefits distribution. This may hinder the income generated from REDD+ to reaching poor households, and can further threaten the livelihoods of forest-dependent and poor households.

2.4.5 REDD+ initiative in Nepal

Nepal has been a pioneer in implementing the REDD+ scheme. The country’s engagement with REDD+ began when Nepal formally became a member of the forest carbon partnership facility (FCPF) scheme of the World Bank in 2008 (Table 2.7). Nepal initiated a REDD+ readiness process with the submission of a Readiness Project Idea Note (R-PIN) to the World Bank in March 2008 (Dhital, 2009), and was nominated for developing a Readiness Preparation Proposal by the FCPF/World Bank in mid 2008 (WOCAN, 2012). With the approval of an Emission Reduction Project Idea Note (ER-PIN) from the World Bank, Nepal is now undertaking to initiate performance-based carbon emissions activities for 2015-2020 in Terai landscape areas (GoN, 2015).
Table 2.7- Evolution of REDD discourses in Nepal

<table>
<thead>
<tr>
<th>When</th>
<th>Agenda and Progress</th>
</tr>
</thead>
<tbody>
<tr>
<td>August 2004</td>
<td>Concerns over the complexity and eligibility of community forestry in Clean Development Mechanism (CDM) under Kyoto Protocol were raised at the 4th national community forestry workshop organised by MFSC</td>
</tr>
<tr>
<td>July 2005</td>
<td>Kyoto think global act local - carbon monitoring project in selected community forests started</td>
</tr>
<tr>
<td>March 2008</td>
<td>Nepal became a member country of forest carbon partnership facility (FCPF) designed by World Bank</td>
</tr>
<tr>
<td>April 2008</td>
<td>Draft Readiness Plan Idea Note (R-PIN) accessing to FCPF</td>
</tr>
<tr>
<td>July 2008</td>
<td>World Bank approved Nepal’s R-PIN</td>
</tr>
<tr>
<td>August 2008</td>
<td>Government established a separate unit (REDD Forestry and Climate Change Cell) under the MFSC to deal with REDD and other forest carbon related activities (institutional structure of REDD cell is shown in figure 2)</td>
</tr>
<tr>
<td>January 2009</td>
<td>World Bank selected Nepal R-Plan for accessing FCPF</td>
</tr>
<tr>
<td>April 2010</td>
<td>Nepal submitted readiness preparation proposal (RPP) to World Bank</td>
</tr>
<tr>
<td>June 2010</td>
<td>World Bank approved Nepal’s RPP</td>
</tr>
<tr>
<td>2010</td>
<td>Nepal became member of UN-REDD Programme (operated collaboratively by FAO, UNDP and UNEP)</td>
</tr>
<tr>
<td>January 2011</td>
<td>Government promulgated Climate Change policy, 2011</td>
</tr>
<tr>
<td>2012</td>
<td>Government (MFSC) initiated REDD+ strategy formulation process</td>
</tr>
<tr>
<td>August 2012</td>
<td>Prepared version 1- REDD+ social and environmental standards in collaboration with Climate, Community and Bio-diversity Alliance (CCBA), CARE International and FECOFUN</td>
</tr>
<tr>
<td>April 2014</td>
<td>World Bank approved Nepal’s Emission Reduction Project Idea Note (ER-PIN)</td>
</tr>
<tr>
<td>2014</td>
<td>MFSC initiated development of Emission Reduction Project Document (ER-PD) as follow up of ER-PIN</td>
</tr>
<tr>
<td>2015</td>
<td>Formulation of Nepal’s REDD+ strategy</td>
</tr>
<tr>
<td>2015</td>
<td>MFSC developed ER-PD</td>
</tr>
<tr>
<td>2015</td>
<td>REDD cell changed to REDD Implementation centre</td>
</tr>
</tbody>
</table>

Source: Adapted from Dahal & Banskota (2009) and GoN, (2015)


The Government of Nepal has formed a separate unit – the REDD forestry and climate change cell under the Ministry of Forests and Soil Conservation (MFSC) for facilitating REDD+ related initiatives (Acharya et al., 2009; Dangi, 2012). A multi-stakeholder forum includes relevant civil society and non-government organizations that foster participation and coordination in formulating the national REDD+ strategy (Figure 2.4) (Paudel & Karki, 2013).
Although formulation of the national strategy is underway several demonstration initiatives are currently in operation in different forest management regimes across the country (Dangi, 2012; Paudel et al., 2013). These initiatives have mainly focused on three aspects of the REDD+ readiness process: capacity building and awareness raising; development of benefit sharing mechanisms; and measurement and monitoring of forest carbon stock (Table 2.8).

Table 2.8- Major REDD+ Initiatives being practiced in Nepal

<table>
<thead>
<tr>
<th>Project</th>
<th>Organisations leading and involved in the project</th>
<th>Major focus of the project</th>
<th>Geographical coverage</th>
<th>Forest management regime</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate change and partnership program</td>
<td>NEFIN with other Indigenous organisations</td>
<td>Piloting of climate change and REDD+, enhance awareness among IPs, advocacy for IPs issues in REDD+</td>
<td>68 Districts</td>
<td>Indigenous Peoples and local peoples</td>
</tr>
<tr>
<td>Design and setting up of a governance and payment CFM for Nepal’ under REDD (2009-2013)</td>
<td>ICIMOD with ANSAB and FECOFUN</td>
<td>REDD+ Methodology development and demonstrating REDD+ payments</td>
<td>Three districts: Chitwan, Gorkha and Dolakha</td>
<td>Community forestry</td>
</tr>
<tr>
<td>Development of MFSC – REDD</td>
<td>Developing benefit</td>
<td>TERAI</td>
<td>Government</td>
<td></td>
</tr>
<tr>
<td>ER-PIN (2013 ongoing)</td>
<td>Cell</td>
<td>sharing plan under REDD+</td>
<td>Landscape Area</td>
<td>and community managed forests</td>
</tr>
<tr>
<td>-----------------------</td>
<td>------</td>
<td>--------------------------</td>
<td>----------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>Forest Resource Assessment Nepal (2010-2014)</td>
<td>MFSC with funding and technical support of Finnish government (FINNIDA)</td>
<td>Assessment of forest condition, maintenance of forest related data and development of institutional capacity of DFRS mainly for REDD+ MRV</td>
<td>Across country</td>
<td>Forests in all physiographic zones</td>
</tr>
<tr>
<td>Grassroots capacity building on REDD+ in Asia and the Pacific (2009-2013)</td>
<td>RECOFTC with FECOFUN, HIMAWANTI and Forest Action</td>
<td>Capacity building of facilitators for REDD+ at the central and local levels, building awareness about REDD+ among local and district stakeholders through</td>
<td>Central, district and community levels</td>
<td>Community forestry</td>
</tr>
<tr>
<td>Hariyoban program funded by USAID (2012-2016)</td>
<td>WWF Nepal with CARE Nepal, NTNC and FECOFUN</td>
<td>Pilot REDD+ at the landscape level, contribute to government for developing national REDD+ strategy</td>
<td>TAL- 9 districts and CHAL- 7 districts – total 16 districts</td>
<td>Landscape approach</td>
</tr>
<tr>
<td>Multi-stakeholder forest program (2012 ongoing)</td>
<td>DFID, SDC and FINNIDA and implementing by MFSC and NGO partners</td>
<td>Support REDD Cell to review RPP and explore climate change mitigation options in community forests</td>
<td>64 Districts (high mountain, mid hills and Terai)</td>
<td>District and community forestry</td>
</tr>
<tr>
<td>Plan Vivo</td>
<td>Livelihood and Forestry Program (LFP) with Rupantaran Nepal</td>
<td>Methodology development</td>
<td>LFP districts</td>
<td>Village development committee level</td>
</tr>
<tr>
<td>REDD+ Reducing poverty in Nepal (2009-2010)</td>
<td>WWF Nepal with Winrock International</td>
<td>Methodology development for carbon measurement and capacity development</td>
<td>13 districts in mid and western Terai</td>
<td>Landscape approach</td>
</tr>
</tbody>
</table>

Source: REDD implementing centre, Ministry of Forests and Soil Conservation, 2014

The government has implemented these demonstration initiatives through a consultative and participatory approach (Dangi, 2012). However, several authors e.g. Bushley (2014), Khadka et al. (2014), Paudel et al. (2013), and WOCAN (2012) have criticised the REDD+ process in Nepal is being dominated by only a few organisations that represent government, civil society and I/NGOs, and for often overlooking the participation of women and some relevant stakeholders.
2.4.6 Opportunities for REDD+ in community forestry

Several authors have claimed that CF provides institutional and biophysical potential for the implementation of REDD+ (Agrawal & Angelsen, 2009). Consequently, the government of Nepal has placed CF at the centre of its REDD+ strategy (West, 2012).

2.4.6.1 Biophysical scope of community forestry for REDD+

REDD+ in CF is built on the premise that existing practices of forest management in CF are complementary to the scheme. For example, several carbon assessment studies have revealed a positive change in carbon stocks in CFs with existing management and forest use practices (Bhattarai et al., 2012; Karky, 2008; Mbaabu et al., 2014; Pandey, Maraseni, & Cockfield, 2014; Rana, 2008; Skutsch et al., 2009). Positive carbon storage gains can occur mainly because the local people adopt a sustainable approach to harvesting and use of forest resources (Banskota et al., 2007; Rana & Goutam, 2009; Shrestha et al., 2012). In Nepal, over 20% of total carbon stock is contained within CFs (Table 2.9) (Oli & Shrestha, 2009).

![Table 2.9- Carbon potential of total forests and community forests in Nepal](image)

<table>
<thead>
<tr>
<th>SN</th>
<th>Categories</th>
<th>Total forests of Nepal</th>
<th>In community forests</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Total forest area (million ha)</td>
<td>5.8</td>
<td>1.2</td>
<td>20.7</td>
</tr>
<tr>
<td>2</td>
<td>Above ground biomass (million tons)</td>
<td>1146.</td>
<td>236.3</td>
<td>20.7</td>
</tr>
<tr>
<td>3</td>
<td>Below ground biomass (million tons)</td>
<td>401.44</td>
<td>82.7</td>
<td>20.6</td>
</tr>
<tr>
<td>4</td>
<td>Dead wood biomass (million tons)</td>
<td>232.2</td>
<td>47.8</td>
<td>20.6</td>
</tr>
<tr>
<td>5</td>
<td>Total biomass (million tons)</td>
<td>1780</td>
<td>366.8</td>
<td>20.6</td>
</tr>
<tr>
<td></td>
<td>Carbon stock in million tons</td>
<td>890</td>
<td>183.4</td>
<td>20.6</td>
</tr>
</tbody>
</table>


CFs offer potential benefits for REDD+ through the application of various forest activities (Table 2.10) (Angelsen & Wertz-Kanounnikoff, 2008; Skutsch & McCall, 2012). For example, Brown et al. (2008) claim that biodiversity conservation and carbon stocks enhancement can be obtained concurrently from two activities related to REDD+ i.e. conservation and sustainable management of forests.

![Table 2.10- Creditable activities in REDD+ and their relevance to community forestry](image)

<table>
<thead>
<tr>
<th>Elements of REDD+ scheme</th>
<th>Changes in</th>
<th>Reduced negative change</th>
<th>Enhanced positive change</th>
<th>Relevance to community forestry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reducing deforestation</td>
<td>Forest area - number of hectares</td>
<td>Avoid deforestation</td>
<td>Afforestation and reforestation (A/R)</td>
<td>Very low</td>
</tr>
<tr>
<td>Reducing forest degradation</td>
<td>Carbon density (carbon per</td>
<td>Avoid degradation</td>
<td>Forest regeneration and rehabilitation</td>
<td>Medium</td>
</tr>
</tbody>
</table>
Evidence exists that REDD+ can deliver carbon storage and livelihoods benefits concurrently, when local communities are provided with autonomous rights to local rule-making for forest management (Chhatre & Agrawal, 2009). Considering such potential, the Nepalese government has emphasised a need for REDD+ through CF such that a synergy between local livelihoods, biodiversity conservation and forest maintenance is achieved (GoN, 2014b).

### 2.4.6.2 Institutional opportunities of community forestry for REDD+

CF has a clear legal framework with a long term management plan and the consistent commitment from the national government (Pokharel & Byrne, 2009). CFs have clear boundaries of forests and definite forest users with well developed community based monitoring systems. Such forest resource and group characteristics provide reliable foundations for the implementation of REDD+ in an efficient and cost-effective manner (Fisher, 2014; Newton et al., 2015; Skutsch & McCall, 2011).

CFUGs can devise forest management strategies that support REDD+ in the local context, thus enhancing local ownership of the REDD+ process (Newton et al., 2015; Sharma, Shyamsundar, et al., 2015). Likewise, CFUGs have well established benefit distribution practices and local participation, which can provide a strong institutional base for the equitable distribution of REDD+ benefits (Agrawal & Angelsen, 2009; Paudel et al., 2013).
2.4.7 Challenges to REDD+ in community forestry

One of the challenges to REDD+ implementation in CFs is that CFs have a limited scope for generating a greater store of carbon (additionality) (Staddon, 2009), mainly because the majority of CFs in some geographic regions of Nepal have a slow growth rate (Acharya et al., 2009; Pokharel & Byrne, 2009). Ojha et al. (2008) and Streck & Costenbader (2012) have argued that such small incremental changes in carbon storage may generate small benefits that are not attractive to local communities in Nepal. Also, administration, operation and transaction costs associated with community negotiations, meetings and monitoring for REDD+ may outweigh the benefits (Bluffstone, 2013; Jindal et al., 2008).

Some authors e.g. Ojha et al. (2013), Nightingale & Sharma (2014), and Lawoti (2008) have raised concerns over the potential negative implication of REDD+ on local livelihoods where societies are highly divided and an exclusionary socio-economic environment exists. Such implications can be more prominent in CF, where poor households in CFUGs have difficulty taking part in decision-making processes and advocating for their benefits due to the prevailing patron-client relationship in local communities (Lawlor et al., 2013; Peskett, 2011).

Implementation of REDD+ through CFs is further complicated by the need to meet multiple interests inside and outside CFUGs. Pilot REDD+ initiatives have revealed some negative outcomes for forest-dependent people when elite members of CFUGs impose restrictions on access to forest resources and threaten customary rights of local people (Mutabazi et al., 2014; Newton et al., 2015; Poudel, Thwaites, et al., 2014). REDD+ changes the economic relationships in CFUGs through channeling a new revenue stream. This may destabilise the existing benefit distribution systems when CFUGs need to meet conditional requirements for accessing REDD+ payments (Bluffstone et al., 2013; Bottazzi et al., 2014).

Some previous studies such as Hiraldo & Tanner (2011b), Bolin et al. (2012) and van Noordwijk et al. (2014) have observed that REDD+ has undermined collective behavior and threatened the motivation of local people to engage in forest conservation when they do not get expected incentives from the scheme (Sills et al., 2014). Such circumstances can appear when REDD+ benefits target only some groups of CFUGs (Patel et al., 2013; Poudel, Thwaites, et al., 2014).
Existing forest laws have not clearly defined carbon ownership in CFs in Nepal, and the government currently retains ownership, while management and use rights are provided to local communities (Bastakoti & Davidsen, 2014; Phelps et al., 2010). The government frequently restricts the delegation of rights, and creates barriers for the outside sale of a few forest products. A lack of clarity in relation to carbon ownership and inconsistent policies and practices can discourage local communities from participating in REDD+ actions (Agrawal & Angelsen, 2009; Gupta, 2012).

2.4.8 Factors associated with REDD+ in community forestry

Some authors e.g. Adhikari & Agrawal (2013), Kashwan & Holahan (2014), and Ngendakumana et al. (2014) have claimed that local factors mostly determine the success of REDD+ through CF in achieving livelihoods, biodiversity and carbon stock outcomes. Socio-economic and livelihoods conditions of local people provide different incentives for participation and implementation of REDD+ (Mutabazi et al., 2014; Zbinden & Lee, 2005). Rural households with different socio-economic conditions have different resource needs, and they may have different motivations for participation in REDD+ activities (Parrotta et al., 2012b). A consideration of the socio-economic circumstances associated with local people is essential for the implementation of REDD+ through CFs, as these factors evolutionary and change over time (Armitage et al., 2008; McKean, 1992).

2.4.8.1 Forest dependency and REDD+ in community forestry

REDD+ offers the promise of achieving synergies between carbon storage, forest biodiversity and livelihood improvement in local communities. However, potential conflict can occur when the removal of forest products undermines carbon storage and biodiversity conservation goals (Movik et al., 2012; Persha et al., 2011; Salas, 2014). Ximenes et al. (2012), Manhas et al. (2006) and Acharya et al. (2011), have noted that an extraction of forest products, especially timber, fuelwood and fodder is associated with a change in carbon stocks and biodiversity. This is especially true, where forest-dependent people rely on forests for subsistence (Kajembe et al., 2012; Mustalahti & Rakotonarivo, 2012). Hence, the IUCN (2011) has identified forest dependency as an important dimension of REDD+ implementation in CFs.
In Nepal, the extraction of fuelwood, fodder and grass from CFs provides the basis for subsistence livelihoods, particularly for the poor, Dalit, women, and indigenous people (Adhikari et al., 2007; Baral et al., 2014; Cooke et al., 2008). However, requirements for these forest resources vary among groups, which can result in conflicts with REDD+ (Mswima & Kanyama, 2014). For example, local elites may not need forest resources as much as the poor do, and CF management structures allow elites to impose restrictions on resource extraction (Bottazzi et al., 2014). Such restrictions are likely to create negative outcomes for the poor despite some positive outcomes in carbon storage enhancement (Mustalahti et al., 2012; Sandbrook et al., 2010).

The reliance of forest users on forest resources has several implications for REDD+. In Nepal, more than two thirds of fuelwood and more than 50% of fodder are extracted from forests (Acharya et al., 2004). CFs are a small (less than 30% of total supply), but permanent source of fuelwood for rural communities (Aryal et al., 2009; GoN, 2012a). There is likely to be a gradual increase in the demand for timber and fuelwood in the future (GoN, 2012a). This will exert a much greater extraction pressure on CFs, making it increasingly difficult to meet timber, fuelwood and fodder needs, as well as to meet REDD+ expectations of carbon storage (Bottazzi et al., 2014).

2.4.8.2 Factors affecting forest products extraction

While forest products such as timber, fuelwood and fodder are subsistence to local livelihood especially for forest-dependent people, several factors can variably influence the extraction from CFs. For example, Chhatre & Agrawal (2008) and Persha et al. (2011) have noted that biophysical factors inherent to CFs, socio-economic circumstances and institutional arrangement and distribution rules within CFUG and outside can affect the level and extent of extraction of forest products from CFs.

Biophysical factors such as proximity of forest to human settlement and size of forests can influence removal of forest products. For example, Fonta et al. (2011) and Adhikari & Lovett (2006a) found high extraction of forest products from forests located close to human settlement due to high dependency from forest users. Pagdee et al. (2006) and Poteete & Ostrom (2002) identified that size of forests is a critical factor in making CFUGs active in protecting forests and reducing harvesting of forest products.
Socio-economic circumstances and livelihood activities such as growing trees in private farmlands and agroforestry development; change in agriculture practice and livestock number, and temporary outmigration also influence removal of forest products from CFs. For example, Oli et al. (2015) and Webb & Dhakal (2011) observed that development of private forests and agroforestry has significantly reduced dependency on forest products thereby reducing extraction. Similarly, Adhikari & Hobley (2011) and Hunter et al. (2014) found that lack of human resource in families due to outmigration can also influence extraction of forest products from CFs. Some authors such as Sapkota & Oden (2008) and Adhikari et al. (2004) have identified that the household socio-economic characteristics of forest users at the household level can vary extraction of forest products.

Understanding factors associated with forest products is critical since these factors can also influence carbon and forest biodiversity by changing the pattern of forest product extraction (Bluffstone et al., 2014). An integrated analysis of social-economic and institutional and biophysical factors associated with forest products extraction can illustrate the influence of these factors interactively and collectively.

2.4.8.3 Institutional arrangements for REDD+

Policies related to REDD+ interface with institutional arrangements and forestry sector rules at the national level (e.g. constitutional rules) as well as (e.g. collective choice and operational rules at local level (Agrawal & Angelsen, 2009; Kashwan & Holahan, 2014; Williams, 2013). Of these, land tenure, property rights, and operational rules such as revenue management and resource distribution have direct effects on REDD+ (Barbier & Tesfaw, 2012; Huettner, 2012). Some authors e.g. Hayes & Persha (2010), Lawlor et al. (2010), and Patel et al. (2013) have claimed that institutional arrangements such as autonomy in local rule-making, provisions for transferring external financial benefits to local people, provisions for local people to engage in the REDD+ design process, and enforcements and monitoring determine the success of REDD+ in CF.

Operational rules related to CF are critical to enhance efficiency of forest management since these rules provide local communities with opportunities to adapt new strategies for managing forests for REDD+ (Ribot & Larson, 2011). Pilot initiatives in Tanzania and Nepal (Newton et al., 2015) have indicated that local communities responded with increased participation in decision-making processes, and redefined forest management practices in relation to REDD+ (Kashwan & Holahan, 2014). However, there are
several concerns related to REDD+ institutional arrangements including the lack of certainty in long-term financial flows, which is a major challenge mainly due to the absence of a concrete mechanism for REDD+ under UNFCCC (den Besten et al., 2014). National level challenges in Nepal include the lack of clarity on a tenure system for carbon in CF relative to the long-term implementation of REDD+ (Bastakoti & Davidsen, 2014; Paudel et al., 2013). For example, the government provides authority for community forests management and use to local people through agreed group constitution and forest operational plans renewed every 5 or 10 years. The need for frequent renewal of operational plans can reduce ownership of forests among local people, and cause them to focus more on short-term objectives for forest product harvesting.

In Nepal, ongoing pilot REDD+ initiatives have been operating as per the existing tenure arrangements outlined in the Forest Act of 1993. Payments from some pilot initiatives are being made to CFUGs based on the assumption that forest carbon is comparable to other forest products. However, Bastakoti & Davidsen (2014), Paudel et al. (2013), and Bushley (2014) have raised concerns about the existing land tenure system of CF, which can encourage recentralisation of forest management authorities mainly because the government has retained ownership of all types of community management systems.

REDD+ in Nepal has been implemented within the framework of forestry. However, REDD+ related activities needs to have coordination with other sectors beyond forestry. For example, Ojha et al. (2016) have highlighted a need for cross-sectoral coordination for REDD+ success since REDD+ may constitute a variety of non-forestry sectors such as agriculture, livestock and infrastructure. Likewise, Brickell (2012) emphasises a need for coordination of REDD+ to effectively address the concerns of forest degradation and deforestation.

Implementation of REDD+ can present obvious changes in forest product extraction from forests. For example, studies on preliminary REDD+ initiatives by Poudel et al. (2014), Maraseni et al. (2014) and Saito-Jensen et al. (2014) in community forests in Nepal and Robinson & Kajembe (2009) and Mutabazi et al. (2014) in Tanzania have observed a decrease in extraction of forest products such as fuelwood and fodder from their forests. Based on a critical review of 10 years of REDD+, Bayrak & Marafa (2016)
observed that changes in forest management practices at local level lead to change in resource use pattern. All of the authors have argued that the changes resulted from the REDD+ pilots whereby the leadership of CFUGs favoured revenue generation from REDD+ and thus limited resource extraction as a quick response for carbon enhancement.

Extraction and use of forest products are generally considered as a prominent local driver of forest degradation (Acharya et al., 2011; Schure et al., 2014; Skutsch, Balderas-Torres, et al., 2011). Therefore, local community involvement in REDD+ pilots tends to change forest product extraction (Maplesden et al., 2013). This suggests that local people have shifted their priority of forest conservation from provision of fuelwood and fodder to carbon stocks. The evolving shift of forest conservation priority and limiting resource use arising from REDD+ likely jeopardises livelihoods of forest-dependent people although it seems to also enhance carbon stocks (Newton et al., 2016).

In some cases, reduction in forest extraction within REDD+ sites has increased the extraction of forest product outside the project sites. For example, Kuik (2014) found a displacement of resource extraction from REDD+ piloted sites to non-project sites (i.e. leakage or displacement of deforestation and forest degradation). Additionally, protection of REDD+ site forests by meeting their forest product needs from non-REDD+ forests may lead to a persistent deforestation and forests degradation, and would thus generate a limited contribution of REDD+ initiative to the mitigation of climate change (Butarbutar et al., 2016; Kuik, 2014).

While REDD+ likely discourages the extraction of forest products by local people from their project forests, it appears to also provide a means of reducing illegal felling of forest products. For example, Cavanagh et al. (2015) from South East Africa observed a reduction of illegal felling of timber with the implementation of REDD+, associated with the improvement and enforcement of laws related to forests products use and distribution. Based on findings of their research, Luttrell et al. (2011) from Indonesia and Anderson & Zerriffi (2014) from Africa have argued that appropriate design of REDD+ can enable local people to enforce forest protection rules which can lead to both conservation of forests and improvement of forest governance. This suggests that REDD+ may present both negative and positive effects on forest product extraction and
use, depending on the REDD+ design process and existing forest management rules.

2.4.9 REDD+ benefit sharing and ecosystem services in community forestry

2.4.9.1 Overview of REDD+ benefit sharing

Benefit sharing involves the distribution of monetary and non-monetary incentives generated through REDD+ among stakeholders (Campese, 2012; Pokorny et al., 2013). There are two types of policies related to benefit sharing namely: compensation - benefits designed to cover the forgone opportunity costs of allowing deforestation and incentives - benefits designed to encourage positive behaviours (Brown et al., 2008; Peskett et al., 2008).

REDD+ benefit sharing involves multi-level transactions (Figure 2.5) (Angelsen & Wertz-Kanounnikoff, 2008; Skutsch, 2013). These are: (i) from international to national level, (ii) national to sub-national level or sometimes directly to local institutions, (iii) sub-national to local level institutions, and (iv) among community members.

According to Skutsch et al. (2011), REDD+ benefit sharing can be made with an output-based or input-based system. Output-based systems are also known as performance-based systems or result-based systems, in which incentives are provided based on changes in carbon storage and reduction in carbon-dioxide emissions (Balderas-Torres & Skutsch, 2012). In input- based systems, also known as action-based approaches,
incentives are distributed based on the activities conducted by the local communities (Peskett et al., 2011; Skutsch et al., 2014). Skutsch et al. (2014) argue that a combination of both input and output-based systems can also be applicable to the REDD+ benefit sharing based on the contribution of forests managers to the reduction in carbon emissions and carbon stock enhancement. An output-based system is applicable in countries such as in Nepal where enhancement of carbon is measured and rewarded (Skutsch et al., 2014).

2.4.9.2 Dimensions of REDD+ benefit sharing
Effectiveness, efficiency and equity are interrelated elements of benefit distribution via REDD+ (Angelsen et al., 2008). Effectiveness refers to physical performance such as the amount of emissions reduced or amount of carbon stock enhanced, whereas efficiency refers to the cost and time that incurs from achieving REDD+ objectives (Agrawal & Angelsen, 2009; Angelsen & Rudel, 2013). Equity refers to the fairness in the distribution of REDD+ benefits across stakeholders (Di Gregorio et al., 2013).

According to McDermott et al. (2011) equity can be categorised into distributive, procedural, and contextual. Distributive equity is concerned with the distribution of benefits, risks and costs associated with REDD+ among stakeholders, and it represents primarily economic dimensions related to fairness principles such as justice, equality, and social welfare (McDermott et al., 2011). Procedural equity, refers to fairness in political processes, which involves representation, inclusion, and participation in decision-making (Gebara, 2013, p. 482).

In the context of REDD+, procedural equity involves affirmative action intended to ensure greater access to and participation of poor, women and marginalised people in influencing the decision-making process regarding benefit distribution and implementation of REDD+ (McDermott et al., 2013; Rantala et al., 2015). Procedural equity is imperative to legitimise REDD+ and acknowledge the voice and dignity of stakeholders (Ribot & Larson, 2011; Shepherd, 2009).

Contextual equity represents the overall context, in which distributive and procedural equity concerns are embedded (Loft et al., 2014; McDermott et al., 2013). For example, pre-existing political and socio-economic conditions, and institutional and policy arrangements related to forest management are some of the dimensions of contextual equity (Brown & Corbera, 2003; Larson & Ribot, 2007).
2.4.9.3 Elements of REDD+ benefit sharing

Kelley et al. (2012) have identified four elements of REDD+ benefit sharing that establish the linkage between equity and effectiveness: targeting, tailoring, legitimacy, and alignment/adaptability (Figure 2.6). According to Madeira et al. (2014), targeting is the process of directing the REDD+ benefits to specific activities and their actors that aim to achieve REDD+ objectives. Targeting is also associated with the activities, where benefits are invested for carbon stock enhancement (Enright et al., 2012).

Tailoring refers to the formulation of criteria that are based on levels of forest dependency, needs of forest users, and socio-economic conditions that are needed to shift the behaviour of local communities towards forest conservation (Madeira et al., 2014). Legitimacy represents allowing the participation and inclusion of various stakeholders in REDD+ activities including benefit distributions (Gebara et al., 2014). Alignment/adaptability refers to reconciling the distribution of REDD+ benefits with existing distribution practices (Chapman & Wilder, 2013; Costenbader, 2011; Hoang et al., 2013). Consideration of alignment/adaptability is imperative to ensure the contribution of REDD+ to national plans and priorities (Kelley et al., 2012).

![Conceptual framework of REDD+ benefit distribution and its contribution to livelihood and carbon stock (forest conservation)](chart)

Source: Adapted from Kelley et al. (2012) and Madeira et al. (2014)
2.4.10 REDD+ benefit sharing in community forestry

Benefit sharing is crucial to the changing the behavior of forest users, where forest degradation is attributed to the overexploitation of forest biomass (Robinson et al., 2013). Equitable benefit distribution can overcome challenges associated with REDD+ in CF through the use of benefits for livelihood related activities (Neupane & Shrestha, 2012; Sunderlin & Sills, 2012).

Challenges to benefits sharing include the identification of appropriate criteria to maintain equitable distribution among forest users with different socio-economic conditions and unequal forest dependency (Patel et al., 2013). Pilot initiatives indicate that local communities may have unrealistic expectations of benefits flowing from REDD+. Such circumstances are likely to create difficulties in maintaining collective behaviors, motivation and perpetual efforts of forest users in forest conservation (Brown, 2013; Di Gregorio et al., 2013; Khatri et al., 2010; Mustalahti et al., 2012).

2.4.10.1 Equity in REDD+ through community forestry

The equity concept in REDD+ is multidimensional. According to McDermott et al. (2013) and Skutsch (2013), equity in REDD+ constitutes recognition equity (of rights, knowledge and institution), procedural equity (participation, capacity building, inclusive-decision-making) and distributional equity (benefits and costs). Distributional equity is an important aspect of REDD+ which embodies several approaches namely: pro-poor approach (poverty or needs based-equity); cost-risk-benefit approach (cost-risk-benefit equity) and rights based equity (equal rights) (Campese, 2012; McDermott et al., 2013). Pro-poor benefit distribution is desirable, particularly in socio-economically unequal societies, in which benefits are distributed in favour of the poorest and most vulnerable stakeholders on a needs basis (Blomley et al., 2009; Enright et al., 2012; Mohammed, 2011). In the cost-risk-benefits approach, benefits are distributed based on the costs incurred by an individual or group (Skutsch, 2013).

A pro-poor equity (needs-based equity) should be an important aspect of benefit sharing in Nepalese community forestry, where societies are characterized by a hierarchical system in terms of economics, gender, caste, and ethnicity (Adhikari, 2001; Bennet, 2005; Hobley, 2007). Relatively higher costs of forest conservation are shouldered by poor households as they have greater forest dependency (Schwarte & Mohammed, 2011; Sunam & McCarthy, 2010). Hence, a pro-poor equity is important in CF because:
(i) this approach ensures the access of poor households to REDD+ benefits (Blomley et al., 2009; Luttrel et al., 2013; Pokorny et al., 2013; Ribot & Larson, 2011), and (ii) poor users are well-recognised by Nepal’s CF policies.

However, some authors suggest that pro-poor benefit sharing practices in REDD+ sometimes undermine the collective behaviors of non-recipients which then influence forest conservation and carbon stock outcomes (Kelley et al., 2012; Pascual et al., 2010; Peskett et al., 2008). For example, Enright et al. (2012) and Kerr et al. (2014) argue that a pro-poor equity overemphasises the social equity and livelihood concerns related to forest-dependent people at the expense of forest conservation outcomes. There is also a challenge in retaining support for REDD+ from well-offs or non-recipient members when REDD+ benefits exclusively benefits some selected groups such as poor households, women and marginalised groups.

The usefulness of pro-poor benefit sharing is also governed by the pathways adopted for the distribution of benefits. For example, distribution of REDD+ benefits directly to individuals ensures the access of poor people to benefits (Cornwall et al., 2014; Skutsch, Vickers, et al., 2011). However, the distribution of benefits through communities or groups in terms of a community fund could potentially lead to co-opting of benefits by elite members (Sommerville et al., 2009; Springate-Baginski & Wollenberg, 2010; Tacconi et al., 2010).

2.4.10.2 Effectiveness of REDD+ through community forestry

According to Angelsen & Rudel (2013), the effectiveness of REDD+ is related to the reduction of carbon emissions or enhancement of carbon stock. Achieving effectiveness in these ways depends on social sustainability, improved governance, improved collective action of local people in forest conservation and appropriate land tenure systems (Larson & Petkova, 2011; Naughton-Treves & Day, 2012). In the case of CF, effectiveness in enhancing carbon stocks may depend on some direct interventions usually occurring at local level such as forest management activities (Table 2.11), use of forest resources, motivation and collective actions (GoN, 2010a; Parrotta et al., 2012b; Skutsch, Balderas-Torres, et al., 2011). Paudel et al. (2013), Pandey et al. (2013) and Maraseni et al. (2014) have claimed that some enabling activities such as policy and institutional arrangements related to forest management, and socio-economic conditions
and market factors also influence the REDD+ effectiveness in mitigating climate change.

Table 2.11- Forest management activities and relevancy to carbon stocks enhancement and REDD+

<table>
<thead>
<tr>
<th>Forest activities</th>
<th>Perceived (+ve) outcomes</th>
<th>Perceived (-ve) outcomes</th>
<th>Relevance to 5 forest activities under REDD+ (Reduced deforestation, forest degradation, enhancement of carbon stock, conservation of forest and sustainable management of forest)</th>
</tr>
</thead>
</table>
| Enrichment plantation | - Increase different type of plant species when diverse native plants are grown and new tree species introduced (richness)  
- Increase the number of the plants in forests (density)  
- Improve the ecological capacity of forest in the long term (resilience)  
- Enhance carbon stock  
- Increase stock of timber, fuelwood and fodder (support to meet local needs) | - Challenge of monoculture (plantation of single species) and negative impact on biodiversity  
- Takes time to grow trees if plantation replacing natural forests  
- Plantation can initially release carbon during soil activities  
- Large scale plantation often replace the natural forests – thus cause of deforestation  
- Loss of access to cattle grazing | Enhancement of carbon stocks and conservation of forest |
| Thinning and pruning | - Fulfill immediate needs of intermediate forest products – pole, fuelwood and fodder  
- Increase revenue by selling surplus forest products  
- Increase growth capacity of preferred tree species (residual stems)  
- Stimulate the regeneration of ground flora  
- Enhance biomass and carbon stock in the long term  
- Balance local and global needs | - Disturb natural growth of trees if not implemented in technically sound manner (e.g. concentrated thinning and non-scientific pruning (lopping) may lead to retarding tree growth)  
- Problem of overharvest if not monitored properly  
- Reduce density and diversity of species when users remove unwanted tree species and may lose ecological resilience capacity | Sustainable management of forests |
| Fire management (Construction of forest fire lines) | Reduces potential forest fire incidences and hazards  
Stimulate perpetual growth of forests  
Ensure permanency of carbon stock and forest resources | Not always effective in all types of terrain (i.e. in steep terrain)  
Sometimes removal of trees and shrubs occurs during fire lines  
Adverse effect on soil and may increase carbon emission – soil work  
Sometime costlier than benefits from forests particularly in small scale community forests | Conservation of forest and reduction of forest degradation |
|---|---|---|
| **Grazing management (control and regulation)** | Stimulation of natural regeneration  
Improvement of trees | Household may need to reduce number of livestock or need to alter livestock management strategy | Sustainable management of forests |
| **Enhancing agro-forestry in private land** | Fulfill the local needs thereby reduces pressure on forests  
Create supplementary habitat for biodiversity  
Establish “matrix of biological connectivity” between forests and modified agriculture land hence enhance diversity | Issue of permanence as individual can decide to fell or conserve trees in the farm  
Selection of species, | Conservation of forests |
| **Reduced impact logging** | No change in harvesting tools  
But changes in harvesting techniques. For example, CFUGs restrict felling of crooked, dead and dying trees for fuelwood and clear cylindrical trees for timber | Quantity of fuelwood may be restricted due to decrease of dead, dying and crooked trees in the forests. Aged people may not be able to get fuelwood if they can’t get such trees in forest near house | Reduction of forest degradation and sustainable management of forests |
| **Promotion of sustainable consumption of forest resources** | Improve forest conditions by reducing pressure | May impose restriction on access to quality and adequate forest resources  
Highly forest dependent people without alternatives in private land will suffer  
Difficult to change behavior of local communities | Sustainable management of forests |

Source: Adapted from Parrotta et al. (2012b)
2.4.10.3 Efficiency in REDD+ in community forests

Efficiency refers to what extent REDD+ achieves goal at minimum costs (Angelsen et al., 2009). According to Newton et al. (2015), CFs are generally naturally regenerated forests, and restoration of forests may be relatively cheaper for the carbon stock. Likewise, Agrawal & Angelsen (2009) and Fisher (2014) argue that REDD+ through CFs will be efficient because of the presence of well-established institutional arrangement for benefit sharing such as record keeping, reporting systems, auditing and conservation practices. However, various authors such as Korhonen-Kurkie et al. (2013), Assembe-Mvondo et al. (2013) and Brockhaus et al. (2014) argue that REDD+ needs multi-levels governance processes, auditing, monitoring and reporting requirements, which may demand participation of several actors and incur larger institutional administration and operation costs.

The key to the success of REDD+ is to balance social and environmental outcomes by maintaining social equity, cost efficiency, and enhancing effectiveness. Gebera et al. (2013) argue that maintaining social equity can enhance both efficiency and effectiveness, while Skutsch (2013) argue that efficiency and effectiveness are equally necessary for REDD+ to access market based incentives. Given the contradictory views, the concern remains regarding the way in which REDD+ payments improve equitable benefit sharing for improvement of local livelihoods and conservation of forests for enhancing carbon stock cost efficiently in CF, where local people have been exercising pre-existing benefit sharing practices and collective behavior for forest conservation goal (Angelsen & Wertz-Kanounnikoff, 2008; McDermott & Schreckenberg, 2009; Mutabazi et al., 2014). Peskett et al. (2011) and Cronkleton et al. (2011) have argued that the distribution system and use of REDD+ payment may change the local people’s behavior in using and managing forests and change existing rules whereby conservation of forest and enhancement of carbon stock may occur.

2.5 Reflection on critical questions

The review of global knowledge and theories reveal that trade-offs and synergies across ecosystem services take place mainly due to human interventions such as policy arrangements (national and international) and management practices (local). The generation of one ES can be detrimental to the provision of other services, leading to trade-offs, which can occur at different spatial and temporal scales, and between beneficiaries relying on different services. International policy arrangements such as
implementation of REDD+ may lead to negative implications on the generation of ESs, since REDD+ mainly focuses on one ES i.e. reduction of carbon emissions and enhancement of carbon stock. Such implications may be severe in community managed forests, where poor and forest-dependent communities rely on several non-carbon ESs such as timber, fuelwood, fodder and fibre for their subsistence.

Change in carbon stocks and forest biodiversity in the face of REDD+ through CFs is mainly governed by the forest dependency of local people and removal of forest products. Removal of forest products in CFs may further be associated with several factors that include national policies and local rules and institutional arrangements such as access, use and management rules of forests, biophysical circumstances, group characteristics, socio-economic condition and forest management practices.

Despite some positive outcomes, REDD+ initiatives have also posed several challenges to group management, benefit sharing and livelihoods and local forest management practices. Understanding the intersection of REDD+ with local context through CF and its implication in generating carbon and non-carbon benefits such as forest biodiversity, local livelihoods and institutional improvement is an important aspect in determining the future strategy of REDD+. Such research in Nepal is relevant as the country has been implementing several REDD+ pilot initiatives in several forest management regimes including CF, where livelihoods of poor and forest-dependent people are closely linked with forest ESs. An understanding of the changes in carbon and non-carbon ESs, group management and institutional arrangements, benefit sharing and local livelihoods outcome and forest management approaches with REDD+ can provide an integrated knowledge of the feasibility of such initiative in forests managed by local communities with different socio-economic background.

2.6 Chapter summary

The review of existing literature indicates that the REDD+ incentive has emerged as a prominent approach to climate change mitigation through forest carbon stocks enhancement, while also conserving forest biodiversity and improvement of local livelihood. However, there are considerable gaps in scientific knowledge, particularly integrated social and ecological knowledge of REDD+ with reference to CF. The following gaps have been identified from the literature review, with regards to possible options to design REDD+ as an effective mechanism in CFs.
Changes in carbon stocks, forest biodiversity and forest products extraction are not assessed in an integrated way: Available literature has indicated potential implications of forest biodiversity and forest resource use, while REDD+ mainly focuses on carbon stocks. However, there is limited knowledge and empirical evidences about the implications of REDD+ on carbon stocks, forest biodiversity and forest product removal as only a few REDD+ initiatives are implemented at the local level.

Relationships between carbon stocks, forest biodiversity and forest products extraction in community forests are less researched: Existing studies have revealed that carbon stocks, forest biodiversity and removal of forest products have inherent relationships and such interactions vary across different spatial and temporal scales. An understanding of relationships between these ESs is important to enable future prediction of possible outcomes of forest ESs for the effective implementation of REDD+. However, there is very limited evidence available about the relationships between carbon stocks and forest biodiversity and removal of forest products, especially in CFs, where forests are conserved through use of forest products.

Factors affecting forest products extraction and their effects on carbon stocks and forest biodiversity in community forests are less clear: The available studies have indicated that carbon stocks and forest biodiversity outcomes are directly associated with the removal of forest products. While previous studies have illustrated some potential factors associate with the extraction of forest products, there is still limited knowledge about the factors affecting removal of forest products in CFs. An understanding of these factors is essential for REDD+, as socio-economic circumstances and institutional arrangements under CFs are dynamic and change over time. Literature has indicated some factors associated with the removal of forest products that include institutional arrangements such as resource extraction rules, socio-economic and demographic circumstances, forest usage dynamics and dependency, and resource system size and vegetation types. However, potential effects of these factors are little assessed with respect to carbon stocks and forest biodiversity for REDD+.

Changes in local practices in group management, benefit sharing and forest management with REDD+ in community forests are not assessed: Existing literature has indicated that an implementation of REDD+ through pre-existing CF can influence
local communities to change their existing decision-making processes, participation and existing forest management practices. This is mainly due to the fact that REDD+ require local communities to meet some pre-conditions for access to the incentives. In response, local communities may adopt several modifications and formulate new approaches in their existing practices of group management and decision-making processes, benefit sharing and forest activities. Despite the realities, there is very little research undertaken on changes in local practices with reference to implementation of REDD+, especially in CFs.
Chapter 3- Research methodology: General overview

3.1 Introduction
Chapter 2 reviews existing knowledge about ecosystem services, biodiversity, livelihoods contributions of CFs and potential implications of REDD+ on forest biodiversity and local livelihoods. My research attempts to understand the dynamics of carbon stocks, forest biodiversity and forest resource removal, and potential local factors associated with these dynamics in CFs managed under REDD+. My specific research aims are: (1) to assess the dynamics of carbon stocks, forest biodiversity, and forest products extraction in CFs, (2) to analyse relationships across these variables, (3) to understand potential factors affecting removal of forest products, and (4) to explore the changed practices in CFs due to REDD+. This current chapter presents the general methods used to address these research aims.

This inter-disciplinary research has been undertaken to understand the interconnectedness of socio-economic circumstances (local communities) and forest ESs outcomes in CFs under REDD+ in Nepal. While this research is broadly divided into two parts i.e. an ecological part (Chapters 4 and 5) and a social part (Chapters 7 and 8), this chapter provides a general overview of the research approaches and methods used. This chapter also introduces the research site and criteria for selection of CFUGs for the study. Detailed research methods for the first (ecological) component are discussed in Chapters 4 and 5, while the qualitative research methods adopted for the social component are discussed in detail in Chapter 6.

3.2 General overview of research approaches and methods
Socio-ecological systems are characterised by complex interactions between social and ecological elements (Beier et al., 2008; Chan et al., 2012; Cote & Nightingale, 2012). In the context of forest management, the socio-ecological system is considered as an adaptive system, where local people rely on forest-derived ESs (Binder et al., 2013). At the same time social, economic and institutional dynamics associated with these people and their use and management of forest ecosystems may change (de Groot et al., 2002; Hansen, 2014; McAfee et al., 2010). My research seeks to understand the interactions of elements of the social and ecological system in the context of the introduction of REDD+ into pre-existing CF systems by adopting an inter-disciplinary research approach (Figure 3.1). According to Stock & Burton (2011), Visseren-Hamakers et al.
(2012), de Sassi et al. (2015) and Beichler et al. (2014), inter-disciplinary research seeks to integrate viewpoints of at least two disciplines (e.g. natural and social systems) to generate new knowledge on particular concerns.

While the ecological research comprises quantitative data which are often in terms of facts, the social research combines both quantitative and qualitative data and these data are often interpretative. As such, my research has adopted a ‘pragmatic’ research paradigm that integrates both positivist and interpretive paradigms (see Chapter 6 for further discussion of these research paradigms) (Evans et al., 2011). The integration of positivist and interpretive paradigms provides the research with the ability to analyse current dynamics and co-occurrence of ecosystem services and forest biodiversity, while also exploring the effects of social-economic and institutional factors on ecological outcomes (Thomas & Koontz, 2011). The research has employed a mixed methods approach that comprises quantitative and qualitative research techniques, allowing the integration of data related to ESs and forest biodiversity as well as complex socio-economic circumstances (Table 3.1).

**Figure 3.1- Inter-disciplinary research approach for social-ecological study**
### Table 3.1- Summary of research components

<table>
<thead>
<tr>
<th>Types of data</th>
<th>Data sources and collection techniques</th>
<th>Data analysis framework</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Biophysical data</strong> (carbon stocks, vegetation data, use of forest products)</td>
<td><strong>Secondary data:</strong>&lt;br&gt;• ICIMOD inventory, database&lt;br&gt;• CFUG operational plan, records, reports, log books, meeting minutes&lt;br&gt;• Records from FECOFUN, District Forest Office&lt;br&gt;<strong>Primary data</strong>&lt;br&gt;• Vegetation survey</td>
<td>• SPSS for statistical analysis&lt;br&gt;• ArcGIS for thematic mapping&lt;br&gt;• S’ programming</td>
</tr>
<tr>
<td><strong>Socio-economic, individual and institutional data</strong></td>
<td><strong>Secondary data</strong> (CFUG forest management, fund mobilisation, users’ participation):&lt;br&gt;• CFUG operational plan, records, reports, log books, meeting minutes&lt;br&gt;<strong>Primary data:</strong>&lt;br&gt;• Semi structured in-depth interview&lt;br&gt;• Household questionnaire survey&lt;br&gt;• Focus group discussion&lt;br&gt;• Follow up survey through mail&lt;br&gt;• Participant observation</td>
<td>• Thematic hierarchical content analysis supported by NVivo computer based tool&lt;br&gt;• Excel tool</td>
</tr>
</tbody>
</table>

A set of quantitative and qualitative methods were used to collect data for my study (Table 3.2). Ecological data were in the form of numbers, while data from qualitative approaches were in the form of opinions, feelings and views from people of different well-being, gender, and caste/ethnic groups. Qualitative data also include description of practices, behaviours and policies.

### Table 3.2- Overview of data collection and analysis methods and techniques

<table>
<thead>
<tr>
<th>Use of data collection and analysis methods</th>
<th>Ecological chapters</th>
<th>Social chapters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td><strong>Data collection</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forest inventory (by ICIMOD and by researcher)</td>
<td>√</td>
<td></td>
</tr>
<tr>
<td>Records of CFUG, FECOFUN and forest offices</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Household survey</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Individual semi-structured interview</td>
<td>√</td>
<td></td>
</tr>
<tr>
<td>Key informant interview</td>
<td>√</td>
<td></td>
</tr>
<tr>
<td>Mail survey</td>
<td>√</td>
<td></td>
</tr>
<tr>
<td>Focus group discussion</td>
<td>√</td>
<td></td>
</tr>
<tr>
<td>Participant observation</td>
<td>√</td>
<td></td>
</tr>
<tr>
<td><strong>Data analysis</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPSS</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>ArcGIS</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>S’ Programming</td>
<td>√</td>
<td></td>
</tr>
<tr>
<td>NVivo</td>
<td></td>
<td>√</td>
</tr>
</tbody>
</table>

The results from the two approaches are connected and compared to arrive at common findings and conclusions (Figure 3.2) (Creswell, 2013). Chapter 6 provides a basis for
the use of a mixed research approach, and elaborates on research paradigms, research approaches, and tools and techniques relevant to the social component of research.

3.3 Country background

Nepal is a landlocked country situated in the central Himalayan region, with a total area of 147,141 square kilometers bordering India to the south, east and west, and China to the north. The country is politically divided into five development regions, 14 zones and 75 districts. It consists of five major physiographic zones which are Terai, Silwalik (Churia), Middle Mountain, High Mountain, and High Himal (LRMP, 1986). These zones vary in their terrain, soil composition, bio-climate and forest types as well as population densities, ethnicities, land use and livelihoods (Figure 3.3).

The total population of Nepal is about 26.5 million with a 1.35% average annual growth rate (CBS, 2011). Nepal is a multi-religious and multi-cultural country, comprising different caste and ethnic groups belonging to Indo-Aryan and Tibeto-Burman Linguistic families. Over 86% of people live in the rural areas, and engage predominantly in subsistence-based farming.

Figure 3.2- Explanatory design of mixed methods design in socio-ecological system

Source: Cresswell (2013) and Cameron (2009)
Forests are an integral part of the farming system in Nepal (Rasaily & Ting, 2012a), with vegetation varying from tropical in the low land Terai to Tundra in the high Himal (GoN/MFSC, 2014). A recent forest resource assessment survey indicates that forest, together with other wooded land, covers about 6.61 million ha which is 44.746% of the total land area of the country, an increase of 5.14% from the previous national forest inventory in 1994 (DFRS, 2015b). However, there are regional variations in terms of changes in forest conditions. According to a recent assessment of forest cover by the Department of Forest Research and Survey (forest resource assessment), the forest area in the Terai decreased by an annual rate of 0.44% during the period 2001-2010 and the forest in the Siwalik decreased by an annual rate of 0.18% from 1995-2010 (FRA/DFRS, 2014). In contrast, another report based on the same assessment indicated an increase of forest cover in middle hills and high mountain zones, mainly due to community forestry, and temporary outmigration of local people (DFRS, 2015a).

A total of 118 ecosystems, 76 vegetation types and 35 forest types have been identified in the country (MoE, 2010). The country occupies about 0.1 percent of the global land area; however, it harbors 3.2% and 1.1% of the world’s known flora and fauna respectively and includes several designated Himalayan biodiversity hotspots (GoN/MFSC, 2014). Forests are key habitats for the majority of these fauna and flora in...
Nepal, indicating that loss of forests may be critical for the conservation of biodiversity, leading to an impact on agriculture and rural livelihoods.

3.4 Selection of research location, units and participants

3.4.1 Dolakha district as a research site

My research was undertaken with CFUGs in Charnawati watershed, Dolakha district, Nepal (Figure 3.4). Dolakha is located in the north east of Nepal, covers an area of 214,287 ha and supported a population of 186,557 in 2011 (CBS, 2011). Forest, agriculture and pasture are the main land uses. Dolakha encompasses 41 village development committees (VDCs) and one municipality. Fourteen VDCs are within the Gaurishankar Conservation Area (GCA, established in 2011), which is located in the northern part of Dolakha.

![Figure 3.4- Map of research sites](image)

Dolakha district is home to a variety of caste and ethnic groups including the high-caste Thakuri, Brahmin, and Chhetri and people from minority indigenous groups Thami, Surel, and Jirel (DDC, 2011). Local people obtain their main livelihood from subsistence agriculture (the major occupation of 95% of the population), while some individuals are employed in local government and non-government organisations. Following are some of the criteria for selecting Dolakha district for my research.
1. Dolakha has a varied topography across the Middle Mountain, High Mountain and High Himal Zone which contain diverse forest types from tropical in the lower land to high mountains.

2. Dolakha is a pioneering district for the implementation of the community forestry system, with historical forest development supported by the Swiss development agency since 1956 with different priorities and focus in different phases of projects (DFO, 2013).

3. The district is also one of the pioneer districts for the implementation of the REDD+ initiative with the practice of carbon payment to local communities (ICIMOD, 2012).

4. Dolakha is one of the districts that applies the Forest Stewardship Council (FSC) certification standards in sustainable use and management of CFs (DFO, 2013).

3.4.2 Vegetation and CFUG status in Dolakha

Forest covers over 47% (101,500 ha) of Dolakha (DDC, 2013); with the altitudinal range of the district spanning 732 m to 7148 m (Mount Gaurishankar). Vegetation distribution closely follows altitude. Tropical forests occurs from sea level up to 1000 m, and these include broad leaved, hard-wood tree species such as hill Sal (Shorea robusta), Terminalia spp. and their associates (DFO, 2013). Sub-tropical forests occur between 1000 m to 2000 m and include Schima-castanopsis, Pinus roxburghii and Alder forest in the moist areas.

Lower temperate forests occur from 2000 m to 3000 m with the main tree species including Rhododendron, Madhuca indica, Rakchan, Quercus, Pinus wallichiana and Pieris pacia. Temperate forest spans 3000 m and 4000 m, where Rhododendron (white rhododendron – Chimal), Betula, and Thingure Salla are found. Alpine forests occur above 4000m and are characterized by Juniper and bushy vegetation.

In Dolakha, 44 % (44,598.65 ha) of forest is being managed under the CF system by 412 CFUGs (DFO, 2013), which comprise nearly 185,000 members from 45,234 households. Of these, 55 CFUGs, covering 16,526 ha of CFs occur in the Gaurishankar Conservation Area. Leasehold forestry is also a major forestry program in Dolakha, and covers 879.22 ha which is managed by 175 leasehold forest user groups (DFO, 2013).

Forest management on private farm land is increasingly practiced in Dolakha, from which households can meet some of their forest product needs. According to the DFO
(2013), there are 14 registered private forests managing an area of 16.44 ha on private land. However, the practice of planting trees within private cultivation land is increasing (DFO, 2013).

Forestry complements agriculture practices by providing forest products such as fodder, grass and manure, grazing land, and ESs that support water provision and land stabilisation (DFO, 2013). The forest in Dolakha is also home to numerous non-timber forest products such as medicines, aromatic plants, and raw material for veneer factories.

3.4.3 Introduction to Charnawati watershed
My research was undertaken with 19 CFUGs in the Charnawati watershed (835 - 3549 masl) in Dolakha district (Figure 3.5). The watershed encompasses five village development committees namely; Phasku, Katakuti, Magapauwa, Lankuridanda, and Boch, and Bhimeshwor municipality, covering a total area of 14,037 hectares (ICIMOD, 2012).

Agriculture, forest, and pasture land are the main land uses in Charnawati (ICIMOD, 2010d). Over 50% of the watershed is covered by forest, and agriculture land covers over 40%. The altitude of this watershed ranges from 835 m to 3549 m (ICIMOD, 2010a). Vegetation in the watershed includes sub-tropical broad-leaved hill Sal forest to low mountain forest such as *Betula* and *Quercus* forest. There are 58 CFs in Charnawati that cover an area of 5,996 ha, and are managed by 3,234 households. Over 50 ha of forests is being managed via leasehold forestry by 15 leasehold forest user group representing 163 households (ANSAB, 2012).

Among various community-managed forest approaches being practiced in Nepal, leasehold forestry is a new frontier primarily focused on conserving degraded forests and improving the livelihoods of land-poor (less than 0.5 ha of land and annual income less than NRs. 6,100) and landless households. Leasehold forestry is underpinned by the devolution of forests from central to local communities whereby management and use rights of government forests are devolved to the poorest households for long-term (i.e. initially leased for 40 years and could be extended for another 40 years) (Bhattarai & Dhungana, 2005; Chhetri, 2009). Leasehold forestry differs from community forestry in-terms of tenure arrangement (e.g. 40 years) and number and categories of households
involved (5-10 households) and type of forests (e.g. only shrub lands, degraded from natural calamities and forests with less than 20% land cover) and size of forests (0.70 to 1.0 ha per household) (Laudari & Kaini, 2014). Leasehold forestry integrates forest management with livestock and forage production and micro-enterprises. Charnawati watershed provides a showcase of integrated management of both community and leasehold forestry by people with diverse economic background.

Charnawati is further home to diverse ethnic groups such as the indigenous peoples (Thami, Tamang, Newar, and Bhujel), Dalit (Blacksmith, Goldsmith and Cobbler), and Thakuri, Brahmin and the higher caste Chhetri (Socio-economic baseline survey, 2010). Charnawati watershed provides an ideal context to understand the relationships between the implementation of REDD+ and local CFs. With an objective of developing carbon payment mechanisms, a REDD+ pilot was implemented with CFUGs of Charnawati watersheds by the International Centre for Integrated Mountain Development (ICIMOD) and its collaborators in 2009 (ICIMOD, 2010a). All 58 CFUGs in Charnawati watershed have been involved in this REDD+ initiative, and are implementing various related REDD+ activities inside and outside CFs. The CFUGs involved in the REDD+ initiative were provided with financial incentives from the trust fund established under the REDD+ pilot initiative, on the basis of social and biophysical criteria including carbon stocks being increased in their forests (ICIMOD, 2010b).

Figure 3.5 - Key features of Charnawati watershed
Source: ICIMOD (2010d)
3.4.4 CFUG as unit of analysis

CFUGs are local level autonomous institutions which are responsible for implementing nationally and internationally designed forest related activities, and are mandated independently to manage CFs, and utilise the benefits from these forests (GoN, 1993). CFUGs design forest management activities and implementation plans and formulate utilisation schemes that consider the needs of forest users and conditions of the forests.

CFUGs can consult with and obtain support from government organisations (mostly from the District Forest Office), relevant donor agencies and related stakeholders. They may also review their forest management plans in line with externally designed policies and interventions (GoN, 1995b). For Nepal, a CFUG is an appropriate grassroots level institution to put any international environmental and climate change related policies into practice (MoE, 2010).

CFUGs are comprised of member households (GoN, 1995b). Each household nominates members who represent them in CFUG activities (GoN, 1995a). Hence, a CFUG is a social unit where social, economic and institutional processes take place in relation to the management and use of forest resources. Therefore, CFUGs are the most logical unit of analysis to use for my study of the impact of forest management on the capacity of CFs to provide ESs to society, and how ESs benefits are dispersed among different forests users.

Given that CFUGs are the logical socio-demographic unit of analysis, it follows that CFs are the best unit of analysis for ecological assessment of ESs provision, and the interaction between ESs and forest user groups. CFs comprise diverse vegetation assemblages that contribute to locally and globally important ESs (Lavorel & Grigulis, 2012; Patterson & Coelho, 2009; Vira et al., 2012). Hence, CFs are the appropriate level to examine how forest management strategies can impact on the provisions of ESs.

I also consider households (as members) of CFUGs as an information unit for the qualitative study (Chapter 6, 7, and 8). A household, in this case, is defined as a group of people living together and sharing the same kitchen (Smeeding & Weinberg, 2001). Household characteristics determine the rules and norms related to forest product harvesting, use, and forest management (Adhikari, 2003a).
In total, 19 CFUGs were selected for analysing changes in ESs and plant diversity and interrelationships among variables from 2010 to 2013. These 19 CFUGs were selected based on criteria related to group and biophysical characteristics (see Chapter 4). Two of the 19 CFUGs were selected for more in-depth social analysis, in which individual households are regarded as the unit of analysis (for more information on these CFUGs and selection of households, see Chapter 6). Findings generated from the two levels ( ecological results generated from 19 CFUGs, and social results generated from 2 CFUGs within these 19 CFUGs) underpinned my research (Figure 3.6). As explained in the earlier section, this research is based on a combination of quasi-experiment and case study, whereby underlying causal connections between outcomes from ecological analysis through quasi-experiments have been developed with the explanatory responses derived from case studies (Thomas & Koontz, 2011).

Figure 3.6- Illustration of linking group level ecological changes with individual level perception and feeling

Note: CFUG - community forest user group
Chapter 4 - Status of carbon stocks, removal of forest products and forest biodiversity

4.1 Introduction

REDD+ has been considered to be an effective climate change mitigation strategy under the UN framework convention on climate change. This initiative aims to preserve forests while generating multiple benefits to local and global communities (Phelps, Friess, et al., 2012). Several REDD+ pilot initiatives have been established in developing countries, including Nepal in association with various forest management regimes including CF.

While CF may be a good avenue for implementing REDD+ initiatives (as indicated by Agrawal & Angelsen, 2009; Bowler et al., 2011; Robinson et al., 2013; Skutsch & McCall, 2012), some concerns have been raised about reconciling the aims of REDD+ with the objectives of existing forest management practices (Lupala et al., 2014). For example, the primary aim of REDD+, improved carbon storage, may not align with biodiversity conservation goals or strategies designed to improve livelihoods (Mustalahti et al., 2012; Visseren-Hamakers, McDermott, et al., 2012).

CFs in Nepal are managed under common national policy provisions; however, local communities can design operational rules and moderate forest activities according to their needs, and social and ecological context (Ojha et al., 2007). Biophysical and social outcomes of CFs thus vary with differing forest resources, group and socio-economic circumstances (Chand, 2011; Coleman, 2009; Pandit & Bevilacqua, 2011a; Yang et al., 2013). Given the inter-CFs differentiation, the impacts of REDD+ on local communities are also likely to vary across CFs (Parrotta et al., 2012a).

Carbon storage potential may be positively related to tree diversity in certain forests (Kirby & Potvin, 2007; Pedro et al., 2014; Schulp et al., 2008); however, this relationship can vary with vegetation type, plant species composition, and plant growth rate (Jackson & Ingles, 1994; Smith et al., 1997). Moderating this relationship is the application of different forest management practices that can have direct and indirect effects on carbon storage and maintenance of plant species diversity (Hosonuma et al., 2012; Paudel et al., 2013; Skutsch, Balderas-Torres, et al., 2011).
The potential for REDD+ to improve biodiversity conservation and the flow of non-carbon forests benefits to local communities (e.g. timber, fuelwood and fodder/grass) is still the subject of substantial debate (Pandey, Cockfield, et al., 2014; Ratsimbazafy et al., 2011; Tacconi et al., 2013). Given this, it is important to examine the relationship between key benefits of forests (e.g. carbon stock, timber, fuelwood, fodder, and plant diversity) and how these vary across CFs managed under the REDD+ scheme.

The aim of this chapter is to examine short-term changes in carbon stocks, forest biodiversity (plant species diversity, plant species richness, and stem density), and the removal of forest products (timber, fuelwood, and fodder) in REDD+ piloted CFs in Nepal. I have used plant species diversity, richness and stem density as forest biodiversity indicators since these elements are useful properties to evaluate the effect of forest management activities (Imai et al., 2014; Latham et al., 2014). These elements are also useful indicators to evaluate the progress of Convention on Biological Diversity 2020 targets (Pereira et al., 2013). Timber, fuelwood and fodder are selected for my study as these forest products are most demanded and harvested forest products in CFs, and are closely linked with the livelihoods of local communities (Dhakal & Masuda, 2008). Harvest of these products is made under the operational rules designed by CFUGs. Harvest of timber is governed by demand from CFUGs members as well as market structure, while fuelwood and fodder harvest is determined by the socio-economic condition of local communities. Moreover, removal of these forest products may directly be associated with the change in carbon stocks. This chapter also considers biophysical characteristics of CFs that may influence the flow of benefits from forests and impact on plant diversity. The analysis sheds light on how a focus on forest carbon storage through REDD+ may impact on forest conservation and the livelihoods of local communities.

4.2 Methodology

4.2.1 Description of community forest user groups

My study was carried out in 19 CFUGs of Charnawati watershed (652-3238 masl) selected by using multiple criteria (Table 4.1) (see Chapter 3 for further details). Each CFUG was associated with a different community forest that was part of a REDD+ pilot scheme. The CFs are characterised as semi-natural as they implement several forest conservation and management activities such as execution of enrichment plantation, selective thinning, construction of forest fire lines, regulated grazing and harvesting of
forest products mainly timber, fuelwood, and fodder/ground grass (hereafter fodder). Collectively, the CFs encompass diverse vegetation types such as *Shorea robusta* at lower altitudes (e.g. Sitakunda and Chranawati-2 CFUGs) and *Rhododendron* and *Quercus* tree species at higher altitudes (e.g. Bhitteri and Thansadeurali CFUGs), and are subject to different forest management techniques. The CFUGs are characterised by diverse ethnic groups with different socio-economic conditions, interests, needs, and priorities over the CFs, and vary in age (based on the date the forest was handed over by the government) with different institutional and forest management experiences. Given the variation in biophysical characteristics, group and socio-economic and institutional characteristics, CFUGs were classified into the following categories: high altitude (>2000m 11 groups) or low altitude (<2000m 8 groups); mature (handover of forest management to the local community occurred before or at 2000 AD, 13 groups), or less mature (handover of forest management occurred after 2000 AD, 6 groups); and small (≤1.0 ha of forest per household, 12 groups), or large (>1.0 ha of forest per household, 7 groups) (Table 4.1).

Planting trees, thinning, pruning and branch cutting, fire control and forest product harvesting are common forest activities for the majority of CFUGs. However, selection of tree species for plantation, size of forests applied for thinning and pruning, amount of forest products and actions of fire control vary across CFUGs according to the size of forests, type of vegetation, location of forests (altitude) and forest product needs of local people. For example, low altitude forests have adopted fire control measures such as construction of forest fire line due to high risks of forest fire. A few CFUGs have adopted forest patrolling and protection of water sources.

**Table 4.1- Main characteristic of community forests**

<table>
<thead>
<tr>
<th>Community forest</th>
<th>Altitude</th>
<th>Maturity (age of hand over)</th>
<th>Per household forest size (ha)</th>
<th>Main vegetation type</th>
<th>Major forest activities of CFs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barkhedandapari</td>
<td>Low</td>
<td>Mature</td>
<td>Small</td>
<td><em>Schima-castanopsis,</em> <em>Pinus roxburghii</em></td>
<td>Plantation, fire line construction, thinning and pruning</td>
</tr>
<tr>
<td>Bhakare</td>
<td>Low</td>
<td>Less mature</td>
<td>Small</td>
<td><em>Pinus roxburghii</em></td>
<td>Fire line construction, thinning and pruning</td>
</tr>
<tr>
<td>Bhitteri</td>
<td>High</td>
<td>Mature</td>
<td>Large</td>
<td>Oak, <em>Rhododendron,</em> <em>Thingure Salla</em></td>
<td>Plantation (both timber and non-timber forest products- broom grass, fibre species- Argeli and Lokta), thinning and pruning.</td>
</tr>
<tr>
<td>Charnawati 1</td>
<td>High</td>
<td>Mature</td>
<td>Large</td>
<td>Oak</td>
<td>Plantation (tree species)</td>
</tr>
<tr>
<td>Area</td>
<td>Elevation</td>
<td>Status</td>
<td>Size</td>
<td>Species and Products</td>
<td>Management Activities</td>
</tr>
<tr>
<td>---------------------------</td>
<td>-----------</td>
<td>--------</td>
<td>--------</td>
<td>-----------------------</td>
<td>--------------------------------------------</td>
</tr>
<tr>
<td>Charnawati 2</td>
<td>Low</td>
<td>Mature</td>
<td>Small</td>
<td>Shorea robusta, Pinus roxburghii</td>
<td>Plantation, fire line construction, thinning and pruning</td>
</tr>
<tr>
<td>Chyasebhagabati</td>
<td>High</td>
<td>Mature</td>
<td>Small</td>
<td>Alder, Pinus roxburghii, Schima wallichii</td>
<td>Thinning and pruning, Demarcation between forest and cultivated land</td>
</tr>
<tr>
<td>Dhandesinghdevi</td>
<td>High</td>
<td>Less mature</td>
<td>Large</td>
<td>Rhododendron, Pinus patula, Castanopsis</td>
<td>Plantation (tree species and fibre species – Argeli, Daphne, Broom grass)</td>
</tr>
<tr>
<td>Eklepakha</td>
<td>High</td>
<td>Mature</td>
<td>Small</td>
<td>Schima-castanopsis, Pines,</td>
<td>Plantation, thinning and pruning</td>
</tr>
<tr>
<td>Harisiddhimai</td>
<td>Low</td>
<td>Mature</td>
<td>Small</td>
<td>Schima-castanopsis, Pinus roxburghii</td>
<td>Thinning and pruning</td>
</tr>
<tr>
<td>Juggedarkha</td>
<td>High</td>
<td>Less mature</td>
<td>Small</td>
<td>Rhododendron, Thingresalla, Pinus wallichiana</td>
<td>Plantation and Thinning and pruning</td>
</tr>
<tr>
<td>Kopila</td>
<td>Low</td>
<td>Mature</td>
<td>Large</td>
<td>Schima wallichii, Alder, Kalikath (Myrisine semiserrata), Rhododendron</td>
<td>Plantation (tree species, broom grass) thinning and pruning, fire line construction</td>
</tr>
<tr>
<td>Majhkharkalisepani</td>
<td>High</td>
<td>Mature</td>
<td>Large</td>
<td>Oak, Rhododendron, Pinus</td>
<td>Plantation</td>
</tr>
<tr>
<td>Mathani</td>
<td>Low</td>
<td>Mature</td>
<td>Small</td>
<td>Alder, Pinus wallichiana, Schima wallichii</td>
<td>No plantation, Thinning and pruning, fire line construction</td>
</tr>
<tr>
<td>Napkeyanmara</td>
<td>High</td>
<td>Mature</td>
<td>Large</td>
<td>Alder, Pinus wallichiana, Rhododendron, Castanopsis</td>
<td>Plantation and thinning and pruning</td>
</tr>
<tr>
<td>Setidevidadar</td>
<td>High</td>
<td>Less mature</td>
<td>Large</td>
<td>Rhododendron, oak</td>
<td>Thinning and pruning, Patrolling</td>
</tr>
<tr>
<td>Shivajungbhumesthan</td>
<td>Low</td>
<td>Less mature</td>
<td>Small</td>
<td>Alder, Schima wallichii</td>
<td>Thinning and pruning (decreased in later year of REDD+ implementation)</td>
</tr>
<tr>
<td>Sitakunda</td>
<td>Low</td>
<td>Mature</td>
<td>Small</td>
<td>Pinus roxburghii, Shorea robusta</td>
<td>Fire line construction, Plantation, forest patrolling</td>
</tr>
<tr>
<td>Thansadeurali</td>
<td>High</td>
<td>Mature</td>
<td>Small</td>
<td>Oak, Rhododendron, Pinus patula</td>
<td>Plantation, thinning and pruning, forest patrolling</td>
</tr>
<tr>
<td>Thumkadanda</td>
<td>High</td>
<td>Less mature</td>
<td>Small</td>
<td>Rhododendron, Pinus wallichiana, Pinus patula</td>
<td>Plantation, Thinning and pruning, water source protection</td>
</tr>
</tbody>
</table>

Source: Field survey, 2013
4.2.2 Data collection

My research used various data to measure forest carbon stocks (regulating ecosystem service (ES)), forest products (provisioning ESs – timber, fuelwood, and fodder/grass), and forest biodiversity (plant species diversity, plant species richness, and stem density; see Appendix 1). I have used plant species diversity, richness, and stem density as indicators of forest biodiversity, to understand the impact of forest management with reference to carbon stocks and forest products extraction in relation to the REDD+ pilot. Plant species diversity is comprised of two basic components i.e. types of plant species (species richness) in a given forest or vegetation community and the number of individuals of each plant species (relative abundance or species evenness) in the same forest area (Hamilton, 2005; Magurran, 2004). Species richness represents compositional diversity and accounts for the total number of different plant species present in the forests (Imai et al., 2014; Long & Shaw, 2010). Species evenness representing structural diversity accounts for the relative abundance (or how particular plant species distribute) of particular plant species. This indicates that plant species diversity and species richness are interrelated but different attributes of forest biodiversity and provide different interpretation forest biodiversity.

Some authors (e.g. Mligo, 2015; Stirling & Wilsey, 2001) have pointed out that the measurement of both attributes could provide complete representation of forest plant biodiversity since these components are site-specific and impacted differently by resource use practices. Therefore, assessment of two attributes in measuring forest biodiversity in CFs enables an understanding of both ecological stability of forests, and the conservation perspective of local communities regarding their perception of biodiversity value, choice of plant species and adoption of short and long-term forest management activities (Harvey et al., 2010; Hicks et al., 2014; Newton et al., 2016; Phelps et al., 2011). I have focused on measurement of these two biodiversity attributes to assess the relationships between particular forest products (i.e. timber, fuelwood and fodder) and carbon stocks because there is a general assumption that the changes in these forest biodiversity attributes and carbon stocks are associated with the removal of these forest products (Skutsch, Balderas-Torres, et al., 2011).

4.2.2.1 Collection of carbon stocks data

Raw data related to carbon stocks were collected through the ICIMOD database, which was gathered from the forest inventory conducted by ICIMOD and its collaborator.
between February and April in both 2010 and 2013. These data included the height and diameter at breast height (dbh) of trees and saplings, and the number of seedlings and shrubs in each forest. This forest inventory was undertaken by forest technicians of ICIMOD and its collaborators using the guidelines developed by a team of experts and approved by the government of Nepal (Subedi et al., 2010).

The ICIMOD forest inventory surveys were undertaken using a stratified random sampling design. Forests were stratified into two strata; i.e. dense (≥ 70% canopy density) and sparse (< 70% canopy density), using a geographic information system (ArcGIS) with Geo-eye satellite images captured on the 2nd November, 2009. Permanent plots of 250 m² were established in CFs (MacDicken, 1997, p. 54), and these plots were randomly distributed in each stratum using the Hawth Analysis tool in ArcGIS (www.spatial ecology.com) (see Figure 4.1).

Figure 4.1- Map showing permanent plots in community forests

Trees with a dbh of more than 5 cm were counted in a circular plot of 8.92 m radius to estimate tree density in each forest (see Figure 4.2). Sapling (dbh of 1 cm - 5 cm) and seedling (diameter less than 1 cm) density were calculated from a sub-plot of 5.64 m and 1 m radius respectively, while weight for leaf litter, herbs, shrubs, and soil samples were collected from a sub-plot of 0.56 m radius (see Appendix 2 for details of field sampling and carbon stock calculations).
Figure 4.2- Composite sampling designs for carbon data collection

Note: AGTB - above ground tree biomass, AGSB - above ground sapling biomass, DBH – Diameter at breast height, LHG – leaf litter and herbs, SoC – Soil organic carbon

4.2.2.2 Collection of forest products data

The data of annual harvest of timber (cubic feet), fuelwood (kg), fodder (kg) for 2010 and 2013 were collected from the records and distribution log book, and meeting minutes of CFUGs during my field visit to Nepal (July-October 2013). These data were verified through meetings with key group members including the chairperson, vice chairperson, secretary, and treasurer of CFUG EC and knowledgeable members of CFUGs.

4.2.2.3 Collection of vegetation data for assessing bias of data 2010 and 2013

While measuring carbon stock and plant diversity from two repeated measurements in the same plots there is high chance of bias in the data related to the likelihood of local communities not implementing forest activities and harvesting products in and around the permanent plots. To assess potential bias, I measured plant species diversity through vegetation survey in new plots in each community forest. For this, vegetation data from an additional 50 plots (see Figure 4.2) were collected between August and September 2013 using the same methods as applied in the ICIMOD forest inventory surveys (Section 4.3.2.1). Tree (≥5 cm dbh) density was measured in a circular plot of 250m² whereas sapling (trees < 5 cm dbh) density and seedling density were measured in plots of 5.64 m and 0.56 m radius, respectively. These additional plots were established after reviewing forest carbon plots and attempting to maximise the representation of forest aspects and vegetation type across CFs.

The new plots were established in CFs using Google Earth freeware software (digital globe imagery date 15/12/2012) and GIS layers. The boundaries of CFs and permanent
carbon plots were reviewed with Universal Transverse Mercator (UTM) at 45 Zone projection systems. The degree decimal/UTM projection system was acquired in Google Earth. The Google Earth 3D image facility was examined with terrain features of the CFs, through which I acquired information on the aspects (orientation) of forests, altitude, topography, terrain, ecological features and location of permanent carbon plots. The additional 50 plots for the vegetation survey were laid out manually (in the field) by considering all the ecological features in the CFs (Figure 4.3). ArcGIS was used to map the additional plots in the CFs.

![Map showing forest inventory plots for vegetation survey](image_url)

**Figure 4.3**- Map showing forest inventory plots for vegetation survey

### 4.2.3 Analysis of data

I have used data from ICIMOD inventories conducted in Feb-May 2010 and Feb-May 2013 for the assessment of changes in carbon stocks and forest biodiversity attributes, while data from forest inventory August–Sept 2013 was used to assess whether there was bias from not implementing forest activities in permanent plots. For this, I have primarily analysed data in two steps. In the first step, I calculated carbon stocks, plant species diversity and use of forest products. I then analyzed changes (i.e. difference between Feb-May 2010 and Feb-May 2013) of these variables using the derived data with simple statistical tools i.e. SPSS.
4.2.3.1 Carbon stocks

Total carbon stocks for this study included five carbon pools: above and below ground tree carbon, sapling and shrubs, herbs and grass, leaf litter, and soil organic carbon. Above ground biomass was estimated using an equation proposed by Chave et al. (2005) since a Nepal-specific allometric equation was not available (see Appendix 2 for equation). While this equation may not represent well the local species, the objective is to assess the change over time; any error is unlikely to be significant. Below ground biomass was estimated using root: shoot ratio whereby root parts are estimated to contain 20% of total above ground biomass (MacDicken, 1997, p. 84). Total biomass was converted into carbon stock by multiplying with the default value 0.47 (IPCC, 2006). Soil organic carbon data for 2010 was obtained from ICIMOD (2010a). Data calculated for 2010 were used also for 2013, considering that soil carbon does not change over such a short period of time (4 years) assuming the same land-use practices (Coleman et al., 1989; MacDicken, 1997; Maraseni & Pandey, 2014; Martin et al., 2013). Average per ha forest carbon stock in dense and sparse strata of each community forest was calculated by dividing the total carbon stock of that strata by the number of survey plots established in that strata. Average weighted per ha carbon stock of each community forest was then calculated based on the area of dense and sparse strata in each forest (Appendix 3 for details). The data are presented as per ha carbon stocks in 2010 and 2013, and the difference in per ha carbon stock between these years.

4.2.3.2 Timber

Per ha timber harvested was calculated from the data of total timber distributed to forest users in terms of quantity of sawn timber and number of poles. As reported by key members of CFUGs, the average length and dbh of the poles are considered to be 10 feet and 7 inches, respectively. Total volume of these poles was calculated using the formula $V = \pi r^2h$ (where $V$ = volume in cubic feet, $r$ = dbh in inches (converted measured diameter from inches into feet by dividing by 12) and $h$ = height (length) in feet). Per ha harvest volumes of timber in each community forest were then estimated by dividing total timber harvested (sum of pole volume and sawn timber) by the area of the respective community forest.
4.2.3.3 Fuelwood
Fuelwood data were collected in terms of full and half head loads (bhari). Based on consultation with local communities, a full head load of fuelwood carried by an adult is considered to be 35 kg. Per ha annual harvest of fuelwood of each community forest was then calculated by dividing the total quantity of fuelwood harvest (total number of full and half-head loads for a given year) by the area of the respective community forest.

4.2.3.4 Fodder and grass
These data included ground grass, green bedding material, and leafy fodder (hereafter ‘fodder’) collected by forest users for the use of livestock. The data were measured as head loads of fodder harvested during winter and summer verified through meeting with key members of CFUGs. As reported by CFUG members, forest users harvest fodder in full head loads and an armful (1 angalo), and three armfuls of fodder make a full head load. Total fodder harvested was calculated by multiplying full head loads (or a portion thereof) by 35 (1 full head load equals 35 kg). Per ha harvest of fodder in each forest was then estimated by dividing the total quantity of fodder harvested by the area of the respective community forest.

4.2.3.5 Plant species diversity and richness
Plant species diversity was estimated using the Shannon-Wiener diversity index (H’), which accounts for the number of species and their relative abundance (Appendix 4) (Magurran, 2004). Species richness of each CF was estimated using a rarefaction equation based on raw plant species data (number of different species of trees, herbs, shrubs and seedlings) recorded in sample plots (Appendix 5). The index increases either by having additional unique species or by having greater species evenness.

4.2.3.6 Stem density
Stem density was estimated by counting the number of trees, saplings, and seedlings in the 250m$^2$ survey plots. The average number of stems per plot was calculated by dividing the total number of stems with the total number of plots in each community forest. Stem density per ha in each CF was then calculated by multiplying the density of stems in plots by 40 (stem density measured in plots of 250m$^2$ was estimated into per ha, 10000m$^2$ equals 1 ha). Stem density values for 2010 and 2013 are shown in Table 5.1 (Chapter 5).
4.2.4 Result of bias analysis

I analysed potential bias from management and use practices by local people in permanent plots of forest inventory by establishing new plots outside permanent plots in each community forest. Forest survey was carried out in July–Sept 2013 during my field visit. Per ha carbon stocks, plant diversity, species richness and stem density were analysed using data collected during the field visit (Appendix 6). I analysed bias of forest management using Wilcoxon rank sum (i.e. Mann-Whitney test) at $\alpha = 0.05$ significance level. Wilcoxon rank sum or Mann-Whitney test is useful for comparing two groups using two independent random samples (Haynes, 2013).

Table 4.2- Illustration of results of Wilcoxon rank sum test (Mann-Whitney test) of difference value of carbon, forest biodiversity in forest inventory between ICIMOD and new plots (at significance level $\alpha = 0.05$, in two-tailed tests)

<table>
<thead>
<tr>
<th>Forest ecosystem services and types of plots</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Median</th>
<th>Std. Deviation</th>
<th>Mean Rank</th>
<th>Z-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2013 ICIMOD plot</td>
<td>141.78</td>
<td>302.01</td>
<td>229.97</td>
<td>203.63</td>
<td>78.91</td>
<td>18.74</td>
<td>-0.42</td>
<td>0.686</td>
</tr>
<tr>
<td>2013 New plot</td>
<td>152.15</td>
<td>421.15</td>
<td>209.05</td>
<td>213.21</td>
<td>37.07</td>
<td>20.26</td>
<td>1.06</td>
<td>0.297</td>
</tr>
<tr>
<td>Plant diversity</td>
<td>0.43</td>
<td>2.10</td>
<td>1.36</td>
<td>1.28</td>
<td>0.37</td>
<td>17.58</td>
<td>-1.06</td>
<td>0.297</td>
</tr>
<tr>
<td>2013 New plot</td>
<td>0.50</td>
<td>2.22</td>
<td>1.43</td>
<td>1.53</td>
<td>0.45</td>
<td>21.42</td>
<td>1.06</td>
<td>0.297</td>
</tr>
<tr>
<td>Species richness</td>
<td>4</td>
<td>24</td>
<td>11.73</td>
<td>10</td>
<td>4.47</td>
<td>25.08</td>
<td>-3.11</td>
<td>0.001</td>
</tr>
<tr>
<td>2013 New plot</td>
<td>7</td>
<td>39</td>
<td>17.47</td>
<td>16</td>
<td>7.03</td>
<td>13.92</td>
<td>1.44</td>
<td>0.152</td>
</tr>
<tr>
<td>Stem density</td>
<td>1080</td>
<td>4720</td>
<td>2604</td>
<td>2560</td>
<td>865.85</td>
<td>22.11</td>
<td>-1.44</td>
<td>0.152</td>
</tr>
<tr>
<td>2013 New plot</td>
<td>780</td>
<td>4720</td>
<td>2271</td>
<td>2213</td>
<td>1059.81</td>
<td>16.89</td>
<td>0.14</td>
<td>0.152</td>
</tr>
</tbody>
</table>

The results indicate that there is no significant difference in carbon ($p=0.686 > 0.05$), plant diversity ($p=0.29 > 0.05$) or stem density ($p=0.152 > 0.05$) between permanent plots established by REDD+ and those established in July-Sept 2013 (Table 4.2). However, the results indicate a significant difference in species richness ($p=0.001<0.05$) for these plots. This suggests that local people adopted similar forest activities in and outside permanent plots in each community forest, indicating there is no management bias. Hence, the data for 2010 and 2013 are comparable.

4.2.5 Change in carbon stock, plant diversity, and removal of forest products

The results are presented in descriptive tables showing mean and standard deviation of variables. Additionally, change in carbon stock, forest products extraction, plant species diversity and richness, and stem density between 2010 and 2013 was analysed using a non-parametric, two-tailed Wilcoxon signed rank test ($\alpha = 0.05$). The Wilcoxon signed rank test is a useful test to determine significant changes between two conditions or
occasions (i.e. periods) (Gibbons & Chakraborti, 2011). This test is guided by repeated-measure design, and assesses whether the population mean ranks of variables differ significantly.

In this research, a statistical value (Z-value) of less than -1.96 or greater than 1.96 at the 5% probability level denotes significant change in carbon stocks, plant species diversity, and forest products extraction between 2010 and 2013. The mean rank of variables as identified through the Wilcoxon tests was used to represent the magnitude of positive (an increase) or negative (a decrease) changes occurring between 2010 and 2013. The changes were scaled as follows: substantial increase (++), marginal increase (+), stable (no change) (0), marginal decrease (-), and substantial decrease (--). To understand the patterns of carbon stock, plant species diversity and richness, stem density, and removal of forest products, the results are presented overall and in different categories classified according to the following variables – altitude (topographic), maturity (institutional), and per household forest size (biophysical).

4.3 Results of change between 2010 and 2013

Summary results are presented in Table 4.3, while explanation of changes in carbon stocks, plant species diversity, and removal of forest products are illustrated in sub-sections. Results about changes in carbon stocks, forest biodiversity attributes, and forest products extraction are presented in sub-sections with descriptive statistics, followed by the results of statistical analysis. The overall results indicated an increase of carbon stocks in all CF types, while contrasting changes appeared within the forest biodiversity indicators and extraction of forest products from 2010 and 2013.

<table>
<thead>
<tr>
<th>Description of carbon stocks, plant diversity and removal of forest products</th>
<th>Pattern of changes across different community forest types</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low altitude</td>
<td>High altitude</td>
</tr>
<tr>
<td>Carbon stocks</td>
<td>++</td>
</tr>
<tr>
<td>Plant species diversity</td>
<td>-</td>
</tr>
<tr>
<td>Plant species richness</td>
<td>0</td>
</tr>
<tr>
<td>Stem density</td>
<td>-</td>
</tr>
<tr>
<td>Timber</td>
<td>+</td>
</tr>
<tr>
<td>Fuelwood</td>
<td>-</td>
</tr>
<tr>
<td>Fodder</td>
<td>-</td>
</tr>
</tbody>
</table>

Source: Data analysis, 2013
4.3.1 Change in carbon stocks

There was a positive change in carbon stocks in all CFs (n = 19) between 2010 and 2013 (Figure 4.4). The overall mean per ha carbon stock in 2010 was 194.80 tC (range 129.94 - 273.2 tC, sd = 36.40) compared to 209.04 tC in 2013 (range 141.78 - 302.01 tC, sd = 37.08). Average annual per ha carbon increment was 3.56 tC, but this varied across different forest types (Table 4.4).

Figure 4.4- Carbon stocks change across community forests in 2010 and 2013

There was a significant increase in carbon stocks from 2010 (median = 188) to 2013 (median = 203) (Wilcoxon signed rank test, Z = -3.82, p = 0.001). However, the mean annual increment varied across CFs (Tables 4.4 and 4.5). Low altitude and less mature CFs had the highest average increment (Table 4.4, Appendix 7).

Table 4.4- Carbon stocks across different categories of community forests

<table>
<thead>
<tr>
<th>Categories of community forests and measurement year</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Median</th>
<th>Std. Deviation</th>
<th>Annual increment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low altitude (8)</td>
<td>129.94</td>
<td>273.20</td>
<td>193.67</td>
<td>194.09</td>
<td>45.80</td>
<td>4.21</td>
</tr>
<tr>
<td>2010</td>
<td>129.94</td>
<td>273.20</td>
<td>193.67</td>
<td>194.09</td>
<td>45.80</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>2013</td>
<td>141.78</td>
<td>201.54</td>
<td>207.64</td>
<td>48.28</td>
<td></td>
</tr>
<tr>
<td>High altitude (11)</td>
<td>168.66</td>
<td>251.26</td>
<td>195.63</td>
<td>185.24</td>
<td>30.24</td>
<td>3.08</td>
</tr>
<tr>
<td>2010</td>
<td>168.66</td>
<td>251.26</td>
<td>195.63</td>
<td>185.24</td>
<td>30.24</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>2013</td>
<td>178.90</td>
<td>207.96</td>
<td>199.11</td>
<td>28.95</td>
<td></td>
</tr>
<tr>
<td>Mature (13)</td>
<td>146.03</td>
<td>273.20</td>
<td>197.93</td>
<td>193.18</td>
<td>36.87</td>
<td>3.79</td>
</tr>
<tr>
<td>2010</td>
<td>146.03</td>
<td>273.20</td>
<td>197.93</td>
<td>193.18</td>
<td>36.87</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>2013</td>
<td>169.51</td>
<td>213.12</td>
<td>203.63</td>
<td>38.22</td>
<td></td>
</tr>
<tr>
<td>Less mature (6)</td>
<td>129.94</td>
<td>231.87</td>
<td>188.03</td>
<td>184.97</td>
<td>37.77</td>
<td>4.38</td>
</tr>
<tr>
<td>2010</td>
<td>129.94</td>
<td>231.87</td>
<td>188.03</td>
<td>184.97</td>
<td>37.77</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>2013</td>
<td>141.78</td>
<td>202.21</td>
<td>202.51</td>
<td>36.11</td>
<td></td>
</tr>
<tr>
<td>Small (12)</td>
<td>168.66</td>
<td>251.26</td>
<td>188.36</td>
<td>186.69</td>
<td>37.75</td>
<td>3.69</td>
</tr>
<tr>
<td>2010</td>
<td>168.66</td>
<td>251.26</td>
<td>188.36</td>
<td>186.69</td>
<td>37.75</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>2013</td>
<td>141.78</td>
<td>203.12</td>
<td>195.61</td>
<td>40.28</td>
<td></td>
</tr>
<tr>
<td>Large (7)</td>
<td>184.78</td>
<td>262.08</td>
<td>196.86</td>
<td>173.57</td>
<td>33.72</td>
<td>3.33</td>
</tr>
<tr>
<td>2010</td>
<td>184.78</td>
<td>262.08</td>
<td>196.86</td>
<td>173.57</td>
<td>33.72</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>2013</td>
<td>178.90</td>
<td>219.20</td>
<td>191.62</td>
<td>30.95</td>
<td></td>
</tr>
<tr>
<td>Average (19)</td>
<td>129.94</td>
<td>273.20</td>
<td>194.80</td>
<td>188.14</td>
<td>36.40</td>
<td>3.56</td>
</tr>
<tr>
<td>2010</td>
<td>129.94</td>
<td>273.20</td>
<td>194.80</td>
<td>188.14</td>
<td>36.40</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>2013</td>
<td>141.78</td>
<td>209.05</td>
<td>203.63</td>
<td>37.07</td>
<td></td>
</tr>
</tbody>
</table>
Table 4.5- Change in carbon stocks in different community forest types between 2010 and 2013 (changes were positive for all community forests)

<table>
<thead>
<tr>
<th>Categories of community forests</th>
<th>Z^b-value and probability (p)(^c) in parenthesis</th>
<th>Carbon change and mean rank(^c)</th>
<th>Magnitude of change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low altitude (8)</td>
<td>-2.52(^b)(p = 0.01)</td>
<td>Positive for 8 (4.5)</td>
<td>++</td>
</tr>
<tr>
<td>High altitude (11)</td>
<td>-2.93(^b)(p = 0.003)</td>
<td>Positive for 11 (6.0)</td>
<td>++</td>
</tr>
<tr>
<td>Mature (13)</td>
<td>-3.18(^b)(p = 0.001)</td>
<td>Positive for 13 (7.0)</td>
<td>++</td>
</tr>
<tr>
<td>Less mature (6)</td>
<td>-2.20(^b)(p = 0.028)</td>
<td>Positive for 6 (3.5)</td>
<td>++</td>
</tr>
<tr>
<td>Small (12)</td>
<td>-3.05(^b)(p = 0.002)</td>
<td>Positive 12 (6.5)</td>
<td>++</td>
</tr>
<tr>
<td>Large (7)</td>
<td>-2.36(^b)(p = 0.018)</td>
<td>Positive 7 (4.0)</td>
<td>++</td>
</tr>
</tbody>
</table>

a. Probability value, b. Z-value based on negative ranks, c. Number of community forests experiencing positive, negative or no change, mean rank value in parenthesis.

4.3.2 Change in plant species diversity, richness and plant-stem density

Mean plant species diversity (Shannon-Wiener diversity index) was 1.50 (range 0.60 - 2.22) in 2010 and 1.37 in 2013 (range 0.43 - 2.11). Mean species richness was 19 (sd = 7.90) in 2010 and 18 in 2013 (sd = 7.03). Mean stem density was 2948 (sd = 1410.11) in 2010 and 2604 (sd = 865.85) in 2013.

There was a significant decrease in overall median plant diversity between 2010 (median = 4.3) and 2013 (median = 3.6) (Z = -3.26, p = 0.001), but no significant difference in plant species richness and stem density between these years. Nevertheless, higher negative mean ranks were observed for both attributes in the majority of CFs (Table 4.6), which suggests that while overall values did not differ, more CFs experienced a decline in species richness and stem density than an increase.

Table 4.6- Change in plant species diversity, species richness and stem density between 2010 and 2013

<table>
<thead>
<tr>
<th>Forest biodiversity attributes</th>
<th>Z^b-value and probability (p)(^c) in parenthesis</th>
<th>Carbon change and mean rank(^c)</th>
<th>Magnitude of change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant diversity species</td>
<td>-3.26(^b)(p=0.001)</td>
<td>Positive for 3 (4.67), Negative for 16 (11) equal for 0</td>
<td>--</td>
</tr>
<tr>
<td>Species richness</td>
<td>-1.60(^b)(p=0.11)</td>
<td>Positive for 7 (7), Negative for 11 (11.09), equal for 1</td>
<td>-</td>
</tr>
<tr>
<td>Stem density</td>
<td>-1.08(^b)(p=0.27)</td>
<td>Positive for 8 (8.50), Negative for 11 (11.09), equal for 0</td>
<td>-</td>
</tr>
</tbody>
</table>

a. Wilcoxon signed sum ranks, b. based on positive ranks for species richness, stem density, and plant diversity, c. Number of community forests experiencing positive, negative or no change, mean rank value in parenthesis.

Mean plant species diversity, species richness, and stem density varied widely among CF types. Low altitude, small, and mature CFs had the highest mean plant species diversity, while high altitude and large CFs had the highest species richness (Figures 4.5
and 4.6, Appendix 8). High altitude, less mature, and large CFs had the highest stem density (Figure 4.7).

![Figure 4.5](image)

**Figure 4.5-** Mean and standard error of plant species diversity in different community forest in 2010 and 2013

![Figure 4.6](image)

**Figure 4.6-** Mean and standard error of plant species richness in different community forests in 2010 and 2013

There was a statistically significant negative change in plant species diversity in all CF types, except in low altitude CFs between 2010 and 2013 (Table 4.7). Negative mean ranks were observed in low altitude CFs, indicating a marginal decrease of plant species diversity in these forests while a significant decrease of species diversity in the other categories of CFs.
No statistically significant change was recorded in plant species richness for all categories of CFs over the same period. However, negative mean ranks were observed in the majority of high altitude, and large CFs, indicating a marginal reduction of species richness in these CFs (Table 4.8). The results further show that there was no change in plant species richness in low altitude, mature and small CFs.

Table 4.7- Changes in plant species diversity in community forests between 2010 and 2013

<table>
<thead>
<tr>
<th>CF categories</th>
<th>Zb-value and probability (p)b in parenthesis</th>
<th>Plant species diversity change and mean rankc</th>
<th>Magnitude of change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low altitude (8)</td>
<td>-1.4b(p = 0.16)</td>
<td>Positive for 2 (4.0), Negative for 6 (4.67), equal for 0</td>
<td>-</td>
</tr>
<tr>
<td>High altitude (11)</td>
<td>-2.84b(p = 0.004)</td>
<td>Positive for 1 (1.0), Negative for 10 (6.5), equal for 0</td>
<td>--</td>
</tr>
<tr>
<td>Mature (13)</td>
<td>-2.62b(p = 0.009)</td>
<td>Positive for 2 (4), Negative for 11 (7.55), equal for 0</td>
<td>--</td>
</tr>
<tr>
<td>Less mature (6)</td>
<td>-1.99b(p = 0.04)</td>
<td>Positive for 1 (1), Negative for 5 (4), equal for 0</td>
<td>--</td>
</tr>
<tr>
<td>Small (12)</td>
<td>-2.51b(p = 0.01)</td>
<td>Positive for 2 (3.5), Negative for 10 (7.1), equal for 0</td>
<td>--</td>
</tr>
<tr>
<td>Large (7)</td>
<td>-2.02b(p = 0.04)</td>
<td>Positive for 1 (2.0), Negative for 6 (4.33), equal for 0</td>
<td>--</td>
</tr>
</tbody>
</table>

a. Wilcoxon Signed Ranks Test, b. Based on positive ranks, c. Number of community forests experiencing positive, negative or no change, mean rank value in parenthesis

Table 4.8- Changes in plant species richness in community forests between 2010 and 2013

<table>
<thead>
<tr>
<th>CF categories</th>
<th>Zb-value and probability (p)b in parenthesis</th>
<th>Plant species richness change and mean rankc</th>
<th>Magnitude of change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low altitude (8)</td>
<td>-0.28b(p= 0.77)</td>
<td>Positive for 4 (4.0), Negative for 4 (5.0), equal for 0</td>
<td>0</td>
</tr>
<tr>
<td>High altitude (11)</td>
<td>-1.84b(p= 0.06)</td>
<td>Positive for 3 (3.17), Negative for 7 (6.5), equal for 1</td>
<td>-</td>
</tr>
</tbody>
</table>
The results show that changes in stem density were almost identical to plant species richness for the same period (Table 4.9). The results indicate negative mean ranks for the majority of high altitude, mature and small CFs, indicating that there was a marginal decline in stem density in these CFs. The results further show that there were negative mean ranks in low number of CFs, indicating that there was no decline of stem density in these CFs.

Table 4.9- Changes in stem density in community forests between 2010 and 2013

<table>
<thead>
<tr>
<th>Categories of community forests</th>
<th>Probability and Z-value (p) in parenthesis</th>
<th>Stem density change and mean rank</th>
<th>Magnitude of change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low altitude (8)</td>
<td>-0.49b (p= 0.62)</td>
<td>Positive for 4 (3.63), Negative for 4 (5.38), equal for 0</td>
<td>-</td>
</tr>
<tr>
<td>High altitude (11)</td>
<td>-1.02b (p = 0.30)</td>
<td>Positive for 4 (5.38), Negative for 7 (6.36), equal for 0</td>
<td>-</td>
</tr>
<tr>
<td>Mature (13)</td>
<td>-0.66b (p = 0.50)</td>
<td>Positive for 6 (6), Negative for 7 (7.86), equal for 0</td>
<td>-</td>
</tr>
<tr>
<td>Less mature (6)</td>
<td>-0.94b (p = 0.34)</td>
<td>Positive for 2 (3.0), Negative for 4 (3.75), equal for 0</td>
<td>-</td>
</tr>
<tr>
<td>Small (12)</td>
<td>-0.70b (p = 0.48)</td>
<td>Positive for 6 (5), Negative for 6 (8), equal for 0</td>
<td>-</td>
</tr>
<tr>
<td>Large (7)</td>
<td>-1.01b (p = 0.31)</td>
<td>Positive for 2 (4.0), Negative for 5 (4.0), equal for 0</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 4.9- Changes in stem density in community forests between 2010 and 2013

4.3.3 Change in removal of forest products

Average per ha timber harvest was 11.66 cubic feet (range 0.00 - 44 cubic feet, sd = 14.02) in 2010 and 11.68 cubic feet (range 1 - 57 cubic feet, sd = 12.67) in 2013. Average per ha fuelwood harvested was 1275 kg (range 11-4745 kg, sd = 1403.17) in 2010 and 747.78 kg (range 20 – 2494 kg, sd = 767.07) in 2013. Average per ha fodder harvested was 2071.21 kg (range 21 – 8446 kg, sd = 2416.97) in 2010 and 2097.42 kg (range 0-7819 kg, sd = 2633.47) in 2013.

There was a statistically significant decline in fuelwood extracted between 2010 and 2013 (Z = -2.34, p = .01). No statistically significant difference was found for timber or
fodder over the same period (Table 4.10). There was an increase in the average volume of timber harvested, but a decrease in the harvest of fuelwood and fodder in 11 of the 19 CFs.

Table 4.10- Change in removal of timber, fuelwood, and fodder in community forests between 2010 and 2013

<table>
<thead>
<tr>
<th>Forest products</th>
<th>Z-value and probability (p)</th>
<th>Forest products change and mean rank</th>
<th>Magnitude of change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timber</td>
<td>-0.52^(b)(p=0.60)</td>
<td>Positive for 11 (8.86), Negative for 7 (10.50), equal for 1</td>
<td>+</td>
</tr>
<tr>
<td>Fuelwood</td>
<td>-2.34^(c)(p=0.01)</td>
<td>Positive for 6 (4.50), Negative for 11 (11.45), equal for 2</td>
<td>--</td>
</tr>
<tr>
<td>Fodder</td>
<td>-1.29^(c)(p=0.19)</td>
<td>Positive for 5 (8.60), Negative for 11 (8.45), equal for 3</td>
<td>-</td>
</tr>
</tbody>
</table>

a. Probability value, b. Based on negative ranks, c. Based on positive ranks d. Number of community forests experiencing positive, negative or no change, mean rank value in parenthesis

The results show that low altitude and small CFs had higher mean per ha timber harvested in both 2010 and 2013 compared to high altitude and large CFs (Figure 4.8). However, the mean value of timber harvested in mature CFs was higher than that of less mature in 2013, while it was much lower in 2010.

Figure 4.8- Mean and standard error of timber harvest in different community forests in 2010 and 2013

There was a decrease in the mean value of fuelwood harvested for all types of CFs in 2013 compared to 2010 (Figure 4.9). However, the results reveal that mature and small CFs had the higher values of fuelwood harvested both in 2010 and 2013. Less mature
CFs had the smallest value of fuelwood harvested compared to other categories of CFs with the smallest mean value of change between 2010 and 2013 (Figure 4.9).

![Figure 4.9- Mean and standard error of fuelwood harvest in different community forests in 2010 and 2013](image)

While fodder harvested generally decreased between 2010 and 2013, the results reveal that changes in fodder harvested varies across the forest types (Figure 4.10, Appendix 9). The results further show that mean value of fodder harvested differs among CF types. Less mature and small CFs had the highest values for fodder harvest in both 2010 and 2013, while large and mature CFs had the lowest values.

![Figure 4.10- Mean and standard error of fodder extraction in different community forests in 2010 and 2013](image)
Change in the harvest of forest products varied among the different CFs types between 2010 and 2013. Mature CFs had a significant increase in timber harvest, while low altitude and small CFs had a marginal increase (Table 4.11). In contrast, a marginal decrease in timber harvest was observed in high altitude and less mature CFs.

A statistically significant negative change was observed for the extraction of fuelwood in mature and small CFs (Table 4.12). Removal of fuelwood declined in the majority of low and high altitude, less mature and large CFs with higher negative mean ranks compared to positive mean ranks in the majority of CFs. Fodder harvest slightly decreased in the majority of CFs with higher negative mean ranks (Table 4.13). However, this difference was not statistically significant for any of the CF categories.

Table 4.11- Change in timber harvest in different community forests in 2010 and 2013

<table>
<thead>
<tr>
<th>Categories of community forests</th>
<th>Z*-value and probability (p)a in parenthesis</th>
<th>Timber harvest change and mean rankd</th>
<th>Magnitude of change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low altitude (8)</td>
<td>-1.18b(p=0.23)</td>
<td>Positive for 6 (3.5), Negative for 1 (7), equal for 1</td>
<td>+</td>
</tr>
<tr>
<td>High altitude (11)</td>
<td>-0.48b(p=0.62)</td>
<td>Positive for 5 (5.5), Negative for 6 (6.42), equal for 0</td>
<td>-</td>
</tr>
<tr>
<td>Mature (13)</td>
<td>-2.43b(p=0.01)</td>
<td>Positive for 10 (7), Negative for 2 (4), equal for 1</td>
<td>++</td>
</tr>
<tr>
<td>Less mature (6)</td>
<td>-1.15b(p=0.24)</td>
<td>Positive for 1 (5), Negative for 5 (3.2), equal for 0</td>
<td>-</td>
</tr>
<tr>
<td>Small (12)</td>
<td>-0.58b(p=0.55)</td>
<td>Positive for 8 (5.81), Negative for 4 (7.88), equal for 0</td>
<td>+</td>
</tr>
<tr>
<td>Large (7)</td>
<td>-0.10b(p=0.91)</td>
<td>Positive for 3 (3.67), Negative for 3 (3.33), equal for 1</td>
<td>0</td>
</tr>
</tbody>
</table>

a. Probability value, b. Based on negative ranks, c. Based on positive ranks, d. Number of community forests experiencing positive, negative or no change, mean rank value in parenthesis

Table 4.12- Change in fuelwood extraction in different community forests in 2010 and 2013

<table>
<thead>
<tr>
<th>Categories of community forests</th>
<th>Z*-value and probability (p)a in parenthesis</th>
<th>Fuelwood collection change and mean rankc</th>
<th>Magnitude of change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low altitude (8)</td>
<td>-1.40b(p=0.16)</td>
<td>Positive for 3 (2.67), Negative for 5 (5.6), equal for 0</td>
<td>-</td>
</tr>
<tr>
<td>High altitude (11)</td>
<td>-1.83b(p=0.06)</td>
<td>Positive for 3 (2.33), Negative for 6 (6.33), equal for 2</td>
<td>-</td>
</tr>
<tr>
<td>Mature (13)</td>
<td>-2.11b(p=0.03)</td>
<td>Positive for 4 (3.0), Negative for 8 (8.25), equal for 1</td>
<td>--</td>
</tr>
<tr>
<td>Less mature (6)</td>
<td>-1.21b(p=0.22)</td>
<td>Positive for 2 (1.5), Negative for 3 (4), equal for 1</td>
<td>-</td>
</tr>
<tr>
<td>Small (12)</td>
<td>-1.96b(p=0.05)</td>
<td>Positive for 4 (3.50), Negative for 8 (8), equal for 0</td>
<td>--</td>
</tr>
<tr>
<td>Large (7)</td>
<td>-1.21b(p=0.22)</td>
<td>Positive for 2 (1.5), Negative for 3 (4), equal for 2</td>
<td>-</td>
</tr>
</tbody>
</table>

a. Probability value, b. Based on positive ranks, c. Number of community forests experiencing positive, negative or no change, mean rank value in parenthesis
Table 4.13- Change in fodder extraction in different community forests in 2010 and 2013

<table>
<thead>
<tr>
<th>Categories of community forests</th>
<th>Z*-value and probability (p)* in parenthesis</th>
<th>Fodder harvest change and mean rank†</th>
<th>Magnitude of change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low altitude (8)</td>
<td>-0.70b (p=0.48)</td>
<td>Positive for 2 (6.5), Negative for 6 (3.83), equal for 0</td>
<td>-</td>
</tr>
<tr>
<td>High altitude (11)</td>
<td>-0.98b (p=0.32)</td>
<td>Positive for 3 (3.67), Negative for 5 (5), equal for 3</td>
<td>-</td>
</tr>
<tr>
<td>Mature (13)</td>
<td>-0.53b (p=0.59)</td>
<td>Positive for 4 (6.75), Negative for 7 (5.57), equal for 2</td>
<td>-</td>
</tr>
<tr>
<td>Less mature (6)</td>
<td>-1.75b (p=0.08)</td>
<td>Positive for 1 (1.0), Negative for 4 (3.5), equal for 1</td>
<td>-</td>
</tr>
<tr>
<td>Small (12)</td>
<td>-0.97b (p=0.32)</td>
<td>Positive for 4 (5.5), Negative for 7 (6.29), equal for 1</td>
<td>-</td>
</tr>
<tr>
<td>Large (7)</td>
<td>0.67b (p=0.50)</td>
<td>Positive for 1 (5.0), Negative for 4 (2.5), equal for 2</td>
<td>-</td>
</tr>
</tbody>
</table>

a. Probability value, b. Based on positive ranks, c. Number of community forests experiencing positive, negative or no change, mean rank value in parenthesis

4.4 Discussion

RQ 1-What is the status of carbon stocks, plant species diversity, and removal of forest products in community forests?

There was a substantial variation in carbon stocks, plant species diversity, and extraction of forest products in CFs from 2010 to 2013. A significant increase in carbon stocks was observed across the CFs, although the amount of that increase varied according to the CFs types. Plant species diversity declined, but again, by varying magnitude for different CFs types. Although there were no statistically significant changes in plant species richness or stem density between 2010 and 2013, there was a marginal decline in both with greater negative mean ranks in the majority of CFs. Fuelwood collection declined substantially over the survey period, with the decline more pronounced in certain CFs types. Temporal change in timber harvest showed a mixed pattern across different CFs types, while fodder harvest declined slightly over the survey period.

4.4.1 Change in carbon stocks

I assessed carbon stocks in CFs before and after the implementation of REDD+. Very few studies have conducted this specific comparison, so I have compared my results with carbon assessments in CFs in similar ecological regions in Nepal, and with other countries without REDD+.  

91
In my study, there was an average annual increment in carbon stocks of 3.56 tC ha\(^{-1}\) from 2010 to 2013. This trend is consistent with the results of previous studies in CFs in similar ecological regions of Nepal (e.g. Banskota et al., 2007; Bhattarai et al., 2012; Karky, 2008; Magar, 2012; Rana, 2008; Rana et al., 2008; Shrestha et al., 2012). However, the annual increment of carbon recorded in my study was greater than that found in past surveys in CFs without REDD+. Hence, the implementation of REDD+ in my study area may have led to greater emphasis on carbon storage among forest managers.

Pandey et al. (2014) and Shrestha et al. (2014) also observed a greater annual increment of carbon stocks in REDD+ CFs compared to non-REDD+ CFs, attributing this increase to changed forest management approaches. My results are also supported by Beyene et al. (2013), who found increased carbon stocks in community controlled forests in Ethiopia with changes in forest management triggered by REDD+.

Kanninen et al. (2010) and Parrota et al. (2012a) discussed ways that forest managers may increase carbon stocks in CFs under REDD+. Firstly, local communities can maintain forests by applying reduced impact logging, and plantation. Secondly, local communities can maintain or improve carbon stocks through grazing regulation and fire control. Thirdly, they can increase carbon stocks by prolonging the rotation period of logging and regulating the harvest of forest products. As described by local communities, the majority of CFUGs introduced regulation of fuelwood collection and introduced alternative energy schemes in my research area (see also Chapters 7 and 8). The changes in forest management that occurred in my study area were likely linked to the incentives to improve carbon storage that are inherent in REDD+.

In my study, a greater increase in carbon stocks observed in low altitude CFs, is in accord with the results from a recent study in REDD+ CFs in Nepal (Pandey, Maraseni, & Cockfield, 2014). This result may be linked to the presence of fast-growing subtropical broadleaved tree species in low altitude forests (Berenguer et al., 2014), and to faster microbial activities and litter decomposition at higher temperatures leading to the higher productivity that characterises low altitude forests (Malhi et al., 1999; Raich et al., 2006). Gough et al. (2008) suggested also that lower altitude forests have a longer growing season, which leads to greater potential for increased rates of carbon storage compared to high altitude forests. Previous studies by Zhu et al. (2010) in China, and...
Moser et al. (2011) and Leuschner et al. (2007) in Ecuador have reported that carbon stocks decrease as altitude increases. Some authors e.g. Thomas et al. (2010) in US and Garcia-Gonzalo et al. (2007) in Finland observed that stimulation of forest carbon storage has gradually increased due to global warming and CO₂ fertilisation. This suggests that ongoing global warming causes some changes in carbon stocks increment besides the changes in forest management activities and location of forests.

There was a greater increment over time in carbon stocks in less mature (in terms of when the forest was designated as a CF) compared to more mature CFs. Less mature forests, however, stored less carbon, as found by previous studies (Camacho et al., 2011; Ranabhat et al., 2008). Hence, the margin for carbon increment in less mature forests is possibly more than it is for mature forests (Bluffstone et al., 2015; Coleman, 2009; Pokharel, 2012). Also, the less mature forests in my study site were degraded lands before being handed over by the government to local communities (Springate-Baginski et al., 2003). As recognised by Edwards et al. (2010), degraded forests have greater scope for restoration and improvement in carbon storage potential. Moreover newly formed CFUGs usually adopt protection-oriented activities at least in the initial year of the hand over, with restriction of the harvest of some forest resources (Edmonds, 2002; Springate-Baginski et al., 2001).

In general, my results suggest there was a positive change in carbon stocks in CFs between 2010 and 2013. The outcome was the result of ecological factors inherent in the forests, change in socio-economic circumstances in the study areas, and modified forest management activities influenced by the implementation of REDD+. I discuss the latter in detail in Chapters 7 and 8.

4.4.2 Change in plant species diversity, richness, and stem density

Plant species diversity in my study was less than values calculated in other studies in CFs in Nepal and elsewhere (e.g. Mandal et al., 2013; Pandey, Maraseni, Cockfield, et al., 2014; Poudel, Fuwa, et al., 2014), though greater than the plant species diversity estimated by Baral & Katzensteiner (2009) in mid-hills CFs in Nepal.

Plant species richness in my study was much higher in high altitude forests (above 2000m) compared to low altitude forests (up to 2000m), consistent with the study of Vetaas & Grytnes (2002) and Grau et al. (2007) in Nepal, and Oommen & Shanker
(2005) in India, who observed greater species richness up to 3300 m altitude. This supports my results; high altitude forests in my study area span 2000 m to 3300 m.

There was a decline in plant species diversity and plant species richness from 2010 to 2013, coinciding with the implementation of REDD+. Similar results for plant species diversity were found by Pandey et al. (2014) in CFs in Nepal, after implementation of REDD+. These authors highlighted the preference of local communities for plant species with a high carbon potential as the reason for declining plant species diversity.

Plant species diversity may decline according to how local communities value different plant species. While some species may be highly valued for uses such as timber or fuelwood, introduction of carbon-focused incentives through REDD+ may change values and priorities (Baraloto et al., 2014). The results from my study are related to ecological context, but also to changes in forest management (see Chapter 8).

According to Edwards et al. (2010) and Battles et al. (2001), forest management activities relevant to REDD+ can follow two pathways that change the status of plant species diversity. First, local communities may select trees to plant that enrich carbon stocks (Battles et al., 2001). Second, communities may thin forests and extract forest products such as fuelwood, timber, and fodder, which can alter plant species diversity as preferred species are removed. These activities do not always result in a decline in plant species diversity. For example, Esther et al. (2014), Gondard et al. (2007), and Coote et al. (2012) noted an increase in plant species in semi-natural forests like CFs through the introduction of new plant species during plantation activities.

Stem density varied across CFs in my study area, being higher in high altitude, less mature and large CFs. Variation in stem density is mainly determined by selective logging practices of CFUGs. Higher stem density in high altitude CFs may reflect the fact that in my study area these forests are often distant and inaccessible from human settlements leading to less tree removal (see Chapter 7). In less mature CFs, CFUGs usually apply less intensive thinning regimes and remove fewer standing trees to allow natural regeneration at least in the early stage of forests resulting in greater stem density. Higher stem density in large CFs reflects the fact that these forests are large enough to meet user needs without reducing stem density substantially.
4.4.3 Change in extraction of forest products

The removal of fuelwood generally declined from 2010 to 2013 across all CF types, while the extraction of fodder exhibited only small differences. The amount of timber extracted increased in low altitude and mature forests, while it decreased in less mature forests although there was large uncertainty in these results.

Household level fuelwood collection in CFs is associated with several factors including income level, economic status of forest users (Hofstad et al., 2009), resource availability, and distribution rules (Heltberg, 2004). Higher income levels and improvement in economic status may increase the purchasing power of households for alternative energy schemes, reducing the demand for fuelwood from local forests (Arnold et al., 2006; Cooke et al., 2008). This is important in the case of REDD+, where implementation and provision of financial incentives through REDD+ can improve the economic status of forest users and may motivate switching from fuelwood to other forms of energy (e.g. improved cooking stove – see Chapter 8).

Results similar to mine were found by Webb & Dhakal (2011), who observed a reduction in fuelwood extraction in rural communities due to switching from fuelwood to other energy schemes. Pokharel (2003), Aryal et al. (2009), and Link et al. (2012) also observed a gradual decrease in fuelwood extraction from CFs with the introduction of alternative energy schemes.

The impact of reduced extraction of fuelwood from CFs may be compensated by wood from other sources, primarily private farmlands (see Chapter 7). Baral et al. (2014) and Lamichhane (2009) noted that fuelwood is still one of the most demanded and harvested forest products in the majority of Nepalese CFs. However, the decline in fuelwood extraction recorded in my study could be related to a management focus on increasing carbon stocks (Poudel, Thwaites, et al., 2014). For example, respondents from the group interviews I conducted reported that CFUGs were motivated through REDD+ to undertake restriction on fuelwood collection and implement alternative energy schemes (see Chapter 8). Maraseni et al. (2014) also found a decline in fuelwood extraction in REDD+ piloted CFs in Nepal, especially when CFUGs aimed to maximize carbon stocks in their forests.
There was a small increase in timber harvesting over the survey period. Timber harvesting is viewed as a consequence of economic and institutional interaction (Rana, 2008), and incurs a relatively higher cost related to money and skill, compared to other forest products (Ojha et al., 2009; Sinha, 2011). As reported by Baral et al. (2014) and Rai et al. (2010), timber in CFs is usually harvested only by well-off households. Increased timber harvesting in some CFs of my study may be attributed to improvement of household income of local communities from income activities such as outmigration, vegetable farming and small financial contributions of REDD+ pilot project. However, lower timber harvesting in some CFs was possibly due to restrictions on harvesting, particularly to enrich carbon stocks for maximising future REDD+ incentives (Kronenberg & Hubacek, 2013; Poudel, Thwaites, et al., 2014), and less availability of timber (Yadav et al., 2003).

The marginal difference in fodder harvest from 2010 to 2013 possibly reflects the fact that this resource is not in high demand among CFUGs (Baral et al., 2014; Lamichhane, 2009). Dependency on fodder is also lower more generally owing to an increase in fodder trees and ground grass on private farmlands (Barshila et al., 2013).
Chapter 5 - Relationships between carbon stocks, forest biodiversity, and forest products extraction

5.1 Introduction

This chapter discusses the pattern of association between carbon stock, forest biodiversity and removal of forest products. Chapter 4 indicates that REDD+ initiatives likely generated negative outcomes for plant species diversity and forest products extraction in CFs, while carbon stocks increased. REDD+ is designed to enhance forest carbon stocks but may also generate co-benefits including the conservation of biodiversity and improvement of local livelihoods. This did not appear to be occurring in my study area, leading to concerns about the viability of REDD+ in CFs. It is clear that both trade-offs and synergies occur in the management of carbon, plant diversity and forest resources across CFs, and it is vital to identify which particular forests offer opportunities for synergy (providing multiple benefits) or experience trade-offs (e.g. the enhancement of carbon stocks leads to a reduction in either plant diversity or forest resource access).

The extraction of forest products generally reduces forest carbon stocks. Unsustainable and overharvesting of forest products causes forest degradation, particularly in CFs, where the majority of people rely on forest products for their subsistence livelihoods (Skutsch, Balderas-Torres, et al., 2011).

There has been increased interest in synergies between protecting carbon stocks and continued supply of forests products (Fahey et al., 2009; Pandey, Cockfield, et al., 2014). At the same time, conservation of forest biodiversity is highly valued by local, national, and international authorities (CBD, 2011). However, some REDD+ initiatives have shown that there are potential trade-offs between protecting carbon stocks, forest biodiversity, and local livelihoods in certain circumstances (Chhatre & Agrawal, 2009; Miah, 2014; Visseren-Hamakers, McDermott, et al., 2012).

Despite the potential for REDD+ to improve carbon stocks while also protecting biodiversity and improving local livelihoods, limited research has been conducted on the relationships between those factors (Martin et al., 2013). Better understanding of these relationships would help to reduce the potential for trade-offs in the supply of these benefits that might arise during the implementation of REDD+. Characterisation
of the relationships is also vital, in order to improve management and forest policies integrating REDD+ which aim to enhance carbon stocks and forest products extraction and conserve biodiversity.

There is great potential to manage multiple benefits from forests, and several authors (e.g. Cavanaugh et al., 2014; Gamfeldt et al., 2013; Ruiz-Benito et al., 2014; Thompson et al., 2012), have noted a positive relationship between plant species diversity, carbon stocks, and tangible forest products (i.e. timber, fuelwood and fodder). Higher plant species diversity can enhance the resilience of forest ecosystems generating greater biomass for carbon stocks and removal of forest products (Hicks et al., 2014; Pedro et al., 2014). However, some authors (such as Day et al., 2014; Jandl et al., 2007; Kirby & Potvin, 2007) have highlighted that higher plant species diversity may not always be critical to the delivery of carbon storage and forest products. For example, Crossman et al. (2011) estimated a greater amount of carbon stock is sequestered in monoculture plantation using high-yielding species compared to mixed-species plantation.

This chapter assesses associations between carbon stocks, three forest biodiversity attributes (i.e. plant species diversity, species richness, and stem density), and extraction of three forest products (timber, fuelwood, and fodder), using data from the ICIMOD forest inventory and records from CFUGs. The findings of the analysis are discussed with reference to ecological circumstances and underlying factors of forest ecosystem degradation.

### 5.2 Collection and analysis of data

Data related to carbon stocks, forest biodiversity attributes and extraction of timber, fuelwood, and fodder were collected as per Chapter 4 (see section 4.2 for details). Details amount of forest products removal, carbon stocks and biodiversity attributes for 2010 and 2013 are given in table 5.1. I applied two approaches to the analysis and presentation of data for this study.

#### Table 5.1- Details of carbon stocks, plant diversity and forest products removal from 2010 to 2013

<table>
<thead>
<tr>
<th>Name of community forests</th>
<th>Per carbon stocks (tC)</th>
<th>Plant species diversity</th>
<th>Species richness</th>
<th>Stem density</th>
<th>Per ha Timber (cubic feet) extraction</th>
<th>Per ha Fuelwood (kg) extraction</th>
<th>Per ha Fodder (kg) extraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barkhedandapari</td>
<td>195.00</td>
<td>211.66</td>
<td>2.10</td>
<td>11</td>
<td>1400</td>
<td>2768</td>
<td>692</td>
</tr>
<tr>
<td>Bhakare</td>
<td>231.87</td>
<td>242.33</td>
<td>1.30</td>
<td>14</td>
<td>1440</td>
<td>268</td>
<td>8446</td>
</tr>
<tr>
<td>Bhitteripakha</td>
<td>251.26</td>
<td>253.21</td>
<td>1.59</td>
<td>30</td>
<td>2338</td>
<td>197</td>
<td>426</td>
</tr>
<tr>
<td>Charnawati 1</td>
<td>242.18</td>
<td>262.08</td>
<td>1.52</td>
<td>41</td>
<td>2600</td>
<td>34</td>
<td>21</td>
</tr>
<tr>
<td>Charnawati 2</td>
<td>193.18</td>
<td>203.63</td>
<td>1.82</td>
<td>19</td>
<td>2690</td>
<td>102</td>
<td>3175</td>
</tr>
</tbody>
</table>
First, I analysed pairwise associations between variables for 2010 and 2013, using Spearman’s rank order correlation ($\alpha = 0.05$). The strength of association ranges between -1 and +1, and this was classified into five categories, namely: zero, weak, moderate, strong, and perfect following Dancey & Reidy (2007) (Table 5.2).

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Chyasebhagabati</td>
<td>169.53</td>
<td>182.56</td>
<td>2.22</td>
<td>2.10</td>
<td>13</td>
<td>15</td>
<td>1560</td>
<td>2520</td>
<td>1</td>
<td>5</td>
<td>1853</td>
<td>1697</td>
<td>3786</td>
<td>3786</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dhandesinghdevi</td>
<td>226.61</td>
<td>230.89</td>
<td>1.34</td>
<td>1.18</td>
<td>23</td>
<td>22</td>
<td>2400</td>
<td>2280</td>
<td>17</td>
<td>11</td>
<td>713</td>
<td>621</td>
<td>1324</td>
<td>467</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eklepakha</td>
<td>171.78</td>
<td>189.71</td>
<td>1.46</td>
<td>1.360</td>
<td>18</td>
<td>19</td>
<td>3400</td>
<td>2560</td>
<td>13</td>
<td>12</td>
<td>296</td>
<td>438</td>
<td>296</td>
<td>337</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harissidhumai</td>
<td>146.03</td>
<td>169.51</td>
<td>1.27</td>
<td>1.24</td>
<td>9</td>
<td>7</td>
<td>5680</td>
<td>3320</td>
<td>2</td>
<td>7</td>
<td>2074</td>
<td>741</td>
<td>59</td>
<td>21</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jugedarkha</td>
<td>185.24</td>
<td>199.11</td>
<td>1.72</td>
<td>1.20</td>
<td>27</td>
<td>18</td>
<td>4520</td>
<td>3280</td>
<td>24</td>
<td>9</td>
<td>11</td>
<td>56</td>
<td>836</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kopila</td>
<td>173.57</td>
<td>191.62</td>
<td>1.43</td>
<td>1.53</td>
<td>13</td>
<td>17</td>
<td>2680</td>
<td>2480</td>
<td>2</td>
<td>2</td>
<td>415</td>
<td>421</td>
<td>208</td>
<td>155</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Majhkharkalisepani</td>
<td>168.66</td>
<td>178.90</td>
<td>1.45</td>
<td>1.28</td>
<td>23</td>
<td>17</td>
<td>4240</td>
<td>2600</td>
<td>0.6</td>
<td>6</td>
<td>2898</td>
<td>20</td>
<td>830</td>
<td>261</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mathani</td>
<td>273.20</td>
<td>302.01</td>
<td>1.79</td>
<td>1.62</td>
<td>13</td>
<td>15</td>
<td>1720</td>
<td>2320</td>
<td>3</td>
<td>18</td>
<td>3713</td>
<td>2153</td>
<td>1658</td>
<td>716</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Napkeyanmara</td>
<td>194.04</td>
<td>211.79</td>
<td>1.75</td>
<td>1.61</td>
<td>26</td>
<td>23</td>
<td>2340</td>
<td>2280</td>
<td>2</td>
<td>5</td>
<td>1610</td>
<td>943</td>
<td>2024</td>
<td>3602</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Setidevidadar</td>
<td>184.70</td>
<td>205.91</td>
<td>0.59</td>
<td>0.42</td>
<td>14</td>
<td>14</td>
<td>5120</td>
<td>4720</td>
<td>6</td>
<td>1</td>
<td>332</td>
<td>332</td>
<td>1120</td>
<td>1120</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shivajungbhumeshthan</td>
<td>129.94</td>
<td>141.78</td>
<td>1.32</td>
<td>1.26</td>
<td>14</td>
<td>15</td>
<td>1480</td>
<td>2640</td>
<td>0.0</td>
<td>23</td>
<td>202</td>
<td>225</td>
<td>450</td>
<td>225</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sitakunda</td>
<td>206.62</td>
<td>221.82</td>
<td>1.09</td>
<td>1.13</td>
<td>14</td>
<td>15</td>
<td>1720</td>
<td>1760</td>
<td>42</td>
<td>57</td>
<td>582</td>
<td>384</td>
<td>991</td>
<td>873</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thangsadeurali</td>
<td>188.14</td>
<td>192.12</td>
<td>1.40</td>
<td>1.16</td>
<td>20</td>
<td>16</td>
<td>1600</td>
<td>1440</td>
<td>9</td>
<td>19</td>
<td>4745</td>
<td>2494</td>
<td>2987</td>
<td>2283</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thumkadanda</td>
<td>169.83</td>
<td>181.29</td>
<td>1.53</td>
<td>1.57</td>
<td>18</td>
<td>20</td>
<td>3880</td>
<td>3920</td>
<td>33</td>
<td>11</td>
<td>1511</td>
<td>1287</td>
<td>7724</td>
<td>7819</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Second, I analysed synergies and trade-offs in the forest attributes using methods described in Luck et al. (2009). I standardised the numerical values of carbon stocks, forest biodiversity attributes and forest products using Z-scores so that the value of each attribute had a mean zero and a standard deviation of one (Appendix 10). Then I calculated the median value for each attribute. This was used as the threshold value to determine if forest attributes values were high or low (i.e. above or below the median value, respectively). Finally, I plotted forest attribute values in pairwise comparisons to identify trade-offs or synergies for any given CF using S+ software (see Appendix 11).

For example, in a pairwise comparison of values for carbon stocks and plant species diversity, a given forest may have high values for both (positive synergy), low values for both (negative synergy), a high value for carbon stocks, but a low value for plant diversity (a trade-off favouring carbon stocks), or a low value for carbon stocks and a high value for plant species diversity (a trade-off favouring plant diversity and, therefore, conservation value) (Figure 5.1). A number from 1-19 was assigned to each CF (Figure 5.2) and these numbers were used as labels in the scatter plots showing trade-offs and synergies (see Results). Basic characteristics of these CFs were as mentioned in chapter 4.
Note: Showing trade-offs and synergies in carbon stocks and plant species diversity. Solid black lines represent the median values. For example, the top left hand quadrant (blue) represents forests with high carbon stock values (above the median value for carbon stocks), but low values for plant species diversity (below the median value for plant species diversity).

Figure 5.1- Illustration of associations between two variables

Figure 5.2- The number assigned to each community forest
(Used to label the forests in trade-off/synergy graphs)
5.3 Results

5.3.1 Correlations across carbon stocks, forest biodiversity and forest products

The results for 2013 are presented in the main text, while the results for 2010 are presented in Appendix 12. There were mostly weak correlations across CFs for carbon stocks, forest biodiversity attributes, and forest products extraction (Table 5.3). Plant species diversity was significantly positively correlated with fuelwood, suggesting CFUGs get this resource mostly from diverse CFs (although fuelwood and species richness were negatively correlated). In general though, forests biodiversity attributes were negatively correlated with forest product extraction (although correlations were mostly weak) (Table 5.3).

Table 5.3- Association (Spearman’s rank order correlations) between carbon stocks, and plant diversity, species richness and stem density in 2013

<table>
<thead>
<tr>
<th>Carbon stock, forest biodiversity attributes, and forest products</th>
<th>Correlation (r_s) for parenthasis are p-value</th>
<th>Strength of association</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon stock and plant species diversity</td>
<td>-0.14 (p= 0.54)</td>
<td>Weak</td>
</tr>
<tr>
<td>Carbon stock and species richness</td>
<td>0.23 (p= 0.33)</td>
<td>Weak</td>
</tr>
<tr>
<td>Carbon stock and stem density</td>
<td>-0.28 (p= 0.24)</td>
<td>Weak</td>
</tr>
<tr>
<td>Carbon stock and timber</td>
<td>0.01 (p=0.98)</td>
<td>Weak</td>
</tr>
<tr>
<td>Carbon stock and fuelwood</td>
<td>-0.06 (p=0.81)</td>
<td>Weak</td>
</tr>
<tr>
<td>Carbon stock and fodder</td>
<td>0.05 (p=0.83)</td>
<td>Weak</td>
</tr>
<tr>
<td>Plant species diversity and timber</td>
<td>-0.16(p=0.50)</td>
<td>Weak</td>
</tr>
<tr>
<td>Plant species diversity and fuelwood</td>
<td>0.48 (p=0.03)</td>
<td>Moderate</td>
</tr>
<tr>
<td>Plant species diversity and fodder</td>
<td>0.26(p=0.27)</td>
<td>Weak</td>
</tr>
<tr>
<td>Species richness and timber</td>
<td>-0.02(p=0.93)</td>
<td>Weak</td>
</tr>
<tr>
<td>Species richness and fuelwood</td>
<td>-0.21(p=0.21)</td>
<td>Weak</td>
</tr>
<tr>
<td>Species richness and fodder</td>
<td>-0.19(p=0.43)</td>
<td>Weak</td>
</tr>
<tr>
<td>Stem density and timber</td>
<td>-0.37(p=0.11)</td>
<td>Moderate</td>
</tr>
<tr>
<td>Stem density and fuelwood</td>
<td>-0.22(p=0.34)</td>
<td>Weak</td>
</tr>
<tr>
<td>Stem density and fodder</td>
<td>-0.26(p=0.27)</td>
<td>Weak</td>
</tr>
</tbody>
</table>

*correlation is significant at the 0.05 significance level (2-tailed)

5.3.2 Trade-offs and synergies across carbon stocks, forest biodiversity and removal of forest products

Trade-offs between carbon stocks and forest biodiversity attributes (i.e. plant species diversity, species richness, stem density) were found in the majority of CFs (Table 5.4). Trade-offs between carbon stocks and removal of fuelwood also appeared in the majority of CFs, while synergies in the majority of CFs were observed between carbon stocks and fodder removal.

Plant species diversity showed trade-offs with removal of timber in higher number of CFs, but synergies with fuelwood and fodder removal in the majority of CFs. Species richness had synergies with timber and fuelwood removal while it had trade-offs with
fodder removal in the majority of CFs. The analysis indicates that most CFs showed trade-offs between stem density and removal of all forest products. This suggests that there was no clear pattern of trade-offs or synergies between carbon stocks, forest biodiversity attributes and removal of forest products.

Trade-offs were particularly prevalent for carbon stocks, whereby a CF had a high carbon stock value and a low value for forest biodiversity attributes or forest products, or vice versa (Table 5.4). This was true also for stem density, where trade-offs existed with timber, fuelwood, and fodder. Synergies were more prevalent for plant species diversity or species richness and timber, fuelwood, and fodder (Table 5.4). This suggests that CFs with high forest biodiversity values were also important for providing critical resources to local communities.

**Table 5.4- CFs with trade-offs and synergies between carbon stocks and forest biodiversity attributes and forest products in 2013**

<table>
<thead>
<tr>
<th>Variables for relationships</th>
<th>Trade-offs (domination of service A)</th>
<th>Trade-offs (domination of service B)</th>
<th>Total CFs with trade-offs</th>
<th>Positive synergy</th>
<th>Negative synergy</th>
<th>Total CFs with synergies</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) Carbon and (B) Plant species diversity</td>
<td>5</td>
<td>5</td>
<td>10</td>
<td>5</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>(A) Carbon and (B) species richness</td>
<td>6</td>
<td>6</td>
<td>12</td>
<td>4</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>(A) Carbon and (B) Stem density</td>
<td>6</td>
<td>6</td>
<td>12</td>
<td>4</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>(A) Carbon and (B) Timber</td>
<td>5</td>
<td>5</td>
<td>10</td>
<td>5</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>(A) Carbon and (B) Fuelwood</td>
<td>6</td>
<td>6</td>
<td>12</td>
<td>4</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>(A) Carbon and (B) Fodder</td>
<td>4</td>
<td>4</td>
<td>8</td>
<td>6</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>(A) Plant species diversity and (B) Timber</td>
<td>6</td>
<td>6</td>
<td>12</td>
<td>4</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>(A) Plant species diversity and (B) Fuelwood</td>
<td>3</td>
<td>3</td>
<td>6</td>
<td>7</td>
<td>6</td>
<td>13</td>
</tr>
<tr>
<td>(A) Plant species diversity and (B) Fodder</td>
<td>4</td>
<td>3</td>
<td>7</td>
<td>6</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>(A) Species richness and (B) Timber</td>
<td>4</td>
<td>4</td>
<td>8</td>
<td>6</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>(A) Species richness and (B) Fuelwood</td>
<td>4</td>
<td>4</td>
<td>8</td>
<td>6</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>(A) Species richness and (B) Fodder</td>
<td>6</td>
<td>6</td>
<td>12</td>
<td>4</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>(A) Stem density and (B) Timber</td>
<td>5</td>
<td>5</td>
<td>10</td>
<td>5</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>(A) Stem density and (B) Fuelwood</td>
<td>6</td>
<td>6</td>
<td>12</td>
<td>4</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>(A) Stem density and (B) Fodder</td>
<td>6</td>
<td>6</td>
<td>12</td>
<td>4</td>
<td>3</td>
<td>7</td>
</tr>
</tbody>
</table>

**5.3.2.1 Trade-offs and synergies between carbon stocks and forest biodiversity**

Community forests #2 (Bhakare) and #17 (Sitakunda) consistently experienced trade-offs favouring carbon stocks over all forest biodiversity attributes (Figure 5.3). That is,
they had higher than median carbon stock values, but lower than median plant species diversity, richness and stem density. Conversely, CFs #8 (Eklepakha), #12 (Majhakharkalisepani), and #19 (Thumkadanda) had higher than median forest biodiversity attributes values, but lower carbon stocks values. Positive synergies were consistently recorded for CFs #3 (Bhitteri) and #14 (Napkeyanmara).

Synergies and trade-offs in 2013 differed slightly from those recorded in 2010 (Appendices 13 and 14). For example, in the carbon – plant diversity relationship and carbon – stem density relationship, CF #18 (Thansadeurali) shifted from trade-offs favouring carbon stock to negative synergies (lower than median values of carbon stocks and plant species diversity and stem density).

![Figure 5.3- Community forests with trade-offs and synergies between carbon stocks, plant species diversity, species richness, and stem density 2013](image)

Note: Numerical values of blue and orange indicate trade-offs, while values in light green and grey indicate positive and negative synergies respectively. Solid black lines are the median values.
5.3.2.2 Trade-offs and synergies between carbon stocks and forest products

A positive synergy between carbon stocks and all forest products was recorded for CF #13 (Mathani), whereas consistent trade-offs favouring all forest products were recorded for CF #18 and #19, and favouring carbon stocks for CF #4 (Charnawati-1) (Figure 5.4).

Some CFs shifted between trade-off/synergy relationships from 2010 to 2013. For example, CF #18 had positive synergies both in the carbon – timber and carbon – fuelwood relationships for 2010, while shifting to trade-offs favouring timber and fuelwood for 2013 (Appendices 13 and 15).

Figure 5.4- CFs with trade-offs and synergies between carbon stocks, and forest products extraction in 2013
5.3.2.3 Trade-offs and synergies between plant species diversity and forest products

Community forests # 13 and # 19 had positive synergies between plant species diversity and all forest products, while CF# 4 had negative synergies (Figure 5.5). CF# 18 showed trade-offs favouring all forest products over plant species diversity.

Changes in relationships between 2010 and 2013 included CF #10 (Jugedarkha), which showed trade-offs favouring fuelwood and fodder in 2010 compared to negative synergies in 2013 (Appendices 13 and 16). CF #11 (Kopila) shifted from negative synergies to trade-offs favouring plant diversity in the plant diversity – timber relationship, and to fodder in the plant species – fodder relationship.

Figure 5.5- Community forests with trade-offs and synergies between plant species diversity and forest products extraction in 2013
5.3.2.4 Trade-offs and synergies between species richness and forest products

A positive synergy between species richness and all forest products was consistently recorded in CF #19 (Figure 5.6). Community forest #13 had trade-offs favouring all forest products over richness, while CF # 4 had trade-offs favouring species richness over all forest products.

Community forests #5 (Charnawati-2) and #11 experienced different relationships in 2010 and 2013 (Appendices 13 and 17). CF #5 had positive synergies between species richness and timber for 2010, and shifted to negative synergies for 2013. In the species richness – fuelwood relationship, this CF shifted to negative synergies from trade-offs favouring species richness for 2013, while the CF shifted from positive synergies to trade-offs favouring fodder in the species richness – fodder relationship. Community forest #11 shifted from negative synergies in 2010 to trade-offs in 2013 favouring species richness in both species richness – timber and species richness- fodder relationships.

Figure 5.6- Community forests with trade-offs and synergies between species richness and forest products in 2013
5.3.2.5 Trade-offs and synergies between stem density and forest products

Community forest # 19 had positive synergies consistently between stem density and all forest products (Figure 5.7). Consistent trade-offs favouring all forest products over stem density existed for CFs #13 and #18.

Community forests #3, #5, #11, and #16 (Shivajungbhumethan) experienced different relationships between stem density and all forest products for 2010 and 2013 (Appendices 13 and 18). For example, in the stem density – timber relationship, CF #5 shifted to negative synergies in 2013 from positive synergies in 2010. In the stem density – fuelwood relationship, this CF shifted to negative synergies from trade-offs favouring stem density. Community forest #11 shifted to negative synergies from trade-offs favouring stem density in the stem density - timber relationship.

![Figure 5.7- Community forests with trade-offs and synergies between stem density and forest products extraction in 2013](image-url)
5.4 Discussion

5.4.1 Relationships between carbon stocks and forest biodiversity attributes

Forest carbon stocks were weakly negatively correlated with plant species diversity and stem density, and weakly positively correlated with species richness. Higher levels of plant diversity may coincide with greater carbon stocks in some natural forests (Balvanera et al., 2006; Gamfeldt et al., 2013; Parrotta et al., 2012a; Shirima et al., 2015), but there was no evidence of this in my study. This may be due to the prevalence of plant species with low carbon-storage capacity in my research site. In some cases, lower carbon stocks can exist even in highly diverse forests if the dominant tree species has a low carbon storage capacity (Baker et al., 2004; Keeling & Phillips, 2007; Kirby & Potvin, 2007; Van Con et al., 2013).

Some previous studies in CFs in Nepal have shown weak relationships between plant species diversity and carbon stocks (Bowler et al., 2010; Karna, 2012; Mandal et al., 2013). However, a recent study by Pandey et al. (2014) reported a decrease in plant species diversity with an increase in carbon stocks in CFs managed under REDD+.

A negative correlation between carbon stocks and plant diversity was found also by Paoli et al. (2010) in Indonesia, An-ning et al. (2008) in China, and Kimaro & Lulandala (2013) in Tanzania. Pellegrini et al. (2016) found negative relationships between carbon and forest biodiversity at local scale analysis due to the influence of specific activities in reducing biomass or diversity. In my study area, this pattern may be the result of selective logging. Burton et al. (2013) and Franklin et al. (2002) recognised that an inverse relationship between carbon stocks and plant diversity could arise due to selective logging, usually adopted to stimulate the growth of small trees. Selective removal of large trees may greatly reduce carbon stocks, but not impact negatively on plant species diversity (Widenfalk & Weslien, 2009). In my study, respondents from the group interviews reported that selective logging is applied as a tool for both forest management and extraction of large trees in the majority of CFs and this may explain the negative correlation between carbon stocks and plant species diversity (see Chapter 8).

I found a weak negative association between carbon stocks and stem density. Borah et al. (2013) in India, Murphy et al. (2013) in Australia, and Slik et al. (2010) in Borneo, also found no or insignificant relationships between carbon sequestration and stem
density. This implies that carbon stocks depend more on the size and carbon storage capacity of particular trees in a forest rather than simply the number of plants present. Saatchi et al. (2007) in the Amazon basin and Wang et al. (2011) in Canada recorded less carbon stocks despite a greater stem density, mainly due to the prevalence of smaller trees in their forests. It appears that growth stage of forests can determine the relationship between carbon stocks and stem density. In my research site, the majority of CFs contain mature tree species and CFUGs may apply forest thinning annually, leading to low forest density.

In terms of trade-offs and synergies, there were varying results across CFs and forest attributes. CFs with consistent positive synergies between carbon stocks and forest biodiversity attributes were mostly high altitude, mature, and large forests. In contrast, CFs with trade-offs favouring carbon stocks over plant diversity and stem density were mostly low altitude, small forests, occurring in both the less mature and mature forest categories. This indicates that trade-offs and synergies between carbon stocks and forest biodiversity attributes varied across CFs on the basis of elevation, maturity and per household forest size.

Positive synergies between carbon stocks and forest biodiversity existed mostly in high altitude and large forests. Large forests may have forest lands to introduce new plant species via plantation and conservation of existing forests in addition to harvesting area. The combination of conservation of existing forests and introduction of new species can increase both carbon stocks and maintain plant species diversity (Howe et al., 2014; Jacob et al., 2010).

Trade-offs favouring carbon stocks over plant species diversity occurred mostly in small forests located at low elevation. These forests may support plant species with higher carbon-storage capacity (Baral et al., 2009). Small forests may apply protection of forests after the implementation of the REDD+ pilot. Protection of existing natural forests can contribute to carbon stocks enhancement; however, protection of forests without introducing new plant species via plantings may not increase plant diversity (Huston & Marland, 2003; Vianna & Fearnside, 2014).

5.4.2 Relationships between carbon stocks and forest products extraction

Forest carbon stocks were weakly positively correlated with extraction of forest products, except for fuelwood. In general, a higher level of forest products extraction
corresponds with lower carbon stocks in forests (Khatun, 2011; Schwenk et al., 2012). However, there was no evidence of this for timber and fodder in my study. A positive relationship between carbon stocks and timber could be due to the application of sustainable harvesting techniques by local people in CFs. Adoption of reduced impact logging for timber extraction may not reduce carbon stocks (Mazzei et al., 2010; Nghiem, 2014; Putz et al., 2008). In many cases, post-harvest restoration and plantation is generally applied, which may enhance carbon stocks despite the removal of trees for timber (Perez-Garcia et al., 2005; Thornley & Cannell, 2000).

Relationships between carbon stocks and timber are governed by how timber is extracted from the forests (Pyörälä et al., 2014; Seidl et al., 2007) and intensity of timber logging (Martin et al., 2015). As reported by local people during group interviews (Chapter 7), timber is generally extracted under the limit of annual allowable harvesting in the majority of forests in my study area. This means that timber extraction may not impede the overall growth of forests and carbon stocks (Meng et al., 2003; Putz et al., 2012), and in my study area, timber is generally extracted from selected tree species from a particular patch of forests.

There was a very weak positive association between carbon stocks and fodder extraction. This could be due to methodological concern. For example, in my research area fodder is generally extracted from the leaves and branches of selected tree species without damaging standing trees. An allometric equation especially for Nepal, which would take account of whether trees are sound or badly decayed and branches and leaves are removed, has not been developed. However, my equation gives the same results for trees of the same height and DBH with and without collection of branch and leaves for fodder. Therefore, removal of branches without damaging trees may not adversely affect carbon stocks calculations as the allometric equation used for the calculation of biomass does not capture the branches removed from the trees (Barshila et al., 2013; Singh & Sundriyal, 2009).

I found a very weak negative relationship between carbon stocks and fuelwood. A decline in carbon stocks can be caused by increases in the extraction of forest biomass (Rusu, 2013), and repeated removal of biomass may not provide enough time for forests to recover carbon stocks (Putz et al., 2008; Sist et al., 2014). While dry materials for fuelwood is extracted almost throughout the year in some CFs in my research study area.
(see Chapter 7), this currently does not appear to be having a significant negative impact on carbon stocks in forests. However, this needs to be carefully monitored in future years.

Trade-offs and synergies between carbon and extraction of forest products again varied across CFs. CFs with trade-offs favouring carbon stocks over all forest products were mostly larger forests in the less mature and mature categories and at low and high altitude. This demonstrates the resilience of large forests to local community demands and the capacity to maintain carbon stocks while also supporting forest product needs. Such a relationship is dependent on future levels of demand for forest products and the management strategies implemented to ensure sustainable harvesting practices.

While relationships between carbon stocks and forest product extraction reflect the level of forest dependency of local people, they are also influenced by access to alternatives to forest products, private sources of products in addition to CFs, rules regarding forest product distribution, and local perceptions of the importance of protecting carbon stocks (Beyene et al., 2013; Engida & Mengistu, 2013). For example, Chhatre & Agrawal (2009) found positive synergies between carbon stocks and forest product extraction in larger CFs, where sustainable resource use practices were adopted.

5.4.3 Relationships between forest biodiversity attributes and forest products

5.4.3.1 Relationships between plant species diversity and forest products

Plant species diversity and species richness had generally a negative association with forest products extraction, except in the case of plant species diversity and fuelwood and fodder. This suggests that a greater amount of fuelwood and fodder was extracted from more diverse forests.

Relationships between forest products and plant species diversity are associated with the parts of trees that are extracted for use (Teklay, 2014). Extraction of fuelwood from green and standing trees and fodder from tree removal is restricted in the majority of CFs in my research site, where these resources are extracted mainly from stumps, dead twigs, branches and leaves (see Chapter 8). Removal of these resources may have trivial effect on the number and diversity of living plant species (Gonzalez, 2001; Poudel, 2012), although over the long term it may adversely impact overall forest biodiversity. Shrestha et al. (2013) in oak forests in Nepal observed no impact on plant diversity from
the extraction of fodder from tree branches. These authors reported that the removal of fodder up to a certain amount (i.e. intermediate disturbances) may actually result in an opening in the forest canopy, which can lead to greater plant diversity.

Adewuyi & Olofin (2014) and Matsika et al. (2013) observed a decrease in plant species diversity when fuelwood was extracted without standard rules and practices. In absence of these rules, local people may extract forest products based mostly on needs and past requirements (Kouami et al., 2009; Sahoo & Davidar, 2013), leading to negative effects on plant species.

My results showed a weak negative correlation between timber extraction and plant species diversity in forests. According to local people in my research site, timber is generally extracted from live-standing trees of specific plant species with certain qualities such as strength, durability, and straightness. Repeated removal of live-standing trees may eventually decrease the number of plant species in forests (Boucher et al., 2011; Hall et al., 2003). Similar results were observed by Martin et al. (2015), who found that a decrease in plant species diversity was associated with intensive logging for timber.

Extraction of timber may have negative effects on the natural regeneration, seeding and saplings of forests due to physical damage to soils during timber harvesting (Hartmann et al., 2012; Tavankar & Bonyad, 2015). This is highly relevant to my research site since timber extraction is generally performed manually in CFs (involving large numbers of people felling, trimming, and removing logs). Moreover, extraction of timber may have a greater negative impact on plant species diversity if post-harvest recovery activities are not adopted (Bouget et al., 2012; Bruciamacchie et al., 2006; Scherer et al., 2000).

CFs having trade-offs favouring timber over plant diversity were mostly small forests at high altitude. Prevalence of such trade-offs in high altitude forests may be due to the slow growth of forests. Introduction of new plant species is often unsuccessful due to the unsuitable ecological condition and limited forest area. In such forests, frequent and intensive extraction of timber may have a negative effect on distribution of plant diversity (Duguid & Ashton, 2013; Gritten et al., 2014).
Positive synergies in some CFs between plant diversity and fuelwood or fodder may be the result of CFUGs planting multipurpose tree species for fodder and fuelwood, which can also increase overall forest diversity (see Chapter 8). This effect was observed mostly in mature and both large and small forests. Forest users of larger forests may apply such activities because they may have enough space for planting multiple tree species. People of mature CFUGs may have better knowledge about tree plantation likely due to a long involvement in forest activities. This possibility has already been supported by findings of some previous studies (Pagdee et al., 2006; Pokharel, 2012) that some mature CFUGs are more experienced at forest management.

5.4.3.2 Relationships between stem density and forest products
I found a weak negative correlation between stem density and extraction of forest products, indicating that a greater amount of forest products were extracted from less dense forests. Stem density is generally associated with intensity of extraction of forest products (Jain et al., 2010; Jiang et al., 2015; Thomas et al., 1999). It implies that higher intensity of extraction of forest products likely reduces stem density, especially when fuelwood and fodder are taken from live standing trees (Tavankar & Bonyad, 2015).

In my study area, the majority of CFs had trade-offs favouring stem density over forest products extraction, especially large forests at high altitude. In general, large forests have longer harvesting rotations and fewer forest activities, sometimes owing to restricted access, leading to a relatively higher stem density.
Chapter 6- Research methodology for social study

6.1 Introduction

This chapter describes the research methodology related to the qualitative social research. Following the general overview of research approaches for the socio-ecological study described in Chapter 3, this chapter provides an overview of research paradigms, introduces some research approaches, and discusses specific tools and techniques for qualitative data collection and analysis. Under the broad framework of inter-disciplinary research, this component of the research follows an inductive approach of social research, and describes contexts and potential factors associated with biophysical outcomes in CFs by applying a pragmatic paradigm which combines components of the interpretive paradigm (predominant in my study) and positivist paradigm.

This chapter broadly introduces research paradigms. The sections 6.2 and 6.3 discuss the theoretical basis of this research and research paradigms applied to inter-disciplinary research respectively, followed by illustrations of different research approaches and different data collection techniques in a mixed-method approach. An overview of the research design for the social component of research is provided in 6.4, while section 6.5 presents the researcher’s personal context. Section 6.6 describes overall fieldwork procedures, while criteria for CFUGs selection for the qualitative study are presented in section 6.7. Sections 6.8, 6.9 and 6.10 describe the methods adopted for this research to collect qualitative, quantitative socio-economic and secondary data respectively. Data analysis approaches are discussed in section 6.11 while section 6.12 explains validity and reliability for the research. Ethical considerations and limitations of this qualitative research are discussed in sections 6.13 and 6.14 respectively.

6.2 Theoretical basis of this research design

Patterson & Williams (2005) describe research paradigms as the basic foundation of social research. According to Guba & Lincoln (1994) and Neuman (2007), a research paradigm features an organized framework with basic assumptions of research, from where research methodologies and techniques originate to respond to the research questions. Sarantakos (2012) describes a “paradigm” as a theoretical perspective that provides the structure, the process, and the direction of social research.
Although paradigms adopted can vary on the basis of a researcher’s perspective, interpretive, positivist, and pragmatist are paradigms often used in social research (Crotty, 1998; Sarantakos, 2012; Sobh & Perry, 2006). The interpretive (i.e. constructive) paradigm derives from cultural and historical interpretation of the social life-world (Crotty, 1998). This paradigm grew out of the philosophy of hermeneutics (i.e. theory of interpretation) (Mackenzie & Knipe, 2006). The interpretive paradigm is usually associated with qualitative research, and proponents of this paradigm emphasise a need to understand the subjective meaning of everyday actions of people (Neuman, 2007; Weber, 2004), suggesting that “reality is socially constructed” (Mertens, 1998, p. 12). Under this paradigm, researchers interpret the problems and concerns associated with the actions of people, using several research methods including participant observation and in-depth interview (Bryman, 2012; Dhillon & Backhouse, 2001).

Positivism is the most common research paradigm, which relies on general principles to explain particular phenomena and their causal factors (King & Horrocks, 2010). Positivism is based on empiricist philosophy (Mackenzie & Knipe, 2006) and on the view that there is a single objective reality to any research phenomenon that can be measured and understood, and scientific knowledge of the real world is derived from empirical observations (Tashakkori & Teddlie, 2009). According to Bryman (2006) and Gray (2009), the positivist paradigm adopts precise quantitative data collection methods such as experiments and surveys. The results of such research are usually explained in the form of numbers, and cause and effect relationships (Bahari, 2012; Sarantakos, 2012).

Pragmatism is a research paradigm in which the meaning of a phenomenon is determined based on practical consequences. This paradigm places “the research problem” at the centre of decisions about methods, and considers all approaches to understanding the problems (Creswell, 2013, p. 11). Pragmatism is not committed to any particular philosophy or perspective on reality (Mackenzie & Knipe, 2006, p. 197). As noted by a number of authors such as, James (2012), Creswell (2013), and Biesta & Burbules (2003) the pragmatist paradigm is an integrated paradigm built on both the interpretive and positivist paradigms. Considering the scope, this research has adopted the pragmatic approach, whereby the research capitalises on inherent strengths of both quantitative and qualitative research approaches.
6.3 Associated research paradigms and approaches to research design

Understanding inter-relationships between social and ecological system with reference to ESs and biodiversity in CF is a relatively new area of research. Cote & Nightingale (2012) and Nightingale (2003a) argue that there are no commonly accepted research paradigms for investigating the interconnectedness between social process and ecological outcomes in CFs. However, some studies on social-political dimensions and ecological outcomes of CF have represented a combination of positivist and interpretive research paradigms (Hobley et al., 1996; Nightingale, 2003b, 2006; Ostrom, 2006).

Some authors such as Andersson et al. (2007), Bahari, (2012), Dhakal, (2014), and Vihervaara et al. (2010) have suggested the pragmatic paradigm provides an appropriate research approach for social-ecological study in relation to forest outcomes. Shannon-Baker (2015) also highlights advantages of using the pragmatic paradigm incorporating a combination of qualitative and quantitative research approaches, primarily to understand the complex interactions of social and ecological process.

This research followed the pragmatic paradigm by combining qualitative and quantitative methods. The following sub-sections introduce three research approaches i.e. quantitative, qualitative, and mixed methods research approach, and justify the selection of mixed methods as an approach for this research.

6.3.1 Quantitative research approach

Quantitative data collection is a traditional ‘scientific’ approach based on measurement of ‘facts’, of the ‘one reality’ that exists (Bahari, 2012; Bryman, 2012). According to Neuman (2007), the quantitative research approach was originally developed in the natural sciences, whereby natural objects were considered as a source of information or producers of data. This approach draws from the philosophical foundation of the positivist research paradigm (Bahari, 2012; Bryman, 2012).

The quantitative approach requires hard data in the form of numbers, and in the context of social sciences, such data are collected through methods such as household survey, empirical observation, documentary methods, and experiments (Creswell, 2013). Some authors e.g. Bahari (2012), Creswell (2013), and Guba & Lincoln (1994) claim that the quantitative approach has the highest scientific quality in relation to minimisation of potential personal bias of the researchers. However, this approach is often criticised for
its inability to distinguish people and social institutions from “the world of nature” (Yegidis & Weinbach, 2006). Further, the research process and instruments of quantitative research approach usually do not connect researchers with the everyday life of research participants. However, this research approach is useful for gathering data from larger numbers of people (Choy, 2014). The quantitative research approach is also useful to make observations more explicit, and easier to aggregate, compare, and summarise (Babbie, 2012).

6.3.2 Qualitative research approach

The qualitative approach attempts to understand the research issues or particular situations by investigating people’s individual perspectives (Denzin & Lincoln, 2011; Gall, 2001; Hesse-Biber, 2010; Malterud, 2001). Qualitative research rejects the idea that there is a single reality or set of ‘facts’, but seeks to build an understanding of a situation through exploring the different ‘realities experienced or constructed by different individuals’ (Flick, 2009).

Qualitative research aims to understand people, but not to measure them (Sarantakos, 2012). According to Gephart (1999), qualitative research lies in the interpretive research paradigm. While qualitative research is originally developed for social sciences and underpinned by interpretive approaches, it enables researchers to study social and cultural phenomena. This approach further provides the scope for addressing issues of influence and impact, and aims to explain subjective reasons and meanings which lie behind social actions (Deetz, 1996; Reeves & Hedberg, 2003).

This research approach provides an understanding of local people’s perceptions, priorities, and experiences of some phenomena or situation (Bryman, 2012). The qualitative research approach focuses on subjective data (Neuman, 2007), and uses soft data in the form of words, photographs, and symbols, collected through several methods including interviews (individual and group interview), observations, audio-video recordings, field notes, personal documents, and memos, using structured and semi-structured interview protocols (Creswell, 2013; Kumar, 2011). Data from a qualitative approach are generally collected through relatively small sample sizes from a broader population (Marshall, 1996).
The qualitative research approach represents the flexible nature of research design. Maxwell (2012) argues that data related to particular phenomena or context, collected through engaging with research participants are useful to determine the causes and process of occurrence of particular events and phenomena. In the case of inter-disciplinary socio-ecological systems, the qualitative research approach enables assessment of management effectiveness through people’s experiences the intricate relationships between human actions and ecological systems (Persha, 2005).

6.3.3 Mixed methods approach
A mixed methods approach involves the integration of both qualitative and quantitative research approaches in a single study (Bryman, 2012). According to Hitchcock et al. (2005) and Creswell (2013), the key idea behind the application of mixed methods is to develop a complete understanding of a research problem by converging qualitative and quantitative evidences.

Qualitative and quantitative research approaches alone are not always adequate or appropriate, and neither is necessarily superior to the other for inter-disciplinary social research (Creswell, 2013). Flick et al. (2012) and Ivankova et al. (2006) argue that the qualitative and quantitative approaches complement each other, and their use together allows for robust analysis that draws on the strengths of both approaches. Consequently, the mixed methods approach has evolved as a third research approach, in addition to purely qualitative or quantitative research (Denscombe, 2008; Hesse-Biber, 2010; Johnson et al., 2007; Tashakkori & Teddlie, 2010).

A mixed methods approach provides researchers with an opportunity to generate a large body of information through a range of sources in the form of numbers, words and pictures. According to Denzin & Lincoln (2011), mixed methods are flexible, and data are collected concurrently or sequentially from various sources. These data are merged, connected, and embedded at one or more stages in the process of research to generate reliable findings (Creswell, 2013, p. 230).

Figure 6.1 shows a continuum of quantitative and qualitative methods under the schematic framework of the mixed methods approach. The social component of this (my) research adopts zone D with a primarily qualitative approach with some quantitative aspects.
Figure 6.1- The QUAN – Mixed – QUAL continuum
(Adapted from Teddlie, 2005, p. 212)

(Note: Zone A consists of totally quantitative research, while zone E consists of totally qualitative. Zone B represents primarily quantitative research with some qualitative components. Zone D represents primarily qualitative research, with some quantitative research. Zone C represents totally integrated mixed methods research. The arrow represents the QUAN-MIXED-QUAL continuum. Movement towards the middle of the continuum indicates a greater integration of research methods. The movement away from the centre (and toward either end) indicates a greater segregation of research methods). This research adopts zone D.

Nevertheless, there are some weaknesses of a mixed methods approach. One of the major limitations is the duplication of information if the diversity of methods/approaches is not assessed in a reflective way (Tashakkori & Teddlie, 2010). It is also difficult to interpret conflicting results from quantitative and qualitative methods (Onwuegbuzie & Johnson, 2006). Some potential strengths and challenges of the mixed methods approach are presented in Table 6.1.

<table>
<thead>
<tr>
<th>Table 6.1- Highlights of strength and challenges of mixed methods approach</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strengths</strong></td>
</tr>
<tr>
<td>• Words, pictures, and narrative can be used to add meaning to numbers, and at the same time, numbers can be used to add precision, embodies research strengths of both methods</td>
</tr>
<tr>
<td>• Researcher can generate and test a grounded theory</td>
</tr>
<tr>
<td>• Because of different forms of data from different sources can answer a broader and more complete range of research questions</td>
</tr>
<tr>
<td>• Findings from two methods can be triangulated, which can provide stronger evidence for a conclusion through convergence and corroboration of findings</td>
</tr>
<tr>
<td>• Can add insights and understanding and increase the generalisability of the results.</td>
</tr>
<tr>
<td>• Use of two methods together can produce more complete knowledge necessary to inform theory and practice</td>
</tr>
<tr>
<td>• Provides the opportunity to reflect a greater diversity of divergent views</td>
</tr>
</tbody>
</table>

Source: De Lisle (2011) and Driscoll et al. (2007)
One of the motivations for adopting a mixed methods approach for this research is to enhance the reliability of the findings from the interrelated components of social and ecological (i.e. biophysical for this research) systems in CFs. Interactions between the social and ecological elements of CFs are inherently complex. Understanding the dynamics within these elements, may require data from different approaches and sources, which is possible only through a mixed methods approach.

The ecological component of this research adopts quantitative methods only, while the social component utilises both quantitative and qualitative methods. This research adopts the ‘explanatory sequential’ mixed methods approach (Cameron, 2009; Ivankova et al., 2006), where ecological data were analysed first, and the qualitative social data derived from the in-depth case study provided a detailed understanding of policies, opinions and experiences that helped explain the findings from the ecological research.

6.4 Research design- intensive case study and ecological study

The ecological research involves collection of extensive data across 19 CFUGs, while the social research involves intensive case studies in 2 CFUGs. Kumar (2011) describes a case study as an evidence-based practical approach, which deals with the total population as one entity for a holistic understanding of a situation or a case. A case could be an individual, or an organization (group, community), or a geographical unit (Babbie, 2012; Gray, 2013; Yin, 2011). From the perspective of scale, case study research confines data collection to a small geographical unit; however, it focuses on acquiring an in-depth understanding of an issue, an event or activity within the bounded settings (Denzin & Lincoln, 2011; Eisenhardt, 1989; Merriam, 2002; Yin, 2011). In case study-based research, researchers employ a variety of procedures for data collection that include observations (participant observation and non-participant observation), interviews, focus group discussion (FGD) and surveys (Noor, 2008; Yin, 2011).

Some limitations of the case study approach include difficulties of drawing cause-effect conclusions, and of generalising to the wider population from a single case (Flyvbjerg, 2006; Zainal, 2007). Possible biases in data collection and interpretation are also considered to be a weakness of the case study approach. However, such limitations of case studies can be overcome through using causal-process tracing, whereby the researchers can investigate the factors that lead to concrete outcomes (Blatter & Haverland, 2012).
The first part of this research has examined forest outcomes in terms of biophysical data assessed using statistical techniques (presented in Chapters 4 and 5). Any changes in ecosystem service outcomes could be associated with several factors including institutional arrangements, local people’s perceptions and behaviours in relation to forest management and use practices, and how these might vary amongst people with different social and economic backgrounds. In seeking the perceptions, experiences, and practices of local communities, an in-depth interaction with local people of selected CFUGs provides an appropriate approach for this social research.

Based on the research objectives and available time and resources, two case sites (CFUGs) were identified from amongst the 19 ecological study CFUGs to generate both depth and breadth in understanding of the linkages between ecological and social implications of the REDD+ pilot programme. Two CFUGs were identified with different forest types located in different elevations and with different CFUG size (i.e. number of households in CFUG) (see section 6.7). In each CFUG, in-depth interviews, FGD and household surveys were carried out. Information related to biophysical outcomes, forest dependency, rules of resource extraction, forest management practices, and group participation status were linked and validated from the evidence provided by these case study CFUGs (Dhakal, 2014).

6.5 Research context and researcher’s identity

While the positivist paradigm assumes an entirely subjective process that produces replicable data (i.e. there is only one reality and the researcher’s task is to uncover that reality), the interpretive paradigm makes no such assumption. Rather, it assumes that the researcher is an intrinsic component of the research process, and that decisions are constantly being made by the researcher that influence the data collected. This is especially important when undertaking semi-structured interviews and FGD (Whiting, 2008). By adopting these research techniques, it is important to place the researcher into the research context. This section provides information on me as the researcher, my professional background, and illustrates my motivation, capacity and perspective in relation to the problems and issues arising in the research. This section also considers bias in the research process, and precautions taken to minimise such bias.

I was born and grew up in a rural village in the western middle hills of Nepal, where people have a deep connection with natural resources management for their livelihood.
Thus, I am familiar with, and have experienced human and nature connection, in the context of the middle hills region of Nepal.

Having grown up in a farmer family, I was involved in farm and forest activities during my childhood. Being a member of an ethnic group (i.e. indigenous people), I have experience of the influence of local social and economic condition and institutions in resource management. However, being a male born into a middle class family, I may not have had personal experience of the kind of poverty and gender based discrimination that is especially prevalent in natural resources management in rural Nepal.

Academically, I have been trained in forestry and social sciences in Nepal and abroad, and have obtained knowledge, skills and experience in natural and applied sciences. Upon completion of a Bachelor in Forestry Sciences, my work in natural resource management with an international NGO provided experience and understanding of the contribution of Nepal’s forests to local livelihoods, and their potential in global initiatives for climate change mitigation. Research undertaken for my Masters degree in sustainable resource management (Germany) examined the potential of REDD in Nepal’s CFs.

My interest in REDD+ and its interaction with local people was further expanded when I worked as coordinator of a multi-faceted REDD+ pilot project implemented through CF in Nepal. The project focused on developing a governance system of REDD+ payments, developing a participatory carbon stocks monitoring system, and capacity building in the local community. My experiences in working with local communities, developing institutions and guidelines for implementation of REDD+ pilot programmes simulated my thinking on the challenges of REDD+ providing concurrent outcomes on carbon stocks, local livelihood, and forest biodiversity.

This research was conceptualised at the time of the 17th CoP meeting of the UNFCCC, which introduced social and environmental safeguards as a precondition for REDD+ implementation. The REDD+ pilot investigated by this research is the first of its kind in south Asia. This REDD+ pilot was designed based on the findings from previous carbon assessments undertaken by project proponents such as ICIMOD with the intention that CFUGs would receive financial incentives together with knowledge and skills for carbon monitoring, to encourage local communities to manage CFs for both
enhancement of carbon stocks and local livelihoods (Rana et al., 2012; Shrestha et al., 2014). However, the program proponents gave little attention to biodiversity issues in designing the incentive distribution mechanism (ICIMOD, 2010b).

The pilot project also sought to provide evidence based on experience to the global discourses on how financial incentives from REDD+ can influence local communities to change forest management practices for climate change mitigation. My observations through involvement in the pilot project suggested that encouraging local communities to focus on carbon stocks through the promise of financial incentives presented risks for conservation of forest biodiversity, for traditional forest use practices and for the livelihoods of poor forest users. Such concerns were beyond the scope of research associated with the REDD+ pilot, however, understanding the implication for social and ecological aspects of CF was important for the integration of CF into the ongoing REDD+ strategy process in seeking a long-term approach to climate change mitigation. Thus, the need for research into the interaction between REDD+ and local factors such as carbon stocks, forest biodiversity, and resource use in the context of CFs in Nepal became evident. Figure 6.2 presents the underlying context that inspired the research concept.

My family background and work history provide a strong context for research that touches on the political, institutional, socio-cultural, and livelihood issues and strategies of forest-dependent people.

However, conducting social research in rural Nepal presents many challenges, with the majority of people being illiterate, with feudal patron-client relationships still strongly evident and influenced by the caste system. Undertaking research with disempowered
groups in such a society requires access to these groups and sympathetic facilitation. Further, women and Dalit informants may be unwilling to express their views openly to a male non-Dalit researcher. To avoid potential biases and to create a favorable environment for discussion, women and Dalit facilitators were engaged to facilitate focus group discussion with women and Dalit in both CFUGs.

### 6.6 Field work procedures

This section describes the procedures followed during the field work and data collection. A single field visit over 4 months from July to October 2013 allowed for the collection of social and ecological data (Table 6.2).

The field work started with introduction and consultations with central level and district level stakeholders. Consultation at district level was made with a district FECOFUN, district forest officer, and ANSAB representative to select two CFUGs for case study. Data collection from the two case study CFUGs was started through contact with key persons of these CFUGs suggested by the district FECOFUN. Key persons were informed about me, my research objective, and purpose of visit, and a meeting with them was requested at a time and place suitable to them.

#### Table 6.2: Summary of key activities followed in the field

<table>
<thead>
<tr>
<th>Date</th>
<th>Place</th>
<th>Activities</th>
<th>Stakeholders</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>13-16 July 2013</td>
<td>Kathmandu</td>
<td>Meeting with national stakeholders</td>
<td>Representatives of ICIMOD, central FECOFUN and REDD-Cell MFSC</td>
<td>Shared research concept, consulted, discussed policy level issues and obtained ecological data from ICIMOD</td>
</tr>
<tr>
<td>18 July 2013</td>
<td>Dolakha</td>
<td>Meeting with district stakeholders for CFUG selection</td>
<td>District FECOFUN, District Forest officer and field staff of ANSAB</td>
<td>Discussed research concept and selection of 2 CFUGs for case study</td>
</tr>
<tr>
<td>31 July-October 2013</td>
<td>Case study Dolakha</td>
<td>Focus group discussion, in-depth interview, household survey, meeting and activities, observation, and forest inventory</td>
<td>Executive committee members, women’s group, Dalit group, Indigenous people</td>
<td>7 FGDs recorded, 39 in-depth interviews of CFUG members,</td>
</tr>
<tr>
<td>September 2013</td>
<td>Dolakha</td>
<td>Participant observation, forest condition, attending local and district meeting</td>
<td>Local, district level</td>
<td>14 interviews from district and central stakeholders, observed 4 CFUG level, 2 district level FECOFUN meetings, and one district stakeholders meeting,</td>
</tr>
<tr>
<td>October 2013</td>
<td>Kathmandu</td>
<td>Interview</td>
<td>Central level stakeholders</td>
<td>In-depth interview linking perspective of local people</td>
</tr>
<tr>
<td>Oct-December 2014</td>
<td>Central level</td>
<td>Email interviews</td>
<td>Central level stakeholders</td>
<td>Collected policy level information to link findings emerging from group level data</td>
</tr>
</tbody>
</table>
Data from the two case study CFUGs was collected at different times i.e. all forms of data were collected from one CFUG before moving to the second. Data collection in each of the two case study CFUGs began with an introductory meeting with the executive committee (EC). The purpose of these meetings was to share the research objectives with EC members of the CFUG, and to work with the EC to update previous assessment of households’ well-being. Households within each CFUG were categorised into four groups (i.e. well-off, medium, poor and very poor), based on locally designed criteria. Based on the updated data from the CFUGs, households in each category were randomly selected for the household survey in presence of members of the EC of both CFUGs.

Considering the time and availability of research participants due to it being the farming season, I began by undertaking household surveys for data collection (see section 6.9), followed by semi-structured in-depth interviews (section 6.8.1). However, FGDs were conducted through the same period as in-depth interviews depending on the availability of participants for FGD (section 6.8.2). The first focus group in each case study was conducted with the EC to get an overview of CFUG activities in relation to resource dependency and distribution, and changes in rules and dependency following implementation of REDD+. Semi-structured interview with some key CFUG members (mainly EC members) were carried out at the conclusion of the field work. These interviews were focused on gaining a deeper understanding of issues that had emerged from earlier interviews, as well as identifying any new issues. Throughout the field research period, I attended CFUG EC meetings, district FECOFUN, and district stakeholder meetings. Interview with central level stakeholders were carried out after finishing the field survey in order to understand the similarities and differences in perspective on issues reflected by local people. Email interviews (6.8.4) with central level stakeholders were done upon completion of data analysis. Figure 6.3 provides an overview of socio-economic data collection methods, tools, source, level of data, and participants of the research.
6.7 Selection criteria of case study CFUGs for in-depth interview

As a result of discussions with district FECOFUN, district forest office, and ANSAB staff, two of the 19 CFUGs (Table 6.3) involved in the ecological research were selected for the in-depth social study. On the basis of criteria described below, Sitakunda and Thansadeurali CFUGs were selected, both in the Bhimeshwor municipality of Dolakha (Figure 6.4).
### Table 6.3- Information of 19 community forests and selection of 2 community forests for case study

<table>
<thead>
<tr>
<th>SN</th>
<th>Community forest</th>
<th>Altitude above and below 2000m</th>
<th>Year started as community forests, revision of forest operational plan</th>
<th>Per house hold forest size (ha)</th>
<th>Main vegetation type</th>
<th>Ethnic group percentage of (B-C/D/IP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Barkhedandapari</td>
<td>Low</td>
<td>1997 (1 and next proposed for 2015)</td>
<td>0.40</td>
<td>Schima-castanopsis, Pinus roxburghii</td>
<td>0.82/0.13/0.05</td>
</tr>
<tr>
<td>2</td>
<td>Bhakare</td>
<td>Low</td>
<td>2003 (First revision in 2014)</td>
<td>0.79</td>
<td>Pinus roxburghii</td>
<td>0.63/0.02/0.35</td>
</tr>
<tr>
<td>3</td>
<td>Bhitteri</td>
<td>High</td>
<td>1995 (2 and next proposed for 2015)</td>
<td>2.23</td>
<td>Oak, Rhododendron, Thingure Salla</td>
<td>0.60/0.00/0.40</td>
</tr>
<tr>
<td>4</td>
<td>Charnawati 1</td>
<td>High</td>
<td>1995 (2 and next proposed for 2015)</td>
<td>3.74</td>
<td>Oak, Rhododendron, Pines</td>
<td>0.68/0.01/0.31</td>
</tr>
<tr>
<td>5</td>
<td>Charnawati 2</td>
<td>Low</td>
<td>1998 (1 and next proposed for 2014)</td>
<td>0.29</td>
<td>Shorea robusta, Pinus roxburghii</td>
<td>0.80/0.08/0.12</td>
</tr>
<tr>
<td>6</td>
<td>Chyasebhagabati</td>
<td>High</td>
<td>1998 (1 and next proposed for 2015)</td>
<td>0.39</td>
<td>Alder, Pinus roxburghii, Schima wallichii</td>
<td>0.37/0.46/0.17</td>
</tr>
<tr>
<td>7</td>
<td>Dhandesinghdevi</td>
<td>High</td>
<td>2002 (1 and next proposed for 2015)</td>
<td>1.58</td>
<td>Rhododendron, Pinus patula, Castanopsis</td>
<td>0.33/0.25/0.41</td>
</tr>
<tr>
<td>8</td>
<td>Eklepakha</td>
<td>High</td>
<td>1995 (3 revisions but no REDD+ incorporated)</td>
<td>0.81</td>
<td>Schima-castanopsis, Pines</td>
<td>0.21/0.00/0.79</td>
</tr>
<tr>
<td>9</td>
<td>Harisiddhimai</td>
<td>Low</td>
<td>1995 (2 times revision)</td>
<td>0.26</td>
<td>Schima-castanopsis, Pinus roxburghii</td>
<td>0.27/0.00/0.73</td>
</tr>
<tr>
<td>10</td>
<td>Jugedarkha</td>
<td>High</td>
<td>2002 (1 and next proposed for 2015)</td>
<td>1.00</td>
<td>Rhododendron, Thingure Salla, Pinus wallichiana</td>
<td>0.21/0.01/0.78</td>
</tr>
<tr>
<td>11</td>
<td>Kopila</td>
<td>Low</td>
<td>1997 (1 and next proposed for 2015)</td>
<td>1.08</td>
<td>Schima wallichii, Alder, Kalikath (Myrisine semiserrata), Rhododendron</td>
<td>0.80/0.12/0.09</td>
</tr>
<tr>
<td>12</td>
<td>Majhkharkalisepani</td>
<td>High</td>
<td>1996 (1 and next propose in 2015)</td>
<td>1.04</td>
<td>Oak, Rhododendron, Pinus</td>
<td>0.32/0.15/0.53</td>
</tr>
<tr>
<td>13</td>
<td>Mathani</td>
<td>Low</td>
<td>1996 (1 and next proposed 2015)</td>
<td>0.37</td>
<td>Alder, Pinus wallichiana, Schima wallichii</td>
<td>0.86/0.03/0.11</td>
</tr>
<tr>
<td>14</td>
<td>Napkeyanmara</td>
<td>High</td>
<td>1999 (1 Revision and next proposed for 2018)</td>
<td>1.25</td>
<td>Alder, Pinus wallichiana, Rhododendron, Castanopsis</td>
<td>0.38/0.01/0.61</td>
</tr>
<tr>
<td>15</td>
<td>Setidevidadar</td>
<td>High</td>
<td>2006 (1 Revision with REDD+)</td>
<td>2.03</td>
<td>Rhododendron, oak</td>
<td>0.01/0.00/0.99</td>
</tr>
<tr>
<td>16</td>
<td>Shivajungbhumesthan</td>
<td>Low</td>
<td>2001 (2 Revisions - one with REDD+)</td>
<td>0.97</td>
<td>Alder, Schima wallichii</td>
<td>0.00/0.02/0.98</td>
</tr>
<tr>
<td>17</td>
<td>Sitakunda</td>
<td>Low</td>
<td>1993 (3 times revision, latest with REDD+ provision)</td>
<td>0.81</td>
<td>Sub-tropical forests (Pinus roxburghii, Shorea robusta)</td>
<td>0.82/0.03/0.15</td>
</tr>
<tr>
<td>CFUG</td>
<td>Location</td>
<td>Forest Type</td>
<td>Year</td>
<td>Species</td>
<td>CFUG Size</td>
<td>Source</td>
</tr>
<tr>
<td>------</td>
<td>--------------</td>
<td>-------------</td>
<td>------</td>
<td>-------------------------------</td>
<td>-----------</td>
<td>------------------------------------------------------------------------</td>
</tr>
<tr>
<td>18</td>
<td>Thansadeurali</td>
<td>High</td>
<td>1996</td>
<td>Lower temperate forest (Oak,</td>
<td>0.33</td>
<td>Forest operational plan and interview with CFUGs executive committee, 2013</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Rhododendron, Pinus patula)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.44/0.14/0.42</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Thumkadanda</td>
<td>High</td>
<td>2000</td>
<td>Rhododendron, Pinus wallichiana, Pinus patula</td>
<td>0.28</td>
<td>Source: Forest operational plan and interview with CFUGs executive committee, 2013</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.05/0.00/0.95</td>
<td></td>
</tr>
</tbody>
</table>

Note – B/C – Brahmin/Chhetri, D – Dalit, and IP – Indigenous Peoples

Source: Forest operational plan and interview with CFUGs executive committee, 2013

Figure 6.4- Selected CFUGs for case study

CFUG size per household: The size of forest in relation to number of forest user households is an important determinant of resource use practices and forest
management activities (Chhatre & Agrawal, 2008). Sitakunda (per household forest area 0.81 ha) and Thansadeurali (per hh forest area 0.33 ha) CFUG are examples of relatively greater and smaller per household forest size respectively.

**Ethnic diversity:** Ethnic diversity is a key determinant of economic, social and political status in Nepal. For example, Brahmin and Chhetri, the so called upper class groups under the Hindu caste system, are socially, economically, and politically powerful groups in Nepalese society, with a dominating influence in CFs management. Ethnic groups are culturally different, and may have different use practices for forest products, which may also lead to different priorities in decision making (Adhikari et al., 2004). Different ethnic groups may also differ in livelihood strategies, private land size, levels of wealth, and opportunities for other work. Such variation across forest users can determine differential resource needs and thus forest dependency (Sapkota & Odén, 2008). In terms of ethnic groups, Sitakunda CFUG is dominated by Brahmin and Chhetri, while Thansadeurali CFUG has nearly equal representation of ethnic groups such as Tamang, Dalit, and Brahmin/Chhetri (Table 6.6).

**Status of forest operational plan:** Under the REDD+ pilot, CFUGs are expected to change forest management and resource use practices (Poudel, Thwaites, et al., 2014). Selection of CFUGs with and without carbon provisions in their operational plans provides an opportunity to explore how CFUGs have changed their long-term forest management activities, strategies and rules. Both Sitakunda and Thansadeurali CFUGs are part of the REDD+ pilot, however, Sitakunda completed a revision of its forest operational plan in 2011 to incorporate provision of payments for ecosystem services. On the other hand, REDD+ and carbon provisions are not incorporated into the Thansadeurali forest operational plan.

**Type of forests/vegetation-** It is generally considered that growth of trees, their capacity to sequester and store carbon, and status of plant species diversity vary across forest types (Parrotta et al., 2012a). Sitakunda contains sub-tropical forest dominated by hardwood broadleaf tree species such as Sal (*Shorea robusta*) and Chir pine (*Pinus roxburghii*). In contrast, Thansadeurali CFUG contains lower temperate forests mainly dominated by conifer tree species such as *Pinus patula*, *Pinus wallichiana*, Rhododendron, Thingure Salla and Oak.
6.8 Techniques for collection of qualitative socio-economic data

Qualitative data were collected at CFUG level using semi-structured interviews, FGD, participant observation, and participatory resource mapping, while data from district and national level stakeholders were collected through semi-structured in-depth interviews and online surveys. Participants for semi-structured interviews at CFUG level were the household heads (those who lead and direct other household members). In absence of household heads, interviews were conducted with another person identified by the respective family. The selection of these households followed a stratified sampling from households of four well-being groups, i.e. well-off, medium, poor, and very poor.

Households in the two case study CFUGs were categorised based on well-being rankings completed in 2011 under the Swiss-Nepal community forestry project. For this research, the household categories were reviewed and updated using local community defined criteria in each CFUG (Appendix 19) through a meeting with EC members and forest users with representatives of Dalit and Indigenous Peoples (IP), women, school teachers, and users who have knowledge of households within the community. A breakdown of the number of households in each CFUG assigned to the four well-being categories is presented in Table 6.4.

Common criteria identified by both CFUGs included landholding type and size, education level of family members, type of income sources, food sufficiency, quality of house, social status such as involvement in local network and institutions, as well as status as money lenders/borrowers. These criteria have been commonly adopted for well-being ranking by other researchers in CF in Nepal (Gentle & Maraseni, 2012; Sapkota & Odén, 2008; Sharma & Filius, 1999).

Table 6.4- Number of total households in case-study CFUGs with different well-being status

<table>
<thead>
<tr>
<th>CFUG</th>
<th>Well-off</th>
<th>Medium</th>
<th>Poor</th>
<th>Very poor</th>
<th>Total households</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sitakunda</td>
<td>5</td>
<td>117</td>
<td>30</td>
<td>23</td>
<td>175</td>
</tr>
<tr>
<td>Thansadeurali</td>
<td>57</td>
<td>100</td>
<td>201</td>
<td>24</td>
<td>382</td>
</tr>
<tr>
<td>Total households</td>
<td>62</td>
<td>217</td>
<td>231</td>
<td>47</td>
<td>557</td>
</tr>
</tbody>
</table>

Source: Field survey, 2013

6.8.1 Individual in-depth interviews

The in-depth interview is underpinned by an interpretive perspective (Walter, 2006). According to Patton (2002) and Seidman (2013), the in-depth interview is a social
research data collection method, where interviewers explore the respondents’ deep insights, feelings, experiences, and perspectives on a particular topic or problem. This method is often known as the discovery-oriented method, and is appropriate for extracting maximum information from minimum respondents (Flick, 2009; Legard et al., 2003).

Semi-structured interview is one form of in-depth interview, where the interaction between interviewer and respondent is guided by a general plan of inquiry prepared by the interviewer (Babbie, 2012; Longhurst, 2003). In contrast to a conventional structured question and response method, the semi-structured in-depth interview allows researchers to ask follow-up or probing questions, and thus deliver the deeper insights and understanding sought (Neuman & Kreguer, 2003; Powell & Single, 1996).

According to Neuman (2007), three types of questions can be asked in in-depth interviews (for this research semi-structured interview) in a logical sequence. The interviewer begins the conversation with descriptive questions to understand the context and description of the issues. With this type of question, an interviewer sets the environment for the interview on an intended topic. The opening of an interview is also an important stage to build the relationship with the informant, to establish trust and to stimulate the informant’s responses – so descriptive questions are relatively easy to answer, and build a process of interactions based on trust. This stage is followed by more structured questions, whereby the conversation focuses on acquiring deeper conceptual opinions, experiences and perspectives from the respondents. Questions in the final stage concentrate on understanding the contrasts and similarities between the elements and categories.

Table 6.5 presents some strengths and weakness of the in-depth interview. However, the described weaknesses or limitations can be minimised through (i) developing and field-testing research questions, (ii) developing a rapport with research participants to know their availability (time and location), (iii) providing prior information to the participants about the research objective and obtaining the consent from participants, and (iv) ensuring a neutral role in facilitating the interview (Bryman, 2012).
Table 6.5- Strengths and weaknesses of in-depth interview

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Usually yield richest-data, details, new insights</td>
<td>• Time consuming and expensive</td>
</tr>
<tr>
<td>• Allow probing through face-to-face contact with respondents</td>
<td>• Interviewee may distort information through recall error</td>
</tr>
<tr>
<td>• Provide opportunity to explore topics in depth</td>
<td>• Potential biases of interviewer</td>
</tr>
<tr>
<td>• Allow interviewer to explain and clarify questions, increasing the likelihood of useful responses</td>
<td>• Volume of information too large, difficult to transcribe and reduces data</td>
</tr>
<tr>
<td>• Flexibility in administering interview to particular individuals or circumstances</td>
<td>• Difficulties in recording the interview properly</td>
</tr>
</tbody>
</table>


This research applied semi-structured in-depth interview (see Appendix 20 for interview guidelines) to generate an understanding of the forest products extraction and changes in local practices of CFs following the REDD+ pilot. In-depth interviews were largely conducted with forest users of the case study CFUGs, as well as with district and national level respondents. At CFUG level, a total of 39 participants from the two case study CFUGs were purposively selected to deliver a stratified sample across the four well-being groups and different ethnic/caste, groups and, gender (Table 6.6). Snow ball sampling was also adopted in some instances, whereby informants provided advice on potential sources of particular information (i.e. chain referral sampling) (Browne, 2005; Kendall et al., 2008). While interviews were undertaken across the four well-being groups and ethnic/caste groups, actual numbers of interviews in each group reflect the complexity of issues raised in response to research questions.

Table 6.6- Households selected for semi-structured in-depth interview at CFUG level

<table>
<thead>
<tr>
<th>CFUG</th>
<th>Household according to well-being</th>
<th>Household according to ethnic group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Well-off</td>
<td>Medium</td>
</tr>
<tr>
<td>Sitakunda</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total households (175)</td>
<td>5</td>
<td>117</td>
</tr>
<tr>
<td>Interview (N=19)</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Thansaderuali</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total households (382)</td>
<td>57</td>
<td>100</td>
</tr>
<tr>
<td>Interview (N = 20)</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Total households (557)</td>
<td>62</td>
<td>217</td>
</tr>
<tr>
<td>Households selected for in-depth interview (N=39)</td>
<td>5</td>
<td>14</td>
</tr>
</tbody>
</table>

Source: Field survey, 2013
Representation of fewer respondents in well-off category households in Sitakunda for in-depth interview occurred mainly because of their absence during the researcher’s field visit. The majority of households in this category live in district headquarters and in Kathmandu (capital city of Nepal) for most of the time. These households have little concern about forest management and have little or no experiences in the REDD+ pilot activities.

Similar in-depth interviews were conducted with a total of 11 district and 3 central level stakeholders who have direct involvement in CF and the REDD+ pilot initiatives. The district level participants comprised government officials, members of CFUG networks including FECOFUN and Watershed REDD+ Network, and members of non-governmental organisations who have knowledge and experience in the research topic (Table 6.7). In-depth interviews were also conducted with central level stakeholders representing ICIMOD, FECOFUN and ANSAB seeking to understand the strategies promoted for community forest management by the REDD+ pilot project.

<table>
<thead>
<tr>
<th>Participants</th>
<th>Type of organisations</th>
<th>Sex</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Government</td>
<td>NGO</td>
<td>CSO</td>
<td>Men</td>
</tr>
<tr>
<td>Central level (N=3)</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>District level (N=11)</td>
<td>4</td>
<td>2</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>Total (14)</td>
<td>4</td>
<td>3</td>
<td>6</td>
<td>12</td>
</tr>
</tbody>
</table>

Source: Field survey, 2013, Note: NGO – Non-Government Organization, CSO – Civil Society Organization

The interviews were recorded with a digital voice recorder (Garmin). Interviews were carried out at a place and time of convenience to respondents. This was particularly important when planning interviews with CFUG members, to assist in establishing an open relationship with informants, and because field research was undertaken during the rainy season when most local community members are very busy with farming, and participant availability was an issue. It was my experience that making the purpose of the research very clear to potential informants, and offering flexibility in seeking a time when they were available, and a place where they would feel most comfortable was very successful in enlisting interview participants.

6.8.2 Focus group discussion
The FGD is another method of attaining in-depth social data. According to Bloor (2001) and Khan et al. (1991), FGD is a form of group interview, in which a small number of people (usually 8-12) having common experience and interest are interviewed on a topic
of importance to a particular study. During the discussion, facilitators (researcher) provide a context to research participants to discuss, prioritise, negotiate, and to mutually reshape their points of views and opinions (Ritchie, 2003). FGD has increasingly been used as a tool for qualitative data collection in social science research particularly in research on health (Heary & Hennessy, 2002; Robinson, 1999; Wong, 2008), education (Wilson, 1997), and natural resources (Kaplowitz, 2000; Kaplowitz & Hoehn, 2001).

According to DiCicco-Bloom & Crabtree (2006) and Morgan (1997), FGD is an appropriate technique when researchers require conclusive views from a particular group of people on issues related to some particular research topics that arise in individual interviews. Hence, FGD has become a useful tool for understanding complex interactions within socio-ecological systems through allowing marginalised and excluded people such as Dalit, women, and illiterate participants to express their opinions, concerns, and experiences in a comfortable way (Gilmour & Fisher, 1991; Kitzinger, 1995). Table 6.8 presents some strengths and weaknesses of FGD.

<table>
<thead>
<tr>
<th>Table 6.8- Strengths and weaknesses of focus group discussion</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strengths</strong></td>
</tr>
<tr>
<td>Can obtain in-depth information with follow-up questions</td>
</tr>
<tr>
<td>Capability to use non-verbal behaviour as a research input – facial expressions or body language</td>
</tr>
<tr>
<td>Opportunity for group participants to interact with each other</td>
</tr>
<tr>
<td>More information within short time</td>
</tr>
<tr>
<td>Can be creative using visual aids and exercise</td>
</tr>
<tr>
<td>Opportunity for participants to learn from other group members</td>
</tr>
</tbody>
</table>

Source: Bryman (2012), Khan et al. (1991) and Sim (1998)

Given the potential weaknesses of FGD, a researcher should have excellent facilitation skills and should stimulate discussion to create a comfortable environment to encourage every participant to express their views (Bryman, 2012). At the same time, involvement of a suitable number of participants is important to enrich discussion (Khan et al., 1991).

In this research, a total of seven FGDs were conducted with CFUG EC members, women, Dalits, and indigenous peoples in the two case study sites. However, FGD was
not conducted with Indigenous Peoples (IPs) in Thansadeurali CFUG, because issues related to them were adequately explored during semi-structured interviews. A total of 74 participants including 37 women, 21 Dalits, and 21 IPs took part in the FGDs. Total number of participants in the FGDs ranged from 6 to 16 (Table 6.9). These FGDs were organised in an interactive way using relevant discussion tools such as pebble scoring and trend analysis for assessing forest management activities and use of forest products over time. I facilitated FGDs using a discussion checklist for EC and Dalit, women and IPs (Appendix 2). I employed Dalit and female facilitators for FGDs with Dalit and women groups respectively, to communicate and set the environment for interview. Views and opinions of participants and conclusions of discussions were recorded by digital audio device as well as in posters and pictures.

### Table 6.9- Number of participants in focus group discussion organized with different interest groups

<table>
<thead>
<tr>
<th>CFUG</th>
<th>Dalit</th>
<th>IP</th>
<th>Women</th>
<th>EC members</th>
<th>Total participants</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>W</td>
<td>T</td>
<td>D</td>
<td>1P/1I</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>B/C</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>T</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>W</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>IP</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>B/C</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>T</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>W</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>IP</td>
</tr>
<tr>
<td>Sitakunda</td>
<td>1</td>
<td>5</td>
<td>6</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>1</td>
<td>8</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td></td>
<td></td>
<td>13</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td></td>
<td></td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td></td>
<td></td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>4</td>
<td>9</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td></td>
<td>10</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td></td>
<td>33</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>18</td>
<td></td>
<td>32</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>74</td>
<td>37</td>
<td>111</td>
<td>21</td>
<td>37</td>
</tr>
</tbody>
</table>

Note: CFUG- Community Forest User Group, EC – Executive Committee, M – Men, W- Women, T- Total, D - Dalit, IP – Indigenous Peoples, B/C- Brahmin and Chhetri

Dalits and women participants of FGDs were mostly illiterate. Domination by elite, well-off, educated and higher caste groups (particularly in FGDs with an ethnically mixed group such as women and EC members) was a problem in FGDs. Even in a FGD with a single caste group such as Dalits in one CFUG, educated members dominated the discussion. Active engagement with less vocal participants was necessary in all FGDs to ensure all views were heard. However, equal and active involvement was noticed in FGD with indigenous peoples in Sitakunda CFUG.

### 6.8.3 Participant observation

Participant observation is used to collect qualitative data in combination with other research methods (Sarantakos, 2012). According to Schmuck (2006), participant observation is a useful tool to observe different aspects of physical, social, economic, and cultural context through observation of non-verbal expressions of research participants during verbal interviews. According to DeWalt & DeWalt (2011) and Kumar (2011), participant observation is used to triangulate data collected through in-
depth interviews and group discussion, and to enhance the quality and richness of the research outcomes.

Observation is usually undertaken in natural settings, is unstructured, and flexible (Tashakkori & Teddlie, 2009). This technique provides researchers with opportunities to learn about the actual situation of activities that research participants perform in their daily lives, as well as offering unanticipated information related to the research topic (Denscombe, 2014).

However, the method is often criticised. Parke & Griffiths (2008) observe that participant observation is an inherently subjective exercise, arguing that its reliability depends on the researchers’ diligence and disciplines. Iacono & Holtham (2009) consider it to be a time-consuming method, not practical in applied research with a shorter period of data collection. Further, Kawulich (2005) describes difficulties in recording and documenting data since it is hard to write down everything that is important when researchers are in the act of participating and observing with research participants.

This research applied participant observation during field work to observe activities associated with REDD+ and forest management. These activities included monthly meetings of CFUG EC, CFUG meetings, resource distribution meetings, and forest users’ participating in various activities including extraction of forest products, and working on fire lines and plantations. During the field work, 7 meetings (2 district FECOFUN, 4 EC meetings including a grass distribution meeting in Thansadeurali CFUG, and one district stakeholder meeting) were observed, where I remained an ‘outsider”, and observed the behavior and dynamics of participants involved in the decision-making process. Additionally, income generating activities implemented with the REDD+ seed grant were observed in both CFUG and some ecological study CFUGs. I also participated in vegetation surveys conducted by my two assistants (one skilled- forester, one local facilitator), and 3 CFUG members, where I observed and documented the condition of forests. Although these observations were not primary measures of data collection, they were useful to verify the reality of the forest condition, resource extraction, livelihood activities, and decision-making processes expressed by research participants during the in-depth interviews and FGDs.
6.8.4 Email and telephone interview

The online survey is also an important tool to verify issues and information that have emerged from previous data and to deepen understanding of the issues (O'Neill, 2004). According to Dillman (2011), online or internet survey is a tailor-designed method of data collection which yields high response rates, with few respondent errors if questions are clear and concise. I collected data from 8 central level stakeholders through an email questionnaire. A set of open ended questions (see Appendix 2) were administered to central level stakeholders related to perception, experiences and opinions of the social and ecological implications of REDD+ in CF, with particular focus on forest biodiversity and forest resources extraction. The questionnaire also asked about national level policy initiatives in response to such potential impacts. The participants represented government officials (Ministry of Forests and Soil Conservation- REDD implementation centre), international and national non-government organisations (WWF, CARE Nepal, ANSAB, and Multi-stakeholder forestry programme), Dalit organisation (DANAR), and FECOFUN. Telephone interview was arranged with district FECOFUN members and key members of CFUG EC such as chairperson and secretary, of the two case study CFUGs in August 2015 to obtain forest product extraction data for 2014 and to confirm queries which appeared during analysis of data, such as incidence of forest fires and resource use.

6.9 Collection of quantitative socio-economic data

Quantitative data related to socio-economic aspects are usually collected through questionnaire surveys or household surveys (De Vaus, 2014). Such surveys are increasingly used to collect data in ecological and physical science research (Brown, 2004). This technique collects data through a set of structured questions (Blaikie, 2003; Onwuegbuzie et al., 2009).

Household surveys can be administered through face-to-face or telephone interviews or through postal surveys. In this research, with a high proportion of illiterate informants and with a low penetration of services and technologies such as post and telephones, the face-to-face approach was adopted. As well as household demographics, socio-economic information related to extraction of forest products, resources dependency, use of alternative energy, landholding size, and livestock number, as well as perceptions of REDD+, were collected through a household survey with a set of structured
questions (Appendix 23). Information generated through these household surveys were used to substantiate the results from in-depth interview, FGD and data from CFUG records.

Stratified random sampling was adopted to select households for this survey, whereby households from the four well-being groups were randomly identified. A total of 74 households (34 from Sitakunda and 40 from Thansadeurali CFUGs) were surveyed from across the four well-being groups (Table 6.10). The household survey was carried out with the household head (that person indicated by the CFUGs operational plan to represent and contribute to CFUG activities), or their spouse or in some cases, both together.

<table>
<thead>
<tr>
<th>CFUG</th>
<th>Household according to well-being</th>
<th>Household according to ethnic group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Well-off</td>
<td>Medium</td>
</tr>
<tr>
<td>Sitakunda</td>
<td>Total (175)</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Total HH for survey (N=34)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>(20%)</td>
<td>(15%)</td>
</tr>
<tr>
<td>Thansadeurali</td>
<td>Total (382)</td>
<td>57</td>
</tr>
<tr>
<td></td>
<td>Total for survey (N = 40)</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>(12%)</td>
<td>(6%)</td>
</tr>
<tr>
<td></td>
<td>Total households (557)</td>
<td>62</td>
</tr>
<tr>
<td></td>
<td>Households selected for household survey</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>(8%)</td>
<td>(6%)</td>
</tr>
</tbody>
</table>

Table 6.10- Number of household (hh) for questionnaire survey

Source: Field survey, 2013 (Note: IP- indigenous Peoples, B/C – Brahmin and Chhetri)

6.10 Collection of secondary data

Secondary data related to the mobilization of CFUG funds were collected from the CFUG financial audit report. Information on forest management activities, participation of forest users in collective forest related activities, frequency of monthly EC meetings and meeting agendas, attendance of EC members at EC meetings, participation of users in GA, and incidences of forest fires were collected from the records and meeting minutes of CFUGs. Forest operational plans and group constitutions were assessed to identify existing provisions for benefit sharing, decision-making process and rules for access, use, and management of forest resources and group funds including REDD+ funds.

National level policy data were also collected from the news media, reports and bulletins, and other official documents particularly from the REDD implementation centre under the MFSC, project organisations (ICIMOD, FECOFUN, and ANSAB),
district level FECOFUN, District Forest Office, and other forestry related organisations. Some demographic and market related data were collected from the District Development Committee and the central bureau of statistics.

International policy documents relating to climate change mitigation and, biodiversity conservation strategies and plan were reviewed. For the national context, the national climate change policy, Nepal’s REDD+ strategy, Readiness Preparation Plan and Readiness Plan Idea Note, the forest act, forest regulations, master plan for forestry sector, forestry sector strategy, National biodiversity strategy plan, and Circulations of governments were also analysed.

6.11 Analysis of data
In social research, a general approach to data analysis involves the categorisation and organisation of data in a systematic pattern (Thorne, 2000). Qualitative research provides non-numeric data, usually in the form of text (e.g. from published reports, interview and FGD transcripts, and field notes), so data analysis involves the analysis of the content of that text, to uncover and understand the big picture through organisation of the data and identification of trends and patterns.

6.11.1 Analysis of qualitative data
Qualitative data collected through in-depth interview and FGD were analysed using a thematic hierarchy approach supported by the computer based NVivo -10 programme (King & Horrocks, 2010, p. 152). Basic steps of data analysis involved data preparation, data reduction, organisation and interpretation (Sarantakos, 2012). In terms of data preparation, digitally recorded interviews in Nepali were directly translated and transcribed verbatim into English. The data from transcriptions were reduced into themes through coding of segments of text (Bryman, 2012). Categorical aggregation was used to organise feelings, opinions, and experiences of respondents into sub-themes (Stake, 1995). Relevant sub-themes were then aligned into themes (hierarchical approach) based on the commonalities (repetition and converging ideas) and contrasts. Derived data (sub-themes and themes) were represented in the form of segments of text, or quotations. Sub-themes and themes were then described and interpreted in terms of trends and relationships based on the commonalities and contrasts. Logical chains and threads of evidence and findings were developed, which were eventually built up as conceptual and theoretical coherence to the overarching theme (Gibbs, 2008). Identified
sub-themes from focus group discussions, online survey, participant observation and other qualitative data (e.g. generated from document reviews and informal talking) were correlated and contrasted with sub-themes of in-depth interview to draw inferences. Figure 6.5 illustrates the process of relating sub-themes into hierarchical themes from the qualitative data.

![Diagram of hierarchical themes](image)

**Figure 6.5 - Illustration of process of qualitative data analysis according to hierarchical themes**

Some direct quotes from in-depth interviews, FGDs, and online surveys are presented in the results to illustrate perceptions, views and experiences of research participants. These quotes are coded according to the origin of participants. The code for in-depth interviewees of local CFUG members starts S or T which indicates Sitakunda and Thansadeurali CFUG. The last letter A, B, C or D indicates respondents from well-off, medium, poor and very poor well-being groups respectively. The sequence of interview from particular well-being groups in each CFUG are indicated with numbers consecutively. For example, SB1 refers to the first respondent of medium well-being group of Sitakunda, and TC1 represents the first respondent of poor well-being group of Thansadeurali CFUG. The codes for participants from FGD, district and central level stakeholders have been assigned as shown in Table 6.11.

### Table 6.11- Code assigned for interviewees from different levels

<table>
<thead>
<tr>
<th>Codes</th>
<th>Stakeholder level</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB1</td>
<td>First interviewee from medium group in Sitakunda CFUG</td>
</tr>
<tr>
<td>TC1</td>
<td>First interviewee from poor group in Thansadeurali CFUG</td>
</tr>
<tr>
<td>D1</td>
<td>First interviewee of district level stakeholders</td>
</tr>
<tr>
<td>C1</td>
<td>First interviewee of central level stakeholders</td>
</tr>
</tbody>
</table>
Analysis of factors affecting forest products removal and their effects on carbon stocks and forest biodiversity

CFs are managed according to a complex system of social and ecological elements. The dynamics of social and ecological changes are associated with the contextual factors in relation to extraction of forest products from CFs. Thus understanding these factors and their relation to carbon stocks and forest biodiversity is critical to ascertain the long-term contribution of REDD+ to CF (Agrawal & Angelsen, 2009). For the purpose of this research, potential factors are defined as the elements associated with the extraction of forest products from CFs. These include policy and institutional arrangements (i.e. distribution rules, monitoring and enforcement), biophysical characteristics (i.e. physical distance to forests from settlements, forest size and vegetation types), and social and economic circumstances (trees growing in private farmlands, change in traditional agriculture practices, road access, development of wood-based industries, and outmigration). This research analysed factors that have the potential to influence removal of forest products based on the experiences of local communities, district and national stakeholders.

Analysis of changed practices with REDD+ pilot

Changes in group management and decision-making processes, benefit sharing and forest management practices following the REDD+ pilot initiative were assessed by analysing research participants’ experiences and opinions. Research participants were asked to describe the regularity of EC meetings, participation of forest users in GA and decision-making processes and benefit sharing practices, priorities of allocation of CFUG funds and changes in forest management practices for the last couple of years (from 2010 to 2013), and were asked to provide possible explanations associated with these changes. Responses of research participants that described REDD+ or carbon projects as the causes of these changes were interpreted as changes which had happened because of REDD+. The experiences of research participants (e.g. at CFUG level, District level, and Centre level) were substantiated by cross-referencing to CFUG records and document analysis (CFUG office records, meeting minutes) in relation to forest activities, allocation of CFUG funds to different activities, change in frequency and agenda of CFUG EC meetings and general assemblies, attendances of EC members at EC meetings, changes in forest user participation in general assemblies and forest activities.
6.11.2 Analysis of socio-economic quantitative data
This research used quantitative socio-economic data collected from household survey, to provide information on a range of characteristics relating to extraction of forest product, use of energy, livestock number and forest management among households of different well-being and caste groups. For this, quantitative data were arranged and tabulated in spreadsheets, and outcomes were presented in the form of descriptive statistics, figures, charts and graphs. Some data collected from CFUG and DFO office records such as mobilisation of group funds, meeting frequency, meeting agenda and practices of forest management activities have also been presented in the form of descriptive tables, charts, and graphs.

6.11.3 Estimation of importance value index (IVI)
I developed an importance value index (IVI) of two case study CFs purposefully to determine the overall importance of tree species in the CFs (Pereki et al., 2013). The IVI is a composite of three ecological parameters (density, frequency and dominance) that provides an indication of relative value of tree species to local people (Giliba et al., 2011; Poulsen et al., 1996). The IVI rank also provides knowledge about important species in CFs that local people prefer to use. The IVI index was calculated by summing the percentage values of the relative frequency, relative density and relative dominance (Curtis & McIntosh, 1951; Razavi et al., 2012). The tree species data for this calculation was taken from the ICIMOD data-base described in Chapter 4. A high IVI rank indicates high density and dominant species in the forests. The results of this analysis substantiate the responses from in-depth interviews about the changes in plant species composition in CFs.

6.12 Validity and reliability
Reliability and validity are two interrelated research concepts that are recognised to be important in qualitative inquiry (Golafshani, 2003). Sarantakos (2012) defines, reliability as the ability of the research methods to generate consistent results, while validity is the production of accurate results measuring what was intended to be measured. In sum, reliability is consistency in measurements, while validity is truth in measurements. Hence, production of both reliable and valid results is the foundation for rigor in qualitative research (Morse et al., 2008).
The issues of reliability or consistency within the context of social research are associated with measurement errors which may emerge through different techniques used for data collection (Bapir, 2014; Drost, 2011). Therefore, reliability in social research can be enhanced by standardising data collection techniques (Patton, 1999). According to Neuman (2007) and Silverman (2010), reliability can also be improved by maintaining a consistent sequence of questions to every research participant (e.g. in the case of household survey), and adopting a consistent approach to recording data for the different methods used (e.g. interviews, group discussion, observation and document reviews).

Validity is mainly concerned with the degree to which a finding is judged to have been interpreted in a correct way (Patton, 1999). Validity can be enhanced by clarifying questions to research participants, comparing the results of research with the results obtained by other researchers in a similar context, and by keeping accurate and detailed field notes to record variations in responses from different techniques (Brink, 1993). As suggested by Brink (1993), Bryman (2012), and Drost (2011), this research has adopted a number of measures to enhance reliability and validity of results (Table 6.12).

### Table 6.12- Approaches applied to ensure reliability and validity in this research

<table>
<thead>
<tr>
<th>Reliability</th>
<th>Validity</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Questions (both in-depth interview and household survey) were clearly explained to respondents</td>
<td>- CFUGs for case study were selected as per criteria and consultation with district stakeholders</td>
</tr>
<tr>
<td>- Questions were asked in the same sequences to all respondents to generate consistent responses in the household survey</td>
<td>- Ensured the research process covered all aspects of the research topic</td>
</tr>
<tr>
<td>- Information was also collected through household survey using open questioning on some topics from in-depth interviews. Results from the two methods were correlated and triangulated.</td>
<td>- Evidence of CFUGs were shared with district stakeholders, and data were collected through different techniques where inconsistencies and contradiction appeared</td>
</tr>
<tr>
<td></td>
<td>- Results were compared with other studies in similar context</td>
</tr>
</tbody>
</table>

### 6.13 Ethical consideration

This research involved gathering the perceptions, opinions and experiences of local people. The data collection process was conducted in accordance with ethical considerations and standards of the CSU’s Human Research Ethics Committee (HREC) (HREC protocol number 410/2013/07) (Appendices 24 and 25). Every interview was carried out with the formal consent of participants. Privacy and confidentiality was fully maintained as the researcher was aware of the ethical issues of social research. In order
to obtain their informed consent, the researcher informed respondents about the research project, the use of data, and confidentiality of the data in the research.

The participation of respondents was voluntary. Respondents were informed that they were free to withdraw their participation at any time. Any record, photographs and data related to them were taken with consent of the respondents.

6.14 Possible biases and limitations of qualitative research

The possible biases for this social research include personal and methodological (Huesemann, 2002). According to Salway & Wakefield (2005), possible sources of personal bias in qualitative social research include respondents, and the researchers themselves; while sources of methodological bias include questions and the environment of interviews.

Personal biases due to the respondents occur both intentionally and unintentionally. Intentional biases occur when respondents want to give an answer that pleases the interviewers. Conversely, unintentional biases arise due to respondents being unaware of the correct answer. Personal biases related to researchers arise mainly due to communication skills, their beliefs and affiliations, and unwillingness to accept the viewpoints of gender, well-being and ethnic groups that are different from the researchers’ own.

In this research, a bias emerged related to existing social norms that Dalit and marginalized are excluded from participation in research processes. Such bias was avoided by organising focus group discussions separately for Dalit, women and indigenous peoples. To ensure their active participation research objectives were translated into Nepali language so that literate people could read and understand, and objectives could be consistently explained to illiterate research participants. In regards to bias owing to the researcher’s communication skills, I maintained professional ethics by acknowledging the views and perspectives of all research participants.

All of these biases and limitations might still have some implications on research findings, although precautions, mentioned above, were adopted. I undertook a case study in two CFUGs to understand social, economic and institutional linkages with the ecological outcomes in 19 CFUGs with reference to implementation of the REDD+ pilot initiative. These linkages were developed through the explanatory responses,
opinions and perceptions of respondents. To enrich the meaning of opinions and experiences of respondents, explanatory responses were substantiated with social and biophysical quantitative data generated through household surveys and secondary sources.

6.15 Scope of study

Findings from such case study research can contribute to understanding the complexity of relationships, issues and factors related to the problem being studied. While this might not be exactly the same in every case, the research outcomes from a small number of cases can provide an important window into interactions and deliver complex understandings and explanations of the dynamic workings of those societies studied.
Chapter 7- Understanding the factors affecting removal of forest products and their effects on carbon stocks and forest biodiversity

7.1 Introduction

The removal of forest products can be a potential source of trade-offs for carbon stocks and forest biodiversity. This chapter discusses the factors associated with the extraction of forest products from CFs. Chapter 4 indicated that REDD+ likely results in reduced extraction of forest products, while chapter 5 showed a possibility of both synergies and trade-offs in the relationships between removal of forest products, carbon stocks and forest biodiversity in CFs. It is clear that the extraction of forest products can be associated with a number of local and external factors, and it is vital to understand such factors and their positive or negative influences on forest products extraction, carbon stocks and biodiversity.

The removal of forest products (e.g. timber, fuelwood, and fodder) is common among CFUGs for subsistence. The extraction of forest products from CFs can be influenced by biophysical or socio-economic characteristics and institutional arrangements. For example, Chhatre & Agrawal (2008) and Persha et al. (2011) found that forest size can affect forest product extraction, while Belay et al. (2013), Sapkota & Oden (2008), Adhikari (2003b) and Ostrom & Nagendra (2006) noted that socio-economic characteristics (e.g. agriculture practice) and institutional arrangements can influence the use of forest products.

The extraction of forest products generally reduces carbon stocks and can change tree species composition. According to Villamagna et al. (2013) and Skutsch et al. (2011), the removal of timber, fuelwood and fodder beyond the production capacity of forests (assessed annual allowable harvest in the case of CFs) results in forest degradation, reduced carbon stocks and forest biodiversity loss. Hence, this chapter explores the factors associated with the extraction of forest products and how that may influence carbon stocks and forest biodiversity, using the broad socio-ecological system framework (Figure 1.1 Chapter 1), which draws on qualitative and quantitative data.
This chapter (I) presents data from in-depth interviews with local forest users of different well-being and caste/ethnic groups from two case study CFUGs - Thansadeurali and Sitakunda (Appendix 26). Thirty-nine interviews were undertaken with CFUG members, including five from well-off households, 14 from medium and 10 each from poor and very poor households. These interviewees included 25 from the Brahmin and Chhetri caste, and 7 each from Indigenous Peoples (IPs) and Dalit. Data are also presented from 14 in-depth interviews with district and central level stakeholders involved in the REDD+ pilot and community forestry programme, and local owners of wood-based factories. FGDs were also conducted with members of different interest groups, including IPs, Dalits, women’s groups, and the EC of each case study CFUG.

Thematic analysis of qualitative data identified a number of critical factors that influence extraction of forest products (Figure 7.1). These data are presented alongside quantitative data related to the extraction of forest products, access to alternative energy, tree species availability, and incidences of forest fires, which were collected through household survey and group records from the two case study CFUGs and the district forest office (DFO). Forest product extraction either increased or decreased, and factors associated with these changes are organised into four broad themes (Figure 7.1).

![Figure 7.1](image_url)

*Figure 7.1- Hierarchy of institutional, biophysical and socio-economic factors affecting extraction of forest products in community forests*
7.2 Existing practices and change in extraction of forest products

This section describes the responses and experiences of interviewees when asked about forest resource use practices in CFs, with a particular focus on perceptions of changes in the extraction of timber, fuelwood and fodder.

7.2.1 Change in extraction of timber

Timber is commonly harvested by member households for residential buildings and livestock sheds. For this study, timber refers to the wood harvested in the form of logs, sawn planks and extracted from pole size trees, and wood from big branches of trees used for small houses and cowsheds. Due to durability, strength, and resistance to insect damage, certain tree species are preferred by local communities for timber in residential buildings.

Timber has relatively greater economic value than other forest products since it has multiple-use potential, and is also used for public infrastructure such as community buildings, bridges, and schools. CFUGs often sell timber outside their CFUG membership, such as by auction to contractors and as contribution to public buildings. Local forest users can access timber (100 cubic feet and 50 cubic feet for new house construction and house maintenance) once every five years (Appendix 26) in both case study CFUGs. Use of timber across CFUGs varied according to household needs, income level, distance to forests, road accessibility, personal skills, availability of trees on private land, and CF rules associated with timber extraction. These factors are dynamic and change over time with changing social conditions, economic growth and national/external policy deliberations.

Extraction of timber is generally carried out by the member households of CFUGs or the CFUG EC, usually within the limits of the harvestable quantity stated in each CFUG’s forest operational plan. Extraction either increased or decreased due to single or combined effects of socio-economic characteristics of forest users, forest product distributions rules, evolutionary factors (i.e. migration, market and road networks) and external initiatives such as the REDD+ scheme.
A majority (28 out of 39) of CFUG interviewees (12 from Sitakunda CFUG, 16 from Thansadeurali CFUG) reported that timber is extracted from the CFs both for domestic uses and for public buildings. As noted by a member of Sitakunda CFUG:

“...forest users in our CFUG extract timber from community forests for the construction and maintenance of buildings and cow sheds. We use timber for furniture very rarely as the CFUG provides only a limited quantity of timber to households...” (SB3).

The extraction of timber varies across households with different well-being status. As reported by respondents, household income level is one major factor that determines the extraction of timber by households from CFs because harvesting of timber involves a fee payable to the CFUGs and labour costs for felling, trimming and transportation. One very poor interviewee from Sitakunda CFUG explained that:

“...well-off households usually extract timber since they can afford harvesting costs. My house is old. Wooden beams are getting weak and about to break. Although I need wood to repair wooden beams of my house but I cannot extract timber because it is so expensive for harvesting and transportation of timber...” (SD5).

Similar experiences were reported by respondents of Thansadeurali CFUG, where timber extraction is considered costly since the forest is located far away. Because of high transportation and harvesting labour costs, poor households cannot harvest timber from CFs. As noted by one poor household respondent:

“...well-off households harvest more timber than poor households. Well-off users have high income and can build house. At the same time, they can afford the costs of labour and transporting timber by truck from the forest since we have road access to the forest...” (TC4).

The presence of skilful human resources within the household also determines the level of access to and extraction of timber across households of different well-being and ethnic/caste groups. For example, one very poor single woman from Dalit of Thansadeurali CFUG explained:

“...I need timber for the maintenance of roof of house and cowshed. However, I have neither husband nor money. We have to reach upper part of the forest for good timber species such as Thingure Salla. I cannot provide enough money for labour to harvest timber. Labour charge is very expensive in our village. A labourer demands Nepali Rupees 500 for a day with 3 meals...” (TD1).

Responding to the query of whether the extraction of timber has changed in the CFs in recent years, the majority of respondents reported that extraction of timber declined
after the development of CFs, but has gradually increased in more recent years. In this regard, the former secretary of Thansadeurali CFUG reported that:

“...timber extraction significantly decreased in our community forests compared to before community forestry development. However, extraction of timber has gradually increased in recent years because of increased demand of local forest users and overharvesting by some permit holder CFUGs...” (TB1).

Some well-off respondents from both CFUGs claimed that extraction of timber has declined in their CFs due to increased availability of trees from private lands. One well-off interviewee, a former chairperson of Thansadeurali CFUG explained:

“...use of timber from community forest is decreasing. This is mainly due to the improvement of trees in private land. Local people started growing trees on private land when they got involved in community forestry program. Now, the trees have been usable (big enough to be) for timber use. So, users’ demand on timber from community forests is decreasing as compared to former time...” (TA2).

All district level interviewees reported that growing of trees on private land has increased in Dolakha District including in the case study CFUGs, which has become a sustainable source of forest products. According to an employee of the district forest office:

“...an increase in demand by local forest users for seedlings from district forest office indicates an increase in growing trees on private land in Dolakha district since the beginning of development of community forests. This has enhanced private forests. As a result, extraction of timber has gradually decreased in community forests...“ (D3).

However, seven poor and one very poor interviewee (four from Sitakunda and four from Thansadeurali CFUG) argued that development of trees in private lands has not contributed to a decrease in extraction of timber from CFs. According to them, forest users having trees on private land are mostly well-off households with large landholdings. Private forest owners have a strong interest in maximising profit and tend to sell their trees to the saw mills, while they extract timber from CFs for their own domestic use. In this regard, one poor interviewee of this CFUG explained that:

“...I agree that fuelwood and fodder extraction from forests has decreased due to increase in development of trees on private land. However, users who have trees on their private lands tend to sell their trees to the saw-millers and market for money. These households extract timber from the community forests at a cheaper rate for their domestic use. As a result, there is no decrease in timber extraction...” (TC3).
As reported by FGD participants of the EC of Thansadeurali CFUG, and as outlined in the forest operational plan, the harvest limit for each household is a maximum of 100 cubic feet for construction of a new house and 50 cubic feet for house maintenance. However, poor and very poor respondents of Thansadeurali CFUG described overharvesting of timber beyond the amount permitted by CFUG, with overharvesting having increased by forest users with permits for domestic purposes. According to one very poor respondent:

“...timber extraction in our community forest has increased due to incidences of over harvest of trees. I heard that permit-holder households harvested timber beyond permitted quantity last year and sold to the saw mills...” (TD3).

A few well-off households and FGD participants of Thansadeurali CFUG EC agreed that growing trees on private lands has not contributed to a reduction in timber demand. According to these respondents, high quality timber tree species such as Thingure Salla and Kholme are found only in high elevation in the Thansadeurali CFs. These tree species do not grow on private lands, which are mostly located at lower elevation than the CFs. Local forest users grow mostly Alder on their private land, which provides a lower quality timber.

“...local people mostly prefer timber from Thingure Salla, which is only found in upper part of our community forests. This is high quality timber trees. We do not have these trees in private land. CFUG has set lower per unit timber fees for Thingure Salla owing to the distance to forests, where Thingure Salla is available. Because of both quality trees and lower fees, local forest uses make high demand, which caused an increase in extraction of timber from our community forests...” (TA3).

Similar experiences were reported by FGD participants of Sitakunda CFUG EC. High quality timber tree species such as Sal (Shorea robusta) and Saj (Terminalia tomentose) are found only in CFs. According to a former chairperson (SB5), local forest users as well as government offices have high demand for such timber from their CFs, which has led to an increase in timber extraction.

I used the Importance Value Index (IVI) to understand the importance of tree species (not including saplings and seedlings) that forest users prefer to harvest (detail in Chapter 6). Using forest inventory data from ICIMOD (see Chapter 4), IVI was calculated by summing the percentage values of the relative frequency, relative density and relative dominance of each species. A high IVI rank indicates high density and dominant species in the forests. Dominant tree species for 2010 were Gurans, Kamali,
Oak, Kholme, Pahele and Thingure Salla. However, these species, especially Oak, Gurans and Thingure Salla decreased in 2013, while Pate Salla and Rani Salla increased from 2010 to 2013 (Figure 7.2). However, the analysis showed an increase in IVI of Sal trees in Sitakunda CFUG, while the IVI of Chirpine, Saj and Kyamuno has decreased for the same period of time (Figure 7.3). A decrease can be due to extraction of this species for timber, fuelwood and fodder. As reported by the present chairperson, Sal tree species have a high natural regeneration capacity. Regarding the decrease in Chirpine, the respondent reported that their CFUG provides both timber and fuelwood from live-standing trees of Chirpine.

Figure 7.2- Importance value index of tree species in Thansadeurali CFUG for 2010 and 2013

Figure 7.3- Importance value index of tree species in Sitakunda CFUG for 2010 and 2013
Development of wood-based factories such as saw-mills, veneer factories, furniture and paper factories has been reported by the respondents of Thansadeurali CFUG as a major factor influencing overharvest of timber from CFs. According to the respondents, development of the timber-based industries in close proximity to CFs has stimulated forest users to seek profits from illegal felling and over extraction of timber above the permitted quantity. As explained by one well-off respondent of Thansadeurali CFUG, who was also an official in the district development committee,

“...veneer factories and saw mills have been established close to our forests. They need round wood as raw materials. It has induced forest users to extract timber from community forests. There are several incidences in our CFUGs that forest users have had permission to harvest timber from forests for domestic purposes but instead have sold to saw mills. Consequently, timber extraction has increased...” (TA1).

The current chairperson (TB5) of this CFUG described the same problem, saying he had heard that 50% of timber harvested from CFs is sold to saw mills by permit-holder households, and that EC members cannot follow permit-holders for 5-6 days after the timber harvest to determine whether they use the timber for their own house or sell it to saw-mills.

Owing to strict rules and cumbersome administration processes associated with timber harvesting from CFs, saw-millers have also increased their extraction of timber from private land owners. For example, one saw-mill owner said that:

“...in the past, we used to bring timber from the community forests for our saw mill. However, extraction of timber from community forests involves cumbersome processes. Since timber extraction from private owners is easy and efficient, we prefer timber extraction from private forest owners...” (D7).

Respondents from the district FECOFUN and the district forest office explained that private owners can make a big profit selling timber from private land. According to them, the fees they pay for timber from CFs are much lower than the price they receive for the sale of their own timber. In many cases, this price difference provides an incentive for private forest owners to sell their timber to saw mills, and to extract timber from CFs for their own use. In this regard, one interviewee, also an employee of the district forest office, stated that:

“...planting of trees in private land in Dolakha district has significantly increased, and that has supplied nearly 90% of woods and raw materials to the veneer factories and saw mills. Nevertheless, extraction of timber in some CFs remains the same. This is actually due to price differences of
timber from community forests and private lands. Private owners tend to profit by selling trees to saw-millers, while they extract timber for their own use from community forests…” (D3).

The analysis of household survey data shows a variation in extraction of timber across households from different well-being groups in the two case study CFUGs. A higher proportion of well-off households extract timber from CFs in Thansadeurali CFUG, while the percentage of households extracting timber did not vary in Sitakunda CFUG across the different well-being groups (Table 7.1). However, with only a single well-off household surveyed in Sitakunda, the presence or absence of a clear trend is not able to be confirmed.

Regarding the amount of extracted timber, the results showed a greater amount of timber extracted by well-off households in both Sitakunda and Thansadeurali CFUGs although the average amount of timber extracted varied (Table 7.1). Generally, the well-off households have greater private land area and a higher number of trees growing in their own land. The results showing higher timber extraction by well-off households in CFs, in terms of both proportion of households and amount of timber extracted, indicate that availability of trees on private land does not appear to reduce the amount of timber extracted from CFs. These results support the arguments made by poor and very poor respondents that well-off households harvest more timber from CFs despite the increase in available trees on private land.

Table 7.1- Proportional distribution of households of well-being groups extracting timber in Sitakunda and Thansadeurali CFUGs in 2013

<table>
<thead>
<tr>
<th>Well-being groups</th>
<th>Sitakunda CFUG</th>
<th>Thansadeurali CFUG</th>
<th>Average amount of timber extracted by each household (cubic feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HH surveyed</td>
<td>HH harvest</td>
<td>HH %</td>
</tr>
<tr>
<td>Very poor</td>
<td>7</td>
<td>1</td>
<td>14</td>
</tr>
<tr>
<td>Poor</td>
<td>8</td>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td>Medium</td>
<td>18</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>Well-off</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>34</td>
<td>4</td>
<td>12</td>
</tr>
</tbody>
</table>

Source: Household survey, 2013

Road access to CFs has been linked by respondents from both CFUGs with increased extraction of timber, though this is mainly identified by poor and very poor respondents, who do not have the financial resources to harvest timber. Construction of a road
passing through Thansadeurali CF from the Jiri- Kathmandu road to Kalinchowk Bhagawati (a site of religious pilgrimage) five years ago has led to increased timber extraction and illegal activity. One very poor respondent from Thansadeurali CFUG elaborated:

“...incidences of over-extraction of timber above the permitted quantity have increased by some households with the improvement of transportation facilities due to construction of the road. Last year, some households extracted timber above their permitted amount and transported it during the night. They were able to transport timber during night mainly because of road access...” (TD4).

In Sitakunda CFUG, road access also has a direct influence on timber extraction. The road from Kathmandu to Jiri passes directly through their forest, which is relatively large compared to neighbouring CFs. According to the FGD participants and interviewees, the CFUG has had to supply timber for the construction of government offices and electric poles in Dolakha. As explained by the current CFUG chairperson:

“...our forests are accessible to the main road. Besides, the district level-government offices often ask for timber from our forests for the construction of office buildings. We could not refuse. As a result, extraction of timber increased...” (SB6).

According to a former chairperson of the Sitakunda CFUG, a large demand for timber from the local government office and school for buildings has resulted in an increase in tree removal. As he further explained:

“...our forests are relatively large in size and accessible to the main road. Besides, demand for timber from government offices, the municipality has consistently pressured us to allow construction of a landfill site inside our community forests because of the road network. This has increased forest fire incidences every year and loss of trees and woods from the forests...” (SB5).

District stakeholders including forest officials also recognised that illegal felling and over extraction beyond the annual allowable quantity occur in CFs as a result of the development of road networks. According to these interviewees, the road network has improved transportation facilities for the forest users, which has facilitated illegal felling in some CFUGs.

As reported by district level research participants, a revision of the central level policy on forest products use by the central government for the Terai region of Nepal has also had a direct effect on local practices of timber extraction in the mid-hills district
including Dolakha. According to these respondents, restriction of timber extraction on
some trees in Terai regions of Nepal caused a reduction in timber supply to Kathmandu,
which affected timber extraction in Dolakha and other districts nearby to Kathmandu.

As explained by one district level forest official:

“...when central government banned removing the Sal trees from community
forests and national forests of Terai region of Nepal, the pressure of timber
demand increased in Dolakha as well as other mid-hills districts. We
experienced increased pressure in Dolakha because this district is close to
Kathmandu...” (D1).

Timber extraction data collected from CFUG records revealed a general increase in the
per ha extraction of timber in both case study CFUGs between 2009 and 2014 (Figure
7.4), although a dramatic reduction in harvest occurred in Sitakunda CFUG in 2014.
Harvest of timber in Thansadeurali CFUG grew from 10 cubic feet/ha in 2009 to 26
cubic feet/ha in 2014, while in Sitakunda CFUG it increased from 11 cubic feet/ha in
2009 to a peak of 23 cubic feet/ha in 2013. Regarding the extraction of a larger quantity
of timber in Sitakunda CFUG; the chairperson of this CFUG mentioned that:

“...we harvested greater quantity of timber in 2013. We are constructing our
CFUG office building. We needed timber for the building construction.
Further, we sold some amount of timber outside CFUG members to make
money for building construction...” (SB5).

Regarding the dramatic reduction in the harvest of timber in 2014, the secretary of this
CFUG (interviewed by phone in August 2015) reported that the CFUG had a greatly
reduced timber demand from their forest users. At the same time, the CFUG did not sell
trees to people outside their CFUG members or to government offices. According to the
respondent, the CFUG did not sell timber through auction for the group fund because
they had already completed construction of the office building.
The data reveal a general increase in per capita extraction of timber for both CFUGs for 2009 and 2014; however, there was no consistent trend (Figure 7.5). Although there was a gradual increase in timber extraction in later years, per capita timber extraction decreased in Sitakunda CFUG for 2014.

The forest operational plans of Sitakunda and Thansadeurali CFUGs allow an annual per hectare maximum timber harvest of 15 and 22 cubic feet respectively. However, the data in Figure 7.4 show that both CFUGs harvested above the harvestable quantity (Sitakunda CFUG in 2012 and 2013 and Thansadeurali CFUG in 2014). This indicated
that not only did timber extraction increase but that the CFUGs also did not always abide by the harvestable quantity limits.

Responding to a query about the increase in timber extraction in Thansadeurali CFUG in 2014, the secretary of Thansadeurali CFUG (Telephone interview in August 2015) reported that timber extraction significantly increased in 2014 due to the high demand for timber by forest users for domestic use as well as for the construction of monastery, temple and school. The respondent also described that extraction of timber has not changed with the implementation of the REDD+ project in terms of quantity, however, they have restricted timber extraction of Thingure Salla (a slow growing tree species with quality timber mostly located in the upper part of Thansadeurali CF and diminishing from the forests due to over extraction by forest users) encouraging members to harvest Pate Salla (a planted tree species with low quality timber commonly found in CFs) (see Chapter 8). This indicates that Sitakunda and Thansadeurali CFUGs extracted timber based on user needs rather than limiting extraction to the annual allowable quantity (Figure 7.4). However, plantation of Pate Salla can become an ecological problem although it has provided an alternative source of timber.

In general, the results showed that well-off households extract a higher quantity of timber from CFs than less well-off households. Although removal of timber slowed after the introduction of community forestry, the data from group records and experiences of interviewees revealed that extraction of timber has increased in recent years. This increasing trend of timber extraction is unexpected given the increase of tree growing in private lands, but can in part be explained by the profit that can be made by owners of private forests from selling their own trees into the commercial market, while sourcing timber for private needs from the CFs at a cheaper price. Other factors such as the development of road networks, development of wood-based industries such as sawmills, furniture, veneer and paper factories, availability of high quality timber tree species in CFs, and the introduction of central level policies that restrict timber harvest in Terai regions of Nepal have contributed to the increase in demand and extraction of timber in case study CFs. Although the results revealed a consistent trend of increasing extraction of timber in Thansadeurali CFUG, extraction of timber dramatically decreased in Sitakunda CFUG in 2014, which indicates that factors associated with timber extraction are context specific and dynamic, and change over time, causing localised patterns of timber extraction.
7.2.2 Change in extraction of fuelwood

Fuelwood is a basic source of household energy, mostly used in cooking food for humans or cattle (gruel or animal porridge) and heating, but also for large community events such as festivals, weddings and funerals. Fuelwood is consumed by all types of users in both case study CFUGs. Thansadeurali CFUG provides permits for collection of fuelwood as dried twigs, branches, and stumps during six month periods starting from November every year, without any charge for the collection. The CFUG restricts extraction of green branches and trees except for special occasions such as funerals and wedding ceremonies, though does provide green twigs and branches derived from silviculture operations such as thinning and pruning to those forest users participating in such activities. Sitakunda CFUG allows forest users to collect dried and fallen twigs and branches throughout the year without any fees, while a major portion of the fuelwood is supplied to forest users from live-standing trees during winter every year with fees of NRs. 5.00 for each headload (approximately 35 kg) of fuelwood.

When respondents were asked about the existing practices of fuelwood extraction from CFs, all interviewees (19 from Sitakunda CFUG, 20 from Thansadeurali CFUG) uniformly reported that fuelwood is harvested for domestic purposes from the CFs as represented by the following comment:

"...fuelwood is the most important forest product for forest users in our community forest. Most of the households of our forest group harvest more or less fuelwood from the community forest..." (SC1).

While fuelwood is the major forest product used by the majority of households in both case study CFs (Appendices 27 and 28), extraction of fuelwood from CFs varies across households depending on family size, number of livestock, distance to forests, well-being status and cultural practices. One woman respondent of Newar ethnicity from Sitakunda CFUG reported that fuelwood is an important fuel source for them to prepare alcohol that is needed to perform special cultural events and feasts.

"...fuelwood is the main forest product that I collect from the community forests. I am a member of Newar- an ethnic group. I prepare alcohol at home which we need every festival, and cultural events such as birth, marriage, and death. We need fuelwood to prepare alcohol..." (SC3).

As reported by the respondents, family size also determines the demand for fuelwood from CFs. Large families require a greater quantity of fuelwood, while also having
sufficient labour to fetch fuelwood from the CFs. A few respondents reported that
because of insufficient human resources, they could not participate in thinning and
pruning activities and thus could not access green branches and twigs for fuelwood.
Families with insufficient human resources also collect less fuelwood from forests.
According to one respondent of Thansadeurali CFUG:

“...our CFUG provides access to fuelwood for six months during winter. Because of insufficient human resource we cannot collect sufficient fuelwood during the permitted time. Sometimes, we will be busy at the time. However, family with large family size can collect fuelwood...” (TC3).

While fuelwood is still consumed by the majority of households of both case study
CFUGs, the majority (30 out of 39) of interviewees of the two case study CFUGs (10
from Sitakunda CFUG, 20 from Thansadeurali CFUG), five district level interviewees
and participants from seven FGDs reported that extraction of fuelwood from CFs has
gradually decreased in recent years. The following quotation represents the common
view of the interviewees in regard to the decrease in extraction of fuelwood.

“...extraction of fuelwood from community forests has significantly
decreased over the last couple of years. In former time, there was no place
to rest head loads of fuelwood in Chautaro (platform) because so many
households used to go for fuelwood in community forests. Nowadays, number of households has decreased that collect fuelwood from community forests...” (TC5).

Temporary outmigration of local youths and adults for better jobs and for education has
been reported by some interviewees in both CFUGs as the main factor for a decrease in
fuelwood collection in CFs. A reduced number of youths and adults reduces the human
labour available to fetch the fuelwood from CFs as fuelwood collection is a time-
consuming task, requiring walking long distances, gathering dried twigs and branches,
and often carrying heavy loads. As reported by a very poor interviewee of Sitakunda
CFUG:

“...my son and daughter migrated temporarily to Kathmandu and India for
better job. My wife and I are getting older. So, we cannot collect fuelwood
and fodder from the forests during permitted time. We buy fuelwood from a
nearby neighbour who has trees on their private land...” (SD6).

Temporary outmigration also reduces fuelwood demand in other ways. Some
households stated that they have reduced their livestock number owing to insufficient
human resources for herding and fetching fodder, which also reduces their fuelwood
needs. As noted by one well-off respondent:
"...my sons and daughters temporarily migrated to Kathmandu for their study. My wife and I live here. We do not need much fuelwood for cooking. We have also stopped keeping cattle. We use liquid petroleum gas and coal stove for two persons in our family...” (TA1).

As reported by respondents of Thansadeurali CFUG, a decrease in fuelwood extraction is also attributed to the transformation of agriculture practices from traditional cropping practice (i.e. planting of maize, wheat and millet) to vegetable farming (cauli flower and potato farming). According to the respondents, vegetable farming has increased local employment opportunities and provided alternative livelihoods, especially for very poor households, who previously survived by selling fuelwood in the district centre of Charikot. As mentioned by a very poor woman interviewee of this CFUG:

"...I used to collect and sell fuelwood at the market for survival. Nowadays, I go for labour work in vegetable farming (cauli flower and potato farming) run by our neighbours. I can earn NRs 150 in a day. Sometimes, I work as a labourer in the district headquarters. Being involved in labouring work is good for me since CFUG doesn’t permit sale of fuelwood outside CFUG...” (TD1).

All interviewees (20) in Thansadeurali CFUG stated that the increased availability of trees from private land has significantly decreased the extraction of fuelwood from CFs. According to the respondents, growing trees on private farmlands has increased with the introduction of restrictions on cattle grazing after the development of community forestry. According to one well-off interviewee:

"...local people have grown trees in private lands through natural regeneration and through plantation with control of cattle grazing both in community forests and private farmland. Plantation in agriculture land increased when local people got involved in plantation activities of community forests by learning to plant the trees. An increase of Alder trees, a fast growing species on private land has significantly decreased our fuelwood dependency from community forests...” (TA3).

The establishment of trees on private lands and their contribution to the change in fuelwood collection varied across the two case study CFUGs, and across different well-being households within each CFUG. FGD participants of Thansadeurali CFUG EC attributed a significant decrease in fuelwood extraction from CFs to the growing of trees on private farmlands. However, respondents from Sitakunda CFUG reported a lower contribution of trees on private land to any decrease in fuelwood extraction. According to these respondents, at a low altitude much of the land is irrigated and planted to rice rather than to trees. With a limited area of non-irrigated land, there has been only limited planting of trees on private farmlands.
Analysis of fuelwood extraction from CFs from household survey data revealed that a higher proportion of households of Sitakunda CFUG extracted fuelwood from CFs compared to households of Thansadeurali CFUG in 2013 (Table 7.2). In both CFUGs, a higher proportion of poor and very poor households extracted fuelwood from CFs compared to medium and well-off households. However, a higher proportion of medium wealth households in Sitakunda CFUG have extracted fuelwood.

In terms of the amount of fuelwood extracted, more very poor, poor and medium wealth households in Sitakunda CFUG extracted over 20 headloads. This can be attributed to the lower number of households in Sitakunda CFUG growing trees on private farmlands. While well-off households generally have greater land-holding size (see Chapter 6), forest users of Sitakunda CFUG prefer planting rice to planting trees.

The results revealed that a higher proportion of very poor and poor households have extracted fuelwood from CFs in the case of Thansadeurali CFUG; however, a smaller proportion of poor households extracted a larger quantity (i.e. above 20 headloads). These results correspond with the in-depth interview data that showed fuelwood extraction has decreased in Thansadeurali CFUG for households growing trees on their private farmlands. However, extraction of a lower quantity of fuelwood by very poor households was explained by their involvement in local labour such as vegetable farming and purchasing fuelwood from neighbours.

Table 7.2- Fuelwood dependency of different well-being households in Sitakunda and Thansadeurali community forest user groups in 2013

<table>
<thead>
<tr>
<th>Community forest user group</th>
<th>Household well-being group</th>
<th>Total households surveyed</th>
<th>HH extracted fuelwood from community forests</th>
<th>HH extracted less than 20 headloads</th>
<th>HH extraction more than 20 headloads</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sitakunda</td>
<td>Very poor</td>
<td>7</td>
<td>6 (86)</td>
<td>3 (50)</td>
<td>3 (50)</td>
</tr>
<tr>
<td></td>
<td>Poor</td>
<td>8</td>
<td>7 (88)</td>
<td>5 (71)</td>
<td>2 (29)</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>18</td>
<td>12 (68)</td>
<td>7 (58)</td>
<td>5 (42)</td>
</tr>
<tr>
<td></td>
<td>Well-off</td>
<td>1</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>34</td>
<td>25 (73)</td>
<td>15 (60)</td>
<td>10 (40)</td>
</tr>
<tr>
<td>Thansadeurali</td>
<td>Very poor</td>
<td>7</td>
<td>4 (57)</td>
<td>4 (100)</td>
<td>0 (0)</td>
</tr>
<tr>
<td></td>
<td>Poor</td>
<td>20</td>
<td>9 (45)</td>
<td>7 (78)</td>
<td>2 (22)</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>6</td>
<td>1 (17)</td>
<td>1 (100)</td>
<td>0 (0)</td>
</tr>
<tr>
<td></td>
<td>Well-off</td>
<td>7</td>
<td>2 (29)</td>
<td>2 (100)</td>
<td>0 (0)</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>40</td>
<td>16 (40)</td>
<td>14 (88)</td>
<td>2 (12)</td>
</tr>
<tr>
<td>Combined both community forests</td>
<td></td>
<td>74</td>
<td>41 (55)</td>
<td>29 (71)</td>
<td>12 (29)</td>
</tr>
</tbody>
</table>

Source: Household survey, 2013
Respondents of Thansadeurali CFUG explained that some small land-holders who have insufficient trees for fuelwood prefer to purchase fuelwood from their neighbours rather than collect it in the CFs. As explained by a very poor interviewee of this CFUG:

“...I live with my granddaughter. We could not collect enough fuelwood during permitted season (6 months). We purchased a tree from neighbour with NRs.1,000. We obtained nearly 12 head loads of fuelwood from that tree...” (TD2).

The contribution of trees from private farmlands to a reduction in fuelwood extraction from CFs has also been reported by the majority of district level interviewees. According to respondents, Dolakha district is a pioneer district for the growing of trees on private lands. According to these district level informants, many forest users have become self-sufficient for their fuelwood needs.

The majority of in-depth interview respondents from both case study CFUGs, FGD participants and district level interviewees also reported that the introduction of alternative cooking technologies and fuel sources, such as improved cooking stoves, iron stoves and biogas by the REDD+ pilot project and increased availability of and access to liquid petroleum gas and electricity have also become a major factor in the decrease in fuelwood extraction from CFs. According to one well-off interviewee from Thansadeurali CFUG, also an employee of the district development committee:

“...local communities have adopted improved cooking stove, iron stove and biogas with the support of REDD+ project. Most of the users of our CFUG use coal stove. Only a few households have adopted electricity and liquid petroleum gas for cooking. Use of diversified cooking energies has reduced the use of fuelwood consumption and has directly decreased fuelwood extraction from community forests...” (TA1).

Some respondents from Sitakunda CFUG provided a different perspective on the extraction of fuelwood following the introduction of alternative fuel sources. While they agreed adoption of improved access to different alternative energies has increased across households in their CFUG, they believed that the majority of households still use fuelwood for cooking porridge for buffalo and cattle. According to one woman respondent:

“...many households have adopted different alternative energies such as iron stove, coal stove, and improved cooking stove through REDD+ pilot project. Some households use liquid petroleum gas and electricity. However, the households who have adopted alternative energies have not decreased quantity of fuelwood extraction from the community forests. This
Household survey data indicated that there has been some adoption of different energy sources and technologies for cooking, though a greater percentage (over 80%) of households of both case study CFUGs still use traditional cooking stoves (Figure 7.6). Results also show the use of both partial-biomass (i.e. cooking stove, improved cooking stove, coal stove and iron stove) and non-biomass cooking energies (i.e. electricity, biogas and liquid petroleum gas) by households in recent years. These data indicate that energy sources are not mutually exclusive, so a household may adopt more than one energy sources or technology. Interviewees associated the adoption of diverse cooking fuel source or technologies with a decrease in their fuelwood consumption.

Distribution rules in relation to the duration and season of fuelwood collection and source of fuelwood have been reported by some respondents of both CFUGs as a determining factor for the change in extraction. As reported by respondents of Thansadeurali CFUG, the CFUG provides fuelwood only from dried twigs and branches which means they may need a whole day to collect a head load of fuelwood. Some forest users live far from the forests, so prefer not to go to forests for fuelwood, preferring to save time for other economic activities. As reported by a distant forest user of Thansadeurali CFUG:

“...households living far from CFs do not tend to go to forests for fodder and fuelwood. For example, I used to go to forest in former time. However, I prefer to purchase trees for fuelwood from neighbours and avoid going to forests. We need a whole day for a headload of fuelwood. People tend to save their time for other income generating activities...” (TC4).
In the case of Sitakunda CFUG, human settlements are close to the CFs, and the CFUG provides fuelwood from live-standing trees which are easy to harvest. As reported by in-depth interviewees and FGD participants of Sitakunda CFUG EC, almost all forest users collect fuelwood from the CF because of the close proximity to the forests and being allowed to collect fuelwood from green trees, so the process of collection of fuelwood requires less time and effort. While Sitakunda CFUG previously provided fuelwood only from standing trees, following implementation of the REDD+ project, the CFUG has encouraged collection of fuelwood from green branches as well (see Chapter 8).

In response to a question regarding the distribution of fuelwood from live-standing trees, FGD participants of the Sitakunda CFUG EC explained that dried and fallen twigs are less available in their CFs. According to the respondents, forest fires occur almost every year, which causes a loss of dried twigs and stumps in the forests (see Appendix 29). Therefore, the CFUG needs to provide fuelwood from live trees to meet the needs of forest users.

Two former and current chairpersons of Sitakunda CFUG were also of the view that per household forest size influences management of CFs. According to these respondents, small CFs generally have restrictive rules for distribution of forest products and have gradually reduced extraction to maintain the productivity of forests. However, because of the large size of their forest, the EC cannot impose restrictive rules on distribution of forest products including fuelwood. As stated by a former chairperson of this CFUG:

“...our neighbour CFUG - Budhabhimsen CFUG is relatively smaller forest compared to our CFUG. However, this CFUG has been managing forest efficiently. They set up strict rules and enforce them tightly in the field. They impose strict fines. Users are conscious of the rules too. In contrast, our forest is big in size. User households of our CFUG are less conscious of limits. We have high demand for which executive committee member of our CFUG cannot deny their demand...” (SB4).

Forest size was also discussed by FGD participants of the Thansadeurali CFUG EC. According to the current chairperson of Thansadeurali CFUG, their forests are very small in comparison to the number of CFUG household members involved, and they set the forest product distribution rules accordingly. The respondent further added that:

“...our forest size is small in relation to number of households involved. We have nearly 400 household members. Provision of fuelwood distribution
through dried twigs and branches for fuelwood for six months of time is an approach that seeks restriction of resource use. Such provisions have encouraged forest users to find alternatives to fuelwood. At the same time, every household does not extract forest product every year. If every household extracts, our forests would have diminished even a few years ago...” (TB5).

Analysis of data collected from group records (i.e. forest operational plans and forest product distribution log books) illustrates that per ha quantity of fuelwood extracted has been much greater in Thansadeurali than in Sitakunda CFUG, but has consistently decreased in Thansadeurali CFUG from 2009 to 2014 (Figure 7.7), while there is no consistent pattern of decrease in fuelwood extraction in Sitakunda CFUG for the same period. The results of this analysis correspond with the experiences of in-depth interviewees. However, in later years of REDD+ implementation, there appears to be a small decrease in the amount of per ha fuelwood extracted in Sitakunda CFUG. This was explained by the change in the source of fuelwood, from only live-standing trees, to fuelwood also from branches without felling standing trees (see Chapter 8).

![Figure 7.7- Changes in per ha extraction of fuelwood (one headload or Bhari = 35 kg) in Sitakunda and Thansadeurali community forest user groups](image)

(Source: CFUG records, 2013 and phone interview, 2015)

The results show a higher per capita amount of fuelwood extraction in Thansadeurali CFUG (Figure 7.8). The results indicate a gradual decrease in fuelwood extraction from 2009 to 2014 for Thansadeurali CFUG; however, there was no consistent trend in Sitakunda CFUG for the same period.
In sum, fuelwood extraction varied across the two case study CFUGs in terms of the pattern of change and harvested quantity. Fuelwood extraction has decreased consistently and significantly in Thansadeurali CFUG, while only a small decrease in extraction occurred in Sitakunda CFUG owing to the location of forests close to the villages, provision and access to green trees for fuelwood (distribution rules), and limited cultivation of trees in private lands due to inadequate non-irrigated land, despite the introduction of alternative energies.

Decrease in fuelwood extraction in Thansadeurali CFUG is related to the collective effects of multiple direct and indirect factors. Direct factors that contributed to a decrease in fuelwood extraction included an increase in available trees on private land, introduction of alternative energies for cooking, access to and availability of electricity and liquid petroleum gas, limited human resources available for fuelwood collection, and local income-generating labour opportunities. Indirect factors include temporary outmigration of youths and adults, per household forest size, greater distance to the forest (location context), distribution rules, and changes in agriculture practices.

### 7.2.3 Change in extraction of fodder

Extraction of fodder and collection of grass and green bedding materials (hereafter collectively fodder) is associated with livestock management and grazing practices by forest users. Fodder is an important forest product to forest users with livestock, especially at certain times of the year when fodder and grasses are unavailable in their
private lands. During winter, fodder from the CFs becomes an important source of livestock feed, usually harvested in the form of leaves, flowers, buds, and branches. Thansadeurali CFUG provides fodder through green leaves and foliage from CFs during winter (i.e. December to April) each year, while certain patches of forests designated by the CFUGs EC are open for collection of fodder and bedding materials. In general, extraction of fodder has also decreased, due to growing trees on private land and reducing livestock numbers, due to restriction on cattle grazing.

When respondents were asked about existing practices of fodder extraction, a total of 15 interviewees (seven from Sitakunda CFUG and eight interviewees from Thansadeurali CFUG) reported that fodder from CF provides an important source of livestock feed. According to the respondents, local forest users extract fodder from CFs usually during winter as well as in the rainy season when they have no alternative sources of fodder from private lands. For example, one poor interviewee of Thansadeurali CFUG mentioned that:

“...I harvest fodder from community forest during winter when CFUG permits. During winter, we do not have other alternatives of fodder to feed goat and cattle. We are not allowed to graze cattle in the forest. So, we need to harvest fodder of Khasru trees from community forests...” (TC3).

While extraction of fodder is common practice in both CFUGs, it varies across households of different well-being categories, influenced by household livestock number, availability of fodder trees from private land and of human resources for fodder harvesting. For example, as reported by one very poor respondent of Thansadeurali CFUG, very poor households extract a low amount of fodder as they tend to have fewer cattle than well-off and medium class households. As noted by one very poor Dalit woman interviewee:

“...I have just one buffalo and two goats at home. Even for these cattle, I go to community forest sometimes for fodder since I do not have sufficient fodder and grass in my private farmlands. However, I extract much less fodder than other households who have large number of cattle...” (TD1).

Analysis of household fodder harvest from household surveys reveals that the poor well-being group has the highest proportion of households extracting fodder, that a high proportion of medium well-being households also extract fodder but that a low proportion of the very poorest households extract fodder (Table 7.3). The limited sample of one well-off household in Sitakunda CFUG makes any pattern difficult to
verify for well-off households. However, based on Thansadeurali CFUG, the very poor are the well-being group with the lowest proportion of households extracting fodder.

In response to a query regarding fodder extraction by well-off and medium households, the chairperson (TB5) of Thansadeurali CFUG reported that some local forest users prefer to feed their cattle with fodder from Khasru (Oak species found in the CF) even though they have sufficient fodder from other species on their own private land. This perspective regarding the special value of certain fodder species such as Khasru (Oak species) was supported by a medium class respondent from the same CFUG.

"...we usually feed cattle and buffalo grass and fodder from private lands. However, some households including me with sufficient fodder from private farmlands also extract fodder from the community forests. Local people perceive that Khasru (Oak species) leaves are highly nutritious that is useful for buffalo and goat for higher milk production. However, I do not really need to go to forest for fodder..." (TB6).

In terms of the amount of fodder harvested from CFs, the results show that there was a small difference in the amount harvested by households among different well-being groups within each case study CFUG in 2013 (Table 7.3). Poor and very poor households in Sitakunda CFUG and very poor households in Thansadeurali CFUG had extracted higher amounts of fodder from CFs.

However, in relative terms, the percentage of household that extracted fodder from CFs is significantly lower for very poor households although average amount of fodder is relatively higher for this category of households than others. Data shown in Table 7.3 and the response from interviews clearly indicate that amount of fodder extracted from community forests is largely governed by the alternative sources such as fodder available in private farmlands or private land holding size, and opportunity cost for harvesting fodder from CFs (e.g. distant users normally well-off households do not prefer harvesting fodder from CFs to save their time to invest for other profitable activities).

<table>
<thead>
<tr>
<th>Well-being groups</th>
<th>Sitakunda CFUG</th>
<th>Thansadeurali CFUG</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HH surveyed</td>
<td>HH harvested</td>
</tr>
<tr>
<td>Very poor</td>
<td>7</td>
<td>2</td>
</tr>
</tbody>
</table>
Forest users need fodder to feed livestock throughout the year. Owing to limited cultivation of fodder in private land due to marginal and small landholdings, landless or land poor households (i.e. very poor households) need to harvest more fodder from CFs than households with private landholdings. Very poor and poor households have less livestock because of insufficient fodder from private farmland, along with CFUGs’ restriction on fodder collection (permission only for six months in the case of Thansadeurali CFUG) in CFs. According to research participants, during the months that the CF is closed to fodder harvest, medium and well-off households can harvest from their private farmlands to complement their fodder supplies.

Analysis of fodder harvested according to four categories of household landholding sizes (landless (no land of their own), small landholding (up to 0.25 ha), medium landholding (from 0.26 ha to 0.5 ha) and large landholding (more than 0.50 ha)) indicate that a higher proportion of small landholding households of both CFUGs extracted fodder from CFs (Table 7.4). While a smaller proportion of medium landholders in Sitakunda CFUG extracted fodder, those that did extracted a higher average amount of fodder per household than other well-being groups. In Thansadeurali CFUG, small landholders extracted a greater average amount of fodder per household than other landholding groups.

Responding to a query about the higher amount of fodder harvested by medium landholding groups in Sitakunda CFUG, one former chairperson (SB4) reported that local forest users of all landholding types have a low amount of fodder on private land. In the case of the low amount of fodder harvested by medium and large landholding households in Thansadeurali CFUG, a former chairperson (TA2) reported that medium and large landholdings usually tend to harvest oak leaves during winter to feed their cattle, while small landholding households extract fodder during winter as well as grass during summer (i.e. rainy season). As reported by the present chairperson and observed by the researcher himself during the field visit in 2013, two landless households of Thansadeurali CFUG do not have any livestock and as a result they have not extracted fodder from the CF.
Table 7.4- Number of households with different landholding sizes that extracted fodder from Sitakunda and Thansadeurali community forests in 2013

<table>
<thead>
<tr>
<th>Case study community forest user groups</th>
<th>Households with different landholding size</th>
<th>Proportion of households of different landholding size and average fodder (in bhari or headload) (Parentheses are percentage of households)</th>
<th>Average per household extracted fodder (in bhari or headloads)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Households surveyed</td>
</tr>
<tr>
<td>Sitakunda</td>
<td>Landless</td>
<td>0</td>
<td>0 (0)</td>
</tr>
<tr>
<td></td>
<td>Small landholding (0-0.25ha)</td>
<td>3</td>
<td>2 (67)</td>
</tr>
<tr>
<td></td>
<td>Medium landholding (0.25 – 0.50 ha)</td>
<td>13</td>
<td>4 (31)</td>
</tr>
<tr>
<td></td>
<td>Large landholding (more than 0.50ha)</td>
<td>18</td>
<td>8 (44)</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>34</strong></td>
<td><strong>14 (41)</strong></td>
</tr>
<tr>
<td>Thansadeurali</td>
<td>Landless</td>
<td>0</td>
<td>0 (0)</td>
</tr>
<tr>
<td></td>
<td>Small landholding (0-0.25ha)</td>
<td>7</td>
<td>4 (57)</td>
</tr>
<tr>
<td></td>
<td>Medium landholding (0.25 – 0.50 ha)</td>
<td>11</td>
<td>6 (55)</td>
</tr>
<tr>
<td></td>
<td>Large landholding (more than 0.50ha)</td>
<td>20</td>
<td>7 (35)</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>40</strong></td>
<td><strong>17 (43)</strong></td>
</tr>
<tr>
<td>Combined two community forests</td>
<td><strong>Total</strong></td>
<td><strong>74</strong></td>
<td><strong>31 (42)</strong></td>
</tr>
</tbody>
</table>

Source: Household survey, 2013 (Note: according to respondents, 1 bhari or headload is equivalent to 35kg)

Responding to a query about the change in extraction of fodder from CFs in recent years, a total of 32 interviewees (15 from Sitakunda CFUG and 17 from Thansadeurali CFUG), seven district level interviewees, and participants of four FGDs of Sitakunda and Thansadeurali CFUGs reported that extraction of fodder has gradually decreased in recent years. As noted by one interviewee from Thansadeurali CFUG:

“...extraction of fodder and collection of grass has gradually decreased in our community forest. In former time, many households used to extract fodder especially of Khasru (Oak species) trees from community forest. Only, a few households extract fodder nowadays...” (TB1).

When respondents were asked about factors that have influenced this change in extraction of fodder, the respondents of Thansadeurali CFUG commonly reported that extraction of fodder has decreased due to a change in livestock management, as local people have transformed their agriculture practices from traditional to cash-based vegetable farming. In this regard, one respondent of this CFUG described that:
“...local people have gradually changed the traditional cropping system to vegetable farming, for which they prefer poultry manure to cattle dung and manure. As a result, the number of cattle and livestock has reduced in our village especially among those who have started vegetable farming. As a consequence, extraction of fodder from community forests has decreased...” (TA3).

As reported by the respondents of both CFUGs, local people have gradually reduced their number of livestock owing to changes in agricultural practice, and they have changed livestock types from cattle to buffalo and goat for milk and meat. Grazing practice has also changed from pasture grazing to stall feeding. Reducing grazing in private land has stimulated tree growth, which has reduced the need for fodder extraction from CFs. As reported by one interviewee of Thansadeurali CFUG:

“...local forest users have gradually transformed livestock from cattle to buffalo and goat for milk and meat. Usually buffalo and goat are fed in stalls. Increasing stall feeding has reduced cattle grazing in private lands which resulted in tree growing and less extraction of fodder from community forests...” (TC1).

As reported by FGD participants and in-depth interviewees of Thansadeurali CFUG, the reduction in number of livestock is also attributed to the temporary outmigration of local youths and adults, especially males. According to the respondents, temporary outmigration has reduced farming activities (to only one crop each year), as well as the number of livestock, especially oxen. One pair of oxen is shared by many households as a result of the reduced availability of human resources for farming activities, cattle rearing and fetching fodder from the CFs.

A respondent of Thansadeurali CFUG, who started vegetable farming, reported that vegetable farmers use poultry manure instead of cattle dung, which has also resulted in a decrease in the numbers of cattle in their CFUGs. Reduction in livestock number reduces fodder requirements and thus decreases the demand for fodder from CFs. As explained by the chairperson of this CFUG:

“...farming activities have reduced due to lack of human resource resulting from the temporary outmigration. A decrease in farm activities along with decrease in number of cattle has resulted in an increase in the number of trees on agriculture lands, and thus has reduced forest product dependency from community forests...” (TB5).

Analysis of change in the numbers of types of livestock in 2009, 2011 and 2013 from household survey data shows that in Sitakunda CFUG between 2009 and 2013 there has
been a decrease in the average per household number of cows (from 2.33 to 2.26) and
buffalo (from 2.47 to 1.93), with an increase in goat numbers (4.53 to 4.85) (Table 7.5).
However, the results from Thansadeurali CFUG showed a decrease in average per
household numbers of all livestock types (cows from 2.05 to 1.60, buffalo from 2.10 to
1.60 and goats from 6.57 to 5.30) (Table 7.6).

In Sitakunda CFUG, the average number of goats has increased in poor and very poor
households, decreased in well-off households and remained unchanged in medium class
households from 2009 to 2013. The average number of cows has increased in very poor
households, while it remained unchanged in poor households and has decreased in
medium well-being households; however, the average number of cattle is still higher in
the medium well-being group (3) than in other well-being groups. The number of
buffalo has decreased except in very poor households in Sitakunda CFUG.

The results from Thansadeurali CFUG show that the average numbers of all livestock
types has decreased in households with all well-being groups, except very poor
households, from 2009 to 2013. For example, the average number per household of
cattle, buffalo and goats has increased in very poor households from 0.8 to 1.80, 1.80 to
2.00 and 2.30 to 3.10 respectively.

Responding to a query about cattle in Sitakunda CFUG, FGD participants with
Indigenous Peoples reported that local forest users need to have oxen for ploughing in
rice farming. A smaller decrease in the number of cattle for medium well-being
households and no change in cattle in poor households compared to very poor
households occurred because these well-being groups are mostly involved in paddy
cropping and need oxen for ploughing. As noted by one poor household who has oxen
for rice farming:

“...we have oxen and cow mainly for using them to plough for paddy
farming during rainy season. Without oxen we cannot cultivate rice and
paddy. At the same time, we usually take oxen to graze in community forest.
If we do not take oxen grazing during winter, they cannot efficiently plough
during rainy season in the paddy field...” (SC3).

Regarding the increase in average number of goats in very poor households in
Thansadeurali CFUG and both poor and very poor households in Sitakunda CFUG, the
chairpersons of both CFUGs reported that some very poor and poor households have
started goat rearing through the financial support received from the REDD+ pilot
project (see Chapter 8). In response to a query about livestock rearing by well-off households in Sitakunda CFUG, one well-off respondent (SA1) reported that they do not have livestock except five goats, as they are less dependent on agriculture, rather they operate their own business (Petrol and Diesel supply station).

Table 7.5- Change in average per household number of cattle, buffalo and goats in Sitakunda community forest user group from 2009 to 2013

<table>
<thead>
<tr>
<th>Household categories</th>
<th>Cattle</th>
<th>Buffalo</th>
<th>Goat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very poor</td>
<td>1.80</td>
<td>1.60</td>
<td>2.20</td>
</tr>
<tr>
<td>Poor</td>
<td>1.60</td>
<td>1.80</td>
<td>1.60</td>
</tr>
<tr>
<td>Medium</td>
<td>3.60</td>
<td>3.60</td>
<td>3.00</td>
</tr>
<tr>
<td>Well-off</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Average</td>
<td>2.33</td>
<td>2.33</td>
<td>2.26</td>
</tr>
</tbody>
</table>

Source: Household survey, 2013

Table 7.6- Change in average per household number of cattle, buffalo and goats in Thansadeurali community forest user group from 2009 to 2013

<table>
<thead>
<tr>
<th>Household categories</th>
<th>Cattle</th>
<th>Buffalo</th>
<th>Goat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very poor</td>
<td>0.80</td>
<td>0.80</td>
<td>2.20</td>
</tr>
<tr>
<td>Poor</td>
<td>1.80</td>
<td>1.40</td>
<td>1.40</td>
</tr>
<tr>
<td>Medium</td>
<td>3.40</td>
<td>2.40</td>
<td>1.40</td>
</tr>
<tr>
<td>Well-off</td>
<td>2.20</td>
<td>1.80</td>
<td>1.40</td>
</tr>
<tr>
<td>Average</td>
<td>2.05</td>
<td>1.60</td>
<td>1.60</td>
</tr>
</tbody>
</table>

Source: Household survey, 2013

In line with the results of the household survey data analysis shown in Table 7.6, all interviewees from Thansadeurali CFUG, including very poor and poor households, described a decrease in the total number of livestock. The respondents uniformly reported that the reduced number of cattle arising from restrictions to cattle grazing in CFs, reduced agriculture activities and changes in agriculture practices and a lack of human resources arising from temporary outmigration have together resulted in enhanced natural regeneration and increased growing of fodder trees on both private land and CFs. According to one poor interviewee from Thansadeurali CFUG:

“...we restricted cattle grazing not only in community forests but also in private land by reducing number of cattle. As a result, natural regeneration of trees increased particularly in our farm land. Fodder trees such as Dudhilo and Kutmero have improved. We use the trees for fodder for our goats and cattle...” (TC5).

In the case of Sitakunda CFUG, research participants reported that fodder/grass extraction from CFs has decreased due to an increase in the availability of fodder from
the private land of some households. One well-off interviewee of this CFUG mentioned that:

“...cultivation of fodder trees on private farmland has increased in our CFUG. I have also planted grass such as clover in agriculture land. I feed cattle and goats. I do not collect grass from community forests. Other households also do not collect grass from community forests as they did before...” (SA1).

Some respondents from Sitakunda CFUG stated that a decrease in availability of grass and fodder in their CFs due to persistent cattle grazing and incidence of forest fires has resulted in reduced fodder/grass extraction from their CF. For example; one interviewee of this CFUG reported that:

“...grazing is commonly practised in our community forests. We do not have fodder trees in the forest. Ground grass is also not growing well where cattle have overgrazed, so grass is found only in steep terrain...” (SC3).

Analysis of household survey data regarding cattle grazing and feeding practices reveals that in Thansadeurali CFUG, the majority of households (60%) do not have livestock (Table 7.7) and nearly 25% of households practice stall feeding. In Sitakunda CFUG, nearly half of the respondents practice stall feeding only, while a further 41% use stall feeding supplemented by up to 3 months of grazing each year in the CFs. The results of the analysis of household survey data about cattle grazing and feeding practices (Table 7.7) support the reports in-depth interviewees who explained a decrease in fodder extraction is associated with a decrease in livestock numbers (see Tables 7.5 and 7.6) and changed grazing practices.

<table>
<thead>
<tr>
<th>Community forest group</th>
<th>Percentage of households practicing different strategies of livestock feeding in community forests</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Grazing 6 months in community forests</td>
<td>Grazing for 3 months in community forests and stall feeding</td>
</tr>
<tr>
<td>Sitakunda (n=34)</td>
<td>2 (6)</td>
<td>14 (41)</td>
</tr>
<tr>
<td>Thansadeurali (n=40)</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Total n=74</td>
<td>2 (3)</td>
<td>14 (19)</td>
</tr>
</tbody>
</table>

Source: Household survey, 2013

As reported by participants of all FGDs, forest fires often occur in their CFs, which induces new grasses for cattle grazing but also causes loss of ground flora and crowns, as well as loss of foliage in fodder trees (see Appendix 29). Forest fire causes a loss of
native fodder trees as well as a reduction in plant diversity. For example, the secretary of Sitakunda CFUG during a telephone interview in August 2015 described that some unpalatable weeds (e.g. Banmara or Gandhe - *Ageratina adenophora*) gradually appeared in areas recovering from forest fires. These exotic species replace native plant species, including fodder trees species, and are thus a threat to productivity of CFs.

The results of analysis of data from CFUG records indicate that extraction of fodder from CFs has decreased in both CFUGs from 2009 to 2014 although per ha amount of fodder extraction varies between the two CFUGs (Figure 7.9). Over the years recorded in Figure 7.9, extraction of fodder in both CFUGs was at a peak in 2010 and decreased consistently from 2011, with a sharp decline in 2014 in Thansadeurali CFUG. Coincidently, fodder extraction for 2012 and 2013 remained almost unchanged in both CFUGs (65 headloads per ha in Thansadeurali CFUG for 2012 and 2013, with 24 and 25 headloads for Sitakunda CFUG). In general, a decreasing trend in extraction of fodder in both CFUGs is observed over the latter years of the survey period, although the per ha amount of fodder collected in Thansadeurali CFUG is still higher compared to Sitakunda CFUG, which can be explained at least in part by the larger size of the Sitakunda CFUG.

![Figure 7.9- Change in per ha fodder (bhari) extraction in Sitakunda and Thansadeurali community forest user groups](image)

Source: Field survey, 2013 and phone interview, 2015

The results show a similar trend of changes in per capita as in per household fodder extraction from 2009 to 2014 in both case study CFUGs (Figure 7.10). However, a
small increase appeared in Sitakunda CFUG in 2013 compared to the per capita amount of fodder in 2012, while in Thansadeurali CFUG recorded same amount for 2012 and 2013. The results indicate a sharp decline in 2014 for both CFUGs.

![Graph showing per capita fodder extraction in Sitakunda and Thansadeurali](image)

**Figure 7.10- Change in per capita fodder extraction (one headload or Bhari = 35 kg) in Sitakunda and Thansadeurali community forest user groups**

In sum, fodder is extracted by households of all well-being groups except well-off households in Sitakunda CFUG. Very poor households have slightly higher fodder demands on CFs than other well-being groups, mainly due to the limited cultivation of fodder on private farms because of marginal and small land-holdings. Extraction of fodder has generally decreased in recent years as a result of socio-economic circumstances. The factors include the reduction in number of livestock, change in cattle grazing practices and an increased availability of fodder trees on private farmlands. Other factors include the change in cattle feeding because of the change in agriculture practices from traditional cropping (maize, wheat and millet) to vegetable farming, and unavailability of human resources due to temporary outmigration of mainly male youths and adults.

### 7.3 Synthesis of factors affecting extraction of forest products

The extraction of timber has generally increased, while extraction of fuelwood and fodder has decreased in both case study CFUGs in recent years. Factors associated with the changes in extraction of timber, fuelwood and fodder have operated in different ways (direct and indirect), and at different levels (i.e. local and central or even global levels in the case of REDD+) and are also multi-dimensional.
The factors identified through my study can be organised into four broad thematic categories that include biophysical characteristics, socio-economic circumstances, occurrence of natural and human induced disturbances, and policy and institutional arrangements related to the distribution of forest products (Figure 7.11). Policy factors associated with the change in extraction of timber include local and central level factors, while changes in extraction of fuelwood and fodder are predominantly a result of local factors including biophysical characteristics, socio-economic circumstances, distribution rules and occurrence of natural and human induced disturbances.

![Figure 7.11- Factors associated with the extraction of timber, fuelwood and fodder and their linkage with carbon stocks and forest biodiversity](#)

The pattern of influence of the identified factors can be categorised as effect (√) and no effect (×) on change in the extraction of timber, fuelwood and fodder in CFs (Table 7.8) and changes may be positive or negative.

**Table 7.8- Summary of factors associated with and their effects on the extraction of timber, fuelwood and fodder in community forests**

<table>
<thead>
<tr>
<th>Indirect or underlying factors</th>
<th>Proximate factors</th>
<th>Degree and pattern of effects (increase or decrease) in extraction of forest products</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Timber</td>
</tr>
<tr>
<td>Policy and institutional arrangements</td>
<td>Restriction to cattle grazing</td>
<td>√ (+)</td>
</tr>
<tr>
<td></td>
<td>Provision of green trees for fuelwood</td>
<td>×</td>
</tr>
<tr>
<td></td>
<td>Restriction on collection of fuelwood from green</td>
<td>×</td>
</tr>
<tr>
<td></td>
<td>Specific time for resource collection</td>
<td>×</td>
</tr>
<tr>
<td></td>
<td>Revision with restriction in resource use policy for Terai region</td>
<td>√ (+)</td>
</tr>
<tr>
<td>Biophysical characteristics</td>
<td>Distance to forests (close distance from settlement to forests)</td>
<td>√ (+)</td>
</tr>
<tr>
<td></td>
<td>Availability of preferred forest trees (such as high quality timber – Thingure Salla and Kholme in Thansadeurali CFUG and Sal and Asna in Sitakunda CFUG)</td>
<td>√ (+)</td>
</tr>
</tbody>
</table>
Fodder – Oak species in Thansadeurali CFUG

<table>
<thead>
<tr>
<th>Socio-economic circumstances</th>
<th>Size of forests (large size forests) – forest users are less active and less conscious</th>
<th>Size of forests (small size forests)- forest users are active and conscious of use and conservation of forest</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>√ (+)</td>
<td>√ (+)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Change in agriculture practices from traditional to vegetable farming</th>
<th>Trees growing on private lands</th>
<th>Development of local employment opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td>√ (+)</td>
<td>×</td>
<td>√ (+)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Introduction of alternative energies and technologies</th>
<th>Access to and availability of electricity and liquid petroleum gas</th>
<th>Temporary out-migrated youths and adults</th>
</tr>
</thead>
<tbody>
<tr>
<td>×</td>
<td>√ (-)</td>
<td>√ (-)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Development of wood-based industries/factories</th>
<th>Landholding size (small landholding size)</th>
</tr>
</thead>
<tbody>
<tr>
<td>√ (+)</td>
<td>×</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Incidence of forest fires</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>×</td>
<td>√ (-)</td>
</tr>
</tbody>
</table>

7.4 Discussion

7.4.1 Biophysical characteristics provide options for forest products extraction

7.4.1.1 Distance to forests from settlement reduces fuelwood and fodder removal

The distance of forests and the CFUG office from the settlement is associated with a change in extraction of fuelwood and fodder when forest users have alternative sources for these forest products. This was observed particularly in Thansadeurali CFUG, where forests are located further away from human settlements. Forest users who live further away from their CFs tend to collect less fuelwood and fodder compared to nearby forest users.

Forest users of Thansadeurali CFUG, who live further from the forests, need to spend more time in order to gather fuelwood and fodder, and these users tend to seek alternative resources including purchasing trees from neighbours for fuelwood, growing trees on private farmlands, using alternative fuels and technologies for cooking and reducing their number of livestock (see Adhikari & Lovett (2006b) for similar findings). Several studies of CFs in Nepal and elsewhere have examined forest product extraction in relation to distance to forests and many of them (e.g. Fonta et al., 2010; Jumbe & Angelsen, 2011; Khatri-Chhetri, 2006; Poteete & Ostrom, 2004; Sapkota & Odén, 2008) have shown that users rely less on forest products if living further away from their CFs.
My results contradict Adhikari et al. (2004), who found no differences in fuelwood collection by forest users of the mid-hills region of Nepal according to the distance they live from their CFs. However, Adhikari et al. (2004) also explained that in the case study area there were no alternative sources of fuelwood or introduction of alternative technologies for cooking. So, the reduction in extraction of fuelwood and fodder with distance from the CFs seems to relate to local people placing a value on their time available for different productive activities, and depends on the presence of alternative products such as trees on private farmlands, or opportunities to reduce demand through alternative technologies and fuel sources.

There was no difference in timber removal related to distance of forest users to the CFs in Thansadeurali CFUG. According to the participants, timber harvesting is relatively less time-consuming as timber is provided from live-standing trees, which are easy to find in the forests, and also timber has high value, and forest users have no appropriate alternatives for sourcing timber.

### 7.4.1.2 Forest product extraction approaches vary across different size CFUGs

The size of forests appeared to influence forest product extraction, mainly through the formulation of forest product distribution rules, particularly for fuelwood and fodder. Thansadeurali CFUG (a small forest per household forest size) tended to adopt more restrictive regulations for removal of forest products, especially for fuelwood and fodder. For example, as shown in section 7.2.3, Thansadeurali CFUG restricts fuelwood collection from green trees, while Sitakunda CFUG (relatively large forests) provides fuelwood mainly from live-standing trees and green branches to meet the expectation of forest users that they can collect fuelwood from live-standing trees. This finding supports the view of Cooke (2000) that CFUGs with a large forest area per household likely extract more forest products from their CFs.

The size of forests in relation to households or families participating in CFUGs is also associated with the conservation behaviour of forest users. For example, Thansadeurali CFUG (with small per household forest size) seeks to reduce extraction of forest products through actively managing their forests. They have divided their forests into smaller sections for management by four sub-groups, to achieve protection, monitoring and distribution of forest products. However, such approaches were not observed in
Sitakunda CFUG. Restriction can also be imposed through formulation of conservation rules. In consideration of their forest size and condition, Thansadeurali CFUG fully restricts cattle grazing, while Sitakunda CFUG adopts rotational grazing.

One explanation for the restrictive behaviour in relation to forest product extraction might be that users of small forests seek to demonstrate their success in managing their forests to neighbouring CFUGs, FECOFUN and DFO. This would reduce the risks of them losing their CFs since the DFO can withhold CFUG authority of forest management if CFUGs are found to be overharvesting or destroying their forests.

My results support the views of Pagdee et al. (2006) and Poteete & Ostrom (2002) that local people using small forests are often more active and conscious of forest protection through reducing removal of forest products. Chand (2015) and Misra & Kant (2004) also argued that CFUGs with small forests often implement forest activities by increasing households contributions to conservation activities, which results in increased per area forest productivity compared to larger forests. Evidence from institutional assessments by Chhatre & Agrawal (2008) and Cronkleton et al. (2012) indicates that it is relatively difficult to monitor and control illegal felling in larger forests, which can lead to increased illegal removal of forest products and forest degradation in such forests.

In terms of carbon stocks, some studies (Bhattarai et al., 2012; Chhatre & Agrawal, 2009) found a higher per unit area of carbon stocks in larger CFs than small CFs. However, my results (Chapter 4) indicate that small forests had a higher annual increment of carbon stocks (Table 4.4) (3.69 tonne Carbon ha$^{-1}$ yr$^{-1}$ in small forests and 3.33 tonne carbon ha$^{-1}$ yr$^{-1}$ in large forests) and plant species diversity (Table 4.8). The increment of carbon stocks in CFUGs was coincident with the decrease in fuelwood and fodder extraction both in small and large forests. Some previous studies (Lupala et al., 2014; Maraseni et al., 2014; Neupane & Shrestha, 2012) have noted that carbon stocks enhancement is often attributed to a reduction in the removal of forest products, implying that there is a trade-off between carbon stock enhancement and removal of forest products.

My results suggest that there may be potential trade-offs between forest products removal and carbon stocks and forest biodiversity in small forests. However, these
trade-offs likely vary across CFs, as CFs in Nepal have a large variation in forest area per household size, ranging from the smallest (0.001 ha ThatiRani CF Myagdi district) to the largest size (89.54 ha Namjung CF Darchula district) (DoF, 2015). This indicates that small forests may have to ban forest product removal if they want to enhance carbon stocks and forest biodiversity.

7.4.1.3 Distribution of different tree species with different use value influences forest products removal

The extraction of timber and fodder was associated with the distribution of vegetation types in terms of use value of tree species in CFs. Some forest users of Thansadeurali CFUG tend to collect oak leaves (Quercus sp.) as fodder for cattle and goats, especially for milking cows. A high level of timber extraction was attributed to the presence of high quality-timber species such as Thingure Salla and Kholme in their CFs, which in turn leads to a decrease in the number of these tree species (IVI- Figure 7.3 and 7.4).

The removal of tree species according to whether the species is of high value can influence tree composition and carbon storage because carbon storage capacity varies in accordance with natural characteristics of tree species such as wood density (Baker et al., 2004; Henry et al., 2010) and growth (Jackson, 1994; Khanna, 2004; Silver et al., 2004). The distribution of tree species of different use value can also be influenced by the level of forest activities and silviculture operations such as thinning and pruning forests, which then affects carbon stocks and tree composition (Maraseni & Pandey, 2014).

My results show that biophysical context such as proximity of villages to forests, per household forest size and vegetation types and perceived use value can affect extraction of forest products and also carbon stocks and plant diversity. However, carbon storage and plant diversity can also vary across other biophysical characteristics including topography, elevation and aspects of forests that affect growth and renewal (Henry et al., 2010; Martínez-Cabrera et al., 2009; Williamson & Wiemann, 2010). For example, low altitude tropical forests can store carbon faster than temperate forests (Gibbs et al., 2007).
7.4.2 Influence of socio-economic circumstances on forest products removal

7.4.2.1 Tree growing on private farmlands reduces fuelwood and fodder extraction

The expansion of tree growing on private farmlands is associated with a decrease in removal of forest products mainly fuelwood and fodder from CFs. This indicates that CFs provide a complementary source of forest products for the majority of forest users. Although there is variation between the two case study CFUGs, the findings generally show that growing trees on private farmlands has increased leading to noticeably reduced fuelwood and fodder harvest from CFs. This finding is similar to a recent study by Oli et al. (2015) in the mid-hills region of Nepal, which found that over 50% of fuelwood and fodder demand of forest users is supplied from private farmlands, and that this supply has increased in recent years. Arnold et al. (2006) from Tanzania, Regmi (2010) from low-land Nepal, and Pandit et al. (2014) from the mid-hills region of Nepal all reported that extraction of fuelwood has decreased with an increase in planting of trees on private farmlands. In a study in the Dolakha district of Nepal that included two CFs from my research, Niraula et al. (2013) also found a decrease in fuelwood and fodder extraction due to increased tree planting on private farmlands, resulting in improved forest cover.

There were a number of links between increased tree planting on private farmlands and decreased harvesting of fuelwood and fodder from CFs. Firstly, as reported by respondents from Thansadeurali CFUG, trees planted by local people at the beginning of CF are now harvestable for fuelwood and fodder. Secondly, forest users seek to secure basic forest products by growing trees on their land, especially where a large number of households are managing a small forest like the Thansadeurali CFUG, and when they perceive strict rules. Thirdly, as research participants reported, planting trees has increased the supply of wood to wood-industries and some local people use part of this wood for fuelwood. However, I did not find such experiences in Sitakunda CFUG, where local people have not planted many trees on their farmlands, as the community forest is larger and with irrigation facilities, and they prefer to use their land for rice cropping.

There was no association between trees growing on private farmlands and timber removal from CFs in the case study CFUGs. There are three possible explanations for this observation. Firstly, many trees on private farmlands have not yet reached adequate size for use as timber, since most of the trees were planted after the development of CFs.
(15-20 years ago). Secondly, species selected for plantings on private farmlands were fast growing and of lower value for timber. For example, as reported by respondents, high value timber tree species such as Thingure Salla and Kholme in Thansadeurali CFUG and Sal and Saj in Sitakunda CFUG were reported to be found only in their CFs. Thirdly, well-off and medium well-being households generally have trees on private farmlands (Oli et al., 2015), and these are the same households who have dominated formulation of forest products distribution rules within their CFUGs, such as determining the thresholds of quantity and price of forest products (Ferguson et al., 2015; Pandit & Bevilacqua, 2011a). Thus, Thansadeurali CFUG has set a lower price (NRs. 20 per cubic feet) for high value trees such as Thingure Salla compared to a low value tree species such as Pate Salla (NRs. 50) to accommodate transportation costs for Thingure Salla which is found further from human settlements and roads. This low price has enabled forest users to access quality timber for domestic consumption while harvesting timber from private farmlands for a profit. Consistent with my findings, Webb & Dhakal (2011) reported that growing trees on private farmlands contributes little to the reduction in timber extraction from CFs.

A decrease in extraction of fuelwood and fodder from CFs owing to the increase in growing trees on private farmlands can be associated with the increase in biomass or carbon stocks in CFs shown in Chapter 4. Some previous studies (e.g. Acharya & Kafle, 2009; Ajit et al., 2013; Nair et al., 2009) have shown similar findings and acknowledged that carbon stock enhancement in CFs has resulted from the reduction in removal of forest products associated with growing trees on private farmlands. Growing trees on private farmlands near CFs can also contribute to the improvement of forest biodiversity. Some studies (e.g. Carter, 1992; Gilmour & Nurse, 1991; MacDonald, 2003) have shown that growing trees on cultivated lands contributes to the improvement of natural regeneration in nearby natural forests by enhancing seed dispersal of multiple tree species. Kapos et al. (2012), Perfecto & Vandermeer (2008) and Schroth (2004) also noted a similar finding in improvement of forest biodiversity close to private farmlands, because of improvement of connectivity between natural forests and farmlands.

Given the above, local people may need to be encouraged to increase growing of trees, including trees for timber, by compensating their contributions to conservation of CFs through an incentive based mechanism like REDD+.
7.4.2.2 Change in agriculture practices reduces fuelwood and fodder removal

The change from traditional subsistence farming to growing vegetables as cash crops has contributed to a decrease in demand for fuelwood and fodder from CFs. Some studies (Dev et al., 2003; Yadav et al., 2003) have recognised that agriculture is closely associated with the removal of forest products in Nepal’s CFs, and thus change in agriculture practices can have an effect on forest products extraction. There are two possible explanations for this in Thansadeurali CFUG. Firstly, the change from the practice of growing traditional crops for household consumption such as maize and millet to growing vegetables has provided employment opportunities. Those landless or land poor forest users who previously sought to earn a small income by selling fuelwood gathered in their CF can now earn a daily wage from being employed in vegetable farming, and thus have reduced their extraction of fuelwood from CFs.

The second explanation is that the shifting from maize and millet crops to vegetables has also changed the demand for fertiliser from cow dung to poultry manure. Maintenance of a herd of livestock requires collection of both fodder and fuelwood from the forest for feeding and cooking cattle porridge (Oli et al., 2015; Rasaily & Ting, 2012b), and so a reduction in livestock numbers has reduced the demand for fuelwood and fodder from CFs.

However, these changes did not appear to be occurring in Sitakunda CFUG. Cultivated land of forest users of this CFUG are mostly irrigated lands suitable for rice farming. Local farmers prefer to grow rice to other crops, and believe that the profit from rice is greater than that from other land uses, including from vegetable farming.

Change in agricultural practices does not always cause forest losses or degradation, but can also be a contributor to forest improvement in the case of CFs, when forest users change from high forest-dependent agriculture practices to low-forest dependent practices. This may have implications for the recently developed Agriculture Development Strategy (2014) and Forestry Sector Strategy (2014), which both have a low priority on cross-sectoral integration in their major strategies. Integration of these sectors appears important since nearly 80% of the rural population engages in some agriculture practice (GoN, 2014a) over 80% of these households use fuelwood from the forest for cooking energy (WECS, 2010) and 50% need fodder for their livestock.
This suggests that encouraging forest users to adopt highly profitable and low-forest dependent agriculture practices can both increase household income as well as reduce forest product extraction, potentially leading to positive outcomes for carbon stocks and forest biodiversity.

### 7.4.2.3 Temporary outmigration reduces fuelwood and fodder collection

The temporary outmigration (short-term national and international migration for employment and education), especially of male adults and youths, has reduced fuelwood and fodder extraction from CFs in two ways. Firstly, outmigration reduces the availability of human resources to collect fuelwood and fodder. It was observed in Thansadeurali CFUG that a decrease in human resources also reduces livestock numbers especially oxen (they have initiated ox-sharing practices) by reducing the household’s agriculture activities, which further reduces the need for fuelwood and fodder (Section 7.2.2 and 7.2.3). Although fuelwood collection was not noticeably reduced in Sitakunda CFUG, a shortage of male labour within the village, and an increase in wage labour costs owing to outmigration of males, was presenting problems for fuelwood harvesting for many remaining households dominated by older people and women. This supports findings of several previous studies (Adhikari, 2005; Beyene, 2011), who have noted that households with larger family sizes extracted larger quantities of high labour-intensive forest products such as fuelwood and fodder as they have a ready source of labour.

Second, national or international outmigration for employment may increase household income, leading to an increase in the capacity of local households to afford alternative energies for cooking fuels (Tuladhar et al., 2014). Forest users, especially households with a smaller family size, appeared to prefer using alternative energies (e.g. LPG and kerosene) for cooking fuel. This is consistent with the findings of Poudel et al. (2014), Baland et al. (2012), Tiwari & Bhattarai (2011) and Massey et al. (2010) from CFs in Nepal and by Hunter et al. (2014) in South Africa, by Qin (2010) in China, and by Lopez et al. (2006) in Mexico, where outmigration reduced household demand and extraction of fuelwood and fodder.

There were no obvious effects of temporary outmigration on the extraction of timber. However, timber from CFs was mostly extracted by high-income or well-off households. This suggests that as temporary outmigration for employment can increase
household income, the result could be an increase in timber extraction. Based on evidence from Madagascar (Nawrotzki et al., 2011) and from Nigeria (Fonta et al., 2011) there was a greater demand for timber by out-migrant households compared to non-migrant households as a result of their increased wealth.

The positive effects of outmigration in decreasing extraction of forest products and improving conditions of CFs have been reported by Adhikari & Hobley (2011) and Jaquet et al. (2015) from studies in eastern and western mid-hills districts (Khotang and Kaski respectively) of Nepal. The authors observed an increased tree cover in CFs, due to a decrease in fuelwood and fodder harvest arising from an increase in growing trees on private farmlands and from a shortage of human resources. In an analysis of migration effects on tropical forests, Hecht et al. (2015) noted a similar positive contribution of outmigration to employment and remittances and to a decrease in extraction of fuelwood and fodder and improvement of forest condition.

Given the above evidence, forest management strategies may need to consider the implications of outmigration, since current rates of international outmigration for employment are over 7% of the total population of Nepal, and the contribution from outmigration through annual remittances has increased from 18.5% of gross domestic product (GDP) in 2010 to 29% in 2014 (GoN, 2014c).

7.4.2.4 Improved road access increases timber removal

Improved road access and transportation facilities increased extraction of timber, but did not appear to have a noticeable influence on fuelwood and fodder removal. The evidence from Thansadeurali CFUG demonstrates that overharvesting and illegal removal of timber increased with an improvement of road access to the CFs. This supports the findings by previous researchers (Acharya et al., 2011; Paudel et al., 2013) from Nepal and Putz et al. (2014) from Brazil, who reported the occurrence of a greater incidence of illegal felling in forests with road access compared to forests without road access.

Greater extraction of timber in Sitakunda CFUG was attributed to a high demand for timber by government agencies and timber contractors, mainly because of the improved road access and better transportation facilities to the forests. Improved road access can change extraction behaviour of government agencies and logging companies due to a reduction in their harvesting time and increased efficiency, resulting in increased
demand and extraction of timber. Pokharel (2013) from Western Terai and Banjade (2012) from the mid-hills region of Nepal reached similar conclusions. Banjade (2012), for example, found that in CFUGs with road access to their forests, more timber was harvested and the income from timber sales (mostly to contractors) was three times higher than for CFUGs without such access. Similarly, based on experiences in their studies from the Mid-hills region of Nepal, Chand (2015) and Pandey (2015) reported that a strong motivation for local people to construct rural roads close to or through their CFs is generally associated with timber extraction from the forests. Paudel et al. (2013) and GoN (2014e) have identified rural road construction as a major driver of forest degradation in CFs, mainly because of its effects on timber removal, both during and after construction.

However, there was no influence of improvement of road access (from village to forests) on fuelwood and fodder extraction. Forest users usually do not harvest fuelwood and fodder in bulk, rather they collect a full head load and transport it manually, and this is not so reliant on good road access for those who do not have a private vehicle or the ability to hire a vehicle for carrying fuelwood.

Change in extraction of forest products due to road access can change carbon stocks and forest biodiversity. For example, Singh & Singh (1997) working in government forests from Uttarakhanda Himalayan, India and Mon et al. (2012) working in open access forests (i.e. ownership not given to local people) in Myanmar have reported higher timber extraction and reduced biomass in forests close to the road head compared to forests distant from the road head. In terms of forest biodiversity, Thapa & Chapman (2010) observed lower stem density and plant species diversity in forests close to roads, due to higher extraction of forest products, than in distant forests, in their analysis in Bardia National Park, Nepal. Dons et al. (2014) noted greater extraction of forest products close to roads, leading to greater forest degradation. However, in their carbon assessment study, Pandey et al. (2014) found no clear differences in carbon stocks in CFs located nearby and further away from roads, mainly due to effective conservation and monitoring of forests by local people. Deng et al. (2011) also noted no effects of improved road access on forests in China due to adoption of strict conservation rules. This indicates that the effect of road access on carbon status and forest biodiversity can be contextual, and is governed by local factors including forest management regimes.
My results have implications for the recently developed climate change policies (viz., Nepal REDD+ strategy) which generally assign a low priority to addressing the role of road construction in forest loss and on extraction of forests products. My analysis is particularly relevant to the mid-hills region of Nepal since the construction of the rural road network in this region is one of the major prioritised activities of the government, having increased the national annual budget for local road networks from 5% to 8% over the past five years (GoN, 2013).

### 7.4.2.5 Development of wood-based factories increases timber extraction

Development of wood-based factories (i.e. saw mills, plywood and veneer mills, paper factories) can also influence the extraction of forest products, especially timber. CFUG data and responses of interviews from Thansadeurali CFUG indicate that some overharvesting of timber and illegal felling was associated with the establishment of wood-based factories close to their CFs. Development of wood-based factories induced forest users to overharvest timber beyond the permitted quantity, as they were able to sell timber to the factories or saw mills. As suggested by Lawrence et al. (2006), development of wood-based industries close to forests increased the commercial value of wood, thus increasing the demand for timber by forest users.

Further, the price difference between what CFUGs charge their members for harvesting timber (e.g. NRs 20 per cubic feet for Thingure Salla in Thansadeurali CFUG), and what the factories are willing to pay (NRs. 560 per cubic feet) provides a strong motivation for forest users to sell timber from their private farmlands to factories, and to extract timber from CFs for their domestic use (Section 7.2.1). This supports the view of Ruiz-Perez et al. (2004) that a local wood-based market increases forest products extraction by motivating local people to change their resource use behaviour. The finding is also consistent with Masozera & Alvalapti (2004) from Rwanda and Poudel et al. (2014) from CFs from the Dang district of Nepal, who observed removal of a large number of mature trees in forests close to wood-based factories compared to forests located further away from the factories.

Although the sale of timber to wood factories can enhance income for CFUGs or individual forest users, I found that such income enhancement is mainly achieved through overharvest or illegal logging by well-off households or households who can afford timber harvesting, in which case, neither the CFUG nor poor households are receiving an enhanced income. Instead there was an apparent increase in conflict among
forest users due to the benefits from overharvesting of timber going to only a few opportunistic households.

7.4.3 Institutional arrangements mediate the demand and supply condition of forest products
There were no straightforward influences of institutional arrangements on extraction of forest products. However, I found that change in the extraction of timber, fuelwood and fodder is variably influenced by the institutional arrangements set for CFUGs, mainly the distribution rules, which are designed and enforced by CFUGs according to the availability of forest products, condition of forests and local needs as discussed in section 7.4.1.2 (per household forest size and distribution rules).

A decrease in fuelwood and fodder extraction was associated with CFUGs in Thansadeurali placing limits on collection time and duration. In contrast, Sitakunda CFUG allows forest users to collect fuelwood throughout the year. Hence, institutional arrangements for access provision for different types of forest products and harvesting times can affect extraction behaviour of forest users. Some studies (e.g. Edmonds, 2002; Pokharel, 2008a) in Nepal and elsewhere (e.g. Ajake & Anyandike, 2012; Robinson & Kajembe, 2009; Tucker et al., 2007) have identified a reduction in extraction of forest products from forests with the development of restrictive distribution rules. Likewise, Khatri-Chhetri (2006) found a lower extraction of forest products in CFUGs in Nepal, where strong formal rules have been developed governing extraction and distribution, compared to forests with less formal rules.

Local CFUGs also mediate the internal and external demand for forest products by limiting supply through the formulation of rules. For example, despite high demand from local forest users, wood industries, timber contractors and government offices, both case study CFUGs limited their timber harvest below the allowable quantity prescribed by their operational plans, apart from Sitakunda CFUG in 2013 and Thansadeurali CFUG in 2014 (Chapter 7 Section 7.2). As reported by respondents from Thansadeurali CFUG, with a large demand for timber, fuelwood and fodder from a larger number of households, their forests would have already been destroyed if they had not limited the quantity of removal of forest products. Consistent with the views of Agrawal & Yadama (1997), Andersson & Agrawal, (2011), Oldekop et al. (2013), Agrawal (2001) and Ostrom (2009b), my research has found that CFUGs use
institutional arrangements as a means to regulate and mediate local needs and non-local demands on forest products, according to the conditions and supply capacity of forests.

In light of the above, CFUGs can achieve positive changes to carbon stocks and forest biodiversity by mediating extraction of forest products through appropriate institutional arrangements. In their assessment of biophysical outcomes under different institutional conditions, Coleman (2009) and Chhatre & Agrawal (2009) found positive associations between improved forest conditions in terms of carbon stocks and institutional arrangements such as active monitoring, distribution rules and sanctioning. Bluffstone et al. (2015) observed high carbon stocks both in registered and non-registered CFs in Nepal resulting from formulation, monitoring and enforcement of harvesting rules. In contrast, in an institutional and biophysical analysis study, Hayes (2006) observed low vegetation density (i.e. forest biodiversity) where resource extraction rules were not enforced properly due to the formation of rules without consultation with local forest users.

7.5 Chapter conclusion
This chapter discusses the factors associated with changes in the extraction of timber, fuelwood and fodder and relates these to changes in carbon stocks and forest biodiversity, based on the experiences from two case study CFUGs.

The results indicate that an increase in timber extraction was associated with the development of road networks, development of wood-factories and distribution of high value tree species in the CFs. A decrease in extraction of fuelwood was related to greater physical distance to forests, expanded growing of trees in private farmlands, change in subsistence agricultural practices to cash-oriented vegetable farming, increased availability of alternative energies for cooking fuel, lack of household level human resources due to temporary outmigration of youths and male adults and changes in distribution rules. The major factors associated with a decrease in fodder extraction were increased growing of trees on private farmlands, falling livestock numbers due to transformation of agricultural practices, and lack of human resources due to outmigration. My research also found that the distribution of high value tree species can influence fodder extraction, and that the size of forests in relation to number of household members and restrictive distribution rules can reduce fuelwood and fodder extraction.
The extraction of timber, fuelwood and fodder is attributed to a combination of biophysical (contextual) characteristics and socio-economic and institutional arrangements (dynamic factors). In terms of links between forest product extraction, carbon stocks and forest biodiversity, the factors leading to increased timber extraction can subsequently negatively affect carbon stocks and forest biodiversity, while the factors associated with the decrease in fuelwood and fodder extraction may contribute positively to carbon stocks and forest biodiversity (Table 7.9). Carbon stocks and biodiversity can also vary according to biophysical characteristics, such as topography and elevation of forests, which can lead to variation in growth pattern and wood density of tree species among other things. Therefore, forest management strategies may need to understand the influence of biophysical and socio-economic circumstances on forest products extraction in order to integrate these aspects into institutional arrangements for enhancing synergies between extraction of forest products, carbon stocks enhancement and forest biodiversity conservation.

Table 7.9 illustrates the contribution of the identified factors to the negative or positive effects on carbon stocks and forest biodiversity, drawing on the result sections 7.2 and findings from discussions section 7.4 from the two case study CFUGs.

**Table 7.9- Illustration of factors affecting extraction of timber, fuelwood and fodder and their effects (P– Positive and N- Negative) on carbon stocks and forest biodiversity**

<table>
<thead>
<tr>
<th>Underlying factors</th>
<th>Proximate factors</th>
<th>Possible effect on carbon stocks</th>
<th>Possible effect on forest biodiversity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Policy and institutional arrangements</td>
<td>Restriction to cattle grazing</td>
<td>P</td>
<td>P</td>
</tr>
<tr>
<td></td>
<td>Provision of green trees for fuelwood</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>Restriction on collection of fuelwood from green-standing trees</td>
<td>P</td>
<td>P</td>
</tr>
<tr>
<td></td>
<td>Specific time for resource collection (6 months for fuelwood and fodder during winter in Thansadeurali CFUG)</td>
<td>P</td>
<td>P</td>
</tr>
<tr>
<td></td>
<td>Revision with restriction in resource use policy for Terai region</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Biophysical characteristics</td>
<td>Distance to forests (close distance from settlement to forests)</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>Distribution of high use value tree species (such as high quality timber – Thingure Salla and)</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Socio-economic circumstances</td>
<td>Change in agriculture practices from traditional to cash-oriented vegetable farming</td>
<td>P</td>
<td>P</td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>----------------------------------------------------------------------------------</td>
<td>----</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>Trees growing on private lands</td>
<td>P</td>
<td>P</td>
</tr>
<tr>
<td></td>
<td>Development of local employment opportunities</td>
<td>P</td>
<td>P</td>
</tr>
<tr>
<td></td>
<td>Introduction of alternative energies and technologies</td>
<td>P</td>
<td>P</td>
</tr>
<tr>
<td></td>
<td>Availability of electricity and liquid petroleum gas</td>
<td>P</td>
<td>P</td>
</tr>
<tr>
<td></td>
<td>Temporary outmigration of youths and male adults</td>
<td>P</td>
<td>P</td>
</tr>
<tr>
<td></td>
<td>Development of road access</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>Development of wood-based industries/factories</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>Landholding types (irrigated land)</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>Non-irrigated prefer planting trees</td>
<td>P</td>
<td>P</td>
</tr>
<tr>
<td></td>
<td>Livestock size (large)</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Occurrence of natural and human induced disturbances</td>
<td>Incidence of forest fires</td>
<td>N</td>
<td>N</td>
</tr>
</tbody>
</table>
Chapter 8- REDD+ pilot and practice changes

8.1 Introduction

Building on my exploration of the trends in carbon stocks, forest biodiversity attributes and forest products extraction in chapter 4, the relationships between these variables across CFs in chapter 5, and factors affecting removal of forest products and their influence on carbon and biodiversity in chapter 7, this chapter highlights the major changes in forest management, benefit sharing and group management adopted by CFUGs under the REDD+ pilot. The chapter further briefly reviews the policies related to climate change and community forestry in relation to REDD+ implementation through CFs.

The REDD+ scheme, which is designed to provide financial incentives for enhancement of carbon storage capacity in forests, may alter management priorities and outcomes for forest conservation and the traditional objectives of CFs to deliver livelihood improvement. Therefore, implementation of REDD+ through the pre-existing community forestry system can influence local forest managers to change their existing forest activities and resource use practices, along with benefit distribution and institutional and group management practices (Evans et al., 2012; Lee & Pistorius, 2015; Sills et al., 2014). The REDD+ scheme may also interact with national and local level climate change and forestry policies, which can result in different outcomes for carbon, forest biodiversity and livelihoods. This chapter first describes the changes in local practices arising from implementation of the REDD+ pilot, and then considers the coherence between REDD+ and existing policies and the potential opportunities and challenges that arise for carbon, biodiversity and livelihood improvements.

The objectives of overall REDD+ scheme likely correlate with those of the management of community forests such as to conserve forests (i.e. enhancement of carbon and conservation of biodiversity) and to support livelihood improvement (Agrawal & Angelsen, 2009; Newton et al., 2016). Identification of institutional arrangements (i.e. benefit sharing, decision-making and governance system) of community forests management is critical to ensure that support for conservation of forests thereby enhances carbon stocks and contributes to the climate change mitigation envisioned by the REDD+. While community forests have been demonstrating a pioneering approach to forest improvement and biomass enhancement, the extent of its biophysical and
institutional feasibility for the incentive-based mechanism like REDD+ is still unclear (Bluffstone et al., 2013; Fisher, 2014; Rosenbach, 2013). However, proper design of REDD+ through community forests can generate mutual benefits both to REDD+ and community forests (Newton et al., 2016; Newton et al., 2015). While REDD+ can provide a means of reinforcing the existing community forestry system, it is important to understand the extent to which the existing institutional arrangements and mainly benefit sharing and forest conservation practices can complement with the REDD+.

The Norwegian Agency for Development (NORAD) funded REDD+ pilot was initiated in 2009 through 105 CFUGs of Kayarkhola watershed of Chitwan district, Ludikhola watershed of Gorkha district and Charnawati watershed of Dolakha district aiming to develop and piloting various REDD+ activities including benefit sharing and inclusive governance system (ICIMOD, 2012). This project also aims to assess and establish baseline value of carbon stocks both at watershed and CFUGs levels to facilitate the carbon payments.

The approach of this project was to learn through various demonstration REDD+ activities (such as carbon assessment, capacity building, benefit sharing, monitoring and verification), and contribute to the national REDD+ policy process, and to demonstrate the feasibility of a payment process through the community forestry system in Nepal and through similar forest management approaches. Further the project has sought to focus on the concerns of indigenous peoples, Dalit, women and marginalised forest users as envisioned by the community forestry system. This is done by involving poor and marginalised forests users in capacity building activities, forest carbon measurement and benefit sharing process under the REDD+ pilot.

As this pilot was a first initiative of this kind for Nepal, the project has sought to engage its key stakeholders such as government, civil societies and local CFUGs in design and implementation of the project (ICIMOD, 2011). For example, central FECOFUN, a network of CFUGs, has been involved as a collaborating partner of the project at national level, while its district chapters were involved in the implementation. At the local level, project activities were implemented for and with the collaboration of existing local CFUGs, which are autonomous and self-governing institution for managing forests and sharing benefits (ICIMOD, 2010c; Shrestha et al., 2014). Collaborating partners claimed that the project has been implemented with the consent
NORAD REDD+ attempts to test key aspects of REDD+ through existing community forestry framework. While the success of community forests resulted from the interaction of multiple policy and contextual factors beyond community forests, it is important to understand how REDD+ interacts with contextual conditions of community forests and beyond (Marquardt et al., 2016). Given the implementation of first REDD+ pilot of its kind, it is also interesting to understand how REDD+ can be negotiated with community forests and beyond to acquire expected outcomes for both REDD+ and community forests. This chapter analyses how REDD+ pilot interacts with community forests and explores the changes in local practices arising from the REDD+ project.

The central level research participants (e.g. C1, C2 and C3 - project proponents) interviewed during the introductory interactions of the 2013 field visit described activities implemented under the REDD+ pilot project related to carbon measurement, awareness raising and capacity building, while seed grants have also been distributed to local CFUGs in project districts including the Dolakha district (Chapters 3 and 6). According to these respondents, a multi-stakeholder REDD+ trust fund advisory committee had been established at the central level representing government agencies, civil society organisations and three project proponents (ICIMOD, FECOFUN and ANSAB). Similar district level advisory committees were formed in the project districts to facilitate the distribution of REDD+ funds to the local CFUGs (Appendix 30).

During the round table discussion organised at the beginning of data collection in Dolakha, district level stakeholders (representing FECOFUN, government agencies, and ANSAB), reported that the district level advisory committee had provided seed grant funds to local CFUGs based on the criteria defined by the REDD+ trust fund guidelines such as the number of poor households, Dalit and indigenous peoples (IPs), and women, and the change in carbon stocks of their CFs (Appendix 31). Participants in this discussion also described the formation of a Watershed REDD+ Network with representatives from CFUGs involved in the REDD+ pilot through which local CFUGs could communicate and learn from each other by sharing their experiences of implementing REDD+ activities.
Seed grants distribution under the REDD+ pilot project was initiated to explore how governance system of payment distribution can be adapted for performance-based REDD+ scheme at the local level within the community forestry system. Thus the aim of this seed fund was to harness learning that can be applied by the policy decision-makers and practitioners to design policies and the implementation of REDD+ at the national level. Priority was given to ensuring the payment mechanism was equitable; respecting the rights of Dalits, women and indigenous peoples, and recognizing the contribution of local people in conservation of forests. While social aspects (number of Dalit, indigenous peoples and poor households, women population) were taken into consideration as virtual payment criteria, change in carbon stocks (i.e. the quantity of carbon stocks increased above the baseline) after the implementation of REDD+ was considered as a performance indicator for the distribution process. According to the respondents affiliated to project collaborating institutions (ICIMOD, ANSAB and FECOFUN), while the fund distribution process was developed within the context of the project, the distribution has been facilitated through the establishment of Forest Carbon Trust Fund (FCTF) representing government (Ministry of forests and soil conservation – REDD implementing centre), civil societies (FECOFUN, NEFIN, HIMAWANTI, DNF) and project collaborators. Governance system of FCTF was designed by the multi-stakeholder task force and approved by national and local stakeholders through a consultative feedback process.

According to Shrestha et al. (2014), REDD+ pilot allocated a total of USD 300,000 for three years (i.e. USD 100,000 per year) as a dedicated amount to distribute to the CFUGs of three piloted watersheds (i.e. Kayarkhola of Chitwan district, Charnawati of Dolakha district and Ludikhola of Gorkha district) of Nepal. Out of the total allocated, the project distributed a total of USD 285,000 to CFUGs considering the carbon stock changes and social factors (i.e. number of poor, Dalit and indigenous peoples’ households, women population) as distribution criteria for three years (2011, 2012 and 2013) (Table 8.1). Charnawati watershed received the highest amount USD 132,879.

Table 8.1- Seed grants amount (in USD) distributed from REDD+ pilot to CFUGs of three watersheds of Nepal

<table>
<thead>
<tr>
<th>Watershed and district under Norad REDD+ pilot</th>
<th>Amount of seed grants (in USD) distributed according to different criteria</th>
<th>Total seed grant distributed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Carbon stock change</td>
<td>Social criteria</td>
</tr>
<tr>
<td>Charnawati (Dolakha)</td>
<td>18,214</td>
<td>27,321</td>
</tr>
<tr>
<td>Kayarkhola (Chitwan)</td>
<td>8,762</td>
<td>13,143</td>
</tr>
</tbody>
</table>
Table 8.2 shows the amount of seed grants received by CFUGs of Charnawati watershed in Dolakha. In 2011 and 2012 a total of 58 CFUGs received the seed grants, while the grants were distributed to 65 CFUGs in 2013 since 7 CFUGs were formed after initiation of the REDD+ pilot in the watershed. Charnawati 1 CFUG received the highest amount of seed grant (USD 7,293) while newly formed Chitreshwormahadev CFUG obtained the smallest amount (USD 176) (Table 8.2). The figures indicate that the amount of seed grants have not consistently increased from 2011 to 2013, while an increase of carbon stocks was reported in consecutive years in all CFUGs (Chapter 4). This suggests that change in carbon stocks was not the only determinant of seed grants distribution across the CFUGs. Therefore, inclusion of social indicators can play an important role in maintaining equity in seed grant distribution.
<table>
<thead>
<tr>
<th>CFUG in Thapuwa</th>
<th>Area 1</th>
<th>Area 2</th>
<th>Area 3</th>
<th>Area 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jugedarkha</td>
<td>950.10</td>
<td>863.16</td>
<td>790.81</td>
<td>2,604.08</td>
</tr>
<tr>
<td>Jyamire</td>
<td>762.26</td>
<td>740.16</td>
<td>672.35</td>
<td>2,174.77</td>
</tr>
<tr>
<td>Kalchhe</td>
<td>612.02</td>
<td>481.44</td>
<td>448.60</td>
<td>1,542.06</td>
</tr>
<tr>
<td>Kamalamai</td>
<td>461.80</td>
<td>529.02</td>
<td>496.02</td>
<td>1,486.84</td>
</tr>
<tr>
<td>Kopila</td>
<td>987.61</td>
<td>720.22</td>
<td>647.41</td>
<td>2,355.24</td>
</tr>
<tr>
<td>Kuktungkhola</td>
<td>0.00</td>
<td>0.00</td>
<td>256.42</td>
<td>256.42</td>
</tr>
<tr>
<td>Kuprisalleri</td>
<td>639.44</td>
<td>688.01</td>
<td>616.84</td>
<td>1,944.29</td>
</tr>
<tr>
<td>Laliguras</td>
<td>425.59</td>
<td>457.37</td>
<td>416.31</td>
<td>1,299.27</td>
</tr>
<tr>
<td>Lodini</td>
<td>618.83</td>
<td>567.18</td>
<td>768.05</td>
<td>1,954.06</td>
</tr>
<tr>
<td>Mahabhir</td>
<td>864.07</td>
<td>802.21</td>
<td>725.99</td>
<td>2,392.28</td>
</tr>
<tr>
<td>Mahankal Sahele</td>
<td>375.20</td>
<td>417.38</td>
<td>381.70</td>
<td>1,174.28</td>
</tr>
<tr>
<td>Harisi ddimai</td>
<td>0.00</td>
<td>0.00</td>
<td>447.22</td>
<td>443.32</td>
</tr>
<tr>
<td>Majhkharkalisepani</td>
<td>1,146.29</td>
<td>1087.29</td>
<td>1,011.33</td>
<td>3,244.92</td>
</tr>
<tr>
<td>Mathani</td>
<td>401.93</td>
<td>401.58</td>
<td>357.21</td>
<td>1,160.72</td>
</tr>
<tr>
<td>Napkeyannmara</td>
<td>868.94</td>
<td>855.94</td>
<td>787.58</td>
<td>2,512.46</td>
</tr>
<tr>
<td>Nurserypakha</td>
<td>0.00</td>
<td>0.00</td>
<td>284.32</td>
<td>284.32</td>
</tr>
<tr>
<td>Palekoban</td>
<td>221.83</td>
<td>297.41</td>
<td>272.64</td>
<td>791.88</td>
</tr>
<tr>
<td>Palung Mahila</td>
<td>341.48</td>
<td>403.27</td>
<td>353.55</td>
<td>1,098.30</td>
</tr>
<tr>
<td>Pauwa</td>
<td>678.76</td>
<td>697.52</td>
<td>639.08</td>
<td>2,015.35</td>
</tr>
<tr>
<td>Pokhari</td>
<td>242.87</td>
<td>310.28</td>
<td>284.12</td>
<td>837.26</td>
</tr>
<tr>
<td>Radha Krishna</td>
<td>0.00</td>
<td>0.00</td>
<td>272.50</td>
<td>272.50</td>
</tr>
<tr>
<td>Ramite</td>
<td>225.52</td>
<td>281.84</td>
<td>257.32</td>
<td>764.68</td>
</tr>
<tr>
<td>Salleri</td>
<td>688.25</td>
<td>731.42</td>
<td>663.24</td>
<td>2082.91</td>
</tr>
<tr>
<td>Sanobothle</td>
<td>369.16</td>
<td>432.17</td>
<td>386.79</td>
<td>1188.12</td>
</tr>
<tr>
<td>Sele Alambhir</td>
<td>0.00</td>
<td>0.00</td>
<td>776.47</td>
<td>776.47</td>
</tr>
<tr>
<td>Setidevidadar</td>
<td>1,905.19</td>
<td>1954.06</td>
<td>1811.52</td>
<td>5670.77</td>
</tr>
<tr>
<td>Setokhola Mahadevthan</td>
<td>0.00</td>
<td>0.00</td>
<td>303.47</td>
<td>303.47</td>
</tr>
<tr>
<td>Shankadevi</td>
<td>1,725.42</td>
<td>1546.31</td>
<td>1425.07</td>
<td>4696.80</td>
</tr>
<tr>
<td>Shivajungbhumethan</td>
<td>379.42</td>
<td>406.54</td>
<td>372.77</td>
<td>1158.74</td>
</tr>
<tr>
<td>Simpani</td>
<td>340.91</td>
<td>437.70</td>
<td>404.02</td>
<td>1182.64</td>
</tr>
<tr>
<td>Simsugure</td>
<td>192.21</td>
<td>284.60</td>
<td>263.81</td>
<td>740.62</td>
</tr>
<tr>
<td>Sitakunda</td>
<td>704.26</td>
<td>782.62</td>
<td>711.72</td>
<td>2198.59</td>
</tr>
<tr>
<td>Srijana</td>
<td>1,666.04</td>
<td>1603.15</td>
<td>1486.23</td>
<td>4755.42</td>
</tr>
<tr>
<td>Sundarimai</td>
<td>297.68</td>
<td>345.06</td>
<td>321.93</td>
<td>964.67</td>
</tr>
<tr>
<td>Thansadeurali</td>
<td>1,563.93</td>
<td>1391.55</td>
<td>1259.81</td>
<td>4215.29</td>
</tr>
<tr>
<td>Tharlange</td>
<td>1,603.30</td>
<td>1276.90</td>
<td>1172.38</td>
<td>4052.58</td>
</tr>
<tr>
<td>Thumkadada</td>
<td>630.82</td>
<td>638.17</td>
<td>575.87</td>
<td>1844.86</td>
</tr>
<tr>
<td>Thutemane</td>
<td>403.02</td>
<td>469.48</td>
<td>415.11</td>
<td>1287.61</td>
</tr>
<tr>
<td>Timuretinsalle</td>
<td>512.75</td>
<td>545.22</td>
<td>503.59</td>
<td>1561.55</td>
</tr>
</tbody>
</table>

Total: 45,534.93, 44,187.90, 43,156.04, 132,878.87

Source: ICIMOD (2013)

Note:
- CFUGs marked with yellow were formed as community forest after the implementation of REDD+ pilot (provided with no seed grants in initial years)
- CFUGs marked with light green were selected for ecological analysis for this thesis
- CFUGs marked with Light blue were selected for both ecological and social analysis for this thesis

Based on the analysis of qualitative data from interviews and focus group discussions (FGDs) with local forest users in the two case study CFUGs, district stakeholders and central level REDD+ proponents, and quantitative data from household survey and CFUG records, this chapter describes and explores changes in institutional capacity such as record keeping, monitoring and reporting, and group management practices.
such as CFUG executive committee (EC) meeting frequency, representation of Dalit and women in EC, participation in general assembly (GA), as well as changes in benefits distribution and use of REDD+ funds, and changes in forest activities. Data drawn from the review of institutional arrangements and CFUG and policy documents are substantiated with results from the synthesis of perspectives from in-depth interviews. The identified changes are organised under three broad themes of group management, benefit distribution and livelihoods, and forest management activities (Figure 8.1).

![Figure 8.1- Perceived changes in forest and group management practices with REDD+ pilot](image)

### 8.2 Change in group management and participation

A CFUG makes operational decisions related to mobilisation of local forest users, formulation and enforcement of resource distribution rules, distribution of benefits, and design and implementation of forest management activities. As indicated by forest operational plans of both case study CFUGs, these day to day activities are generally approved by the EC meeting, which generally takes place once each month, and through CFUG GA, which is generally held once each year.

The institutional processes of CFUGs include the frequency and agenda of CFUG EC meetings, attendance of EC members at EC meetings, participation of local forest users and decision-making processes at the annual GAs, and dissemination of information generated from these meetings to the local forest users.

This section describes the responses and experiences of interviewees in relation to changes in the above mentioned institutional processes over recent years i.e. the period of implementation of the REDD+ pilot. The following results illustrate that the
frequency of CFUG EC meetings, and the representation of Dalit and women in EC and capacity building processes (such as nominated in the Watershed REDD+ Network) has increased in both CFUGs following the REDD+ pilot. However, average attendance of Dalit EC members at EC meeting has decreased, due to insufficient attendance incentives for Dalit EC members, which has prevented them from both taking part in the decision-making process and learning new things about REDD+.

**Executive committee meetings**

According to the forest operational plans of both CFUGs, the EC meetings should be held on a regular basis (5th day of each month in the case of Thansadeurali CFUG and 11th day of each month in Sitakunda CFUG). Almost all interviewees from both case study CFUGs reported that the EC meetings are generally held each month.

The majority of respondents (32 out 39) of in-depth interviews and FGD participants of both case study CFUGs reported that over the last couple of years since the implementation of the REDD+ pilot, the EC has become more active. For example, the former chairperson of Sitakunda CFUG:

“...our CFUG usually holds one meeting every month. However, following the implementation of the REDD+ pilot, we had more meetings than normal. We had sometimes five meetings in a month...” (SB5).

Since implementation of the REDD+ pilot, the CFUG EC is regularly required to participate in meetings with government and donor agencies, and members of the REDD+ pilot monitoring committee are regular visitors to oversee activities. Such visits impose additional requirements on the time of local CFUG EC members to gather and prepare for meetings. For example, FGD participants of Thansadeurali CFUG EC described that EC meeting frequency as well as time commitments of the EC members have increased following the REDD+ pilot. As noted by the current chairperson:

“...frequency of monthly meeting has increased after the REDD+ pilot. Sometimes, we have to organise meeting very urgently because students, project team, donors and other visitors come to our CFUG to discuss our REDD+ activities. This has not only increased meeting frequency but also the time of the executive committee members to receive visitor...” (TB5).

A former secretary (TB1) of Thansadeurali CFUG added that a number of the EC meetings have been held only for REDD+ related agenda. The respondent explained that accessing REDD+ seed grant funds required them to submit a claim form to the district FECOFUN with data on household well-being status and forest carbon stocks,
which required some additional processes to be adopted to gather the data. According to the respondent, CFUGs were required to identify households for allocations of seed grants for various activities, targeting poor households, Dalit and women. Under this program, the CFUGs had to keep a record of seed grant allocations, which had to be audited then submitted to the district FECOFUN and district monitoring committee.

The increase in frequency of meetings and activities of the EC was also described by FGD participants of Sitakunda CFUG EC. A former chairperson (SB4) of Sitakunda CFUG explained that the frequency of EC meetings had increased to more than monthly since the beginning of the REDD+ pilot in 2009 to select local resource persons, organise orientation programmes, and for selection of members for the Watershed REDD+ Network and to undertake the forest carbon inventory.

As reported by FGD participants of the ECs of both CFUGs, increased frequency of EC meetings could mainly be explained by the expectation of a rapid implementation of activities required by the REDD+ pilot. As reported by a former chairperson of Thansadeurali CFUG,

“...the REDD+ pilot requires quick return from CFUGs. We got the seed grant during June-July when we have to prepare the annual financial report of regular CFUG activities. They require information on an ad hoc basis with short notice for which we executive committee members had to convene meetings beyond our regular meeting...” (TA2).

Respondents from the district FECOFUN confirmed these comments and that EC meetings had increased in frequency, and explained that ad hoc EC meetings were held to make necessary decisions on matters arising from the REDD+ pilot. According to the respondents, the REDD+ pilot has initiated a multi-level seed grants distribution system, for which FECOFUN had been asked to gather information from local CFUGs. As noted by one district FECOFUN member, also district REDD+ coordinator:

“...CFUG level meetings have changed after the REDD+ pilot. In many cases, district FECOFUN was asked by the central FECOFUN to collect data from CFUGs very urgently. For which we had to inform CFUGs to prepare their data in a short period of time, which has led CFUGs to organise meetings besides their regular day...” (D10).

When asked about the implications of the REDD+ pilot for CFUG activities, the central level stakeholders (REDD+ pilot project proponents) also agreed that the REDD+ pilot has changed the regular schedule of local CFUGs because of additional requirements for record keeping, auditing and monitoring. As noted by one respondent:
“...the pilot project had three areas of programme at CFUG level such as carbon inventory, payment distribution and capacity building and awareness raising. As a new REDD+ pilot initiative requires carbon and socio-economic data, records kept up to date and preparation of the report, this has caused a change in the regular schedule of local CFUGs including monthly meetings...” (C1).

The REDD+ pilot has also resulted in an increase in time commitment of EC members and in administration costs of CFUGs. For example, FGD participants of the Sitakunda CFUG EC reported that CFUG administration costs have increased following the implementation of the REDD+ pilot. According to the participants, the more frequent EC meetings necessary to make decisions related to the REDD+ pilot have resulted in increased CFUG expenses (i.e. administration costs, implementation costs such as time, and effort, as well as tea and snacks, stationery expenses and meeting allowances).

Increases in costs were also reported by FGD participants of Thansadeurali CFUG EC, where an increase in meeting frequency has increased associated costs including meeting allowances (NRs 50 is paid to each EC member for meeting attendance), stationery and tea and snacks.

**Change in executive committee meeting agenda**

The frequency of CFUG EC meetings is generally associated with the priority and importance of agendas items that need to be discussed, decided and implemented. The following results indicate that the REDD+ pilot has expanded meeting agendas to incorporate topics such as seed grants distribution and carbon monitoring. The REDD+ imposed responsibilities for expanded record keeping and auditing, monitoring and reporting systems are particularly time consuming, leaving less time available for EC members to plan and implement other forest activities. However, REDD+ has likely strengthened the institutional capacity of CFUGs.

FGD participants of CFUG ECs from both CFUGs reported that following the REDD+ pilot, the major agendas of their EC meetings were related to REDD+, such as seed grants distribution and carbon stocks inventory. The respondents further explained that the REDD+ pilot stimulated CFUGs to discuss some pre-existing issues such as forest products distribution.

Although the frequency of EC meetings varies between the two CFUGs, the data show that over 50% of meetings were held for discussion of REDD+ funds (i.e. seed grants)
and benefit distribution in both CFUGs (Table 8.3). Other commonly discussed agenda items included forest products distribution and community development such as awareness raising and capacity building.

Table 8.3- Agenda items discussed and frequency of executive committee meetings of Sitakunda and Thansadeurali community forest user groups (Parenthesis is the number of meetings held in Thansadeurali)

<table>
<thead>
<tr>
<th>Year</th>
<th>Total number of meeting held in a year</th>
<th>Conflict management (fines, over harvest and encroachment)</th>
<th>Forest management and control forest fire, patrolling</th>
<th>Distribution of Forest products</th>
<th>REDD Fund distribution</th>
<th>Community development activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>12 (12)</td>
<td>3 (4)</td>
<td>3 (4)</td>
<td>5 (5)</td>
<td>0 (0)</td>
<td>4 (5)</td>
</tr>
<tr>
<td>2009</td>
<td>14 (17)</td>
<td>4 (4)</td>
<td>4 (5)</td>
<td>5 (4)</td>
<td>0 (0)</td>
<td>6 (8)</td>
</tr>
<tr>
<td>2010</td>
<td>18 (21)</td>
<td>3 (1)</td>
<td>5 (5)</td>
<td>4 (7)</td>
<td>5 (11)</td>
<td>5 (6)</td>
</tr>
<tr>
<td>2011</td>
<td>25 (21)</td>
<td>4 (0)</td>
<td>4 (5)</td>
<td>10 (8)</td>
<td>7 (11)</td>
<td>4 (6)</td>
</tr>
<tr>
<td>2012</td>
<td>34 (20)</td>
<td>6 (3)</td>
<td>10 (4)</td>
<td>7 (6)</td>
<td>8 (12)</td>
<td>7 (5)</td>
</tr>
<tr>
<td>2013</td>
<td>24 (33)</td>
<td>2 (7)</td>
<td>5 (4)</td>
<td>10 (13)</td>
<td>11 (19)</td>
<td>6 (5)</td>
</tr>
</tbody>
</table>

Source: CFUG records and field survey, 2013 (Note- meeting frequencies for each agenda are not mutually exclusive)

Discussion of agenda items related to conflict management such as fines, illegal felling, forest boundary encroachment and overharvesting of timber has increased in Thansadeurali CFUG in the latter years of the REDD+ pilot, while such items have decreased in Sitakunda CFUG in the most recent year of data (2013). The increase in frequency of discussions related to conflict resolution in Thansadeurali CFUG in 2013 was to resolve conflicts about overharvesting of timber by some permit-holder forest users, and to address forest boundary encroachment by individual cultivators.

An increased frequency of discussion of forest products distribution reflects that under the REDD+ pilot, CFUGs have had to consider revision and formulation of rules for forest products distribution, such as collection of fuelwood only from branches (in Sitakunda CFUG), and formation of a monitoring committee and change in distribution of timber practices (from depot rather than individually harvested in Thansadeurali CFUG). The data show no change in frequency of discussion of forest management matters over time, except in Sitakunda CFUG for 2012. According to the chairperson of Sitakunda CFUG, meetings in 2012 included discussion of forest fires as well as the revision of their forests operational plan. The secretary of Thansadeurali CFUG reported that forest management was an agenda item discussed in only a small number of meetings because some patches of forest are managed and conserved by 4 sub-groups of the CFUGs (Chapter 6).
Despite some positive experiences, such as strengthening the existing institutional capacity of CFUGs in record keeping, auditing and reporting mechanisms of both seed grants distribution and carbon stocks monitoring, some negative experiences were also identified by some respondents of Sitakunda CFUG. According to the respondents, extensive discussion on REDD+ matters has meant that less time is available to discuss some “traditional” agenda items relevant to management of their CFs. As noted by one former chairperson of Sitakunda CFUG:

“...increasing frequency of committee meetings means an increase in time of the chairperson since they are required to prepare for the meeting and inform other committee members. As a result, our committee members had less time to plan and implement forest management activities particularly thinning and pruning...” (SB4).

Executive committee meeting attendance

Representation of marginalised households such as Dalit and women on the CFUG EC and attendance at EC meetings are considered by CFUG constitutions and operational plans as a prerequisite for the participatory decision-making process in CFUG. The following evidence indicates that while the frequency of EC meetings has increased in both CFUGs, average attendance of EC members in these meetings has decreased due to insufficient attendance incentives. Dalit EC members have particularly faced problems in attending the increased number of meetings, so the changes arising from the REDD+ pilot have effectively prevented Dalit EC members from participating in the decision-making process, and from learning more about the opportunities arising from REDD+.

As reported by FGD participants of the EC from Sitakunda CFUG, some EC members mainly Dalit and women do not have time to attend each EC meeting held beyond the regular date. A former chairperson of Sitakunda CFUG expressed that:

“...our executive committee includes representation from Dalit and women members. While the executive committee needs to have ad hoc meetings Dalit and women cannot attend these meeting since they have to go for work...” (SB5).

Similar experiences were reported by a few respondents from Thansadeurali CFUG EC, who explained that some women and Dalit members of the EC do not attend each meeting. When asked about the low attendance of women and Dalit members of the EC, one Dalit woman (mother of a member of the EC) of Thansadeurali CFUG did not agree that it was the decision of Dalit and women decision not to attend meetings,
explaining that usually the chairperson and secretary fix the meeting date without consulting with Dalit and women.

“...we Dalit and women can also attend meeting. However, chairperson and secretary organise the meeting on their suitable time and day. This is because chairperson and secretary get first hand notice and information of meeting from district FECOFUN. Chairperson and secretary never consult with us for meeting. We could attend the meeting if they were to inform us in advance...” (TB2).

The analysis of EC attendance data for ethnic and women EC members shows that the average percentage of EC members attending EC meeting has generally decreased in more recent years with an increase in the number of EC meetings (Table 8.4 and 8.5). The average attendance of men EC members in Sitakunda CFUG remained unchanged; however, attendance of women, IPs and Dalit EC members has decreased. Although no consistent pattern of average attendance of EC members appeared in Thansadeurali CFUG, the general trend of average attendance of all EC members has decreased with an increase in frequency of EC meetings (e.g. in 2013 in Thansadeurali CFUG).

**Table 8.4- Average percentage of attendance of committee members of different ethnic and gender groups in Sitakunda community forest group**

<table>
<thead>
<tr>
<th>Year</th>
<th>Average percentage of attendance of different committee members at the executive committee meetings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of committee members representing IP, Dalit and women</td>
</tr>
<tr>
<td>2008</td>
<td>13 (IP-2, Dalit-2, women-4)</td>
</tr>
<tr>
<td>2009</td>
<td>13 (IP-2, Dalit-2, women-4)</td>
</tr>
<tr>
<td>2010</td>
<td>13 (IP-1, Dalit-3, women-5)</td>
</tr>
<tr>
<td>2011</td>
<td>13 (IP-1, Dalit-3, women-5)</td>
</tr>
<tr>
<td>2012</td>
<td>13 (IP-1, Dalit-3, women-6)</td>
</tr>
<tr>
<td>2013</td>
<td>13 (IP-1, Dalit-3, women-6)</td>
</tr>
</tbody>
</table>

Source: CFUG records (Meeting minutes), 2013
(Note- IP- Indigenous Peoples, Other- includes Brahmin and Chhetri other than Dalit and indigenous peoples). Average percentage was calculated based on total number of representatives from each ethnic and gender group and their attendance number at meetings.

**Table 8.5- Average percentage of attendance of committee members of different ethnic and gender groups in Thansadeurali community forest group**

<table>
<thead>
<tr>
<th>Year</th>
<th>Average percentage of attendance of different committee members at executive committee meetings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of committee members representing IP, Dalit and women</td>
</tr>
<tr>
<td>2008</td>
<td>13 (IP-6, Dalit-2, women-3)</td>
</tr>
<tr>
<td>2009</td>
<td>13 (IP-6, Dalit-2, women-3)</td>
</tr>
<tr>
<td>2010</td>
<td>13 (IP-6, Dalit-2, women-4)</td>
</tr>
<tr>
<td>2011</td>
<td>13 (IP-7, Dalit-2, women-4)</td>
</tr>
<tr>
<td>2012</td>
<td>13 (IP-6, Dalit-1, women-4)</td>
</tr>
<tr>
<td>2013</td>
<td>13 (IP-6, Dalit-1, women-4)</td>
</tr>
</tbody>
</table>

Source: CFUG records and Meeting minutes, 2013
Regarding the low attendance of Dalit, and women, one Dalit woman of Sitakunda CFUG (SC2) reported that Dalit and women members cannot attend every meeting as they are held at short notice and women and Dalit have already fixed plans to go to work for their survival. The respondent further explained that:

“...although committee meetings have increased owing to the REDD+ pilot, women, and Dalit committee members cannot attend ad hoc committee meetings due to short notice and their time limitation. The REDD+ pilot has no provisions to ensure their attendance through providing incentives to cover the cost of their time commitment...” (SC2).

The respondent further reported that providing information at short notice also made it very difficult for one IP EC member to attend ad hoc meetings being employed as an IP member of teaching staff at the local school.

An increase in frequency of EC meetings has enhanced group management capacity by enhancing their skills in record keeping, and in auditing and reporting. However, average attendance of women and Dalit members at EC meetings has decreased with an increase in meeting frequency, despite a slight increase in their representation (in number) on the EC in more recent years (Dalit and women in Sitakunda CFUG and women in Thansadeurali CFUG, Tables 8.4 and 8.5 respectively). This has created great concern amongst local CFUG members over the impact of the REDD+ pilot in relation to empowerment of Dalit and women, and promoting transparency in EC meetings.

The increased amount of time required for meetings due to the REDD+ pilot has prevented women and Dalit from participating in the decision-making process and from opportunities for learning new things. The existing meeting allowance of NRs. 50 is not considered adequate for them to leave their other work on which they are highly dependent, and there has been no consideration under the implementation of the REDD+ pilot of providing additional incentive payments targeted to women and Dalit to enable their attendance. The analysis of data and responses from interviews indicate that the attendance of male and non-Dalit EC members, those who can afford the time, has remained unchanged (e.g. in Sitakunda CFUG). In fact, without any additional incentives to women and Dalit members of the EC, the REDD+ pilot has facilitated the domination of the decision-making process by male and non-Dalit EC members (sub-section 8.3.2). The REDD+ pilot has not contributed to the basic principle of community forestry of increasing the participation of women and Dalit in decision-
making processes, nor is it meeting the safeguard principle of REDD+ of protecting the rights of marginalised peoples in decision-making processes by creating enabling conditions (in this case for Dalit and women).

**Annual general assembly of CFUG**

Another element of group management is participation of local forest users in the GA of CFUG. A GA is an annual mass gathering of all members, held by each CFUG as a forum to discuss and legitimise decisions made and approve activities performed by the EC. The GA is also mandated to make decisions related to forest management such as framing rules on forest products removal, fixing schedules of silviculture operations such as thinning and pruning, and managing and distributing CFUG funds. Typically, the GA is the main body of a CFUG for reconciling the diverse interests and preferences of diverse forest users through collective-decision-making processes. The following results reveal that the GA decision-making process has not changed with the REDD+ pilot, while participation of women has slightly increased because of the REDD+ pilot.

Almost all respondents of in-depth interviews from both CFUGs reported that the GA is held once each year, that almost every household needs to take part in it, and that participation of local forest users has increased slightly in recent years. As noted by one well-off respondent from Thansadeurali CFUG:

“...although one member from each household is required to attend the general assembly, every household does not take part. However, from some households, more than one member have been taking part owing to increased interest following pilot REDD+...” (TA3).

Similar experiences were reported by FGD participants from Sitakunda CFUG EC. Households attend the GA to learn about new CFUG programmes and forms of support available from the REDD+ pilot, such as alternative energies for cooking. As explained by a former chairperson of this CFUG:

“...every household does not take part in general assembly. But in recent years, participation has increased. Households want to know more about support provided from carbon project...” (SB4).

The analysis of data available from CFUG records (i.e. meeting minutes) shows that participation of forest users in GA has slightly increased in more recent years of the REDD+ pilot (Tables 8.4 and 8.5). The participation of women has generally increased in both case study CFUGs, though the percentage of participants who were women in
Thansadeurali CFUG fell in 2010 and 2012. Participation of IPs in both CFUGs has gradually increased except in Thansadeurali CFUG for 2012. Dalit’s participation has gradually increased in both CFUGs except in Sitakunda CFUG in 2013.

The current chairperson (TB5) of Thansadeurali CFUG explained the observed increase in attendance at the GA as resulting from the local forest users becoming more interested and wanting to learn about the REDD+ pilot. Similar views were reported by one Dalit woman (SC2) of Sitakunda CFUG who added that a slight increase in participation of women in the GA in more recent years was due to the pilot REDD+, which targets funds towards women, Dalit and indigenous people.

The percentage of women’s participation in the GA has tended to increase in Sitakunda CFUG following the implementation of the REDD+ pilot, peaking in 2011 but remaining just below 50% of participants (Table 8.6). The proportion of women participating in Thansadeurali CFUG is inconsistent and is considerably below that in Sitakunda CFUG (Table 8.7). Participation of IPs (as percentage) in Sitakunda CFUG is nearly stable, while Dalit participation increased slightly following REDD+ with a fall in 2013. The data shows that there is no consistent pattern of participation of IPs in Thansadeurali CFUG, while Dalit participation increased in 2012 and 2013.

<table>
<thead>
<tr>
<th>Year</th>
<th>Indigenous Peoples</th>
<th>Dalit</th>
<th>Brahmin and Chhetri</th>
<th>Men</th>
<th>Women</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>14 (14)</td>
<td>5 (5)</td>
<td>82 (81)</td>
<td>61 (60)</td>
<td>40 (40)</td>
<td>101</td>
</tr>
<tr>
<td>2009</td>
<td>15 (14)</td>
<td>5 (5)</td>
<td>86 (81)</td>
<td>61 (58)</td>
<td>45 (42)</td>
<td>106</td>
</tr>
<tr>
<td>2010</td>
<td>17 (15)</td>
<td>8 (7)</td>
<td>91 (78)</td>
<td>63 (54)</td>
<td>53 (46)</td>
<td>116</td>
</tr>
<tr>
<td>2011</td>
<td>17 (16)</td>
<td>7 (6)</td>
<td>85 (78)</td>
<td>57 (52)</td>
<td>52 (48)</td>
<td>109</td>
</tr>
<tr>
<td>2012</td>
<td>19 (16)</td>
<td>8 (7)</td>
<td>94 (77)</td>
<td>67 (55)</td>
<td>54 (45)</td>
<td>121</td>
</tr>
<tr>
<td>2013</td>
<td>22 (15)</td>
<td>6 (4)</td>
<td>116 (81)</td>
<td>77 (53)</td>
<td>67 (47)</td>
<td>144</td>
</tr>
</tbody>
</table>

Source: CFUG records, 2013

Table 8.6- Participation of forest users in general assembly in Sitakunda community forest user group (Parentheses are percentage of participation)

<table>
<thead>
<tr>
<th>Year</th>
<th>Indigenous Peoples</th>
<th>Dalit</th>
<th>Brahmin and Chhetri</th>
<th>Men</th>
<th>Women</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>84 (38)</td>
<td>16 (7)</td>
<td>119 (55)</td>
<td>145 (66)</td>
<td>74 (34)</td>
<td>219</td>
</tr>
<tr>
<td>2009</td>
<td>86 (39)</td>
<td>14 (6)</td>
<td>121 (55)</td>
<td>140 (67)</td>
<td>81 (37)</td>
<td>221</td>
</tr>
<tr>
<td>2010</td>
<td>89 (39)</td>
<td>15 (7)</td>
<td>124 (54)</td>
<td>162 (71)</td>
<td>66 (29)</td>
<td>228</td>
</tr>
<tr>
<td>2011</td>
<td>No general assembly held</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>124 (42)</td>
<td>29 (10)</td>
<td>142 (48)</td>
<td>212 (72)</td>
<td>83 (28)</td>
<td>295</td>
</tr>
<tr>
<td>2013</td>
<td>85 (35)</td>
<td>21 (9)</td>
<td>140 (56)</td>
<td>155 (67)</td>
<td>91 (37)</td>
<td>246</td>
</tr>
</tbody>
</table>

Source: CFUG records, 2013
The current chairperson of Thansadeurali CFUG (TB5) attributed the lower participation rate of women in their GA to the considerable distance from many residences and farms to the CFUG offices, and the difficulty for women to allocate 4-5 hours of their time to the process. The respondent further explained that their CFUG discusses the REDD+ pilot and seed grant funds with women forest users during their women’s group meeting (a separate group but involving few women CFUG members) held at the CFUG office each month.

Although women’s participation has slightly increased in the GA in Sitakunda CFUG, it is still below the requirements indicated by the Community Forestry Development Guidelines in Nepal, where at least 50% of total participants should be women in any decision-making including the GA. The situation of women’s participation in Thansadeurali CFUG is well below the requirements indicated in the forestry guidelines.

As reported by district level respondents (both FECOFUN and district forest office), an increased interest and motivation of local forest users in the GA was attributed to the REDD+ pilot orientation program being targeted towards women, Dalit and IPs participation. However, according to respondents from district FECOFUN, even though the REDD+ pilot had implemented similar orientation activities in the two CFUGs, distance from residences to meeting place (most people have to travel further in Thansadeurali CFUG) has resulted in different levels of participation of forest users in the GA.

Despite the observed small increase in total numbers of local forest users participating, one very poor respondent (TD4) from Thansadeurali CFUG said there had been no change in the decision-making process during GAs. Most of the decisions are made by EC and local elites without adequate consultation with other forest users.

“...there is an increase in interest of local forest users in the REDD+ pilot which caused a slight increase in participation in general assembly. However, consultation and discussion process in general assembly has not changed at all. The executive committee members share the general plan and associated expenditure, and seek consent for these. However, they generally make the decision by executive committee members and few elites even and do not discuss with local forest users...” (TD4).
The analysis of household survey data shows that nearly 60% (n=74) of participants reported that their EC members do not consult with local forest users during decision-making. The result of this analysis supports reports from in-depth interviews that most of the decisions are made by the EC members without adequate consultation with local forest users.

**Communication and information sharing**

This section considers communication with forest users as a component of group management practice. Such communication includes the sharing of outcomes of decisions made in EC meetings and of information regarding new initiatives of the REDD+ pilot. Information sharing and communication between and within CFUGs is a requirement of the REDD+ pilot to keep forest users informed about their rights, roles and responsibilities in relation to REDD+, to gain their consent and enhance participation in and legitimisation of REDD+ activities. The following results indicate that there are no notable changes in information sharing practices among local forest users within CFUGs and between CFUGs about the REDD+ pilot provisions. However, a lack of adequate communication and information sharing has created some degree of confusion and dissatisfaction over the REDD+ seed grant distribution among forest users.

As reported by the chairperson of Thansadeurali CFUG (TB5), the EC still uses a local communication system known as “Katuwal” for information regarding harvesting of forest products and GA meetings. However, the CFUG secretary and chairperson also use mobile phones to inform EC members about any emergency meetings held beyond the regular meeting (i.e. 5th day of every month).

“Katuwal” is a traditional system of mass communication informing people orally. As reported by the chairperson, one Dalit (Pariyar) performs this by playing a drum in certain places from where local people of villages can hear properly. Almost all respondents of in-depth interviews reported that the “Katuwal” system is the main source of accessing information about harvesting operations (i.e. fuelwood and fodder), GA meetings and forest activities (such as plantation and thinning and pruning).

Sitakunda CFUG uses mobile phones to communicate with committee members, while they disseminate CFUG related information to their forest users through EC members
representing the four hamlets. As reported by the current chairpersons of both CFUGs (SB7 and TB5), with a relatively small number of closely located forest user households, EC members believe that they do not need to use other means of information sharing. The respondents further explained that the EC members represent different settlements to enable communication between the EC and local forest users. In both case study CFUGs, the chairperson and secretary are responsible for confirming whether the information is properly disseminated to all forest users.

While information about harvesting operations, forest activities such as plantation and thinning and pruning and GA decisions is supposedly disseminated through a combination of traditional means (i.e. Katuwal), phone and committee members in Thansadeurali CFUG, and through phone and the EC members in Sitakunda CFUG, FGD participants of Dalit and women groups from Thansadeurali CFUG and Dalit, women and IPs from Sitakunda CFUG argued that sharing of decisions of EC meetings by EC members, particularly about CFUG fund or REDD+ grant distribution, is very poor in their CFUGs. Even though the secretary puts written notices on the notice board at the CFUG office, local forest users rarely visit the office, particularly in Thansadeurali CFUG where the office is some distance from the majority of forest user households.

Some negative effects of the EC’s existing communication and information sharing practices have appeared in seed grant distribution in Thansadeurali CFUG, which has a larger number of forest users’ households located across 12 hamlets. For example, EC decisions on REDD+ seed grant distribution (meeting date and venue for household selection) were usually shared either through EC members to respective hamlets or by putting a notice on the CFUG office notice board. As reported by one woman from Thansadeurali CFUG (TB6), poor households have been deprived from accessing seed grants because of the current practice of information sharing. Poor households rarely visit the CFUG office to see notices, nor can they all read the notice, while EC members do not inform all poor households but inform only a limited number of households such as their relatives and close neighbours. The respondent argued that although her CFUG has provided seed grants to Dalit, women and IPs who have access to the information and notices from CFUG EC, the information has not reached really needy households because of the inefficient communication and information sharing mechanism of CFUG especially for generation and distribution of CFUG funds.
One district FECOFUN representative (D8) reported that the REDD+ pilot has adopted sharing events such as workshops and meetings at the district level to share information about REDD+ with district stakeholders, while they share REDD+ information among the CFUGs through meetings of the “Watershed REDD+ Network” with representatives of each CFUG. The respondent reported that information sharing through Network meetings, and sometimes direct communications by FECOFUN to CFUG EC (especially chairperson and secretary), has been inadequate to inform CFUG members about REDD+ related issues such as seed grant distribution and carbon measurement.

The perception of inadequate communication and information sharing related to REDD+ has resulted in dissatisfaction with implementation of the REDD+ pilot because of a perception that REDD+ seed grant funds have been distributed unfairly. A former chairperson of Sitakunda CFUG (SB4) raised a concern that their CFUG had received a lower amount of seed grants compared to their neighbouring CFUGs despite having a larger area of forests.

The above analysis reveals that communication and information sharing among forest users within CFUGs has not changed or improved despite an expanded agenda due to the REDD+ pilot. Poor communication particularly regarding opportunities for seed grants has likely affected access of poor households to seed grants (benefits). Communication among CFUGs within the research site has also been inadequate to clarify the complexity of REDD+ elements, which has created dissatisfaction among some CFUGs, who perceive the distribution of REDD+ seed grant funds amongst CFUGs as unfair.

**Capacity building and affiliation with Watershed REDD+ Network**

Capacity building activities under the REDD+ pilot include skills development training and opportunities for nomination as network members and orientation activities. The REDD+ pilot has enhanced representation of Dalit and women particularly as local resource persons (LRPs) for involvement in carbon measurement and as REDD+ network members, which has not only enhanced personal capacities but also generated opportunities for local employment.
Both case study CFUGs have enhanced Dalit and women’s empowerment by nominating Dalit and woman members to attend REDD+ network meetings. According to the current chairpersons (SB7 and TB5), Sitakunda CFUG has nominated a Dalit woman and Thansadeurali CFUG has nominated an IP woman to represent their CFUGs at Watershed REDD+ Network.

As reported by one woman representative from Sitakunda CFUG, the Watershed REDD+ Network has provided CFUGs with opportunities to learn from each other and exchange ideas.

"...I attend the network meeting on behalf of our CFUG. Before attending the meeting I discuss with executive committee to prepare sharing matters, while I share the network meeting outcomes to our executive committee members. This practice has helped to exchange CFUG activities with each other..." (SC2).

District FECOFUN members added that the Watershed REDD+ Network is not only a sharing forum across the CFUGs, it has also enhanced cross-monitoring practices as well as collaboration across the CFUGs. For example, one FECOFUN member (D8) reported that prior to the REDD+ network, CFUGs were working in isolation and were not interested in getting information about other CFUGs. However, through the REDD+ network meetings, CFUGs have shown an interest in the activities of other CFUGs and collaborating with others mainly as a result of the distribution of seed grants.

As well as encouraging inclusive representation on the Watershed REDD+ Network, the REDD+ pilot has emphasised the involvement of women, Dalit and IP in other REDD+ related activities such as capacity building training, awareness activities, and local resource persons (LRPs). As noted by a former chairperson of Sitakunda CFUG:

"...we organise REDD+ related orientation program targeting Dalit, IPs and women. It has enhanced their knowledge and understanding on REDD+. Some Dalit women are much aware on REDD+ than executive committee members..." (SB5).

The REDD+ pilot has also enhanced empowerment of women and Dalit because of increased knowledge and understanding. For example, one Watershed REDD+ Network member from Sitakunda CFUG (SC2) reported that attending REDD+ network meetings has increased her confidence to be able to speak in front of large numbers of people and raise concerns.
Local informants indicated that the REDD+ pilot has also generated opportunities for local employment. One local resource person involved in organising awareness raising activities and monitoring of carbon stocks noted that the REDD+ pilot has provided opportunities for casual employment especially (but not only) for Dalit and women who are paid to facilitate awareness raising activities and for carbon inventory.

8.3 Distribution of funds within and across CFUGs

This section considers the distribution of seed grants under the REDD+ pilot both among and within CFUGs. As identified in section 8.1, FCTF Guidelines under the REDD+ pilot emphasise the distribution of seed grants towards integrated activities that include income generating activities for improvement of local livelihoods, forest activities, carbon monitoring and capacity building of local forest users. The following sub-sections present perceptions of changes in priority areas for fund distribution (including CFUG funds generated from internal sources) and their positive and negative implications for CFUGs.

8.3.1 Change in priority for fund distribution within CFUGs

According to the FCTF Guidelines and responses from REDD+ project proponents, the REDD+ pilot seed grants were distributed to local CFUGs on the basis of existing carbon stocks (40%), and social equity criteria (60%) such as ethnic diversity (25%), number of women (15%), and number of poor households (20%) (see Appendix 31). Under these allocations, the seed grants were intended to be invested by each CFUG in activities associated with income generation, capacity building, forest management, carbon measurement, community development and CFUG operational funding (see Appendix 32). The analysis of the data in this section shows that only a small portion of seed grants under the REDD+ pilot has reached Dalit and poor households or been invested for forest conservation. The data presented in following paragraphs also show that the REDD+ pilot has likely reduced the motivation of local people to act collectively or make voluntary contributions to forest conservation, and has destabilised self-regulated CFUGs as a result of distribution of insufficient seed grants to forest users based only on pro-poor and social equity criteria.

In-depth interview respondents from both CFUGs reported diverse areas for spending of CFUG group funds (both CFUG internal and REDD+ pilot seed grant funds). These include: (i) community development and community infrastructure such as support for
schools (furniture and renovations), office and community buildings, drinking water schemes, irrigation canal improvements, rural road and trail improvements, temple and monastery construction; (ii) office administration costs such as salary of office secretary, stationery and meeting allowance for EC members; (iii) forest management activities such as purchasing seedlings, construction of fire lines, salaries for forest guards (in the case of Sitakunda CFUG) and costs of revision of forest operational plan; and (iv) income generating activities and skill-oriented training.

When respondents were asked about changes in priorities of CFUG fund allocation in recent years, some in-depth interview respondents from both case study CFUGs explained that in recent years their CFUG has allocated a portion of funds for income generating activities such as goat farming, vegetable farming, pig rearing, or running a grocery shop. These funds for income generating activities have been targeted towards very poor households, women and Dalit, following the implementation of the REDD+ pilot. According to the respondents, their CFUG had also allocated funds in the same way during the implementation of the Nepal-Swiss Community Forestry Project (NSCFP) a few years back.

FGD participants from both CFUG ECs reported that their CFUG had allocated some of the REDD+ pilot seed grant funds to forest management, development and conservation activities such as plantations in rehabilitation areas, salary of forest guards, construction of fire lines, and introduction of alternative technologies and energy sources for cooking.

When asked about reasons for changes in priorities of funds allocation to income generating and forest activities, Dalit FGD participants from both CFUGs explained that the FCTF Guidelines have prescribed income generating and forest activities as major areas for allocation of seed grants under the REDD+ pilot. As noted by one Dalit woman from Sitakunda CFUG:

“...CFUG distributed the fund to poor households mainly due to the compulsory provision set by the REDD+ pilot and FECOFUN to provide the funds to very poor and Dalit households for income generation and forest improvement related activities...” (SC2).

District level interviewees also recognised that allocation of CFUG funds to income generating and forest activities has increased in recent years as a result of the
compulsory provisions of the REDD+ pilot observing that some CFUGs had allocated their own internal funds along with the REDD+ pilot seed grants to poor households. According to one district FECOFUN member, also a member of district REDD+ advisory committee:

“...CFUGs allocate group funds to different community development activities to benefit a larger number of households. However, with the fund from REDD+ pilot, CFUGs intentionally allocate a certain portion of the fund to the very poor households, women, and Dalit for income generating activities. Moreover, some CFUGs complement the seed grant with their internal group funds to provide grants to poor households for income generating activities...” (D8).

The analysis of data from CFUG records (i.e. audit report) shows that allocation of funds towards income generating activities has increased in both CFUGs following the REDD+ pilot (Tables 8.8 and 8.9). An increase in both proportional and actual allocation of funds can be seen for forest activities such as purchasing seedlings, salary for forest guards, construction and maintenance of fire lines and introduction of alternative energies. Although the actual amount of funds is nearly the same, the proportional allocation to forest activities significantly decreased in Sitakunda CFUG in 2013 compared to the two previous years after the REDD+ seed grant was distributed i.e. 2011. Although both CFUGs initiated allocation of funds to income generating activities in recent years, they have allocated only a small portion of their funds for this purpose. Thansadeurali CFUG increased the actual amount of funds allocated to income generating activities in 2013, although the proportional allocation of funds still remains small relative to the total income. Allocation of funds to income generating activities does not correlate with the increase in total income in both CFUGs.

Table 8.8- Percentage of fund allocation to different activities in Sitakunda CFUG (Parentheses are percentage of fund allocation)

<table>
<thead>
<tr>
<th>Year</th>
<th>CFUG fund allocation to different activities (NRs in ‘000) (parentheses are percentage)</th>
<th>Total budget in NRs in ‘000</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Forest activities</td>
<td>Income generating activities</td>
</tr>
<tr>
<td>2009</td>
<td>6.3 (2.7)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>2010</td>
<td>6.7 (2.6)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>2011</td>
<td>21.1 (9.8)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>2012</td>
<td>43.2 (10.4)</td>
<td>15.6 (3.7)</td>
</tr>
<tr>
<td>2013</td>
<td>40.5 (4.2)</td>
<td>42.4 (4.4)</td>
</tr>
</tbody>
</table>

Source: CFUG records, 2013, (NRs. Nepali rupees)
Note: Categories of fund as per Kanel & Niraula (2004). Forest activities represent forest development, management and conservation related activities, while other activities include running the office, fees and honorarium, and bank balance.

The analysis of data shows that the allocation of funds to community development and community infrastructure activities has generally increased in both CFUGs in more recent years apart from a decrease in Thansadeurali CFUG in 2012.

Table 8.9- Percentage of fund allocation to different activities in Thansadeurali CFUG (Parentheses are percentage of fund allocation)

<table>
<thead>
<tr>
<th>Year</th>
<th>CFUG fund allocation to different activities (NRs in ‘000) (parentheses are percentage)</th>
<th>Total budget in NRs (‘000)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Forest activities</td>
<td>Income generating activities</td>
</tr>
<tr>
<td>2009</td>
<td>12.7 (11.4)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>2010</td>
<td>26.5 (12.9)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>2011</td>
<td>38.1 (9.79)</td>
<td>27.2 (7.0)</td>
</tr>
<tr>
<td>2012</td>
<td>66.9 (24.4)</td>
<td>40.5 (14.8)</td>
</tr>
<tr>
<td>2013</td>
<td>177.3 (18.4)</td>
<td>103.9 (10.8)</td>
</tr>
</tbody>
</table>

Source: CFUG records, 2013, (NRs – Nepali rupees)

With regards to the great increase in spending on community development activities in Sitakunda CFUG in 2013, the current chairperson of Sitakunda CFUG explained that:

“...we used the major portion of CFUG fund for construction of office building. We spent just small amount of fund for income generating and forest management activities this year...” (SB7).

Similarly, the current chairperson of Thansadeurali CFUG (TB5) explained that they allocated a large portion of group funds to community infrastructure development to establish a Daphne fibre processing factory in 2011. The respondent further described that they allocated NRs 125,000 (USD-1,250) for school support (furniture and renovation) in 2013. Both chairpersons reported that they have reduced fund allocation to road construction under the REDD+ pilot.

As previously identified, the Community Forestry Development Guidelines of Nepal, 2009 and Nepal Interim Forestry Sector Plan, 2012 propose that CFUGs should invest at least 35% of total CFUG funds for income generating activities and 25% for forest management, development and conservation activities. However, the analysis of the data (Tables 8.8 and 8.9) shows that even with extra funds from the REDD+ pilot, while spending has increased on income generating and forest activities, expenditures in both CFUGs remain well below such targets.
Prior to the REDD+ pilot, poor households generally lacked access to CFUG funds as CFUGs were allocating nothing to income generating activities and were not targeting particular households. Although CFUGs do not necessarily exclude poor households, Dalit and women from enjoying the benefits of community and infrastructure development activities, allocation of funds to activities such as temple construction, irrigation canal improvement and school supports provides no direct benefits to their daily livelihoods. As reported by one very poor respondent (TD4) of Thansadeurali CFUG, their CFUG EC members tend to save and accumulate funds in the bank to prolong their tenures in the CFUG EC, or invest in community and infrastructure development activities to demonstrate their achievements. Regarding the allocation of CFUG funds, the respondent was critical of the EC for being heavily influenced by local elites who are generally well-off households. He further argued that investment of fund in improvement of irrigation facilities is inequitable, as he has no farmlands and receives no benefit from such investment. Thus, while it may be argued that an investment in irrigation facilities provides for community development, the benefits are only available to those people with farmlands able to access the irrigation waters, leaving the poorest members of the community without access to such benefits.

The above statement reveals that CFUGs tend to invest in community development and community buildings or save their funds in the bank. In this regard, one poor respondent of Thansadeurali CFUG argued that EC members tend to save money in the bank so that they can use it for their own interests such as for EC meeting allowances, training allowance and tea and snacks.

“...CFUG executive committee tends to save more money in the bank rather than distributing to poor households. They use this money for meeting allowance and activities that benefit them. In reality, CFUG’s funds provide benefit to well-off households rather than poor households...” (TC4).

Although the REDD+ pilot has initiated allocation of CFUG funds to income generating activities, CFUGs were found to be reluctant to invest funds generated from internal sources to income generating activities. According to one district forest official (D3), the REDD+ pilot has not influenced the distribution practices of CFUGs funds generated from internal sources because the REDD+ pilot has separate guidelines (i.e. carbon trust fund guidelines) for allocation of seed grants. Similarly, a member of the REDD+ pilot carbon trust fund monitoring committee (D4) argued that the REDD+ pilot did not consider the allocation and distribution of CFUG internal funds as a criteria
for distribution of seed grants to CFUGs. As reported by the respondent, the REDD+ pilot has not influenced or improved the distribution of internal funds of CFUGs since it focuses only on allocation and distribution of REDD+ seed grants.

CFUG records as well as interviews and FGDs responses reveal that CFUGs allocate a small portion of funds to income generating activities but only when they have received funding from external agencies (e.g. the REDD+ pilot and the earlier NSCFP). For example, as reported by former chairpersons of both CFUGs (Thansadeurali CFUG - TA2 and Sitakunda CFUG-SB4), they did not allocate funds to income generating activities in 2009 and 2010 because there was no support from external sources (i.e. the NSCFP had already terminated, while the REDD+ pilot has only provided seed grants since 2011).

The evidence also shows that existing community forestry practice is associated with a low allocation of funds to forest activities. For example, FGD participants of Sitakunda CFUG EC reported that forest activities are generally carried out voluntarily by CFUG members. Their CFUG had not allocated funds for forest activities except for the salary of forest guards and seedling purchasing prior to the REDD+ pilot. However, their CFUG has now allocated funds to reward forest users for their contributions to forest protection in addition to the forest guards’ salaries, seedling purchasing and introduction of alternative cooking stoves. As noted by a former chairperson:

“...we employ a forest watcher to protect forest from illegal felling, forest fires and uncontrolled grazing. We just allocate fund for salary for forest watcher. However, following the REDD+ pilot, we provided women group with NRs 10,000.00 to increase their participation in forest conservation activities. We also used some funds to reward local forest users who are actively involved in forest fire control...” (SB5).

Responding to a question about reconciliation between allocation of the REDD+ pilot seed grant and the CFUGs own funds, one REDD+ pilot proponent (C1) reported that the REDD+ pilot transferred funds to the CFUG account as group income, giving CFUGs the authority to allocate these funds to forest activities and to individual households for income generating activities according to their own needs and priorities, even though the REDD+ pilot specified some preferred areas for funds allocation (Appendix 32).
FGD participants from both CFUG ECs offered differing views regarding the necessity of allocating their funds to forest activities according to the trust fund guidelines. Some respondents argued that the REDD+ pilot has undermined their existing collective forest management practices. For example, following the REDD+ pilot, the allocation of CFUG funds for forest activities and as payments to local people for involvement in forest activities has reduced intrinsic motivations of local forest users to make voluntary contributions. Responding to this concern, one well-off respondent from Thansadeurali CFUG commented:

“...our CFUG provides NRs. 50 per day as snacks to local forest users during the plantation activity. CFUG has also provided NRs. 2,000 each to four sub-groups. However, CFUG does not provide any money during thinning and pruning activity except for providing green twigs for fuelwood derived from thinning. As result, interest of local forest users has reduced to participate in thinning and pruning activity...” (TA3).

During an informal talk, one woman Dalit respondent of Sitakunda CFUG described that the amount of seed grant provided by the REDD+ pilot was very small compared to the income generated through internal sources and not enough to motivate CFUGs to allocate funds for forest activities. According to the respondent:

“...our CFUG has several permanent sources of income such as resin collection, revenue from land fill site, and sale of timber to people outside CFUG. The CFUG earns a higher income from these sources compared to the seed grant received from pilot REDD+. This may be a reason for CFUG having low motivation to implement forest management activities...” (SC2).

This statement suggests that an emphasis on social criteria, such as number of poor, Dalit and IP households and population of women for distribution of seed grants from the REDD+ pilot has provided much lower funds than expected to some CFUGs with a large forest area and hence has reduced commitment to REDD+. For example, Thansadeurali CFUG (0.33 ha per household) received a greater amount of seed grant from the REDD+ pilot than Sitakunda CFUG (0.81 ha per household) despite the relatively smaller size of the Thansadeurali community forest (Appendix 33).

A general perception among local forest users at the beginning of the REDD+ pilot was that the REDD+ pilot would provide seed grants to all forest users irrespective of caste and ethnic groups and classes. However, the REDD+ pilot adopts discriminatory criteria for seed grant distribution by intentionally targeting poor households, Dalit and women. FGD participants of both CFUG ECs reported that they were happy when REDD+ pilot
began, but this has turned to dissatisfaction since the distribution of the seed grants. Some non-Dalit and non-indigenous people (i.e. Brahmin & Chhetri) in both CFUGs reported that the REDD+ pilot has ignored the contribution of some households to forest conservation through meeting their resource demands from their own private farmlands (as explained in Chapter 7). Thus they feel their contribution to maintaining carbon stocks in CFs is unrewarded. As noted by the present chairperson of Sitakunda CFUG:

“...REDD+ pilot has overlooked the contribution of households with large private forests into payment distribution mechanism, as around 40% of fuelwood is supplied through private farm lands in our community forests...” (SD7).

Similar views were also expressed by some well-off respondents of Thansadeurali CFUG, who have a large number of trees on their own farmlands. The respondents reported that well-off households may have less motivation for forest conservation when the REDD+ pilot seed grants distribution process has overlooked the contribution of forest users to forest conservation. As noted by one well-off respondent of Thansadeurali CFUG:

“...I fulfil my needs from private trees for the conservation and improvement of community forests. However, the seed grant under the REDD+ pilot is provided only to poor people. We also contribute to forest conservation but I am not compensated...” (TA3).

There were some contradictory perceptions among forest users over the seed grant distribution approach adopted by the REDD+ pilot, because of their previous experiences. CFUGs have a long experience with an integrated conservation and development programme -ICDP (the NSCFP), which included poverty reduction as a major objective with support targeted towards very poor households. The REDD+ pilot was implemented as the first project in the research site since the NSCFP, and well-off respondents have differing perspectives on it. For example, some well-off respondents criticised the pro-poor or needs-based criteria adopted by the REDD+ pilot for seed grant distribution, and explained that the grants should not be like the supports provided through the NSCFP. Seed grants from the REDD+ pilot should be paid to each household based on their performance rather than their need alone.

In contrast, poor households saw the REDD+ pilot as another opportunity for them following the termination of the NSCFP. Some FGD participants from Dalit group and interview respondents of Thansadeurali CFUG reported that the REDD+ pilot should cover more Dalit and poor households, like the NSCFP.
Referring to the issue of pro-poor based seed grant distribution, one medium class respondent from Brahmin (i.e. Thakuri) group of Thansadeurali CFUG (TB4) demonstrated his dissatisfaction with seed grants distribution criteria as the REDD+ pilot has overemphasised caste and ethnic based criteria. He argued that each household should get seed grants because they have offered equal efforts to the conservation of their CFs.

"...I do not care about the REDD+ fund. It is only for Dalit and indigenous households. If this trend continues, frustration will escalate among non-recipient households mostly Brahmin & Chhetri and well-off households... (TB4).

Thus, some forest users do not believe that the criteria for distribution of the REDD+ pilot seed grants are fair and equitable. According to one district forest official (D2), the REDD+ pilot has generated over-expectation among local forest users, and that prior to funds transfer to local CFUGs, there was inadequate communication with local forest users about the criteria for REDD+ seed grant distribution and possible areas for allocation of these funds. As a result, each household was expecting some funds from the REDD+ pilot. Even some district stakeholders and Watershed REDD+ Network members had little understanding of the distribution criteria until the first seed grants were transferred to the district trust fund advisory committee in 2011.

8.3.2 Has the REDD+ pilot fund improved livelihoods of the poor?

This section explores the effectiveness of seed grants distributed by CFUGs in generating household level income and improving livelihoods of Dalit, women and poor households. The REDD+ pilot acknowledges rural poverty as a major driver of forest degradation, and hence seed grants through FCTF guidelines seek to reduce forest dependency and degradation by improving livelihoods of local forest users. However, after only three years of distribution of seed grants under the REDD+ pilot, it is too early to draw a clear conclusion regarding their effectiveness in generating income and improving livelihoods. The aim of this section is to explore the likely effects of seed grants in contributing to household level income based on the experiences of the respondents so far. The analysis of the data in this section shows that although seed grants under the REDD+ pilot have reached some Dalit and poor households, these grants are likely to be of limited effectiveness in generating income and diversifying livelihoods owing to the distribution of only a small amount of funds, and only as short duration loans.
When respondents were asked about the contribution of seed grants to the improvement of livelihoods of poor households, FGD participants of Dalit group reported that the CFUG has provided cash support under the REDD+ pilot seed grants to local forest users, which they believed has reduced the possibility of mis-appropriation of funds by members of the EC because poor households can directly access cash and initiate income generating activities on the basis of their own interest and capacity. According to the respondents, during the NSCFP, CFUG had provided support for income generating activities in terms of materials enabling some mis-appropriation by EC members. One poor respondent who had received support during the NSCFP reported that:

“...I was supposed to get support from CFUG equivalent to NRs 10,000, provided by Nepal-Swiss community forestry project to operate a grocery. Our CFUG purchased the grocery items from Charikot-district headquarter. However, I did not receive grocery items of equivalent to NRs 10,000. I found some key executive committee members had misused the funds during purchasing grocery items. However, this time, poor households got benefits in-terms of cash without any chance of mis-handling...” (TC3).

Despite the seed grants now being as cash, the contribution of seed grants to income generation still appears to be of limited effectiveness. Some poor respondents of both CFUGs reported that their CFUG provides seed grants as interest-bearing loans. One very poor Dalit woman, a seed grant recipient from Thansadeurali CFUG elaborated:

“...poor households including me want CFUG fund as grant rather than as loan. CFUG even charges interest with a set percentage. CFUG executive committee members consider that poor and Dalit will misuse the fund if it is provided as an interest-free loan or grant. If CFUG seeks to improve the livelihood of poor households they should provide funds as a grant. Current practices of fund distribution cannot contribute to the improvement of our livelihoods...” (TD1).

By providing seed grant funds to those who can repay their loan within a designated timeframe, the CFUGs would appear to be discriminating against poor households for whom the grants are intended. For example, one very poor respondent said he had not taken a loan owing to the level of interest (annual rate of 14%) charged by the CFUG which he was not able to repay.

“...I have never got benefits from CFUG. I did not take seed grant loan because I have to repay with interest. I cannot run any activities. If I do not repay, CFUG fines and punishes us even sometimes social shame...” (TD2).
FGD participants of Dalit group of Sitakunda CFUG raised concerns that the amount of seed grant loans provided by the CFUG was insufficient to operate any income generating activities. According to the respondents, their CFUG tends to provide seed grant loans to many households at once from a limited fund, meaning only a small amount of money is available to each recipient. According to one recipient who has received seed grant loans from Sitakunda CFUG:

"...I got NRs. 5,000 seed grant from CFUGs for goat farming. This money was not sufficient for goat farming. We need at least NRs. 10,000 for 2 goats. Buying one goat is just to increase work load rather than supporting income generation. I could not even operate vegetable farming with this money. So, I used this fund for paying fee and buying stationery for my children...” (SD3).

The issue of duration of the seed grant loans was also raised by some respondents. One very poor respondent from Thansadeurali CFUG reported that the CFUG provides a loan maximum of one year, which is a very short time for them to establish their income generating activities and then repay the loan to the CFUG. As noted by the respondent:

"...our CFUG provides loan for maximum one year. We can do nothing within one year. Even for vegetable farming, we need at least two years to get return. We cannot return loan to CFUG. So, current practice of short-term loan does not contribute to poor households...” (TD4).

The present chairperson of Thansadeurali CFUG agreed with these comments about the small size of the fund offered as loans, and the short duration of those loans, adding that the CFUG had only received NRs. 326,685 (USD 3,266) from the REDD+ pilot for the three years from 2011 to 2013. This amount is not enough to meet the requests from a large number of local forest users, as well as allocation to other activities such as forest activities and office operation. According to the respondent, REDD+ pilot incentives were unpredictable, and they were not given enough information about the amount of the next payment to plan income generating activities properly. The respondent further explained:

"...amount of money received from the REDD+ pilot is much less compared to number of poor households. The expectation among local forest users was very high. So, we provided this available fund for maximum one year with NRs 5,000 to each household. The first round was targeted towards very poor households. Once we provided to all very poor households, we provided this fund to other poor households...” (TB5).

The above statement illustrates that the REDD+ pilot has not resulted in improved benefit sharing practices despite a small increase in access of poor households to seed grants after the REDD+ pilot. The current benefit sharing practices of the case study
CFUGs appeared to be profit-oriented through mobilisation of funds, which has not changed or improved with the REDD+ pilot seed grants. Despite a priority of the REDD+ pilot to make seed grants accessible to poor households, the results show that existing practices have not been effective in generating incomes, owing to the unpredictable and insufficient amount of funds provided, for a short periods and with high interest rate.

One very poor respondent of Thansadeurali CFUG (TD4) was of the view that although the REDD+ pilot focused on income generating activities, most of the key positions of CFUG EC members who facilitate the benefit distribution are well-off households. According to the respondent, these members seek to grow funds by retaining the seed grants in the bank, or by distributing only a small amount of seed grants as short term loans with high interest rates. The respondent further argued that by adopting such practices, CFUGs are acting as profit-making institutions rather than as community welfare institutions that facilitate pro-poor activities, pointing out that the aim of community forestry and the REDD+ pilot is not for CFUGs to operate in such a manner.

According to a member of the District Carbon Trust Fund Monitoring Committee, seed grants have been of limited effectiveness in supporting the establishment of income generating activities. The respondent reported that some households have established poultry farms, goat and pig rearing and vegetable farms; however, some households have used the funds in unproductive activities such as repaying other loans, paying children’s school fees and purchasing rice and grains. According to the respondent, these activities were also less effective because of a lack of skills to operate income generating activities, due to lack of support from service delivery organisations such as veterinary, livestock and agriculture offices as these offices were not coordinated by the REDD+ pilot for such purposes. Further, the respondent was of the view that the amount of grant per household is often too low to be effective.

“...we found CFUGs provide REDD+ fund to very poor households. However, the amount of money provided to local people ranges from NRs 1,500 to 7,500. The executive committee member intended to provide funds to as many households as possible since they do not want to disappoint their forest users. Some households use this fund for unproductive activities...”

(D4).

The analysis of data from CFUG records reveals that only a few households (i.e. 9% in Sitakunda and 7% in Thansadeurali CFUG respectively) benefited from receiving funds
for income generating activities arising from the REDD+ pilot (Table 8.10). The results show that 50% of the total Dalit households and 15% of the total IP households of Sitakunda CFUG received benefits from CFUG, while Thansadeurali CFUG provided seed grants to only 9% of Dalit and 5% of IP households. In both CFUGs, a low proportion of Brahmin and Chhetri households received such benefits (6% in Sitakunda CFUG and 7% in Thansadeurali CFUG). The current chairperson (SB6) of Sitakunda CFUG explained that the low number of recipients resulted from the CFUG only receiving a small amount of seed grants which were insufficient to support many households.

Table 8.10- Number of households directly benefitting from seed grants from 2011 to 2013 (parenthesis is percentage of households benefiting from seed grants with reference to total households of respective category of each ethnic group)

<table>
<thead>
<tr>
<th>CFUG</th>
<th>HH of different caste/ethnic group receiving benefit</th>
<th>Total HH benefitting from seed grant</th>
<th>Total caste/ethnic group HH in CFUGs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IPs</td>
<td>Dalit</td>
<td>Brahmin &amp; Chhetri</td>
</tr>
<tr>
<td>Sitakunda</td>
<td>4 (15%)</td>
<td>3 (50%)</td>
<td>9 (6%)</td>
</tr>
<tr>
<td>Thansadeurali</td>
<td>8 (5%)</td>
<td>8 (9%)</td>
<td>11 (7%)</td>
</tr>
</tbody>
</table>

Source: CFUG record and field survey, 2013 (Note: CFUG-Community Forest User Group, HH - households, IPs- Indigenous Peoples)

One clear message from the above data is that in Sitakunda CFUG where Dalit and IPs households make up only a small proportion of total households, a relatively high proportion of these Dalit and IP households have received seed grants. However, in Thansadeurali CFUG, where there are a large number of Dalit and IPs households (both by number and proportion) and a larger total number of grants going to these households, the proportion of Dalit and IPs households receiving seed grants is much lower (i.e. there are a large number of Dalit and IPs households who have not received funds). This indicates that the money available is insufficient to equitably provide for income generation and livelihood improvement to targeted groups i.e. Dalit and IPs.

8.4 Changes in forest management approaches

The implementation of forest management activities is governed by a CFUG’s forest operational plan, generally designed for a five or ten year period with support from the district forest office. While the REDD+ pilot has increased the perceived value of standing forests by providing seed grants for increasing carbon stocks, the CFUGs
8.4.1 Forest conservation: minimising risks, restricting extraction of forest products and reducing demand

Forest conservation activities are those with the objective of protecting forests (quality and productivity) from further degradation. These include activities that seek to reduce the occurrence of degrading processes such as the prevention of forest fires, forest patrolling, rotational cattle grazing and controlling forest boundary encroachment. Those that impose restriction on removal of forest products (limiting access and imposing quotas) and those that reduce demand for forest products (such as introduction of alternative energies for cooking).

The following results reveal that the CFUGs have adopted a range of these strategies, tightening removal and limiting quotas of forest products and introducing alternative energies for cooking to reduce demand for fuelwood. The results also reveal that tightening removal of charcoal and fuelwood from CFs has both undermined the customary rights and negatively affected livelihoods of forest-dependent forest users, especially affecting one artisanal group (i.e. blacksmiths).

Forest conservation through minimising disturbance regimes

This section considers how the REDD+ pilot has influenced forest conservation activities through minimising disturbance regimes that reduce carbon stocks in the forests. Occurrence of forest fires, cattle grazing, overharvesting and illegal logging and forest boundary encroachment, emerged as likely disturbance regimes in this research.

CFUGs have focused on conservation of forests by minimising the above mentioned disturbance regimes through promoting current practices such as mobilisation of forest watchers and raising awareness among local people, adopting rotational grazing, avoiding tree removal from erosion-prone and water source areas and imposing fines on offenders.

When respondents were asked about changes in forest activities for conservation of forests, FGD participants of the EC and some in-depth interview respondents from Sitakunda CFUG reported that their CFUG has promoted current practices of forest conservation associated with forest fire prevention, forest patrolling and cattle grazing. According to the participants, their CFUG has encouraged the prevention of forest fires
via the construction of fire lines and awareness raising activities. A former chairperson of Sitakunda CFUG reported that:

“...our CFUG focuses on prevention of occurrence of forest fires. We construct fire lines in the forests. We also organise awareness raising activities about forest fires especially for cattle herders and passerby or neighbours, who pass through our forests...” (SB5).

Another initiative of Sitakunda CFUG was to re-recruit a forest guard. They had employed forest guards when community forestry was first introduced, but had stopped this some years before. The FGD participants of CFUG EC reported that under the REDD+ pilot they have again recruited a forest guard, mainly to patrol forests and to minimise illegal logging and incidence of forest fires which are caused by cattle herders, passers-by and municipality workers burning landfill. The participants claimed that hiring a forest guard is one of their major initiatives for forest conservation.

The FGD participants of Sitakunda CFUG EC further reported that their CFUG has adopted rotational cattle grazing to enhance forest conservation. According to the respondents, while free cattle grazing was practiced prior to the REDD+ pilot, their CFUG has adopted rotational cattle grazing in different blocks of forests to stimulate natural regeneration and minimise loss of forests from overgrazing.

Thansadeurali CFUG has also reintroduced forest patrolling to enhance forest protection through minimising illegal felling. As reported by FGD participants of the EC, the CFUG has re-started a rotational roster for forest patrolling by CFUG member households which was stopped a couple of years earlier. According to the respondents, their CFUG has also become active in controlling illegal felling and restoring forests by preventing removal of trees from open land and erosion-prone areas. As reported by the present CFUG chairperson:

“...following the REDD+ pilot, we became aware of the importance of forests not only for forest products but also for carbon stocks because we have to show an increase in carbon in our forests. We re-started forest patrolling by CFUG members on the rotational basis. We have emphasised restoration activities by controlling removal of trees from open land, and from landslide and erosion-prone areas...” (TB5).

In both case study CFUGs, forest patrolling had been a major approach for controlling illegal logging when community forestry was first introduced (rotational patrolling by forest users in Thansadeurali CFUG and by recruiting forest guards in Sitakunda
CFUG). Though these activities had been abandoned some years previously, the REDD+ pilot had stimulated both CFUGs to restart forest patrols.

Another example of forest conservation activities adopted in Thansadeurali CFUG was the enforcement of rules and imposing fines on offenders, particularly those involved in forest boundary encroachment and illegal logging. For example, the present chairperson reported that:

“...our CFUG has become active in controlling boundary encroachment and illegal removal of forest products following the REDD+ pilot. Couple of months ago, the executive committee charged fine to one former chairperson as he had encroached community forest boundary by planting trees...” (TB5).

Some different perspectives were offered by respondents from ECs and forest users on the implications of forest conservation activities. For example, FGD participants of Sitakunda CFUG EC reported that the adoption of rotational cattle grazing has stimulated natural regeneration, while introduction of forests patrolling has reduced illegal activities in the forests. Regarding this, the present chairperson of Sitakunda CFUG reported that:

“...Regulation of rotational cattle grazing and forest patrolling has reduced forest degradation activities. Rotational grazing has diverted pressure into different patches of forests...” (SB7).

However, some Dalit, women and IPs respondents from Sitakunda CFUG argued that they have been deprived of opportunities as a result of introduction of rotational grazing, mainly because of a reduction in forest area available for cattle grazing. According to the respondents, their forests consist of mostly steep terrain and it is difficult to take cattle into steep terrain when smaller forest areas are allocated for grazing their cattle. Thus, farmers, who rely heavily on cattle grazing, appeared to be greatly affected by the adoption of rotational grazing. As reported by one poor IP respondent

“...forest is improved from rotational grazing but restriction on cattle grazing into small patches of forests has affected us. Our forest is steep terrain where we need larger areas for cattle grazing. So, we cannot control our cattle by restricting them to small patch of forests. It is also difficult when we need to take our cattle into forest blocks far away from the cowshed...” (SC1).

In the case of Thansadeurali CFUG, FGD participants of Dalit, women and interview respondents from poor households acknowledged that the CFUG EC has become active
and settled conflicts of forest boundary encroachment following the implementation of the REDD+ pilot. They reported that the CFUG even fined the former chairperson for his offence of boundary encroachment last year. According to the respondents, despite such efforts, the CFUG has been unable to control the occurrence of illegal felling especially for timber extraction, which is mostly performed by well-off households and local elites because of issues associated with socio-economic hierarchy and power in the community. For example, one poor respondent reported that:

“...we are happy that CFUG has become active in controlling forest boundary encroachment. However, CFUG has not been able to control illegal felling activities especially timber extraction completely. This is because local elites and well-off households are involved in these activities...” (TC2).

The above analysis reveals that CFUGs have sought to conserve forests for carbon stocks enhancement through a range of activities, although despite some positive effects in forest conservation, Thansadeurali CFUG has not been able to control overharvesting of timber and introduction of new rules can have negative consequences for forest users, for example those heavily reliant on livestock grazing in CFs.

**Forest conservation through restricting removal of forest products**

The research shows that the CFUGs seek to conserve forests by tightening removal of fuelwood and production of charcoal from CFs and imposing quotas on harvest of some tree species for timber. The present chairperson of Thansadeurali CFUG (TB5) reported that their CFUG has restricted production of charcoal from their CFs by insisting that local forest users who need a blacksmith to repair farming implements must produce charcoal at their own home to take to the blacksmith.

Local forest users and members of EC of Thansadeurali CFUG offered different responses regarding the implication of restriction on charcoal production from CFs. Some participants, mostly EC members and well-off households, reported that restriction on charcoal production has reduced forest degradation. For example, one well-off respondent of Thansadeurali CFUG reported that:

“...restricting charcoal has saved forests from degradation. Preparation of charcoal by forest users themselves who need to repair their equipments has reduced workload of blacksmith...” (TA2).

However, Dalit FGD participants of Thansadeurali CFUG argued that restriction on charcoal production has not only jeopardised the customary rights of blacksmiths, it has
also negatively influenced their livelihoods. According to them, they need charcoal for iron work, which is their traditional skill supporting their survival. One blacksmith from Thansadeurali CFUG reported that:

“...our CFUG has restricted us, blacksmiths from producing charcoal from our community forest. Rather, CFUG has asked local forest users to produce charcoal from their home during a need of iron work from us. We have not only been deprived from our customary rights to access charcoal but have also lost our livelihood because local people now provide only a small amount of grains as payment when they bring charcoal from their home. This is our traditional skill and I have no other skill to adopt for survival...” (TC1).

Another change identified in this research is the introduction of new rules for fuelwood extraction in Sitakunda CFUG. As noted by a former chairperson from Sitakunda CFUG (SB5), removal of fuelwood from live-standing trees has been discouraged. To reduce the felling of trees in the forest, the CFUG now promotes the collection of fuelwood by cutting of branches in addition to live-standing trees. Prior to the REDD+ pilot, CFUG had provided fuelwood only from live-standing trees, which is easy to harvest and produces good quality fuelwood. As noted by the respondent:

“...we have set new rules and encouraged local forest users to collect fuelwood from branches of trees, not from live-standing trees. Prior to the REDD+ pilot, we used to harvest fuelwood from live-standing trees...” (SB5).

The respondent further reported that even though the introduction of rules for collection of fuelwood from branches has not reduced the amount of fuelwood collected from the forests the reduction in number of trees being removed from the forests has enhanced forest productivity.

Participants of the women’s FGD from Sitakunda CFUG argued that this rule has negatively affected mainly women and households with elderly people. According to them, collection of fuelwood from branches is time consuming and expensive compared to collection from live-standing trees. As noted by one woman respondent:

“...collection of fuelwood from branches is difficult particularly for women who cannot climb tree. The executive committee has changed this rule but we have been suffering from this rule. Extraction of fuelwood from branches is also time consuming. We cannot hire labour because it costs too much...” (SC3).

The REDD+ pilot has also influenced timber distribution practice. FGD participants from Thansadeurali CFUG EC mentioned that their CFUG no longer allows forest users
to harvest their own timber, but has formed a timber distribution committee. Previously, the CFUG provided timber from the forests, whereby one or two EC members such as the chairperson and secretary would mark the trees for permit-holders to cut for themselves. One well-off respondent of this CFUG reported that:

“...our CFUG has become active after the pilot REDD+. Now, they have changed timber distribution rules by providing timber through depot rather than from the forests. This was started when we experienced illegal logging of timber by some forest users...” (TA1).

CFUGs have also set new rules for timber distribution in considering the conservation of some high value tree species. As reported by FGD participants of EC in Thansadeurali CFUG, they had imposed a quota on the high quality timber of Thingure Salla (a slow growing tree species which has gradually decreased in their CFs owing to high demand from the local forest users). A similar quota had been introduced in Sitakunda CFUG in relation to timber from Sal trees. According to respondents from Thansadeurali CFUG, one applicant could previously get a total of 100 cubic feet timber, with 50 cubic feet from Thingure Salla and 50 cubic feet from other tree species. The quota for Thingure Salla has now been reduced to 20 cubic feet, and the remaining 80 cubic feet is provided from more commonly available species such as Pate Salla and Gobre Salla.

Imposing a quota on valuable tree species has not changed the total amount of timber extracted from CFs. The current secretary of Thansadeurali CFUG reported in a telephone interview in August 2015 that extraction of timber remained unchanged or had even increased in recent years (2014) due to a greater demand for timber from local forest users. However, the respondent believe that after the REDD+ pilot, CFUGs have become conscious of the importance of conservation of forests, not only for carbon stocks enhancement but also for conservation of valuable tree species for future use.

Almost all district level interviewees (e.g. FECOFUN, district forest office, monitoring committee, watershed REDD+ network) reported that CFUGs have tended to focus on protection-oriented activities after the REDD+ pilot. The respondents acknowledged that under the REDD+ pilot, some CFUGs had formulated new rules to restrict removal of forest products, which has undermined some customary rights. As noted by one district FECOFUN member:

“...although CFUGs become active in controlling illegal activities and reduced forest degradation, the REDD+ pilot has focussed on protection-
oriented forest activities and has induced tightening access to some forest products. As a result, poor households have lost their rights to removal of the forest products…” (D6).

So, in response to the REDD+ pilot, case study CFUGs have largely focused on tightening removal of and imposing quotas for forest products for conservation of forests. Restricting production of charcoal and removal of fuelwood has not only undermined the customary rights of poor households, but has also negatively affected their survival, particularly for the artisanal caste.

Forest conservation through introduction of alternative energies for cooking

Another approach for CFUGs to promote forest conservation is to reduce fuelwood demand through introduction of a range of alternative energies such as biogas plants, improved cooking stoves (ICS) and iron stoves. The following results reveal that alternative energies appeared to be effective in reducing fuelwood consumption and improving indoor quality for better health. However, CFUGs have provided limited support, covering only a small number of households.

FGD participants of the EC of both CFUGs reported that their CFUGs have promoted a range of alternative energies for cooking such as ICS, iron stove, coal stove and biogas plants to complement forest conservation initiatives that reduce demands for fuelwood. As noted by the present chairperson of Sitakunda CFUG:

“...after the REDD+ pilot, we have promoted alternative energies such as biogas, improved cooking stove, iron stove and coal stove. Almost every household of our CFUG has started using coal stove. We reuse charcoal produced from the traditional stoves and improved cooking stove for coal stove which saves nearly 10% of fuelwood compared to traditional stoves…” (SB7).

Women FGD participants of both CFUGs perceived that the promotion of ICS, iron stove and biogas plants were effective not only for reducing fuelwood extraction from forests but also for reducing smoke and improving indoor air quality for better health especially for women. According to the respondents, use of alternative energies has saved fuelwood collection and cooking time for women, making time available for other activities.

The experience of one district FECOFUN member, also the REDD+ pilot coordinator (D10), was that very poor and poor households preferred ICS and iron stoves to biogas
plants not only because the former two (ICS and iron stoves) receive 100% subsidy, but also due to their lower operation costs. After the REDD+ pilot and government subsidies, forest users still need to cover over 20% of the costs of installation of biogas plants, and a biogas plant with a capacity of 4 cubic meters may need nearly 25 kilograms of fresh cow dung everyday (requiring 2-3 adult cows). Poor households cannot rear this number of cattle as they require a permanent source of fodder such as private farmlands. Thus, biogas plants were found to be a popular scheme for well-off and medium households who can afford installation and operation costs. In terms of efficiency, one respondent who has been using biogas plants since 2012 reported that biogas plants can save about 80% of fuelwood consumption, as they still use fuelwood for cooking cattle porridge.

The local forest users also found ICS and iron stoves to be efficient and effective for installation and for reducing fuelwood consumption. For example, one woman respondent of Thansadeurali CFUG (TC5), who has been using ICS since 2012, reported that ICS has reduced her fuelwood consumption by nearly 40%. Similar experiences were expressed by a former chairperson of Sitakunda CFUG (SB5), who has also been using ICS since 2011 and added that he needs only 3 head loads of fuelwood fortnightly with ICS, while he needed 5 head loads of fuelwood with traditional stoves.

Experiences of respondents reveal that the saving in fuelwood are about twice that for biogas plants than for ICS (about 80% compared to about 40%), though after considering the installation costs, it would seem that a larger number of households can benefit from the installation of ICS than from biogas plants. For example, according to FECOFUN REDD+ coordinator (D10), installation of one biogas plant costs about NRs. 30,000 to NRs. 40,000 (USD $300-400), while installation of one mud-brick ICS costs only about NRs 2,000-3,000 (USD $20-30) including the training costs for the ICS promoters (Local Resource Persons). Thus from a cost perspective, installation of ICS seems to be more effective in reducing fuelwood consumption, as the same investment in ICS could benefit around 10 times as many households even though the fuelwood saving per household is less.

Despite a greater effectiveness of ICS, CFUGs have provided subsidies to forest users for only a limited number of ICS. While CFUG restrictions on fuelwood extraction
apply equally to all users, not all users have equal access to alternatives. Some local interview respondents were of the view that their CFUG has not distributed the subsidies for alternatives equitably among local forest users, with particularly negative effects for Dalit and poor households. For example, one Dalit respondent of Thansadeurali CFUG reported that no Dalit households have accessed ICS and biogas under the REDD+ pilot due to their lack of awareness of support for alternative cooking stoves, and they have been using coal stoves, which are less efficient compared to ICS.

8.4.2 Forest improvement activities

Forest improvement activities include planting trees in open lands as well as removing unwanted trees through thinning and pruning for better growth of forests and maintenance of long-term productivity. The research shows that the CFUGs have generally emphasised planting trees for forest improvement, with less focus on promoting thinning and pruning operations, which could enhance forest productivity by providing a sustainable supply of forest products to forest users.

Forest improvement through planting trees

Under the REDD+ pilot, CFUGs have generally promoted planting trees for forest improvement, however, the two case study CFUGs have shown different priorities depending on vegetation types and the time availability of the EC. The following data also shows that the CFUGs have promoted planting trees for carbon stocks enhancement and reforestation of erosion prone areas and open lands, and also to achieve multiple benefits by planting multiple tree species.

In-depth interviewees and FGD participants of Thansadeurali CFUG EC acknowledged that their CFUGs have promoted planting trees following the REDD+ pilot. One former chairperson from Thansadeurali CFUG (TA2) explained that their CFUG has become more aware of the need to plant trees after the REDD+ pilot, although they had previously been planting trees in their forests. He further reported that their CFUG has promoted planting trees not only in open and barren lands and areas where timber has been harvested but also in erosion-prone areas where trees cannot naturally regenerate.

The analysis of data from CFUG records reveals that planting trees is a common activity for both Sitakunda and Thansadeurali CFUGs and has increased in recent years of the REDD+ pilot implementation, especially in Thansadeurali CFUG (Table 8.11).
Referring to increased planting of trees in Thansadeurali CFUG, the present chairperson reported that.

“...we have provided small patches of forests mostly open lands to four sub-groups under our main CFUG. We also provided NRs. 2000.00 available from seed grants to each sub-group annually for planting trees which has resulted in increase in plantation...” (TB5).

Table 8.11- Trees planted in Sitakunda and Thansadeurali community forests per year

<table>
<thead>
<tr>
<th>Year</th>
<th>Annual area planted (hectare)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sitakunda</td>
</tr>
<tr>
<td>2009</td>
<td>0</td>
</tr>
<tr>
<td>2010</td>
<td>0</td>
</tr>
<tr>
<td>2011</td>
<td>1.4</td>
</tr>
<tr>
<td>2012</td>
<td>1.4</td>
</tr>
<tr>
<td>2013</td>
<td>1.4</td>
</tr>
</tbody>
</table>

Source: CFUG records and group interview, 2013

One well-off respondent from Thansadeurali CFUG (TA1) also reported that their CFUG has promoted planting trees under the REDD+ pilot by providing forest users with an allowance for tea and snacks during their involvement in planting activities. So, the increase in planting trees is, at least in part, associated with the incentive provided by the seed grants. CFUGs recognise that planting trees can meet conditions attached to REDD+ funding which requires CFUGs to allocate some seed grants fund to forest activities (explained in section 8.3), as well as to improve their forests.

Another respondent of Thansadeurali CFUG (TB3) reported that a major change in planting trees after the REDD+ pilot was that they have planted multiple tree species to meet multiple local needs such as planting Lokta and Argeli to provide cash income, and Tanki and Kutmero for fodder. Prior to the REDD+ Pilot, the only tree species planted was Pate Salla (*Pinus patula*) for timber. The respondent believes that planting multiple tree species started when their CFUG distributed funds from the REDD+ pilot to their four sub-groups, and those sub-groups planted multiple tree species because the benefits generated from the forests managed by each sub-group goes only to household members of that sub-group.

Forest officials also provided similar responses regarding increases in tree planting, adding that seedling demand by local forest users and CFUGs from the district forest nursery has increased after the REDD+ pilot. As noted by one district forest official:

“...tree plantation by CFUGs has increased after the REDD+ pilot. The seedling demand of CFUGs has increased from our office nursery. Planting
trees is an easy activity that CFUGs tend to carry out for improving forest condition...” (D1).

However, a different situation appeared in Sitakunda CFUG. Both CFUG records and responses from interviews reveal that Sitakunda CFUG has planted trees in only a small area each year, and this has only been since the implementation of the REDD+ pilot. The current chairperson of Sitakunda CFUG (SB7) explained that planting trees was a low priority for the CFUG, mainly because the EC members spent so much of their time in ad hoc meetings related to REDD+ seed grant distribution and office building that there was limited time available to discuss tree planting.

The low priority of planting trees in Sitakunda CFUG was also associated with the types of vegetation. A former chairperson (SB4) reported that their forest is mainly dominated by natural pine forests which regenerate naturally. He further reported that they have focused on stimulating natural regeneration rather than planting new trees in their forests. However, the respondent also claimed that their CFUG had planted trees in erosion-prone areas after the REDD+ pilot.

Forest improvement through thinning and pruning

Thinning and pruning in CFs is associated with the removal of unwanted trees, herbs and shrubs for better growth of preferred tree species. Implementation of these activities is outlined in each CFUG’s operational plan and linked with the supply of forest products (mainly fuelwood) to local forest users and improving the forest condition. The following results reveal that promotion of thinning, pruning, cleaning and weeding greatly varied across the case study CFUGs based on forest types and size. The results also show that CFUGs have generally focused less on promoting thinning and pruning after the REDD+ pilot, which has likely threatened maintenance of long-term forest productivity through continued supply of forest products to forest users.

The current chairperson of Thansadeurali CFUG (TB5) reported that they operate thinning and pruning annually not only for forest improvement but also to supply fuelwood since their relatively small CF cannot meet the fuelwood demand only from dried materials. However, the respondent reported that thinning and pruning has decreased in recent years mainly due to the decrease in fuelwood needs by forest users. According to the respondent, participation of local forest users in thinning and pruning operations has decreased in the latter years of the REDD+ pilot, although their CFUG
had invited forest users to participate in thinning and pruning and to take away by-products derived from these operations. The respondent further said:

“...application of thinning and pruning is performed to supply fuelwood to forest users. We carried out thinning annually and invited to all forest users to take part and take away by-products derived from the thinning and pruning. However, participation of local forest users has decreased in these activities since they can meet their fuelwood needs from their own private lands...” (TB5).

However, one district forest official (D3), directly involved in monitoring CFUG activities held a different view and added that the CFUGs have deliberately reduced thinning and pruning operations since becoming involved in carbon measurement under the REDD+ pilot, and realising the value of each part of trees such as leaves, branches, leaf litter and herbs for carbon stocks enhancement. The respondent further believed that most CFUGs in the area have reduced their weeding and cleaning operations after the REDD+ pilot because they consider that the removal of trees and plants through thinning and pruning will reduce carbon stocks.

Referring to a decrease in thinning and pruning in Thansadeurali CFUG, one respondent (TB6) reported that their CFUG has become less focused on promoting thinning and pruning in their forests with the REDD+ pilot. She argued that, as the CFUG has not provided forest users with tea and snacks allowance to encourage participation in thinning and pruning activities (as they have done for planting trees), this has reduced the motivation of forests users to take part in thinning and pruning activities.

However, FGD participants of this CFUG EC argued that the CFUG allows their forest users who participate in thinning and pruning to take away by-products derived from the thinning and pruning as incentives for participation in these activities.

However, a contradictory perspective was offered by another respondent from Thansadeurali CFUG (TC5), who reported that they are only allowed to remove unwanted herbs and shrubs during thinning, pruning, cleaning and weeding operations, which are not of good quality for fuelwood. One respondent said:

“...we can remove just unwanted herbs and shrubs and weeds which are not useful to fuelwood. CFUG does not allow us to take trees useful for fuelwood and poles. There is little encouragement to participate in thinning and pruning activities since CFUG does not provide snacks allowances as in plantation activity...” (TC5).
The data from CFUG records reveals that no thinning and pruning operations were implemented in Sitakunda CFUG from 2009 to 2013 except in 2011 (Table 8.12), even though their forest operational plan stipulates that they should undertake such activities in 5 hectares of forests each year. The table also shows that thinning and pruning has also decreased in very recent years of the REDD+ pilot in Thansadeurali CFUG, supporting the views of respondents.

Table 8.12- Thinning and pruning activity in Sitakunda and Thansadeurali community forests

<table>
<thead>
<tr>
<th>Year</th>
<th>Thinning and pruning (hectare)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sitakunda</td>
</tr>
<tr>
<td>2009</td>
<td>0</td>
</tr>
<tr>
<td>2010</td>
<td>0</td>
</tr>
<tr>
<td>2011</td>
<td>4</td>
</tr>
<tr>
<td>2012</td>
<td>0</td>
</tr>
<tr>
<td>2013</td>
<td>0</td>
</tr>
</tbody>
</table>

Source: Group records and group interview, 2013

Regarding the low priority of thinning and pruning in Sitakunda CFUG, FGD participants of CFUG EC reported that a large part of their forests do not need thinning, as they are dominated mostly by pine trees that are sparsely dispersed. The respondent also argued that they did not execute thinning and pruning owing to the limited time available due to the increased frequency of EC meetings for record keeping, auditing and seed grant distribution.

Other reasons offered for the low emphasis on thinning and pruning in Sitakunda CFUG are the size of forests and fuelwood distribution practices. One Dalit woman, also an EC member (SC2), reported that because of the large size of the forest and limited availability of dry materials for fuelwood, the CFUG provides forest users with fuelwood from live-standing trees. There is little interest among forest users to participate in cleaning and weeding since the by-products of such activities are of poor quality for fuelwood.

8.5 Coherence between REDD+ pilot, climate change and forest policies

This section considers how the REDD+ pilot lies within the existing forestry and climate change policy and strategies in Nepal, particularly in relation to how it may have influenced changes at the local level that contribute to or contradict with national policies and strategies. The outcomes of this section are generated through reviewing existing forestry and climate change policies and government initiatives as well as from
the responses from in-depth interviews with project proponents, district stakeholders and CFUG members. These outcomes provide insights into the extent of commonalities and differences between different policies and the REDD+ pilot scheme, with the latter mainly seeking to achieve carbon stock enhancement.

Under a broader climate change policy framework, the Government of Nepal has formulated a “Nepal REDD+ Strategy” to guide future forest based climate change mitigation activities including REDD+ through the REDD+ Implementation Centre (RIC) under the Ministry of Forests and Soil Conservation (MFSC) (see Chapter 2). Development of a National Adaptation Plan of Action (NAPA) is another initiative of the Government of Nepal under Nepal’s climate change policy, which has identified forests and biodiversity as one of the key areas of adaptation to be implemented through the MFSC under the guidance of the Ministry of Environment (focal ministry of climate change policy). The NAPA document has emphasised the need to identify local level adaptation actions through Local Adaptation Plans for Action (LAPAs).

The recently developed National Biodiversity Strategy and Action Plan (2014-2020) of Nepal acknowledges the role of climate change adaptation (NAPA/LAPA) and mitigation (i.e. REDD+ scheme) initiatives as potential means of biodiversity conservation through conservation and efficient use of natural resources and improvement in forest resilience.

Analysis of these policies shows that the REDD+ strategy, climate change adaptation under the NAPA/LAPA document (for forests and biodiversity theme), and the National Biodiversity Strategy and Action Plan are three interrelated approaches which are intended to be facilitated by the MFSC. Further, these three approaches all acknowledge CFUGs as potential institutions to facilitate local activities to obtain different but interrelated objectives of climate change mitigation, adaptation and biodiversity conservation.

Despite the potential overlaps and interactions between these three policies and strategies, considerable gaps appear in the integration of three objectives into local practices at the local level (i.e. CFUGs). For example, the Government of Nepal has set up the RIC as the focal unit to guide REDD+ initiatives across the country including through community forestry. However, there has been no development of such explicit
institutional arrangements at a central level within the MFSC, or at the district level, to facilitate climate change adaptation activities.

The REDD+ pilot has been implemented through local community forestry institutions with the intention of supporting the formulation of a Nepal REDD+ strategy based on learning from the regulation of the distribution of seed grants from the central level to local CFUGs. While the REDD+ pilot is meant to support the national REDD+ strategy formulation process, there is no formal coordination between REDD+ pilot organisations and the government organisation i.e. RIC.

Regarding the coordination between the REDD+ pilot and the RIC, one REDD+ pilot proponent (C1) reported that the REDD+ pilot has been implemented through local CFUGs based on informal coordination with RIC at the central level and with district forest offices at the district level. However, one district forest official (D2) expressed that there are considerable gaps regarding the implementation of the REDD+ pilot scheme between the central and district level agencies within the MFSC due to the lack of a functional REDD+ unit at district level similar to the RIC at the central level. As noted by the respondent:

“...we – district forest office representatives have been taking part in the REDD+ pilot activities such as being a member of forest carbon trust fund advisory committee based on the request from a REDD+ pilot proponent - district FECOFUN. However, there is no formal instruction or communication from department of forests or ministry of forests or from REDD+ Implementing Centre regarding the participation in the REDD+ pilot activities. We do not know about our roles for the REDD+ pilot...” (D2).

The above statement reveals considerable gaps in institutional readiness between central and district level government agencies. Despite the involvement of the District Forest Office in the REDD+ pilot activities, concerns have been raised about the ownership and legitimacy of this office in regards to the outcomes of the REDD+ pilot because of a lack of clear roles and responsibilities of the District Forest Office for the REDD+ pilot such as through the RIC at the central level.

Another gap that has emerged in this research is the lack of integration between the REDD+ pilot and existing local policies and practices. For example, as previously discussed, the REDD+ pilot has developed FCTF guidelines to regulate distribution of REDD+ funds from the central Carbon Trust Fund to local CFUGs (see Appendix 30).
However, there is already a benefit sharing system among forest users within CFUGs prescribed by Community Forestry Development Guidelines of Nepal. Some district level respondents argued that the REDD+ pilot has created confusion by developing separate guidelines for the distribution of REDD+ funds (i.e. seed grants) instead of aligning this system with the existing benefit sharing system. As noted by one district forest official:

“...community forestry development guidelines are already in place to distribute benefit among forest users. Carbon trust fund guidelines have created confusion among local CFUGs about the allocation and reporting system. According to community forestry guidelines, CFUGs need to report to district forest office, while they need to report carbon related progress to the district advisory committee through FECOFUN...” (D3).

However, when project proponents (C1, C2 and C3) were asked about the need for development of separate FCTF Guidelines, they responded that existing benefit sharing under Community Forestry Development Guidelines of Nepal have no provision for transferring benefits from the central level to the local CFUGs through the district, while the REDD+ funds are usually derived from international agencies and need some system to enable them to be channelled to local CFUGs. The FCTF guidelines under the REDD+ pilot provide a multi-level structure (i.e. central, district and local CFUGs) for transfer of international incentives such as REDD+ funds (i.e. seed grants). As noted by one respondent:

“...carbon trust fund guidelines have facilitated the transfer of seed grants to the local CFUGs. This has not interrupted the CFUGs’ decision process on fund distribution. Local CFUGs can integrate the seed grants with their existing funds and can distribute to their individual forest users by their collective decision-making processes...” (C2).

Another concern raised by some district level interviewees is the link between the forest carbon inventory initiated by the REDD+ pilot and the forest inventory carried out by CFUGs and the district forest office for revision of CFUG forest operational plans. One district forest official (D1) argued that the REDD+ pilot has initiated an inventory process which is different from the existing practice of forest inventory in terms of objective and methods prescribed by the forest inventory guidelines 2002 (CFD/DoF, 2002). As noted by the respondent:

“...the REDD+ pilot has initiated carbon inventory in community forests. However, each CFUG has to carry out forest inventory to determine the harvestable forest products and get approval of forest operational plan from district forest office. Methodologies of inventory for these two purposes are not compatible due to different data requirements. Although a few CFUGs
have incorporated forest operational plans with carbon inventory, measurement of carbon by CFUGs themselves raises problems...” (D1).

The above statements illustrate that the REDD+ pilot has initiated benefit sharing and carbon inventory in isolation from existing practices of benefit sharing and forest inventory. However, according to one district official (D3), the REDD+ pilot has encouraged the integration of the carbon inventory process with the CFUG’s existing forest inventory. For example, 10 out of 58 CFUGs in the research area have revised their CFUG forest operational plan with the provision of a carbon inventory into the existing practices of their forest inventory.

Table 8.13 illustrates the reconciliation between national and local policies with reference to implementation of the REDD+ pilot. The table shows that different policies have different goals but have some commonalities and relationships. The intention of this analysis is to understand the contribution of these policies to implement REDD+ in achieving biodiversity conservation, local livelihoods and carbon enhancements.

<table>
<thead>
<tr>
<th>Policy, strategies and plan developed at national level</th>
<th>Links with local CFUGs</th>
<th>Perceived effects at CFUG level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate change policy 2010, and NAPA document 2011</td>
<td>• Although CFUGs are identified as potential local institutions for climate change adaptation, no climate change adaptation activities are explicitly incorporated into CFUGs’ forest operational plan</td>
<td>• CFUGs are less aware about the contribution of community forests to climate change adaptation but they know contribution of their forests to climate change mitigation i.e. carbon stocks</td>
</tr>
<tr>
<td></td>
<td>• Lack of clear links on the contribution of existing CFUG activities to the climate change adaptation activities</td>
<td></td>
</tr>
<tr>
<td>National biodiversity strategy and action plan (2014-2020) July 2014</td>
<td>• CFUGs recognise conservation of biodiversity as a tertiary objective in their forest operational plan</td>
<td>• Unless CFUGs know the value and contribution of their forests to biodiversity conservation they have limited motivation</td>
</tr>
<tr>
<td></td>
<td>• CFUGs have limited awareness of their contribution to the national biodiversity goal. For example no obligation for monitoring, auditing and reporting of biodiversity status of community forests to district forest office (like the financial audit report that CFUGs must send to their respective district forest office annually)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• District forest offices are supposed to facilitate the biodiversity strategy into CFUG activities, however, no deliberate activities are designed for</td>
<td></td>
</tr>
</tbody>
</table>
8.6 Discussion

The REDD+ pilot through the pre-existing CF has brought both positive and negative changes in local practices in three major areas: group management including meeting frequency and participation in decision-making processes, benefit sharing practices and livelihoods and forest activities. Positive changes at the CFUG or community level include strengthened institutional capacity of CFUGs, increased representation of women and Dalit in pre-existing institutions of the CFUG EC as well as in institutions.
established under the REDD+ such as the Watershed REDD+ Network, enhanced pro-poor approach of benefit sharing, and revitalisation of forests conservation practices.

Negatives outcomes include that REDD+ likely increases implementation costs of CFUGs and time commitment of forests users, prevents women and Dalit EC members from participating in decision-making processes, reduces motivation of well-off forest users, who are excluded from REDD+ benefits, and threatens the customary rights of forest-dependent people to access forest products. The positive and negative changes arising from the REDD+ pilot are discussed, with reference to previous research findings and the implications for carbon, biodiversity and local livelihoods.

8.6.1 REDD+ strengthens institutional capacity, but increases implementation costs
As previously noted, the REDD+ pilot has influenced group management, participation and decision-making processes of CFUGs. REDD+ may strengthen the institutional capacity of CFUGs and increase representation of marginalised households in the CFUG EC, but it is also likely to increase implementation costs of CFUGs, and the increased number of EC meetings often called at short notice and with no adequate attendance incentive for those who depend on daily labour for their survival, prevents Dalit and women EC members from participating in decision-making.

REDD+ offers CFUGs an opportunity to strengthen institutional capacity by encouraging more systematic practices of record keeping, auditing, reporting and monitoring for both benefit sharing and carbon measurement. The results shown in Figure 8.1 indicate that both case study CFUGs had held a number of ad hoc EC meetings to discuss record keeping, auditing and preparation of reports to enable them to access the REDD+ incentives. While CFUGs still had to deal with their regular agenda items, an increase in ad hoc EC meetings was required to discuss other REDD+ related agendas such as selection of households for seed grants distribution, selection of LRP to implement carbon monitoring and orientation programmes, and preparation of seed grants claims. The majority of research participants reported that their CFUG has become more active and their institutional capacity has been enhanced through discussion of REDD+ related agenda items and preparing for engagement with future REDD+ schemes.
Other studies in Nepal (Maraseni et al., 2014; Newton et al., 2015; Poudel, 2014; Poudel, Thwaites, et al., 2014) have also observed an increase in frequency of EC meetings of CFUGs arising from the requirement of REDD+ to improve record keeping and prepare reports, and undertake audits of seed grants distribution and monitoring of carbon stocks.

I found that a combination of REDD+ orientation programmes targeting women, and Dalit, and the mandatory provision of REDD+ for CFUGs to provide women and Dalit representatives for the newly established Watershed REDD+ Network, has increased the understanding of women and Dalit of their roles and rights within CFUGs and empowered them to participate in decision-making processes. This has resulted in an increased participation in CFUG GA meetings, but also enhanced representation of women and Dalits on the CFUG EC, as well as at the Watershed REDD+ Network.

However, the average attendance of Dalit, IP and woman EC members in EC meetings has decreased in both case study CFUGs with an increase in frequency of EC meetings (Figure 8.2 and 8.3). This was mainly due to the inability of Dalit and women EC members to attend every meeting since EC meetings are often held at short notice when Dalit and women have already fixed plans to go to work (for subsistence), but was also associated with the lack of sufficient incentives to compensate such members for the commitment to such meetings. So, while REDD+ sought to enhance the representation of women and Dalit in decision-making bodies, it did not seek to develop the enabling conditions to ensure their attendance at EC meetings. It would seem that REDD+ has facilitated the domination of the decision-making process by males and non-Dalit members who already hold higher status and authority in the community.

Balderas-Torres & Skutsch (2014) and Khadka et al. (2014) also noted a low level of participation of marginalised groups including women in decision-making processes of CFs due to their limited access to financial benefits. Lawlor et al. (2013), Setywati (2012) and Gurung et al. (2011) all found an association between participation of Dalit and women in REDD+ decision-making processes and their access to REDD+ benefits, arguing that access to benefits for poor EC members can increase both motivation and enhance their survival capacity, which encourages participation in decision-making events. This suggests that both mandatory provision of representation (political opportunity) and ensuring access (economic opportunity) to benefits is required to
enhance representation, participation and attendance of Dalit and women in the decision-making process.

REDD+ is likely to increase the operation and implementation costs of CFUGs. In both case study CFUGs, an increase in the number of EC meetings to discuss the REDD+ related agenda resulted in increased costs for meeting allowances, communications, tea and snacks, stationery, and travel. In their assessments of the impacts of REDD+ in Nepal, Maraseni et al. (2014), Bhattarai (2012) and Poudel (2014) observed an increase in implementation and operation costs of CFUGs following REDD+, arising from the extra EC meetings required to prepare reports necessary for seed grant distribution. Newton et al. (2015), Agrawal & Angelsen (2009) and Sharma et al. (2015) argued that the initial phase of REDD+ can increase implementation costs for CFUGs, since CFUGs may need to improve their existing reporting systems to satisfy the expectations of the REDD+ scheme.

Available evidence of seed grant distribution indicates that REDD+ incentive payments have not been seen to be able to cover opportunity costs (i.e. forgone benefits) from the community forests. For example, as reported by a very poor respondent from an artisanal group (i.e. blacksmith), the amount of seed grant received from REDD+ is far below the forgone value of charcoal production. Findings from a recent study in one of the case study CFUGs (i.e. Thansadeurali CFUG) by Joshi et al. (2016) have indicated that forgone benefits by local forest users for forest product use (NRs 4,905.79 per year per household) was much higher than the net benefits obtained from the REDD+ (NRs 1,290.57 per year per household). Staddon (2009) and Karky & Skutsch (2010) have also argued that REDD+ through CFs may entail high opportunity costs since CFs provide numerous non-monetary benefits to the local population. This raises concern how future carbon incentives arising from performance based REDD+ can cover forgone benefits of CFs and costs incurred by forest users since most of the CFs in Nepal are small in size (both total and per household forest size) and are managed by collective efforts of many forest user households.

One important implication is that increased operation and implementation costs associated with institutional preparation for REDD+ will leave CFUGs with only a small amount of funds for income generating and forest management activities, thus reducing the effectiveness of REDD+ in forest conservation, carbon stocks
enhancement and livelihoods improvement. While the implication of increased costs on forest activities can vary across CFUGs depending on their existing income, small forests who receive a small amount of REDD+ funds or have low internal sources of income may be less interested in engaging in future REDD+ schemes due to the potential increase in implementation costs.

An increase in the frequency of EC meetings to discuss the REDD+ agenda has demanded a greater time commitment of EC members. While one outcome may be enhanced personal and institutional capacity, the priority placed on institutional responses to REDD+ in relation to benefit distribution and carbon stocks measurement can reduce the time available for CFUG EC to consider forest management activities. Kronenberg et al. (2015) found that REDD+ can destabilise existing CFUG activities by shifting the priorities of CFUGs from forest management to REDD+ benefit distribution and carbon inventory. Maraseni et al. (2014) have argued that if the costs of increased time and efforts are not compensated, participation of EC members in REDD+ will be temporary.

My research finds that REDD+ can strengthen the institutional capacity of CFUGs as suggested by Newton et al. (2015), Agrawal & Angelsen (2009) and Fisher (2014) (Chapter 2, sub-section 2.4.6.2), but can also increase costs and time commitments of CFUGs, which raises questions about the effectiveness and cost-efficiency of REDD+, particularly in small CFs. In implementing REDD+, CFUGs must also be mindful of the implications for participation of Dalit, women and poor households, and seek to enhance the inclusiveness of decision-making processes.

8.6.2 REDD+ provides enhanced access to benefits for the poor, but can reduce motivation of non-recipients
REDD+ has promoted a pro-poor approach of benefit distribution to ensure seed grant benefits reach marginalised households. There are two possible explanations for this. First, assuming that marginalised households are highly forest dependent, CFUGs seek to reduce their forest dependency by supporting their livelihoods. Second, adopting a pro-poor approach to benefits sharing builds legitimacy and support for the REDD+ pilot, based on the expectation that such an approach to benefit sharing would be seen as equitable. As indicated in trust fund guidelines, around 60% of REDD+ pilot funds were distributed to CFUGs on the basis of social criteria, and mostly according to the
percentage of Dalit, women and poor households (Figure 8.8). Several studies (e.g. Maraseni et al., 2014; Sharma, Shyamsundar, et al., 2015; Sherpa & Brower, 2015) in Nepal and elsewhere (e.g. Lindhjem et al., 2010; Luttrell et al., 2013) have reported that REDD+ initiatives have adopted a pro-poor approach by delivering benefits to poor households especially to women, Dalit and marginalised CFUG members. Based on the evidence from preliminary REDD+ projects, Gebera et al. (2014), Dokken et al. (2014) and Narloch et al. (2012) believe that the focus on poor households in benefit distribution in preliminary REDD+ initiatives has been designed to build the legitimacy of the REDD+ scheme.

The REDD+ pilot has enhanced equity and pro-poor approach of benefit sharing within and among CFUGs ensuring REDD+ seed grants reach poor and marginalised households. However, REDD+ funds were found to be of limited effectiveness for household level income generation in the case study sites for at least two reasons. First, only a small amount of the fund (i.e. seed grant) was distributed from REDD+ pilot (through forest carbon trust fund) to the CFUGs in the pilot watersheds (see Table 8.1 and 8.2) since this fund was dedicated only to demonstrate a REDD+ payment system within the community forestry system (discussed in section 8.1). Second, despite a difference in the amount of funds allocated by REDD+ pilot to two case study CFUGs, each CFUG distributed only a small proportion of the REDD+ funds to households. Seed grants were made to poor households to meet obligatory criteria set by the REDD+ pilot; however, the amount of fund was generally insufficient to enable poor households with few relevant skills and experiences to establish income generating activities.

REDD+ sought to provide funds for poor people, but paid no attention to how delivery of these funds could be effective in stimulating income generating activities. For example, while REDD+ benefits were given as cash, some recipients had few skills or ideas on how to establish and operate income generating activities, and were found to be using the funds for non-income generating activities such as paying children’s school fees. There was little coordination between REDD+ and other organisations such as the agriculture and livestock office to harness their support for income generating activities. This suggests that providing REDD+ funds to forest user is not the most effective use of the money. Funds must come with the support necessary to build appropriate skills among recipients.
Kerr et al. (2012) from Mexico, Harada et al. (2015) from Indonesia and Nawir et al. (2015) from Nepal and Indonesia have all found that the early phase of REDD+ initiatives provided only limited funds, but tended to spread the funds across as many households as possible, meaning insufficient funds were available to each household for effective income generation activities. Korhonen-Kurki et al. (2015) noted that the REDD+ initiatives have more focus on benefit distribution, with less focus on effective use of funds. In an analysis of four years of REDD+ impacts on household income in Nepal including the CFUGs of my research, Sharma et al. (2015) found no change in household level income following the REDD+ funds, due to insufficient funds provided both from REDD+ to CFUGs, and from CFUGs to forest users.

My research found that REDD+ is likely to create dissatisfaction and reduce the motivation of some forest users to engage in this process. There was a high expectation of benefits among both poor and well-off forest users, based on their experiences from the earlier Nepal-Swiss Community Forestry Project. However, REDD+ was targeted especially towards poor households, excluding well-off households from the opportunity to access REDD+ benefits, resulting in dissatisfaction with the benefits distribution processes. This finding is contrary to Barbier et al. (2012) and Murdiyarso et al. (2012) who reported that financial incentives from REDD+ can motivate all local people. Rather, targeted incentives can de-motivate some groups of people if the REDD+ benefits are unable to address the aspiration of all forest users. Studies from Nepal (e.g. Poudel, 2006; Poudel, 2014; Poudel, Thwaites, et al., 2014) and elsewhere (e.g. Jeremiah et al., 2014; Sutta & Silayo, 2014) reported similar findings that the REDD+ scheme generates dissatisfaction among forest users because of discriminatory benefit distribution criteria targeting only a few selected households.

Lack of consideration of contribution-based criteria such as the contribution of private forests to forest conservation in REDD+ seed grants distribution also appeared to be generating dissatisfaction among some forest users, especially those with trees on their private farmlands. As shown in Chapter 7, growing trees on private farmlands has contributed to forest conservation by reducing fuelwood and fodder extraction. However, REDD+ takes no account of this, and provides no incentive to households with trees on private farmland, or to those who support forest conservation by reducing their forest dependency in other ways.
Seabright (1993) and Bowles & Polonia-Reyes (2012) also found that external funds can create negative consequences if such incentives fail to create common interests among local people. As proposed by Skutsch et al. (2011), Pham et al. (2013) and Maraseni et al. (2014), the findings suggest that a pro-poor and equitable approach of benefit sharing is necessary to enhance the opportunities for poor households to access benefits and improve their livelihoods, but it is not sufficient in itself to create common interests among all forest users to maintain motivation and collective action. Thus, exclusion of contribution-based criteria in benefit sharing may further reduce the motivation of some people to engage in future REDD+ activities, as well as in existing collective action for forest management.

Inadequate information sharing with CFUGs about seed grant distribution can also create dissatisfaction among and within CFUGs. For instance, respondents of Sitakunda CFUGs perceived that the amount of seed grant distributed from REDD+ to them was unfairly small compared to what other CFUGs had received (especially those with similar forest size). CFUGs were not adequately consulted during development of trust fund guidelines and were not informed about the criteria of seed grant distribution. This indicates that the motivation for local CFUGs to engage in REDD+ is also governed by how REDD+ initiatives share information about benefit distribution with local CFUGs (see Chapter 2). Based on studies assessing the implication of REDD+ incentives, Loaiza et al. (2015) and Ollivier (2012) acknowledged that REDD+ can reduce motivation across CFUGs when the CFUGs do not have information that explains smaller REDD+ benefits relative to their contribution to carbon stocks enhancement. As suggested by Patel et al. (2013) and Uprety et al. (2011), inadequate communication and information sharing can create not only dissatisfaction and reduce motivation of forest users within CFUGs, but also misunderstanding across CFUGs.

Financial incentives provide important motivation for local people to engage in REDD+, and hence the criteria and process for benefits distribution are critical to maintain motivation and collective actions. Local people have raised concerns with both the criteria and the process of participation and consultation, or procedural equity. As discussed in Chapter 2, Ribot & Larson (2011) and Rantala et al. (2015) have argued that procedural equity and criteria of distribution or distribution equity are equally important for REDD+ benefit distribution. REDD+ can enhance access of poor households to benefits, but cannot motivate all forest users if it is unable to create
common interests in the benefit sharing mechanism through adequate consultation, sharing and communication.

8.6.3 REDD+ supports forests conservation, but can undermine customary rights
REDD+ seeks to conserve forests through a range of activities inside and outside forests. The results presented in section 8.4.1 reveal that REDD+ provides an opportunity for CFUGs to enforce conservation rules. While both case study CFUGs have adopted practices to reduce degradation by reorganising forest patrolling, I found that Thansadeurali CFUG (small forest) has become more active in controlling forest boundary encroachment and illegal logging through enforcement of rules and charging fines following REDD+. This indicates that generally small forest holdings may adopt REDD+ as a tool to enforce their conservation rules and revitalise forest activities.

Despite some variations between the two case study CFUGs, the research shows that CFUGs have generally reduced thinning and pruning activities, but have enhanced protection-orientated activities and promoted planting trees following REDD+. As REDD+ has increased the value of standing trees by providing seed grants based on the carbon stocks increment, CFUGs seek to keep forests intact by reducing extraction of forest products, considering that the removal of trees from thinning and pruning can reduce carbon stocks from their forests. One likely implication is that REDD+ can destabilise customary practices of CFUGs, because thinning and pruning is considered to be a sustainable means for both supplying forest products and enhancing forest productivity. For example, while their forest operational plan requires thinning activities to cover 5 hectares of forest each year, Sitakunda CFUG has not undertaken thinning since the beginning of REDD+ implementation. Although their forest is dominated by pines which usually do not need thinning, the CFUG has also ceased thinning activities in other parts of the forest of broadleaved tree species such as Sal and Saj. Maraseni et al. (2014) and Sharma et al. (2015) reported that CFUGs in Nepal have reduced thinning, but have increased tree plantings following the implementation of REDD+, indicating that REDD+ has emphasised protection-oriented activities rather than sustainable management of forests.

Introduction of alternative energies such as ICS, iron stoves and biogas plants under the REDD+ pilot scheme has been effective in reducing consumption of fuelwood. While the figures offered by research participants that ICS and biogas may reduce fuelwood
consumption by nearly 40% and 80%, respectively requires further verification, it generally indicates that forest users who have adopted ICS and biogas have experienced a decrease in fuelwood consumption. This supports the finding of Dresen et al. (2014) from Ethiopia and Khanal & Bajracharya (2010) from Nepal that the introduction of ICS reduced fuelwood consumption by around 40% (Ethiopia 40% and Nepal 45%).

The installation of biogas plants in CFUGs has presented some challenges in relation to forest products extraction. Installation of biogas can exert pressure on fodder extraction from forests as forest users may need fodder and grass to feed their cattle. Also, biogas plants appeared unsuitable for land poor and landless forest users since biogas requires high installation and operation costs. Hence, promotion of biogas plants may exclude poor households from benefiting from this alternative energy source.

Support of REDD+ for biogas, ICS and iron stoves was inadequate, and distribution processes of ICS and biogas plants was inequitable in that the CFUGs did not adequately consult with Dalit and poor households. However, I found that the majority of local people are using coal stoves as a complementary cooking strategy, indicating that local forest users are interested in changing from traditional stoves (open fire stoves) to improved stoves. Therefore, encouraging installation of ICS and iron stoves by providing sufficient installation costs targeting poor households can be a good strategy for reducing fuelwood consumption.

Both case study CFUGs have adopted some forms of restriction of access to forest products following REDD+. The smaller forest (Thansadeurali CFUG) has restricted charcoal production to enhance carbon stocks, while the CFUG had the option of expanding the area of community forest as there are no government forests adjacent to existing CFs. In contrast, Sitakunda CFUG has partially restricted grazing by introducing a rotational grazing practice, and has changed the previous open collection of fuelwood from live-standing trees to a system where forest users need to collect fuelwood also from green branches. As shown in Chapter 7, with a larger forest, Sitakunda has introduced fewer restrictions, but the new rules on fuelwood collection has jeopardised fuelwood access for some, especially for older people and families headed by women who are not able to collect fuelwood from branches. The implementation of REDD+ by CFUGs has threatened customary practices of resource access through introduction of access regulations, while not providing forest users with
sufficient compensation for their losses. This has had the greatest impact on artisanal groups (blacksmiths), who rely on charcoal production for their survival, and those who struggle to gather resources under the new rules.

In a study of REDD+ and non-REDD+ CFUGs in Nepal, Poudel et al. (2014) found CFUGs within the REDD+ pilot had introduced restrictions on fuelwood and fodder collection, while the CFUG not involved in REDD+ had not introduced any such restriction. Robinson et al. (2013) from Tanzania and Bottazzi et al. (2014) from Bolivia reported that forest groups reduced the quantity of forest products extraction following REDD+ implementation as a key initiative to secure carbon stocks. In their analysis of REDD+ piloted CFUGs, Pandey et al. (2014) and Poudel (2014) observed an increased restriction on fuelwood and fodder access following REDD+.

In my research, neither of the case study CFUGs has reduced the quantity of timber harvested, but they have changed the source of timber harvesting from high-value tree species to commonly found tree species. The results shown in section 8.4.1 reveal that the CFUGs reduced the harvest of Thingure Salla in Thansadeurali CFUG and Saj and Sal in Sitakunda CFUG, while providing timber from commonly found tree species without reducing the total quantity of timber to forest users (Chapter 4 and 7). This finding contradicts Maraseni et al. (2014) and Sharma et al. (2015) from CFs in Nepal, who found a decrease in timber extraction across CFs after the implementation of REDD+. As shown in Chapter 7, the different responses of CFUGs could be due to the variation in socio-economic circumstances of forest users that can differently influence timber demands. So, by encouraging CFUGs to restrict harvest of fuelwood, fodder and charcoal, REDD+ may threaten traditional livelihoods of local people especially marginalised households. Similarly, Mutabazi et al.(2014) from Tanzania, Poudel et al. (2015) from Nepal and Ratsimbazafy et al. (2011) from Madagascar have noted that limitations on extraction of forest products in response to REDD+ likely affect poor households more than well-off households, as poor households are more reliant on the community forest for basic forest products. This suggests that REDD+ can produce a trade-off between forest conservation for carbon stocks and the livelihood of local people.
8.6.4 REDD+ presents both policy opportunities and challenges for carbon, biodiversity and livelihoods

The review of relevant policies in Nepal shows that implementation of REDD+ through CFs presents several opportunities for climate change mitigation, biodiversity and livelihood improvement. REDD+ implementation under the coordination of Ministry of Forests and Soil Conservation (MFSC) presents the opportunity to integrate three main policies associated with international agreements - climate change policy under the UNFCCC, biodiversity conservation under CBD and sustainable forest management under United Nations Forum on Forests (UNFF), as the MFSC is the focal designated institution for each of these policy instruments. A further opportunity arises from the establishment of the REDD+ Implementation Centre (RIC) within the MFSC to guide and facilitate the REDD+ initiative across the country. The establishment of the RIC under the MFSC has facilitated both the integration of international and national policies into local practices and the generation of multiple benefits for carbon, biodiversity and livelihoods, which can address the needs of local people and concerns and interests of national and global stakeholders (GoN, 2014d).

Despite these opportunities for generating synergies between livelihoods, biodiversity and carbon, the implementation of REDD+ through CFs may present a number of challenges, mainly due to four policy concerns. Firstly, challenges in the implementation of REDD+ arise as there is no REDD+ unit at the district level corresponding to the RIC at the central level. Although the REDD+ pilot has formed a multi-organisations advisory committee at the centre, and district and monitoring committees in the districts to regulate seed grants, the absence of a government-led REDD+ unit below the central level results in a lack of local ownership, and lack of legitimisation by the government bodies of local achievements such as carbon stocks enhancement arising from the REDD+ pilot. Korhonen-Kurki et al. (2013), Nagendra & Ostrom (2012) and Poteete (2012) expressed a similar concern that development of multi-level structures in relation to REDD+ needs to harmonise the multiple social and ecological interests of local, national and international stakeholders. Similarly, Skutsch & Van Laake (2008) recognised the necessity for multilevel REDD+ structures and their linkages, both to transform the international concept of REDD+ into local practice and to legitimise the contribution of local actions to the achievement of national and international goals of carbon stocks and biodiversity conservation, while also delivering local livelihood improvement.
The second challenge relates to the poor coordination between policies within the forestry sector and other sectors of society, mainly because the REDD+ scheme is overly guided by forest policy. REDD+ has limited coordination with non-forestry organisations, despite some REDD+ funded activities having implications for agriculture and livestock, climate change and biodiversity sectors. Limited or no coordination results in limited effectiveness of income generating activities due to an inability of forest users to harness cross-sectoral support, so the implementation of REDD+ through CFs is ineffective without coordination with non-forestry sectors. Ojha et al. (2016) have recognised that the forestry sector cannot flourish in isolation as it is related to a variety of non-forestry sectors such as agriculture, livestock and infrastructure. Graham (2011) and Brickell (2012) acknowledge that coordination and harmonisation of REDD+ policy with non-forestry sectors is essential, to both effectively address forest degradation and maximise the synergies between carbon stocks and livelihoods benefits. However, Korhonen-Kurki et al. (2012) and Somorin (2014) have argued that coordination of REDD+ into existing non-forestry sector policies is a complex and time consuming process, as it may require the modification of elements of existing policies, suggesting that integration of REDD+ into the non-forestry sectors may depend on how those non-forestry sectors embrace REDD+ and climate change concerns. This research thus argues that it will be difficult for REDD+ to become a common initiative encompassing non-forestry sectors while the existing REDD+ initiative is exclusively governed by forest policies and structures.

Another challenge for the REDD+ scheme relates to the lack of clarity in relation to land tenure and carbon rights of forest users. CFUGs lack land ownership rights under existing policy provisions, which provide access, management, exclusion and use rights through agreed forest operational plans renewed for every 5 or 10 years (Chapter 2). Given the frequent renewal of forest operational plans, forest users generally focus only on short-term objectives related to harvesting of forest products. The lack of clear rights and related uncertainty means there is little motivation for CFUGs to integrate long-term forest conservation goals such as carbon stocks enhancement and biodiversity, into their forest operational plans. Larson et al. (2013), Bastakoti & Davidson (2014) and Fisher (2014) have recognised tenure and carbon rights as a global policy issue for community forestry, especially when forests are being managed for the integrated objectives of carbon, biodiversity and local livelihoods. Similar to Bushley & Khatri
(2011), this research argues that although the current contribution of CFs appeared to reduce degradation and increase forest cover, the lack of tenure clarity and long-term ownerships can create sustainability (i.e. permanence) concern for carbon stocks and biodiversity.

The lack of reconciliation of REDD+ initiatives with existing local rules and practices presents another challenge for management of REDD+. The multi-level REDD+ benefit sharing process initiated by the REDD+ pilot appeared to have inadequately integrated into the existing benefit sharing practices of CFUGs. Establishment of a separate auditing and reporting system for REDD+ seed grants both increases costs and time, and reduces ownership over the funds among CFUGs. Carbon inventory undertaken by REDD+ was also not built into the existing CFUGs’ forest inventory practice, creating confusion and increasing costs and time commitment of CFUGs. While the existing forest inventory process generally focuses on the quantification of an annual allowable cut for the forest products harvesting plan and identifying tree species available in forests, the integration of carbon inventory into existing forest inventory practices could contribute to the development of an integrated plan for carbon stocks, forest products harvesting and biodiversity. Tucker et al. (2007), Osei-Tutu et al. (2015) and Brockhaus et al. (2014) also reported that integration and reconciliation of REDD+ activities with local practices and state institutional arrangements provides the conditions to enable success of REDD+, suggesting that reconciliation and harmonisation between centrally-designed REDD+ policies and existing local practices is essential for synergies between carbon stocks, livelihoods and biodiversity conservation.

**8.7 Chapter conclusion**

There were positive and negative effects of the implementation of REDD+ on social, institutional and forest activities manifested at community and household levels. REDD+ has positive effects on strengthening the institutional capacity of CFUGs and promotion of pro-poor and equitable benefit sharing, thereby enhancing representation of marginalised households in decision-making bodies. However, these achievements resulted in increased costs to and time commitment of local forest users, leaving less time for planning forest activities. While REDD+ has enhanced representation of *Dalit* and women in decision-making bodies, it has prevented them from participating in decision-making processes by not providing sufficient attendance incentives.
Despite the emphasis on pro-poor benefit sharing, REDD+ was ineffective in the delivery of household level livelihood outcomes, because the amount of seed grant distributed from the REDD+ to CFUGs was inadequate to establish the income generating activities. Poor households received only a small amount of REDD+ funds since CFUGs leaderships tended to provide funds to as many household as possible for a short loan period (i.e. one year). The time frame and the amount of fund were not adequate for poor households to establish income generating activities, which were attributed to existing distribution practices within CFUGs and allocation of small fund from the REDD+ pilot. Future REDD+ may face challenges in delivering improvements to local livelihoods, if the REDD+ fund does not cover the implementation and opportunity costs (i.e. forgone value of resource use). This raises the concern how future REDD+ can meet the higher operational and implementation cost (section 8.6.1) and compensation of the loss of access to resources of households (reduced benefits from CFs discussed in section 8.6.3) if higher level benefit are not available. If REDD+ payments are inadequate to cover opportunity costs, interest in participating in future REDD+ projects might be reduced, particularly for members of smaller CFUGs. At a household level, imposition of REDD+ without adequate benefits could lead to further marginalization particularly of poor and Dalit households.

Emphasis on pro-poor criteria in benefit sharing excluded well-off households from benefitting from REDD+, and these households may eventually lose enthusiasm for the scheme. This could be problematic since well-off households have been contributing to forest conservation by offsetting their needs through the use of resources from private forests. Targeting poor households through pro-poor and equitable benefit sharing is necessary, but it may not be enough for REDD+ to be effective in the context of CF, where forests are customarily managed through the collective actions of forest users with diverse interests and socio-economic backgrounds.

Restriction on removal of fuelwood and charcoal has likely jeopardised the customary rights of forest product access for forest dependent communities. Meanwhile, the CFUGs tend to adopt a protection-oriented approach and reduce thinning activities to avoid loss of biomass. Although reducing thinning may increase carbon stocks, it can affect long-term forest productivity and forest product supply since these activities are considered to be an appropriate approach for small scale CFs to conserve forests through sustainable supply of forest products.
While Nepal has several enabling policies and institutional conditions for REDD+ implementation, there are still policy challenges that can hinder effective implementation. One of the major challenges appeared to be the lack of a REDD+ unit at the district level to legitimise local achievements. Another concern was the lack of coordination between REDD+ and non-forestry sector policies, which can lead to limited effectiveness of REDD+, since several REDD+ activities pertain to non-forestry sectors. Insecure land tenure and carbon rights appeared to be another policy concern for future REDD+ initiatives, especially for retaining the long-term commitment of forests users for the protection of carbon stocks and biodiversity. Lack of reconciliation between centrally-designed REDD+ polices for benefit sharing and carbon inventory with existing practices of benefit sharing and forest inventory of CFUGs likely increases costs and time commitment of forest users, suggesting that implementation of REDD+ activities in isolation from existing activities can undermine the potential opportunity for synergy between carbon and biodiversity conservation and forest products removal.

I argue that strengthening institutional capacity may lead to trade-offs in the cost-efficiency and effectiveness of implementing REDD+, particularly in small CFs. Implementation of REDD+ must account for the livelihoods and participation of marginalised people to enhance the inclusiveness of decision-making processes, while also enhancing motivation and collective action of forest users for sustainable management of forests.

My research suggests that the distribution of sufficient REDD+ incentives from CFUGs to user households and a combination of contribution-based and pro-poor criteria in benefit distribution are essential to address the interests of diverse forest users, thereby enhancing motivation and collective action, and strengthening institutional capacity. Respect of customary rights and access of marginalised households to forest products and REDD+ benefits, and enhancement of participation in decision-making processes, could both improve local livelihoods and enhance the inclusiveness of REDD+. Promotion of sustainable forest management with multiple forest activities and reconciliation of REDD+ activities into existing CFUG practices can enhance synergies for carbon stocks and biodiversity conservation, which are ultimate goals of both REDD+ and community forestry.
Chapter 9- Synthesis and conclusion

9.1 Introduction

This research set out to explore ecological and social changes in community managed forests in Nepal following the implementation of REDD+. The research sought to answer four key research questions:

(1) How have carbon stocks, forest biodiversity (i.e. plant species diversity, species richness and stem density), and forest products removal (i.e. timber, fuelwood and fodder) changed in community forests in Nepal following the implementation of REDD+?

(2) Are there trade-offs or synergies in protecting carbon stocks, forest biodiversity and the provision of forest products across community forests (CFs)?

(3) What factors likely affect the extraction of forest products from community forests in Nepal, and what implications does this have for carbon stocks and forest biodiversity? and

(4) How has REDD+ changed local forest management practices in CFs?

Guided by an interdisciplinary research approach within a socio-ecological systems framework, I have sought to answer questions 1 and 2 through collection and analysis of quantitative data on forest carbon, plant diversity and the extraction of timber, fuelwood and fodder from a variety of sources including field collection across 19 Community Forest User Groups (CFUGs) within the Charnawati watershed of Dolakha district in Nepal. To answer questions 3 and 4, in-depth case studies were undertaken in two CFUGs within Charnawati to collect qualitative data. Here, analysis focussed on the complexity of interactions between forest resource extraction, carbon stocks and forest biodiversity and CFUG management and decision-making, and the introduction of the REDD+ scheme through community forestry.

This final chapter is a brief summary of the key findings of the research, and considers the contribution the research has made to our understanding of the relationships between forest products extraction, forest carbon and biodiversity, and the implications of the implementation of the REDD+ scheme for local community forestry institutions and practices.
9.2 Synthesis of key findings

My research shows an increase in carbon stocks and a decrease in forest biodiversity following the implementation of REDD+, coinciding with a decrease in fuelwood and fodder removal and an increase in timber removal (Figure 9.1). This suggests that the change in extraction of forest products arising from REDD+ can have different effects on carbon and on biodiversity. There was a negative association of carbon stocks and forest biodiversity, which indicates that high biodiversity does not necessarily contain high carbon stocks. This may be due to variation in growth stage and growth pattern of the forest, and carbon storage capacity of different tree species. While the research shows both trade-offs and synergies across CFs in the relationships between carbon stocks, biodiversity and forest products extraction, trade-offs were generally prevalent when attempting to manage forests for stocks (i.e. forests with high carbon stock value had relatively low biodiversity value or did not contain substantial quantities of forest products).

**Figure 9.1 - Social and ecological changes across community forests under REDD+**

An increase in carbon stocks was associated with a decrease in fuelwood and fodder extraction, and the decrease in extraction of these forest products was influenced by the
combined effects of local and non-local factors related to forest biophysical characteristics, socio-economic circumstances and institutional arrangements (Figure 9.1). Major factors affecting the relationships included the growing of trees on private farmlands, changes in traditional agriculture practices to vegetable farming, and outmigration.

REDD+ affects carbon stocks and biodiversity by influencing CFUGs to change forest management practices and activities such as benefit sharing and harvesting practices. My research shows that restriction on fuelwood and fodder extraction, enhancement of protection-oriented activities, and the introduction of alternative energies arising from REDD+ are associated with carbon stocks enhancement. However, restriction on the extraction of basic forest products such as charcoal and fuelwood has undermined the customary rights and livelihoods of forest-dependent people, while financial incentives are insufficient to compensate for the loss of access, suggesting that REDD+ presents a trade-off between carbon enhancement and extraction of forest products and local livelihoods.

Observed changes in carbon stocks and biodiversity in the study CFUGs were also coincident with several changes in CFUG activities arising from the implementation of REDD+, including institutional processes such as decision-making and benefit sharing and forest activities. REDD+ strengthens the institutional capacity of CFUGs, enhances pro-poor and equitable benefit sharing, increases representation of marginalised people in decision-making and provides the opportunity for CFUGs to revitalise their forest activities and enforce conservation rules. However, the level of monitoring and reporting and improved institutional capacity necessary for REDD+ eligibility increases the costs and time commitment of forest users including the CFUG Executive Committee (EC), leaving only limited time for forest users to consider sustainable management of forests. While REDD+ emphasises a pro-poor approach to benefit sharing, it fails to address expectations of diverse forest users and develop common interests among them, which reduces motivation to engage in REDD+, especially amongst well-off forest users. This results in destabilisation of the customary practice of collective forest activities of self-regulated CFUGs, and poses challenges for sustainable management of forests for carbon and biodiversity. Furthermore, with timber extraction already high in the study CFUGs, exclusion of well-off households from accessing REDD+ benefits can exert pressure on forests by increasing it even further. Hence,
recognition of the contribution of private forests as a criterion for REDD+ benefit sharing could address concerns of well-off households, and maintain motivation and collective action for REDD+ and forest conservation.

REDD+ seeks to enhance participation of women and Dalit in decision-making processes by adopting mandatory provisions, but does not seek to enhance their access to economic opportunities or to provide sufficient attendance incentives to EC members from these groups. The limited amount of support available from REDD+ funds not only prevents Dalit and women from participating in decision-making processes, but can also jeopardise livelihoods, which can increase their forest dependency and lead to negative effects on carbon and biodiversity. While factors associated with the extraction of forest products and REDD+ activities are multidimensional, going beyond the forestry sector, the implementation of REDD+ within the forestry sector policy framework is seemingly unable to address forest degradation and livelihood concerns. Changes in carbon stock and biodiversity can also be associated with the way in which REDD+ initiatives are reconciled with existing local practices. My research shows that a lack of reconciliation between centrally-designed carbon inventory and benefit sharing practices and existing CFUG forest inventory and benefit sharing practices, can reduce effectiveness in developing an integrated plan for harvesting forest products, carbon enhancement and biodiversity conservation.

The following sections explore in further detail some of these findings addressing the major research questions.

9.2.1 Changes in carbon stocks, forest biodiversity and removal of forest products are variable

Chapter 4 analysed short-term changes in carbon stocks, forest biodiversity attributes and removal of selected forest products (timber, fuelwood and fodder) in CFs under REDD+. Since implementation of REDD+, there have been positive changes in carbon stocks, negative changes for forest biodiversity, an increase in timber extraction, and a decline in fuelwood and fodder. Although carbon stocks increased in all CF types (i.e. high and low altitude, small and large and less mature and mature CFs), variation in the annual increment of carbon stocks across these forest types was observed, which can be explained by differences in resource use and vegetation growth patterns. However, increment of forest carbon stocks has also been associated with global warming and
CO2 fertilisation, raising the question whether the contribution of REDD+ to climate change mitigation can be clearly differentiated. Low altitude, small forests and less mature or more degraded forests were more likely to show an increase in carbon stocks with the implementation of REDD+, which assumes that appropriate modifications to management strategies and regulation of consumption of forests products had been adopted.

There was also spatial variation in forest biodiversity attributes (i.e. plant species diversity, species richness and stem density) across CF types. Higher plant species richness and stem density occurred in high altitude and large forests, while plant species diversity was high in low altitude and small forests. Forest biodiversity attributes declined following the implementation of REDD+, but changes in these attributes were inconsistent across CF types. The variation was governed by activities adopted by CFUGs including the selection of tree species for plantations, removal of timber, fuelwood and fodder, and the intensity of thinning operations. REDD+ may be able to enhance forest biodiversity by adopting multiple-species tree plantations, use of optimum thinning operations, and biodiversity-conscious (i.e. considerations of status of tree species during extraction of forest products) extraction of forest products.

In relation to forest management activities, my research indicates that the removal of forest products, influenced by the implementation of REDD+, is one of the key elements that affects forest carbon and biodiversity. Previous studies by Pandey et al. (2014), Magnago et al. (2015) and Murray et al. (2015) have highlighted changes in carbon stocks and forest biodiversity following the implementation of REDD+. One of the key contributions of my research is in providing some understanding of how carbon and biodiversity change in situations where local people change their forest use behaviour following the implementation of externally-designed environmental policies such as REDD+. Such an integrated assessment approach could be useful to analyse the detailed implications of the removal of forest products on carbon stocks and forest biodiversity in forests managed by community and beyond, in different spatial and temporal contexts.
9.2.2 Both trade-offs and synergies between carbon, biodiversity and forest products are possible in community forests

Chapter 5 examined synergies (providing multiple benefits) and trade-offs among carbon stocks, forest biodiversity and removal of forest products across CFs. I found a negative association between plant species diversity and carbon stocks, indicating that more diverse forests do not necessarily accumulate more carbon stocks. I also found that the removal of forest products had generally negative associations with carbon stocks and forest biodiversity attributes, although this varied depending on the type of forest product. For example, an increase in the extraction of timber was coincident with an increase in carbon stocks, but led to a decrease in plant species diversity, while the removal of fuelwood was associated with a decrease in carbon stocks and increase in plant species diversity.

Trade-offs were particularly prevalent for carbon stocks, whereby a CF had high carbon stocks and low forest biodiversity attributes or forest products removal. Synergies between carbon stocks and forest biodiversity attributes and between the extraction of forest products and forest biodiversity, generally occurred in high altitude, mature and large forests. Relatively intact or less accessible forests with high resource production capacity and more experienced forest managers are coincident with synergies between carbon and biodiversity.

As discussed previously (see Chapter 2), there is a common understanding that high biodiversity can support high carbon stocks. Several studies such as Harrison et al. (2014), Haase et al. (2012), Day et al. (2014), Gamfeldt et al. (2013) and Egoh et al. (2008) found a positive relationship between forest biodiversity and carbon in large-scale forested landscapes, where less human interference occurred. My research has shown a negative association between carbon and biodiversity in community forests under intensive management. This suggests that the relationships between biodiversity and carbon stocks are likely to be context dependent, and that such relationships can vary between small and large forests as a result of forest management approaches, and be dependent on forest product use and the environmental characteristics of forests. The trade-offs and synergies between carbon and biodiversity should be viewed as dynamic processes that occur within a spatial and temporal context, while management objectives and resource use priorities of local people are influenced by value-laden environmental policies such as REDD+
Prevailing trade-offs that favour increasing carbon stocks over forest biodiversity or forest products extraction indicate that CFUGs have sought to enhance carbon stocks by changing forest activities and resource extraction. Therefore, understanding of existing forest management strategies and forests resource extraction by CFUGs may assist in designing future forest management strategies under REDD+, with the aim of achieving greater synergies between carbon, biodiversity and forest product provision.

9.2.3 Factors associated with forests products extraction are multi-dimensional

Chapter 7 shows that the extraction of forest products is influenced by multi-dimensional local and non-local factors that include biophysical and socio-economic circumstances, and institutional arrangements. The effects of these factors on the extraction of forest products appeared to be contextual and interactive, and varied across different forest product types.

The increase in timber extraction was attributed to local and external economic activities such as the development of road networks and establishment of wood-based factories, and centrally-designed policy related to timber extraction. Given the increase in the growing of trees on private farmlands, an increase in the extraction of timber may be unexpected, but is a result of the price differences of timber sourced from within and outside CFs.

My research shows a decrease in fuelwood and fodder extraction was associated with a combination of local economic and livelihood activities and biophysical characteristics inherent to CFs. Key factors leading to a decrease in fuelwood and fodder extraction were growing of trees on private farmlands, transformation of agriculture practice from traditional crops to vegetable farming, and temporary outmigration of forest users. A decrease in fuelwood extraction is further associated with restrictions imposed by CFUGs and the introduction of alternative energies and technologies for cooking following the implementation of REDD+. Therefore, the future design of REDD+ will need to consider the dynamics of local and external socio-economic circumstances and biophysical characteristics, to achieve a balance between removal of forest products, carbon stocks and biodiversity conservation.
9.2.4 REDD+ results in both positive and negative effects for community forests

Chapter 8 reveals that the implementation of REDD+ through CFs in Nepal can have both positive and negative effects on local approaches of group management and decision-making, benefit distribution and forest activities. These effects are experienced at CFUG or community and household levels.

The implementation of REDD+ can strengthen institutional capacity and thus enhance the capacity of CFUGs to engage with future national REDD+ schemes. However, the implementation of REDD+ through CFs is likely to increase implementation costs of CFUGs and forest users. While REDD+ has the same reporting and monitoring requirements irrespective of per household forest size and the amount of incentive received, small scale CFs may experience limited benefit as the implementation and operational costs for REDD+ are relatively high. Such high implementation costs leave only a small proportion of funds remaining to support livelihood and forest activities, leading to reduced effectiveness of REDD+ in supporting local livelihoods and forest conservation for carbon and biodiversity.

The REDD+ scheme has enhanced male and non-Dalit dominated decision-making, preventing women and Dalit from participating. My research shows that despite the increase in representation of marginalised people in local decision-making bodies arising from the mandatory provisions of REDD+, their attendance has decreased owing to a lack of provision for poor EC members to access REDD+ benefits. The lack of support for women and Dalit through incentive payments to offset the costs of participating in meetings, particularly the opportunity costs of foregoing paid employment, not only prevents them from participating in the decision-making process, but can also both jeopardise their livelihoods and increase their forest products dependency, leading to negative outcomes for carbon and biodiversity. Hence, my research highlights the need for improved program design to enhance the access of poor people to political and economic opportunities, which may not only lead to improved participation in decision-making, but also improve both their livelihoods and outcomes for carbon and biodiversity.

The delivery of REDD+ funds as seed grants, without associated support for poor households to develop appropriate skills, has resulted in undesirable outcomes in terms of income generating activities. I found that REDD+ can enhance pro-poor and
equitable benefit sharing practices and ensure benefits reach poor households, but that seed grants were of limited effectiveness in generating household level income because the amounts distributed from REDD+ to the CFUGs, and from CFUGs down to individual households, were inadequate. The reluctance of existing CFUG EC members to allocate adequate funds to income generating activities, and the poor integration of REDD+ benefit sharing with existing processes of benefit sharing within CFUGs, inhibits the establishment of appropriate income generating activities. This suggests that adopting a pro-poor approach of benefit sharing from REDD+ to CFUGs is not enough, and that providing support to build capacity of poor households, and improved integration of REDD+ benefit sharing with existing practices in CFUGs, is essential to contribute to livelihood improvement of poor households. If significantly more money was available which covers both implementation and opportunity costs, REDD+ might be able to enhance livelihoods of local people.

My research shows that REDD+ can reduce the motivation of forest users, especially within well-off households who do not have access to REDD+ benefits. Well-off forest users were excluded from accessing the REDD+ benefits due to an emphasis on poor households and pro-poor criteria in benefit sharing. REDD+ benefits have been perceived differently by different forest users, but REDD+ fails to address such diverse expectations and develop common interest among forest users. This has reduced motivation, particularly among well-off forest users who have been contributing to conservation within the community forests by meeting their needs from private forests. Exclusion of well-off households from REDD+ benefits not only reduces their motivation and destabilises collective forest activities of self-regulated CFUGs, but it can also increase the pressure on forests for timber extraction. Hence, both the amount of funds available, and the criteria for distribution of those funds from REDD+ to CFUGs to households are critical for maintaining common interests among forest users, enhancing motivation and maintaining collective actions, and thus enabling a synergy between livelihoods, carbon and biodiversity outcomes.

While CFUGs revitalise forest conservation activities and enforce conservation rules, I found that the CFUGs’ tendency to restrict access to forest products as a means to secure carbon, has undermined the customary rights of access to forest products and the livelihoods of forest-dependent people. Livelihoods are particularly threatened when REDD+ benefits are inadequate to compensate for the loss of forest products access.
Meanwhile, the CFUGs focus on adopting protection-oriented approaches to secure carbon rather than carrying out sustainable management of forest activities. Such approaches may deliver short-term carbon enhancement, but in the long-term can undermine customary practices of CFs of sustainable forest management in terms of supplying forest products to forest users and conserving the forests for carbon and biodiversity.

My research shows that REDD+ can strengthen the institutional capacity of CFUGs as suggested by Newton et al. (2015), Agrawal & Angelsen (2009) and Fisher (2014) (Chapter 2, sub-section 2.4.6.2), but it can also increase costs and time commitments of CFUGs, which raises questions about the effectiveness and cost-efficiency of REDD+, particularly in small community forests. As discussed in Chapter 2 (section 2.4.9), McDermott et al. (2013), Luttrell et al. (2013) and Gebera (2013) have studied that cost-efficiency and effectiveness of REDD+ implementation relating to pro-poor or equitable benefit sharing, and they argue that improving equitable benefit sharing can enhance both cost-efficiency and effectiveness of REDD+. However, my research shows that cost-efficiency and effectiveness should be viewed from two perspectives. First, it should be viewed in relation to strengthening the institutional capacity of local institutions for REDD+ implementation. Second, promotion of pro-poor equitable benefit sharing is necessary, but is not sufficient for ensuring cost-efficiency and effectiveness of REDD+ implementation, especially in community managed forests, where forest users have diverse caste/ethnic/socio-economic backgrounds. Contribution-based and cost-based equity may address the issues raised by local people, who have provided technical contributions such as time and skills, and who have made conservation contributions such as offsetting of forest products needs by meeting their needs from their own lands. Consideration of contribution and cost-based equity beside pro-poor equity can enhance motivation and increase collective actions, leading to enhanced cost-efficiency and improvement of effectiveness of forest conservation, but only if sufficient funds are available to meet the expectations of different groups of people. Thus, a combination of pro-poor or needs-based equity with contribution-based and costs-based equity, and consideration of institutional strengthening, could be necessary to promote cost-efficiency and effectiveness in improving forests.
9.2.5 Policy reforms can expand the scope of REDD+ for carbon, biodiversity and livelihoods

The Government of Nepal has demonstrated its institutional readiness for REDD+ at a central level by formulating Nepal’s REDD+ strategy and forming an institution, the RIC, to guide REDD+ implementation (see Chapter 2). However, as highlighted in Chapter 8, there is no equivalent REDD+ authority at the district level to legitimise local achievements related to carbon stocks enhancement resulting from the REDD+ pilot. While the Government of Nepal has envisioned a sub-national approach for REDD+, including at the district level, the establishment of a designated REDD+ unit at this level is essential to build linkages between global concerns for carbon enhancement and biodiversity, and local concern for livelihoods.

However, the establishment of a government-led sub-national REDD+ unit at the district level may need to consider and respect the existing institutional decision-making authority of local institutions including CFUGs. For example, while there is no government-led REDD+ unit at the district level, the REDD+ pilot has formed the Watershed REDD+ Network within the research district and bundled CFUGs in this watershed into the network, to facilitate centrally-designed benefit sharing and carbon measurement initiatives. Although my research did not evaluate in detail the positive and negative effects of the Watershed REDD+ Network on local decision-making processes, I identified that CFUGs were unable to make some decisions related to REDD+ activities, such as the criteria for benefit sharing. This indicates that with the establishment of sub-national REDD+ units at the district level, it will be critical to consider how such institutions respect and enhance or undermine, local rights. Therefore, the effectiveness of the Watershed REDD+ Network as a middle level REDD+ institution in enhancing autonomous decision-making processes of CFUGs could be another issue to be researched in the future, that would provide lessons for the establishment of local-level government-led REDD+ units.

I found that REDD+ activities related to livelihoods are inherently multi-sectoral, reaching beyond the forestry sector. While REDD+ falls within the boundaries of forest policy, there are substantial gaps in the coordination of REDD+ with other sectoral policies, which can potentially hinder the ability of REDD+ to deliver multiple benefits. The lesson for REDD+ is to enhance cross-sectoral coordination with the objective of enhancing carbon stocks and maximising co-benefits.
I found also that linking national policy and local practice is essential for REDD+ to be effective. For example, the disconnect between the processes for seed grant distribution and carbon inventory within REDD+, and existing benefit distribution and forest inventory processes within CFUGs, has created some confusion among forest users, and increased costs for local CFUGs. The reconciliation of the REDD+ processes of seed grant distribution and carbon inventory with existing practices will capitalise on the experience of local CFUGs, and result in a more cohesive and efficient process. The result would be development at CFUG level of an integrated forest operational plan for short-term forest products harvesting, and long-term carbon enhancement and biodiversity conservation.

9.3 Implications to policy and practices

My research has implications for policies and strategies related to REDD+ and community forestry, in relation to their implementation in Nepal, and could contribute to the design of future REDD+ schemes through CFs and other forest management regimes. Nepal’s REDD+ strategy has envisioned going beyond the enhancement of carbon stocks, by incorporating social safeguards to enhance the rights of local people while also improving environmental safeguards including biodiversity conservation, but has lacked empirical evidence and practical understanding about these two aspects particularly in relation to community forestry, where biophysical outcomes and forests management practices are closely linked with human activities.

REDD+ initiatives in Nepal and elsewhere have often focused their objective of forest conservation on reducing emissions and enhancing carbon stocks, and limited their activities to measurement, monitoring and reporting on carbon stocks. Such confinement keeps local people within a narrow boundary of forest ecosystem service benefits with the exclusion of consideration of forest biodiversity, forest products use and local livelihoods. My research has generated information about the interrelationships between forest biodiversity and livelihoods and carbon stocks, which could be useful in addressing Nepal’s priorities for REDD+ co-benefits, since the Government of Nepal has identified improvement of local livelihoods and conservation of biodiversity as major REDD+ co-benefits (GoN, 2014d).
Community forestry in Nepal is widely considered to contribute to the conservation of forests and livelihood improvement through a pro-poor and equitable benefit sharing approach, suggesting that the enhancement of equitable benefit sharing can both improve livelihoods and conserve forests (MFSC, 2013). However, I found pro-poor and equitable benefit sharing is not always sufficient to promote local livelihoods and forest conservation in community forestry, when conditional financial incentives such as REDD+ funds are provided for the delivery of carbon stock enhancement. Since the benefit sharing mechanism under REDD+ is at a preliminary stage at international, national and local levels, my research will be helpful in the design of more appropriate REDD+ benefit sharing mechanisms for enhancing equitable, efficient and effective outcomes.

While the UNFCCC has considered REDD+ as a forest-based climate change mitigation approach, focusing on factors within only the forestry sector may result in REDD+ being ineffective, as REDD+ interfaces with multi-sectoral concerns beyond forestry. Thus, REDD+ should not be restricted to the specific concerns of the forestry sector, rather it should take a broader environmental governance approach. For example, the Forestry Sector Strategy (2014) and associated forest policies do not adequately consider such a cross-sector coordination and broader environmental governance approach to harnessing benefits from emerging global environmental policies. My research suggests that reform of existing forestry policy is needed to expand the role of the forestry sector, and to enhance cross-sectoral coordination, in order to fully respond to the multi-sectoral scope of global environmental policies such as REDD+.

9.4 Limitations and suggestions for future research

There were some limitations to my research, which could be addressed in future research.

**Detailed study of biophysical and social changes in broader ecological regions:** This research was carried out in CFs of the mid-hills region of Nepal, with particular socio-economic and biophysical characteristics and institutional context. Hence, the findings cannot necessarily be generalised to other parts of the country or more broadly. Indeed, my thesis suggests a high level of context specificity in the results. Further research is needed in other social and ecological contexts, and in other forest management regimes.
such as government managed forests, which represent a major component of forest management in Nepal and other countries.

**Long-term research into carbon stocks change**: Although my research assessed short-term changes in ecological and socio-economic outcomes based on the available information from four years of the REDD+ pilot project, there is scope to investigate longer-term implications as more temporal data become available. Although there were noticeable changes in forest attributes arising from the REDD+ pilot, there are uncertainties as to whether such changes would persist in the long-term with or without REDD+ payments.

**Study of opportunities for integrating forest biodiversity and watershed services for REDD+**: My research focused on understanding the potential opportunities and challenges arising from the implementation of REDD+ through CF, based only on data from CFs which have been paid for the enhancement of carbon stocks. Future studies should examine relationships between forest biodiversity and other ecosystem services, such as watershed services in addition to carbon stocks, and explore bundled payments for ecosystem services schemes, which maximise benefits especially for those relying on smaller scale CFs.

**Analysis of detailed costs and benefits of REDD+ in community forests**: I found that REDD+ imposes high implementation costs onto CFUGs, and demands a high time commitment from CFUG EC members and forest users. However, owing to the scope of the study, my research lacked an analysis of costs and benefits at both CFUG and household level. Therefore, a disaggregated analysis of potential costs and carbon benefits at both CFUG and household level is needed to further understand the implications of REDD+ in CFs.

**Long-term study for REDD+ benefit sharing**: There were challenges arising from an emphasis on pro-poor and equity criteria in benefit sharing, with loss of motivation and of collective behaviour for non-recipient or well-off forest users to engage in REDD+ and forest conservation. Further research should investigate implications of other forms of equity in benefit distribution (contribution- based, cost-benefit equity) with reference to cost-efficiency. This would help REDD+ developers and local people to design appropriate benefit sharing mechanisms based on current experiences of benefit sharing practices adopted by the REDD+ pilot.
Reference


Bhattarai, T. P. (2012). Payment for Forest Carbon Services: An Innovative Policy for Developing Countries which aims at both Climate Change Mitigation and Poverty Reduction. PhD, Centre Queensland University, Queensland, Australia.


Bouget, C., Lassauce, A., & Jonsell, M. (2012). Effects of fuelwood harvesting on biodiversity—a review focused on the situation in Europe 11 This article is one of a selection of papers from the International Symposium on Dynamics and Ecological Services of Deadwood in Forest Ecosystems. *Canadian Journal of Forest Research, 42*(8), 1421-1432.


Fisher, R. J. (2014). Lesson Learned from Community Forestry in Asia and Their Relevance for REDD+ USAID- Supported Forest Carbon, Markets and Communities (FCMC), Program. Washington, DC, USA.


ICIMOD. (2010a). Carbon stock baseline report under REDD+ pilot project implemented by ICIMOD, ANSAB and FECOFUN. Kathmandu: ICIMOD, ANSAB and FECOFUN.


Karna, Y. (2012). Mapping above ground carbon using worldview satellite image and lidar data in relationship with tree diversity of forests. MSc, University of Twente, Enschede, The Netherlands.


Miah, M. D. (2014). Trade-offs between forest conservation and livelihoods of the forest dependent people in the Chittagong Hill Tracts: REDD+ strategy development in Bangladesh: The Rufford Small Grant Foundation.


commodity production, and tradeoffs at landscape scales. *Frontiers in Ecology and the Environment, 7*(1), 4-11.


Poudel, N. R., Fuwa, N., & Otsuka, K. (2014). The impacts of a community forestry program on forest conditions, management intensity and revenue generation in...


Sebyowati, A. (2012). Ensuring that women benefit from REDD. *Unasylva, 63*(1), 239.


Thompson, I., Mackey, B., McNulty, S., & Mosseler, A. (2009). Forest resilience, biodiversity, and climate change A synthesis of the biodiversity/resilience/stability relationship in forest ecosystems. Secretariat of
the Convention on Biological Diversity, Technical Series 43 (pp. 67). Montreal: UNEP.


Vatn, A., Vedeld, P., Petursson, J., & Stenslie, E. (2009). The REDD direction—the potential for reduced forest carbon emissions, biodiversity protection and
enhanced development: a desk study with special focus on Tanzania and Uganda
Noragric Report No. 51.


Yadav, N. P. (2004). *Forest user groups in Nepal: impacts on community forest management and community development.* The University of Leeds, School of Geography, UK.


## Appendices

### Appendix 1- Source of data of carbon stocks, plant diversity, and forest products

<table>
<thead>
<tr>
<th>Ecosystem services</th>
<th>ES category (MEA)</th>
<th>Beneficiary</th>
<th>Unit of measurement</th>
<th>Sources of data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon stock</td>
<td>Regulating</td>
<td>Global</td>
<td>tC ha(^{-1})</td>
<td>Raw data from ICIMOD</td>
</tr>
<tr>
<td>Plant diversity</td>
<td>Biodiversity</td>
<td>National, global</td>
<td>Shannon-Wiener diversity index (Dimension less)</td>
<td>Field survey and ICIMOD</td>
</tr>
<tr>
<td>Species richness</td>
<td>Biodiversity</td>
<td>National, global</td>
<td>Type of species in one CFUG</td>
<td>Field survey and ICIMOD</td>
</tr>
<tr>
<td>Stem density</td>
<td>Biodiversity</td>
<td>National, global</td>
<td>Number per ha</td>
<td>Field survey and ICIMOD</td>
</tr>
<tr>
<td>Timber</td>
<td>Provisioning</td>
<td>Local, national</td>
<td>Cubic feet ha(^{-1})</td>
<td>CFUG record, field survey</td>
</tr>
<tr>
<td>Fuelwood</td>
<td>Provisioning</td>
<td>Local</td>
<td>Kg ha(^{-1})</td>
<td>CFUG record, field survey</td>
</tr>
<tr>
<td>Fodder/grass</td>
<td>Provisioning</td>
<td>Local</td>
<td>Kg ha(^{-1})</td>
<td>CFUG record, field survey</td>
</tr>
</tbody>
</table>

Note: MEA – Millennium Ecosystem Assessment, ha\(^{-1}\) – per hectare, tC – tone carbon, CFUG – Community Forest User Group, ICIMOD – International Centre for Integrated Mountain Development
Appendix 2- Calculation of carbon stocks in community forests

Above ground total biomass was measured using an equation proposed by Chave et al. (2005, p. 93) for moist forest type Eq. 1. The equation used three variables (dbh, tree height, and wood specific gravity) and was expressed as follows.

\[ AGTB = 0.0509 \times \rho D^2 H \]  
Eq. (1)

Where,

AGTB = above ground total biomass (kg)

\( \rho = \) Wood specific gravity (g cm\(^{-3}\), I used Nepal specific gravity suggested by the Master Plan for Forestry Sector, Government of Nepal, 1988)

D = over bark diameter of tree at breast height (cm)

H = total tree height (m – measured by using Vertex – a instrument used for measuring height of trees)

**Above ground sapling** biomass was estimated with the equation developed by Tamrakar (2000) as follows.

\[ \text{Log} \,(\text{AGSB}) = a + b \text{ log} \,(D) \]  
Eq. (2)

Where,

AGSB = above ground sapling biomass (kg)

Log = natural log (dimensionless)

a = intercept of allometric relationship for saplings;

b = slope allometric relationship for saplings; and

D = over bark diameter at breast height (measured at 1.3m above ground) [cm].

The values for \( a \) and \( b \) for all tree species are presented in sub-appendix 2.1

**Appendix 2A- Species parameters details used to estimate sapling biomass (Tamrakar, 2000)**

<table>
<thead>
<tr>
<th>Scientific name</th>
<th>Local name</th>
<th>Intercept (a)</th>
<th>Slope (b)</th>
<th>R square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alnus nepensis</td>
<td>Utis</td>
<td>-2.348</td>
<td>2.102</td>
<td>0.978</td>
</tr>
<tr>
<td>Casearia graveolens</td>
<td>Barkamle</td>
<td>-1.627</td>
<td>1.520</td>
<td>0.990</td>
</tr>
<tr>
<td>Castanopsis indica</td>
<td>Katus</td>
<td>-0.710</td>
<td>1.720</td>
<td>0.970</td>
</tr>
<tr>
<td>Engelhardia spicata</td>
<td>Mauwa</td>
<td>-2.142</td>
<td>1.938</td>
<td>0.987</td>
</tr>
<tr>
<td>Eurya acuminata</td>
<td>Jhigune</td>
<td>-1.743</td>
<td>1.797</td>
<td>0.981</td>
</tr>
<tr>
<td>Ficus neriifolia</td>
<td>Dudilo</td>
<td>-0.986</td>
<td>1.750</td>
<td>-</td>
</tr>
<tr>
<td>Ficus semicordata</td>
<td>Khanyo</td>
<td>-1.370</td>
<td>2.010</td>
<td>0.940</td>
</tr>
<tr>
<td>Fraxinus floribunda</td>
<td>Lakuri</td>
<td>-2.130</td>
<td>2.082</td>
<td>0.971</td>
</tr>
<tr>
<td>Litsea monopetala</td>
<td>Kutmero</td>
<td>-1.880</td>
<td>2.260</td>
<td>0.940</td>
</tr>
<tr>
<td>Lyonia ovalifolia</td>
<td>Angari</td>
<td>-2.833</td>
<td>2.010</td>
<td>0.990</td>
</tr>
<tr>
<td>Maesa macrophylla</td>
<td>Bhokate</td>
<td>-1.769</td>
<td>1.650</td>
<td>0.766</td>
</tr>
<tr>
<td>Melastoma melabathricum</td>
<td>Chulese</td>
<td>3.670</td>
<td>1.050</td>
<td>0.980</td>
</tr>
<tr>
<td>Myrica esculenta</td>
<td>Kafal</td>
<td>-2.535</td>
<td>1.403</td>
<td>0.848</td>
</tr>
<tr>
<td>Myrsine capitellata</td>
<td>Setokath</td>
<td>-1.859</td>
<td>1.932</td>
<td>0.979</td>
</tr>
</tbody>
</table>
The biomass of grasses, herbs and leaf litter was calculated using equation 3 as follows.

\[
LHG = \frac{W_{\text{field}}}{A} \times \left( \frac{W_{\text{subsample, dry}}}{W_{\text{subsample, wet}}} \right) \times 10
\]

Eq. (3)

Where,

LHG = Biomass of leaf litter, herbs and grasses (t ha\(^{-1}\))

\( W_{\text{field}} \) = Weight of fresh field sample of leaf litters, herbs and grasses within an area of size \( A \) (m\(^2\))

\( W_{\text{subsample, dry}} \) = Weight of oven dry subsample of leaf litters, herbs and grasses (g)

\( W_{\text{subsample, wet}} \) = Weight of fresh field sample of leaf litters, herbs and grasses (g)

For trees, saplings, herbs, grasses and leaf litter biomass was converted to carbon stocks using the IPCC (2006) default carbon fraction of 0.47.

Soil carbon (t ha\(^{-1}\)) was determined using equation 4 as follows.

\[
SOC = \rho \times d \times %C
\]

Eq. (4)

Where;

SoC = Soil organic carbon stock per unit area [tha\(^{-1}\)];

\( \rho \) = Soil bulk density [g cm\(^{-3}\)];

\( d \) = total depth at which the sample was taken [cm]; and

\( %C \) = carbon concentration [%]

Below ground biomass of trees and sapling was calculated using root and shoot ratio or multiplying above ground biomass 0.20 considering that root parts contains 20% of the total above ground biomass (MacDicken, 1997, p. 84).
Per ha forest carbon stock was calculated by adding the carbon stock of the five carbon pools using equation (5).

\[ tC = C(AGTB) + C(AGSB) + C(HG) + C(BB) + C(L) + SoC \]

Eq. (5)

Where,
- tC = per ha tone carbon (tC ha\(^{-1}\))
- AGTB = carbon in above ground total biomass (tC ha\(^{-1}\)) (tree)
- AGSB = carbon in above ground sapling biomass (tC ha\(^{-1}\))
- BB = carbon in below ground biomass (tC ha\(^{-1}\))
- L = carbon in carbon in leaf litter (tC ha\(^{-1}\))
- SoC = Soil carbon ((tC ha\(^{-1}\))

**Annual per ha carbon stock increment (tC)** = (Per ha carbon stocks Time 2 – Per ha carbon stock Time 1)/Length of year
### Appendix 3- Details of carbon stocks in community forests in 2010 and 2013

<table>
<thead>
<tr>
<th>Name of CFUG</th>
<th>Forest area (ha)</th>
<th>Strata wise community forests area (Ha)</th>
<th>Strata wise per ha carbon tone carbon (tC) for 2010</th>
<th>Strata wise per ha carbon (tC) for 2013</th>
<th>Weighted mean Per ha carbon (tC) in community forests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barkhedaandapari</td>
<td>35.40</td>
<td>11.61</td>
<td>23.78</td>
<td>252.87</td>
<td>166.75</td>
</tr>
<tr>
<td>Bhakate</td>
<td>104.40</td>
<td>76.26</td>
<td>28.17</td>
<td>261.35</td>
<td>152.06</td>
</tr>
<tr>
<td>Blutteri</td>
<td>542.60</td>
<td>377.67</td>
<td>164.97</td>
<td>262.37</td>
<td>225.81</td>
</tr>
<tr>
<td>Charnawati 1</td>
<td>819.35</td>
<td>733.67</td>
<td>85.67</td>
<td>255.86</td>
<td>125.08</td>
</tr>
<tr>
<td>Charnawati 2</td>
<td>55.12</td>
<td>43.12</td>
<td>11.99</td>
<td>200.53</td>
<td>166.75</td>
</tr>
<tr>
<td>Chaysebhagwati</td>
<td>30.32</td>
<td>23.82</td>
<td>6.5</td>
<td>170.3</td>
<td>166.75</td>
</tr>
<tr>
<td>Dhadesinghdevi</td>
<td>343.69</td>
<td>229.51</td>
<td>114.18</td>
<td>249.5</td>
<td>180.60</td>
</tr>
<tr>
<td>Eklepakha</td>
<td>197.33</td>
<td>157.83</td>
<td>39.58</td>
<td>173.05</td>
<td>166.75</td>
</tr>
<tr>
<td>Harisiddhimai</td>
<td>28.28</td>
<td>3.51</td>
<td>24.85</td>
<td>228.56</td>
<td>134.37</td>
</tr>
<tr>
<td>Jugearkha</td>
<td>125.6</td>
<td>101.5</td>
<td>24.1</td>
<td>189.64</td>
<td>166.75</td>
</tr>
<tr>
<td>Kopila</td>
<td>96.07</td>
<td>88.24</td>
<td>7.83</td>
<td>174.18</td>
<td>166.75</td>
</tr>
<tr>
<td>Majikharkalsepan</td>
<td>174.18</td>
<td>145.73</td>
<td>28.44</td>
<td>169.03</td>
<td>166.75</td>
</tr>
<tr>
<td>Mathani</td>
<td>28.28</td>
<td>22.52</td>
<td>5.77</td>
<td>289.54</td>
<td>209.46</td>
</tr>
<tr>
<td>Napkeyanmara</td>
<td>152.46</td>
<td>82.56</td>
<td>69.9</td>
<td>248.38</td>
<td>129.86</td>
</tr>
<tr>
<td>Setidevi Dadar</td>
<td>421.71</td>
<td>192.63</td>
<td>229.08</td>
<td>225.14</td>
<td>150.69</td>
</tr>
<tr>
<td>Shivajungbhumethan</td>
<td>46.67</td>
<td>16.71</td>
<td>29.97</td>
<td>144.56</td>
<td>121.78</td>
</tr>
<tr>
<td>Sitakunda</td>
<td>141.31</td>
<td>15.72</td>
<td>125.59</td>
<td>180.78</td>
<td>209.86</td>
</tr>
<tr>
<td>Thangsadeurali</td>
<td>124.37</td>
<td>59.08</td>
<td>65.29</td>
<td>213.47</td>
<td>165.22</td>
</tr>
<tr>
<td>Thumkadanda</td>
<td>40.78</td>
<td>20.56</td>
<td>20.22</td>
<td>207.72</td>
<td>131.30</td>
</tr>
</tbody>
</table>
Appendix 4- Estimation of plant species diversity index

Plant species diversity was calculated using Shannon-Wiener diversity index (Shannon and Weaver, 1963) with following equation.

\[ H' = - \sum_{i=1}^{s} (P_i \times \ln(P_i)) \]

Where,

- \( H' \) is tree diversity index
- \( S \) = number of species
- \( P_i \) = Proportion of individuals found in the \( i^{th} \) species \( (P_i = n_i/N) \)
- \( n_i \) = is the number of individuals of species \( i \) in the sample
- \( N \) = total number of individuals sampled

Species richness of each CF was estimated by calculating rarefaction of plant species data recorded from sample plots of the respective CF. Below equation (Appendix 5) was used for rarefaction of species data.
Appendix 5- Calculation of species richness using rarefaction

\[ E(S) = \sum_{i} \left( 1 - \frac{\binom{N - N_i}{n}}{\binom{N}{n}} \right) \]

Expected number of species (species)

Where;

\( E(S) \) = expected number of species in the rarefied sample

\( n \) = standard sample size used for comparison (I have used smallest sample size for this study (Phil Ganter))

\( N \) = total sample size

\( N_i \) = number of individuals in the \( i^{th} \) species in the sample to be rarefied
## Appendix 6- Illustration of carbon, forest biodiversity and forest product removal in 2010, 2013 and leakage plot in 2013

<table>
<thead>
<tr>
<th>Community forests</th>
<th>Per ha carbon stocks</th>
<th>Plant diversity index</th>
<th>Species richness</th>
<th>Stem density</th>
<th>Per ha carbon stocks</th>
<th>Plant diversity index</th>
<th>Species richness</th>
<th>Stem density</th>
<th>Per ha carbon stocks</th>
<th>Plant diversity index</th>
<th>Species richness</th>
<th>Stem density</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barkhedandapari</td>
<td>195.00</td>
<td>2.10</td>
<td>11</td>
<td>1400</td>
<td>211.66</td>
<td>2.07</td>
<td>10</td>
<td>1600</td>
<td>213.21</td>
<td>1.32</td>
<td>14</td>
<td>2213</td>
</tr>
<tr>
<td>Bhakare</td>
<td>231.87</td>
<td>1.30</td>
<td>14</td>
<td>1440</td>
<td>242.33</td>
<td>1.08</td>
<td>12</td>
<td>1080</td>
<td>212.67</td>
<td>1.74</td>
<td>9</td>
<td>780</td>
</tr>
<tr>
<td>Bhitteripakha</td>
<td>251.26</td>
<td>1.59</td>
<td>30</td>
<td>2338</td>
<td>253.21</td>
<td>1.50</td>
<td>27</td>
<td>2684</td>
<td>225.32</td>
<td>1.96</td>
<td>16</td>
<td>1960</td>
</tr>
<tr>
<td>Charnawati 1</td>
<td>242.18</td>
<td>1.25</td>
<td>41</td>
<td>2600</td>
<td>262.08</td>
<td>1.15</td>
<td>39</td>
<td>2760</td>
<td>405.10</td>
<td>1.23</td>
<td>15</td>
<td>1200</td>
</tr>
<tr>
<td>Charnawati 2</td>
<td>193.18</td>
<td>1.82</td>
<td>19</td>
<td>4907</td>
<td>203.63</td>
<td>1.52</td>
<td>11</td>
<td>2200</td>
<td>212.71</td>
<td>1.85</td>
<td>15</td>
<td>2467</td>
</tr>
<tr>
<td>Chyasebhagabati</td>
<td>169.53</td>
<td>2.22</td>
<td>13</td>
<td>1560</td>
<td>182.56</td>
<td>2.10</td>
<td>15</td>
<td>2520</td>
<td>222.04</td>
<td>2.22</td>
<td>13</td>
<td>1560</td>
</tr>
<tr>
<td>Dhandesinghdevi</td>
<td>226.61</td>
<td>1.34</td>
<td>23</td>
<td>2400</td>
<td>230.89</td>
<td>1.18</td>
<td>22</td>
<td>2280</td>
<td>361.01</td>
<td>0.91</td>
<td>8</td>
<td>1440</td>
</tr>
<tr>
<td>Eklepakha</td>
<td>171.78</td>
<td>1.46</td>
<td>18</td>
<td>3400</td>
<td>189.71</td>
<td>1.36</td>
<td>19</td>
<td>2560</td>
<td>232.20</td>
<td>0.63</td>
<td>8</td>
<td>1400</td>
</tr>
<tr>
<td>Harisiddhimai</td>
<td>146.03</td>
<td>1.27</td>
<td>9</td>
<td>5680</td>
<td>169.51</td>
<td>1.24</td>
<td>7</td>
<td>3320</td>
<td>160.17</td>
<td>1.71</td>
<td>10</td>
<td>4520</td>
</tr>
<tr>
<td>Jagedarkha</td>
<td>185.24</td>
<td>1.72</td>
<td>27</td>
<td>4520</td>
<td>199.11</td>
<td>1.20</td>
<td>18</td>
<td>3280</td>
<td>221.40</td>
<td>1.79</td>
<td>14</td>
<td>2930</td>
</tr>
<tr>
<td>Kopila</td>
<td>173.57</td>
<td>1.43</td>
<td>13</td>
<td>2680</td>
<td>191.62</td>
<td>1.53</td>
<td>17</td>
<td>2480</td>
<td>169.11</td>
<td>1.70</td>
<td>9</td>
<td>2600</td>
</tr>
<tr>
<td>Majhkharkalisepani</td>
<td>168.66</td>
<td>1.45</td>
<td>23</td>
<td>4240</td>
<td>178.90</td>
<td>1.28</td>
<td>17</td>
<td>2600</td>
<td>178.97</td>
<td>1.45</td>
<td>14</td>
<td>2440</td>
</tr>
<tr>
<td>Mathani</td>
<td>273.20</td>
<td>1.79</td>
<td>13</td>
<td>1720</td>
<td>302.01</td>
<td>1.62</td>
<td>15</td>
<td>2320</td>
<td>165.79</td>
<td>1.53</td>
<td>9</td>
<td>1720</td>
</tr>
<tr>
<td>Napkeyamara</td>
<td>194.04</td>
<td>1.75</td>
<td>26</td>
<td>3340</td>
<td>211.79</td>
<td>1.611</td>
<td>23</td>
<td>3320</td>
<td>172.25</td>
<td>1.55</td>
<td>24</td>
<td>4720</td>
</tr>
<tr>
<td>Setidevidadar</td>
<td>184.70</td>
<td>0.59</td>
<td>14</td>
<td>5120</td>
<td>205.91</td>
<td>0.430</td>
<td>14</td>
<td>4720</td>
<td>421.15</td>
<td>0.90</td>
<td>9</td>
<td>2960</td>
</tr>
<tr>
<td>Shivajungbhumes thi an</td>
<td>129.94</td>
<td>1.32</td>
<td>14</td>
<td>1480</td>
<td>141.78</td>
<td>1.261</td>
<td>15</td>
<td>2640</td>
<td>152.15</td>
<td>1.40</td>
<td>9</td>
<td>2320</td>
</tr>
<tr>
<td>Sitakunda</td>
<td>206.62</td>
<td>1.09</td>
<td>14</td>
<td>1720</td>
<td>221.82</td>
<td>1.130</td>
<td>15</td>
<td>1760</td>
<td>226.71</td>
<td>1.69</td>
<td>15</td>
<td>3000</td>
</tr>
<tr>
<td>Thangsadeurali</td>
<td>188.14</td>
<td>1.40</td>
<td>20</td>
<td>1600</td>
<td>192.12</td>
<td>1.161</td>
<td>16</td>
<td>1440</td>
<td>231.97</td>
<td>0.50</td>
<td>4</td>
<td>960</td>
</tr>
<tr>
<td>Thumkadanda</td>
<td>169.83</td>
<td>1.53</td>
<td>18</td>
<td>3880</td>
<td>181.29</td>
<td>1.573</td>
<td>20</td>
<td>3920</td>
<td>185.66</td>
<td>1.27</td>
<td>8</td>
<td>1960</td>
</tr>
</tbody>
</table>
Appendix 7- Distribution of carbon stocks in community forests in 2010 and 2013
Appendix 8- Distribution plant diversity index (top left), species richness (top right), and stem density (bottom) in 2010 and 2013
Appendix 9- Extraction of timber (top left), fuelwood (top right), and fodder (bottom) in 2010 and 2013
## Appendix 10- Standardised value of carbon stock, forest biodiversity attributes and forest product extraction

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th></th>
<th>2013</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Carb on stock s</td>
<td>Plant specie s divers ity</td>
<td>Spec ies richness</td>
<td>Stem dens ity</td>
<td>Timb er</td>
</tr>
<tr>
<td>0.01</td>
<td>1.66</td>
<td>-1.01</td>
<td>-1.10</td>
<td>-0.55</td>
</tr>
<tr>
<td>1.02</td>
<td>-0.54</td>
<td>-0.63</td>
<td>-1.07</td>
<td>2.30</td>
</tr>
<tr>
<td>1.55</td>
<td>0.26</td>
<td>1.40</td>
<td>-0.43</td>
<td>-0.19</td>
</tr>
<tr>
<td>1.30</td>
<td>-0.67</td>
<td>2.79</td>
<td>-0.25</td>
<td>-0.82</td>
</tr>
<tr>
<td>-0.04</td>
<td>0.89</td>
<td>0.01</td>
<td>1.39</td>
<td>-0.33</td>
</tr>
<tr>
<td>-0.69</td>
<td>1.97</td>
<td>-0.75</td>
<td>-0.98</td>
<td>-0.76</td>
</tr>
<tr>
<td>0.87</td>
<td>-0.43</td>
<td>0.51</td>
<td>-0.39</td>
<td>0.38</td>
</tr>
<tr>
<td>-0.63</td>
<td>-0.09</td>
<td>-0.12</td>
<td>0.32</td>
<td>0.09</td>
</tr>
<tr>
<td>-1.34</td>
<td>-0.62</td>
<td>-1.26</td>
<td>1.94</td>
<td>-0.69</td>
</tr>
<tr>
<td>-0.26</td>
<td>0.62</td>
<td>1.02</td>
<td>1.11</td>
<td>0.88</td>
</tr>
<tr>
<td>-0.58</td>
<td>-0.17</td>
<td>-0.75</td>
<td>-0.19</td>
<td>-0.69</td>
</tr>
<tr>
<td>-0.72</td>
<td>-0.11</td>
<td>0.51</td>
<td>0.92</td>
<td>-0.79</td>
</tr>
<tr>
<td>2.15</td>
<td>0.80</td>
<td>-0.75</td>
<td>-0.87</td>
<td>-0.62</td>
</tr>
<tr>
<td>-0.02</td>
<td>0.69</td>
<td>0.89</td>
<td>0.28</td>
<td>-0.48</td>
</tr>
<tr>
<td>-0.28</td>
<td>-2.47</td>
<td>-0.63</td>
<td>1.54</td>
<td>-0.40</td>
</tr>
<tr>
<td>-1.78</td>
<td>-0.47</td>
<td>-0.63</td>
<td>-1.04</td>
<td>-0.83</td>
</tr>
<tr>
<td>0.32</td>
<td>-1.12</td>
<td>-0.63</td>
<td>-0.87</td>
<td>2.16</td>
</tr>
<tr>
<td>-0.18</td>
<td>-0.27</td>
<td>0.13</td>
<td>-0.96</td>
<td>-0.19</td>
</tr>
<tr>
<td>-0.69</td>
<td>0.10</td>
<td>-0.12</td>
<td>0.66</td>
<td>1.52</td>
</tr>
</tbody>
</table>
Appendix 11- Steps used in producing graphs showing relationships

1. Identify the median value of CFs for each forest product from standardised scores
2. Read in data that has the community forest number and the standardised scores
3. Plot a blank plot of the pairwise scores as required with appropriate labelling
4. Create a vector of colour numbers in the same order as the scores representing above and below median scores each pair
   - Above or equal x median score and above or equal y median score is green (4)
   - Above or equal x median score and below y median score is blue (5)
   - Below x median score and above or equal y median score is orange (2)
   - Below x median score and below y median score is grey (16)
5. Plot the pairwise scores as required using the text function. Using the scores as coordinates, community forest number as plot symbol/text and the above colour vector for indicating the quadrant.
6. Use the lines command to overlay the medians for x and y scores

Repeat the method for each pair combination required. The plot area was split into a 1x3 array and square plotting area using the `par(mfrow=c(1,3))` command and the `par(pty="s")`
### Appendix 12- Association (Spearman’s rank order correlations) between carbon stocks, forest biodiversity attributes, and forest products extraction in 2010

<table>
<thead>
<tr>
<th>Carbon stocks, forest biodiversity attributes and forest products</th>
<th>Correlation ($r_s$) parenthesis are p-value</th>
<th>Strength of association</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon stock and plant diversity</td>
<td>0.04 ($p=0.85$)</td>
<td>Weak</td>
</tr>
<tr>
<td>Carbon stock and species richness</td>
<td>0.30 ($p=0.21$)</td>
<td>Moderate</td>
</tr>
<tr>
<td>Carbon stock and stem density</td>
<td>-0.34 ($p=0.15$)</td>
<td>Moderate</td>
</tr>
<tr>
<td>Carbon stock and timber</td>
<td>0.35 ($p=0.14$)</td>
<td>Moderate</td>
</tr>
<tr>
<td>Carbon stock and fuel wood</td>
<td>-0.16 ($p=0.51$)</td>
<td>Weak</td>
</tr>
<tr>
<td>Carbon stock and fodder</td>
<td>0.005 ($p=0.98$)</td>
<td>Weak</td>
</tr>
<tr>
<td>Plant species diversity and timber</td>
<td>-0.07 ($p=0.76$)</td>
<td>Weak</td>
</tr>
<tr>
<td>Plant species diversity and fuel wood</td>
<td>0.19 ($p=0.41$)</td>
<td>Weak</td>
</tr>
<tr>
<td>Plant species diversity and fodder</td>
<td>0.31 ($p=0.18$)</td>
<td>Moderate</td>
</tr>
<tr>
<td>Species richness and timber</td>
<td>0.19 ($p=0.43$)</td>
<td>Weak</td>
</tr>
<tr>
<td>Species richness and fuel wood</td>
<td>-0.44 ($p=0.05$)</td>
<td>Moderate</td>
</tr>
<tr>
<td>Species richness and fodder</td>
<td>0.01 ($p=0.94$)</td>
<td>Weak</td>
</tr>
<tr>
<td>Stem density and timber</td>
<td>0.01 ($p=0.96$)</td>
<td>Weak</td>
</tr>
<tr>
<td>Stem density and fuel wood</td>
<td>-0.17 ($p=0.47$)</td>
<td>Weak</td>
</tr>
<tr>
<td>Stem density and fodder</td>
<td>-0.13 ($p=0.57$)</td>
<td>Weak</td>
</tr>
</tbody>
</table>

*correlation is significant at the 0.05 level (2-tailed)
### Appendix 13- Community forests having trade-offs and synergies between carbon stocks and forest biodiversity attributes and forest products, and changes from 2010 to 2013

<table>
<thead>
<tr>
<th>Variables and their relationships</th>
<th>Trade-offs (domination of one service A)</th>
<th>Trade-offs (domination of other service B)</th>
<th>Total CFs with trade-offs</th>
<th>Positive synergy</th>
<th>Negative synergy</th>
<th>Total CFs with synergies</th>
<th>Changed priorities from 2010 to 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) Carbon and (B) Plant species diversity</td>
<td>5</td>
<td>5</td>
<td>10</td>
<td>5</td>
<td>4</td>
<td>9</td>
<td>From PS to TC=15, From PS to TSD= 11, From TPD to NS= 10, From TC to NS = 18</td>
</tr>
<tr>
<td>(A) Carbon and (B) species richness</td>
<td>4</td>
<td>4</td>
<td>8</td>
<td>6</td>
<td>5</td>
<td>11</td>
<td>From NS to TC-5, From TSR to TC- 15, From PS to TRS – 18, From NS to TRS – 11</td>
</tr>
<tr>
<td>(A) Carbon and (B) Stem density</td>
<td>7</td>
<td>7</td>
<td>14</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>From PS to TC – 5, From TSD to PS – 15, From TC to NS – 18, From TC to PS - 3, From NS to TSD - 16</td>
</tr>
<tr>
<td>(A) Carbon and (B) Timber</td>
<td>4</td>
<td>4</td>
<td>8</td>
<td>6</td>
<td>5</td>
<td>11</td>
<td>From PS to TC – 5, From TT to TC – 15, From TC to PS – 13, From NS to TT – 16, From PS to TT - 18</td>
</tr>
<tr>
<td>(A) Carbon and (B) Fuel wood</td>
<td>4</td>
<td>4</td>
<td>8</td>
<td>6</td>
<td>5</td>
<td>11</td>
<td>From NS to TC – 15, From PS to TC – 17, From TFW to NS – 12, From NS to TFW – 8 and 11, From PS to TFW-18</td>
</tr>
<tr>
<td>(A) Carbon and (B) Fodder</td>
<td>4</td>
<td>4</td>
<td>8</td>
<td>6</td>
<td>5</td>
<td>11</td>
<td>From TC to PS – 1, From PS to TC – 7, From TF to PS – 15</td>
</tr>
<tr>
<td>(A) Plant species diversity and (B) Timber</td>
<td>5</td>
<td>5</td>
<td>10</td>
<td>5</td>
<td>4</td>
<td>9</td>
<td>From TPD to PS – 13, From PS to TPD – 5, From PS to TT – 10, From NS to TPD – 11, From NS to TT – 16, From TT to NS - 15</td>
</tr>
<tr>
<td>(A) Plant species diversity and (B) Fuel wood</td>
<td>4</td>
<td>4</td>
<td>8</td>
<td>6</td>
<td>5</td>
<td>11</td>
<td>From TPD to PS – 8, From TPD to NS – 10, From PS to TPD – 12, From NS to PS - 11, From TFW to NS - 17</td>
</tr>
<tr>
<td>(A) Plant species diversity and (B) Fodder</td>
<td>4</td>
<td>4</td>
<td>8</td>
<td>6</td>
<td>5</td>
<td>11</td>
<td>From TPD to NS – 10, From NS to TF – 11, From TF to NS - 7</td>
</tr>
<tr>
<td>(A) Species richness and (B) Timber</td>
<td>3</td>
<td>3</td>
<td>6</td>
<td>7</td>
<td>6</td>
<td>13</td>
<td>From PS to NS – 5, From NS to TSR – 11, From NS to TT- 13 and 16, From TT to NS - 15</td>
</tr>
<tr>
<td>(A) Species richness and (B) Fuel wood</td>
<td>5</td>
<td>5</td>
<td>10</td>
<td>5</td>
<td>4</td>
<td>9</td>
<td>From TSR to PS – 8, From TSR to NS -5, From PS to TSR – 12, From NS to PS -11, From TFW to NS - 17</td>
</tr>
<tr>
<td>(A) Species richness and (B) Fodder</td>
<td>4</td>
<td>4</td>
<td>8</td>
<td>6</td>
<td>5</td>
<td>11</td>
<td>From PS to TSR – 7, From PS to TF – 5, From NS to TSR – 11, From NS to TF - 1</td>
</tr>
<tr>
<td>(A) Stem density and (B) Timber</td>
<td>5</td>
<td>5</td>
<td>10</td>
<td>5</td>
<td>4</td>
<td>9</td>
<td>From TSD to NS – 11, From PS to NS -5, From PS to TSD – 15, From NS to TT – 13, From NS to PS – 16</td>
</tr>
<tr>
<td></td>
<td>From TSD to NS – 5</td>
<td>From PS to TFW – 5</td>
<td>From TFW to NS – 11</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------</td>
<td>-------------------</td>
<td>--------------------</td>
<td>---------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(A) Stem</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>density and</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(B) Fodder</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel wood</td>
<td>6</td>
<td>6</td>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>3</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(A) Stem</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>density and</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(B) Fodder</td>
<td>5</td>
<td>5</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>4</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Appendix 14- Community forests with trade-offs and synergies between carbon stocks, plant species diversity, richness, and stem density in 2010
Appendix 15- Community forests with trade-offs and synergies between carbon stocks and extraction of timber, fuel wood and fodder in 2010
Appendix 16- Community forests with trade-offs and synergies between plant species diversity and extraction of timber, fuelwood and fodder in 2010
Appendix 17- Community forests with trade-offs and synergies between species richness and extraction of timber, fuelwood and fodder in 2010
Appendix 18- Community forests with trade-offs and synergies between stem density and extraction of timber, fuelwood and fodder in 2010
## Appendix 19- Local criteria adopted for well-being in CFUG households

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Well-off</th>
<th>Medium</th>
<th>Poor</th>
<th>Very poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality and area of cultivated land</td>
<td>Large landholding size of irrigated and non-irrigated land</td>
<td>Limited irrigated land and some non-irrigated land</td>
<td>Only non-irrigated land but less</td>
<td>Less or very less land</td>
</tr>
<tr>
<td>Food sufficiency</td>
<td>Food production from own farm sufficient for throughout the year, sale of surplus food</td>
<td>Food production from own farm, sufficiency at least for nine months</td>
<td>Food sufficiency for 6 months, partly share cropping of others, more children</td>
<td>Food enough for not more than 3 months, mostly share cropping of others</td>
</tr>
<tr>
<td>Education</td>
<td>Children enrolled in Kathmandu or district headquarters private schools, most of family members are educated</td>
<td>Children enrolled in local private school or in public school, family members are partially educated (male)</td>
<td>Children enrolled in local public school, very few family members educated (mid level education)</td>
<td>Family members are non-educated, children admitted to public (government) school, but dropped school</td>
</tr>
<tr>
<td>Income sources and money lending</td>
<td>Permanent source of incomes other than agriculture (government, non-government job, pension, business or remittance), bank balance or lending money to neighbors</td>
<td>Source of income from job, pension, business and remittance</td>
<td>Mostly depend on agriculture in own land or share cropping, labour work in local or district headquarters, remittance but low income countries</td>
<td>Daily wages, no permanent income sources, normally borrowing money from local merchant or well-off households,</td>
</tr>
<tr>
<td>Social status in the community</td>
<td>Higher caste group, involved in local network and institution, have good link with district officials and politics</td>
<td>Mostly higher caste group and Indigenous Peoples, partly involved in social network and institution</td>
<td>Mostly indigenous Peoples and lower caste, rarely involved in social network and institution</td>
<td>Mostly from Dalit, not involved in network and institution</td>
</tr>
<tr>
<td>Quality of house</td>
<td>Cement concrete housing in Kathmandu and district headquarters <em>(applies only in Sitakunda CFUG)</em></td>
<td>Permanent house, with zinc sheet</td>
<td>Permanent house with zinc or grass roof</td>
<td>Small house with grass roof</td>
</tr>
<tr>
<td>Household head (single women)</td>
<td></td>
<td></td>
<td></td>
<td>Single women, elderly people</td>
</tr>
</tbody>
</table>

Appendix 20- Checklist of in-depth interview

A. For CFUG members

Participant time required for interview: 2.0-2.30 hrs

Factors affecting removal of forest products from community forests with reference to carbon, biodiversity and forest products (RQ 3)

- What forest products do you extract from community forests?
- What changes have you observed in extraction of forest products in your community forests over the past five years?
- If changed - increased or decreased, why?
- What factors contribute to increase or decrease in forest products extraction from the community forests?

So far we discussed about the change in extraction of forest products in your community forests. Now, we discuss on the REDD+ pilot project (carbon project) that has been implemented in your community forest user group.

REDD+ pilot and changed practices (RQ 4)

1. What changes have you observed in group management in your CFUG after the REDD+ pilot?
   a. Have you experienced any changes in group management (meeting frequency, meeting agenda, decision-making and participation)?
   b. If yes, could you please elaborate the changes you have observed?
   c. Are there any changes in attendance of EC members in committee meeting? (Increase and decrease and reasons)
   d. Are there any changes in attendances of local forests users in general assembly in recent years? (Increase/decrease and reasons)
   e. How information is shared by executive committee and how they communicate to forest users?

2. What changes have you observed in benefit distribution practices in your CFUG with the REDD+ pilot?
   a. Explain activities that your CFUG invests its fund.
   b. What differences have your observed in CFUG’s fund allocation after the REDD+ Pilot?
   c. Who get benefits from CFUG and REDD+ why?
d. Have you observed any changes in benefit distribution rules and practices to local forest users in recent years or after the REDD+ pilot?

e. Have you experienced any changes in improvement of livelihoods and income generation of local forest users after the REDD+ pilot?

f. If not, why?

3. What changes have you experienced in forest management activities after the REDD+ pilot?

a. What differences have you experienced in forest management activities in recent years?

b. What differences have you observed in forest products distribution in recent years (after pilot REDD+)?

c. Any changes in restriction, change in duration and quantity of forest products extraction from forests?

d. Which social group – caste, class or sex group have been most affected and why?
B. For district stakeholders (FECOFUN, District Forest Office, District Carbon Trust Fund Monitoring Committee, Watershed REDD+ Network and Private agency – saw mill owner)

Name of interviewee: ___________________________ Sex: Male/Female: ___________________________
Organisation: ___________________________ Position: ___________________________

Involvement with the REDD+ pilot:

**Change in forest product extraction from community forests (RQ 3)**

- Major forest products that forest users harvest from community forests
- Major changes in extraction of forest products from community (what forest products what change) in recent years i.e. after 5 years
- Major factors associated with the changes in extraction of forest products (factors and forest products)
- Policy provisions related to extraction of forest products

**REDD+ pilot and changed practices at CFUGs (RQ 4)**

- Major changes observed in group management after the REDD+ pilot.
  - Committee meeting, general assembly, Watershed REDD+ Network (Participation, decision-making process and information sharing)
- Major changes observed in benefit distribution practices between and within CFUG with the REDD+ pilot
  - Change in allocation of fund to different activities
  - Effectiveness of funds in income generating activities, forest activities and livelihood improvement
- Major changes experienced in forest management activities in CFUGs after the REDD+ pilot.
  - Change in forest activities increase or decrease or new activities initiated (inside and outside community forests)
  - Change in harvesting practices and distribution rules
- Any new initiatives that CFUGs have initiated after the REDD+ pilot?
C. Interview Guide – central level stakeholders - in-depth interview
Name of interviewee: 
Sex: Male/Female
Organization: 
Designation: 
Date of response:

1. Major concerns experienced in forest products extraction in community forests.
2. What changes have you observed at central level policies and strategies after REDD+ in Nepal?
3. Key challenges and opportunities of REDD+ initiative through community forestry system.
   - From policy and institutional arrangements perspective
   - From practical perspective – size of forest, scale of benefit
4. Key issues in REDD+ payment/benefit distribution in community forest user groups based on experiences of the REDD+ pilot project
5. How can REDD+ in community forests contribute to the carbon enhancement and continued supply of the local forest needs (timber, fuel wood and fodder)?
   - Any challenges the REDD+ restricts the consumption of forest resources – timber, fuel wood and fodder?
   - How REDD+ can contribute achieve co-benefits (local livelihood, biodiversity conservation, forest governance improvement)
   - How can REDD+ achieve these synergy outcomes?
Appendix 21 - Interview guide for focus group discussion

A. CFUG executive committee members
Participants’ time required: 2:30 to 3:30 hrs

**Used participatory tools for the discussion**
- Trend analysis
- Visioning and pathways

**Change in forest products extraction from the community forests (RQ 3)**
- Major forest products extracted by forest users
- Change in extraction of forest products
- Factors (both direct, indirect, internal and external) influence the change in extraction of forest products
- Supply and demand status of forest products

**REDD+ pilot and changed practices (RQ 4)**
- Changes in group management, decision-making and participation of local forests users in group activities after pilot REDD+
  - EC meeting frequency and agenda of meeting
  - Attendance of EC member in committee meeting
  - Participation of forest users in general assembly
- Benefit sharing mechanism
  - Priority areas of CFUG fund allocation
  - Change in priority areas of CFUG fund allocation
- Change in forest activities and forest harvesting
  - Any changes in forest activities – decrease and increase
  - Change in forest product distribution (season, time, quantity, techniques and basis of forest product distribution) to users following the implementation of pilot REDD+
  - Key strategy that CFUG and local forest users are using/have started in relation to forest products
B. Dalit

Proposed participatory tools for discussion

1. *Participatory mapping and mobility map* (to understand their resources and practices of forest product collection)
2. *Pebble scoring* (to appraise and prioritize/compare forest products each other or importance)

Checklist for discussions

Major factors that influence change in extraction of forest products (RQ 3)

Forest products collection/harvest and use from community forests

(Participatory resource mapping/mobility map)

- Availability of forest products
- Collection of forest products by forest users

Priority over forest products (pebble scoring)

- Identification of forest products that mostly collect from community forests and prioritize (pebble score)

Change in extraction of forest products

Factors affecting change in extraction of forest products

REDD+ pilot and changed practices (RQ 4)

- Major changes in group management (decision-making, participation) after REDD+ pilot (carbon project)
  - Any changes in committee meeting frequency and agenda
  - Attendance of EC members
- Major changes in benefit sharing system (CFUG fund and REDD+ fund)
  - Any special provision of CFUG or REDD+ fund to *Dalit*?
  - Any improvement of household income of *Dalit* from CFUG and REDD+ fund?

Major changes observed in forest management activities and resource distribution after the REDD+ pilot

- Changes in forest activities that you have experienced
- Effects that you have experienced

C. Women group

Checklist for discussions

Major factors that influence change in extraction of forest products (RQ 3)

Forest products collection/harvest and use from community forests

(Participatory resource mapping/mobility map)
• Availability of forest products
• Collection of forest products by forest users

**Priority over forest products (pebble scoring)**
• Identification of forest products that mostly collect from community forests and prioritize (pebble score)

**Change in extraction of forest products**

**Factors affecting change in extraction of forest products**

**REDD+ pilot and changed practices (RQ 4)**
• Major changes in group management (decision-making, participation) after REDD+ pilot (carbon project)
  • Any changes in committee meeting frequency and agenda
  • Attendance of EC members
• Major changes in benefit sharing system (CFUG fund and REDD+ fund)
  • Any special provision of CFUG or REDD+ fund to women?
  • Any improvement of household income of women from CFUG and REDD+ fund?

Major changes observed in forest management activities and resource distribution after the REDD+ pilot
• Changes in forest activities that you have experienced
• Effects that you have experienced

**D. Indigenous peoples**

**Checklist for discussions**

**Major factors that influence change in extraction of forest products (RQ 3)**

**Forest products collection/harvest and use from community forests**

**(Participatory resource mapping/mobility map)**
• Availability of forest products
• Collection of forest products by forest users

**Priority over forest products (pebble scoring)**
• Identification of forest products that mostly collect from community forests and prioritize (pebble score)

**Change in extraction of forest products**

**Factors affecting change in extraction of forest products**

**REDD+ pilot and changed practices (RQ 4)**
• Major changes in group management (decision-making, participation) after REDD+ pilot (carbon project)
• Any changes in committee meeting frequency and agenda
• Change in attendance of EC members
• Major changes in benefit sharing system (CFUG fund and REDD+ fund)
  • Any special provision of CFUG or REDD+ fund to Indigenous peoples?
  • Any improvement of household income of indigenous peoples from CFUG and REDD+ fund?

Major changes observed in forest management activities and resource distribution after the REDD+ pilot
• Changes in forest activities that you have experienced
• Effects that you have experienced
Appendix 22- Checklist for mail survey with central level stakeholders

Name of interviewee: 
Sex: Male/Female
Organisation: 
Designation: 
Date of response:

1. What are the key challenges and opportunities of REDD+ initiative in Nepal?
2. What are the key challenges/risks and opportunities of REDD+ initiative in community forestry system? (Policy, technical, practical or any)
3. Key issues in REDD+ payment/benefit distribution (based on any REDD+ benefit distribution practice/case with community forest user group in Nepal.
4. How can REDD+ in community forests contribute to the carbon enhancement (global objective) and continued supply of the local forest needs (timber, fuel wood and fodder)?

- What kind of risks does the REDD+ present in consumption of forest resources – timber, fuel wood and fodder?
- How can REDD+ deliver synergy outcomes - local needs and global objective?
- How can REDD+ be possible through community forestry program?
Appendix 23- Household questionnaire survey

Total estimated time: about 2-2:30 hrs

Method: face to face interaction, interview and record

Name of CFUG:                           Village Development Committee /Ward:
Household Identification Number:       Date of interview:
Interview start time:                  Interview end time: Code of respondent:

Part A: General Information of respondents and household (HH) characteristics

1. General information

1.1 Name of respondent:

1.2 Sex [Male/Female]:                        Age:

1.3 Status in CFUG: General member [ ] Executive member [ ]

   If executive committee member, which position: [ ]

1.4 Ethnic Group: Brahmin/Chhetri [ ] Dalit [ ] Indigenous peoples [ ]

1.5 Name of the HH head:                     Sex: [Male/Female]         Age:

1.6 Well-being ranking category:

1.7 Primary occupation:

1.8 Other income sources:

2. Household characteristics

2.1 Total household size:

2.2 Structure of family: Male:…Female:…(Below 10 years- )

Part B:  Land holding, livestock and forest product collection (RQ 3)

3. Landholding details

<table>
<thead>
<tr>
<th>Land use type</th>
<th>Agricultural land (Ropani/Ana) (1 ropani is equivalent to 0.05089 hectare)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Self owned Rented or leased in</td>
<td>rented or leased out</td>
</tr>
<tr>
<td>Irrigated (paddy field)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Partly irrigated for vegetable farming</td>
<td></td>
<td></td>
</tr>
<tr>
<td>non-irrigated (upland grown maize/millet)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forest land</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other lands if any</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5Dalit- so called untouchable group of people in Hindu caste system. They are economically poor and socially excluded and marginalized (National Dalit commission, 2004).
4. Livestock holding information

<table>
<thead>
<tr>
<th>Livestock type</th>
<th>Number of livestock</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2009</td>
</tr>
<tr>
<td>Cow/ox</td>
<td></td>
</tr>
<tr>
<td>Buffalo</td>
<td></td>
</tr>
<tr>
<td>Goat/sheep</td>
<td></td>
</tr>
<tr>
<td>Other if any (specify)</td>
<td></td>
</tr>
</tbody>
</table>

5. Livestock management strategy before and after 2009 (√)
A. Stall feeding [ ] b. Grazing [ ] c. Partly grazing and partly stall feeding [ ]

6. Household adopting grazing or partial grazing - number of livestock, grazing sources and strategy

<table>
<thead>
<tr>
<th>Livestock type</th>
<th>Stall feeding</th>
<th>Community forest</th>
<th>Open access</th>
<th>Governmennt forest</th>
<th>Other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cow/ox</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buffalo</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Goat/sheep</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other if any (specify)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Number of cattle and animals will be converted into livestock unit by applying LSU value 0.5 for cow, buffalo and horse and 0.1 for goat and sheep, FAO 2005)

7. Collection of forest products (timber, fuelwood, grass and fodder and leaf litter) from community forest in last 12 months

<table>
<thead>
<tr>
<th>Forest products</th>
<th>Unit</th>
<th>Total collection</th>
<th>Collection from community forests</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>SM</td>
<td>WN</td>
</tr>
<tr>
<td>Timber</td>
<td>Cubic feet</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poles (non-sawn wood)</td>
<td>Number</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuelwood</td>
<td>Headload</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fodder and grass</td>
<td>Headload</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note 1: WN Winter months: Ashwin – Magh (October – March)
SM Summer months: Falgun – Bhadra (April – September)- tree growth season

8. Information on using fuelwood and cooking strategy (Information regarding the different types of energy use strategies for cooking)

<table>
<thead>
<tr>
<th>SN</th>
<th>Energy schemes</th>
<th>Percentage of use</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Traditional stove (tripod stove)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Mud stove</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Improved cooking stove</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Iron stove</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Liquid petroleum gas (LPG)</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Biogas plant</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Kerosene stove</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Coal stove</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Other schemes</td>
<td></td>
</tr>
</tbody>
</table>

Note: Fuelwood or biomass based energy is used only in cooking stove.
Part C: General understanding and perception of respondents towards REDD+, forest condition and group and forest management (RQ 4)
1. Do you know about REDD+ and its implementation in your CFUG? Yes ( ) or No ( )
2. If yes, what benefit have you received from REDD+?
   a. Money b. training, c. employment or d. nothing
3. Do you know seed grants under REDD+? Yes ( ) or No ( )
4. If yes, who get seed grants and why?
5. Have seed grants contributed to improve household income? Yes ( ) or No ( )
6. Do executive committee members consult with forest users during the making decisions related to forest management, distribution of funds and forest products?
   a. Yes b. No comment d. Do not consult
7. Any changes in level of participation of forest users in general assembly (decision-making events) after REDD+?
   a. Increase b. No change c. Decrease
8. What is your opinion that CFU committee and CFUG held meeting timely and frequently after REDD+?
9. How do you agree that information of decisions by CFUG executive committee to forest users committee is disseminated in transparent way?
   a. Strongly disagree b. Disagree c. No comment d. Agree e. Strongly agree
10. Have you observed any change in restriction on forest products access after REDD+? Yes ( ) or No ( )
11. If yes, please explain restriction Timber ( ), Fuelwood ( ), Fodder ( ), Charcoal ( ), Grazing ( ) or any other ( )
12. Are there any changes in forest activities in your CFUG after REDD+? Yes ( ) or No ( )
13. If yes, what are the major activities changed after REDD+?
   a. New initiated
   b. Controlled or banned
   c. As it is
14. What do you think that physical condition of (forest density, tree species) in your CF change after 4 years of REDD+ in your CFUG?
   a. Strongly worse b. Getting worse c. No change d. Getting better e. Excellent
15. How do you think of changing in extraction of forest products by forest users after REDD+?
<table>
<thead>
<tr>
<th>Forest products</th>
<th>Decreasing</th>
<th>No change</th>
<th>Increasing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timber</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuelwood</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fodder</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

16. Do you want to make any notes else?
Appendix 24- Approved human research ethics by CSU

12 June 2013

Mr Eak Rana
Charles Sturt University
Po Box 789
Albury
NSW 2640

Dear Mr Rana,

The School of Environmental Sciences, Ethics in Human Research Committee has approved your proposal “Ecosystem services trade-offs in forest commons: Learning from community forests in central Himalaya, Nepal” for a twelve month period from 11th June 2013.

The protocol number issued with respect to this project is 410/2013/07. Please be sure to quote this number when responding to any request made by the Committee.

Please note that the Committee requires that all consent forms and information sheets are to be printed on university letterhead.

You must notify the Committee immediately should your research differ in any way from that proposed.

You are also required to complete a Progress Report form, which can be downloaded from www.csu.edu.au/research/forms/chre_annrep.doc, and return it on completion of your research project or by 11th June 2014 if your research has not been completed by that date.

The Committee wishes you well in your research and please do not hesitate to contact Dr Rosemary Black on telephone 02 60519983 or email rblack@csu.edu.au if you have any enquiries.

Yours sincerely

Catherine Garoni
Admin Assistant
School of Environmental Sciences
Ethics in Human Research Committee
Direct Telephone: 02 60519850
Email: cgaroni@csu.edu.au
Appendix 25- Consent form for research participants

Consent Form for research participants

Ecosystem services trade-offs in forest commons: Learning from community forests in central Himalaya, Nepal

1. The purpose of the research has been explained to me clearly. I have read and understood the information sheet that has been provided to me.

2. I know I am free to withdraw my participation in this research at any time as this is my volunteer participation. I also know if I withdrew my participation, I will not be subjected to any penalty and fine.

3. I understand that any information or details provided by me for this research will be confidential. I know neither my name nor any other identifiable information related to me will be used and published without my consent and written permission.

4. I hereby permit to audio record ( ) / not record ( ) my interview and discussion.

I know the research project has been approved by the Human Research Ethics Committee of Charles Sturt University. I understand that if I have any complaints or concerns about this research, I can contact:

NOTE: Charles Sturt University’s Environmental Science’s Ethics Committee has approved this project. If you have any complaints or reservations about the ethical conduct of this project, you may contact the Committee through the Executive Officer:

Name: The Executive Officer
School of Environmental Sciences Ethics in Human Research Committee
Charles Sturt University
PO Box 789 Albury NSW 2640
Tel: (02) 60519850
Fax: (02) 60519987
Email: enviroscience@csu.edu.au

Any issues you raise will be treated in confidence and investigated fully and you will be informed of the outcome.

Signed by: ___________________________ Print Name: ___________________________
Date: ________________________________

The Commonwealth Register of Institutions and Courses for Overseas Students (CRICOS) Provider Number is 00309F for Charles Sturt University and the Charles Sturt University Language Centre.
## Appendix 26- Basic information of Sitakunda and Thansadeurali community forest users groups

<table>
<thead>
<tr>
<th>Basic characteristics</th>
<th>Sitakunda</th>
<th>Thansadeurali</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of handover (AD)</td>
<td>1993</td>
<td>1996</td>
</tr>
<tr>
<td>Year of forest operational plan revised</td>
<td>2 (in 2001 and in 2012)</td>
<td>2 (in 2001 and in 2008)</td>
</tr>
<tr>
<td>Forest area (ha)</td>
<td>141.31</td>
<td>124.37</td>
</tr>
<tr>
<td>Location of forest</td>
<td>Bhimeshwor municipality ward number 6, Kirantichhap, Dolakha</td>
<td>Bhimeshwor municipality ward number 12, Makaibari, Dolakha. But users involved from ward number 10, 11, 12 and 13</td>
</tr>
<tr>
<td>Number of total households involved in CFUG</td>
<td>175</td>
<td>382</td>
</tr>
<tr>
<td>Dalit households (untouchable or impure group under Hindu caste system)</td>
<td>6 (Cobbler – tanners and shoemaker and Damai – tailor and shoemaker)</td>
<td>53 (Black smith, Gold smith, Damai – Tailor and musician, Cobbler- tanners and shoemakers)</td>
</tr>
<tr>
<td>Indigenous Peoples households</td>
<td>26 (Bhujel, Newar)</td>
<td>162 (Tamang, Newar, Bhujel)</td>
</tr>
<tr>
<td>Brahmin/Chhetri households</td>
<td>143 (Karki, Kunwar, Budhathoki, Thupa, Khatri, Subedi, Dahal, Bhandari, Raut, Basnet, Mahat, Khadka, Siwakoti, Chauhan)</td>
<td>167 (Thakuri, Khatri, Dahal, Subedi, Karki, Raut, Basnet, Yogi)</td>
</tr>
<tr>
<td>Annual group membership fee</td>
<td>No fee</td>
<td>NRs 30</td>
</tr>
<tr>
<td>Cattle grazing</td>
<td>Regulated</td>
<td>Strictly restricted</td>
</tr>
<tr>
<td>Fuelwood distribution</td>
<td>Live-standing trees (in January) and dried woods twigs and stumps throughout the year</td>
<td>November–April (Dried materials)</td>
</tr>
<tr>
<td>Per household fodder limit</td>
<td>Grass throughout the year, bedding materials with inform to EC members</td>
<td>November – March from Oak species from main forests and grass from sub-committee forests during summer</td>
</tr>
<tr>
<td>Per household timber limit</td>
<td>100 cft for new and 50 cft for maintenance of house (every five years)</td>
<td>100 cubic feet for new and 50 cubic feet for maintenance house (every five years)</td>
</tr>
<tr>
<td>Fees per cubic feet timber</td>
<td>NRs 200 for Sal and Nrs 40 for Chirpine</td>
<td>NRs 15 for Thingure Salla and NRs 20 for other species and</td>
</tr>
<tr>
<td>Total population</td>
<td>898</td>
<td>2,114</td>
</tr>
<tr>
<td>Women</td>
<td>444</td>
<td>1,052</td>
</tr>
<tr>
<td>Men</td>
<td>454</td>
<td>1,062</td>
</tr>
<tr>
<td>Total members in executive committee</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>Women members in executive committee</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td><em>Dalit</em> members in executive committee</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Indigenous People in executive committee</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Per household landholding size (ha/hh)</td>
<td>0.24</td>
<td>0.21</td>
</tr>
<tr>
<td>Per household irrigated land size (ha/hh)</td>
<td>0.29</td>
<td>0.08</td>
</tr>
<tr>
<td>Per household non-irrigated land size (ha/hh)</td>
<td>0.19</td>
<td>0.35</td>
</tr>
</tbody>
</table>

### # of households using different types of alternative energy schemes

<table>
<thead>
<tr>
<th>Energy scheme</th>
<th>Sitakunda</th>
<th>Thansadeurali</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved cooking stove</td>
<td>15</td>
<td>17</td>
</tr>
<tr>
<td>Biogas plant</td>
<td>4</td>
<td>19</td>
</tr>
<tr>
<td>Iron stove</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td>Coal stove</td>
<td>90</td>
<td>75</td>
</tr>
<tr>
<td>Liquid petroleum gas</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>Electricity for cooking (partly)</td>
<td>10</td>
<td>20</td>
</tr>
</tbody>
</table>

Source: Forest operational plans of Sitakunda and Thansadeurali CFUGs and group meeting
Appendix 27- Prioritisation of forest products by participants of focus group discussion with *Dalit* (right) and Indigenous Peoples (left) in Sitakunda CFUG
Appendix 28- Prioritisation of forest products by participants of focus group discussion with Women’s group (right) and Dalit group (left) in Thansadeurali Community forest user group.
Appendix 29- Incidences of forest fires in Sitakunda community forests

<table>
<thead>
<tr>
<th>Occurrence of forest fire year</th>
<th>Tentative forest area (ha) damaged by fire</th>
<th>Main causes</th>
<th>Control measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>105 (Block A, B and C)</td>
<td>Smokers</td>
<td>Self-controlled</td>
</tr>
<tr>
<td>2010</td>
<td>70 (Block B and C)</td>
<td>Smokers</td>
<td>Controlled by forest users</td>
</tr>
<tr>
<td>2011</td>
<td>40 (Block C)</td>
<td>Landfill site</td>
<td>Controlled by forest users</td>
</tr>
<tr>
<td>2012</td>
<td>35 (Block D)</td>
<td>Landfill site</td>
<td>Self-controlled</td>
</tr>
<tr>
<td>2013</td>
<td>52 (Block A)</td>
<td>Unknown</td>
<td>Controlled by forest users and police</td>
</tr>
<tr>
<td>2014</td>
<td>100 (Block B, C and D)</td>
<td>Unknown</td>
<td>Self controlled (Left to nature to control as due to steep terrain local people could not attempt control)</td>
</tr>
</tbody>
</table>

Source: The secretary of CFUG executive committee (through telephone) on 5 August 2015.
Appendix 30- Trust fund governing structure of the REDD+ pilot project

Source: ICIMOD, (2010b)
Note – Dotted lines represent reporting, data and information flows; solid lines represent seed grant distribution
**Appendix 31- Criteria of seed grant defined in carbon trust fund guidelines under pilot REDD+ initiative**

<table>
<thead>
<tr>
<th>Criteria of seed grant distribution</th>
<th>Proportion of seed grant</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon sequestration (carbon stock and increment)</td>
<td>40%</td>
<td>24% is for forest carbon stock (carbon stabilisation) and 16% is for carbon stock increment</td>
</tr>
<tr>
<td>Proportion of <em>Dalit</em> users households in CFUG</td>
<td>15%</td>
<td>Dalit – so called untouchable groups of people under Hindu caste system. Socially and economically poor</td>
</tr>
<tr>
<td>Proportion of users (households) who are indigenous peoples</td>
<td>10%</td>
<td>Indigenous peoples are traditionally more forest dependent than others</td>
</tr>
<tr>
<td>Proportion of households from economically poor (well-being category)</td>
<td>20%</td>
<td>Each CFUG identifies households in different well-being class based on self-defined indicators such as landholding size, income sources, livestock number, education of family members, social status</td>
</tr>
<tr>
<td>Proportion of women population in CFUG</td>
<td>15%</td>
<td>Women population in CFUGs, number of women in decision-making body – the EC of CFUGs</td>
</tr>
</tbody>
</table>

Source: ICIMOD, (2010b) and Rana et al., (2012)
Appendix 32- Comparison of the areas of fund mobilisation between the REDD+ trust fund guidelines and community forestry guidelines

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Descriptions</th>
<th>REDD+ trust fund guidelines</th>
<th>CF development guidelines 2009 (amended)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pro-poor activities/livelihood improvement</strong></td>
<td>Inside forests- promote non-timber forest products for cash income</td>
<td>Targeted but percentage of allocation not specified</td>
<td>35%</td>
</tr>
<tr>
<td></td>
<td>Outside forests- skill enhancement training, goat rearing, contribution to running grocery shop, poultry farming, vegetable farming</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Activities related to forest restoration, conservation, and management</strong></td>
<td>Inside forests- plantation, application of silviculture techniques, grazing management, fire management Outside forests – alternative energy, fodder and grass management</td>
<td>Targeted but specified</td>
<td>25%</td>
</tr>
<tr>
<td><strong>Capacity development of forest users</strong></td>
<td>Training and awareness raising for women, Dalit, and indigenous peoples, school teachers, youth and social leaders</td>
<td>Targeted but specified</td>
<td>Not targeted</td>
</tr>
<tr>
<td><strong>Forest carbon measurement and monitoring</strong></td>
<td>Training and involve in forest carbon measurement</td>
<td>Targeted but specified</td>
<td>Not mentioned</td>
</tr>
<tr>
<td><strong>Other activities related to CFUG</strong></td>
<td>Operation cost – office running, community development activities</td>
<td>Not mentioned</td>
<td>Not targeted</td>
</tr>
</tbody>
</table>

Source: Carbon Trust Fund Guidelines, ICIMOD, (2010b) and GoN, (2009)
Appendix 33- Income (In NRs.) from different sources in Sitakunda and Thansadeurali community forest user group

A. Sitakunda Community forest user group (parenthesis is percentage)

<table>
<thead>
<tr>
<th>Fiscal year</th>
<th>Forest products sale (revenue)</th>
<th>Seed grant from Pilot REDD+</th>
<th>Other sources, (membership fee and carry forward)</th>
<th>Total income</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>185,400 (77.6)</td>
<td>0</td>
<td>53,504 (22.4)</td>
<td>238,904 (100)</td>
</tr>
<tr>
<td>2010</td>
<td>207,433.21 (78.8)</td>
<td>0</td>
<td>55,724.52 (21.2)</td>
<td>263,157 (100)</td>
</tr>
<tr>
<td>2011</td>
<td>112,784 (52.4)</td>
<td>0</td>
<td>102,630 (47.6)</td>
<td>215,414 (100)</td>
</tr>
<tr>
<td>2012</td>
<td>362,366 (87.1)</td>
<td>48,479 (11.7)</td>
<td>5,104 (1.2)</td>
<td>415,949 (100)</td>
</tr>
<tr>
<td>2013</td>
<td>448,345 (46.5)</td>
<td>93,425 (9.7)</td>
<td>423,051 (43.8)</td>
<td>964,821 (100)</td>
</tr>
</tbody>
</table>

Source: CFUG records
Note: NRs – Nepali rupees

B. Thansadeurali community forest user group (Parenthesis is percentage)

<table>
<thead>
<tr>
<th>Fiscal year</th>
<th>Forest products sale (revenue)</th>
<th>Seed grant from Pilot REDD+</th>
<th>Other sources, (membership fee and carry forward)</th>
<th>Total income</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>76,500 (68)</td>
<td>0 (0)</td>
<td>35,501.75 (32)</td>
<td>112,001.75 (100)</td>
</tr>
<tr>
<td>2010</td>
<td>99,400 (48)</td>
<td>0 (0)</td>
<td>107,588.36 (52)</td>
<td>206,988.36 (100)</td>
</tr>
<tr>
<td>2011</td>
<td>90,900 (23)</td>
<td>0 (0)</td>
<td>299,209.8 (77)</td>
<td>390,109.84 (100)</td>
</tr>
<tr>
<td>2012</td>
<td>70,750.80 (26)</td>
<td>143,865.18 (52)</td>
<td>59,729 (22)</td>
<td>274,344.98 (100)</td>
</tr>
<tr>
<td>2013</td>
<td>429,964.00 (45)</td>
<td>182,820.00 (19)</td>
<td>353,327.8 937</td>
<td>966,111.83 (100)</td>
</tr>
</tbody>
</table>

Source: CFUG records