Evaluating spatial and social factors to effectively implement community forest management operational plans in Nepal

By

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Abstract

Sustainable forest management is a crucial issue in developing countries where the majority of the rural population relies on forests for livelihoods. While Nepal's community forestry program is widely recognized for successfully conserving and regenerating forests, its contribution towards enhancing the livelihoods of forest-dependent communities is suboptimal. This is largely due to poor design and implementation of the operational plans for managing community forests. Therefore, the aim of this thesis is to understand how operational plans can be designed to optimise forest management and utilisation practices. It achieves this by: 1] assessing the extent to which operational plans are sub-optimal, and this is found to have both biophysical and social components; 2] determining local communities perceptions on those biophysical and social factors influencing forest management; and finally 3] determining how operational plans can be adapted to the needs and practicable management of community forests.

The conceptual framework to achieve this aim integrates biophysical, particularly spatial, and social factors to assess the capacity of current operational plans. The thesis employs a mixed methods approach to integrate quantitative and qualitative domains of the research problem in the context of 13 community forests representing natural mixed *Schima-Castanopsis* (SC) and *Schima-Castanopsis-Shorea robusta* (SCS) forests in two villages of Lamjung district, Nepal. The data was collected from multiple sources including forest inventory, household interviews, group discussions, expert consultations, operational plans and maps published by government offices.

The annual consumption and supply of fuelwood was estimated from household interview and forest inventory and compared with the respective quantities provided in the operational plans. It revealed that the majority of operational plans report fuelwood consumption and supply well below the standard variations of estimated quantities for the same; thus indicating that operational plans are inadequate and inconsistent to estimate the consumption and supply of fuelwood.

The analysis of spatial patterns of stump distribution, which also reflects forest management practices, reveals that wood extraction is clustered mostly in timber producing forests like SCS forests. Further, the intensity of wood extraction has confined at the convenient locations close to the settlements, road and foot tracks and in flatter areas. This indicates the poor performance of operational plans to regulate and maintain spatial integrity of forest management and utilization across the forests.

The series of group discussions revealed that current state of forest management is at a very basic form, and that several social, biophysical and spatial factors influence management practices. The three primary factors are: low income benefits from forest; consequent reduced dependency on forests; and inadequate capacity for technical forest management. Nine other contributing factors were identified to shape the user groups' motivation to forest management. Even though current operational plans are information intensive, they are deficient in relevant information on local contextual factors. Consequently, these plans are inadequate for practical use to inform forest management decisions.

The thesis offers an improved understanding of community forest management in the changing context of local communities managing forests. It demonstrates that forest users are conditioned by various socio-economic, biophysical and spatial factors that set local context of forest management. Accordingly, it gives a new impetus to reconsider the scope of operational plans in the light of existing capacities and incentives of user groups to effectively implement operational plans for enhance forest management. To move this end, forest policies should emphasise on collaborative research of silviculture based forest management and promote enterprise based forest management to augment the technical capacity and incomes from community forestry.

Keywords: operational plans, community forestry, spatial factors, forest silviculture

Declaration

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name, in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission in my name, for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for the joint award of this degree.

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List of abbreviations

AAC	Annual Allowable Cut
ACAP	Annapurna Conservation Area Project Area
ACIAR	Australian Centre for International Agricultural Research
CBS	Central Bureau of Statistics
CIFOR	Centre for International Forestry Research
DFO	District Forest Office
DFRS	Department of Forest Research and Survey
DoF	Department of Forest
DoS	Department of Survey
EIA	Environmental Impact Assessment
EnLiFT	Enhancing Livelihood from Agroforestry and Community Forestry
FAO	Food and Agricultural organization
FECOFUN	Federation of Community Forest Users, Nepal
FUG/C	Forest User Group/Committee
GIS	Geographic Information System
GoN	Government of Nepal
GPS	Global Positioning System
HMG	His Majesty's Government
IEE	Initial Environmental Examination
LFO	Local Forest Officer
MFSC	Ministry of Forests and Soil Conservation
MoPE	Ministry of Population and Environment
MPFS	Master Plan for Forestry Sector
NACRLMP	Nepal Australia Community Resource Management and Livelihood Project
NFA	Nepal Foresters' Association
NTFP	Non Timber Forest Products
SC/SCS	Schima-Castanopsis/Schima-Castanopsis-Shorea robusta
SFM	Sustainable Forest Management
UNCBD	United Nations Convention on Biological Diversity
VDC	Village Development Committee

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Chapter 1: Introduction

1.1 Overview

Forest resources play a vital role in shaping the livelihood of people in rural communities of Nepal. Over 83% of country's population lives in rural areas and rely on public and private forests for meeting their diverse needs of goods and cash income. As these forests are intricately linked to the livelihoods of local communities, the Government of Nepal introduced the community forestry programme in late 1970s to simultaneously serve the dual goals of conserving forest resources and enhancing livelihood of the forest dependent population (Bhattarai 2016). For this, parts of national forests are still being handed over to the local communities who are traditionally dependent on the forests and desirous to manage and utilize the forests in a sustainable manner. These forests are managed according to the operational plans that illustrate and outline the procedures and activities of forest management and implemented by the forest user groups.

While community forestry is widely appreciated for its contribution to increase forest cover, its impact on effective management of these forest for economic development of local communities has remained suboptimal (Gilmour 2016; Thoms 2008). Despite enabling policies and institutions, under-management of community forests is the growing concerns of policy makers and researchers in the country (MFSC 2016; Yadav et al. 2009). It calls for broadening the scope of researches that integrate social, biophysical and spatial factors shaping the context of forest management in the remotes areas of the country. There are plethora of researches addressing the governance issues of community forest management, but there is a paucity of studies that integrate social and biophysical factors to evaluate the forest management strategies and its outcomes. Therefore, this thesis is designed to integrate these factors to investigate on the current practices of forest management and elucidate perceptions and opinions of forest user groups and forestry professionals to make management operations adaptable to the varying context and needs of forest dependent communities.

1.2 Aim of the thesis

The overall aim of this research is to contribute towards designing the operational plans that optimize the forest management and utilization practices in community forestry programme of Nepal

In particular, the research objectives are:

1. To assess the extent to which current operational plans are sub-optimal by integrating social and biophysical components of forest management and utilization
2. To determine the perception of local communities on biophysical and social factors influencing forest management and utilization, and
3. To determine how operational plans can be adapted to the needs and practice of forest management

These objectives are underpinned by following research questions. These questions are based on the current debate on the relevance of technical operational plans in the changing context of forest-people interaction in the mid hill region of Nepal (Rutt et al. 2014; Toft, Adeyeye & Lund 2015).

1. How do current operational plans reflect the demand and supply of forest products?
2. To what extent do biophysical factors influence the management and utilization practices of community forests?
3. How do local communities perceive the influence of various biophysical and social factors that shape the management practices (priorities) of community forests? and
4. What is the scope of current operational plans to enhance forest management planning in community forestry?

Research objective 1 is addressed by the research questions 1 and 2. The second and third research objectives are addressed by research questions 3 and 4 respectively.

1.3 Structure of the thesis

The thesis is organized in eight chapters.

Chapter 2 provides general background of community forestry globally and in Nepal. It begins with a brief history of emergence and expansion of community forestry-worldwide. It provides overview of various community based forest management regimes from around the globe and changing context of forest management in general. Then, it provides the historical overview of community forest development in Nepal with contemporary issues that shape pertaining to implementation. It provides a description of the operational plan and its role in the process of community forest handover and management.

Chapter 3 provides the general conceptual framework employed. The conceptual framework adopts the mixed methods of inquiry with biophysical and socioeconomic factors as the key elements for determining the effectiveness of forest management. This chapter also provides a descriptive overview of different methods used for data collection, analysis and presentation.

Chapter 4-7 provide the results of the analysis to answer the research questions. These are presented as one paper that has already been published, and three other papers currently submitted to scientific journals.

Chapter 4 presents the status of current operational plans to reflect the consumption and supply of forest products. Taking fuelwood as the case, the chapter evaluates the adequacy of current operational plan to estimate the consumption and supply of fuelwood. The quantity of annual fuelwood consumption and its supply from forests and private land were derived from household interview and forest inventory data. The results were compared with the demand and supply data provided in the operational plans. In addition, fuelwood information provided in two consecutive periods of the operational plans was compared to examine the general trend of fuelwood demand and supply. The results reveal that operational plans were not consistent to estimate the consumption and supply of fuelwood between the operational plan periods. The chapter concludes that current operational plans are not adequate to reflect the consumption and supply of fuelwood and suggests for revision of methods to determine the consumption of forest products including fuelwood.

Chapter 5 is a manuscript that evaluates the spatial pattern of wood extraction in the forests. Based on forest stock and stump data at the sample plots, the chapter presents the results from analysis of spatial autocorrelation and multivariate logistic regression. The derived global and local Moran indices indicate that the intensity of wood extraction is spatially clustered in the timber producing forests like *Schima-Castanopsis-Shorea robusta* (SCS) forests. The results from multivariate regression analyses demonstrate that wood extraction is confined in the locations closer to the road, settlements and in relatively flatter slopes. Then, it discusses the efficacy of operational plans to regulate and maintain spatial integrity in forest management and wood extraction across the forests. The chapter emphasizes the need of integrating spatial data in the process of deriving zonation or block maps to be used in spatial planning of forest management and utilization.

Chapter 4 and 5 together examine the adequacy of operational plans to represent the consumption and supply of forest products as well the effectiveness to perform forest management and utilization envisaged in the operational plans.

Chapter 6 is a manuscript that assesses the current state of forest management and underlying factors influencing it. It shows how forest user groups identify the factors and their relative influence in shaping their forest management operations. It provides empirical evidence to describe the current state of forest management by bringing together locally perceived social, biophysical and technical factors. Then, it discusses the results in the context of current practices of forest management and utilization. The chapter highlights the major factors to influence the motivation of forest user group to enhance forest management.

Chapter 7 is a manuscript that presents the general scope of operational plans to the forest users in the context of existing management practices of community forests. It examines the objectives and activities of forest management across the community forests as well as user groups' knowledge of the content of operational plans through a series of group discussions. The discussion section in this manuscript reviews the conclusions from the preceding chapters along with emerging literature and relates this to the practical relevance of information supplied in operational plans. From this review, it recommends a need to revise existing operational plans to make them adapt to the current context of management practices observed in the community forests.

Chapter 6 and 7 together assess the social and biophysical context of community forest management to suggest ways to design operational plans that are relevant to the need, priorities and practice of forest management.

Chapter 8 discusses and concludes the major study finding by integrating the results presented in chapter 4-7. It provides the general context of community forestry at present and outlined lesson learnt. It concludes with policy recommendation.

The linkages of different chapters are briefly provided in the figure 1.1.

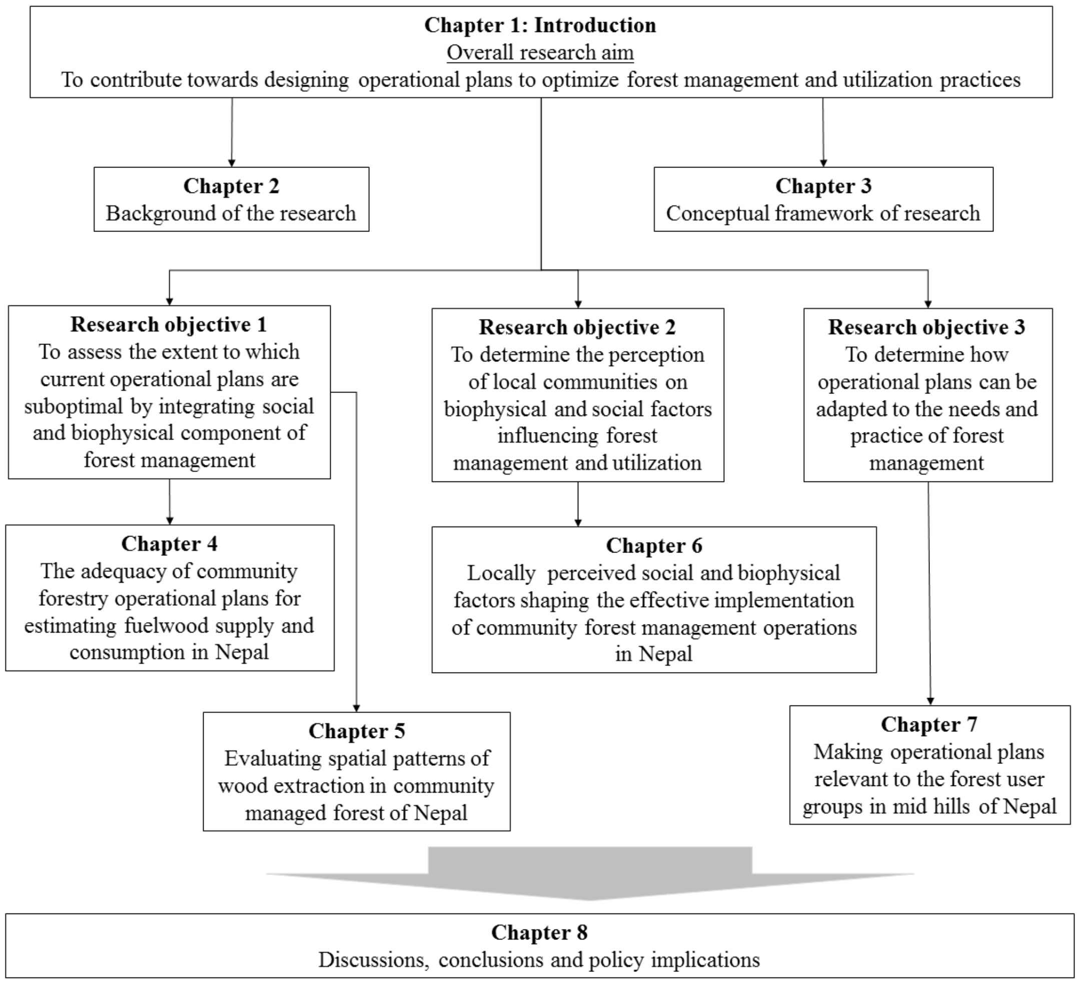

Figure 1.1: Thesis structure illustrating the linkages of research aim and resulting outcomes (as chapters).

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Chapter 2: General background of the research

2.1: Emergence and expansion of community-based forest management

Forest depletion and degradation is a global challenge. Despite global commitments to halt deforestation, the world's forest coverage has continued to shrink from 31.6 percent in 1990 to 30.6 percent in 2015 (FAO 2018). The forest loss is particularly evident in the low income countries where majority of population is inextricably linked to the forest resources as inputs of their subsistence farming and livelihood systems (FAO 2015). The increasing concerns over widespread deforestation and problems confronting forests and forest dependent population prompted to the efforts towards addressing them simultaneously through community-based forest management approaches (Charnley & Poe 2007; Gilmour 2016).

The evolution of community forestry as a formal modality of forest management started since mid-1970s. It stemmed from the *forestry for local community development* programme lunched by FAO in 1976 (Babili & Wiersum 2013; Gilmour 2016). The programme characterized community forestry as any situation which closely involves local people in a forestry activity either through activities by individual households or those involving the community as a whole (FAO 1978). Although community forestry was initially emerged in the global South to reverse widespread deforestation crisis, it gradually expanded to the global North during 1980s as a strategy to address public concerns over environmental conservation (Charnley & Poe 2007). Since the 1990s, large number of countries around the world reformulated forestry sector policies and created space for public participation to enhance decentralized forest governance (Babili & Wiersum 2013; Jong et al. 2016).

The main feature characterizing community forestry is the devolution of management responsibilities and control from central government to the forest dependent communities for achieving the twin goals of conserving biodiversity and enhancing livelihoods of forest dependent communities (Charnley & Poe 2007; Rajpoudel, Fuwa & Otsuka 2014). It relies on the theoretical premise that local communities, when sufficient property rights over forest resource is granted, can organize themselves and develop institutions to regulate the use of forest, enhance benefits to the community members and manage them sustainably (Agrawal

& Ostrom 2001; Gibbs, Williams & Ostrom 2005; Gilmour 2016; Negi et al. 2018; Ostrom 1990; Pailler et al. 2015; Shackleton et al. 2002; Wade 1987). Community forestry envisages that local population have greater interests on sustainable use of natural resources than distant managers like state government; that forest dependent communities possess deep knowledge and understanding of ecological processes, intricacies and practices for effective management of those resources; and that local communities can bear the cost of forest management for collective benefits (Babili & Wiersum 2013; Brosius, Tsing & Zerner 1998; Ostrom 1990). In addition, community forestry is rooted to and built on the traditional knowledge and experiences of local people accumulated over generations of intimate and continuous interaction and participation with the natural environment (Berkes, Folke & Gadgil 1995; Kellert et al. 2000; Messerschmidt & Hammett 1997)

Community forestry initiatives show wide global variations with diverse definition and forms in practice reflecting the historical and cultural contexts within which they were emerged and developed (Charnley & Poe 2007; Gilmour 2016; Lawry et al. 2012). The common terms used to denote include: participatory forest management (PFM), decentralized forest management, community based forest management (CBFM) and joint forest management (JFM) (Babili & Wiersum 2013). These approaches are collectively known as 'community forestry' with diverse meaning and practices around the world.

Although there are various forms of community forestry, the common denominator to all forms is the provision of certain level of participation of local communities in the process of forest management planning and implementation (Gilmour 2016; Glasmeier & Farrigan 2005; Torres-Rojo, Moreno-Sánchez & Mendoza-Briseño 2016). The nature of devolution of tenure rights to the community can define different community forestry regimes in practices. At the generic level, two main types of community forestry have been distinguished: 1) community based forestry in which communities are the owners and managers of the forests. Evidences of this model come from Tanzania (Babili & Wiersum 2013; Barry, Larson & Colfer 2010), Nepal (Bhattarai 2016) and the Philippines (Pulhin, Inoue & Enters 2007), and 2) joint forest management in which local communities manage government owned forest jointly with government agencies (Wiersum 2004). It is widely practiced in India (Agrawal & Chhatre 2006; Nagendra & Gokhale 2008), Mexico (Bray, Antinori & Torren-Rojo 2006; Klooster & Masera 2000; Torres-Rojo, Moreno-Sánchez & Mendoza-Briseño 2016) and United States (Wyckoff-Baird 2005). In the review of forty years of community forestry, Gilmour (2016) further categorized the spectrum of community forestry typologies into five regimes in the order of increased power devolved. They are: 1) participatory conservation, 2) joint forest management, 3) community forestry with limited devolution, 4) community forestry with full devolution, and 5) private ownerships of smallholder forestry (Gilmour 2016). The nature of public participation simultaneously varies from passive to active when the tenure rights is increased in the order. These forms of community forestry may co-exist in many countries like in Tanzania and Nepal with their specific objectives and a set of rules (Babili & Wiersum 2013; Ojha et al. 2007).

Over time, community forestry gradually developed and proliferated around the world as a central feature of larger movement to forest management and conservation (Armitage 2005; Charnley & Poe 2007; Gilmour 2016). As a result, the absolute forest area under different forms of community forestry has continued to grow covering more than 15 percent of the global forest area (RRI 2014; White & Martin 2002). In 2008, the share of community managed forests reached 27 percent[1] of total forest area in developing countries (For details: Pelletier, Gelinas & Skutsch 2016). At present, it is estimated that approximately 730 million hectares forest (about 28 % total forest cover) in 62 countries across representing all regions is managed under some forms of community based forest management systems. However, in reality, the forest area *de facto* managed by local people under customary tenure greatly exceeds the area of community and indigenous lands acknowledged by statuary law (Pelletier, Gelinas & Skutsch 2016).

Community forestry has now emerged as a valuable policy modality to contribute towards sustainable forest management and livelihood improvement of forest dependent communities (Gilmour 2016). Various reviews of community forestry programmes across the world have confirmed that strong local tenure over forests is associated with good forest management outcomes compared to other forms of state managed forest like protected area

[1] The figure includes data from the 15 countries with most reliable data sets (Pelletier, Gelinas & Skutsch 2016)

(Ellis & Porter-Bolland 2008; Porter-Bolland et al. 2011; Seymour, Vina & Hite 2014; Sikor et al. 2013). In a nutshell, community based approaches to forest management emerged at the most opportune time when policy makers were struggling to find appropriate institutions for addressing the deteriorating condition of mountain environment of developing countries and public concerns on environment in developed countries.

2.2. Community forestry development in Nepal

Nepal is one of the pioneering countries to introduce and legitimize community based forest management in Asia. Community forestry is viewed as a modern attempt to revive, often quite established, traditional and indigenous culture and institutions for conserving and managing natural resources (Berkes, Folke & Gadgil 1995; Berkes et al. 1998; Gilmour & Fisher 1991). However, forest management in Nepal begun with resource exploitation before the prominence of community forestry (Dahal & Cao 2015)

In Nepal, one can distinguish between three different periods of time in relation to forest management and protection. The political objectives and institutions of each period determined the mode of forest management and conservation issues. These periods can be observed under three distinct policy environment of privatization (1768-1951), centralization (1957-1978) and decentralization (1978 onwards) (Acharya 2002; Gurung, Karki & Bista 2011). Before 1951, five initiatives were taken: 1) establishment of *Ban Janch Adda* (forest inspection office) and *Kathmahal* (timber office) throughout the country in 1884; 2) opening of central forest management office in 1924; 3) establishment of the Department of Forests in 1942 as a responsible institution to manage country's forests; 4) set up of Forest School under Forest Service to provide technical training to foresters; and 5) establishment of Forest Ministry in 1951 (Palit 1996).

Despite these institutions, state exercised little control over the forest until 1957. Instead, people were encouraged to convert forest land to agricultural land to extend state's control over territory and generate revenue (Wallace 1987). In the virtual absence of any state control and regulation until 1950, local people controlled forest use themselves according to their traditional and indigenous systems prevalent in the mid hill region[2] of the country (Nagendra & Gokhale 2008; Palit 1996). In this period, most of the forest was controlled by local elites, called *Talukdar*, with subsistence-use rights granted to general people for the collection of fuelwood, fodder, leaf litter and small timber. By 1950, about one-third of the total forests and cultivated lands were under *birta*[3] tenure and, of that, 75 percent was held by the members of Rana families[4]. Since the population was low and forest was relatively large, demands for forest products was lower than the potential supply (Bhattarai 2016; Nagendra & Gokhale 2008). This is the period of *indigenous forest management*.

After the fall of the Rana reign in 1950, all forms of traditional systems of forest and land holding were officially abolished. In 1957, all private forests were nationalized and central governance was practised through enforcement of stringent rules and regulations (Dahal & Cao 2015; Pandit & Bevilacqua 2011). The intention of forest nationalization was to bring all the forests under government control from limited elites for the benefits of national economy and public services through their proper conservation and management (Bhattarai 2016; Kanel & Dahal 2008). However, people reacted negatively to the nationalization with the fear of curtailing traditional access and use rights to the forests. As a results, the communal responsibility of forest protection disappeared and forest were converted into an open access common property resources. The situation triggered the desperate conversion of forest land in to cultivation resulting widespread deforestation in the country (Bhattarai 2016; Palit 1996; Pathak, Yi & Bohara 2017).

In early 1960s, new partyless *Panchayat* System was introduced in Nepal. In 1961, Nepal endorsed forest act which categorized country's forests as national, community, religious and private forests. It also made provisions to handover forest protection to the newly formed *Panchayat.* The control over forests was further emphasized by successive legislation including Forest Protection Act 1967. (Bhattarai 2016; Gautam, Shivakoti & Webb 2004b; Nagendra & Gokhale 2008). The period can be recognized as the period of *centralized forest governance*. However, due to the weak institutional capacity of

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[2] The mid hill region is one of the 5 physiographic zones of the country extending from east to west within the elevation range of 200-3000 masl (MPFS, 1998)
[3] The land formally granted by the state to individuals usually on a tax free and heritable basis
[4] The families associated with Rana dynasty who ruled in Nepal from 1846 to 1950.

government to manage forest, coupled with widespread public resentment against centralization, country witnessed an unprecedented rate of deforestation and forest degradation leading to severe ecological concerns (Eckholm 1975b).

Following the Theory of Himalayan Environmental Degradation postulated by Eckholm (1976), population growth and traditional farming systems in uplands and mountains were pointed out as the major drivers of irreversible forest and environmental degradation associated with soil erosion, large scale downstream flooding and siltation in the mountainous countries including Nepal (Eckholm 1975a, 1976). It is observed as the period of *institutional failure* to govern forest under centralised system. Contrary to this prediction, Ives and Messerli (1989) revealed that forests in the uplands remained more or less intact despite continued growth of forest dependent population and emphasized hill farmers' roles as part of the solutions to the problems faced by the Himalayan region (Ives 1989; Ives & Messerli 1989). This observation created space for public participation in forest management to curb increasing rate of deforestation during 1970s, which essentially opened the era of *bureaucratic decentralization* in forest governance.

Accordingly, Nepal prepared a National Forestry Plan in 1976 that paved the way to engage local communities in plantation, forest management and protection activities through local government unit called *Panchayat*[5]. In 1978, the *Panchayat* Rules were promulgated with the provisions of handing over parts of accessible government forests to the *Panchayat* as a community forest (Palit 1996). It was the beginning of the *participatory forestry* approaches to conserve forests. However, this policy did not sustain in long run for its failure to consider livelihood needs of people and devolve sufficient management authority to the local communities (Fisher 1989; Kanel & Dahal 2008).

It is only during late 1980s, community forestry gained rapid momentum as a policy and concept to intimately engage people in forest resource management (FAO 1992). In 1989, Nepal endorsed its 25-years comprehensive Master Plan for Forestry Sector (MPFS) to

[5] Panchayat is a territory based lowest political and administrative unit established under the Panchayat systems

provide exhaustive framework for the systemic development of entire forestry sector. The high priority objectives of the plan include:

"To meet the basic needs for fuelwood, fodder, and other forest products on a sustained basis"

"To promote peoples' participation in forestry resources' development, management, and conservation" ((MFSC 1988)

It means that the plan has a major emphasis on policies and strategies that uphold public participation in forest and biodiversity conservation. In particular, the plan recognized community forestry as a major forestry sector programme with the aim of handing over all accessible forests to the capable and desirous forest user groups (FUG) for their management and sustainable utilization (Rajpoudel, Fuwa & Otsuka 2014). It introduces the *era of community forestry* in Nepal.

The plan was instrumental for formulating Forest Act (1993) and Forest Regulation (1995) that provided legal ground for handing over government forestland to the local communities. These policies recognized the FUGs as self-governing autonomous entities for transferring the State's role of forest management. The current form of community forestry proliferated throughout the country only after the promulgation of these acts and guidelines. Until now, there are about 22, 266 forest user groups managing 2.2 million hectare of forests engaging 2.9 million household ('CFUG Database of Nepal' 2013). The community forestry has now engaged more than 50 percent of country's households and 29 percent of country's total forest area under community based management systems (CBS 2012; MFSC 2016). Current Forestry Sector Strategy (2016-2025) of Nepal is committed to bring 40 percent of country's forests under community forest management system (MFSC 2016). It indicates that community forestry has been established as a major forestry sector policy in Nepal to achieve national goal of prosperity through the sustainable management of country's forest resources.

Community forestry programme in Nepal emerged from contextual background of institutional failure to address environmental problems and evolved with its unique features to manage forest (Nagendra & Gokhale 2008). The uniqueness of Nepal's community forestry can be observed in policies, institutions, participation and benefit sharing mechanism compared to other countries where community forestry regimes have been in operations for decades as a dominant features of forest management like in the Philippines, Mexico and Tanzania (Faure, Ichou & Venisnik 2019)

Among these countries, Nepal has developed strong legal framework to safeguard community forestry programme as a long term strategy of forest governance. The Forest law and Regulations have guaranteed communities to enjoy perpetual ownership over community forests (DoF 1993, 1995). It is most unlikely that government can suspend and/or abolish community rights over community forestry. In the Philippines, forest management agreement is awarded to the community for the period of 25 years and renewable for another 25 years (Pulhin 2000; Pulhin, Inoue & Enters 2007). It implies that persistence of community forestry is uncertain in future. In Mexico, community forestry developed along with the agrarian policy reform and emphasized timber production as social and natural capital for development. (Antinori & Bray 2011; Bray, Antinori & Torren-Rojo 2006). In Tanzania, community forestry evolved in the process of political and bureaucratic decentralization with the devolution of forest management authority to local communities (Babili & Wiersum 2013).

The institution which is entrusted to transfer management rights vary in different countries. In Tanzania, local council is entrusted to manage Village Land Forest Reserve (VLFR) (Babili & Wiersum 2013; Blomley & Ramadhani 2006). Most often, people are relocated from their traditional homestead to new location to form 'new' village council to access forests within the council territory. In Mexico, community forestry is transferred to local administrative units with rights of people to access and use forest. In Nepal, forest user group (FUG) is the key institution to take the responsibility of community forest management. FUG is created independent of already established political and administration units and empowered for taking forest management responsibility (DoF 1993; Pokharel 2012). In the Philippines, locally organized group- called peoples' Organization (PO) is entrusted for community forest management.

Benefit sharing mechanism is critical for the viability of community forestry regimes. Nepal has developed strong benefit sharing mechanism with a clear policy mandate to mobilize the community funds. The FUG is granted rights to fix price of forest products and sell them to generate community fund and disburse it for conservation, community development and livelihood improvements (DOF, 2014). In Tanzania, community incomes go to village council (local government units) and the benefits are realized through community development programmes. In the Philippines, community forest incomes are shared by central government (75%) and local communities (25%). In both Tanzania and the Philippines, there is no clear and pre-existing rules on how the incomes are distributed among the community member (Faure, Ichou & Venisnik 2019).

Community forestry emphasizes on peoples' participation for its success. Nepal has dedicated policy guidelines to encourage the participation of people in all phases of community forestry processes. The strength of the policy is that it has made mandatory to represent all forest users irrespective of their gender, wealth, education and caste while management and benefit sharing mechanism is decided (DoF 2014). In Mexico, participation is encouraged by establishing forest enterprises. In the Philippines and Tanzania, participation of community members is limited as POs and village councils decide on the forest management issues (Babili & Wiersum 2013; Pulhin, Inoue & Enters 2007).

The focus of community forest management vary between the countries. In Mexico, primary focus is on commercial timber production and enterprise development. (Antinori & Bray 2011; Bray, Antinori & Torren-Rojo 2006). In Nepal, production of basic forest products is on priority. The commercial timber harvesting is avoided from most of the forests in hill region of the country. In the Philippines and Tanzania, non-timber forest production is emphasized (Patenaude & Lewis 2014; Pulhin, Inoue & Enters 2007). In these countries, forest is managed according to the approved operational plans. In Nepal, plan explicitly stipulated the prohibited activities in the forest and user groups are held responsible for any breaching of the rules. However, such provisions are absent in the Philippines except implicit preferences towards conservation (Faure, Ichou & Venisnik 2019).

As there is unique experience of adopting community forestry, there is ample opportunities to learn best practice from each countries. However, it is cautioned that there is no 'one-size-fit-all' and stable model to be replicated different context.

2.3. Changing context of community forest management planning

The general context of forest management planning has changed substantially over the years. By the mid-1970, it was apparent that development strategies narrowly focussed on industrialization were not effective to meet the actual needs and aspirations of people. Concurrently, the concept of community forestry emerged and paralleled to the new development paradigm that constituted the "bottom up" planning approach that reflects on the needs and aspirations of poor people. Accordingly, development planning increasingly emphasized on the participation, equity, the general quality of life and the natural environment (Gilmour & Fisher 1991).

Although forest management often rely on the notion of sustainability, the meaning of sustainable forest management (SFM) has continued to change in the modern contexts of national and global policy environments (Sarre & Sabogal 2013). The SFM concepts emerged along with the concept of "sustainable development", defined by the World Commission on Environment and Development (1987) as "development that meets the needs of the present without compromising the ability of future generations to meet their own need. Gradually, SFM emerged as an overarching term that captured a paradigm shift in contemporary forest management systems and practices (Wang 2004).

After the Earth Summit of 1992, the concept of SFM is increasingly viewed as a dynamic intersection between social, economic and environmental values of all types of forests for the benefit of present and future generations (United Nations Forum on Forests 2007). The Summit simultaneously adopted 'convention on biological diversity' that requires signatory nations to take inventories and protection of rare and endangered species; United Nations Framework Convention on Climate Change (UNFCCC) that requires nations to reduce emission of greenhouse gases responsible for global warming; Agenda 21 for sustainable global development; and the United Nations Convention to Combat Desertification (Earth Summit 1992). Such environmental policies and agreements profoundly influenced national forest policies and the way the forest is managed and used around the globe.

In addition, Payment for Environmental Services (PES) has attracted growing interest in recent years. The PES is a mechanism to make direct, contractual and conditional payment to the forest managers for adopting sustainable practices of conservation and restorations (Wunder 2005). The concept of reducing emission from deforestation and forest degradation in developing countries (REDD), under PES, is a carbon financing programme which aims to reduce carbon emissions from forest by providing financial incentive to the developing countries to conserve forests and mitigate climate change (Gilmour 2016; Köhl et al. 2009; Poudel et al. 2014; Skutsch & McCall 2012). Although the concepts of PES and REDD have covered limited spatial coverage, the forest management planning, including community forestry, are increasingly aligned towards the requirements of these mechanism with hope of financial incentives.

Adoption of high objectives like biodiversity conservation can have both threats and opportunities to the practice of community forestry. The threat is that forest management planning can deliberately weaken the local voices of forest dependent communities in the quest of receiving payments for enhanced protection. Moreover, there is a risk of overloading community forestry with burgeoning objectives leading to the breakdown of very essence of collective institutions (Arnold 2001). On the other hand, such payment mechanisms have potential to add to the capacity of local communities to manage forest sustainably (Gilmour 2016; Köhl et al. 2009). Therefore, Gilmour (2016) argued that local interests, capacity, institutional governance and benefit system need to be critically reviewed before adopting additional objectives in management planning of community forestry (Gilmour 2016).

Current policy objectives essentially signify that forest management planning has shifted from single to multiple products including a wide range of ecological service (Başkent 2018). It indicates that solo timber production-oriented approaches are no longer appropriate as multiple use forest management concepts are evolving over time (Başkent 2018; Bettinger et al. 2017). It requires that traditional management planning, which focuses mainly on productive function of the forests, is replaced with the planning process that includes other ecosystem services to optimize the delivery of goods and services (ibid). Crucial task towards such planning is to determine the desired set of multiple objectives with their relative importance and manipulating the forest for their optimization (Gale & Cordray 1991; Kangas 1992). However, identification and ranking of different objectives is itself a critical and daunting task in the process of multiple forest management planning.

Forestry development planning is viewed as the integral part of larger landscape management to harmonize the conflicting objectives of land management in order to balance development and conservation within the region (Bettinger et al. 2017). As forest management planning goes beyond the forest stand, it tends to engage multiple stakeholders, from both private and public realm, with varying interest and capacity at the local, regional and global sphere. Within individual forest, management planning is viewed at multiple scale ranging from management units to entire forest stands (Bettinger et al. 2017). It requires the zonation of forest according to their values and management systems so that location specific planning can be prepared. It is also important to know what is happening where in the forests to address them in planning process. The spatial information generated from multiple sources are being integrated and analysed in GIS environment to develop localized forest management schemes. Therefore, community forestry is growing in the interface of environment, technology and production to meet the needs of multiple people. Such interface has made community forestry planning increasingly complex and challenging globally and nationally like in Nepal.

2.4. Contemporary issues of community forest management in Nepal

During the last four decades, Nepal has witnessed substantial changes in political, biophysical and socio-economic landscapes affecting every aspect of development, including that of community forestry (Gilmour et al. 2014). One of them is the remarkable increase in forest cover. The forest resource assessment (FRA) has reported that forests and other wooded lands cover 6.6 million hectares which is 44.7% of country's total area (DFRS

2015). The report recognized community forestry as being a major contributor to increase forest cover. Other micro-scale studies have consistently confirmed positive impacts of community forest policy in expanding and improving forest conditions throughout the country (Bhattarai, Conway & Yousef 2009; DFRS 2015; Gautam, Shivakoti & Webb 2004a; Gautam, Webb & Eiumnoh 2002; Jackson et al. 1998; Niraula et al. 2013; Tachibana & Adhikari 2009)

However, community forestry programme is under scrutiny for its capacity to achieve poverty reduction objectives. It is evident that despite a large proportion of land under forest (44.7%), Nepal imports timber. Although community forests make up a large proportion of accessible forest, it has resulted limited impacts to generate employment and enhance local economy (MFSC 2016). Yet, community forestry is expected to play greater roles in sustainable development, poverty reduction and food security through appropriate management and development practices (FAO 2014; Gilmour 2016; Khatri et al. 2017).

Concomitantly, Nepal endorsed a 10-year Forestry Sector Strategy (FSS) in 2016 with the aim to diversify and optimize forest utilization through the promotion and value addition of forest products (MFSC 2016). Further, the FSS has targeted to supply timber from current 0.3 million m^3 to 1.0 million m^3 by 2025. In addition, forest based employment is expected to reach 1.2 million from the current 0.2 million persons in the same period. To achieve these policy goals, intensive management of community forests is proposed for the sustainable production and supply of various goods and services beyond the subsistence needs of local communities (MFSC 2009; Miagostovich 2001; Yadav et al. 2009).

However, intensive forest management is comparatively a new concept in Nepal to manage community forests. Until now, forests are either under-utilized as observed in the community forestry or unsustainably managed as reported in government managed forests (Cedamon et al. 2017; Hill 1999; MFSC 2016; Singh 2002; Thoms 2008; Yadav et al. 2009). Thus, it is imperative to identify and evaluate contemporary issues and prevailing practices of community forest management in order to pave the way for enhancing the role of forestry sector in the changing political, biophysical and socioeconomic context of the country.

Following subsections outline biophysical, technical and socio-institutional issues pertaining to forest management in general and community forestry in particular.

2.4.1. Biophysical factors influencing forest management

Nepal is an ecologically fragile country with about 83 percent of total land area under Hill and High Mountains regions. These regions were the primary focus of community forestry programme until late 1980s in order to conserve the forests and reduce environment degradation while meeting the livelihood needs of forest dependent communities. At present, 86 percent of total community forests are located in these regions ('CFUG Database of Nepal' 2013). Most of these community forests are scattered in space, smaller in size and interspersed in human settlements. Many community forests are located on steep slopes with high erosion risks requiring exclusive protection (Springate -Baginski et al. 2003).

Further, biophysical factors are related to the **forest types/conditions**[6] and the topographic condition including **terrain condition** and **accessibility.** These factors effectively limit the choice, area/location, productivity and intensity of management intervention in the community forests. In addition, these factors induce financial constraints to undertake management strategies that involve production like timber (Ezzatia, Najafib & Bettinger 2016). At present, neither government agencies nor local communities are capable to invest on forest management that overcomes biophysical constrains and, in turn, outweighs the cost of operations. As a result, management practices of community forests are rudimentary including activities like clearing of bushes and basic pruning and thinning operations to remove dead, dying, deformed and diseased trees (Cedamon et al. 2017; Ojha 2001; Singh 2002). Therefore, it is imperative to evaluate whether existing forest management and utilization practices are compatible with the biophysical condition and the intensive forest management can be effectively adopted to optimize the production and supply of various goods and services. However, existing management strategies of community forests are poorly informed by these constraining factors.

[6] Terms that are bolded in this chapter form part of the conceptual framework explained in Chapter 3

2.4.2. Scientific forest inventory and regulatory requirements

Community forest management need to conform to the **policies**, **guidelines** and **technical standards** set by the government. Firstly, each community forest is required to undertake scientific forest inventory at the time of drawing and revising operational plans. The inventory serves the purpose of determining the annual allowable cut (AAC) for major forest products and periodic monitoring of forest condition. Generally, AAC is set at 40-60 percent of annual increment estimated for given forest types. However, such scientific inventory is beyond the current capacity of villagers and requires professional foresters with specialized knowledge and training (Thoms 2008). Although the DFO is expected to provide technical support to the forest users, there is a paucity of financial resource and competent staff to address the growing demand of technical services (Dhital, Paudel & Ojha 2003; Toft, Adeyeye & Lund 2015). As community forests are managed mostly for subsistence use by poor and women, who reside in the remote areas and are often illiterate, the procurement of service from forestry professionals to generate technical operational plans can hardly be justified. As a result, the entire process of community forestry is delayed. The FUG's rights of forest utilization is suspended until forest inventory is undertaken and management plans are prepared and/or revised accordingly.

Secondly, community forests need an Initial Environmental Examination (IEE) and Environmental Impact Assessment (EIA) for undertaking any management activities that exceeds certain thresholds. These were the regulatory requirements for the Ministry of Population and Environment (MoPE) which have been entitled to the Ministry of Forest and Environment since 2017. These processes are also too technical, time consuming and villagers are seemingly unable to pay for such specialized studies. Apart from the cost of production, such technical regulatory requirements often deter management of community forestry. Importantly, such technical information is hardly used by local communities to manage forest. Whereas technical details are important for timber-oriented forest management, it is often unjustified in community forestry which are managed mainly for multiple objectives including subsistence production (FAO 2004). Therefore, it is essential to assess the need and relevance of technical details in the contexts of existing capacity and management practices of local communities.

2.4.3. Changing relevance of forests to the rural communities

It is evident that effectiveness of community forests rests on its relevance to rural livelihoods (FAO 2001). In Nepal, community forestry was initiated in response to the scarcity of forest products to the forest dependent communities (Birch et al. 2014). However, the priorities of forest users themselves have changed considerably due to multiple reasons.

In recent years, the relevance of forests to the rural communities is dwindling due mainly to the out-migration, remittance and increased access to the alternative resources to support livelihoods. Outmigration of rural population is on increasing trend since 1990 when Nepal opened for international labour market (Fox 2018). It is estimated that 50 percent of country's households have at least one member migrated abroad or returnee (Tiwari & Bhattarai 2011) and that such migration is prevalent among the young population of ages between 22 and 44 as the main choice of livelihood (Ghimire et al. 2011).

The migration and remittance have resulted multiple effects on the economy and ecology of the rural communities. Most importantly, the agrarian economy has gradually transformed to the cash based economy due mainly to the increased flow of cash from employments in urban centre within country, India and further to the foreign countries (Fox 2018; Tiwari & Bhattarai 2011). For example, the share of non-agricultural sectors in wage employment was increased from 47 percent to 65 percent between 1995 and 2010, whereas the share of farm income in total household incomes declined by more than 33 percent during the same period (CBS 2011). Likewise, people engaged in overseas employment have also substantially increased since 1995. For example, the percentage of household receiving remittance increased from 23 percent to 56 percent between the period 1995 and 2010 (ibid). Accordingly, it is reported that the per capita expenditure of the country has increased by 40 percent and rural poverty has declined by 20 percent between the year 1995 to 2003 (Tiwari & Bhattarai 2011).

Likewise, out-migration from remote communities has caused labour scarcity for agricultural production leading to the land abandonment. The abandoned lands have eventually converted into the forests through natural regeneration and emerged as the source of forest products (Jaquet et al. 2016; KC 2015; Paudel, Tamang & Shrestha 2014). As a result, private lands have been emerged as the source of fuelwood and timber in the rural villages (Kandel et al. 2016; Puri, Nuberg & Ostendorf 2017; Webb & Dhakal 2011)

Such transformations have not only delinked and delocalized the livelihood opportunities of rural population from forests but also changed the ways forests are viewed, managed and utilized (Fox 2018). For example, increased cash incomes have prompted energy transition towards cleaner sources like Liquefied Petroleum (LP) gas, electricity and biogas plants (Link, Axinn & Ghimire 2012). Recent studies have demonstrated that out-migration caused the decline of **user group population** in the rural communities (Paudel, Tamang & Shrestha 2014; Tuladhar, Sapkota & Adhikari 2014). This situation has not only reduced the **dependency on forest** but also changed the **perceived** value of forest to the local livelihood and welfare.

Further, several studies reveal that average relative household incomes from forest is 3.8% (range: 3% to 11.3%) and that these incomes have increased after the introduction of community forestry (Adhikari, Falco & Lovett 2004; Adhikari, Frances & Lovett 2007; Meilby et al. 2014). Despite it, community forestry has not been perceived as the effective path toward improving livelihood and incomes in the rural communities (Gilmour 2016). It is also argued that the costs of community forest management rarely outweigh the benefits accrued therefrom (Rai, Neupane & Dhakal 2016). This is one of reason for deterring local communities from forest management.

The degree to which people depend on forest is a critical component to engage them in forest management (Adhikari, Tanira & Siva 2014). For this, it is imperative that forest planning is informed by the changing context of forest people relationships and dependency while drawing objectives and activities of forest management. In the study, livelihood dependency is conceptualized as the reliance of people on any material and/or service that is produced from forest ecosystem and consumed as the part of living.

2.4.4. Concerns relating to the climate change and biodiversity conservation

After the Earth Summit in 1992, Nepal is committed to reform national policies to accommodate and address environmental issues. The Forestry Sector Strategy (2016) has recognized climate change as a critical issue and emphasized on climate-proofed forest management planning to enhance their climate resilience (MFSC 2016). Nepal is committed to increased protection of forests to enhance carbon sequestration as the strategy of climate change mitigation and community benefits (MFSC 2014, 2015, 2016). Similarly, Nepal has recently reformed sectoral policies in the favour of biodiversity conservation (Oli & Dhakal 2018).

These policy reforms have immensely influenced the forest management priorities in different parts of the country. For example, community forestry has been increasingly viewed as a means of conserving rich biodiversity in the middle hill region of the country which is least represented in current protected area system (Dhakal 2018; HMG 2000; Shrestha et al. 2010). Such policy reforms and priority towards environmental issues have posed a challenge to concurrently achieve the objectives of biodiversity conservation, climate change and poverty reduction though community forestry (Charnley & Poe 2007; FAO 2001; Patenaude & Lewis 2014). However, it is hard to imagine now the future direction of community forestry to meet its policy aspirations.

2.5. Community forest management (operational) plans

It is important to distinguish that community forestry and forest management planning are two different concepts and practices. While community forestry is a policy environment, forest management planning is the application of scientific knowledge to manage forest for achieving the goals of the owners (Bettinger et al. 2017). Forest management planning has a set of objectives and activities which is shaped by the policy environment under which it is defined. The context and issues outlined under section 2.4 suggest that forest planning under community forestry is unique with regard to the problems to be addressed, the character of the forest to be managed and the stakeholder involved in order to achieve the objectives and desires of local, national and global population. With the increased emphasis on climate change and biodiversity conservation, the scope of forest management planning has expanded to encompass new set of players, considerations and alternatives (Torres-Rojo, Moreno-Sánchez & Mendoza-Briseño 2016).

However, the core concepts and principles of forest management planning remain the same and that is the sustainable management of forest (SFM) in order to meet current needs for forest related services and sustain forest resource for future generation to enjoy the forest services as we do today (Bettinger et al. 2017). The SFM is viewed in four circles: economic, environmental, social and cultural. The SFM is achieved in the intersection of these four circles (Schmithu¨sen 2013). The ability of forests to meet the expectation of sustainable forest management generally lies within this intersection and expressed through a management plans.

It is estimated that about 52 percent of world's forests are managed with some types of forest management plans (Bettinger et al. 2017; FAO 2010). Forest management plans are the technical documents which describe the activities required to meet the objectives of forest owners and/or managers (Joshi et al. 2018). A standard forest management plan provides information such as objectives, location and history of forestland, description of inventory of existing resource, schedule of activities, expected benefits and recommendations for optimum benefits (Bettinger et al. 2017). In the past, management plan was guided by the western concepts focusing primarily on timber production and profit maximization. With increasing public interest on ecosystem services, such plans are adapted to include both timber and non-timber products and services (Bettinger et al. 2017; Diaz-Balteiro & Romero 2004)

While there are different forest management planning regimes worldwide as a strategy to promote SFM, variations exist in the tenure system, scope of public participation and focus of the management (Bettinger et al. 2017). Three forest planning regimes can be broadly distinguished: private, community and government planning (ibid). In the private regime, the focus goes on non-declining flow of products for profit maximization from forest enterprises. In government forest planning, the national interests of economic development and environment protection is focused. The interests of general public is often overlooked in these planning regimes. In community regimes, the planning rely on community participation and the plans are jointly developed by government agencies and communities with shared responsibilities. These plans emphasize on meeting the needs of the people residing close to the forests (Bettinger et al. 2017). Therefore, community forest planning differs from other planning regime for their intricate interaction with people. Hereafter, the community forest planning refers to the operational planning in the context of Nepal.

Community forestry planning focus more on the process of engaging people while developing objectives and activities of forest management within the social and institutional context. Therefore, operational plans are considered as the end product of whole planning cycle. There is a national policy guidelines providing whole cycle of community forestry development including operational plan (DoF 2014; NACRMLP 2006). The guidelines have been revised in 2002, 2009 and 2014 in order to address the growing concerns and interests of multiple stakeholder in forestry.

There are two distinct stages to be completed before any forest is officially handed over to the FUGs. It starts with the identification of FUG associated with particular forest area. The FUG includes those households who are traditionally dependent on the forests for livelihoods and are capable and willing to manage forest through collective efforts. Then, a FUG is formed and registered at the District Forest Office (DFO[7]). For this, FUG needs to prepare a “Constitution” that describes, among others, the membership provisions, rights and responsibilities of user groups to protect, manage and utilize forest resources. Each FUG elects an executive committee, called forest user committee (FUC) to administer day-to-day administration of forest management and utilization.

In the second stage, each FUG produce an “Operational Plan” describing forest inventory, objectives and plans of actions for forest management and utilization (Rai, Beek & Dangal 2000). The plan describes the procedures of forest management to apply for the protection

[7] DFO are the district branches of Department of Forests (DoF) at the centre under Ministry of Forests and Environment, Nepal

and improvement of the forest handed over to the FUG and fulfil the livelihood needs of the FUG members. This is the technical phase where forest professional and local FUG need to work together for developing operational plans. This phase provides opportunity to the local communities to express their needs and concerns during planning process. The plans should present careful assessment of past and current condition of the forests in relation to the desired objectives to achieve.

The 'Constitution' and 'Operational Plan' are the prime legal documents in the process of community forest handover (Chand, Kerr & Bigsby 2014; Thoms 2008). Both of these documents are prepared through a series of discussion and consultation among FUG members and consultation with DFO staff (Chand, Kerr & Bigsby 2014; Rajpoudel, Fuwa & Otsuka 2014). This is an important phase in the community forestry process where rights and responsibilities of FUG is negotiated with DFO to manage and utilize forest. Once the operational plan is prepared, the FUC applies to the DFO for formal handover of the forests to the FUGs for management according to the operational plan. These plans are revised in the period of 5-10 years of their implementation.

Therefore, operational plans are the legal, social and technical documents to guide forest management. The essence and applicability of these plans rely on number of factors like quality and relevance of information used; procedures followed to generate objectives and plan of actions; opportunities and constraints identified; personal experience and organizational culture; and the cost of implementation (Bettinger et al. 2017).

At the early stage of community forestry, operational plans focused on the establishment, plantation and protection of community forests. As the community forest policies moved from their primary focus on degraded forests to the natural forests, the scope of operational plans simultaneously broadened to encompass the issues of livelihood and governance to ensure long term sustainability of community forest management (NACRMLP 2006). Likewise, the primary focus of forest planning has now shifted from single objective of basic needs to the multiple objectives including climate change and biodiversity conservation. In this context, forest planning need to identify important objectives and their relative importance so that they can be optimized through management (Başkent 2018; Kangas 1992). For this, operational plans should be adaptive to address evolving issues over time.

2.6. Focus of the Study

The contexts and issues discussed under section 2.4 are widely observed and experienced in the mid-hill region of the country. These issues, either individually or in their any combinations, shape the management priorities, opportunities and activities in the community forestry. These issues are addressed through operational plans that are prepared by analysing the social, environmental (biophysical), economic and cultural context of forest user groups. The issues are critically reviewed in the context of existing forest management practices in community forestry. While community forests are criticized for their sub-optimal management, this study evaluates the underlying factors influencing the motivation of forest user groups to manage forest. In particular, it focuses on how the contemporary issues are understood and incorporated in the planning process of community forestry development.

This study brings relevant biophysical and socio-economic factors to address the research aims provided in Chapter 1. Biophysical factors are conceived as the condition that provides opportunity to the forest dependent population to derive various goods and services of livelihood requirements from forest. Biophysical factors shape the productive capacity of forest to deliver desired goods and services. The social factors determine the livelihood dependency, forest management priorities and policy environment that determine the use of forest to the people. The operational plans require to link biophysical and social factors to regulate forest management and utilization practices. Despite interconnectedness, these factors are often viewed separately and analysed in isolation. Unless these factors are integrated and analysed together, the subtle variations of forest resource and management implication are less apparent to the forest managers.

This study explores how social and biophysical factors are analysed and integrated during planning phase of community forestry. At present, operational plan are based on the limited knowledge of dynamic relationships between these factors and, hence, poorly linked to the contemporary management issues emerged in social, economic and political landscapes. Therefore, this research is conceptualized with the need of integrating biophysical factors including topography and social factors including local peoples' perception to evaluate the priorities, motivation and practices of forest management. These factors need to be integrated and analysed while deriving objectives, activities and outcomes of forest management.

The study first assess the adequacy of operational plans to address social demands of forest products and to undertake forest management activities as prescribed in the operational plans. Then, it evaluates the spatial factors that circumscribe operational planning and implementation to manage forests.

It is argued that perception of local communities towards the value of forest to them is a strong predictor to evaluate the effectiveness of forest management planning and implementation (Negi et al. 2018). For this, it is essential that the needs, capacities and priorities of local communities are identified and articulated during planning process. Therefore, the study elucidates the perception of local communities to evaluate the local context and conditions of forest user groups to effectively manage the forests.

The empirical context of this study is the community forests in the mid-hill region of Nepal. Overall, the study assesses the social and biophysical factors to evaluate the current state of forest management and provide policy recommendation to enhance forest contribution in the conservation and development endeavour of the country.

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Chapter 3: Conceptual framework and research design

3.1 Conceptual framework

This study is designed to integrate social and biophysical systems that are distinct but concurrently operating sub-systems of community forestry. As such, community forestry is perceived as a socio-ecological system related to the communities and the forest. The system is shaped by the continuous interaction between forest and the people. The forest system is manipulated by social system to meet the desires of society. In this study, the system is conceptualized and used to emphasize the interdependence and linkages between the forest resources and the communities managing the forests.

From the background chapter the social factors, including policies, and the biophysical factors, including forest conditions, were shown to have substantially changed since the inception of community forestry. As a result, the priorities and needs of forest dependent communities have changed considerably to influence forest management strategies as the part of livelihood support system (Fox 2018; Shrestha & Fisher 2017). The operational plans of community forests are built on these systems to define the objectives and practices of forest management. Therefore, social and biophysical systems are considered as the important building blocks of community forestry processes and they are linked through the institutional mechanisms. **Figure 3.1** provides the overview of conceptual framework used in this study.

3.1.1. Social system

The social system is defined by the user group characteristics that determine the priorities, motivations, capacity and dependency of local communities to manage forests. Forest user group is characterized as a social entity with inherent differentiation according to the gender, caste, education and wealth status. This differentiation is associated with the capacity and influence of households to access and use forest including community funds (Adhikari, Falco & Lovett 2004; Birch et al. 2014; Lund et al. 2014; Thoms 2008). Studies have reported that poor and women participate less in community forestry and their role in decision making process is weak (Kalyan & Parul 2004; Oli, Treue & Smith-Hall 2016). It is found that social differentiation influence the ways and patterns of forest use (Malla, Neupane & Branney 2003). In general, rural households rely on the forest for livelihood incomes.

In this study, social system is described by following factors:

User group population and dynamics

The size of forest user group is one of the key factors that to determine the degree of population dependent on the forest resources. It is a crucial factor to affect the success of community forestry in many ways (Baland & Platteau 1999; Negi et al. 2018; Poteete & Ostrom 2004). The user population determine the degree of consumption of forest products and influence forest management strategies. Agrawal and Chhatre (2006) argued that user group size has positive influence on forest management but the rate of population change affects negatively to the forest conditions (Agrawal & Chhatre 2006). So, the trends and pattern of population dynamics is a growing concern in community forestry.

In forest dependent rural communities, trend of migration and absenteeism is an important factor to influence demographic characteristics (Ghimire et al. 2011; ICIMOD 2015). The current migration trend has changed the demographic structure leading to the rural communities predominated by the children and aged population (Tuladhar, Sapkota & Adhikari 2014). Hence, the 'residual' population in the rural communities determine the capacity and priority of forest management. Therefore, in addition to the size of forest user group, the dynamics of rural population is an important factor to influence the outcomes of community forest management.

Forest dependency

Studies have shown that forest dependency is an important factor influencing the need of local communities to collectively manage forests (Adhikari, Frances & Lovett 2007; Lise 2000; Manandhar & Shin 2013). Generally, local communities rely on forests for fuelwood, timber, fodder, wild food and other non-timber forest products that support livelihoods. However, there are growing evidence that forest dependency has decreased due to the outmigration of rural population triggered by the increased opportunities of employment outside the place of residence (Fox 2018; Ghimire et al. 2011; ICIMOD 2015). Likewise, private lands have emerged as the source of forest products like fuelwood. Besides, there is an increased availability of alternative energy sources in the local communities (Kandel et al. 2016; Puri, Nuberg & Ostendorf 2017; Webb & Dhakal 2011). As a result, the livelihood needs and priority of FUGs to manage forests has changed. Therefore, it is important to incorporate the emerging context of forest people relationships while assessing and deriving forest management strategies.

Perception and knowledge

Perception and knowledge of forest user group affect the behaviour in relation to forest management and conservation. The motivation and participation of people to manage forests is shaped by the perceived utility of incentives and benefits derived from forest management (Pagdee, Kim & Daugherty 2006). Such perceptions and knowledge prevalent among the forest user groups can affect the overall performance of forest management practices (Beyerl, Putz & Breckwoldt 2016).

Perception based methods are widely used to assess the forest condition, evaluate the value of landscapes and trends of benefits from management (Agrawal & Chhatre 2006; Lund, Balloni & Puri 2010; Shrestha & Medley 2016). It is argued that common interests and shared perception across the user groups can play vital roles in generating successful outcomes of collective forest management (Negi et al. 2018). Likewise, perception of individual members towards an issue can ultimately shape the perception of entire group (Sullivan et al. 2017). In practice, however, individual and group perception shape each other to address a problem or issue related to forest management. As the perception and knowledge change over times, it is essential that forest management strategies are based on the perceived needs, capacity and aspiration of forest user groups in the context of their livelihood requirements.

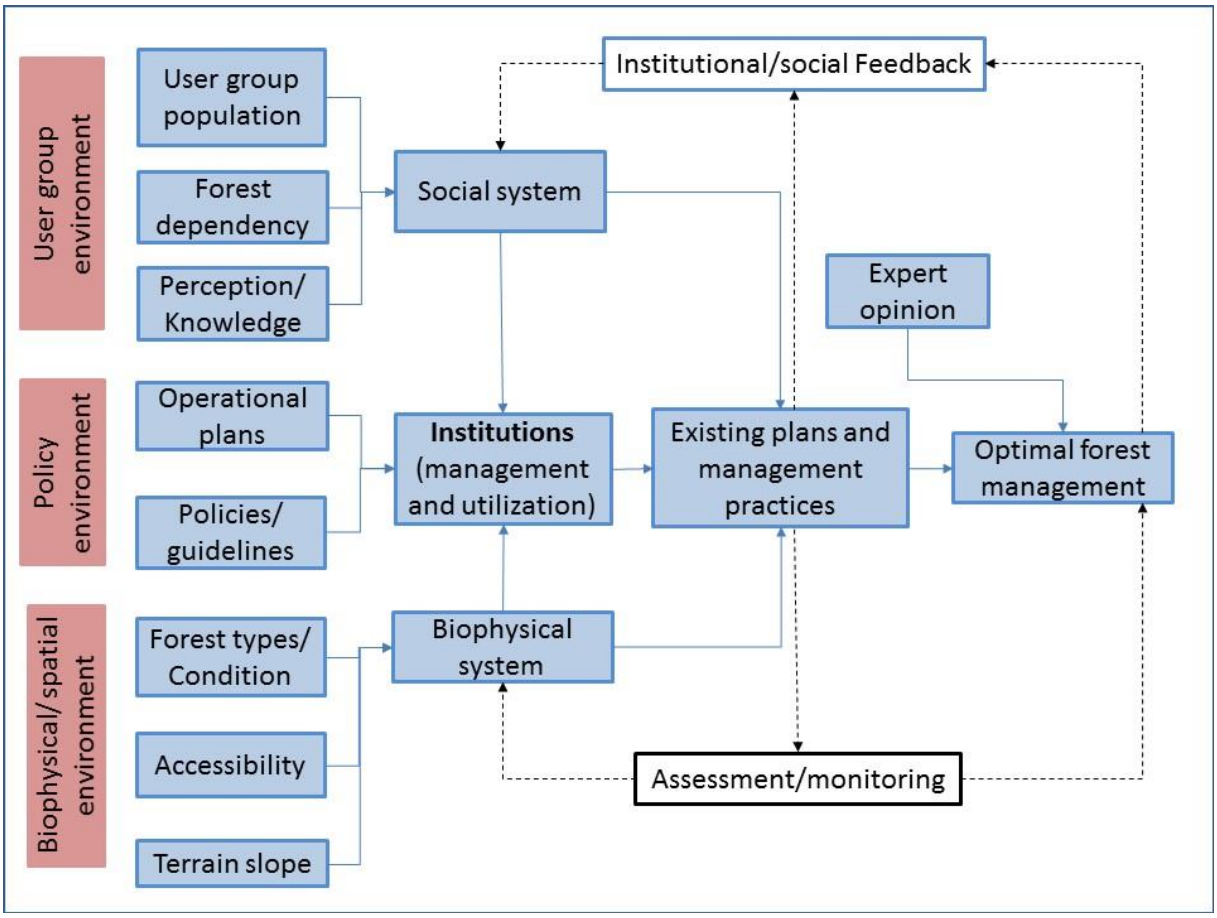

Figure 3.1. Conceptual framework used to analyse community forest management. The flow describes that social and biophysical systems interact through institutional arrangement (of forest management and utilization) resulting to existing plans and management practices. Existing plans are informed by social and biophysical context coupled with expert knowledge to optimize the forest management systems with multiple objectives. As the system is dynamic, social and biophysical systems are assessed to learn institutional feedback and resource condition in order to optimize forest management in new socioecological system.

3.1.2. Biophysical systems

Biophysical factors are related to the forest and tree structure, topography and other locational factors that set localized contexts of forest management. These factors shape the quality of forest and its potential to deliver benefits to the communities. However, these factors are often overlooked while evaluating the management planning of community forestry (Hajjar et al. 2016). In this study, biophysical system is described by the following factors:

Forest condition

The forest conditions determine the state, stock and flow of various goods and services from forest (Hart 1995). There are several evidence that collective action is enhanced if the resource is sufficiently predictable, easily recognizable by the local communities and can be managed beneficially (Ostrom, Gardener & Walker 1994; Pagdee, Kim & Daugherty 2006; Tesfaye 2017). Likewise, studies show that benefits from forest should not be too scarce or too abundant to successfully organize collective management of resources including forests (Araral 2009; Wade 1987). The perceived quality of forests and benefits therefrom determine how forests are managed and utilized by the local communities. Therefore, forest condition is an important factor to determine the strategies of management in community forestry.

Accessibility (from road and settlement)

Accessibility of forests from roads and settlements determine the motivation of people to participate in the forest management (Adhikari, Falco & Lovett 2004; Pagdee, Kim & Daugherty 2006; Tesfaye et al. 2012). Similarly, accessibility to the road influence the nature of user groups' dependency on forests by facilitating livelihood diversification (Charley et al. 2016). The accessibility influences the mobility of people in the forests to collect and transport different forest products. Many evidence indicated that forest products are collected from the locations proximate to settlement and roads (Engida & Mengistu 2013; Hlaing & Inoue 2013). Likewise, proximity to the road increases the connection to urban centre and service providers that can facilitate forest product collection and management (Robinson, Williams & Albers 2002; Thoms 2008). Therefore, accessibility to the road and settlement is an inevitable factor to influence forest management and utilization decisions.

Terrain condition

Terrain condition is important topographic factor that constrains certain management and utilization operations. Accordingly, terrain condition determines the effective area that can deliver various goods and services to the local communities (Gilmour (undated)). The management decisions of forests located in the hilly terrain need to carefully consider the ecological fragility of the land (Ezzatia, Najafib & Bettinger 2016). Further, the forest operations in steeper slopes are risky and, hence, the productive management is limited to moderate and flatter slopes. In addition, the terrain condition restricts the road construction to access the forests. Therefore, it is imperative that forest management strategies are informed by the topographic limitations and opportunities to sustainably produce various goods and services.

3.1.3. Forest institutions to regulate forest management and utilization

The biophysical and social systems are connected through forest institutions to regulate management and utilization of forest. Overall, biophysical factors describe quantity and quality of forests and the environment in which they exist (Butler et al. 2010). The social factors determine demands for various goods and services and motivation to engage in collective action. Together, these systems determine the goals, priorities and strategies of forest management. In general, these goals are shaped by the aspiration (or need) of people and the productive capacity of forest resources. Community forestry operates within these systems and propose deliberate management interventions toward achieving the social and economic objectives of forest management (Franklin et al. 2002).

The community forestry institutions are shaped by the prevailing environment of national **policies, guidelines, plans** and the local practices of forest management and utilization. The operational plans institutionalize the national policies and local practices of forest management to regulate the supply of goods and services to the forest user groups. Therefore, the efficacy of operational plans is determined by the ways they are prepared and implemented.

The operational plans are designed to regulate the utilization behaviour of forest user groups. For this, these plans have a system of forest blocking[8] to bring the entire forest into rotational management regime. The efficacy of operational plans rely on whether the local practice of forest use and/or management corresponds to the spatial planning envisaged in the operational plans. To elaborate further, a forest produces a range of goods and services that may vary across the forest due to the site quality and other management factors (Pastorella

[8] Forest blocking is the system of dividing forest areas into parts for annual operations.

& Paletto 2013). Likewise, people use the forests for different purposes and, simultaneously, display spatial preference to pursue those purposes. Such spatial preference may be influenced by multiple factors like livelihood requirements, distance to the road and settlements, terrain condition and forest types (Robinson & Lokina 2009). So, it is essential that spatial patterns of forest and place preference of local communities in using forest be integrated in the process of defining management strategies.

Forest institutions are dynamic and need to adapt to the emerging opportunities of forest management and experiences gained through implementation. In this study, the content and performance of operational plans are examined to investigate on the existing practices of forest management. This can provide impetus for redesigning the optimal forest management based on the practical experience of forest user groups and opinions of forestry experts.

3.2 Research design

This study employs mixed-methods research design to generate and analyse qualitative and quantitative data and information to address the research questions. The explanation of mixed-methods design used in the study is drawn from Michael R. Harwell (2011) and Creswell and Clark (2007). The qualitative and quantitative research designs represent distinct set of concepts, methods and approaches to infer about the population or phenomena under study. Qualitative research design focuses on discovering and understanding the experiences, perspectives, opinions, and thoughts of participants to explore their meaning, purpose and reality. This is inductive in nature as they generate theories or hypothesis from details provided by a participant. In this design, researcher perform detailed exploration on a topic through case studies, ethnographic works and interviews (Creswell & Clark 2007; Harwell 2011)

Quantitative research design attempts to maximize objectivity, replicability and generalization of findings leading to the prediction. This is deductive in nature for its focus on generating inferences about the characteristics of study population by testing hypothesis.

In this design, researchers set aside their experience, knowledge and perception while conducting research and drawing conclusions (ibid).

There is inherent strengths and weaknesses associated with both research designs. The debate between qualitative and quantitative designs cultivated a ground for the development of mixed methods research design to benefit from the strengths and non-overlapping weakness of either design and avoid inevitable biases (Harwell 2011). In mixed method, researcher can combine qualitative and quantitative techniques, methods and approaches in a single research. The central premise of the mixed-method approach is that the use of quantitative and qualitative approaches in combination provides a better understanding of research problems than either approach alone (Creswell & Clark 2007). Three typical uses of mixed methods are identified; a) testing the findings obtained from different measuring instruments, 2) clarifying and building on the results of one method with another methods, and 3) demonstrating how the results or inferences from one method can influence the subsequent methods or results (Caracelli & Greene 1993). Mixed methods designs are found firmly rooted in the evaluation literature (Salkind 2010).

In particular, mixed method design adopts concurrent triangulation in which quantitative and qualitative data are collected at the same time, analysed separately and results are used to confirm, cross validate or corroborate findings (Leech & Onwuegbuzie 2009). In this design, data collected from multiple strategies need triangulation for their validity and relevancy in the context of research questions being addressed. In mixed methods, triangulation refers to the practice of using multiple sources of data or multiple approaches to analysing data to enhance credibility of a research study (Salkind 2010).

In this study, the quantitative data are collected from forest inventory and household survey and qualitative data are collected through document reviews, individual interviews and group discussions. Forest inventory generates data about the condition, spatial variability and utilization patterns of the forests. Household interviews provide data about the characteristics of the forest user groups. Sampling approaches are designed to represent the variability of forest and household characteristics. While the degree of variability of forest and household are unknown in advance, decision on the sampling intensity is a challenge.

To overcome the situation, minimum sampling intensity is adopted for both forest inventory and household interview. The minimum sampling intensity prescribed in policy guideline was taken as reference for forest inventory. For socio-economic survey, minimum number of household as proposed by CIFOR is used.

This study emphasizes the generation of information that has practical relevance to improve local forest management decisions. Researchers have shown that opinion and perception based methods can generate comparable conclusion on general trends, condition and growth of forests as do by the statistically rigorous quantitative approaches (Agrawal & Chhatre 2006; Lund, Balloni & Puri 2010). Drawing from these studies, this research design utilized both qualitative and quantitative approaches to generate information about community and forests.

3.2.1: Description of the Study area

This study covers Lampung district of Nepal where community forestry is effectively implemented since 1993. It lies between 28^{0}03'19'' and 28^{0}30'39" north latitude and 84^{0}11'11" and 84^{0}41'43" east longitude **(Figure 3.2).** It is a centrally located mountainous district of the country and characterized as a "land of extremes" for its wide range of climatic and physiographic variations (Trapp & Mool 1996). The climate varies from subtropical in the south to arctic in the north. The altitude varies from 500 metre to 7,690 metre within a short distance of 50 kilometres (Shrestha 2007). Such altitudinal and climatic variations give rise to a wide variety of vegetation in the district. The lower altitudinal range is largely covered by tropical mixed forest dominated mainly by Sal (*Shorea robusta*) and other deciduous broadleaved species which is gradually replaced by the upper tropical wet forest of Chilaune-Katus (*Schima-Castanopsis*) along with conifer species in the middle ranges and *Quercus* and *Rhododendron* forest in higher altitudes. The northern part of the district is mostly very rugged and remains covered by permanent or seasonal snow during December-January, giving rise to scrubland, alpine meadows and thickets as dominant vegetation types.

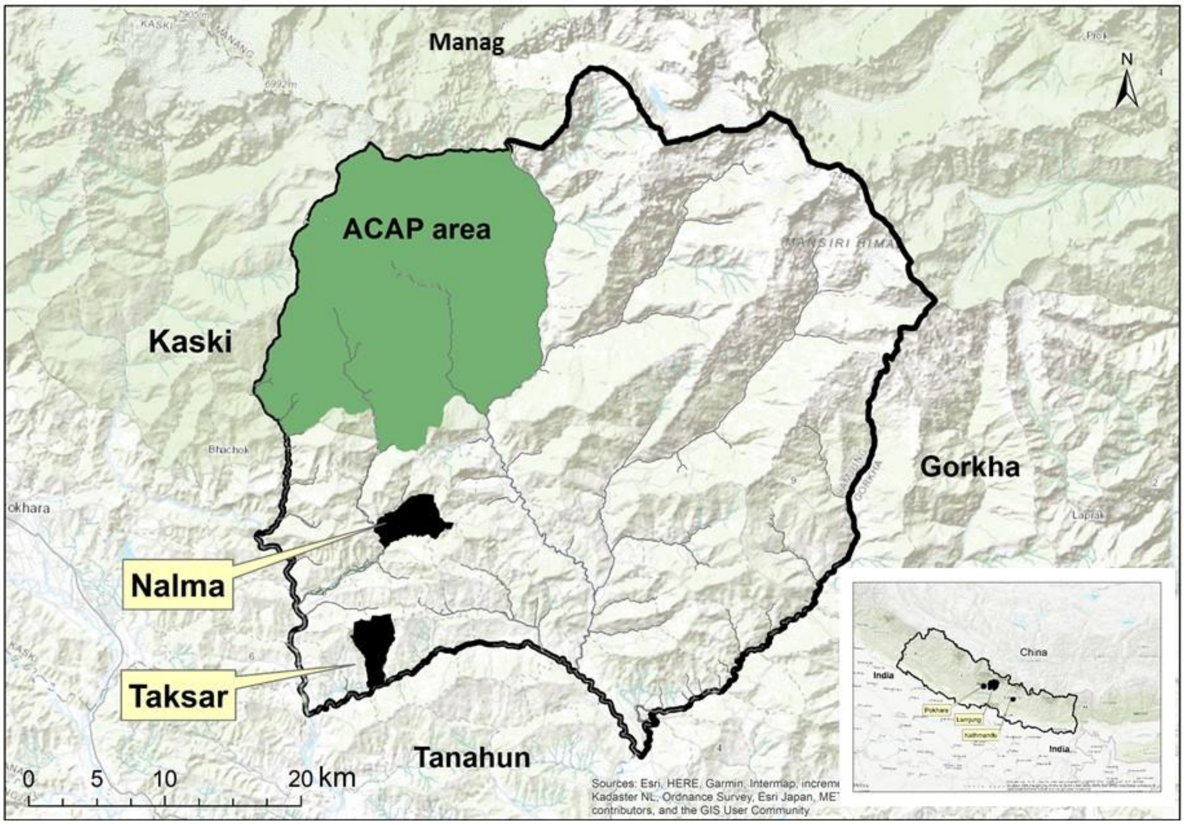

Figure 1.2: Map showing study area

Forest is the dominant land cover types in the district. The Forest Resource Assessment (FRA) report of Nepal showed 52.3 percent forest cover followed by agricultural land (44.6%) (DFRS 2015). Community forestry is the major forestry programme to manage these forests in district. According to the record at District Forest Office (DFO), forest and shrub land together covers 84,316.6 hectare which is 49.3 % of district's total land area[9]. Out of total forest area, 58,187 hectares (60%) is managed by DFO while 26,130 ha (31%) is managed under Annapurna Conservation Area project (ACAP). Of the total forest under DFO jurisdiction, 19,187 ha (32.9%) is handed over to the 318 community forest user groups. **Table 3.1** summarizes current status of forest in the district. List of community forests in the district is provided in the appendix 6.

[9] The forest data at DFO is based on the Land Resource Mapping Project (LRMP) data of 1978.

Table 3.1: Status of community forests in Lamjung District (2015)

Total forest area (ha)	84, 316.6
Forest under District Office (DFO) (ha)	58,189
Forest under Annapurna Conservation Area	26,130 ha
Total number of community forest user groups (FUGs)	318
Forest area under community forest (ha)	19,187 ha
Total households in FUG (% of district's household)	25,187 (60 %)
Percentage of total DFO forest under community forests	32.9
Percentage of total district's forest under community forests	22.7
Average size of community forest (ha)	60.3
Community forest per household (ha)	0.75

Source: District community forest profile 2015, annual progress book.

The community forests represent diverse forest types in the district. The DFO database revealed that 95 percent of total community forests represents natural mixed forest followed by natural forest mixed with plantation (4%). According to the major composition of forests, the natural mixed forest for Chilaune-Katus-Sal (*Schima Wallichii-Castanopsis indica-Shorea robusta-SCS*) occupies 55% followed by Chilaune-Katus (*Schima Wallichii-Castanopsis indica-SC)* forest which is 37% of the total community forest area in the districts. The SCS forests are the main source of timber in the district followed by SC forests.

For detailed study, two village development committees (VDCs[10]), namely Nalma (with limited road and market access) and Taksar (with better road and market access) were purposively selected to represent the typical hill communities. The populace of these villages rely on forest as the part of their livelihoods. These VDCs are the working sites of ACIAR[11] funded "Enhancing Livelihoods and Food Security from Agroforestry and Community Forestry in Nepal (EnLiFT)" project.

[10] The Village Development Committee (VDC) represents the smallest political territory. The VDCs are now merged into larger village council.
[11] Australian Centre for International Agricultural Research (ACIAR)

There are four community forests in Nalma and nine in Taksar. These forests cover 642.2 hectare in Nalma and 392.2 hectare in Taksar. These forests are categorized into SCS and SC forests based on their vegetation composition. The SCS forests predominant in Nalma (57%) and SC forests in Taksar (74%). The list of the community forests are provided in **Table 3.2.** In Nalma, all public forests are managed as community forestry. In Taksar, in addition to community forests, 44.2 hectare forest was managed by 12 leasehold forestry groups.

Table 3.2: Description of community forests in Nalma and Taksar villages, Lamjung District, Nepal

Community forests	*Forest types*	Forest area (ha)[1]	FUG Size[2]
Nalma			
Kagrodevi	SCS	66.2	27
Khundrudevi	SC	135.2	44
Langdihariyali	*SCS*	300.6	164
Sunkot	SC	139.2	37
Taksar			
Adherikhola	SC	35.1	20
Bholdada	SC	13	17
Jamuna Gahira	SC	23.2	9
Lampata	SCS	71.5	260
Nag Bhairab	SC	43.3	64
Pisti	SC	114.5	35
Samkhoria	SC	34.7	21
Sathimure	SCS	28.3	79
Tamakhani	SC	28.6	53

Forest types: SC = *Schima-Castanopsis* forest, SCS: *Schima-Castanopsis- Shorea robusta* forest, [1]The forest area is derived from GIS maps and differ from forest areas provided in respective operational plans. [2]Number of member households, [2]population per hectare of forest.

3.2.2. Overview of the data collection methods

Both qualitative and quantitative data were collected employing various methods. These methods are described in each result chapter (Chapter 4-7). In this section, an outline of each method and data source is given.

Forest inventory

Forest inventory was designed to provide as unbiased data as possible about the condition of the forests. To achieve this purpose, a random sampling was used to represent entire forest area. Forest map is the prerequisite to determine forest area, sampling intensity and plot distribution. The maps of each community forest were obtained from the respective operational plans. As described in the plans, community forest maps were derived from cadastral maps prepared by the Survey Department of Nepal. The cadastral maps are the government's authentic sources to assign land tenure. The community forestry development guidelines recommends the use of cadastral maps to prepare community forest maps (DoF 2014). However, these maps were not georeferenced and were less useful to determine forest areas. So, forest maps of each community forest were first registered in Geographic Information System (GIS) environment in reference to the cadastral maps and parcel information provided in the operational plans.

Once maps were prepared, the area of each community forest was determined. It was found that forest area included in the operational plans and obtained from the GIS maps was different. However, information derived from GIS maps were more consistent and used for all sort of analysis.

Sampling intensity is an important consideration to make reasonable representation of forest area and types. Sampling intensity is generally set by the desired precision of selected variables (i.e. forest parameters) within the population and the available human and financial resources. The main aim of inventory in this study was to generate information to describe the forest characteristics like density and basal area. Community forestry guidelines has set 0.5 percent as the minimum sampling intensity to assess forest conditions. Therefore, sampling intensity of forest inventory was maintained above this minimum.

The sampling intensity was derived for each village. It is determined by the variability of the forest structure, required precision and other logistics supports. The total community forest area in Nalma and Taksar was 641.2 hectare and 392.2 hectare respectively. The forest area in each village was stratified as SC and SCS forests to allocate sample plots for their proportionate representation. In this study, a total of 4.65 hectare in Nalma and 3.4 hectare in Taksar was sampled. It accounts 0.7 percent in Nalma and 0.8 percent in Taksar as sampling intensity, which is well above the minimum requirement set in the policy guidelines. The sampling intensity was distributed in SC and SCS forests of both villages.

After deciding on sampling intensity, sample plots were distributed randomly in SC and SCS forests in each village. The random locations were generated from random point generator of ArcGIS software (Data Management Tools > Feature Class > Create random point). Data were collected from circular plots of 500 square metres. The minimum distance between the points (i. e. plots) was set 100 m. Altogether, 93 sample plots in Nalma and 68 sample plots in Nalma were established in the forests. **Table 3.3** provides total forest area, number of sample plots allocated and corresponding sampling intensity in each SC and SCS forests of both villages. The **table 3.3** shows that each forest type was sampled for at least 0.7 percent. The number of sample plots in each forest type is given in the **Table 3.3** and the distribution of plots in the forest are shown in **Figure 3.4**.

Table 3.3: Number of sample plots in two forest types in each village.

	Forest Types				Total	
	SC		SCS			
Villages	Area (ha)	Number of Sample plots	Area (ha)	Number of Sample plots	Area (ha)	Number of Sample plots
Nalma	274.4	41 [0.7]	366.8	52 [0.7]	641.2	93 [0.7]
Taksar	292.4	50 [0.8]	99.8	18 [0.9]	392.2	68 [0.8]

SC: *Schima-Castanopsis* forest, SCS: *Schima-Castanopsis-Shorea robusta* forests,
The number in square brackets is the sampling intensity in the forest types

These sample plots were distributed in all community forests to represent them proportionate to their size. The coordinates (Northing and Easting) of each sample locations were calculated from ArcGIS. The coordinates were then loaded in the Global Positioning System (GPS) instrument. The location of each plot was navigated with the help of a GPS instrument (Garmin eTrex).

The plots were established, as far as possible, in the predefined locations. However, the locations in deep gullies and steep slope were displaced by 50 metre in random direction. Most of the plots were established in ≤ 40^0 slope except nine plots in Nalma and three plots in Taksar which were established in slope > 40^0. The size of the sample plots (i. e. plot diameter) was adjusted according the slope gradients.

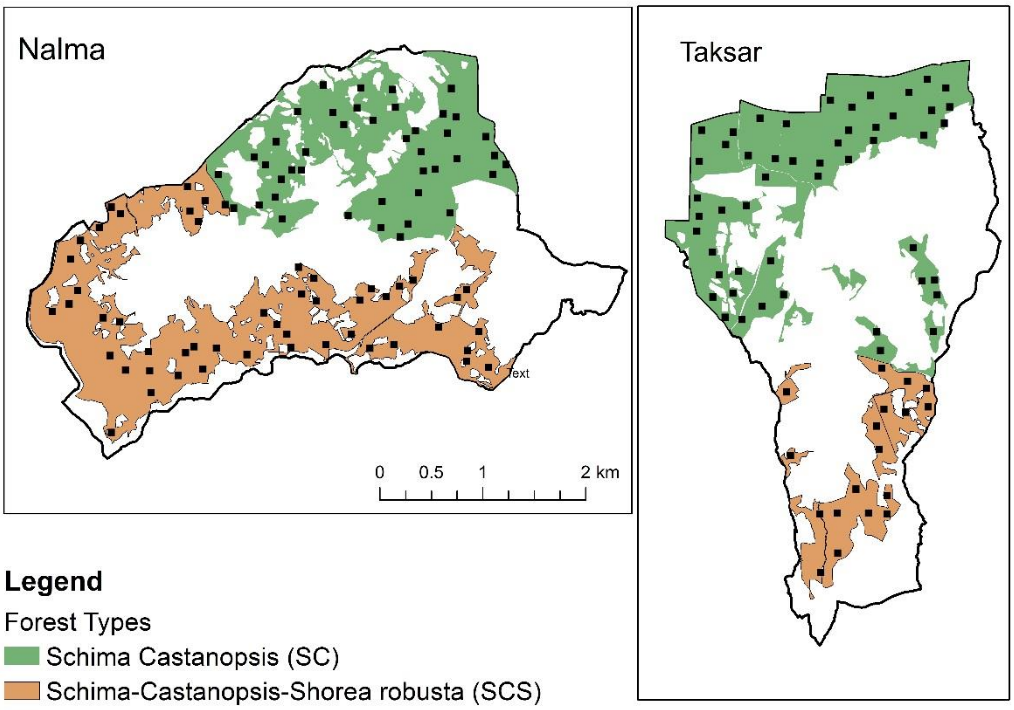

Figure 3.2: Distribution of sample plots in the forests

In each sample plot, the trees ≥ 10 cm diameter at breast height (dbh) were measured. The minimum limit of tree size (i.e. ≥ 10 cm dbh) was fixed as it is the minimum tree size to be valued and used as poles by forest users (DoF 2014). The species names were recorded, and quality of trees were subjectively assessed in three classes as high, medium and low for their potential to produce timber (the description of tree quality is provided in Chapter 6). In addition, the diameter and species of stumps (>10 cm dbh) inside the plot were also measured and recorded. The presence of fallen wood in and around the sample plots was recorded for their use in interpretation of the results. Information on the incidence of fire and grazing in and around the sample plots was gained from local people accompanying the survey team in the forests.

Household interviews

Household interviews were conducted to analyse the characteristics of user group households. For this, a sampling frame of all households registered as FUG members in each community forest was prepared. The list of households was obtained from operational plans and updated for the presence or absence of households in the villages. Altogether, there were 272 households in Nalma and 558 in Taksar registered as the member of forest user groups in different community forests.

The sampling intensity of the social survey varies according to the diversity of households in relation to their wealth, education, location of residence, livelihood practices, ethnicity, gender and age. It is also determined by the nature of analysis with different types of variables. However, this survey does not make *a priori* stratification of the communities to its sampling design and rely on *a posterior* grouping of households as required by the analysis. Therefore, sample households were randomly selected assuming that diversity prevailing in the forest-based communities can be sufficiently captured. Nevertheless, minimum number of samples is an important consideration to make reasonable description of the communities. As a reference, Centre for International Forestry Research (CIFOR) recommends 100 households as the absolute minimum sample size to describe forest dependent communities and their dependency on forests (CIFOR 2007). Therefore, this minimum number was maintained in the social survey. **Table 3.4** shows the number of households sampled in each forest type of both villages with sampling intensity. The sampling intensity, therefore, varied from 11.8 percent to 40.7 percent due to the criteria of minimum numbers of sample households even from smaller sampling frame.

The households were listed and numbered. Then, the households were randomly selected from the list using random number generated in MS Excel. The households which were absent in the village at the time of social survey were replaced by another randomly selected household.

Table 3.4: Number of households sampled in each forest types in Nalma and Taksar

Villages	Forest types		Total
	SC	SCS	
Nalma	33 [40.7]	77 [40.3]	110 [40.4]
Taksar	26 [11.8]	82 [24.1]	108 [19.3]

SC: *Schima-Castanopsis* forest, SCS: *Schima-Castanopsis-Shorea robusta* forests, The number in square brackets is the sampling intensity in each forest type

Each selected household was requested to participate in the survey. At first, chairman of the forest user committees were contacted through DFO office and FECOFUN representatives in the village. In each village, meeting was organized with FUC member to describe the purpose of the study including activities and the support sought from the FUG members. The meeting was useful to build confidence among villagers to support the research activities. Such confidence and trust was useful to access official document like meeting minutes and wood extraction records of the FUG. A letter describing the purposes of the survey and approximate time of survey/interview was provided to each household seeking their pre-informed consent to participate in the survey. The research has received Human Research Ethics Committee approval (H-2015-065), University of Adelaide, South Australia. The research was then conducted in accordance with the research ethics by treating each participants with an open, honest and transparent manner.

Household interview was conducted using both structured and semi-structured approaches. In one hand of the interview, the order of questions and wording were fixed. On the other hand, additional space was provided to ensure openness and flexibility to express new ideas and issues relating to the questions of enquiry. The approach was chosen to fit well to gather mix of qualitative and quantitative data of the household. The interview was guided by a comprehensive questionnaire that included both structured and semi-structured questions relating to household characteristics; demand and supply of forest products; household energy sources, reasons for FUG membership, issues relating to forest management; knowledge of operational plans; and perceptions on forest benefits and motivation for forest management. The household survey questionnaire is provided in the appendix 4.

The questionnaire was administered to each household and the interview was performed at the time of respondents' convenience. For household interviews, 4-5 local enumerators were selected in consultation with members of user group committee (FUC). Local enumerators were employed for the reason that respondents felt comfortable to provide data and express views to the village-members already known to them. It also took less than expected time to complete interviews as some of the household information like family members and their residence period at home was already known to the enumerators. However, there was a risk that enumerators may take advantage of their local knowledge and express the views on the behalf of households. The potential risk was minimized by convincing enumerators about the essence of household interviews and cross-checking the respondents by phone or attending on-going interviews.

The enumerators were trained to make them understand, interpret and code the responses of each question before actual interview with the households. At first, the questionnaire was provided to the enumerators for reading to assess if the questions included were understood as intended. Following it, a training session was organized to elaborate the intent and definition of each question. Then, the enumerators were asked to fill the questionnaire in reference to their own house. The completed questionnaires were checked thoroughly with each enumerator to make sure that the questions were understood as intended and the forms are filled correctly. After a series of cross-checking and interactions, the enumerators were deployed for household interview.

For interview, household head was preferred. However, the interviews did not exclude other members of the household as it was very useful to substantiate and/or correct the information provided by the household head. In addition, the interviews, when outsider like researcher attended, was often surrounded by the neighbours. In such situation, the respondents were interviewed together with immediate neighbours which were friendly to each other. As households in the villages were known to each other, it was beneficial to the respondents to confirm the information provided. The answers of the respondents were noted directly on the questionnaire but the views and opinions which were not accommodated in the questionnaire were noted separately.

The completed questionnaire were thoroughly checked and missing fields were updated either by contacting the households in person or by telephone. The location of each interviewed household was recorded by using Global Positioning System (GPS) instrument to map their geographic distribution. Since the households were clustered in a few small villages, the geographic distribution of households was useful to know whether all the clustered in the village were represented in the sampling. The researcher visited each household with GPS instrument. The respondent households were briefly interviewed by the researcher while recording the GPS locations of the household. The brief interview included one or more sections of the questionnaire.

Acquisition of spatial data

The spatial data were collected from various sources. All the data were integrated in GIS environment for analysis. As described above (under forest inventory), the forest maps were obtained from operational plans and registered in reference to cadastral maps obtained from government offices.

The topographic maps were obtained from Department of Survey of the Ministry of Land Reform and management of Nepal. The topographic map contains dataset on contour, road/track, river, forest and other locational information. The contour data (20 metre interval) were used to generate digital elevation model (DEM). The DEM was used to generate slope maps of the forests. The slope map of each community forest was generated by masking the DEM with the forest maps. The DEM was generated in 10 metre grid size to save information in sharp turns and small patches of the forests that are interspersed with the cultivated lands. The DEM was used to classify the slopes as per required for different analysis. The road/track data of the topographic map represent prominent tracks including the ridges as the transportation network. Therefore, this data set was updated in reference to consultation of local communities and images available in Google Earth ™ and Open Street maps. The settlement map was prepared by digitizing a number of points at prominent house structure visible in the google earth images. The points were grouped to delineate the boundaries of prominent settlements in each village.

The distance of each sample plot (forest inventory) to the nearest settlement and road/track was calculated for spatial analysis. For this, Euclidean distance from each feature (road/settlement) was calculated and extracted those values at each sample point.

The GPS instrument was used to record locational information that were not available in the topographic and cadastral maps.

Group discussion

This method was used to gather information for the deeper understanding of circumstances and background of community forestry initiatives, practices and local issues pertaining to forest management planning. The information and data collected through this method were used to develop and modify the questionnaire for household interviews and consultation with ley informants at the local and national level.

A number of group discussions were organized to elucidate opinion and perception on various aspects of forest management and utilization. The discussion was organized at the FUG level as well as at the village level. The FUG level discussions primarily focussed to understand general practices of forest management, benefits distribution, knowledge of operational plans and locally relevant factors influencing the motivation of forest user groups to manage the forests. The discussion sought to gather best suited qualitative information based on the knowledge and practices of forest user groups. The discussions at the FUG level were participated by 4-5 knowledgeable persons representing former and current member of executive committee.

The village level discussions focussed on the issues relating to the forest management, socio-economic dynamics, potential forest-based enterprises and exchange and/or sale of forest products between forest user groups within and beyond the villages. The discussions were participated by 6-10 participants representing each FUC of the respective villages, FECOFUN members and other key informants representing different profession and livelihood strategies in the villages.

The FUG and village level discussions provided an opportunity to gather required qualitative information and diverse perspectives to describe social and biophysical contexts of community forest management planning. It was rather exploratory part of the data collection for the study and, thus, the participants were chosen purposively based on their engagement and understanding of community forestry process. The issues discussed during these meeting were noted and narrated carefully to best articulate the state of community forest management in the study areas. The questionnaire users for user group interview is provided in the appendix 5.

Following the village discussions, a meeting with experts represented by forestry professional and researchers was organized seeking general opinion on the locally perceived/reported context of community forest management and their policy and operational implications. The consultative meeting provided outside perspectives of the issues related to community forestry which enriched analysis. The discussion sought to acquire general overview of emerging trends and practices of community forest management including technical supports accessible to the forest user groups.

Review of operational plans and policy documents

The review is the process of examining the contents of given documents to analyse the patterns, systems and replicability of information relating to research questions. The content analysis of operational plans is to gather information relating to the objectives, management activities and forest inventory for their categorization and analysis. Other documents reviewed are Forest policy 1993; Forest Regulation, 1995; Community Forestry Development Guidelines, 2014; Forest Product Collection Guidelines, 2015; and Forestry Sectors Strategy (2016-2025). These documents provided legal and policy framework to guide community forestry planning. The review outcomes were essentialised in group discussion and contributed to elaborate the results. **Table 3.5** provides the overview of methods employed, variables used and analysis performed relating to each research questions.

Table 3. 5: Overview of methods used in the study

Data source	Data collected	Analysis	Research Question addressed
Forest inventory	Species and size of trees and stump ≥ 10 cm dbh	Density and basal area across the dbh class	3
		Density and basal area of tree and stump	2
		Annual fuelwood production	1
		Spatial autocorrelation of forest and stump data	2
Household Survey	Family size and composition	Average and effective family size	1
	Reasons of joining FUGs	Frequency of most important reasons	4
	Fuelwood consumption Livestock holding	Average of annual consumption Average holding	1 2
Operational plans and policy document	Planned demand and supply of fuelwood	Comparison with annual consumption and supply	1
	List of forest management strategies and activities	Content analysis/Categorization	3, 4
	List of objectives Procedures of FP collection	Content analysis/Categorization Content analysis	4 2
Topographic / cadastral maps	Contour line (20m interval)	Digital elevation model	2, 3
	data (layers) of road/track and settlements	Euclidean distance to sample plots	2
		Association between forest use and spatial variables	2
	Parcels related to the forests	Registration in GIS environment and calculation of forest/block area based on forest parcels	All
Group discussion	Perceived state of forest management in 0-2 Likert scale	Average of scores within and between community forests	3
	Perceived influence of local factors on forest management in 1-5 Likert scale	Average of scores within and between community forests	3
	Knowledge on the content of operational plans	Narrative analysis	4
Expert opinion	Opinion on the state of forest management Opinion on the scope of operational plan	Narrative Narrative	3, 4 4

FP: Forest Products

3.2.3. Data analysis and presentation

The data analysis includes descriptive analysis, regression analysis and spatial autocorrelation for mapping forest and utilization parameters. The results of analysis are presented as maps, diagrams, models, graphs and narratives. The results have been presented in four self-contained chapters. The methods of data analysis and presentation of results are outlines below and elaborated in each chapter

In chapter four, following analysis results are presented: 1) analysis of annual fuelwood consumption by households, 2) annual supply of fuelwood from forests, 3) comparison of estimated consumption and supply of fuelwood to the prescribed quantity in the operational plans, and 4) general trends of fuelwood demand and supply between two consecutive operational plan implementation periods. These results evaluated the adequacy of operational plans to estimate the fuelwood consumption and supply in the community forestry.

In chapter five, analysis and results of spatial analysis are included. The analysis includes: 1) current status of forest stock and wood extraction, 2) spatial pattern of wood extraction, 3) influence of settlements and slope on forest management and utilization, and, 4) current practices of wood extraction from the forests. The results were employed to evaluate the spatial pattern of wood extraction from the community forests.

In chapter six, locally perceived factors to influence forest management planning and operations are evaluated. The analysis included the list of primary and contributing factors and their relative strength to influence the motivation of forest user groups. The analysis draws a cause and effect diagram to depict the underlying factors to influence the motivation of FUG to manage forests.

In chapter seven, the relevance of operational plans to the forest user groups are evaluated. First, the list of forest management objectives and activities are extracted from the operational plans and compared those objectives across the operational plans. Second, the prioritized objectives of the FUG (as group) and individual members were ranked and compared. Then, scope of current operational plans are assessed from the perspectives of user groups and forestry professionals. The information is largely drawn from the statement and opinion of the respondents in particular research issues or theme.

Overall, the analysis is designed to evaluate the effectiveness of operational plans to represent the demand and supply forest products as well as to execute prescribed forest management activities. In addition, the study results provide critical overview of local factors to describe the current state of forest management and urges for reviewing current planning process reflecting on the priorities, needs and capacity of forest user groups.

The summary of socioeconomic data is provide in appendix 1a and 1b. Summary of forest inventory data is provided in appendix 2. Community forest maps showing their blocks are included in the appendix 3. Appendix 4 and 5 include questionnaire for household interview and group discussion. The appendix provides the list of community forests in the Lamjung district in the year 2015.

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Chapter 4: The adequacy of community forest operational plans for estimating fuelwood supply and consumption in Nepal

Fallen wood in forest (left) and fuelwood collected from private land/forest (right), (Nalma, November, 2015)

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Overall percentage (%)	80		
Certification:	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.		
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Co-Author Contributions

By signing the Statement of Authorship, each author certifies that:

i. the candidate's stated contribution to the publication is accurate (as detailed above);
ii. permission is granted for the candidate in include the publication in the thesis; and
iii. the sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

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The adequacy of community forest operational plans for estimating fuelwood supply and consumption in Nepal

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Abstract

Fuelwood derived from community forests of Nepal is critical for rural livelihoods. Supply of fuelwood is regulated through 5-year operational plans. The aim of this study was to evaluate the adequacy of operational plans in addressing the demand and supply of fuelwood in community forests of Nepal. Data was gathered from operational plans, household interviews and fuelwood supply assessment in 13 community forests of Nalma (inaccessible by road) and Taksar (accessible by road) villages of Lamjung district. Our study revealed that *per capita* annual fuelwood consumption in Nalma (486 kg) was significantly higher than in Taksar (398 kg), and also significantly different combinations of fuelwood, biogas and electricity were utilised between the villages. These differences were associated with their respective distances from the main road. Community forests contributed 57% and 63% of the total fuelwood consumption in Nalma and Taksar, respectively. Of 13 community forests, nine have planned annual demand and supply of fuelwood well below our estimates of actual supply and consumption, indicating that most of the operational plans inadequately represented the prevailing demand and supply of fuelwood. In addition, the planned quantities of fuelwood demand and supply in current operational plans were markedly different and poorly linked to the previous projections, which suggests inconsistent and inadequate application of standard planning guidelines. We recommend a revision of the methods used in the preparation of these plans to determine fuelwood demand and supply in community forestry implementation.

Keywords: fuelwood; community forest; operational plan; supply and demand

1. **Introduction**

Fuelwood collected from forested land is the major source of energy in rural areas of many developing poor countries (Heltberg, Arndt & Shekhar 2000). It is estimated that around 2.5 billion people in developing countries rely directly on biomass fuel for their cooking and heating (IEA 2006). Fuelwood is considered as the most important source of renewable energy in the world (Lauri et al. 2014). It provides 35% of primary energy consumption in developing countries and 14% of the final energy consumption globally (Parikka 2004). In Nepal, 77% of total energy is derived from traditional energy sources, including fuelwood as the major contributor (CBS 2011; Malla, S 2013; MFSC 2014).

Fuelwood extraction from forests has a complex interrelationship with forest degradation and deforestation and there are a range of policy initiatives around the globe to address this issue. Community forestry is one of the policy interventions introduced in Nepal during 1970s to curb environmental degradation, and address the needs of local communities for forest products through their active participation in managing and conserving forest resources (Gurung, Karki & Bista 2011; Pokharel & Nurse 2004). Currently, approximately 30% of the national forest land (1.7 million ha) is managed by 19 361 Community Forest User Groups (FUGs) involving approximately 35% of the country's population[12] (DoF 2017).

An operational management plan is the precondition for transferring and legitimising the management responsibilities of state forests to the FUGs (Kandel et al. 2016). Operational plans provide information on how forests are managed and utilised to safeguard the environment and livelihoods of forest users. These plans provide information on annual demand for various forest products, and a mechanism to supply those products in a sustainable manner. Therefore, reliable information on the status and dynamics of local demands, and on the resources from where the demand is met, is the prerequisite for preparing operational plans for community forestry implementation.

[12] The community forestry profile has now updated. As per July 2018, the total number of FUG is 22, 266 with area 2.2 million hectare involving 2.9 million households (54 % of country's total household)

Community forests are the major sources of fuelwood in Nepal (WECS 2010). The nature of dependency on forests for fuelwood has been well-studied, and is determined by the factors such as the socioeconomic characteristics of households, location of and distance to the forests, and institutional arrangements for allocation within communities (Adhikari, B, Frances & Lovett 2007; Adhikari, S, Tanira & Siva 2014; Agrawal & Chhatre 2006; Arnold & Campbell 1985; Chhetri, Larsen & Smith-Hall 2015; Cooke, Kohlin & Hyde 2008; Edmonds 2002). Socioeconomic development and linkages to broader market systems can alter the priorities of local communities in their demand and use of forest products and services (Kanel et al. 2012; Link, Axinn & Ghimire 2012). For example, high-income households may prioritise environmental services like biodiversity conservation and watershed protection as management objectives, whereas low income households may focus on subsistence energy needs, and collection of fodder and non-timber forest products for commercial outcomes. Such competing priorities influence local forest management decisions as well as national-level policies relating to the production and supply of fuelwood (Kanel et al. 2012). For this, it is important that operational plans capture the social and biophysical characteristics and dynamics of forest utilisation during their formulation. These plans are reviewed at 5- or 10-year intervals to adapt to the changing context of the community and forest environment.

Despite the extensive study of Nepal's community forests for different products and services, there has been no examination of the extent to which operational plans reflect the actual consumption and supply of fuelwood. Such a study is timely in a period where public administration is shifting towards larger regional centres, with a recalibration of policy and institutional processes including those associated with active and equitable forest management.

The aim of this study was to assess the adequacy of operational plans in addressing the demand and supply of fuelwood in the changing socioeconomic context of forest-dependent communities. Specifically, in two case study villages in Lamjung district, we (1) estimated the annual consumption and supply of fuelwood to compare with the planned demand and supply in the operational plans; (2) determined the relative contribution of fuelwood obtained from community forests and private lands to the total consumption; and (3) assessed the general trend of fuelwood demand and supply based on the operational plans prepared in 2008 and 2014.

The fuelwood demand and supply obtained from operational plans are referred to as planned demand and supply to differentiate them from our estimates of actual consumption and supply. The quantity of fuelwood demand and supply provided in the operational plans is considered to be for household use only, as there is no evidence of commercial use and supply of fuelwood in either village.

2. Methods

2.1 Study area description

The study was carried out in Taksar and Nalma villages, locally known as Village Development Committee[13], in the Lamjung district of central Nepal. **Figure 1** provides the location of the study area and distribution of community forests in each village. With the majority of populace being dependent on agriculture and forest resources for their livelihood, the villages represent typical forest-dependent communities of the mid-hills of the country. The villages were selected to represent accessibility (Taksar) and inaccessibility (Nalma) by road.

[13] Village Development Committee (VDC) refers to the smallest political unit governed by the locally elected representatives. After the promulgation of new constitution in 2015, territory of these units are expanded and renamed as Village Councils.

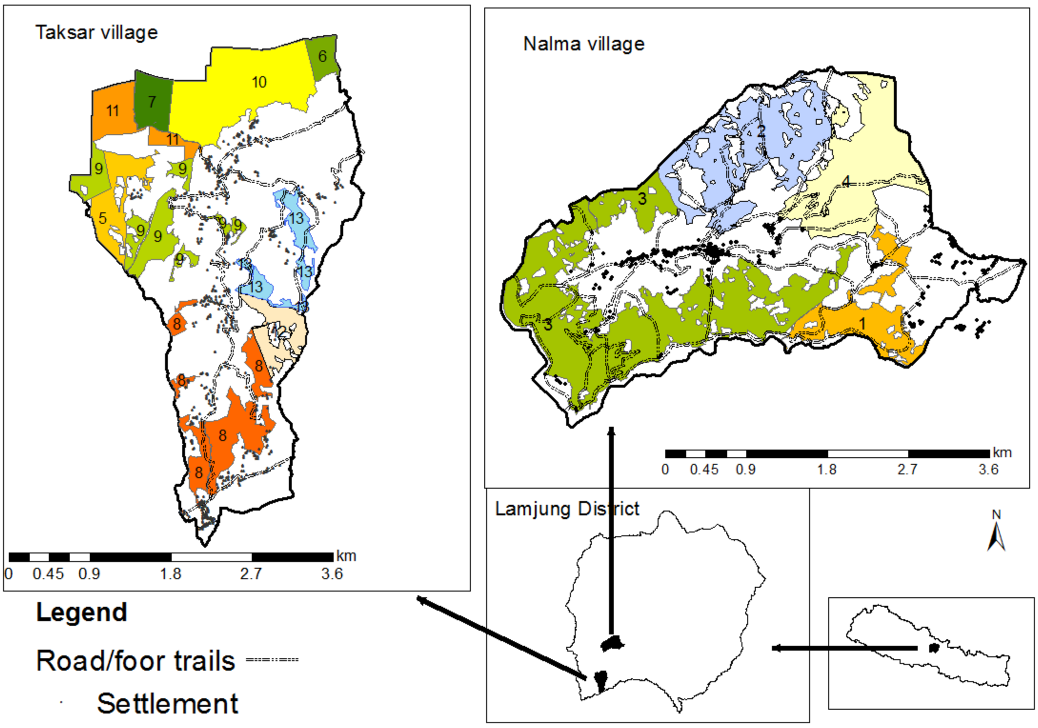

Figure 3. Study area showing villages and community forests. Community forests in Nalma: 1, Kagrodevi; 2, Khundrudevi; 3, Langdihariyali; 4, Sunkot. Community forests in Taksar: 5, Adherikhola; 6, Bholdada; 7, Jamuna Gahira; 8, Lampata; 9, Nag Bhairab; 10, Pisti; 11, Samkhoria; 12, Sathimure; 13, Tamakhani.

Most of the households in both villages are engaged in community forest management. According to the 2011 census, there were 438 and 619 households in Nalma and Taksar, respectively, with a population density of 112 persons km^{-2} and 272 persons km^{-2} in these villages (CBS 2012). Currently, 272 (62%) and 567 (92%) households are registered as community forest users in Nalma and Taksar, respectively. Ethnically, Nalma is more homogenous than Taksar. In Nalma, the community is predominately Gurung (74%) followed by Dalits (22%) and Brahmin-Chhetri (4%). In Taksar, Brahmin-Chhetri is the dominant caste (50%), followed by Gurung (31%) and Dalits (19%).

The study included 13 community forests: four from Nalma and nine from Taksar. **Table 1** provides an overview of the community forests in the two villages. In Taksar, two community forests (Lampata and Sathimure) are located at lower elevation and composed of mixed natural broad-leaved forest of *Shorea robusta*, *Schima wallichii* and *Castanopsis indica*. Other community forests located in middle (Adherikhola, Tamakhani and Nag

Bhairab) and higher (Bholdada, Pisti, Jamuna Gahira and Samkhoria) altitudes are dominated by *S. wallichii* and *C. indica* forest. In Nalma, Sunkot and Khundrudevi are located at higher altitudes and dominated by *S. wallichii* and *C. indica* forests. Two community forests at lower elevations (Langdihariyali and Kagrodevi) are dominated by *Shorea robusta* forest, which is gradually intermixed with *Schima-Castanopsis* at higher altitudes. Other species occurring in the forests included *Alnus nepalensis*, *Magnolia champaca* and *Lagerstroemia parvifolia*.

Table 1: Description of community forests in Nalma and Taksar villages of Lamjung District

Community forests	Start year	OP Period[a]	Forest area (ha)	FUG[b] size	Population	Major species
Village: Nalma						
Kagrodevi	1998	2014–2019	62.55	27	109	*Schima wallichii, Castanopsis indica, Alnus nepalensis*
Khundrudevi	2004	2014–2018	158.43	44	248	*Schima wallichii, Castanopsis indica, Shorea robusta, Alnus nepalensis, Albizia spp.*
Langdihariyali	1998	2012–2018	275.91	164	1012	*Schima wallichii, Castanopsis indica, Shorea robusta*
Sunkot	2006	2011–2017	133.02	37	184	*Schima wallichii, Castanopsis indica, Shorea robusta*
Village: Taksar						
Adherikhola	2003	2014–2019	31.36	20	113	*Schima wallichii, Castanopsis indica*
Bholdada	1996	2014–2019	16.62	17	99	*Schima wallichii, Castanopsis indica*
Jamuna-Gahira	1996	2011–2016	20.73	9	51	*Schima wallichii, Castanopsis indica, Michelia champaca*
Lampata	1996	2014–2023	84.27	260	1490	*Shorea robusta, Schima wallichii, Castanopsis indica*
Nag Bhairab	2003	2014–2018	58.42	64	321	*Shorea robusta, Schima wallichii, Castanopsis indica*
Pisti	1996	2014–2018	110.86	35	262	*Schima wallichii, Castanopsis indica, Michelia. champaca,*
Samkhoria	1996	2012–2017	35.31	21	105	*Schima wallichii, Castanopsis indica, Michelia champaca*
Sathimure	1996	2014–2018	30.05	79	471	*Shorea robusta, Schima wallichii, Castanopsis indica*
Tamakhani	2013	2013–2018	13.23	53	320	*Schima wallichii, Castanopsis indica, Lagerstroemia parviflora*

[a]Current period of operational plans (OP); [b]FUG = community forest user group (number of households)

In this study, fuelwood refers to the woody biomass collected from trees in the form of stem or branches exclusively for fuelwood, or small branches collected as a by-product of fodder collection (Webb & Dhakal 2011). Villagers generally collect green fuelwood and stack it for a year to dry. Therefore, our study considered the quantity of fuelwood consumed by the households in the year of survey irrespective of its collection year.

2.2. Data collection and analysis

The study is based on both primary and secondary data collected through household interviews, group discussions, fuelwood assessments and operational plan reviews. Data collection in the field was undertaken during July–December, 2015. The data collection included the following components.

2.2.1. Household interviews

The focus of household interviews was to estimate the annual fuelwood consumption of households. The sampling frame includes all FUG households in each village. From Nalma and Taksar, 110 and 108 households were randomly selected representing all the FUGs proportionate to their size. This sample size is sufficient for a general understanding of peoples' dependency on forest in rural communities (CIFOR 2007). We conducted household interviews with a questionnaire for gathering information on: (1) family size and residency period of members at the home; (2) major income sources (cash-based or agriculture-based); (3) main energy sources (fuelwood, biogas, electricity (FBE) or combination of these sources); (4) annual fuelwood consumption and its sources (private or community forest); and (5) the number of tree holdings on private lands. Annual fuelwood consumption was derived from recall methods from adult members of the sample households. The fuelwood consumption was reported in *Bhari* (backload) which was converted to kilograms for all analysis and comparisons.

After completing the survey, we classified households into three wealth classes (rich, medium and poor), four energy groups depending on the mix of energy sources used (fuelwood only, F; fuelwood and biogas, FB; fuelwood, biogas and electricity, FBE; and fuelwood and electricity, FE), two income groups (cash and agriculture), and three caste groups (Brahmin-Chhetri, Gurung and Dalits). An independent sample t-test and one-way ANOVA tests were performed to examine differences in fuelwood consumption in the two villages and between different wealth, caste and energy groups within the villages. The effective family size of each household was obtained by excluding the members absent for more than 6 months from the home. We then calculated the *per capita* fuelwood consumption from the effective family size. For assessing the effect of elevation on fuelwood consumption, community forest users were divided into three elevation categories: lower (<800 m), middle (800–1200 m) and higher (>1200 m). As the settlements in Nalma were confined within a narrow elevation range (1000–1200 m), the elevation effect was analysed only for Taksar village.

2.2.2. Assessment of fuelwood supply

Forest inventory was conducted to estimate annual fuelwood production (i.e. supply) from the community forests. We followed community forestry inventory guidelines to determine sample sizes, measurement and annual harvestable quantity of fuelwood (DoF 2004). In Nalma and Taksar, total community forest area was 641.2 ha and 392.2 ha, respectively. Altogether, 93 and 68 sample plots of size 500 m^2 (0.05 ha) were randomly distributed in Nalma and Taksar, respectively. The sampling represented all community forests proportionate to their sizes. In each plot, trees above 10 cm diameter at breast height were measured. A sub-sample of trees in each plot was selected for height measurement. The annual fuelwood production (i.e. supply) available from each community forest was calculated and compared with the planned quantity of fuelwood supply obtained from the operational plans.

2.2.3. Review of operational plans

The operational plans prepared during 2008 and 2014 were reviewed to obtain information on user group and the quantity of fuelwood demand and supply from community forests. We examined the practice of demand and supply derivation from the information provided in the operational plans and discussion with forest officials and FUG executive members.

We converted the quantity of fuelwood from operational plans (i.e. Bhari or *backload*) into kilograms using a conversion factor (1 Bhari = 30 kg) prescribed in the inventory guidelines

(DoF 2004). We divided the quantity of fuelwood demand and supply by the user group population of the respective community forests to obtain planned *per capita* demand and supply. We compared the planned *per capita* fuelwood demand and supply from the current operational plans with our estimates of actual consumption and supply to determine whether the operational plans have adequately represented the actual consumption of fuelwood from the community forests. For this, we calculated the average and standard deviation of *per capita* fuelwood consumption averaging across the sample households of each community forest. Similarly, estimated *per capita* fuelwood supply was obtained by dividing our annual estimated fuelwood production by the user group population of respective community forests. We derived average and standard deviation of estimated annual fuelwood supply by averaging the fuelwood production across the sample plots in each community forest. Then, we defined a range of estimates of consumption and supply (i.e. production) within a standard deviation of the annual average consumption and supply of fuelwood. A community forest was considered 'adequate' for the community if the fuelwood demand and supply planned in the operational plans lie within the range of our estimates for consumption and supply (i.e. in the range of mean ± 1 standard deviation). As about 68% of the estimates fall within this range, this criterion was used to provide a proportion of operational plans that adequately represented the actual fuelwood consumption and supply from the community forests.

Similarly, the planned quantities of fuelwood demand and supply and the user population from operational plans of 2008 and 2014 were compared to assess the general trends of fuelwood demand and supply over the two implementation periods.

3. Results

3.1. Comparing actual and planned supply and demand

3.1.1. Actual fuelwood consumption in two villages

The annual fuelwood consumption by different energy, wealth, income and caste groups is presented in **Table 2**. The *per capita* annual fuelwood consumption in Nalma and Taksar was significantly different ($P < 0.001$). Households in Nalma reported higher *per capita* fuelwood consumption (x = 486±106 kg person^{-1}) than did the Taksar households (x =

398±77 kg person^{-1}). As expected, total household fuelwood consumption showed a strong positive relationship ($r > 0.88$) with the effective family size in both villages.

Table 6. Annual fuelwood consumption by energy, wealth, income and caste group in Nalma and Taksar villages, Lamjung district

Groups	Nalma (n = 110)		Taksar (n = 108)	
	N	Mean *per capita* annual fuelwood consumption (kg)	*N*	Mean *per capita* annual fuelwood consumption (kg)
Energy group				
Fuelwood	16	672	6	547
Fuelwood, biogas (FB)	8	440	23	446
Fuelwood, biogas and electricity (FBE)	47	426	75	370
Fuelwood and electricity (FE)	39	490	4	428
One-way ANOVA		$F = 52.15$ $p < 0.001$*		$F = 22.55$ $p < 0.001$*
Wealth group				
Rich	34	449	25	380
Medium	48	477	44	383
Poor	28	545	39	428
One-way ANOVA		$F = 7.31$ $p < 0.05$*		$F = 4.95$ $p < 0.05$*
Income group				
Cash-based	69	479	77	392
Agriculture-based	41	498	31	415
One-way ANOVA		$F = 0.88$ $p > 0.05$*		$F = 1.9$ $p > 0.05$*
Caste group				
Brahmin-Chhetri	4	424	54	391
Gurung	82	470	33	414
Dalits	24	551	21	394
One-way ANOVA		$F = 6.8$ $p < 0.05$*		$F = 1.02$ $p > 0.05$*
Village total	110	**486***	108	**398***

*significant among the groups. *N*, number of sample households in each group

Fuelwood consumption varied considerably according to the energy, wealth, income and caste groups. In Nalma, the fuelwood consumption was generally higher for all groups compared to Taksar. The proportion of households using a combination of FBE in Taksar was higher (69%) than in Nalma (42%), and this group used a significantly lower quantity of fuelwood compared to the households in the energy group F. However, fuelwood consumption by the FB and FE groups was not significantly different in both villages. Similarly, poorer households, which were 25% and 36% of the total sampled households in Nalma and Taksar, respectively, consumed a significantly higher quantity of fuelwood compared to medium and rich families. In Nalma, fuelwood consumed by different income and caste groups was not significantly different, but in Taksar the households relying on agricultural incomes and the Dalits caste used more fuelwood.

The effect of elevation on fuelwood consumption was evident in Taksar. Settlements in the village were distributed from 400 m altitude at the south to 1300 m in the north. Households residing at the lower (<700 m) elevations used significantly less fuelwood than the households in the middle (700–100 m) and upper (>1000 m) altitudes (r = - 0.43).

3.1.2. Planned fuelwood demand and supply

The planned quantities of fuelwood for demand and supply in the community forests are provided in **Table 3** (column A-D), while Figure 2 depicts our estimates for annual consumption and supply of fuelwood. Figure 2 shows a considerable variation in *per capita* fuelwood consumption as well as supply estimates from the forests. Overall, the planned demand for fuelwood was less than the actual consumption by the FUG members. Out of 13 community forests, the planned supply from nine was well below the adequate range of consumption, while the planned supply from three was above the adequate range (Fig. 2(a)). There was only one community forest with demand within the adequate range. A similar pattern was revealed for the planned supply and our estimated supply of fuelwood from the community forests. Out of 13 community forests, nine planned to be lower than our annual estimate of fuelwood supply, while two had a very high planned quantity compared to our estimates (Fig. 2(b)). For nine community forests, the annual planned supply was only 13–50% of our estimates for fuelwood production from the respective forests. In contrast, the planned quantity of fuelwood supply in three community forests was up to five times higher than our estimates.

Table 7. 1. Planned and actual demand and supply of fuelwood from community forests in Nalma and Taksar villages

Community forests	Fuelwood quantity in operational plans				Actual fuelwood consumption (2015)			Annual supply estimated from household interview (2015)	Annual fuelwood supply from community forests	
	Demand		Supply							
	2008	2014	2008	2014	Community Forest	Private lands	Total		Operational plans (2014)	Estimated from forest survey (2015)
	A	B	C	D	E	F	G	H	I	J
Village: Nalma										
Kagrodevi	264	175	193	251	98±127	371±133	469±25	1263±601	413	2201±1048
Khundrudevi	362	305	400	248	236±170	234±147	470±63	1124±689	455	1759±1079
Langdihariyali	184	152	3526	98	319±199	171±144	490±126	534±324	331	1960±1187
Sunkot	833	905	831	414	262±141	240±118	502±102	1944±1014	547	2688±1402
Total	**246**	**409**	**172**	**287**	**271±192**	**214±152**	**486±106**	**264±186**	**437**	**2127±1171**
Village: Taksar										
Adherikhola	212	354	388	94	300±59	150±108	450±50	612±345	341	2215±3372
Bholdada	289	303	334	57	362±54	70±64	431±41	296±2	434	2257±10
Jamuna Gahira	316	353	744	4157	445±131	38±65	483±71	735±506	9138	1616±361
Lampata	150	382	50	280	218±93	155±111	373±83	58±30	5836	1214±1024
Nag Bhairab	274	1215	86	61	331±49	103±85	434±57	149±94	456	1105±264
Pisti	273	229	438	123	302±93	182±125	484±68	968±537	282	2216±4054
Samkhoriya	303	571	415	3227	225±87	213±52	438±109	700±259	9764	2118±959
Sathimure	305	127	60	18	257±65	133±64	390±41	84±19	301	1391±311
Tamakhani	NA	201	NA	109	280±49	121±28	402±37	215±92	1222	2402±2233
Total	**214**	**421**	**142**	**357**	**257±96**	**142±98**	**398±77**	**37±37**	**3086**	**1837±1399**

Columns A–H, fuelwood per capita (kg); columns I–J, fuelwood per unit area (kg ha^{-1}). Values, mean ± standard deviation

There were major differences between the planned and actual production of fuelwood from the forests. We estimated that the community forests in Nalma and Taksar can supply, on average, 2127 and 1837 kg ha^{-1} y^{-1}, respectively. Operational plans in Nalma planned for 437 kg ha^{-1} y^{-1}, which is only the 21% of our estimated potential supply. In Taksar, however, the planned supply of fuelwood was about 1.7 times higher than our estimates, and this difference was contributed mainly from three community forests, namely Lampata, Samkhoria and Jamuna Gahira. The type and conditions of the forests in the two villages were, however, not markedly different.

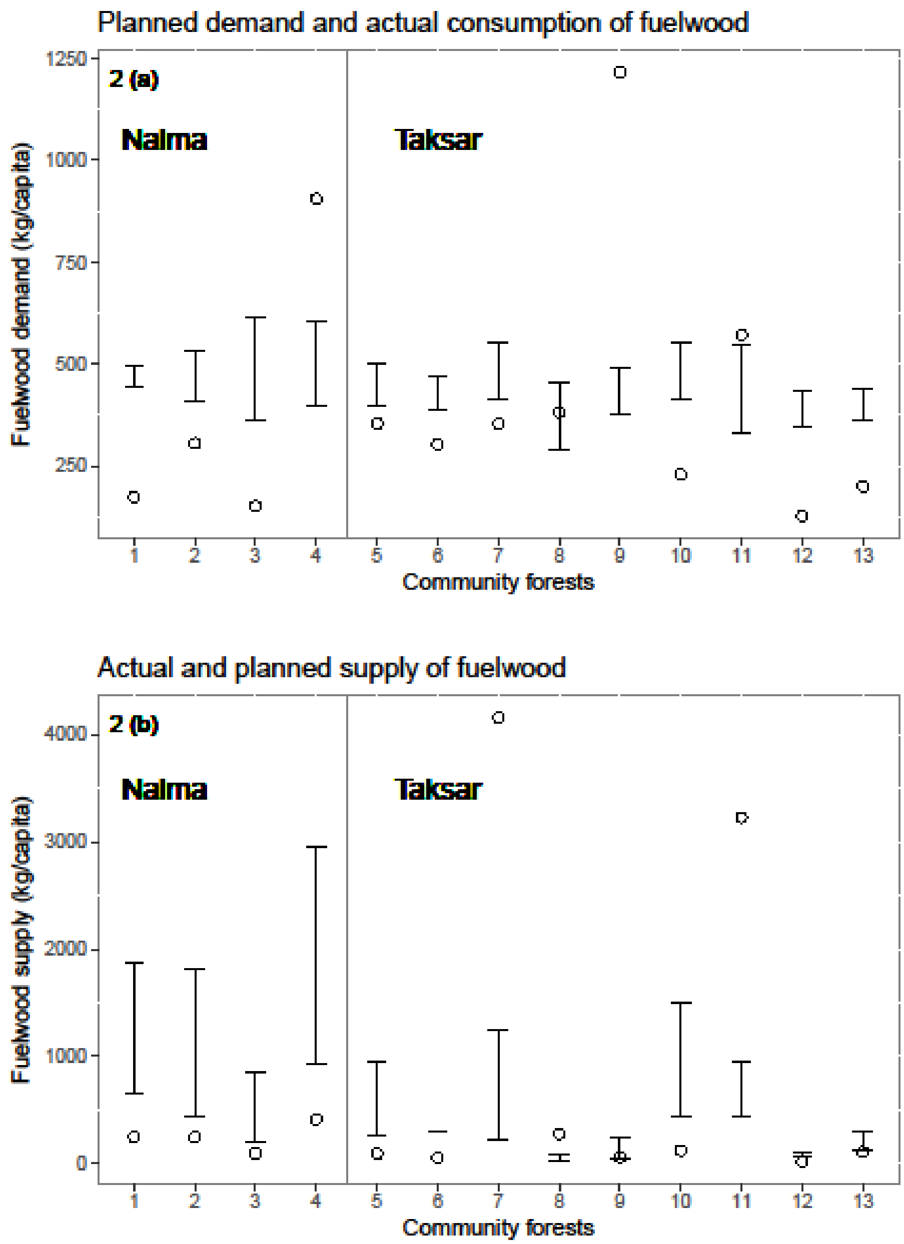

Figure 2. The actual and planned demand, supply and consumption of fuelwood. The vertical bars cover a range (mean ± 1 standard deviation) of actual fuelwood (a) consumption by the households and (b) supply from the forests. The circles represent the planned fuelwood (a) demand and (b) supply obtained from operational plans. Community forests: 1, Kagrodevi; 2, Khundrudevi; 3, Langdihariyali; 4, Sunkot; 5, Adherikhola; 6, Bholdada; 7, Jamuna Gahira; 8, Lampata; 9, Nag Bhairab; 10, Pisti; 11, Samkhoria; 12, Sathimure; 13, Tamakhani.

The actual consumption of fuelwood from the community forests differed from the planned annual fuelwood supply. **Figure 3** depicts the status of planned demand and actual consumption of fuelwood from the community forests. In seven community forests, the actual consumption of fuelwood from the community forests was higher than the planned supply. In five community forests, however, the planned quantity was above the actual consumption, suggesting a surplus of fuelwood supply from those forests. In most cases, the actual quantity of fuelwood obtained from the community forests remained below that required for the adequate range of annual consumption, indicating that villagers do not derive all their fuelwood requirements from the forests. Overall, existing operational plans have underestimated both the actual consumption and supply of fuelwood from the community forests.

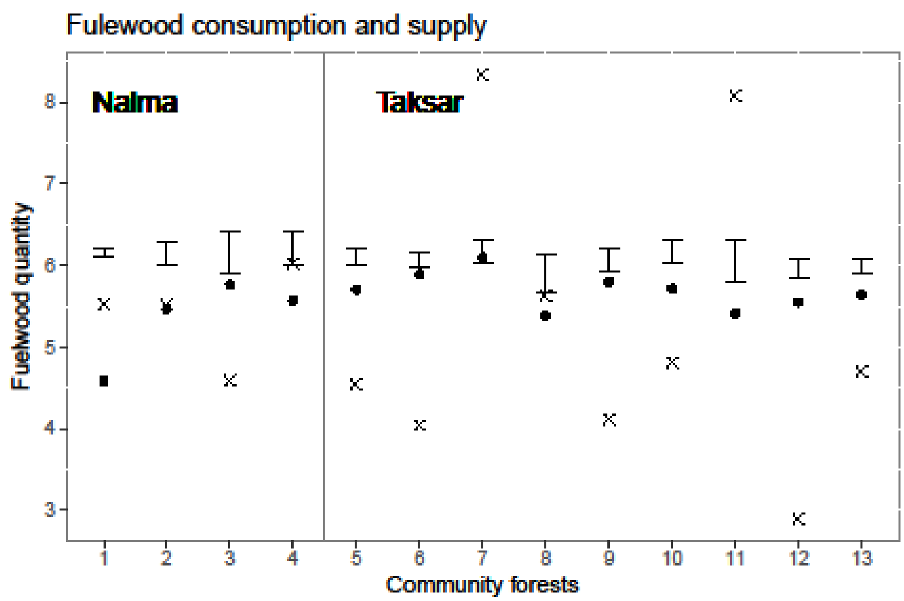

Figure 3: The actual and planned supply of fuelwood from community forests in relation to the actual consumption. The vertical bars represent the range (mean ± 1 standard deviation) of annual fuelwood consumption; x, planned fuelwood supply; •, actual fuelwood consumed from community forests. Vertical scale: log (kg $person^{-1}$). Sequence of community forests, see figure 2.

3.1.3. Comparing contributions from community and private land

As indicated above, community forests were not the only source of fuelwood in the villages. Households also collected fuelwood from trees grown on their private lands. Figure 4 presents the relative share of total fuelwood supplied from community forests and private lands. It shows that in most instances community forests were the main source of fuelwood in both villages. The average contribution of fuelwood from community forests was 63% of the total annual consumption, ranging from 21% (Kagrodevi) to 92% (Jamuna Gahira). For an average household, the fuelwood from community forest constituted 57% and 63% of total annual consumption in Nalma and Taksar, respectively. The proportion of households using fuelwood only from community forests was 19% in Nalma and 14% in Taksar. When comparing the two villages, the proportion of fuelwood deriving from community forests was 70% in Taksar and 48% in Nalma. Similarly, the proportion of fuelwood obtained from community forests was significantly higher for households residing in middle and higher altitudes than the lower altitudes of the Taksar village.

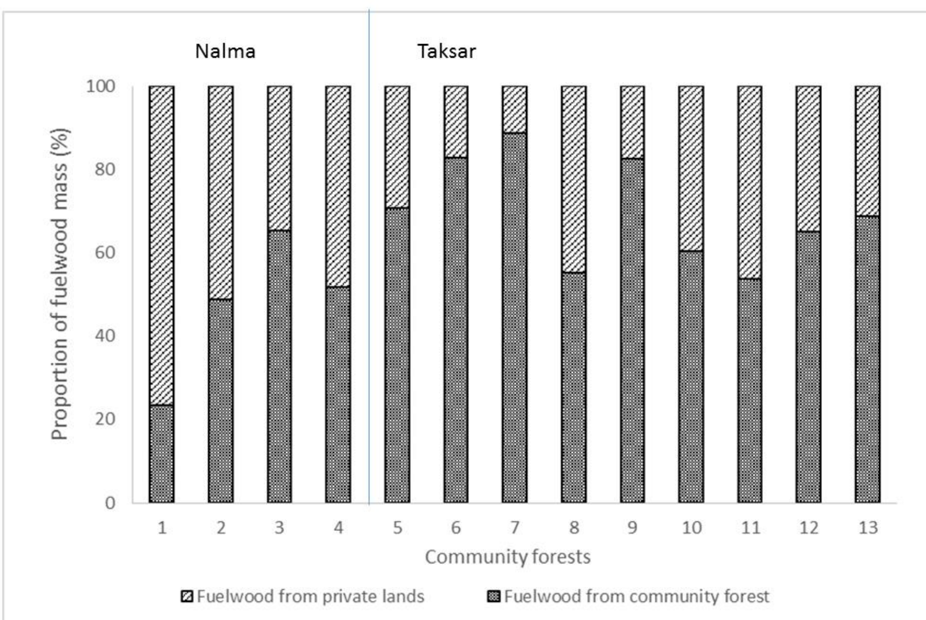

Figure 4. Proportion of fuelwood deriving from community forest and private land. Sequence of community forests, see Figure 2.

Fuelwood from community forests is obtained during management operations like thinning, pruning, timber harvesting and bush cutting. These activities are carried out once a year, and fuelwood collected from these operations is distributed either on the basis of the contribution to management or sold to the users at nominal prices as specified in the operational plans. The collection of dry fuelwood, which comes mainly from dry twigs and fallen branches, was open in Nalma but partly regulated in Taksar. In Nalma, poor families collected fuelwood from forests except during the monsoon season (July–September). In Taksar, fuelwood collection was confined to a specified period of the year, but dry fuelwood could be collected for a week on the eve of major festivals (October/November).

Trees growing on the terrace risers, fallow lands and privately owned forests were the main sources of private fuelwood. More than 92% of households owned trees in their farm lands. The average number of trees held or owned by the households in Nalma was significantly higher (125±158.7) than in Taksar (43±50.7), and the quantity of fuelwood from private land was positively associated with the number of trees owned (Spearman coefficient (ρ) for Taksar and Nalma was 0.44 and 0.50, $P < 0.001$)) in both villages. In Nalma, fuelwood consumption from private land was significantly higher in richer families than in the other two wealth classes, but such a difference was not evident in Taksar.

In group discussions, private land was considered as the emerging source of fuelwood supply. Out of 13 FUGs, four identified private land and three identified community forests as the major source of fuelwood. Villagers perceived that the amount of fuelwood derived from private land is increasing, due mainly to the growth of trees on abandoned, previously cultivated land. In Nalma, 58% of the sample households indicated that land fallowing was the major reason for the increase in the number of trees in private lands. In Taksar, trees planted for fuelwood, timber and fodder were the primary reasons for the increasing number of trees on farmland.

3.1.4. Change in operational plans over time

Figure 5 presents the changes in planned demand and supply of fuelwood (from Table 3) in operational plans prepared in 2008 and 2014. It shows that fuelwood demand and supply between the operational plans does not follow a consistent pattern among the community forests. In four community forests (Andherikhola, Bholdada, Nag Bhairab and Sunkot), an increase in fuelwood demand was accompanied by a decrease in supply. For Nag Bhairab community forest, fuelwood demand planned in 2014 was more than four times that of 2008, although the population decreased slightly in the same period. Similarly, in Langdihariyali community forest, the planned supply of fuelwood quantity in 2014 was 35 times lower than 2008 while population had decreased only slightly in the same period. In Jamuna Gahira and Samkhoria community forests, however, the planned fuelwood supply in 2014 was more than five times and seven times, respectively, that of the year 2008. For other four community forests, namely Pisti, Sathimure, Khundrudevi and Langdihariyali, both demand and supply decreased from 2008 to 2014.

Discussion with respective forest users indicated that such exceptional changes in the fuelwood demand and supply between 2008 and 2014 was not realistic. The users view was that the fuelwood demand had not significantly decreased between 2008 and 2014, but the dependency on the community forests for fuelwood has gradually decreased due to the use of private trees and other energy sources.

The determination of fuelwood supply in the operational plan was based on the forest inventory data derived following the procedures prescribed in the forest inventory guidelines (For details see:DoF 2004). However, there was no detailed account on how the annual quantity of fuelwood demand was derived and included in the operational plans. According to the policy guidelines, fuelwood demand is determined from household interviews and a series of discussions with different interest groups within the community. However, a discussion with forest officials indicated that the demand quantity provided in the operational plans was standalone information which was not derived from a demand survey and consultation with forest user groups. Out of 13 FUGs, eight expressed their ignorance of the demand quantity of fuelwood in their respective operational plans. It suggests that the derivation of fuelwood demand in the community forests did not follow the procedures outlined in the policy guidelines while preparing operational plans.

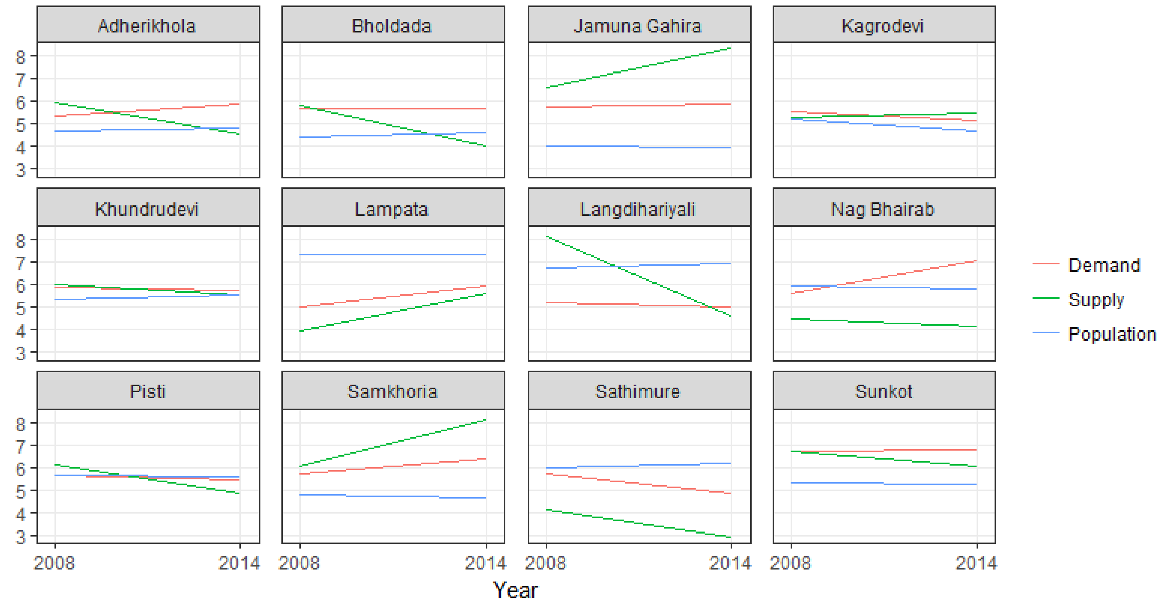

Figure 5. Fuelwood demand, supply and user group population of community forests obtained from operational plans. Vertical axis: demand, log (kg person^{-1}); supply, log (kg person^{-1}); population, log (population). Tamakhani community forest in Taksar is excluded as the first operational plan was prepared in 2014.

4. Discussion

4.1. Annual fuelwood consumption

Fuelwood was a widely used forest product from the community forests in both villages. Several studies have estimated fuelwood consumption in the middle hills of Nepal, with results ranging from 360 to 683 kg person^{-1} y^{-1} (Kandel et al. 2016; Malla, Y, Neupane & Branney 2003; Manandhar & Shin 2013; MFSC 2014; Shrestha 2005; Webb & Dhakal 2011). Thus, our estimates of fuelwood consumption for Nalma (486 kg person^{-1} y^{-1}) and Taksar (398 kg person^{-1} y^{-1}) fall within the range of estimates from previous studies for the region.

Fuelwood consumption varied substantially in relation to the location of the village and socioeconomic characteristics of the forest-dependent communities. The households in both villages used a combination of fuelwood, biogas, liquefied petroleum gas (LPG) and electricity to meet their energy requirement. The gradual shift from a traditional farm-based rural economy in the middle hills to a cash economy, which is due mainly to remittances and urbanisation, has markedly influenced energy preferences (Kanel et al. 2012). This is consistent with energy transition theory: that increased incomes and linkages to broader economic contexts (Link, Axinn & Ghimire 2012). The higher fuelwood consumption in Nalma compared to Taksar can be attributed to the remoteness of Nalma which inhibited the regular supply of alternative energy sources like LPG. Electricity for cooking was not reliable in both villages due to the limited period of daily power supply throughout the year.

4.2 Comparing planned and actual fuelwood consumption

Although there is a comprehensive policy guideline prescribing procedures for deriving demand and supply of fuelwood from community forests (DoF 2014), there was a considerable departure in actual estimates of consumption and supply from that contained in current operational plans. In the majority of operational plans, the planned quantity of fuelwood demand was below the adequate range deduced for actual consumption. In some community forests, however, the planned demand was often significantly higher than the actual consumption. Furthermore, the actual fuelwood obtained from the community forests was below the adequate range of annual consumption but was higher than the planned quantity in the operational plans. It suggests that the operational plans were prepared without sufficient understanding of fuelwood demand, or consultation with groups using different types of energy sources. While comparing the supply of fuelwood from the forests, the planned quantity in the operational plans was generally lower than the adequate range of our estimates. It reinforces the view that operational plans are conservative and protection-oriented, and that the forests are managed at a suboptimal level for fuelwood production (Yadav et al. 2003; Yadav et al. 2009)

The fuelwood demand of users may not necessarily be met by the forests they manage. While demand is determined by the size of the FUGs, supply is determined by the extent and types of the forests. As per the policy guidelines, fuelwood demand and supply should be analysed together so that any deficit or surplus can be addressed while implementing operational plans. However, it appears that demand and supply are derived in isolation, and that they are poorly integrated during the preparation of operational plans. Discussion with community forest managers and forest officials in the district suggested that local forest offices focussed more on forest inventory and annual harvestable quantity, but ignored the corresponding demand side of fuelwood planning in the communities. In many cases, FUG members were not aware that the operational plans specified the quantity of annual demand and supply of fuelwood. Our results resonate with the claim that information provided in the operational plans is inadequate and of poor quality, and that the plans are rarely referred to in local forest management decision-making (Rutt et al. 2014; Toft, Adeyeye & Lund 2015)

4.3. Fuelwood from private land

Trees on private land have emerged as one of the important sources of fuelwood supply in the middle hill region. Previous studies from the region on the contribution of private fuelwood to total consumption gave results varying from 12% to 72% (Kandel et al. 2016; Shrestha 2005; Webb & Dhakal 2011) In our study, private land contributed 43% and 37% of total annual fuelwood consumption in Nalma and Taksar, respectively. The fuelwood contribution from private lands was associated with the total tree holdings by households. Across the mid-hills, trees are naturally regenerating on private land as land is being less intensively utilised or abandoned. This is a consequence of the declining rural labour force as men seek international employment and others migrate to urban areas (Paudel, Tamang & Shrestha 2014). Accordingly, the supply of fuelwood from private sources is expected to increase in future (CBS 2011)

Private fuelwood can, therefore, provide important flexibility to the management of fuelwood production and supply from the community forests, and can potentially change the priorities for management of community forests. However, the contribution of private fuelwood is not currently accounted for in the demand and supply analysis in community forestry planning.

4.4. Trends of fuelwood demand and supply

The trends of fuelwood demand and supply between 2008 and 2014 were inconsistent for the studied user group population. As the FUG population and the extent of the forests remained stable between the periods, an exceptional rise or fall in fuelwood demand and supply between two implementation periods is difficult to interpret. Such ambiguity may have arisen due to the inconsistent and incomplete application of policy guidelines by different planners while preparing the operational plans. Overall, operational plans have not realistically captured the trends of fuelwood demand and supply in the context of changing social and demographic dynamics in the region.

The status of fuelwood demand and supply has two interrelated policy implications. First, fuelwood demand primarily reflects the resource endowments of the population as well as socioeconomic development and urbanisation (IEA 2006). Accordingly, there is the opportunity for forest management objectives to shift from subsistence products to ecological services like biodiversity conservation and increased carbon storage. Second, the status and trend of various products and services supplied from the forests reflect the degree of management success over the time. The operational plans are dynamic documents that should capture both of these trends to inform forest management decisions. The existing practices of preparing operational plans are inadequate to serve these purposes.

In conclusion, the operational plans for community forests presented inconsistent and unrealistic estimations of fuelwood demand and supply. Although there are comprehensive policy guidelines for the derivation of demand and supply of fuelwood, none of the operational plans of the 13 community forests were consistently applied over the period of implementation. As the operational plans provide inputs for fuelwood-related policy formulation, it is essential that these plans realistically represent the demand and supply of fuelwood from the community forests. We recommend a revision of the methods used in the preparation of these plans to determine fuelwood demand and supply in community forestry implementation.

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Chapter 5: Evaluating spatial patterns of wood extraction in community managed forest of Nepal

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Prominent foot trail in the forests (Sathimure community forest) (Taksar) (left) and the stump of a tree harvested for timber in Langdihariyali community forests (Nalma) (right), November, 2015

Statement of Authorship

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Co-Author Contributions

By signing the Statement of Authorship, each author certifies that:

i. the candidate's stated contribution to the publication is accurate (as detailed above);
ii. permission is granted for the candidate in include the publication in the thesis; and
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Evaluating spatial patterns of wood extraction in community managed forest of Nepal

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Abstract

The intensity of wood extraction in relation to the forest stock is an important indicator of sustainable forest management. We examined whether the spatially regulated management and utilization policies enforced in community forestry result in spatial congruence between the forest stock and wood extraction. Using stump density and basal area as indicators, we assessed the state and spatial distribution of wood extraction in 13 community forests in two rural villages of mid-hills Nepal. The community forests are classified as natural mixed *Schima wallichii-Castanopsis indica-Shorea robusta* (SCS) and *Schima wallichii-Castanopsis indica* (SC). The forest data were collected from randomly distributed sample plots in community forests. The spatial data like road, slope and community forest were acquired from government maps and updated in the reference of other data on webs. Moran's global and local indices were calculated to assess the spatial clustering of stump and forest stock at the sample points and identify the locations with significantly high-high and low-low clustering. The probability of wood extraction was estimated using binary regression with distances to road and settlements, forest types and terrain slope as the predictors. Overall, wood extraction from SCS forests was higher in both villages. The intensity of wood extraction was similar between SC and SCS forests in Nalma but it was significantly higher in SCS forest of Taksar. The analysis of spatial pattern of forest user by using Moran's global indices indicated that forest stock and wood extraction are spatially clustered and that wood extraction intensity does not correspond to the forest stock. Further, wood extraction intensity has confined at the convenient locations close to the roads and settlements. The current evidence of wood extraction may be manifested to location specific forest degradation undermining the long term sustainability of forest management. Our results indicate that the systems of spatial planning stipulated in current operational plans are less effective to regulate forest management and wood

extraction practices in community forests. Therefore, we suggest that the effects of geospatial factors (road, settlement, slopes) on wood extraction should be analysed while preparing operational plan so that management efforts can be directed and monitored across the forest. The spatial knowledge of local communities can be utilized to identify and delineate intensive use zones across the forest through participatory mapping process. Such zonation map, together with geospatial factors, can be used to improve the current practice of forest blocking and spatial planning of forest management and wood extraction from community forests.

Keywords: spatial autocorrelation, Moran indices, community forests, wood extraction, basal area,

1. Introduction

Wood extraction for fuelwood and timber is a common activity of community based forest management in developing countries. A number of studies have assessed the types, quantity, and trend of different forest products extracted and used by the agrarian communities (Adhikari et al., 2004, Baland et al., 2010, Pandit and Bevilacqua, 2011, Birch et al., 2014, Meilby et al., 2014, Langat et al., 2016) but only a few studies have investigated the spatial pattern of such extraction and its effects on forest condition and degradation (Ahrends et al., 2010, Albers and Robinson, 2013). Wood extraction has been identified, and will continue, as one of the most important drivers of deforestation and degradation in developing countries like Nepal (Hosonuma et al., 2012, MFSC, 2014).

Wood production from forests varies across the space and determined by the biophysical factors like: topography; vegetation types and forest structure; accessibility to road and markets; wood demand; and regulatory policies and practices. For example, Yuanfa and others (2014) examined the spatial structure of a forest after timber harvesting and found that the harvested trees represent the diameter structure of the forests (Yuanfa et al., 2014). Other studies reported that the intensity of wood extraction reduces as the distance from the forest edge and transportation infrastructure increases (Kohlin and Parks, 2001, Furukawas et al., 2011, Dons et al., 2014). Robinson and others (2002) developed an econometric model and concluded that the spatial patterns of aggregate extraction of non-timber forest products (NTFP) from the forest is influenced by the heterogeneity of forest users and their access to the market (Robinson et al., 2002, Langat et al., 2016). Ghate and others (2009) have observed that greater access to road and market reduces dependency on forest but increases degradation and deforestation (Ghate et al., 2009). These studies suggest that forest product extraction is shaped by the spatial configuration of forests in relation to its user groups, road networks and marketing opportunities, and that extraction activities are confined close to the village and road giving rise to forest degradation and deforestation in those locations (Robinson et al., 2002, Ahrends et al., 2010). Various policies have been introduced worldwide to restrain forest degradation by influencing the extraction behaviour of forest dependent communities.

In Nepal, community forestry is one of the policy initiatives to influence the extraction behaviour of forest users. Under this policy, certain parts of national forestland is handed over to the locally organized forest user group (FUG) for their sustainable management and utilization. Each FUG prepares an operational plan that specifies, among other criteria, the number of blocks[14] as the unit of annual administration of management operations including forest product extraction. Forest blocks represent the spatial variations of forest conditions, management requirements and operational ease. Likewise, an annual quantity of wood (timber and fuelwood) extraction is prescribed for each block (DoF, 2014). The underlying assumption of forest blocking is that the FUG follows the regulatory rules of forest product extraction and that annual wood extraction does not exceed the growth rate of the forests. So, the operational plans are designed to ensure that forest management activities spread across the forests and that wood extraction maintains spatial integrity with forest stocks. However, there is paucity of studies that have examined the efficacy of spatial planning to regulate forest management and wood extraction as envisaged in the operational plans.

The aim of this study is, therefore, to examine the spatial patterns of wood extraction in community managed forests taking two rural villages of middle hill of Nepal as the case study sites. We do this by: 1) assessing the current state of wood extraction from community forest by using stump data; 2) evaluating the spatial (clustering) patterns of forest stock and wood extraction in the forest; and 3) estimating the influence of biophysical factors (forest types, distance to road and settlement, terrain slope) on wood extraction. The underlying hypothesis is that forest users adhere to the spatial rules of operational plans to maintain spatial integrity between wood extraction and forest

[14] Blocks are the management units of a forests designated for annual operations. The number of blocks of a forest is determined by the size of the forest itself, topographic condition, forest condition and, sometimes, shaped by the spatial distribution of forest users and other facilities.

conditions. The stump parameters (density, basal area) were used as the indicators of extent and intensity of wood extraction from the forests.

2. Methods

2.1. Study area

The study was carried out in the community forests of Taksar and Nalma villages in the Lamjung district of central Nepal **(Figure 1).** These villages were purposively selected for their population dependent on agriculture and forest-based livelihoods. Altogether, there are nine community forests in Taksar and four in Nalma. These community forests cover 642.2 ha in Nalma and 392.2ha in Taksar **(Table 1).** The forests in both sites are characterized by the natural mixed *Schima wallichii-Castanopsis Indica* (SC) and *Schima wallichii- Castanopsis indica- Shorea robusta* (SCS). The SCS forests predominate the lower altitudes (450 – 600 m) in both villages followed by the gradual mixing with and replaced by the SC forests in higher altitudes (1,400 – 1,700 m). The table reveals that SCS and SC forest predominate Nalma (57%) and Taksar (75%) village respectively.

The elevation of Nalma and Taksar varies from 567 metre to 1,700 metre and 450 metre to 1,420 metre respectively. Most of the forests in Nalma are located on the steeper slopes and are accessible by traditional foot trails. In Taksar, the forests in the northern region are located on steep slopes and are further away from settlements compared to the forests in lower elevation.

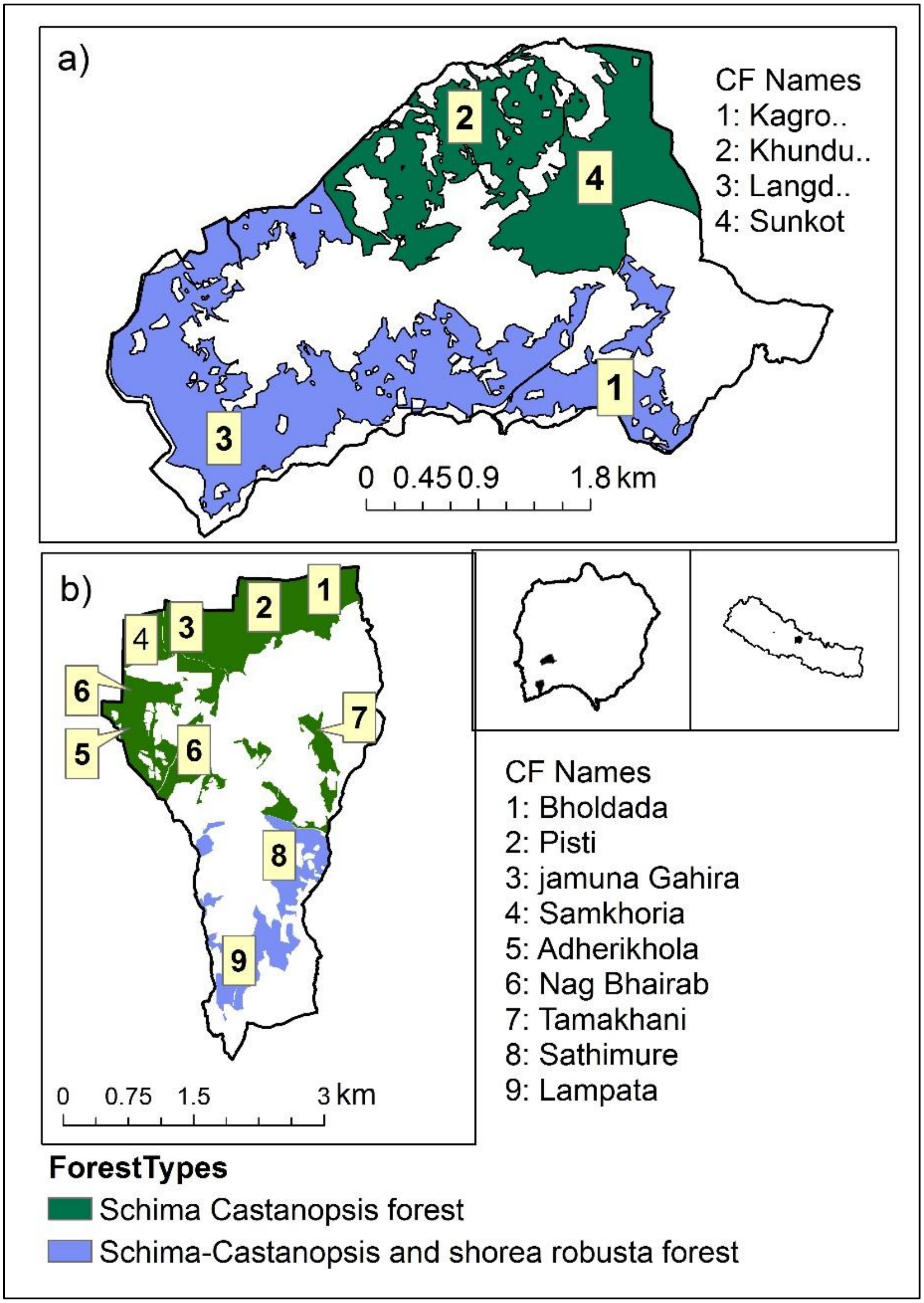

Figure 1: Study area showing forest type distribution in a) Nalma and b) Taksar villages. The numbered labels shows the locations of community forests.

Table 1: Description of community forests in Nalma and Taksar villages, Lamjung Nepal

Community forests	Forest types	Forest area (ha)	FUG Size[1]
Nalma			
Kagrodevi	SCS	66.2	27
Khundrudevi	SC	135.2	44
Langdihariyali	SCS	300.6	164
Sunkot	SC	139.2	37
Taksar			
Adherikhola	SC	35.1	20
Bholdada	SC	13	17
Jamuna Gahira	SC	23.2	9
Lampata	SCS	71.5	260
Nag Bhairab	SC	43.3	64
Pisti	SC	114.5	35
Samkhoria	SC	34.7	21
Sathimure	SCS	28.3	79
Tamakhani	SC	28.6	53

Forest types: SC = *Schima-Castanopsis* forest, SCS: *Schima-Castanopsis- Shorea robusta* forest, [1]Number of member households, [2]population per hectare of forest.

The settlement pattern is different in two villages. In Nalma, it is distributed along the ridge, surrounded by the forests and confined within the narrow range of altitude. In Taksar, the lower altitude belt (in southern region) is densely populated and the settlements are distributed around the forests. In higher altitude belt (in northern region), the settlements are sparsely distributed in southern slopes but the forests are located in northern slopes. Taksar has better road networks to access urban centres compared to Nalma.

2.2. Forest inventory to assess wood extraction

Fuelwood and timber are the major wood products collected from community forests. The wood extraction data, as observed by the presence of stumps, was collected from forest inventory conducted during July-December 2015. The data was collected from a system of randomly distributed sample plots of size 500 m^2. We established 93 plots in Nalma and 68 plots in Taksar representing each community forest proportionate to their size. The sampling intensity in Taksar and Nalma was 0.8% and 0.7% respectively which is considered sufficient for inventory of community forests (DoF, 2004). The sample plots were established, as far as possible, at the pre-defined locations. Most of the sample plots were located at the slope ≤ 40 degree. There were nine plots in Nalma and three plots in Taksar established in slope > 40 degree. The original plot locations in inaccessible areas, such as steep slopes and deep gullies, were shifted toward the random direction by 50 m. The following variables were measured and recorded in each plot: species name, diameter at breast height (dbh) of trees (dbh ≥ 10 cm), height of selected trees (m) and stump diameter (cm). The trees < 30 cm dbh are considered as poles and they are not extracted for timber from community forests (DoF, 2004).

2.3. Spatial data generation and management

We obtained spatial data from multiple sources. The topographic maps published by Department of Survey (DoS) in 1996 was used to extract contour and road/trails data. The contour data (20 m interval) was used to generate a Digital Elevation Model (DEM) for constructing slope maps. The road data was updated by overlaying them on high resolution base map of ArcGIS™ and Google Earth™. The road network constitutes both traditional foot trails and the newly constructed roads to the villages. We digitized the visible residential structures on the base map and Google Earth™ images to prepare settlement and village maps. The community forest maps were obtained from operational plans. The forest maps included in operational plans were derived from cadastral maps but they were not geographically referenced. These maps were registered to the common system of geographic reference for integrated analysis in Geographic Information System (GIS) environment. The Euclidean distance from the road and settlement boundaries was calculated and masked by the community forest maps using Spatial Analyst tool of ArcGIS. Accordingly, we extracted distance from road and settlements for each sample plot.

2.4. Analysis of forest stock and wood extraction

We defined a number of variables to represent forest and stump data, user group and spatial variables as provided in **Table 2**. We used descriptive statistics (average) to describe forest and stump data for each village, forest type and community forest. Tree and stump parameters, namely *nTotal*, *gTotal*, *nStump*, *gStump*, *nProp* and *gProp* are used to assess the current state of forest stock and wood extraction in each forest type. For spatial analysis, the village was taken as the unit of analysis unless otherwise specified in the context of analysis.

Table 2: The variables related to forest and its parameters, user group and spatial factors used in evaluating the wood extraction pattern from community forest.

Factors	Description
Forest variables	
ForType	The dominant vegetation types, either SC (*Schima-Castanopsis* mixed forest) or SCS (*Schima Castanopsis-Shorea robusta* mixed forest)
nTotal	Tree density (sph-stem per hectare)
gStump	The stump basal area (m^2/ha^{-1})
nStump	The stump density (sph)
gTotal	Tree basal area (m^2ha^{-1})
nProp	The proportion of *nStump* to the *nTotal* (*nStump*/*nTotal*)
gProp	The proportion of *gStump* to the gStump (*gStump*/*gTotal*)
User variables	
dUser	The number user group population per hectare of community forest (Forest area (ha)/Total population)
Spatial variables	
Slope	The terrain slope (degree) derived from DEM
RdDist	The Euclidean distance (m) from the nearest road/trails
SettleDist	The Euclidean distance(m) from the nearest village boundaries

2.5. Analysis of spatial pattern of wood extraction and forest stock

We derived Moran's indices (*I*) from sample point data to evaluate the spatial patterns of forest stock and wood extraction across the forest. We calculated Moran's global *I* to examine if the general patterns of forest stock and wood extraction are clustered or dispersed in the forest. The Moran's global *I* is computed as follows (1):

$$I = \frac{(1/W)\sum_{h=1}^{n}\sum_{i=1}^{n} w_{hi}((y_h-\bar{y})(y_i-\bar{y})}{(1/n)\sum_{i=1}^{n}(y_h-\bar{y})^2} \quad (1)$$

where y_h and y_i are the observed values of variable y at the locations *h* and *i*, $\bar{y}$ is the mean of variable y, w_{hi} is the elements of the spatial weight matrix for the relationship between the y values at the locations *i* and *h*, *W* is the sum of the all weights for a given distance and equals to the number of observations. The Moran's *I* varies from -1 (for dissimilarity) to +1 (for similarity) indicating the degree of spatial clustering of forest and stump values at the sample locations across the forest in each village. The 0 for global *I* indicates the complete randomness of the neighbouring values with no spatial autocorrelation. The highly significant *I* index suggests the clustering patterns of values across the forest but it does not inform the locations of local clusters in the space. So, we calculated the Local Indicator of Spatial Autocorrelation (LISA), also called local Moran's Index, to measure the degree of spatial association of a variable within a particular distance of each observation at the sample plots (Anselin, 1995). The local Moran's Index (*I*) provides the extent of significant spatial clustering of similar values around the sample location, which is calculated as follows (2):

$$I_i = \frac{y_i-\bar{y}}{\sigma^2}\sum_{h=1, h\neq 1}^{n}[w_{ih}(y_h - \bar{y})] \quad (2)$$

Where I_i is the Moran's local index at location *i*, y_i are the observed values at location *i*, $\bar{y}$ and σ^2 are the mean and variance of *y*, and W_{ih} is the weighted matrix.

In this analysis, we conceptualized that spatial relation of a phenomena (e.g. presence of stump) at a unknown point can be estimated by the inverse distance between two locations *i* and *h* where the phenomena is known.

The LISA measures the degree of spatial autocorrelation at each location (Anselin, 1995). The high positive local Moran's *I* indicates that the observed value at the location is surrounded by the similar neighbouring values and suggest spatial clustering. Such clustering includes high-high cluster (i. e. the value at the location is statistically higher than its neighbouring locations with high value) and low-low cluster (i. e. the value at the location is statistically lower than its neighbouring locations with low values). The high negative local Moran *I* values indicates the potential outliers. In this study, we used ≤ 0.05 significance level for analysing the spatial clustering. We used *gTotal* and *gProp* to represent the existing forest stock and intensity of wood extraction.

We used spatial statistics tools of ArcGIS to calculate Moran's indices. The Moran *I* was calculated from spatial autocorrelation functions of Analysis Patterns tools and local Moran *I* was calculated from Cluster and Outlier Analysis (Anselin local Moran *I*) function of Mapping cluster tool. The significant clustering of forest stock and wood extraction is presented in maps for visualization purpose.

2.6. Regression analysis to evaluate the influence of spatial factors on wood extraction

First, we examined the average intensity of wood extraction in relation to the slope and the distance from settlements and road. For this, we arbitrarily set three distance classes from settlements (<400 m, 400-800 m and >800 m), three distance classes from road (<200 m, 200-500 m and >500 m) and three slope classes (< 20^0, 20^0-35^0 and >35^0). We then calculated the average intensity of wood extraction (*gProp*) in each class for the comparison between the classes.

In order to analyse the association of wood extraction with the spatial factors related to distance, slopes and forest types, we built a generalized linear model (GLM) with binomial distribution and logit link function. It explains the probability of a tree being cut at the location of sample plot. For this, we coded each tree in each plot either as 1 (for stumps) or 0 (for living trees) and used as binary response variable in the regression model. Explanatory variables included are *ForType*, *SettleDist*, *RdDist* and *Slope*. The multivariate binomial regression model is given as (3):

$$P(y=1) = \frac{\exp(a_0 + a_1 ForType + a_2 SettleDist + a_3 Slope + a_4 RdDist)}{(1 + \exp(a_0 + a_1 ForType + a_2 SettleDist + a_3 Slope + a_4 RdDist)} \qquad (2)$$

where, *P* (y=1) is the probability of a tree being cut (=1) and $a_0 \ldots a_4$ are the regression coefficients for the variables supplied to the model. The distance and slope variables were measured at the centre of the sample plots and assigned to all trees and stumps recorded in the plot. We plotted the probability of tree cut as combined effect of each factor used in the model.

Finally, we generated a probability map of tree cutting using regression coefficients for each spatial layers. The map presents the wood extraction probability across the forests as the combined effect of distances, forest types and slope factors in two villages.

2.7. Group discussion to assess the practice of wood extraction

Group discussions were organized in each community forest to assess general practices of forest management and wood extraction. The members of forest user group committee (FUC) were invited in the discussion. The discussion was focussed primarily to understand how the spatial rules of existing operational plans are followed in annual forest management and wood extraction operations in the community forests. In addition, FUG members were asked to discuss on the general practice of forest blocking and spatial planning. The information obtained was used to interpret and/or substantiate the results derived from other methods.

3. Results

3.1. Current status of wood extraction from stump data

Table 3 provides the cross tabulation of total number of trees and stumps recorded from the sample plots of SC and SCS forests in two villages. In Nalma, we recorded a total of 3,666 stems from 79 plots, of which 3,067 were living trees and 599 were stumps. In Taksar, 2,163 stems were recorded from 54 plots, of which 352 were stumps. On average, 6.4 stumps (standard deviation = 7.5) in Nalma and 5.1 stumps (standard deviation = 5.1) in Taksar were recorded in each plot. The percentage of stumps in SC and SCS forest was about the same (~16.3%) in Nalma but it differed substantially between SC (12.3%) and SCS (26.3%) forest in Taksar. Stump was not recorded in 14 plots in each village which accounts 15% in Nalma and 20% in Taksar.

Table 3: Cross tabulation of total count of stump and tree in sample plots of SC and SCS forests in Nalma and Taksar. The number in square parenthesis is the column percentage.

Density (sph)	Nalma			Taksar		
	SC	SCS	Total	SC	SCS	Total
Tree	1138 [83.2]	1929 [83.9]	3067 [83.7]	1357 [87.7]	454 [73.7]	1811 [83.7]
Stump	229 [16.8]	370 [16.1]	599 [16.3]	190 [12.3]	162 [26.3]	352 [16.3]
Total	1367 [100]	2299 [100]	3666 [100]	1547 [100]	616 [100]	2163 [100]

SC = *Schima-Castanopsis* forest, SCS: *Schima-Castanopsis- Shorea robusta* forests

Similarly, the average size (dbh) of living trees was bigger than the stumps in each village, forest type and community forest (see **Table 4**). Pole sized trees constitutes about 80% of the living trees and 90% of the stumps in both villages. It suggests that the wood extraction largely involves pole size trees from both types of the forests.

The average values of tree and stump parameters (per hectare) for villages, forest types and community forests are calculated and provided in the **Table 4**. The table reveals that average tree density and basal area in Nalma is 659.7 stem ha^{-1} and 30.7 m^2ha^{-1} respectively, which is significantly higher than the density (532.7 stem ha^{-1}) and basal area (26.4 m^2 ha^{-1}) in Taksar. Unlike in Taksar, tree density of SCS forest (742.1 stem ha^{-1}) is significantly higher than SC forest (555.1 stem ha^{-1}) in Nalma.

Table 4: Descriptive (average) statistics of tree and stump parameters in each village, forest type and community forest. The units of each variable are same as described in Table 2, unless otherwise specified at the column head of the variables.

Spatial units	nTotal	gTotal	nStump	gStump	Tree Size (cm)[1]	Stump Size (cm)[1]	dUser[2]
Villages							
Nalma	659.7	30.7	128.8	3.9	21.6	18	2.4
Taksar	532.7	26.4	103.5	3.3	22.4	18.9	8.1
Forest Types							
Nalma-SC	555.1	28.1	111.7	3.4	22	18.1	1.6
Nalma-SCS	742.1	32.8	142.3	4.3	21.4	17.9	3.0
Taksar-SC	542.8	26.3	76.0	2.1	22.1	17.8	4.3
Taksar-SCS	504.4	26.8	180.0	6.8	23.2	20.1	19.6
Community forests							
Kagrodevi-SCS	810.3	36.4	132.5	4.2	21.5	18	1.6
Khundrudevi-SC	456	27.3	71.0	2.6	23.9	19.8	1.8
Langdihariyali-SCS	729.8	32.1	144.1	4.3	21.4	17.9	3.4
Sunkot-SC	649.6	28.8	150.5	4.1	20.8	17.3	1.3
Adherikhola-SC	690.2	27.5	83.3	2.0	19.9	16.5	3.2
Bholdanda-SC	860	29.6	150.0	2.7	19.9	14.6	7.6
Jamuna Gahira-SC	426.7	23.2	26.7	0.4	21.4	14.1	2.2
Lampata-SCS	476.7	25.4	211.7	8.4	22.9	20.6	20.8
Nag Bhairab-SC	462.3	21.4	108.9	3.2	22.4	18.6	7.4
Pisti-SC	541.1	27.0	45.6	1.4	22.4	18.2	2.3
Samkhoria-SC	444	28.3	36.0	1.0	24.5	18.3	3
Sathimure-SCS	560	29.5	116.7	3.5	23.7	18.1	16.6
Tamakhani-SC	554.3	28.4	134.3	4.0	23.1	18.6	11.2

[1] Average size, [2] population per hectare forest, SC = *Schima-Castanopsis* forest, SCS: *Schima-Castanopsis- Shorea robusta* forests

The density (*nStump*) and basal area (*gStump*) of stump varied between forest types and community forests in two villages. Overall, *nStump* and *gStump* were higher in Nalma but they were not significantly different from Taksar. Likewise, the density and basal area of stump were not statistically different between SCS and SC forests in Nalma. In contrast, *gStump* (6.8 m^2h^{-1}) and *nStump* (180 sph) of SCS forests found significantly higher than SC forests in Taksar. In

Taksar, stump density varied from 26.7 sph in Jamuna Gahira (SC) to 211.7 sph in Lampata (SCS) forests. Accordingly, the stump basal area also varied from 0.4 m^2ha^{-1} to 8.4 m^2ha^{-1} in the same community forests. In Nalma, stump density was highest in Sunkot (SC) but the stump basal area was highest in Langdihariyali (SCS) forests.

3.2. Spatial pattern (clustering) of wood extraction

The calculated Moran's *I* for *gTotal*, *nTotal*, *gStump*, *nStump*, *gProp* and *nProp* are presented in the **Table 5**. The table reveals that Moran's global *I* is highly significant for all tree and stump parameters (except for *nTotal* in Taksar*)* at the 0.001 and 0.05 significance level. It indicated that both forest stock and stumps values were spatially clustered in the forests.

Table 5: Spatial autocorrelation (global Moran's *I*) by using inverse distance weight as the spatial relationship of values in the space. The distance thresholds applied for Nalma and Taksar are 548.0m and 619.1m respectively.

Variable	Moran's *I*	
	Nalma	Taksar
gProp	0.23^{a}	0.29^{a}
nProp	0.23^{a}	0.34^{a}
gStump	0.15^{a}	0.31^{a}
nStump	0.28^{a}	0.27^{a}
nTotal	0.19^{a}	0.08^{n}
gTotal	0.24^{a}	0.12^{b}

The superscripts ^{a}, ^{b} and ^{n} indicate that the values are significant at 0.001, 0.01 and non-significant values.

We used Moran's local index *I* for *gProp* and *gTotal* to examine the local clustering of these values in the forest. The locations with high-high and low-low clustering are presented in the significance maps (**Figure 2).** The figure clearly depicts the spatial clustering of *gTotal* and *gProp* in two villages. It is apparent that the higher values of *gTotal* and *gProp* have clustered at different locations. In Nalma, the higher values of *gTotal* is clustered mostly along the southern boundary corresponding to SCS forest (**Fig 2a**) but the high values for *gProp* is clustered in two locations; one at the south-west (SCS forests) region close to the forest boundary; and next at the north-east (SC) locations (**Fig 2b**). Likewise, we noticed that low values of *gProp* are clustered at two locations; one at the southern boundaries of SCS forest; next at the north-east part of the SC forests

(Fig 2b). In Taksar, the high and low values of *gTotal* have clustered at the northern part the village in SC forest **(Fig 2c)** but the high values of *gProp* have clustered at the southern SCS forest (**Fig 2d).**

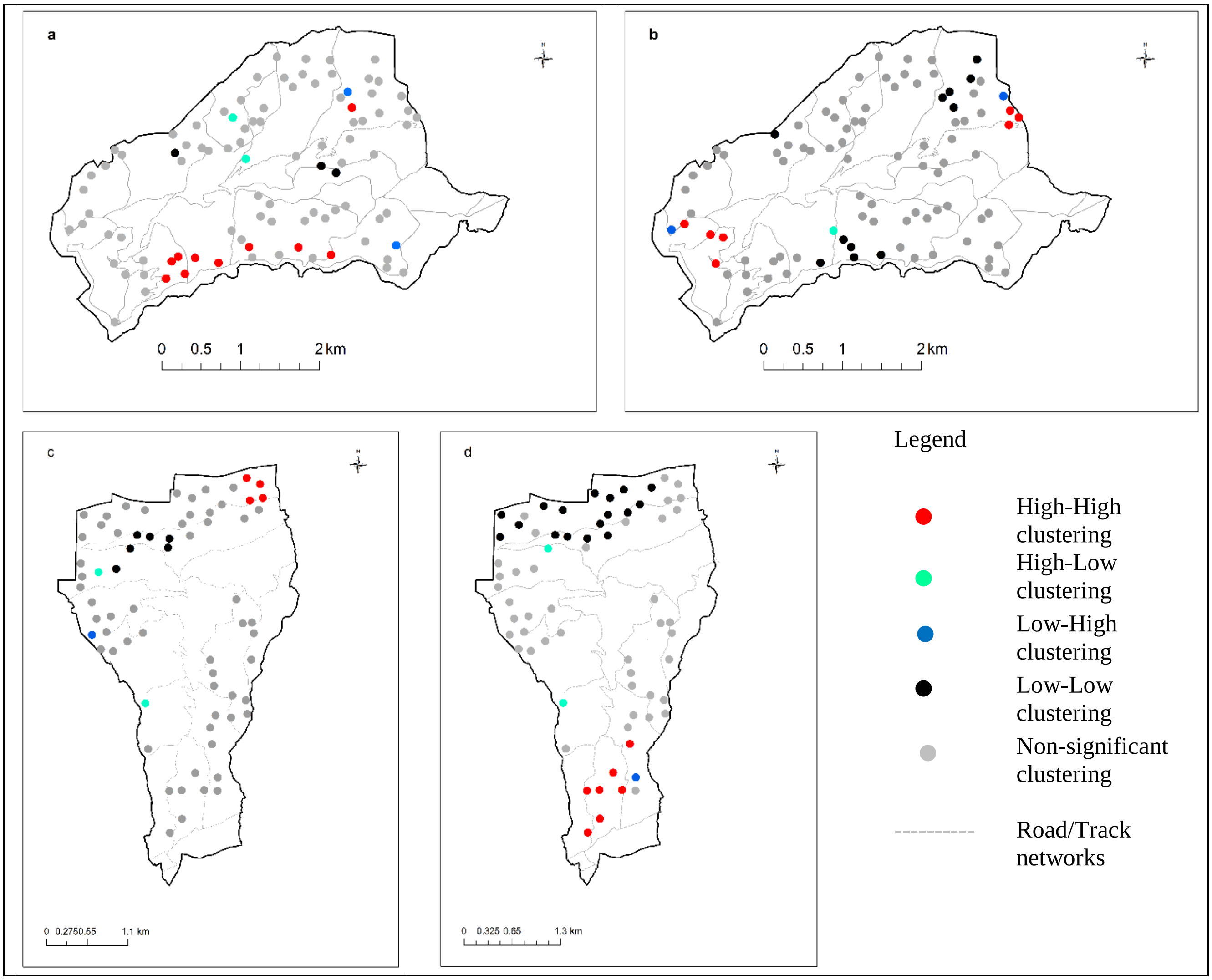

Figure 2: The maps showing the significant local clustering of *gTotal* and *gProp* in Nalma (a, b) and Taksar (c, d) villages respectively. The high-high clustering is the location with significantly high values surrounded by the high value neighbours. The low-low clustering is the locations with significantly low values surrounded by the low value neighbours.

3.3. Influence of biophysical factors on wood extraction

The analysis of spatial autocorrelation indicated that wood extraction is spatially clustered in the forest. **Figure 3** depicts the intensity of wood extraction (*gProp*) in predefined classes for village distance, road distance and slopes. The figure clearly depicts that the intensity of wood extraction is highest in distance classes close to settlement and road and at the flatter slopes.

Table 6 summarizes the results of regression model to evaluate the influence of biophysical and distance factors to predict wood extraction probabilities from forests. The table reveals that all the factors (predictors) are statistically significant to estimate the tree-cutting probability in Nalma except road distance in Taksar. Forest type was the most important predictor of tree cutting probability. The result revealed a lower tendency of cutting trees from SCS forest in Nalma than in Taksar. Other factors included in the model resulted in inverse relationships to the tree cutting probability. The influence of slope and distance from road and settlements was negatively associated with the tree cutting probability in both villages but the uncertainty was higher for increased distance in Taksar.

Table 6: The estimated values for the multivariate binomial regression model explaining the probability of a tree being cut in the forests. The tree cut (cut =1) is used as binary response to estimate the tree cutting probability. The values in square brackets are the standard error of the estimates.

Variables	Nalma	Taksar
ForType (SCS = 1)	- 0.2156 [0.1022][c]	0.5304 [0.1415][a]
SettleDist	- 0.0016 [0.0001][a]	- 0.0010 [0.0003][b]
Slope	- 0.0315 [0.0046][a]	- 0.0187 [0.0062][b]
RdDist	- 0.0018 [0.0005][a]	- 0.0010 [0.0007][n]
Intercept	0.5161 [0.1963][b]	- 0.7226 [0.2302][b]

The superscripts [a], [b] , [c] and [n] indicate the significance at 0.001, 0.01. 0.05, and non-significance. SCS: *Schima-Castanopsis- Shorea robusta* forests

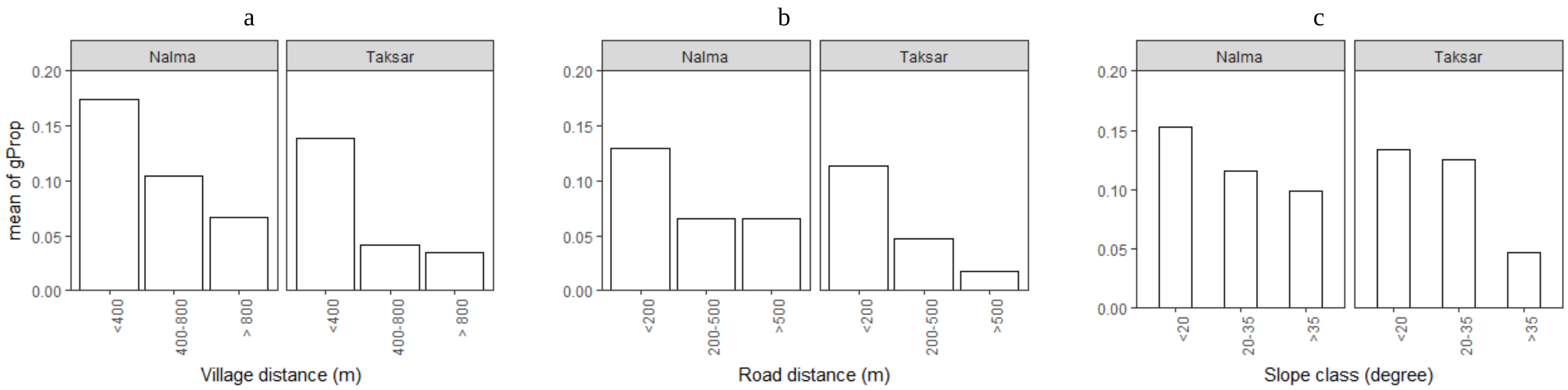

Figure 3: Intensity of wood extraction (*gProp*) in relation to a) settlement distance, b) road distance and c) slope class in Nalma and Taksar villages. The *gProp* in y-axis represents the proportion (intensity) of wood extraction.

Figure 4 represents the combined effect of factors predicting the tree cutting probability in two villages. The figure clearly depicts that the probability of tree cutting in SC and SCS forests is opposite in two villages. The probability of tree cutting in SCS forest resulted higher in Taksar but lower in Nalma compared to the SC forests of respective villages. The distance and slope factors were negatively associated with the tree cutting probability in both villages.

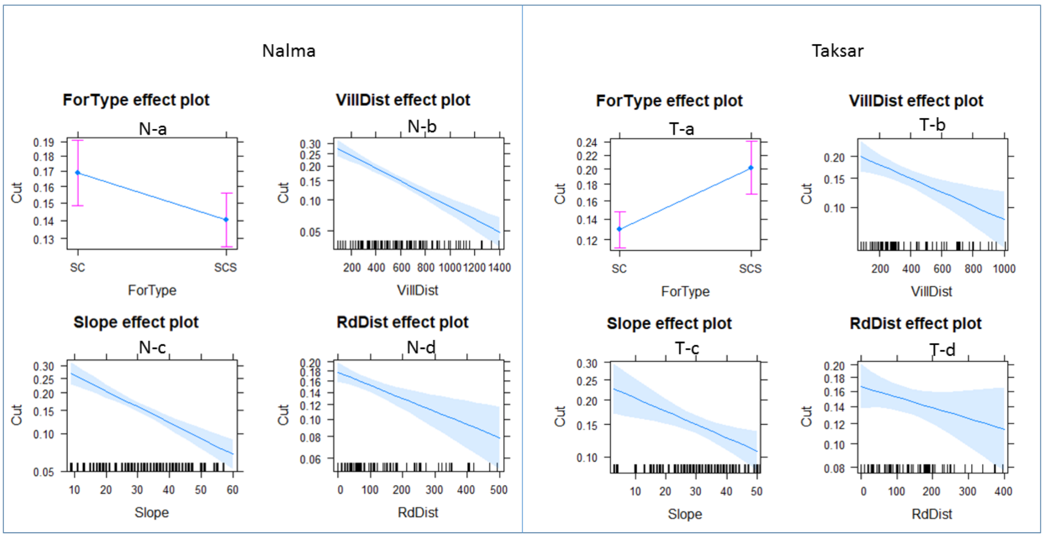

Figure 4: The estimated probability of a stem being cut plotted against each predictor variable for Nalma and Taksar villages. The 95% confidence interval of predicted probability is represented by smooth band for continuous predictors and by vertical lines for factor predictors (in this case, For Type (SCS and SC). The y-axis is the probability of tree being cut. The plots are referred N-a..d and T-a..d to represent the combined due to forest types, village(settlement distance, slope and road distance in Nalma and Taksar village respectively.

Figure 5 represents the probability map of wood extraction derived from spatial relationships of tree cutting with road and settlement distance, slope and forest types. The map clearly shows that the forests located at the northern region of Taksar, which is dominated by SC forest, have low probability of tree cutting. In contrary, the SCS forests in southern region appeared with higher probability for wood extraction **(Fig 5b).** In Nalma, probability of wood extraction is likely to occur close to the road and settlements in both SCS and SC forests **(Fig 5a).**

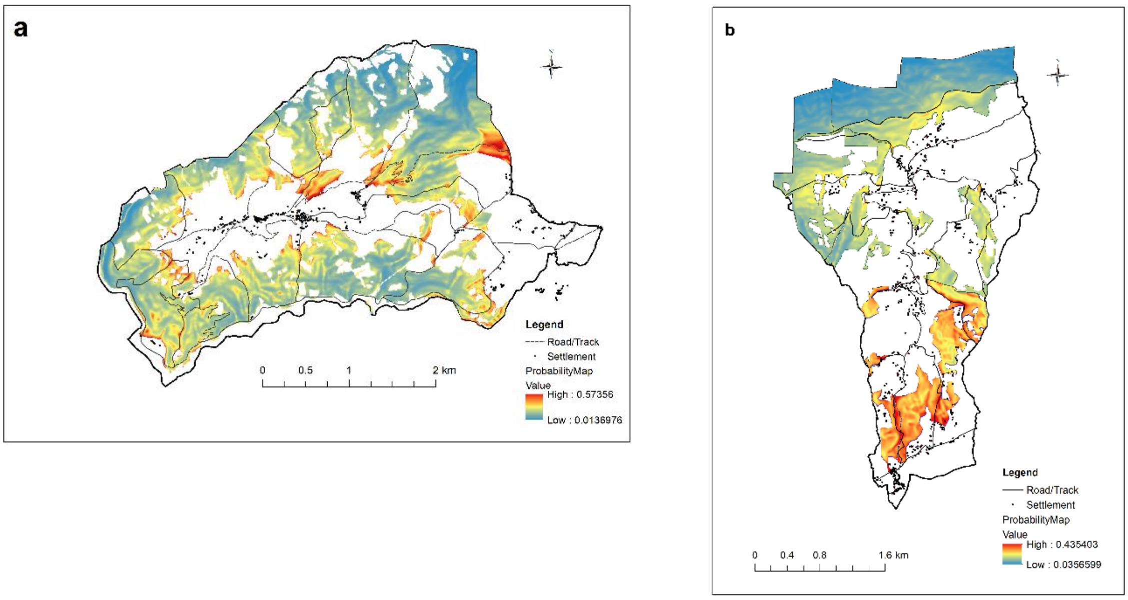

Figure 5: Probability maps of a) Nalma and b) Taksar for a tree being cut as the combined effect of spatial factors (distance to village, road and slope) and forest types. The regression coefficient of binomial model was used to the spatial layer to generate the probability map.

3.4. Assessment of existing wood extraction practices

Group discussions revealed a general awareness of user groups about forest blocks and management operations prescribed in each block to be undertaken in rotation. Forest management activities were carried out mainly to obtain fuelwood and poles for local consumption. Forest users admit that management activities were not performed in entire blocks as prescribed in the operational plans, but limited to selected locations close to the settlements and road and/or foot trails and easy terrain. It was indicated that timber extraction occurred mainly in SCS forests of both villages and that timber extraction was not confined to specific forest blocks. The incidences of illegal harvesting was denied except in SC forests (Sunkot) of Nalma.

Although forest management and wood extraction activities were defined for each block, forest users were not fully aware of criteria applied to forest blocking for spatial planning. The number of blocks in a community forest varied from three (Bholdada) to ten (Nag Bhairab) and the block size ranged greatly from 12 hectare (Bholadada) to 300 hectare (Langdihariyali). The user groups expressed limited understanding of forest maps included in the operational plans.

According to them, these maps were not verified on the ground and boundaries of forest blocks were arbitrarily drawn in the maps. The forest maps were derived from cadastral map by selecting forest and/or bushland parcels. We found that forest users were unable to locate the boundaries of forests and blocks on the ground. In addition, the forest management and extraction in blocks located away from the settlements was less likely due to the increased travel time to and from the forest blocks.

4. Discussions

In this study, we used stump density and basal area to evaluate the state and spatial pattern of wood extraction from community managed forests in two rural villages of Nepal. The most universal need of wood extraction in the villages is for fuel, followed by poles and timber for construction and furniture making. Wood extraction is associated with management operations like clearing, thinning, pruning, singling and timber harvesting. Our results indicate that wood extraction density is higher in Nalma than in Taksar. This greater reliance on wood products can be attributed to the remoteness of village with restricted supply of alternative sources of household energy and construction materials (Puri et al., 2017). Likewise, wood extraction from SCS forests was higher in both villages. The SCS forests are the major sources of Sal (*Shorea robusta*) timber in both villages. In Taksar, wood extraction was highest in SCS forests which can be attributed to either or any combination of higher user density, better forest management, proximity to road/trails and settlement and moderate terrain slope.

Community forest policies and guidelines urge that local control over forest management and utilization can maintain spatial integrity between wood extraction and forest stocks. For this, a spatially explicit operational plan is prepared and enforced to regulate management and wood extraction activities across the forest. These plans include forest blocks and management activities to be performed annually in each block (DoF, 2014). Accordingly, it is expected that forest management and wood extraction operations adhere to the spatial rules specified in the operational plans. However, our results indicated that such policy aspiration is not achieved at present planning and implementation process. The results revealed that locations with intensive wood extraction and the highest forest stock clustered apart in the forests. Such spatial incongruences suggest that management operations prescribed in the operational plans are not performed throughout the forest area. Our results reject the hypothesis that forest users follow the spatial rules of operational plans in order to regulate management and wood extraction operations across the forests.

The spatial pattern of wood extraction is the manifestation of forest management activities undertaken by user groups. Our analysis presented that forest management operations, including wood extraction, is confined in the certain parts of SCS forests which produce timber. In addition, the results clearly indicated that wood extraction is not shaped merely by the existing blocking of the forest but it is influenced by other factors related to forest types, road/foot trails, settlement patterns and terrain slopes. These factors place certain constraints and opportunities to determine wood extraction decisions. For example, operational plans have restricted the harvesting of timber from steep slopes, but it has been happening in locations close to the roads/foot trails and settlements. Our results resonate with the findings of other studies that report intensive extraction at the locations close to road and settlements (Kohlin and Parks, 2001, Robinson et al., 2002, Ezzatia et al., 2016). The results indicate that intensity of wood extraction is not distributed in the forests but concentrated largely at the convenient locations of the forests. The ultimate consequence of such extraction is the over exploitation of wood products at the confined locations, as already indicated in SCS forests, leading to the gradual degradation of forest (Nagendra et al., 2003). However, current operational plans are poorly informed by such subtle patterns of wood extraction that may undermine the sustainability of forest management in future.

The operational plans have envisaged the system of forest blocking as a strategy to introduce spatial policies of forest management and wood extraction in community forests. However, our results have questioned the efficacy of existing practice of forest blocking to maintain spatial integrity of wood extraction and forest stock across the forests. As reported by the forest users, existing forest blocks are not consistent and convenient to the spatial patterns of population distribution and, as a result, the blocks located farther from the settlements are hardly managed and/or used. It essentially meant that management and extraction operations are not always informed by the system of forest blocks and, instead, often occur close to the settlements and roads. The results clearly indicate that forest blocking that are concentric to the settlements or parallel to the road/trails can better represent the current practice of wood extraction from forests. To translate this information into practice of forest blocking, it is essential that the spatial factors that influence wood extraction are identified and integrated in the process of deriving forest management activities while preparing operational plans.

There are number of geospatial data sources available in public domain. The topographic maps and cadastral maps published by Department of Survey (DoS) of Nepal are the best available spatial dataset. However, the data pertaining to land cover and infrastructure like road and trails are already outdated since they were generated during 1990s. Moreover, these datasets contain limited ground details that can be used at the scale of individual community forests. Despite this limitation, these data have legal standing and the operational plans have to rely on forest maps derived from these sources (DoF, 2014). The maps included in the operational plans were derived from cadastral maps but they were hardly verified and referenced on the ground, and hence provide little value to the forest user groups.

While the dataset can be updated in reference to Google Earth ™ images, Open Street maps ™ and ground reference points taken by the Global Positioning System (GPS) instrument, it needs special software and skills to make use of these data to improve the spatial planning of forest management. It is beyond the current capacity of a forest technician working in community forests. Nevertheless, available spatial data can be applied to initiate participatory mapping and blocking of community forests.

Such data and maps can be used to encourage local communities to locate and map reference points, road/trails, settlement patterns, steep slopes, types and conditions of forest and the forest blocks with varying intensity of wood extraction. Such mapping processes can utilize the spatial knowledge of local communities to explain where, why and how forest management and wood extraction activities are taking place in the forests (Messerschmidt and Hammett, 1997, McCall and Minang, 2005). Further, participatory mapping processes can enhance the understanding of forest condition and direct alternative ways for management and utilization in relation to the transport infrastructure, settlement patterns and the priorities of user groups (Messerschmidt and Hammett, 1997, Kohlin and Parks, 2001, Charley et al., 2016, Cedamon et al., 2017). This information contribute towards generating zonation map that can improve the participatory spatial planning and institutions for forest management and wood extraction.

Our results indicated that current state and spatial patterns of wood extraction may not threaten the sustainability of community forest management. However, it is essential that these latent patterns of forest uses are carefully and thoughtfully understood and incorporated in the spatial planning process of community forests so that undesired consequences like degradation are not manifested in the longer period of time (Bettinger et al., 2017).

5. Conclusions

Wood extraction is a common phenomenon in community forests to obtain fuelwood and timber for local consumption. The study presented empirical evidence of wood extraction pattern and its spatial integrity with forest stock in the community forests of two rural villages of mid hill Nepal. Overall, wood extraction intensity was similar in two villages but it was significantly higher in timber producing SCS forests of Taksar due to their proximity to road and settlements as well as easier terrain conditions.

The operational plans of community forests have embraced the elements of spatial planning by introducing the system of forest blocking for the rotational management of forest and wood extraction. The underlying purpose of such planning is to maintain spatial integrity between forest stock and wood extraction across the forests. However, our results indicate that higher intensity of wood extraction is observed in community forests that produce timber, and the extraction is confined to certain locations close to the road, settlements and flatter slopes. It suggests either or both that the intensity of forest management is low and confined mostly in convenient locations, or spatial rules of operational plans are poorly observed in practice. As a consequence, there is a risk of location specific forest degradation leading to wood extraction practice unsustainable in future.

The influence of factors related to road accessibility, proximity to settlements, forest types and terrain slopes are unavoidable in shaping the spatial pattern of wood extraction. However, these factors are poorly recognized in the process of forest blocking and management prescription of current operational plans. Hence, this study argues for promoting participatory mapping to integrate spatial factors and local knowledge to generate zonation map of wood extraction intensity. The zonation map can be utilized to improve the existing practice of forest blocking and spatial planning to direct and monitor wood extraction in different parts of the forests. Based on spatial evidence of wood extraction, we argue for the need of reshaping forest blocks that are concentric to settlements and parallel to the road and trails. Such forest blocks can better represent the existing practices of wood extraction and should feature in the process of operational plan preparation.

In recent years, forest management in the world places increasing emphasis in ecological and social concerns. Forest operational plan is considered as a prerequisite to provide guidelines for implementing activities to utilize, manage and develop forests to address these concerns in space and time. However, this study indicated that spatial planning envisaged in the operational plans cannot effectively influence the practices of forest uses by local communities. Therefore, it is recommended that spatial planning should be informed by existing biophysical and social contexts for developing practical management and utilization strategies.

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Chapter 6: Locally perceived social and biophysical factors shaping the effective implementation of community forest management operations in Nepal

Group discussion on local factors influencing forest management (Left) and the sensitivity of forest area under construction activities (Nalma) July, 2018

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Contribution to the Paper	Collected field data; analysed and interpreted data; prepared manuscript and acted as first and corresponding authors		
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Certification:	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.		
Signature		Date	16 Aug, 2018

Co-Author Contributions

By signing the Statement of Authorship, each author certifies that:

i. the candidate's stated contribution to the publication is accurate (as detailed above);
ii. permission is granted for the candidate in include the publication in the thesis; and
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Name of Co-Author	Ian Nuberg		
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Contribution to the Paper	Helped in interpretation of results, provided comments and feedback to the manuscript		
Signature		Date	16-8-18

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Signature	Date 16/08/2018

Locally perceived social and biophysical factors shaping the effective implementation of community forest management operations in Nepal

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Abstract

Despite an ostensibly conducive policy environment in Nepal, community forest management has stagnated at a suboptimal level in delivery of the benefits stipulated in operational plans. This study assesses the current state of forest management against the backdrop of locally relevant factors that influence management strategies in 13 community forests in the mid hill region of Nepal. It adopts a mixed-method approach utilizing data collected from forest inventory and operational plans of these community forests, household survey and focus group discussions. The results reveal that the current state of forest management is very basic and largely confined to bush cutting and removal of low quality trees. We identified three primary factors influencing user groups' motivation to enhance forest management, namely: livelihood dependency on forests; forest incomes and benefits; and the capacity to technical forest management. Accordingly, there is a low incentive to adopt silvicultural systems to manage forests. Even though timber is considered as the main source of income, its production is constrained by terrain condition, regulatory procedures, accessibility to road and market and inadequate capacity to undertake silviculture-based forest management. The study concludes that the current level of benefits is insufficient to stimulate forest user groups to enhance forest management. We suggest policy imperatives that: 1) promote enterprise-based forest management to increase forest-based incomes; and 2) adopt collaborative action research to experiment and demonstrate beneficial effects of silvicultural systems to increase forest productivity.

Keywords: Community forestry, local factors, forest quality, forest dependency, forest management, operational plans

1. Introduction

The central ethos of community forestry is that people living adjacent to the forest organize themselves and take collective responsibility of forest management for their benefits. Consequently, community-based forest management have been featured in policy documents as a strategy for linking forest conservation to the economic prosperity of forest dependent communities in developing countries. The objective of such decentralized forestry programmes is to increase the participation of forest dependent communities in decision making and benefits related to environmental resources (Agrawal and Gupta 2005). Further, it is argued that greater control of local communities over forest resources leads to the sustainable management of, and benefits from, the forests to enhance livelihoods opportunities (Charnley and Poe 2007).

Nepal is one of the pioneer countries to embrace forest management programmes that involve local communities (Gautam et al. 2004; Pandit and Bevilacqua 2011). Under this programme, parts of accessible national forestland are handed over to the locally organized forest user group (FUG) with the devolved rights and responsibilities of management and sustainable utilization of forest produces (Thoms 2008). For this, each FUG prepares its own operational plan (OP) specifying the systems of forest management, development and utilization (DoF 2014). Currently, there are 22, 266 FUGs managing 2.2 million hectares of national forests formally handed over to them. The programme has engaged 2.9 million households which is, according to the population census of 2011, about 53 percent of the total households in the country (CBS 2012; DoF 2017). Furthermore, forest policies have progressively encouraged FUGs to effectively implement operational plans for generating the expanded range of goods and services to benefit local communities and contribute to national development (MFSC 2016). Several studies and review reports have revealed the success of community forestry in halting deforestation and improving forest condition (DFRS 2015; Gilmour 2016; Niraula et al. 2013). However, it is argued that improved environmental resources are rarely concomitant with the increased flow of benefits to the local communities (Thoms 2008). In addition, other studies have reported that community forests are underutilized and the benefit flow has stagnated at sub-optimal levels due mainly to the passive management practices (Cedamon et al. 2017; Coleman 2009; Yadav et al. 2009). However, there is paucity of studies that link factors that are locally perceived to influence the management strategies of, and benefits from, community forestry.

Meta-analyses have presented a comprehensive list of factors that directly or indirectly influence the practices of community forest management (Baynes et al. 2015; Tesfaye et al.

2012). However, the influence of those factors on forest management strategies are specific to local context and change over time. Generally, the perceived scarcity of resource can encourage local communities to form a group for collective action to achieve the needs which would not be obtained by individual action (Wade 1987). The presence of viable alternatives to meet the given needs may alter the incentives and priorities of people towards forest management. The factors include user group characteristics such as social and ethnic differentiation; nature of dependency on forest; technical and organization experiences; and accessibility to market and road have shown both facilitating and impeding influence on collective efforts of forest management (Agrawal 2001a; Agrawal and Chhatre 2006; Agrawal and Ostrom 2001; Baland and Platteau 1996; Gautam 2007; Poteete and Ostrom 2004). Nevertheless, the consensus is that early and regular supply of economic benefit is essential to motivate and engage local communities in community forestry (Maryudi et al. 2012; Pokharel 2012). Though forests provide a range of benefits, the value of those benefits is perceived differently across the FUGs and such perception is rooted to the social and biophysical context of community forest management.

However, there is paucity of studies elucidating the perception of local communities to identify the locally relevant factors that better describe the changing relationships of communities with forest and their likely influences on management priorities and strategies. Perception based methods are useful to understand the capacity, priorities and management performance of FUGs where on-the ground management often poorly corresponds with stated policies (Bluffstone et al. 2008; Klooster 2002; Upton et al. 2015). Hence, it is imperative that forest management operations are linked to the empirically-derived evidence of locally-perceived factors rather than mere emphasis on theory-data congruence to characterize the outcomes (Richman et al. 2016). Inspired from these insights, this study attempts to analyse the locally perceived factors that determine the forest management activities in the mid-hill region of Nepal. Once these situational factors are identified, it can be used to objectively assess the current state of forest management and evaluate the current as well as future potential of adopting different management operations for remote communities.

This study draws on a detailed review and assessment of forest management practices, and the underlying factors that circumscribe the management operations in community managed forests. Specifically, the study focuses on: i) the existing forest management strategies and activities and the current state of their implementation; ii) the local factors and their causal links to determine FUG's motivation towards enhancing forest management; and iii) the locally perceived influence of the local factors on forest management strategies and activities.

2. Methods and study sites

The study employed a mixed-method research design that combines qualitative and quantitative data generated from multiple sources to better understand and interpret the phenomena under investigation (Harwell 2011). There were 13 case study community forests sampled from Nalma and Taksar villages of Lamjung district at the central hill region of Nepal **(Figure 1).** The community forests in the villages were purposively selected to represent the typical rural populace with about 15 years of experience in community forest management. Whereas Nalma is situated in remote areas with limited access to fair-weather roads, the Taksar community forests have better access to the road and urban centres. Further, the forest-people relationships in the villages have changed over time with the consequences on community forest management strategies and operations (Gilmour et al. 2014). The forests in the case studies represent natural mixed *Schima wallichii - Castanopsis indica* (SC) and *Schima wallichii-Castanopsis indica - Shorea robusta* (SCS) forests and provide a range of goods and services to the local communities.

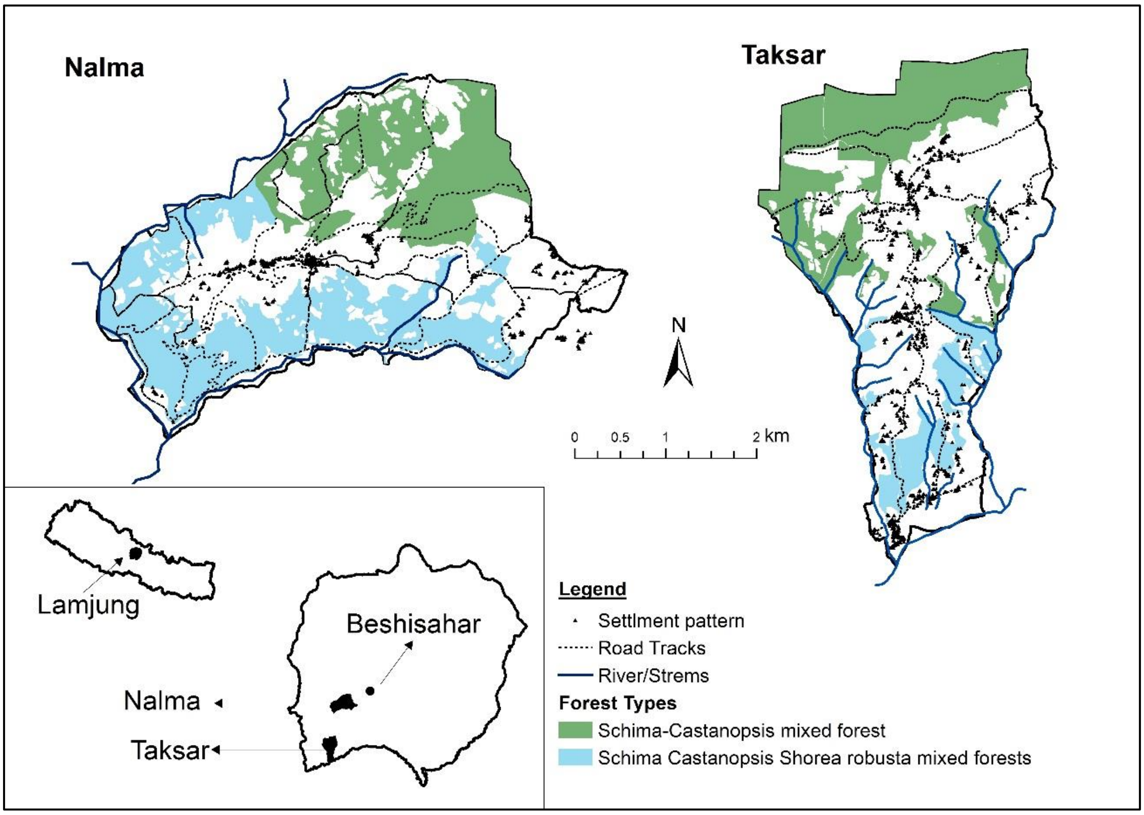

Figure 4: Map showing study area, Nalma and Taksar villages of Lamjung District, Nepal

The study is based largely on the group discussion to assess the current state of forest management and identify locally relevant factors to influences management decisions. The results of group discussions were analysed along with the data obtained from forest inventory, household interviews, terrain analysis and relevant policy reviews. The following four methods were employed to collect data.

1. Review of operational plans and guidelines to identify forest management strategies and regulatory processes;
2. Focus group discussions to identify locally perceived factors that influence forest management strategies;
3. Forest inventory to assess the physical status of forest; and
4. Household survey to determine changes in household characteristics of forest users

Relevant details are as follows.

1.1. Review of operational plans and regulatory guidelines:

The operational plans of the 13 community forests were reviewed to identify the major strategies being employed and specific forest activities that fell within those strategies. The regulatory guidelines on harvesting of forest products were reviewed and essentialised for the purpose of presenting for discussions with forest users.

1.2. Focus group discussions:

Focus group discussions (FGD) were held in each of the 13 community forest user groups. Participants were current and previous committee members, local leaders and community forestry stakeholders (e.g. from Federation of Community Forest Users Nepal, FECOFUN). There were usually 7 to 8 participants in each FGD. In the discussion, participants were directed to accomplish the following tasks:

a. subjectively assess the state of forest management (management-score) at the scale of 0-2: where 0 represents no or negligible implementation of an activity; 1 for limited implementation; and 2 for regularly implemented activity;

b. identify locally relevant factors that influence forest management strategies and the perceived influence of those factors (factor-score) along the 1-5 Likert scale; where 1 represents the factors with lowest influence and 5 represents the factors with highest influence on forest management. To elaborate, the lower score assigned for a factor indicates that the factor provides low incentive or motivation to enhance forest management.

c. Derive causal diagrams depicting relationships and links of local factors to influence user groups' motivation for enhancing forest management

The discussions were led by "why" questions to critically assess the importance, relevance and influence of each factor in the context of local forest management. It was supported by data collected from the other three methods listed above. Participants in each FGD identified factors that explained the state of management activities.

A fourteenth FGD was held with 8 forestry professionals with extensive experience in community forestry in the Nepal at the Nepal Foresters Association office in Kathmandu. They were in strong agreement with the village-level FGD results and contributed to the grouping of results into primary and contributing factors.

1.3. Forest inventory:

Altogether, 93 plots across 4 forests in Nalma, and 68 plots across 9 forests in Taksar, were randomly sampled proportionate to the size of the community forest. The species, size and quality of trees above 10 cm diameter at breast height (dbh) was recorded within the circular plots of 500 m^2. The density (stems ha^{-1}) and basal area (m^2 ha^{-1}) distribution of trees across the 5 cm dbh class interval were calculated. Tree quality was subjectively assessed into three categories as provided in **Table 1**.

Trees measured in the sample plots were categorized as merchantable (dbh ≥ 30cm) and poles (dbh < 30 cm) trees. The relative frequency of merchantable trees is important indicator to evaluate the timber potential of the forests. Further, the species used for timber in the villages were categorized as timber species and its frequency was calculated for each community forest. Forest data were analysed to generate empirical evidences to evaluate the perceived quality of forests from group discussions.

Table 8: Description of criteria used to assess the tree quality for timber production

Tree quality	Description	Timber fraction
High	A live tree with a good form and now or prospectively having a length of at least 6 m in sound saw logs and not more than 4% of cull volume in the section from the stump to the upper limit of saw log of merchantable quality	2/3
Medium	A sound live tree not qualified in the class "high". The tree must have now or prospectively at least one 3m section of saw log quality or two 1.8m or longer saw log sections. A log is considered as a saw log (merchantable) if the yield of lumber is 50% or more of the yield of a perfectly straight and sound saw log.	1/2
Low	A live tree that, because of poor form, roughness, injury or decay, does not now or in the future yield logs of merchantable quality.	1/3

To assess the terrain condition of the forest, a digital elevation model (DEM) was generated from the contour data (20 m interval) obtained from Department of Survey (DoS) of Nepal. The DEM was used to derive slope maps of the community forest areas. As the forest in steeper slopes are prohibited for tree felling, the slope map was used to determine the effective areas for productive management.

1.4. Household survey:

Household interviews were conducted to gather data on family composition, livestock population and its trends and household energy sources. The household members were categorized as residential for those living more than six months at the villages and absent for those living outside. The education of the members was represented by the number of school years completed. The trend of livestock holding was assessed as increasing, stable or decreasing over the last 10-year period. Household energy was recorded as fuelwood, electricity or biogas or combination of these sources. Altogether, 110 and 108 households were interviewed in Nalma and Taksar respectively using a structured questionnaire. The sample size is assumed to be sufficient to understand the forest people relationship in the rural communities (CIFOR 2007). This data was compared with census data from 2001 and 2011. Household information was used to triangulate the perception based data from group discussions.

3. Results

3.1. Forest management activities and the state of their implementation based on operational plans and group discussions

The review of operational plans revealed management strategies for the protection, management, development and utilization of community forests. The management activities under each strategy and the perceived state of their implementation are provided in **Table 2**. The table indicates that bush cutting, thinning and pruning and fuelwood extraction - collectively known as *godmel* - plantation and/or enrichment planting, and timber harvesting are the major activities planned for forest management. Overall, fuelwood collection, grazing control and bush cutting were the top three management activities in all community forests. Out of total 13, timber harvesting was identified as limited or negligible activity in nine and frequent activity in four community forests. Similarly, the construction of fences and firebreaks were the least implemented activities by all community forests. The plantation and/or enrichment plantation was a limited activity in six but it was not implemented in other seven community forests.

In practice, only a limited set of *godmel* activities were carried out in all forests. This activity was integrated with thinning pruning, bush cutting and small sized timber harvesting. The discussions revealed that forest users were not able to carry out *godmel* over entire blocks as specified in operational plans. Based on the scores, the average management score of 13 community forests was 0.7 (i.e. limited extent) with coefficient of variation of 34%. However, there was great variation among the activities across the community forests. For example, wood extraction was scored as the most common activities (1.8) followed by grazing control (1.5) and bush cutting (1.3). Within the community forests, the overall management score was highest for Lampata (1.3) indicating that most of the forest management activities were implemented.

Table 9: The state of forest management strategies implemented in community forests.

Management strategies →	Maintenance		Protection			Development		Utilization		
Activities →	Bush cutting *	Thinning/pruning *	Fencing	Firebreaks construction	Grazing control	Plantation/ Enrichment	NTFP promotion	Timber harvesting	Fuelwood extraction *	Average (Management score)
Community forests (forest type)										
Kagrodevi (SCS)	1	0	0	0	2	0	0	1	1	**0.6**
Khundrudevi(SC)	2	1	0	0	1	0	1	2	2	**1.0**
Langdihariyali (SCS)	2	0	0	0	1	1	0	2	1	**0.8**
Sunkot (SC)	1	0	0	1	1	0	0	0	2	**0.6**
Adherikhola (SC)	1	0	0	0	1	0	0	0	2	**0.4**
Bholdada (SC)	1	0	0	0	2	0	0	0	1	**0.4**
Jamuna Gahira(SC)	1	0	0	0	1	0	0	1	2	**0.6**
Lampata (SCS)	2	1	0	1	2	1	1	2	2	**1.3**
Nag Bhairab (SC)	1	0	0	0	2	1	0	0	2	**0.7**
Pisti (SC)	1	0	0	0	1	1	0	1	2	**0.7**
Samkhoria (SC)	2	0	0	0	2	1	0	1	2	**0.9**
Sathimure (SCS)	1	0	0	0	2	1	1	2	2	**1.0**
Tamakhani (SC)	1	1	0	0	1	0	0	1	2	**0.7**
Average	**1.3**	**0.2**	**0.0**	**0.2**	**1.5**	**0.5**	**0.2**	**1.0**	**1.8**	**0.7**

0 = no or negligible activities, 1: yes but only in limited extent, 2: yes, frequent activities; SC= *Schima-Castanopsis* forests, SCS = *Schima-Castanopsis* and *Shorea robusta* forests, * Local practices collectively known as *godmel* operations

Figure 2 depicts the frequency of community forests undertaking different forest management activities at varying degrees of intensity. The figure shows that most of the management activities are implemented to only a limited extent. The intensity of timber harvesting ranged from none (for most of the SC forests) through limited (including some SC and SCS forests) to frequent activities (for SCS forests). For majority of community forests, the extent of activities such as thinning, pruning; non-tree forest product (NTFP) promotion, fencing and firebreaks construction was none or negligible. Among the activities, thinning and pruning, NTFP promotion, firebreak construction and fencing were the least implemented activities in the community forests.

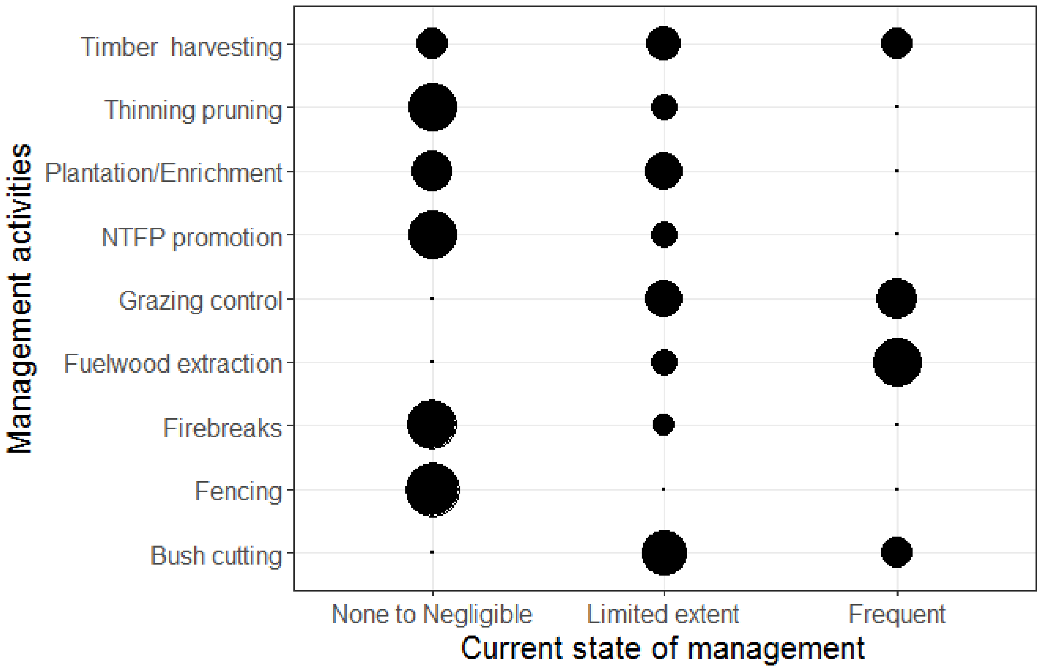

Figure 5: The frequencies (number) of community forests undertaking various forest management activities at the given state of intensity (none to negligible, limited and frequent). The bubble size indicates the percentage of community forests undertaking particular management activity for given intensities.

3.2. Local factors and their causal links to shape forest management strategies

Altogether, three primary and nine contributing factors influencing forest management strategies were identified through a series of group discussions. **Figure 3** depicts the causal links between these factors to shape the state of community forest management. The three primary factors identified were forest dependency, forest incomes and capacity of technical forest management.

There was general consensus among the FUGs and forestry professionals that the extent and nature of forest dependencies determine the FUG's motivation to forest management. Population changes due to migration, availability of substitutes for forest products and practices of livestock foraging were identified as the major contributing factors to define forest dependency. Similarly, income derived from forest was perceived as influential factor to enhance forest management. The size of forest incomes is largely determined by the quality of forests to produce desired products, terrain condition to allow forest operations, regulatory mechanisms and accessibility to road and markets. Finally, the technical capacity of FUGs to apply silvicultural systems to forest management was perceived as important factor for enhancing forest management. These factors collectively shape the overall motivation of forest user groups to enhance community forest management.

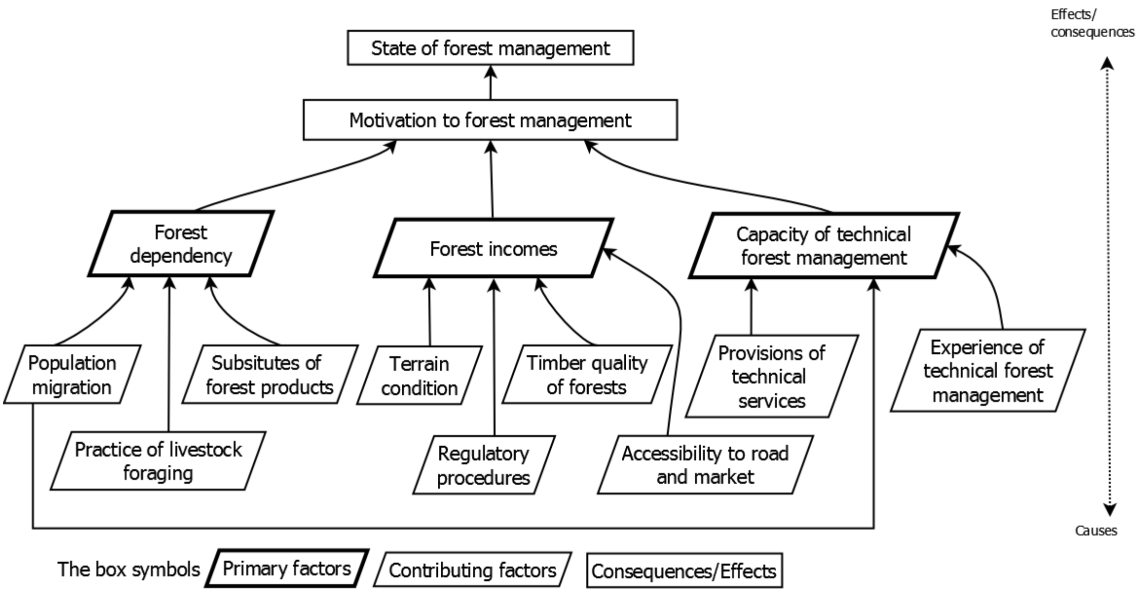

Figure 3: The causal diagram linking primary and contributing factors to shape forest users' motivation for enhancing forest management.

The contributing factors can have individual or combined effects to influence forest management. For example, motivation to forest management may be increased if the forests are located in easy terrain and/or they can produce timber to fetch better incomes for the community. The causal diagram (Fig 3) depicts that while factors under each principle factors are favourable, there will be positive effects on forest management. Further, forest users expressed that forest incomes could be enhanced if regulatory procedure of timber harvesting were simplified and shortened. Similarly, the technical skills and knowledge of silvicultural systems can motivate FUGs to enhance forest management. Therefore, the influence of these factors is site specific and needs locally relevant evidence for evaluation. The following sections present the perceived influence of these factors on forest management.

3.3. Perceived influence of local factors on forest management

Table 3 provides the perceived influence of local factors to determine the forest management strategies in community forests. The table reveals that the average of factor scores across the community forests remained 2.4 which is about midway in the Likert Scale used. The table indicates that technical skills to forest management (1.6), accessibility to road (1.9) and migration of rural population (2.1) were the responsible factors to lower the users' motivation in forest management. Overall, the average score for forest quality (3.0) and regulatory procedures (2.8) remained above the midway in the Likert scale, suggesting that these factors are favourable incentives to forest management. Likewise, average score across the factors was highest in Lampata (3.7) and Sathimure (3.6). The highest scores to these forests were contributed for their low rate of out-migration, good quality forest, road accessibility and easier terrain. The lowest scores resulted in Bholdada (1.6), Pisti (1.7) and Jamuna Gahira (1.9) was contributed mainly by difficult terrain, high rate of out-migration, low timber quality of forests and inaccessibility from roads. These perceived influences of each contributing factor are evaluated in reference to the results obtained from household interviews, forest inventory, group discussions and policy reviews.

Table 10: The primary and contributing factors to shape the motivation of forest users to implement forest management strategies. The values in the cells indicate the relative scores of the factors to influence forest management. The factors score was assessed in 1-5 scale, where 1 represents the least and 5 represents the most important factor as incentive to forest management.

Primary factors →	Forest dependency			Forest income/ benefits				Technical capacity[1]		
Contributing factors →	Population migration	Practice of livestock foraging	Substitute of forest products	Terrain condition	Timber quality of forest	Access to road and markets	Regulatory procedures	Silvicultural knowledge and skill	Provisions technical services	Average (Factor score)
Community forests (forest types)										
Kagrodevi (SCS)	1	3	2	2	5	1	3	1	1	**2.1**
Khundrudevi (SC)	3	3	3	4	4	2	2	1	2	**2.7**
Langdihariyali (SCS)	3	3	3	2	5	3	2	2	2	**2.8**
Sunkot (SC)	2	3	3	2	1	3	3	1	2	**2.2**
Adherikhola(SC)	2	2	2	3	1	2	3	1	2	**2.0**
Bholdada (SC)	1	2	2	1	1	1	3	1	2	**1.6**
Jamuna Gahira (SC)	1	2	3	1	3	1	3	1	2	**1.9**
Lampata (SCS)	4	3	2	4	5	4	4	3	4	**3.7**
Nagbhairab(SC)	2	3	4	1	2	2	2	2	2	**2.2**
Pisti (SC)	1	2	2	1	2	1	2	1	3	**1.7**
Samkhoria (SC)	1	2	2	3	3	1	3	2	3	**2.2**
Sathimure (SCS)	4	3	3	4	5	2	4	3	4	**3.6**
Tamakhani (SC)	2	2	2	2	2	2	2	2	2	**2.0**
Average	**2.1**	**2.5**	**2.5**	**2.3**	**3.0**	**1.9**	**2.8**	**1.6**	**2.4**	**2.4**

Forest types: SC= *Schima-Castanopsis* forests, SCS = *Schima-Castanopsis* and *Shorea robusta* forests, [1]Technical capacity to scientific forest management

3.3.1 Population outmigration:

The group discussion revealed that the outmigration and absenteeism of family members is an increasing trend in both villages. Out of total, five community forests expressed that out-migration including absenteeism was the most serious factor to restrict forest management activities. While out-migration has reduced the forest dependent population, it has simultaneously caused labour scarcity for forest works. Our results revealed that the average family size of user households is 6.1 persons in both villages but, due to the absenteeism, the effective size has reduced to 3.9 persons and 4.1 persons in Nalma and Taksar respectively. On average, absenteeism of household members in Nalma (2.2 persons) was slightly higher than in Taksar (1.9 persons). The absenteeism was observed among educated members as the average school year of absent members was 8.0 and 8.6 in Nalma and Taksar which is almost double of the resident members in the respective villages.

3.3.2. Practice of livestock foraging:

The overall influence of this factor across the community forest appear to be neutral (i. e 2.5) to influence forest management. For seven community forests, the score was assigned 3, meaning that livestock foraging practice is an incentive to forest management. However, the household survey revealed that livestock holdings and husbandry practices have substantially changed in recent years. Livestock holdings have decreased in 60% of households in Nalma and 53% in Taksar over the last ten years. The traditions of keeping a large sized cattle-shed (*goth*) has almost disappeared in Nalma and, instead, villagers prefer to keep only a few livestock for meeting their domestic requirement of milk and meat. As goat and sheep can graze in steeper slopes, and need less supplementary feed, these animals have replaced and reduced the number of cow and buffalos held by households. The practice of stall feeding is growing with 47% households in Nalma and 35 % in Taksar following this practice. Further, fodder for animals is supplied mostly from private lands. These changes of livestock husbandry are perceived to reduce the dependency on the forest for fodder, bedding materials and grazing space.

3.3.3. Substitutes of forest products:

Forest users reported that substitutes to forest products has reduced incentives for forest management. Substitutes of forest products (e.g. fuelwood) is increasingly available either or both from private land and commercial supplies. In both villages, trees grown outside forests including private lands have emerged as the alternative sources of fuelwood and small-sized timber. Similarly, the proportion of households relying only on fuelwood for household energy was less than 20% in both villages, meaning that villagers use other energy sources like liquefied petroleum (LP) gas, electricity and biogas for cooking and heating purposes. Despite this the average score (i. e. 2.6) for this factor indicates that forest users have certain incentives to manage forest as the source of forest products in both villages.

Likewise, the frequency and materials of household construction has changed in recent years. In Nalma, new house construction has been negligible over the last five years. In Taksar, on the other hand, house construction is on a growing trend along the road, but the construction of houses now relies more on commercially supplied materials. The household survey revealed that the roof of about 95% houses in Nalma and 76% houses in Taksar was made up of galvanized iron sheet. The new design of house construction has reduced the use of wood as beam, scantlings, rafters and plates for framing the roof of the building and its walls.

3.3.4. Terrain conditions:

Topography influences the operational difficulty for forest operations. The forests included in this study are located on moderate to steep slopes. Forest users perceived that management operations, which are mostly manual, were very risky in steep terrain, thus resulting low income. According to the local forest officers (LFO), timber is not harvested from forests exceeding 35° slope and along the river bank. The terrain analysis revealed that, of the total community forests area, 48.2 % in Nalma and 35.6 % in Taksar are located above 35° slope (**Figure 4**). Such restrictive policies have reduced the effective areas for the supply of already prescribed timber and other products from the forests. However, current operational plans are not informed by the slope and terrain induced constraints on annual harvesting planning.

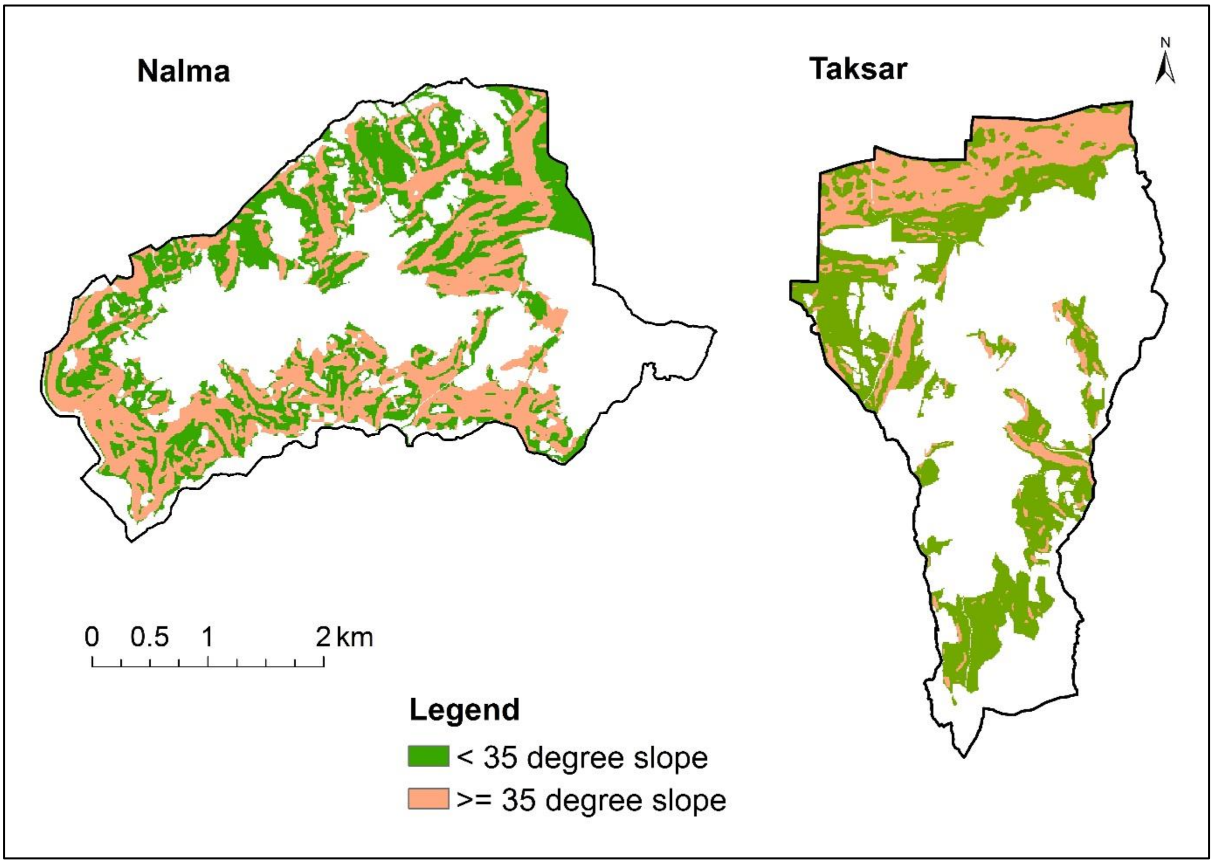

Figure 4: Community forest areas in Nalma and Taksar showing two slope classes: < 35°, which is locally endorsed for regulating timber harvesting operations in the forests; and > 35°, which is protected from timber harvest but not for other forest uses.

Accordingly, the average score for terrain condition in the Likert scale was 2.3, indicating that it is one of the limiting factors for management operations. The average score of terrain condition was lowest (1) for Bholdada, Jamuna Gahira, Nagbhairab and Pisti community forests which suggests that steepness of terrain is the major impediment to motivate people to enhance forest management activities.

3.3.5. Timber quality of forests:

Forest quality was assessed for its potential to yield timber. The species composition, size distribution and quality of trees are used to examine the forest quality in relation to timber production. Villagers ranked Sal (*Shorea robusta*) as the most preferred species for its strong and durable timber as well better prices received. The Sal tree alone represents 37% and 14% of total forest trees in Nalma and Taksar respectively. Other timber species in the forests are Uttis (*Alnus nepalensis*), Katus (*Castanopsis indica*), Chilaune (*Schima wallichii*), Kadam

(*Anthocephalus chinensis*) Lakuri (*Fraxinus floribunda*), Chap (*Michelia champaca*), Sandon (*Oujenia oojeinensis*) and Tuni (*Toona ciliate*).

The frequencies of merchantable trees and timber species in the forests are provided in the **Table 4**. The table reveals that abundance of merchantable trees was highest in Sathimure (27%) followed by Lampata (26%), Samkhoria (26 %) and Khundrudevi (24%). Likewise, the frequency of merchantable trees was lowest in Bholdada (10 %), Jamuna Gahira (11 %) and Adherikhola (14 %). Similarly, timber species constituted the major proportion of trees in the forests. On average, timber species constitutes the 80 percent of the forest composition in both villages**.** In four community forests, tree species occupied > 90 percent of the total trees composition. In Sunkot, the abundance of timber species was found lowest (46.9 %).

Table 11: The frequency of merchantable trees and the species used for timber in community forests

Community forests	Merchantable trees (%)	Timber Species (%)
Kagrodevi	18	92
Khundru	24	71
Langdihariyali	18	84
Sunkot	15	47
Adherikhola	14	86
Bholdanda	10	78
Jamuna Gahira	11	58
Lampata	26	95
Nag Bhairab	19	95
Pisti	21	80
Samkhoria	26	70
Sathimure	27	95
Tamakhani	20	85

The density and basal area distribution of trees across the 5 cm dbh classes are presented in **Figure 5**. The figure reveals the predominance of pole sized trees (dbh < 30 cm) (**Fig 5a)** with fewer large sized trees as represented by the basal area distribution **(Fig 5b).** The figure shows that pole sized trees predominant the forest composition in Bholdada, Jamuna Gahira and Adherikhola community forests.

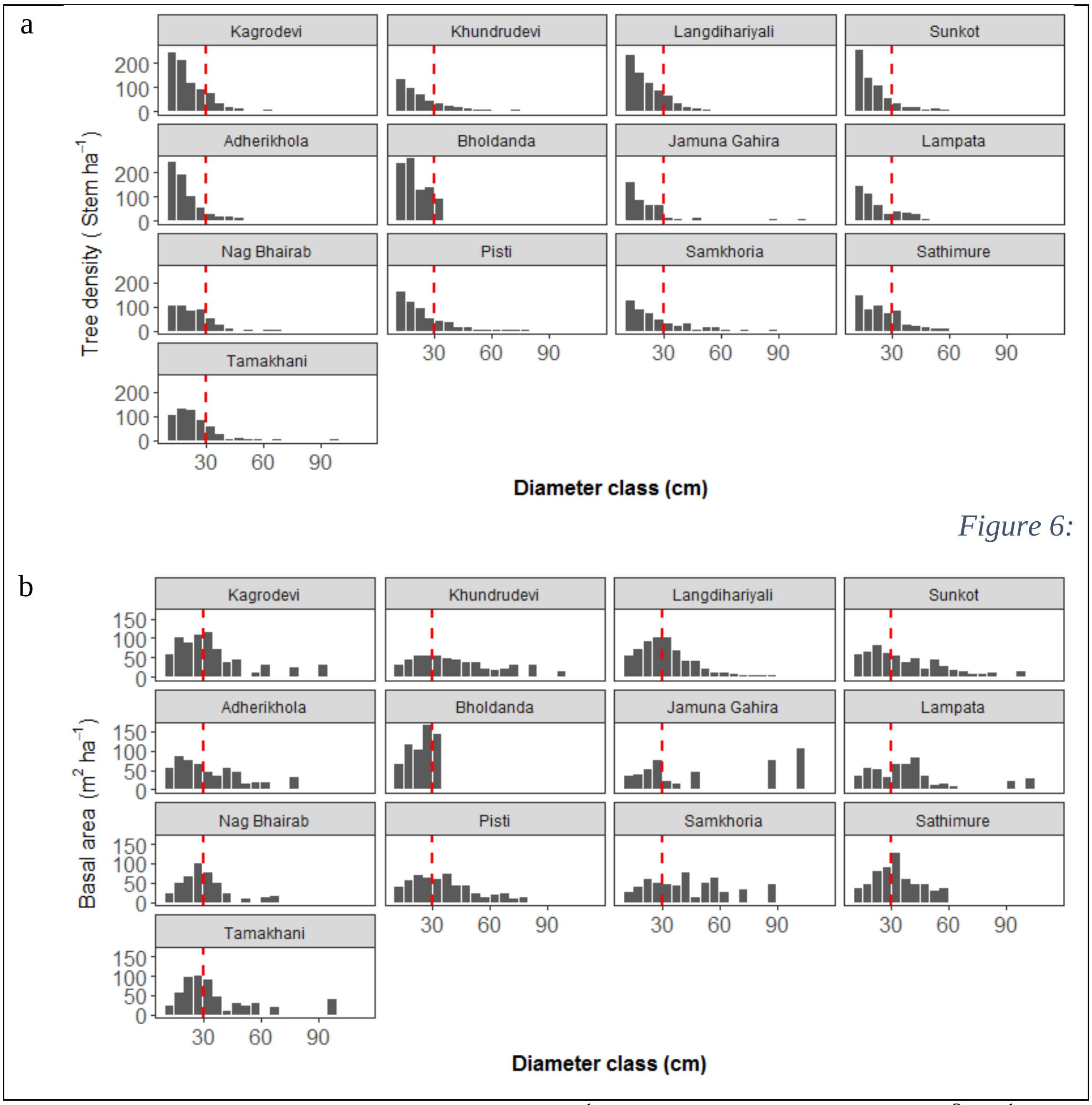

Figure 5: Distribution of tree density (Stem ha^{-1}) (above-a) and basal area (m^2 ha^{-1}) (below-b) over diameter class (5 cm interval). The vertical dash line divides the trees into poles (<30cm) and poles (≥ 30cm).

Tree quality is important factor for producing timber. **Figure 6** depicts the preponderance of high, medium and low quality trees in all community forests. The figure clearly reveals the prevalence of low quality timber trees in both SC and SCS forests in both villages. The SCS forests have relatively higher percentage of good quality trees compared to the SC forests in both villages. The SCS forests were thus considered good for timber production.

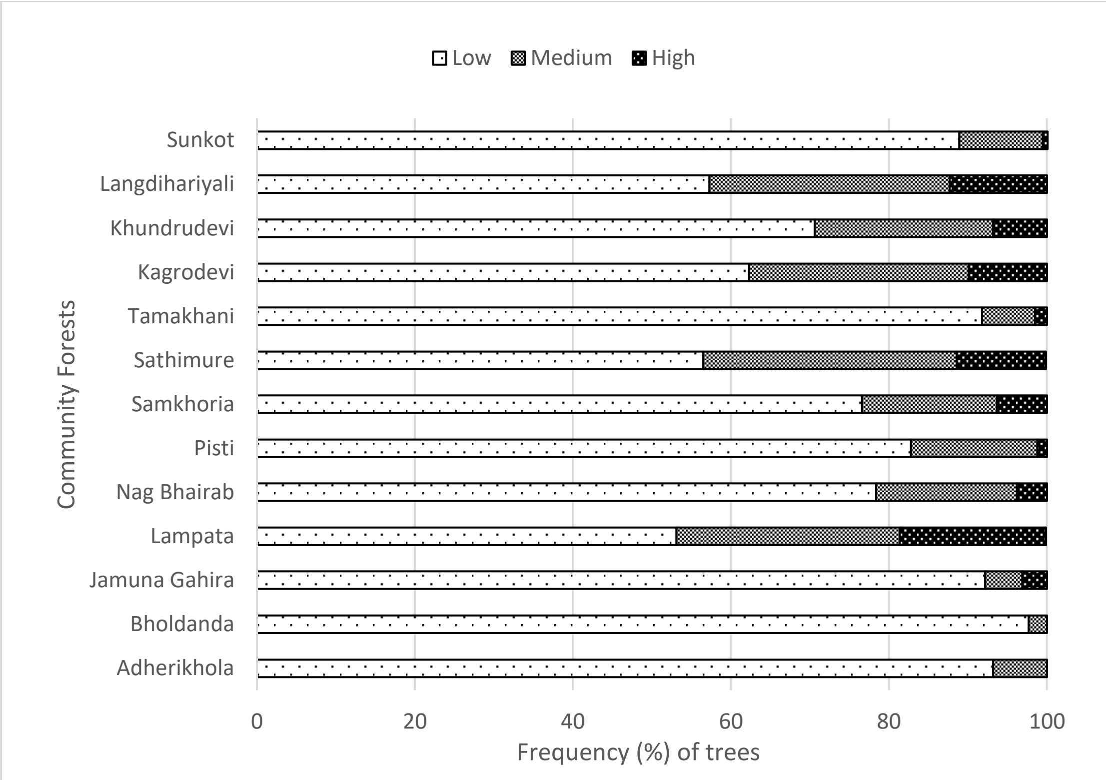

Figure 6: The relative proportion of high, medium and low quality trees in community forests as measured in forest inventory.

The average score (3.1) for this factor indicates that timber quality of forests is perceived as an incentive to manage forests. For SCS forests, the timber potential is highest in both villages but most of the SC forests scored lowest (1) for their potential to produce timber. Accordingly, users of SC forests were less interested in enhancing forest management.

3.3.6. Regulatory procedures:

Perceptions on regulatory procedures stemmed from the forest users' experience of harvesting timber. Even though forest users can collect fuelwood and other products as specified in their operational plans, a formal permission from the forest office is required for timber harvesting.

The review of policy guidelines in relation to this factor revealed that a series of steps need to be followed to acquire a harvesting permit (GoN, 2015). **Figure 7** traces the general steps, institutions involved and related activities in the process of obtaining timber harvesting permits. At first, the FUC needs to assess local demands of timber and get approval from the general assembly (step1). Then, in assistance of local forest office (LFO), FUC selects, marks and records trees to prepare detailed harvesting inventory (step 2). This is the mandatory document to include with application for harvesting permit (step 3). Once the application is received, LFO and DFO verify the marked trees in the forests and scrutinize closely and compare with operational plans (step 4-5). Once the verification process is satisfactorily accomplished, the harvesting permit is granted (step 6). The FUC is solely responsible for the harvesting operations adopting standard protocol of tree felling, sectioning, grading and transportation (step 7). The LFO monitors the harvesting operation and reports to district forest office (DFO) for review (step 8). Once the entire operation is found satisfactory, the DFO can issue necessary permits to distribute the timber according to the prioritized forest users (step 9).

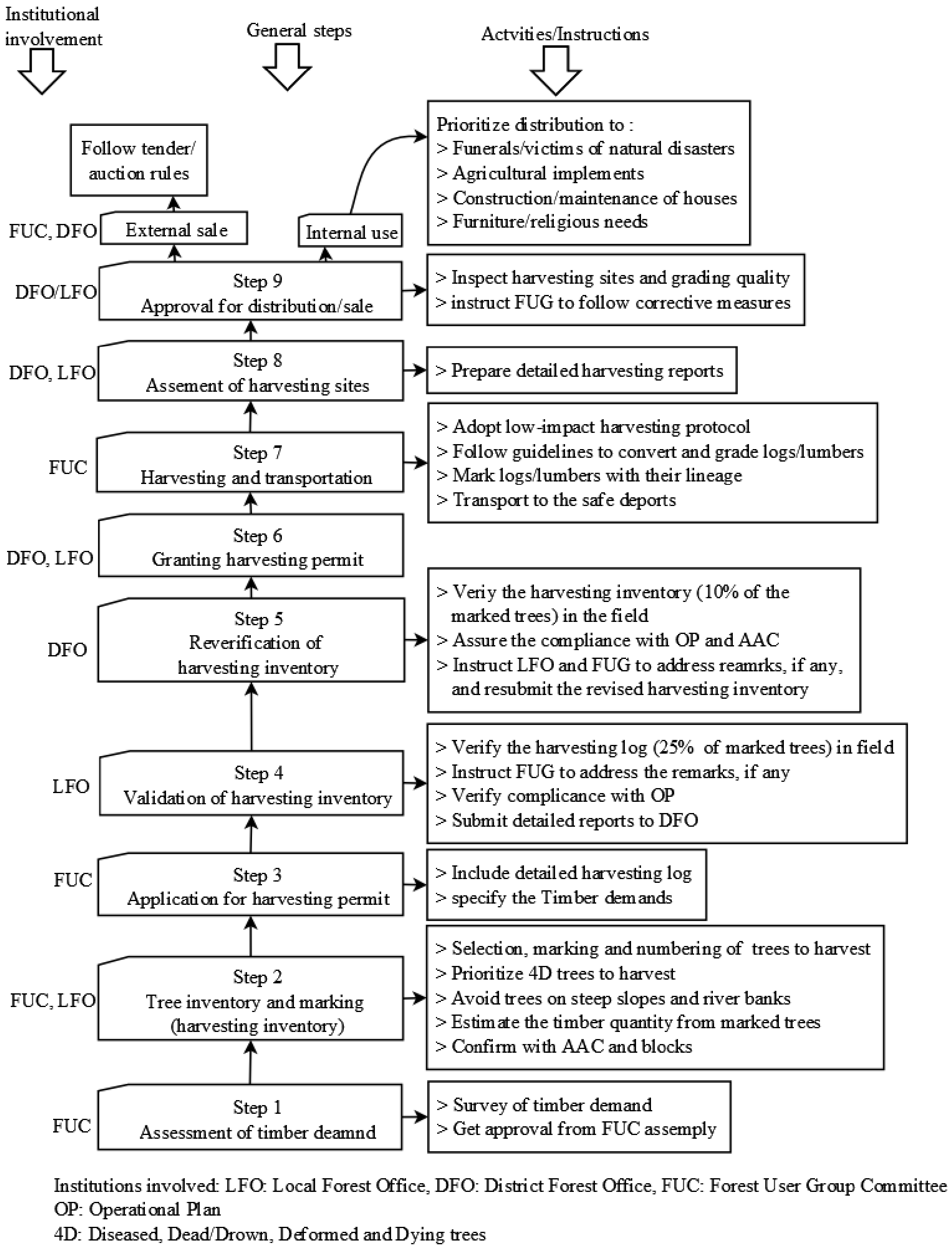

Figure 7: General mapping of regulatory procedure for timber harvesting from community forests derived from the review of policy guidelines and focus group discussion.

Figure 7 clearly indicates that forest officials are directly or indirectly involved throughout the harvesting process. During the discussion, forest users perceived this process as too complex and time-consuming. Forest users need to visit the forest office about 20 times to get through this process. Every stage involves informal payments (i.e. bribes) and other transaction costs (accommodating and feeding officials) which diminishes the net benefits from timber sales. As the timber demand in SC forest was low, the process of obtaining timber harvesting permit was generally skipped by allocating the whole trees to the households demanding timber. However, the overall score of this factors is 2.8, indicating that regulatory mechanism may not be the most important limiting factor to timber harvesting.

Forest users also perceived regulatory constraints to establish forest-based enterprises in the villages. Sawmills were perceived as the best enterprise option but the criteria to establish and operation of these are restrictive involving many agencies in the process. Further, it is not explored yet on the potential forest enterprises in these villages. Consequently, village respondents were not keen to establish forest-based enterprises and preferred other opportunities like jobs in foreign countries and business in urban centres.

3.3.7. Accessibility to road and market:

Forest users mentioned that road access to their forest is limited or not existent in remote areas. As a result, harvesting and transportation of timber from forest is very difficult. It was perceived as one of the most inhibiting factors for timber production. It was reported that an earthen road has passed through two community forests (Sunkot, Lampata) and was under construction in a third (Langdihariyali). In Pisti and Sunkot, users reported that fuelwood obtained from *Godmel* operations was left in the forest due to the remoteness of forest and inaccessibility from the road. The average score (1.9) of this factor indicates that it is one of the major impediments to enhance forest management for income generation.

3.3.8. Silvicultural experience and knowledge:

Silvicultural knowledge and experience of forest management was perceived as the most important limiting factors in most of the community forests. Out of 13 community forests, 12 have already completed at least two operational plan periods of 5-year each. During this period, silvicultural systems prescribed in operational plans were not effectively implemented. Instead, forest users and forest officials continued with basic management operations like protection and restrictive extraction. As a result, local users and forestry technicians lack hands-on experience and knowledge to apply silvicultural systems. The discussion revealed that forest officials were indifferent towards silvicultural systems and local users relied on their own indigenous knowledge, priorities and practice of forest management.

3.3.9. Provision of technical services

Inadequate technical services to the forest users was perceived as a limiting factor to facilitate forest management activities. Generally, forest users demand technical support to prepare operational plan and carryout thinning, pruning and harvesting operations. The forest offices are the responsible agencies to extend such technical services to the forest users. However, the discussion with forestry professionals revealed that forest offices are not proficient to handle a growing demand of technical services from forest user groups. The limited technical services is reflected in the operational plans of community forests which are often prepared on an ad-hoc basis with limited, sometime no, consultation and interaction with user groups. Forest officials are mostly occupied with routine office work and make occasional monitoring of forest management activities and timber harvesting operations.

Overall, there was general agreement among FUGs and forestry professionals that motivation to enhance forest management operations has declined in rural communities. It was largely contributed by the inadequacy of benefits and incomes derived from the forests coupled with reduced livelihood dependency on forest and lack of technical capacity to undertake active forest management. However, the discussions indicated that the development of favourable situations of any combination of these factors may encourage people to enhance forest management operations in the community forestry.

4. Discussion

4.1. Current state of community forest management

The operational plans of community forests stipulate a number of strategies for the protection, development, management and utilization of forests but the state of their implementation varies across the community forests. Overall, forest management is rudimentary and confined to basic operations like bush cutting and removal of inferior trees to obtain fuelwood and timber to meet local demands. Forest management strategies are complementary to each other and carried out in specified blocks. In the early phases of community forestry, the government prioritized degraded forestland for community forests by their development through plantation and strict protection measures. This protection approach has emerged and perpetuated as the dominant culture of forest management in the community forestry of Nepal (Shrestha and McManus 2018; Yadav et al. 2009). Moreover, it is shaped by the locally perceived criteria of superior and inferior wood for steering management strategies that remove undesired species in the favour of desired ones. Our results concur with the arguments that community forests are undermanaged and local communities emphasize on favourite species used mainly for timber (Cedamon et al. 2017; Ojha 2001).

4.2. Local factors and their perceived influences to shape forest management

Local factors that influence forest management are diverse and rooted to the social, biophysical and technical aspects of community forestry. This study identified three primary and nine contributing factors that influence forest management practices in 13 community forests of Lamjung district in mid hill region of Nepal. These factors collectively shape the motivation of forest user groups to enhance forest management. At present, most of these factors were perceived as less favourable to enhance forest management. Further, the results reiterate the need of identifying a broad range of factors which are likely to influence the successful designing and implementation of community forestry programme (Baynes et al. 2015). Overall effects of contributing factors to the primary factors are summarized as follows:

4.2.1. Forest dependency

Livelihood dependency on forests has decreased due to the outmigration of rural population, declining livestock holdings and presence of alternatives to forest products. Population out-migration and absenteeism is a common phenomenon in the remote and rural communities. The census data between 2001 and 2011 has indicated a decreasing trend of population in both villages (CBS 2012).

The knock-on effect of outmigration affects the economy and ecology of rural communities. First, it reduces labour force for agricultural production which results in land abandonment (KC 2015; Paudel et al. 2014). The abandoned lands are gradually converted into forests as the source of fuelwood, poles and fodder. It is estimated that private trees contribute 37-43% of annual fuelwood consumption in the village (Puri et al. 2017). Second, the remittance sent by the migrated members to their family in village has increased the purchasing capacity of members to afford alternative energy sources like electricity, bio-gas and liquefied petroleum gases. Such cash flow into the village has facilitated the transformation of traditional farm-based economy to cash economy resulting reduced dependency on forest (Kanel et al. 2012; Shrestha and Fisher 2017). Third, grazing restrictions and a paucity of workforce to rear the livestock have forced households to reduce livestock numbers and replace them with few highly productive animals (Fox 2018). Finally, outmigration is greater among the educated household members who are less dependent on the forests due to alternative income sources (Adhikari et al. 2004). Nevertheless, current state of dependency on forest for fuelwood and timber has been perceived as an incentive to engage people in basic forest management operations.

4.2.2. Forest incomes and benefits

The rationale behind community forestry rests on the utilisation of forests and livelihood benefits to the forest dependent communities (Shrestha and McManus 2018). The perceived value of forest benefits at present and future is one of the prerequisites for securing long term engagement of local communities in forest management (Baynes et al. 2015; Coleman 2009; Pokharel 2012). However, our study indicates that the current level of incomes and benefits accrued from community forests are perceived as limited and insufficient to motivate people in forest management. Such perceptions affirm that community forestry has limited contribution to the livelihoods of forest users and that forest incomes varied greatly representing 3 - 29 percent of total household incomes (Chhetri et al. 2015; Malla et al. 2002; Meilby et al. 2014; Oli et al. 2016). This perceived value, however, does not account the indirect benefits like watershed conservation and land protection.

Timber is perceived as an important source of income but its production is restricted by the terrain conditions, forest quality, regulatory procedures and accessibility to road and markets. Timber harvesting in hilly terrain is complex and need to simultaneously address the terrain complexity, ecological consequences and economic limitation (Ezzatia et al. 2016). Such considerations effectively reduce the potential of forests to produce timber. In addition, the quantity and quality of timber depend on the forest types. The SCS forests are perceived as superior to SC forests for timber production. The timber potential of SC forests is perceived to be low due to the predominance of small sized and low quality trees. While forests constitute good proportion of various timber species, such perception is based largely on the availability of Sal timber and does not necessarily reflect the timber potential of forests.

Although forest products can be collected as prescribed in the operational plans, timber harvesting is controlled by forest offices by imposing a set of terms and conditions to be fulfilled before issuing harvesting permits (GoN 2015). It is a lengthy process and involves engagement of forest offices before acquiring harvesting permits and distribution of timber to the users. The process is further complicated if the timber is sold to outside users. Our results concur the arguments that ultimate decisions of forest product harvesting rests on the forest authority (Shrestha and McManus 2018). As a result, forest users often tend to limit the timber harvesting within the internal demand by allocating timber tree directly to the individual households. It is a strategy to avoid the complex process and reduce the transactional cost of timber harvesting.

The accessibility to road and market influence the incomes from the forests. It is consistent with the research finding that road accessibility increases the value of forest products and provides incentives for managing them to avoid over-exploitation (Agrawal 2001b). In contrast, other studies suggest that accessibility to the road and market can increase other employment opportunities and hence reduce reliance on forest and interests on its management (Baland and Platteau 1996; Charley et al. 2016). Risks aside, what is argued is that the accessibility to the road and markets can help forest users to optimize the forest management efforts in relation to the benefits accrued (Robinson et al. 2008). However, road accessibility in the community forests included in this study is very weak.

4.2.3. Low capacity of technical forest management

Forest management capacity is determined by the practical knowledge of silvicultural system and provision of technical services to assist in management operations. Forest users have successfully protected the forests but the capacity, knowledge, experience and interest to apply silvicultural systems is limited. Such limitation emanates from the conservative attitudes ingrained in the forest bureaucracy and forest users (Cedamon et al. 2017). Firstly, there is a lack of demonstrated results to showcase the benefits of applied silviculture in the community forests. Successful demonstration can motivate people to learn and imitate the practice in their own forest (Walter et al. 2005). Secondly, forest technicians, who facilitate community forestry, are less confident about the consequence of applied silvicultural systems on forest stock and flow of goods and other services (Shrestha and McManus 2018; Walter et al. 2005). Accordingly, forest technicians tend to prescribe conservative operational plans nurturing passive management (Yadav et al. 2009). Finally, it is pointed out that forest office and user groups lack finance and human resources to effectively execute the management strategies prescribed in the operational plans (Dhital et al. 2003; Toft et al. 2015). Technical assistance received from the forest offices were limited to prepare operational plans and monitoring of timber harvesting. This study identified that the technical capacity and experience of FUGs and forest technicians to apply silvicultural operations was the most important limiting factor to enhance forest management.

Overall, community forest management is influenced by multiple social and biophysical factors. Our results can be a generic model to evaluate the forest management in other parts of the country because the trends observed in our study sites represents the overall context of mid hill region of Nepal. Our results reinforce that economic benefits and incomes accrued from forests is the major determinant of community interests to enhance forest management (Charnley and Poe 2007; Gilmour 2016; Gilmour et al. 2004). However, community forestry is yet to be upgraded as the means of livelihood and economic development through forest based enterprising.

5. Conclusion and policy implications

The study presents the locally perceived factors influencing forest management strategies in the community forests of rural Nepal. The operational plans have stipulated a set of complementary management strategies and activities for the protection, management, development and utilization of community forest. However, the overall state of implementation of these activities is perceived as elementary and confined on basic operations of like bush clearing and removal of low quality trees to meet the local demands of fuelwood and timber.

The series of group discussions identified nine locally relevant factors and their influence in shaping motivation of forest user groups to enhance community forest management. These factors were linked under three primary factors, namely forest dependency, forest incomes and benefits, and technical capacity to manage forest. A perception-based method was employed to assess the influence of these factors on forest management. The study found that livelihood dependency on the forest has reduced due mainly to the outmigration of rural population, declining livestock holding and substitutes of forest products. The outmigration has caused labour scarcity for forestry operations and, due to the remittance, increased access to alternative energy source and construction materials. Similarly, the current flow of incomes and benefits is perceived as inadequate to motivate people for enhancing forest management. Timber is the major source of income but its production is restricted by terrain slopes, forest types and quality, lengthy and complex regulatory procedures and accessibility to road and markets condition. Further, technical competency of forest users and forest official is perceived as poor and inadequate to adopt silvicultural systems of forest management.

It is learnt that forest users can effectively identify social and biophysical factors that influence the circumstances, interests and priorities of forest management. It calls for two policy interventions. First, community forestry is not perceived as a means of income generation and wealth development. Such perception is rooted to the notion of managing forests for basic needs and provide low incentive and/or motivation to enhance forest management. Therefore, it is imperative that policies and practices are focussed on promoting enterprise-based forest management to create employment and incomes locally and beyond. Second, forest quality for timber production can be improved by manipulating forest structure. For this, forest development policies need to emphasize the collaborative action research on silviculture, which involves forest users and forestry officials, to experiment and demonstrate appropriate silvicultural systems.

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Chapter 7: Making Operational Plans relevant to the Forest User Groups in Mid-hills of Nepal

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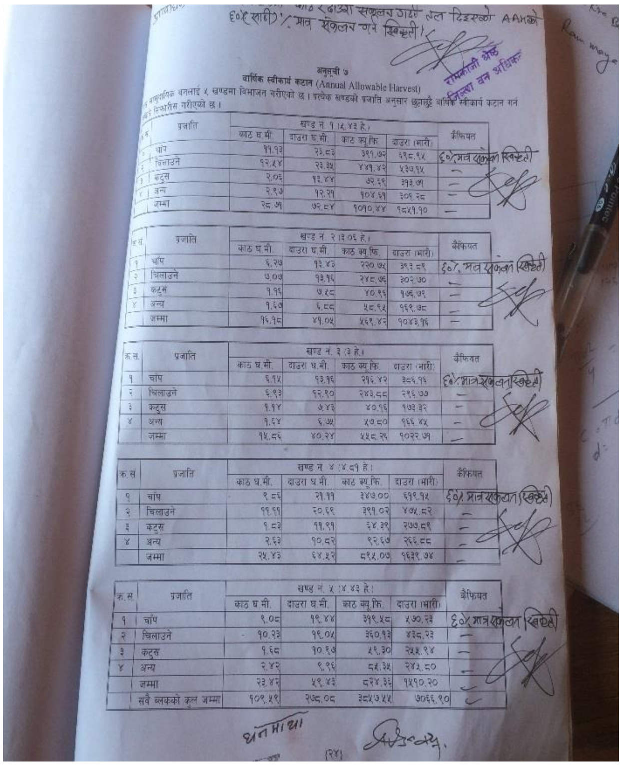

Operational plans (left) and it's content (annual harvesting) (right)

Statement of Authorship

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Contribution to the Paper	Collected field data; analysed and interpreted data; prepared manuscript and acted as first and corresponding authors		
Overall percentage (%)	80		
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By signing the Statement of Authorship, each author certifies that:

i. the candidate's stated contribution to the publication is accurate (as detailed above);
ii. permission is granted for the candidate in include the publication in the thesis; and
iii. the sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

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Signature		Date	16 / 08 / 2018

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Making Operational Plans relevant to the Forest User Groups in Mid-hills of Nepal

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Abstract

Operational plans are the key element in community forestry of Nepal. However, the relevancy of these plans to forest user groups (FUG) is under scrutiny. This study investigates the usefulness of operational plans against the backdrop of knowledge, capacity and management practices of FUGs. Data was collected from 13 operational plans, 14 group discussions including forestry professionals and 218 household interviews in two villages of Lamjung district. Whereas operational plans should specifically reflect site specific objectives and activities of forest management, the survey revealed identical objectives across the community forests. Current operational plans are technically complex, poorly linked to the place-based context of livelihood needs and less useful to the FUGs to enhance forest management. This study proposes to differentiate community forests according to their production potentials and revise current operational plans by removing the contents that have little or no relevance to the FUGs.

Keywords: operational plans, subsistence use, forest user groups (FUG), community forestry

1. Introduction

Community forestry is considered as an innovative policy of decentralized forest governance that intimately engages local communities in the management of forests on which they are dependent, with the expectation of enhancing forest conservation and users' livelihood. (Pokharel *et al.* 2007; Chen *et al.* 2013). There are diverse forms of community based forest management practices around the world that have emerged in different social, political, cultural and historical contexts with varying degree of devolved rights and responsibilities to the local communities (Charnley and Poe 2007). Among them, joint forest management, collaborative forest management and community forestry are in common. In Nepal, participatory approaches to forest conservation were formally introduced in 1978 to address rampant deforestation and degradation linked to the population growth and agricultural expansion (Gautam *et al.* 2004). However, the current form of community forestry proliferated only after the enactment of forest law and regulations during early 1990s. Specifically, Forest Act 1993 and Forest Regulations, 1995 provided legal foundation to handover accessible parts of the state forest to the local communities for sustainable management and utilization (DoF 1993; DoF 1995). The underlying purpose of these policies is to empower local communities and stakeholders to play greater roles in the forest conservation and community development.

Community forests are managed according to the management plan. The main aim of such plans is to introduce a system and procedures so that forests are sustainably managed and used. These plans provide guidelines for implementing different activities to achieve multiple social and ecological objectives of forest management (Bettinger *et al.* 2017). Whereas the context of forest management is diverse worldwide, management plans are often rooted to the early concepts of "forest working plans" that evolved in Germany during mid-nineteenth century with the primary objective of timber production (FAO 2004; Gilmour (undated)). These plans are prepared by professional foresters, rely on forest inventory data and guided by the technical standards set forth by government (Cronkletona *et al.* 2012). However, such plans and practices are increasingly receiving disapproval as the objectives of forest management have gradually shifted from timber production towards producing multiple goods and services (Hart 1995; Klooster and Masera 2000; FAO 2004). Further, such plans are found costly to produce, time consuming to get approval from concerned authority, and beyond the capacity of local communities to understand and follow (Pulhin *et al.* 2007; Thoms 2008; Cronkletona *et al.* 2012). In community-based forestry, forest management plans need to carefully reflect on the multiple objectives of production as well as the needs and capacities of local communities. It is important particularly in developing countries where community forestry is conceived mainly for enhancing livelihood of forest-based communities.

The empirical context of this study is the community forestry programme of Nepal. Under this programme, the power of forest management and utilization is devolved to the forest user groups (FUGs) to manage forests according to the constitution and operational plans. While the constitution defines the rights and responsibilities of FUGs, operational plans illustrate how forests are managed, developed and utilized (Thoms 2008; Lund *et al.* 2014). Each FUG elects an executive committee, called forest user committee (FUC) for the management and administration of forest operations. Crucially, forestry laws and regulations have provided FUCs greater power to make decisions regarding the management of their forest resources through collective efforts.

In Nepal, operational plans are approved by the District Forest Office (DFO[15]). The Forest Regulations (1995), and the community forestry development guidelines outline the general contents and processes of preparing operational plans (DoF 1995; DoF 2014). In principle, the plan is prepared by local communities with the technical assistance of the DFO. In contrast, the current practice of preparing operational plans is dominated by forest bureaucrats in shaping the overall objectives and activities of forest management (Ojha 2006; Rutt *et al.* 2014). As a result, the elements of timber-oriented management plans have been propagated into the operational plans of community forestry. Moreover, contemporary issues such as climate change and biodiversity conservation have influenced the Nepal's forest policies and strategies. This, in turn, has infiltrated the management objectives and plans of community forestry (Gilmour 2016; MFSC 2016). As a consequence, the language of operational plans are increasingly reflecting the higher-level political commitments to the environment without addressing the ground-level reality of FUGs.

Accordingly, there is a paucity of studies examining the practical relevance and value of these information-intensive operational plans to the FUGs that informs local forest management. Indeed, two studies (Rutt *et al.* 2014; Toft *et al.* 2015) recently questioned whether the technical content and inventory-based information of operational plans are adequate and relevant to the purpose of informing FUG's forest management decisions. There is clearly a need to make operational plans relevant to local communities that are simple to understand and linked to the livelihood practices of local communities (FAO 2004; NACRMLP 2006). For this, it is essential to gain an understanding of peoples' needs, aspiration and capacity to manage forests. The current study attempts to understand how community forestry practices and local communities interact through forest management planning. Moreover, it utilizes the knowledge and priorities of forest user groups to reflect on content and information supplied in the operational plans, and exemplify their relevance to the forest users. This study contributes to the ongoing debate on science and power in participatory forestry (Rutt *et al.* 2014).

[15] District Forest Office (DFO) is the district branch of Department of Forest (DoF)

In particular, this study examines the scope and relevance of operational plans in the context of existing need, capacity and practices of forest management in the mid hill region of Nepal. Even though operational plans include a broad range of content (e.g. including biodiversity conservation, climate change mitigation), the objectives and activities of forest management; types and condition of forest; and the supply and demand of forests products are the keys elements to frame entire plan. Therefore, this study is designed to elucidate the answers to the following three questions:

1) What are the objectives and activities of forest management stipulated in the operational plans?
2) How do FUGs understand, interpret and utilize the contents related to the forest condition and the supply and demand of forest products? and
3) What is the scope of current operational plans to mobilize community forest management?

The answers to the question (1) elucidate the FUG's knowledge on the objectives and activities of forest management mentioned in their operational plans. It examines whether forest management objectives represent the priorities for FUGs to manage forest. The answers to question (2) provide local understanding and interpretation of technical contents related to the forest condition and the supply and demand of forest products. The answers to question (3) indicate the general scope of operational plans in the current management practices in community forests. Overall, the answers to these questions provide impetus to make operational plans relevant to the knowledge and practice of forest management.

2. Methods

The study employs a qualitative approach to data collection and analysis. It draws on the fieldwork in Nalma and Taksar villages of Lamjung districts in the mid-hill region of Nepal **(Figure 1)**. It critically reviewed operational plans and policies, and undertook household interviews and a series of group discussions with FUG members, representatives of Federation of Community Forestry Users, Nepal (FECOFUN), DFO staff and forestry professionals.

2.1. Study area

Nalma and Taksar villages represent the typical rural communities with the populace dependent on agriculture and forest for their livelihoods. The community forestry was initiated since early 1990s in both villages. Until now, there are four community forests in Nalma and nine in Taksar. This study included all of these community forests and FUGs as the empirical context of this study.

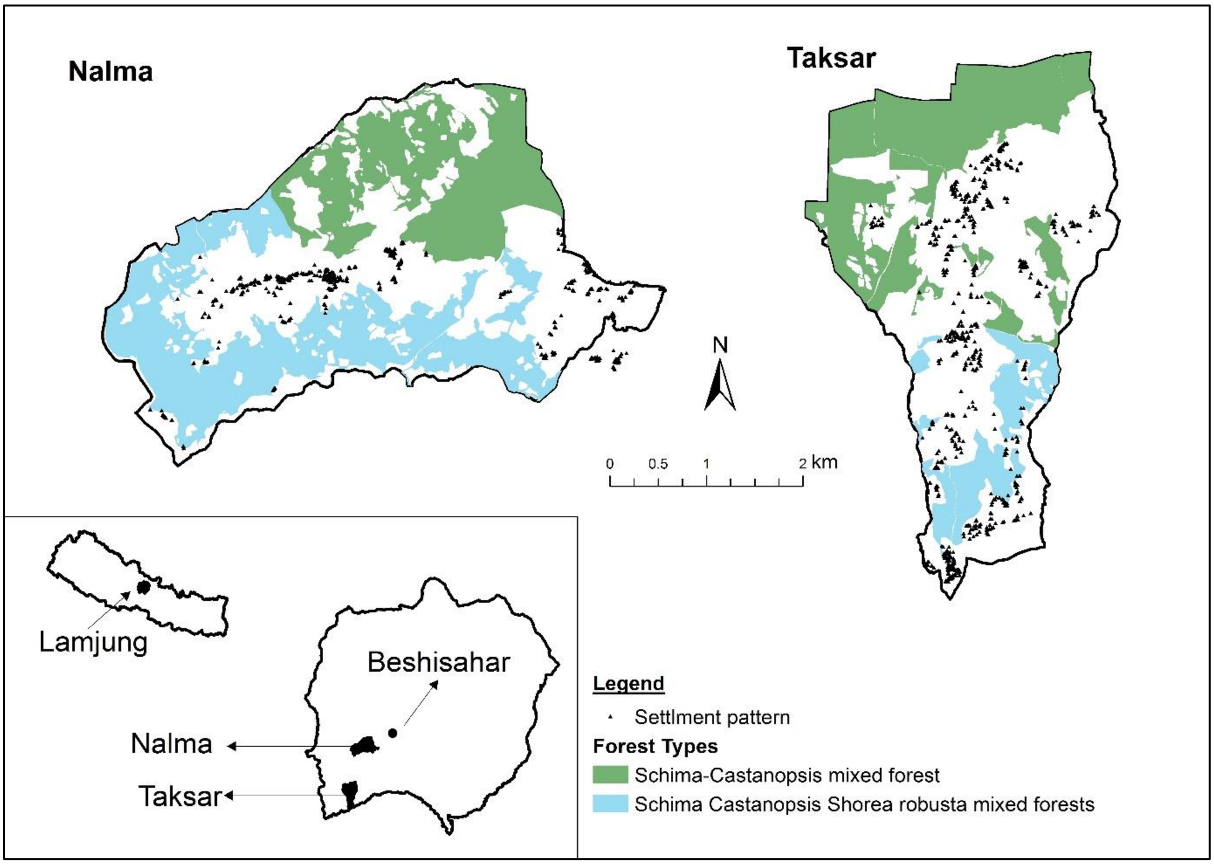

Figure 7: Map showing study sites in Lamjung district, Nepal

Nalma is located away from the road access and market centre. It is almost 20 km away from the largest town in the district (Besisahar) and connected by an unsealed, fair-weather road. The settlements in the village are confined along the ridge, surrounded by the forests and distributed within a narrow altitudinal range. The southern belt of Taksar is well connected by the road networks to the urban centres but the accessibility to the northern belt is poor. The settlements are densely distributed around the forests except in northern region where most of the forest is located in northern slopes while users are resided in the southern slopes.

The altitudes ranges from 567 meter to 1,700 metre above sea level in Nalma and 450 m to 1,420 metre above sea level in Taksar. The main vegetation types represented by the community forests are the natural mixed forest of Katus-Chilaune-Sal (*Schima wallichii-Castanopsis indica-Shorea robusta*) and Chilaune-Katus (*Schima wallichii -Castanopsis indica*), hereafter referred by SCS and SC forest respectively. The vegetation in lower altitudes are dominated by Sal (*Shorea robusta*) forests which is gradually replaced and dominated by Chilaune-Katus (*Schima wallichii-Castanopsis indica*) forests in both villages. A general description of community forests and their dominant uses is provided in the **Table 1.**

2.2. Data collection

2.2.1. Review of operational plans to assess the objectives and activities of forest management

The operational plans of 13 community forests were reviewed to examine the objectives of forest management, activities to be undertaken and links between them. For this, the objectives stipulated in the plans were listed and clumped into four themes as follows: sustainable forest management (protection, silvicultural operations and utilization); institutional development; biodiversity conservation; and adaptation and mitigation to climate change. Then, the planned activities affecting each thematic objective were grouped together.

Table 12: Description of community forests in Nalma and Taksar villages, Lamjung district

Community forests	Forest types	Forest area (ha)[a]	Major species	Dominant use
Nalma village				
Kagrodevi	SCS	62.55	*Schima wallichii, Castanopsis indica, Alnus nepalensis*	**†Fuelwood, †timber**
Khundrudevi	SC	158.43	*Schima wallichii, Castanopsis indica, Shorea robusta, Alnus nepalensis, Albizia spp.*	Fuelwood, timber
Langdihariyali	SCS	275.91	*Schima wallichii, Castanopsis indica, Shorea robusta*	Timber
Sunkot	SC	133.02	*Schima wallichii, Castanopsis indica, Shorea robusta*	Fuelwood
Taksar village				
Adherikhola	SC	31.36	*Schima wallichii, Castanopsis indica*	Fuelwood
Bholdada	SC	16.62	*Schima wallichii, Castanopsis indica*	Fuelwood, poles
Jamuna-Gahira	SC	20.73	*Schima wallichii, Castanopsis indica, Michelia champaca*	Fuelwood
Lampata	SCS	84.27	*Shorea robusta, Schima wallichii, Castanopsis indica*	Fuelwood, timber
Nag Bhairab	SC	58.42	*Shorea robusta, Schima wallichii, Castanopsis indica,*	Fuelwood
Pisti	SC	110.86	*Schima wallichii, Castanopsis indica, Michelia. champaca,*	Fuelwood, †timber
Samkhoria	SC	35.31	*Schima wallichii, Castanopsis indica, Michelia champaca*	Fuelwood
Sathimure	SCS	30.05	*Shorea robusta, Schima wallichii, Castanopsis indica*	Fuelwood, timber
Tamakhani	SC	13.23	*Schima wallichii, Castanopsis indica, Lagerstroemia parviflora*	Fuelwood, poles

[a]The forest area obtained from operational plans, [b]Total number of households registered as forest user groups. SC = *Schima- Castanopsis indica* forests, SCS = *Schima- Castanopsis indica -Shorea robusta* forests.

2.2.2. Group discussions

Group discussions were organized to elucidate the answers to the questions outlined above. These discussions were organized at two levels: one at individual FUG and next at village level.

The meeting at FUG level was participated by 5-6 persons representing current and former executive committees. These discussions aimed to answer research questions (1) and (2).

Following a FUG level meeting, two village level discussions, one in each village, were organized. These discussions were participated by 6-10 persons representing each community forest of the village, DFO/LFO staff, FECOFUN representatives and school teachers as key informants. These discussions focussed on answering research question (3) on the general trend, observation and scope of operational plans to manage forests. As the participants differed in their opinions over the questions discussed, the central ideas were narrated in consensus and keywords expressed during the discussion were noted for further elaboration and analysis.
A group of forestry professionals were invited for a meeting at the Nepal Foresters' Association (NFA) office at Kathmandu. The meeting was participated by 8-10 forestry professionals with expertise in community forest implementation in different region of the country. The main aim of the meeting was to explore the opinion and hands-on experiences of planning and implementing process of community forestry from national perspectives. The meeting further elaborated the answer to question (3) with the broader experience of community forestry in the country. The discussion critically identified the scope of current operational plans in the context of forest management activities observed in the hill regions. In addition, key informant interviews were made with 5 forest officials directly involved in community forests of the study sites. Such information was used to substantiate as well as triangulate the results obtained from group discussions.

2.2.3. Household interviews

Interviews with the FUG households were conducted to elucidate basic information mainly in two aspects: objectives of membership in FUG and state of forest product (fuelwood and timber) supply. For this, a semi-structured questionnaire with a list of objectives, which were identified during group discussion, was administered and asked the respondents to rank the three most important objectives, in the order of 1-3, for joining FUGs. The frequencies of each objective were derived and compared between two villages and the results from group discussion. For forest product use, the households were asked whether they obtained fuelwood in the year (of survey, i.e. 2015) and the timber during last 5- year (2011-2015) period. The percentage of households receiving fuelwood and timber was calculated and the reasons for not receiving timber were explored. The households included in the interview were randomly selected from the list of the households of forest users in each village. Altogether, 110 and 108 households from Nalma and Taksar villages respectively participated in the interview. The households represented all community forests proportionate to their user group size in both villages. This information was used to substantiate and elaborate the information obtained from group discussion.

3. Results

3.1. Forest management objectives and activities derived from operational plans

Table 2 provides an overview of objectives and activities provided in the operational plans. The table reveals a range of objectives including sustainable forest management, biodiversity conservation, institutional development and climate change mitigation. Each objective is supported by a number of activities as outlined in the table. The objectives stipulated in the operational plans are, however, complementary to each other and the activities outlined can affect one or more objectives simultaneously. For instance, while sustainable forest management can contribute to biodiversity conservation and climate change mitigation, other activities like fire and grazing control can benefit biodiversity conservation and carbon sequestration.

The activities relating to biodiversity conservation and climate change mitigation have received substantial space in the current operational plans. For example, the size of the operational plans ranged from 45-55 pages divided into 6-8 section including annexes. Of the total pages, 31 percent presented forest management activities and 25 percent described activities relating to biodiversity conservation and climate change adaptation and mitigation. The introduction section occupied 10 percent of operational plans to describe forest characteristics, achievement of previous operational plans and management objectives. It indicates that major portion of OP is devoted to climate change and mitigation stories from global, regional and local context. The sectoral strategies for climate change are also included. The OP lacks important information on how forest people relationship is changing and to influence forest management. Moreover, it was notable that the operational plans included in this study presented an identical set of objectives and activities of forest management.

Table 13: Objectives and activities of forest management derived from operational plans

Objectives	Planned activities
SFM-Protection	• Protection from grazing, fire and encroachment • Patrolling, surveillance and awareness campaign • Fines and penalties to trespassers
SFM-Silvicultural operations	• Forest blocking for annual silvicultural operations adopting thinning and pruning guidelines • Stand improvement by removing undesired species, bushes and 3D trees[1] • Promote natural regeneration of native and multipurpose species
SFM-Utilization	• Forest stock assessment (density, growing stock etc.) • Regulate forest product harvesting as per AAH[2] • Provide forest product in emergency cases and community development • Promote forest-based enterprises including ecotourism • Initiate commercial farming of valuable NTFPs[3]
Institutional development	• Graduated pricing of forest products for different wealth classes • Manage community funds for forest development, pro-poor IGAs[4] and community development including land leasing to poor groups • Encourage participation, including women, in forest management activities
†Biodiversity conservation	• Identify and list native species and establish arboretum • Protect forest from fire, grazing, encroachment etc. • Conserve wildlife habitats like den, snag, waterholes, burrows etc. • Provision of compensation to the losses due to wild animals • Control and/or remove invasive species • Awareness generations for biodiversity conservation
†Adaptation and mitigation to climate change	• Prepare and implement adaptation and mitigation plans • Enhance carbon sequestration† • Promote plantation and agroforestry programme • Control forest loss from encroachment and fire • Introduce climate change resistant operational plans • Sectoral programmes to address climate change impacts

[1]3D trees: Dead, Diseased and Deformed trees; [2]Annual Allowable Harvesting quantity, [3]Non-timber forest products, [4]Income Generation Activities, † Included as long term objectives, SFM: sustainable forest management

3.2. Group discussions

The results of group discussion are organized in accordance to the questions asked. The results from household interviews elaborate the opinions expressed in the discussions.

1. What are the objectives and activities of forest management stipulated in the operational plans?

The number of FUGs mentioning different objectives of forest management are presented in the **Table 4.** The table reveals that forest protection was the main objective across the community forests followed by the easy access to forest products and the security of traditional rights over forests. Out of 13 FUGs, 9 mentioned that community forestry reinstated traditional rights over the forests and it was most prevalent among the FUGs of SC forests. In contrast, FUGs of SCS forests emphasized on objectives related to the subsidized price of forest products, fund generation and the regulation of timber harvesting. Biodiversity conservation, scientific forest management and income generation were the least stated objectives across the community forests. The FUGs in Lampata community forest reported scientific forest management as one the objectives because there was a research programme on silvicultural systems in collaboration with the EnLiFT[16] project.

Table 14: The objectives of community forest management derived from group discussions

Main objectives	Number of community forests stating the objective in		
	SC forests [9]	SCS forests [4]	Total [13]
Forest protection	8	3	12
Easy access to forest products	8	2	10
Claiming traditional rights over forests	8	1	9
Subsidized price of forest products	2	4	6
Fund generation from timber sale	2	3	5
Regulate timber harvesting and supply	2	3	5
Land protection from erosion/landslides	2	2	4
Income generation activities for poor families	-	2	2
Scientific forest management	-	1	1
Biodiversity conservation		1	1

SC = *Schima-Castanopsis* forests, SCS = *Schima-Castanopsis-Shorea robusta* forests. The numbers in square brackets indicate the number of community forests.

[16] Enhancing Livelihood and Food Security from Agroforestry and Community Forestry (EnLiFT) projects under financial support of Australian Centre for International Agricultural Research (ACIAR)

Likewise, individual households expressed a number of reasons for joining FUGs. **Table 4** presents the percentage of respondents stating different reasons. It reveals that 51 percent in Nalma and 46 percent in Taksar joined FUG to access forest products in subsidized prices. It followed by the respondents who sought increased access to forests products (19%). Similarly, 12 percent respondents in Nalma and 9 percent in Taksar joined FUG to claim and retain traditional right over the forests.

Table 15: Expressed reasons for joining community forest user groups (first reason only)

Reasons	Nalma (110)[1]	Taksar (108)[1]
Subsidised prices of forest products	51	46
Access to forest products increases	19	42
Claiming rights over forests	12	9
Demanded by forest officials/villagers	10	0
Other benefits like training	4	1
Social prestige and identity	4	0
No special reasons to join FUG	1	2

[1]number of household interviewed. The number in the table represent the percentage of respondents to state the reason.

In addition to management objectives, FUG members identified a narrow range of forest management activities as provided in the **Table 5.** The table clearly revealed that '*godmel*' - a locally used term to represent activities of bush cutting, fuelwood collection and thinning-pruning operations- and '*sanrakshan*'- a generic term that includes protection from fire, theft and encroachment- were two common activities popularly known to FUG members. Timber harvesting activity ranged from regular (like in most of SCS forests) to low and sporadic (like in most of SC forests). Other activities reported were: plantation of income generating plants like broom grass (*Thysanolaena latifolia*) and waterhole conservation for biodiversity conservation.

Table 16: Forest management activities derived from group discussion

Management activities	Number of Community forests stating the activity		
	SC forests [9]	SCS forests [4]	Total
Godmel operations: bush cutting, pruning and thinning	9	4	13
Sanrakshan operations: protection from theft, grazing, fire and encroachment	9	4	13
Timber harvesting: regular and sporadic harvesting to meet local needs	4	3	7
Plantation: broom grass and fodder trees as income generation	1	2	3
Waterhole conservation for biodiversity	-	1	1

SC = *Schima-Castanopsis* forests, SCS = *Schima-Castanopsis-Shorea robusta* forests. The numbers in square brackets indicate the number of community forests.

To enable the understanding of process to draw forest management objectives and activities, FUG members mentioned following expression in common: Each quote hereafter ends with its [reference].

"*Generally, objectives are proposed by the forestry staff and we follow them. We do not remember any discussion related to it in our community. According to them [forestry staff] the standard objectives and management activities are mentioned in the book [operational plan] and we should abide by them [1.1]"*

A deviation to this [1.1] view was observed in Sathimure and Lampata community forests. The FUGs recalled a meeting held with forestry staff that discussed, among others, the objectives of FUG to manage forests. However, the groups were not fully aware of all the objectives inserted in the operational plans.

Likewise, FUG expressed following regarding the extent of different management activities in their forests:

"Operational plans have outlined many activities. However, it is beyond our capacity to carry out these activities in the forest and its blocks. We do 'godmel' operations annually in small parts, mostly in convenient locations of the forests, to obtain fuelwood [1.2]"

Overall, the discussion on the question revealed that FUG members held limited knowledge of objectives and activities of forest management and the process of drawing them in the operational plans.

2. How do forest user groups understand, interpret and utilize the contents related to the forest condition and the supply and demand of forest products to manage forests?

The responses to this question are provided in the **Table 6**. The table reveals the knowledge of FUG members about the technical content of the operational plans varies across the community forests. The operational plans included annual demand quantity mainly for fuelwood and timber, but FUGs were not fully aware of this information. According to FUGs, demand information may be the requirement of operational plans but it does not necessarily represent what is consumed by the households. Out of 13, nine expressed that timber demand was negligible in the community forests and two indicated that the demand was higher than prescribed quantity.

Regarding the content related to forest stock, FUGs univocally expressed their inability to understand and interpret the numbers supplied in the operational plans. Out of 13, seven FUGs mentioned that forest stock data was derived from forest inventory to describe forest condition, but eight FUGs expressed that forest stock data of operational plans is hardly used to describe forest by local communities.

In contrast, FUGs expressed better knowledge on information related to annual allowable harvest (AAH), In general, FUGs perceived that AAH is the maximum quantity of forest products that can be harvested annually and that it is applicable to timber only. Out of 13 FUGs, seven expressed that AAH was not relevant to them because timber harvesting was either non-existent, low or sporadic from the respective community forests. The AAH for fuelwood was found less useful because FUGs obtained fuelwood either or both by participating in *godmel* operations in forests or from private lands. Overall, FUGs were aware of AAH of timber as the key information of the operational plans.

Table 17: User groups' knowledge on forest product demand, supply and forest stock specified in operational plans.

Related OP information	State of knowledge and interpretation	Forest Types	
		SC [9]	SCS [4]
Forest product demand	• No ideas about how this information was derived and included in OP	4	3
	• It may the requirement of OP but it hardly represent what we consume. It should be an indicative only	8	2
	We have negligible timber demand from our forests	7	2
	Timber demand is higher than specified in the operational plans	2	2
Forest stock	• It is all numeric and we don't know about it	9	4
	• It was derived from forest inventory to describe our forests	4	3
	• It should be about the condition of our forest we don't use these tables to describe our forests.	6	2
Annual allowable harvest	• Fuelwood is obtained from 'godmel' operations and the quantity is regulated by area not by pre-defined quantity. So it is not relevant to fuelwood collection.	7	3
	• Fuelwood is obtained mostly from private lands and this information is not useful for us	7	2
	• It is the maximum quantity of timber to extract annually and we should not exceed this quantity	4	3
	• Our timber harvesting is low and sporadic, so this information is not very useful to us	4	2
	• We don't need to know because we don't harvest timber	3	-

OP: Operational Plan, SC = *Schima-Castanopsis* forests, SCS = *Schima-Castanopsis-Shorea robusta* forests. The numbers in square brackets indicate the number of community forests in that category and the maximum possible number in each cell

Regarding forest product demands, the FUGs expressed the following opinion in common:

"*We don't know how demand information was derived in the operational plan. Fuelwood and timber are collected from private land and community forests but their demand has reduced due to the increasing use of alternative sources like Liquefied Petroleum (LP) gas, electricity and biogas. The fuelwood from community forests depends on the area we cover in "godmel" operations. Timber demand is generally low in our community forests because trend of new* *house construction is almost nil. Users prefer Sal (Shorea robusta) timber instead of what is available in our (SC) forests [2.1]".*

A variation to this opinion was expressed in Lampata. At the time of revising operational plan, DFO staff provided a form to collect households' demands for timber, fuelwood and agricultural implements. The data was handed over to the DFO staff. The FUG members reported that households tend to overestimate forest product demand so that future demands can be made in that reference. Similarly, FUG members of SCS forests in Taksar expressed that timber demands was on an increasing trend but the current supply was insufficient. In both villages, SCS forests are the source Sal (*Shorea robusta*) timber to the FUG members of neighbouring community forests.

The opinions related to timber demand and use [2.1] resonate with the results obtained from household interviews. Out of total households interviewed, 20 percent in Nalma and 27 percent in Taksar received timber from their own community forests during a five-year period. The households who did not obtain timber during this period expressed multiple reasons as presented in the **Table 7**. For example, 75 percent in Nalma and 39 percent in Taksar stated they had not need of timber during the period. Similarly, 24 percent in Nalma and 34 percent in Taksar obtained timber from private lands. Unlike in Nalma, 24 percent of the total households in Taksar applied for, but did not receive, timber from SCS forests during the period. In SC forests, the proportion of households receiving timber from other community forests was 20 percent in Taksar and 4 percent in Nalma. Likewise, 63 percent of respondents in Nalma and 44 percent in Taksar collected fuelwood from community forests.

Table 18: The frequency of reasons for not using timber during five-year period

	Nalma [88][1]			Taksar [79][1]		
Stated reasons	SC	SCS	Total	SC	SCS	Total
Applied but not received	0	0	0	0	24	16
Inferior quality of timber	0	0	0	4	0	2
Obtained from private lands	33	20	24	44	30	34
Obtained from other forest	4	0	1	20	0	6
Timber was not needed	63	80	75	32	42	39
Unable to afford for timber	0	0	0	0	4	3

[1]Number of households who had not received timber during 5-year period (2010-2015)

The knowledge on the content related to the forest stock was similar among the FUG members. The FUGs further elaborated the usefulness of forest stock data as follow:

"The operational plan described our forest in number and we don't understand it. We know what is happening where and we can easily identify the places with good and bad condition. We know that forest inventory was not conducted in all parts of forests during the preparation of operational plan [2.2]'

The discussions revealed that FUGs have not gone through the content of operational plan. In addition, the response below signify the relevance and usefulness of operational plans in SC forests:

"*The operational plan, with the official seal on it, is a legal document that retains and guarantees our rights over forests. It illustrates the technical specification of forest management. However, we mostly conduct godmel only and do it based on our own experience. So, we don't need to read and follow the operational plans [2.3]"*

Overall, FUG members retained varying level of knowledge on the technical content related to the forest stock, AAH and forest product demands provided in the operational plans.

3. What is the scope of current operational plans to inform community forest management?

This question was presented to the village level discussions as well as to a group of forestry professionals. The responses to this question elaborated the scope of operational plans in the context of local forest management practices. In the village meetings, participants reported that SC forest were managed mainly for subsistence use and SCS forests were the main source of timber in both villages. However, the meeting indicated that operational plans were not considerate to such differences, which was expressed as:

"Community forests vary greatly in their potential to produce timber, as do forest users in their capacity to manage these forests. However, operational plans often present identical objectives and activities to manage these forests [3.1]"

The meetings further highlighted that operational plans have stipulated objectives and activities that are not directly connected to the livelihood priority of FUGs and mentioned:

"There are myriad of objectives and activities included in the operational plans but many of these are introduced by the agencies preparing the plans and are weakly linked to the capacity and livelihood needs of user groups. The objectives related to biodiversity conservation and climate change are not at the local priority but they can be achieved concurrently when forest is conserved. Such objectives surpass the scope of individual community forests and need regional intervention [3.2]"

The meetings acknowledged the decreasing dependency on forests and its consequences on forest management as follows:

"*Forest users are less interested to participate in forest management activities due to the increasing out-migration and presence of alternatives to construction materials and household energy. As a result, forest management is limited to 'godmel' operations to obtain fuelwood and, sometime, small timbers. However, operational plans are not informed by the changing interests and priorities of FUGs to manage forests [3.3]"*

The key message of this quote resembles to the [2.1] above and indicates that operational plans do not reflect to the changing context of forest people relationships in the rural villages. Current operational plans have not articulated the existence and influence of alternative energy sources while deriving the objectives of forest management.

The meetings pointed out that the relevance of operational plans rely on the practice of forest management. It was expressed as:

"*For forest office, the operational plans may be comprehensive for its technical content. It may be useful to the FUG harvesting timber like in SCS forests. For FUGs managing forest for subsistence use only like in SC forests, the operational plans are hardly more than a pile of information with little or negligible practical relevance to manage forests [3.4]"*

This quote and below implicitly suggest to the need of shortening the contents in operational plans to make them relevant to management needs:

"*On one hand, DFOs are unable to extend technical assistance to implement forest management and, on the other hand, they allocate resources to generate information that has little relevance to the forest user groups. Moreover, the need of revising operational plans in five year period has hardly added any value but most often repeated the same contents. So, it is possible to revise operational plans in 10-15 years [3.5]"*

In a meeting with forestry professionals, it was agreed that the objectives of forest management are expanding, and the information supplied in the operational plans are expanding. There was consensus that the technical content of the operational plans was less useful to inform management practices in the mid hills regions of the country. Likewise, it was acknowledged that livelihood dependency on forest has decreased in the remote communities reducing the motivation to enhance forest management. The meeting highlighted the consequence of out-migration and flow of remittance to influence forest management activities. While stating the scope of operational plans, the meeting resonate the views and opinions expressed as in [3.3] and [3.4] of village meetings. The meeting expressed:

"Forest management practices vary greatly across the country according to the forest types and the nature of livelihood dependency of local communities. However, forests officials often continue to provide identical set of prescription without considering local problems and opportunities of forest management. To be realistic, we have to categorize forest user groups according to the intensity of forest management and support required. The content of operational plans for subsistence management [like SC forests] can be shortened to include basic information of forest and its simple management operations only and additional content can be included in operational plans for intensive forest management including timber harvesting [like SCS forests] [3.6]".

This expression clearly indicates that basic form of operational plans is adequate to manage forest for subsistence use. The suggested contents of basic operational plans are the names, address, area, types and condition of the forests and the elementary management activities like *godmel* operations.

These discussions revealed that current operational plans are information-intensive, but they are not well understood and used by FUGs. The opinions of forest users and forestry professionals indicated a need of recalibrating the current operational plans to include the contents that are relevant to user groups, easy to understand and enable forest users in management decisions.

4. Discussion

Overall, the results can be summarized and discussed as follows. The operational plans of community forests revealed a wide range of objectives and activities of forest management including sustainable forest management; institutional development; biodiversity conservation; and climate change mitigation and adaptation. Among these objectives, operational plans have elaborated the procedures and methods of forest management as the major component of the plans. However, current operational plans included in this study presented identical objectives and activities across the community forests. Even though socio-economic and biophysical context of forest user groups vary, operational plans appeared poorly reflected on those place-based contexts of forest management.

The FUGs have a different, yet simple, set of objectives to manage forests. The most important objectives were: forest protection, increased access to forest products and claiming traditional rights over forests. These are some of the underpinning factors of community forest management to secure tenure rights over forest and its resources throughout the world (Pagdee *et al.* 2006; Yin *et al.* 2016). It is notable that one of the objectives to engage in community forestry is to reinstate traditional rights over the forests. This objective was prevalent mostly among the FUGs of SC forests who were managing forest mainly for subsistence use.

The objectives related to biodiversity conservation and climate change were not identified as important by the local communities, but the activities related to them were substantially elaborated in current operational plans. These objectives were not in the priority of FUGs nor could they be achieved by the individual community forests. Such incongruences of priority objectives between FUGs and operational plans arise due to the lack of attempts to engage local communities while drawing these objectives and activities of forest management (FAO 2004). It appears that the set of objectives and activities are proposed by the DFO staff directly from national policy documents without customizing them to fit in the place-based context of local communities.

Further, there was apparent difference of prioritized objectives between individual and collective forest management situation. Unlike FUGs priorities, individual households prioritized usufruct rights such as subsidized prices of forest products, followed by the increased access to forest products and rights over forests. It is one of the common features that forest dependent communities organize themselves to produce and access goods and services collectively which is practically impossible to do so by individual members (Wade 1987).

Likewise, FUGs re-iterated a narrow range of management activities in their forests. Despite an extensive list of activities outlined in the operational plans, '*sanrakshan'* (forest protection from theft, grazing, fire and encroachment) and '*godmel*' (simple thinning, pruning and bush cutting operations) were the predominant practices of forest management in the community forests. Such a rudimentary form of forest management is not peculiar to the community forests included in this study, but it is the commonly reported phenomena from other parts of the country (Ojha 2001; Yadav *et al.* 2003; Yadav *et al.* 2009; Cedamon *et al.* 2017). It indicates that these management practices are at the best that FUGs can perform to obtain fuelwood and timber.

Forest users' knowledge about the technical content of operational plans, such as forest product demand and forest stock, was limited or non-existent. Nevertheless, FUGs consider that this information may be the requirement of the operational plans. Consequently, instead of using forest stock data of operational plans, forest users were confident to employ their own experience, knowledge and observations to describe forest condition. Such perceived assessment can yield comparable results as of standard methods to assess forest condition (Agrawal and Chhatre 2006; Lund *et al.* 2010). In contrast, FUG members held better knowledge on the AAH of forest products. However, there was general impression that AAH is applied to timber harvesting only. The AAH for fuelwood was found irrelevant because its annual supply relies on the area of *godmel* operations and most of the households derive fuelwood from the private lands.

These results corroborate the studies from other countries that the information included in the operational plans are often predefined by the government law, legislation and technical standards regardless of their actual relevance to the users to manage forests (FAO 2004; Pulhin *et al.* 2007; Cronkletona *et al.* 2012). As a result, forest users find them difficult to understand

and tend to ignore the information that has no direct bearing to the forest management practices and livelihood requirements. The results related to the users' knowledge on the content of operational plans corresponds to other studies in Nepal that have questioned the practical relevance of technical information provided in the operational plans (Rutt *et al.* 2014; Toft *et al.* 2015).

The operational plans of Nepal are considered too technical and resource intensive; reflect low quality participation; and have limited focus on forest-dependent poor who show poor understanding of the plans. This is not exceptional in that similar faults are observed in other countries, such as the Philippines, India, Guatemala and Bolivia (FAO 2004; Pulhin *et al.* 2007; Cronkletona *et al.* 2012). In these countries, forest management operational plans focus on timber harvest. In Nepal, operational plans are designed mainly for the subsistence use of forest products, but forest users are unable to implement the technical operational plans even for this function. These operational plans do not even accurately represent forest product supply and local communities' consumption patterns (Puri *et al.* 2017), so even if they could be put into effect, they would not have the desired result on forest ecological integrity and livelihood needs. The operational plan is revised in each five-year period, but the value added with the new operational plan is perceived to be negligible to enhance forest management.

This study emphasizes that operational plans and policies underlying them should facilitate, rather than constrain, FUGs to manage forests. As community forests are managed mostly by poor and women, who are often illiterate, the plans should be simple; cost effective; easy to understand and implement; and linked to the livelihood priority and capacity of local communities (FAO 2004; NACRMLP 2006; Giri and Darnhofer 2010). However, current operational plans in Nepal are neither simple nor linked to the need of FUGs. For example, there is growing body of knowledge that rural outmigration, substitutes of forest products and flow of cash incomes have transformed the context of user groups to manage forests (Giri and Darnhofer 2010; Paudel *et al.* 2014; Jaquet *et al.* 2015; Jaquet *et al.* 2016; Fox 2018) but the operational plans are poorly informed by the trends of such transformation and continued as if they are operating in isolation.

The lack of human and financial resources in the forest offices are often quoted as the underlying reasons for their inability to provide technical supports to the user groups to manage forests (Dhital *et al.* 2003). Paradoxically, whatever limited resources available are being allocated to generate information that is not understood or utilized by the forest users. Furthermore, despite continued emphasis on technical operational plans, there is no empirical evidence that these plans either guarantee or enhance technical forest management.

Nevertheless, forest users were cautious in their dismissal of the value of operational plans. These plans serve as the legal document to secure the rights and ownership of local communities over the forests. The operational plan is considered as symbolic of the ownership of community forestry, rather than a device to synergize the needs, aspirations and capacities of local communities.

This study calls for the revising the content of operational plans to make them relevant to the FUGs. The revision should emphasize the participation of illiterate and marginal groups who are dependent on the forest but do not understand technical explanation provided in the operational plans. The Forestry Sector Strategy of Nepal has proposed to categorize FUGs according to their production potential and support needed (MFSC 2016). To this effect, FUGs can be categorized as *subsistence* and *production* users considering their potential to produce timber. For *subsistence* users, like SC forests, simple operational plans can be drawn with basic information on forest (like area, location, types), simple objectives (like forest protection from theft, fire etc.) and management procedure including "*godmel*" operations. Considering low management intervention, the operational plans can be revised in the period of 10-15 years. The condition of these forests can be assessed by using national forest data combined with participatory methods. For *production* users, like SCS forests, present day operational plans may be applicable provided that objectives and activities are reframed taking into account of site-specific problems and opportunities of forest management. For these forests, simple forest inventory supported by participatory assessment can be applied to assess forest conditions and determine the annual quantity of tree harvesting. It implies that existing operational plans can be completely revised to meet the requirements of FUG groups to manage forests. In the revision process, it is imperative that poor and marginal groups participate and contribute for collective action and institutional development.

Likewise, the objectives and activities related to biodiversity conservation, climate change and numerical details of forest stock can be removed without compromising the relevance of operational plans to the forest users. This can substantially reduce the current size of the operational plans with content that are generated with, understood by and relevant to the local communities. Such place-based operational plans enhance the adaptability of the plans to the realities of local communities and avoid one-size-fit-all application across the country (Chen *et al.* 2013).

5. Conclusions

This study examined the relevance of operational plans to the FUGs in the mid hill region of Nepal. In particular, it assessed the FUG's knowledge on, and relevancy of, information related to the objectives and activities of forest management, condition of forest and forest product supply and demand to inform forest management decisions.

The operational plans revealed a broad spectrum of objectives and activities related to the sustainable forest management; institutional development; biodiversity conservation; and climate change adaptation and mitigation. However, these objectives and activities are identical across the community forests. This indicates that operational plans are poorly linked to the local needs and opportunities of forest management. Likewise, the *godmel*- which include bush cutting and basic thinning pruning operations- and *sanrakshan*- which include forest protection from theft, grazing and fire- are the two most popular activities practised by the FUGs. Similarly, FUG's knowledge on the technical content of the operational plans was either non-existent or limited to selected information. In contrast, the knowledge of AAH is better among the FUGs involved in timber harvesting.

There is general consensus from local FUGs and the forestry professionals that the current operational plans are too technical, complex to understand by illiterate rural communities, costly to produce, poorly connected to local context and, hence, less useful to the local communities to inform management decisions. Despite technical operational plans at hand, FUGs continue with the basic management operations that fit to their current capacity and livelihood needs. The operational plan has emerged as the symbol of ownership rather than a device to synergize the priority and capacity of people and forests.

Hence, this study calls for the revision of current operational plans to make them user friendly with content that are relevant to the FUGs to manage forest. For FUGs managing forest for *subsistence* use, a simple operational plan with limited information on forest characteristics and management activities is proposed. For *production* potential forests, current operational plans can be revised to draw site-specific objectives and activities. These operational plans should have the contents that are directly linked to the management need and relevant to the capacity of FUGs. Such operational plans can be adapted to the varying context of FUGs to manage forests.

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Chapter 8: Discussion, conclusions and policy implications

8.1. Overview of discussions

This chapter links the findings of the research to the current literature and integrates them to provide a broader picture of community-based forest management. It ends with some policy implications to improve the practice of community forestry in the mid hills of Nepal.

The overall aim of this study has been to contribute towards better design of operational plans so they can optimize forest management and utilization practices. The research aim has been achieved by three specific objectives and four research questions. The study is guided by the conceptual framework to approach each of the research objectives. The framework integrates various social (user group characteristics, forest dependency, and perception/knowledge), biophysical (forest characteristics and topography including accessibility) and institutional (regulatory policies) factors influencing the practices of forest management and utilization planning. The study provides a deeper understanding of current contexts and issues underlying community forest management and emphasizes on the need of linking forest management strategies with the livelihood promotion of forest dependent communities.

8.2. The extent to which operational plans are suboptimal to manage and utilize forests.

This objective has been split into two parts. At first, it assesses the adequacy of operational plans to represent the consumption and supply of forest products. Taking fuelwood as the case, it examines the integrity of operational plans to capture livelihood dependency of local communities on forests. Second, it assesses the efficacy of operational plans to regulate the forest management and utilization. Taking wood extraction as the case, it evaluates how forest management and utilization is spatially regulated across the forests.

8.2.1. Adequacy of operational plans to estimate the consumption and supply of fuelwood

The operational plans describe how community forests are managed and utilized by the user groups. Therefore, information on demand and supply of forest products is critical to derive forest management and utilization objectives in community forestry. In rural communities, fuelwood is one of the major forest products that people obtain from community forests (Kandel et al. 2016). In addition, private lands are emerging as the source of fuelwood to the rural communities (Manandhar & Shin 2013; Puri, Nuberg & Ostendorf). Other studies have indicated an increasing use of alternative energy sources by the rural household (Kanel et al. 2012; Link, Axinn & Ghimire 2012). It clearly indicates that fuelwood is not the *only* source of energy for rural households. In rural communities, richer households tend to use less fuelwood and more alternatives energy sources (like LP gas, biogas and electricity) compared to poorer families. The finding contradicts with other studies which have reported that poorer households depend more on fuelwood for domestic consumption (Adhikari, Falco & Lovett 2004; Kandel et al. 2016)

In this research, operational plans are found inadequate and suboptimal to represent the consumption and supply patterns of fuelwood in the community forestry. Even though operational plans have specified the quantity of annual demand and supply of fuelwood, these quantities are usually well below the standard variations of estimated annual consumption and supply of fuelwood obtained from household interviews and forest resource assessment. In addition, the contribution of community forests to the total fuelwood consumption ranged from 57 percent to 63 percent among the forest user groups (Puri, Nuberg & Ostendorf 2017). It implies that community forests are not the *only* source of fuelwood in the rural communities. Tree resources grown in private lands and other common spaces have emerged as potential source of fuelwood for domestic consumption (FAO 2000; Kandel et al. 2016). Tree products obtained from off-forest resources can be an important factor to determine forest dependency of rural communities and, thereby, develop sustainable utilization plan of community forest. However, the contribution of tree products from outside the community forests has not been duly assessed and incorporated in the operational planning of community forestry.

Similarly, there is marked differences between the projected fuelwood demand and supply between two consecutive periods of operational plans. The plans are not informed by the factors that resulted such inconsistent estimates of fuelwood demand and supply in rural communities. It substantiates the argument that community forestry planning emphasizes more on developing plans (as product) than logical ‘process’ that links the changing livelihood requirements of people to the forest management strategies (FAO 2004). It essentially indicates the failure of operational plans to realistically reflect the changing context of forest use by the local communities.

The operational plans are developed following the standard guidelines and procedures developed for community forestry. The guidelines specify, among others, the procedures for determining the demand and supply of forest products to draw objectives and activities of forest management (DoF 2014). The results of this study indicate that standard planning guidelines are applied inconsistently and inadequately to estimate fuelwood demand and supply. The study questioned the applicability of methods and procedures prescribed in existing planning guidelines to estimate fuelwood consumption by rural communities and, therefore, recommends for revision. While fuelwood from private land are used, it should be incorporated in community forestry planning process.

8.2.2. Spatial patterns of wood extraction in community managed forests

In addition to representing the demand and supply of forest products, operational plans are designed to regulate forest management and utilization practices in the community forests. Wood extraction in community forests occurs either during management activities like thinning and pruning to obtain fuelwood and poles, or during timber harvesting operations (Cedamon et al. 2017). The density and basal area of stumps and trees were used to assess the spatial patterns of forest management and utilization.

Operational plans have introduced spatial planning strategies by allocating forest blocks for rotational management and utilization (Yadav et al. 2003). Forest is divided into blocks according to the accessibility, terrain condition, forest types and management requirements including protection and biodiversity conservation (Başkent 2018). The concept of forest blocking is rooted to the practice of large scale forestry operations where timber harvesting is regulated either by volume or area control methods (Boncina & Cavlovic 2009). In community forestry, where large scale harvesting is avoided, spatial planning aims primarily at regulating annual management operations in the forest. It includes forest map with blocks and emphasizes on maintaining spatial integrity between forest stock, wood extraction and management practice across the forests. The plan describes how much forest products can be collected from different parts or blocks of the forests. It is argued that spatial planning can facilitate forest user groups to effectively implement operational plans and regulate forest use patterns across the forest. However, the study indicated that forest users were unable to undertake even basic management activities like '*godmel*' in the blocks as specified in the operational plans. As a result, the patterns of management and utilization is deviated from what is envisaged in the operational plans.

The study reveals a subtle pattern of wood extraction from the community forests. First, wood extraction has concentrated mainly in the timber producing forests comprising the mixture of *Schima wallichii*, *Castanopsis indica* and *Shorea robusta*. Secondly, the intensity of wood extraction poorly corresponds to the forest stock across the forests. Generally, wood extraction has concentrated close to the road, settlements and in moderate slopes. The patterns of wood extraction presented in this research resonate with the results from forests with *de facto* open access regime. (Dons et al. 2014; Robinson, Williams & Albers 2002). It suggests that, despite the provision of rotational management strategies, the forest management and utilization practices are not distributed across the forests.

The observed patterns of wood extraction represent either or both of two circumstances: first, the operational plans have not adequately represented the management and utilization practices of forest user groups; and second, the operational plans are not effective to regulate and influence the extraction behaviour of the forest user groups. In either case, the efficacy of operational plans appears substandard and poor to maintain spatial integrity in wood extraction. Although it is less conspicuous and latent at present, the consequences of existing extraction patterns can be manifested to threaten the viability of forest system mainly due to cyclic and over extraction of wood from convenient locations (Nagendra et al. 2008).

The findings of this study concur with other studies that the effect of spatial and biophysical factors related to road accessibility, proximity to settlements, forest types and terrain condition are inexorable to influence the extraction behaviour of forest users (Dons et al. 2014; Ezzatia, Najafib & Bettinger 2016; Robinson, Williams & Albers 2002). Therefore, operational plans are required to assess the degree and nature of influence these factors can have to determine the spatial preference and patterns of wood extraction by forest users. Although the plans have specified that wood harvesting is avoided in the steep slopes and erosion prone areas, they lack information on where and to what extent those areas are located in the forests. The absence of such information can seriously degrade the quality of spatial planning to regulate forest management. The standard policy guidelines specify that spatial planning is drawn according to the need and convenience of forest user groups and the condition and management objectives of forests (DoF 2014). However, the study finds that policy guidelines are not observed while drawing spatial strategies of forest management. Alternatively, the study finds that existing policy guidelines have limited application in the context of community forestry where community needs vary in different time of the year and across year and where forests are rarely managed in rotational basis and local communities need to utilize accessible forest.

In order to improve the usefulness of spatial planning, this study suggests to integrate local spatial knowledge to evaluate the influence of different spatial factors in forest management and utilization practices. Participatory methods can be employed to use local knowledge to generate zonation map of wood extraction intensity across the forests (Gautam 2006; McCall & Minang 2005). Such zonation map can be a useful management tool to improve current practice of forest blocking and monitor wood extraction in different parts of the forest. Accordingly, there is a need of realigning forest blocks that can best represent the spatial pattern of wood extraction. Based on the study, it is forest blocks that are concentric to the settlements and parallel to the road and/or tracks can best represent the current practice of wood extraction. Such spatial planning approach can be complex to devise at the beginning but it serves as a useful tool to monitor the impact of wood extraction occurring only in and around convenient locations.

8.3. Locally perceived social and biophysical factors shaping management and utilization practices in community forestry

Despite enabling policies and institutions, community forests in Nepal are undermanaged. This study reveals that the current state of forest management is very basic and largely confined to the bush cutting and removal of low quality trees. As in most other parts of the country, forest management is found at the suboptimal level (Cedamon et al. 2017; Singh 2002; Yadav et al. 2009).

Current literature has identified a wide range of factors influencing the successful performance of community based forest management (Agrawal & Chhatre 2006; Baynes et al. 2015; Kanel & Bala Ram Kandel 2004; Pokharel et al. 2015; Tesfaye 2017; Tesfaye et al. 2012). These studies have identified "economic benefits/incomes" as one of the most important factors to motivate local people to manage forest.

The study has identified three primary factors; namely forest dependency, forest incomes and benefits, and the skill of technical forest management; to influence FUG's motivation to enhance forest management. These factors do not only shape the practice of forest management but also determine the priorities and motivation of forest user to manage community forests. It reveals that livelihood dependency on forests has decreased and gradually delinked from forests due to the outmigration, reduced number of livestock and presence of alternative sources of cooking fuel including private trees. The result corroborates with the finding of other similar studies which have reported reduced livelihood dependency on forests due to variety of socioeconomic factors (Fox 2018; Jaquet et al. 2016; Link, Axinn & Ghimire 2012; Paudel, Tamang & Shrestha 2014)

Similarly, the potential of forest incomes and benefits is restricted due to the terrain difficulty; low timber productivity of forests; lengthy and complex regulatory mechanisms; and the remoteness of the forests from road and settlements. Likewise, inadequate capacity of FUGs and DFOs has limited the latitude of silvicultural practices to enhance forest management. Whereas these factors appear as the sub-set of already identified factors, the relative influence of each factor is site specific and any combination of these factors can enhance or degrade the motivation of FUG to engage in collective management of forests.

The results of this study are consistent with other studies. Most often, success of community based forestry is assessed in terms of the benefits to the local communities (Lawrence 2007). It is argued by many scholars that immediate and cost effective benefits from forest is a crucial factor to motivate rural communities to participate and enhance forest management (Agrawal & Chhatre 2006; Beauchamp & Ingram 2011; Behera & Engel 2006; Carter & Gronow 2005; Ellis et al. 2015; Engida & Mengistu 2013). Drawing from different cases of community forestry from developing countries, it has been concluded that successful outcomes of community based forestry is associated with the perceived benefits and/or incentives accrued to the local communities (Musyoki et al. 2016; Pagdee, Kim & Daugherty 2006; RECOFT 2013). It is reported that linking forestry programme to the economic development can facilitate social and economic justice, good forest management, and biodiversity protection (Bray, Antinori & Torren-Rojo 2006; Bray et al. 2003). In Mexico, Tanzania and Bolivia, community forestry programmes are linked to the forest based enterprises like timber production to generate incomes and employments to the local communities (Babili & Wiersum 2013; Bettinger et al. 2017; Diaz-Balteiro & Romero 2004; Ellis et al. 2015). It concurs the argument that inadequate benefits from community forest can discourage local people to engage in forest management. For example, in the Philippines, Peoples' Organization (POs), which are the legitimate managers of community forestry, are found inactive due mainly to the limited incentives associated with forest management (Pulhin, Inoue & Enters 2007). In this study, existing flow of benefits from forest is perceived to be inadequate for motivating local people in forest management- meaning that FUGs are inactive. Timber can fetch better incomes to the communities but this potential is constrained by the quality of forest for timber production and restrictive regulatory framework in relation to harvesting, transporting, processing and sale of timber. Local people and government agencies do not have any strategic plan for developing forest based enterprises. There is a lack of technical and financial capacity and business-oriented institutions associated with community forestry (Macqueen 2013). In this context, community forestry can hardly be perceived as a means to benefit rural communities.

As pointed by others (e.g. (Beauchamp & Ingram 2011; Miagostovich 2001; Thoms 2008; Walter et al. 2005), this study also identifies that technical capacity of FUGs and DFO is an important constraint to successfully implement forest management operations in community forests. Considering the complex and multifarious needs of communities, FUGs need continuous technical assistance and related support after their formation. Government agencies (i. e. DFO, LFO) are expected to provide technical supports to the FUGs to develop and implement locally appropriate forest management operational plans (Thoms 2008).

Paradoxically, forestry technicians themselves lack required skills and hands-on experiences to suggest any silvicultural systems suitable for given forest types and management objectives (Springate -Baginski et al. 2003). As a result, forest management rely largely on indigenous knowledge and practices known to the local communities.

The study indicated that the factors inhibiting or enhancing forest management operations are intrinsic to the social, economic and biophysical circumstances and that those factors are well recognized by the local communities. Combined with other demographic and social factors, people are less dependent on forest and get more of their forest needs from other sources.

To address the situation, a two-pronged policy strategies is proposed. First, active and equitable forest management should be emphasized and promoted to increase forest incomes to the local communities. Such management initiatives should rely on the aim of the user groups and the biophysical condition of the forest (Gilmour (undated). Second, collaborative action research should be initiated with local communities to experiment and demonstrate the beneficial effects of silvicultural systems to enhance forest productivity. These policy initiatives can augment the capacity of DFOs and FUGs to undertake silviculture based forest management and expand the range of benefits to the FUGs.

8.4. Relevance of operational plans to forest user for managing forests

Operational plans are the key policy and management document in the process of community forestry. These plans describe the methods and procedures of managing forest to meet the objectives of sustainable forest management and livelihood enhancement. The success of community forestry largely relies on how the plans are prepared and implemented in practice (NACRMLP 2006). Therefore, it is essential that planning process in community forestry is considered as an opportunity to empower local communities to prepare locally relevant operational plans. For this, the planning guidelines should emphasize the exchange of information and extensive interaction with local communities to negotiate on why and how forest is managed (DoF 2014; FAO 2004). As community forests are managed by rural communities, who are often poor and illiterate, emphasis on simple operational plans that are relevant to the need and capacity of forest user groups is growing (FAO 2004; Thoms 2008).

However, several studies have shown that operational plans of community forestry adhere to the technical contents of management plans that are prepared for timber production (Rutt et al. 2014; Thoms 2008; Toft, Adeyeye & Lund 2015). Such technical operational plans, which are prepared by forestry professional like in Tanzania and the Philippines, often curtail the full realization of the potential benefits from community forest management (FAO 2004; Scheba & Mustalahti 2015).

As pointed out by Gilmour (2016), operational plans of community forestry have set ambitious objectives of forest management including biodiversity conservation and climate change mitigation (Gilmour 2016). These lofty objectives represent the national level political commitment to the environment and, hence, bear little relevance to the needs and capacities of forest management to the FUGs. Although environmental objectives are elaborated in the operational plans, they are not the priority of local communities. However, with increased emphasis on environmental objectives, there is a risk that management can prioritize protection over the rights of local people to use forest (Babili & Wiersum 2013; Pelletier, Gelinas & Skutsch 2016; Poudel et al. 2014).

Generally, community forestry operational plans in developing countries are prepared by professional foresters and implemented by local communities (Cronkletona, Pulhinb & Saigalc 2012; Pulhin, Inoue & Enters 2007; Scheba & Mustalahti 2015). There is general consensus among FUGs and forestry professionals that current operational plans are too technical to comprehend by local communities, costly and tedious to produce, poorly connected to the local livelihood systems and, hence, less useful to the FUGs to inform local forest management decisions (Scheba & Mustalahti 2015; Thoms 2008; Toft, Adeyeye & Lund 2015). Even though DFOs emphasise on technical operational plans, these plans have not promoted technical forest management in practice. Instead, FUGs continue with the basic forest management operations that can best fit to their current capacities and livelihood needs. As a result, operational plans have emerged as the symbol of ownership rather than a devise to synergize the priorities and capacities of FUGs to manage forest for livelihood enhancement.

Based on these results, this study suggests the revision of current operational plans to make them simple and user friendly with the information relevant to the FUGs to manage forests. For FUGs who are managing forests for subsistence use only, a simple operational plan with limited information of forest characteristics and basic management operation is proposed. For FUGs who harvest timber, current operational plans can be revised with the site specific objectives and management activities. The intent of the revision of operational plans is to assess and reflect the requirements and capacity of forest user groups to manage forests. It underscores the need of producing and/or supplying relevant information that is on demand for forest management and can be understood and used by the rural communities (World Bank 2008). Such operational plans are drawn against the backdrop of capacity, need and practice of forest management to make them adaptable to the varying context of FUGs.

Overall, the findings of the research converge towards a point to focus at the intersection of research, policy and practice. The volumes of research that have illuminated the strengths and weaknesses of community forestry from around the world are the treasury of scholarships to enrich community forestry regime of forest management. Although the treasury has accumulated a range of theory, knowledge and experience, its application to improve policy formulation process of community forestry is limited. The limitation stems from the replicability of knowledge and experience to the context other than their origin. While policies and guidelines are formulated for their wider application, the issues specific to the given context are unique and, hence, often overlooked. Therefore, it resulted a narrower overlapping between research, policy and practices in community forestry.

Whereas scientific orientation is desirable to improve forest management, it should be relevant and applicable to the specific context shaped by the culture, capacity and priority within which community forestry operates. One of the examples is the professionalization of community forestry where technical procedures and standards are emphasised. The practical relevance of technical emphasis, however, hardly goes beyond the rituals (Lund 2015). Such rituals are reflected in the operational plans which are failed to represent the reality of forest people relationships and regulate the forest management. The study also demonstrated that community forests are undermanaged and that local context of biophysical and social factors have restricted the adoption of silvicultural systems prescribed in the operational plans. Despite it, policy guidelines continue to emphasize on generating technical operational plans with the contents that are practically little relevance to the local communities to improve forest management strategies and decisions. Instead, the condition of scientific requirements has reinstated the power of forestry staff to manipulate benefits from the community forestry.

This research has the empirical contribution to the scholarships that scientific requirements have been overemphasized in community forestry policies without reflecting on their relevance local communities managing forests. The findings and arguments drawn from this study are consistence with the theories and researches in the interface of science and power in community forestry governance (Lund 2015; Nightingale 2005; Scheba & Mustalahti 2015; Toft, Adeyeye & Lund 2015; Walter et al. 2005).

8.5. Social and institutional contexts of community forestry in Nepal

In this section, social and institutional issues and contexts of community forestry are drawn briefly. It provides the current state of institutions to govern community forestry. The issues are outlined as follows:

First, the issue of equity is persistent in the community forestry institutions. The issues of equity are stemmed from already existed unequal power relations creating discriminated access and rights over community forestry. Forest user group (FUG) is the basic institution to take management responsibility of forest and address the issues of governance including equity. FUG is formed by organizing the population traditionally reliant on a particular forest. In the early stage, FUG was conceptualized as a group of people living in a small spatial unit with homogenous social structures and shared norms and interests on forests (Charnley & Poe 2007). Over time, it is recognized that FUG, which is a subset of the community, is a heterogeneous entity differentiated in terms of gender, caste, wealth and education (FAO 1997). This differentiation is associated with the unequal power exercised by the community members to access and use benefits from community forest (Adhikari, Tanira & Siva 2014; Shrestha & McManus 2018).

Studies have reported that social heterogeneity of FUG is apparent and reflects in the ways and patterns they use forest products (Adhikari, Falco & Lovett 2004; Agrawal & Gupta 2005; Malla, Neupane & Branney 2003; Shrestha & McManus 2018). There is general agreement among researchers that middle and high income households accrue the most benefits from community forests (Gilmour 2016; Lund et al. 2014; Moktan, Norbu & Choden 2016; Shrestha & McManus 2018). The development priorities often ignore the needs and aspirations of the poor and disadvantaged groups (Pailler et al. 2015). However, poor or marginal groups can benefit from investment in community development works such as road, school building, drinking water and electrification (Bhattarai 2016; Lund et al. 2014; Manandhar & Shin 2013). It suggests that the issue of equity in community forestry is relevant today as much as it was during 1990s.

Second, livelihood dependency of rural population has shifted from agrarian based incomes to cash based incomes. This shift is attributed to the flow of cash into the rural area from people employed in urban centres and foreign countries. For almost half of the country's population, foreign employment has been the dominant livelihood choice (Sijapati, Bhattarai & Pathak 2015; Tiwari & Bhattarai 2011).

In Nepal, outmigration and remittances in rural communities have caused enormous impacts on agricultural production and forest management. The outmigration created chronic shortage of young and skilled human resources in agricultural production posing critical threat to ensuring food security (Gauchan 2018). The scarcity of labour has forced rural households to reduce livestock population and practice stall feeding. Trees grown in the abandoned agricultural lands are used as alternative source of fodder, fuelwood and small timber. With increased cash incomes, households have replaced fuelwood by other commercial energy sources (Kanel et al. 2012; Lee et al. 2015; Link, Axinn & Ghimire 2012). These changes have collectively reduced the dependency of rural households on forest. It implies relevance of forest to the rural communities is declining. Moreover, the current flow of benefit and incentives is insufficient to motivate people for forest management (Adhikari, Tanira & Siva 2014). For rural people, potential of community forestry has negligible value to improve their livelihood. (Puri et al. 2020). It questions the long term engagement of local communities in forest management. Nevertheless, it is observed that local people are culturally/ethically linked to the forest and they are willing to protect them.

Third, environmental objectives are not on the priority of local communities but they are shaping the practice of forest management. It is erroneous to assume that all community forest can attend to environmental objective or that those objective are desirable and feasible goal for all communities (Kellert et al. 2000). As community forestry has demonstrated its success in conserving forest, it has received global attention in the context of various forestry-related policies including payment for environmental services (PES) initiatives (Gilmour 2016; Molnar et al. 2011). Nepal is already committed to increase forest protection to enhance carbon sequestration as the strategy of climate change mitigation (MFSC 2014, 2015). With these policy reforms, there is a risk that community forestry can undermine the rights and interests of local communities including poor and women to access and use forests (Sills et al. 2014). Another risk is that it can force people to renegotiate their relationship with the forest by monetizing nature (Bayrak & Marafa 2016). In the context that forest has declining relevance to the rural livelihoods, community forestry can increasingly prioritize environmental objectives in its management. It ultimately results that community forestry management will be more conservation in future than it is now.

Fourth, silvicultural system applicable for community forestry has not developed yet. In the forty years of implementation, community forestry has failed to develop appropriate silvicultural system to manage forests. In most cases, these forests are managed mainly for fuelwood and fodder for subsistence farming economy (WINROCK 2002). Simple operational plans, which is largely based on traditional knowledge and practice, has been sufficient to organize the existing state of forest management (FAO 2004). However, in the absence of appropriate knowledge, forestry staff often propose standard silvicultural practices that are less suitable to the species and forests of preference in rural communities (Lawrence 2007).

Nevertheless, community forestry policy guidelines have emphasized on the scientific forest management based on silvicultural system. It essentializes the role of professional foresters and structured system of information gathering, dissemination and operational planning to manage forests (Lund 2015). Local people are unable to draw and implement scientific forest plan themselves and rely on the support from DFO and LFO (Thoms 2008). Regrettably, forestry technicians themselves lack required skills and hands-on experiences to apply silvicultural system of forest management for a particular forests. Instead, forestry staff often resist to accept culture and behaviour favourable to community forestry and try to retain their power within the framework of monitoring (Lawrence 2007). It means that government forestry staff enjoy mostly acting as gate-keeper or fee collectors than technical service provider. The technical deficiency has been reflected in the quality of operational plans which have failed to estimate the demand and supply of fuelwood in rural communities (Puri, Nuberg & Ostendorf 2017).

Forest management in hilly terrain, which is mostly remote and ecologically fragile, is a labour intensive endeavour. The scarcity of human labour is already an issue in the rural communities. In hilly terrain, mechanization of forestry operations may be financially unjustified and topographically restrictive (Ezzatia, Najafib & Bettinger 2016). In such context, the scientific management of community forestry is an elusive goal.

Fifth, the federal system of governance may reshape the institutional arrangements of community forestry. With the promulgation of the Constitution of Nepal in 2015, existing development processes and institutions are being assessed for their roles in the development of the country and community forestry is not an exception (Aryal, Laudari & Ojha 2020). The federal constitution and the election of three layers of the government- federal, provincial and local- has necessitated the careful review of existing rules and institutions to regulate the community forestry systems. The review should, in particular, focus on two issues: FUG regulations and revenue sharing mechanism from community forests (Ojha 2019). Regarding FUG regulation, the pre-federal system arrangement is that DFO is responsible to regulate FUG with sole rights to handover national forestlands as community forests. In current systems, local government does not have any regulatory power to govern community forestry. In the federal system, local governments are constituted as a strong and enlarged system with greater power to govern itself. As forest is included under the concurrent (i.e. under the power of government at three level) list of the constitution, concerns related to the community forestry is the responsibility of local and provincial governments.

The mechanism of revenue sharing earned by community forest has emerged as a contentious issue. The Local Government Operation Act proposed that FUG require to pay 10% on the sale of forest products to market. The proposal is defended by the FECOFUN- a national federation of community forest users of Nepal- claiming that it is against the spirit of community forestry to impose tax by different layers of the government.

In this context, crucial task is to situate community forestry governance within the changed political and institutional framework of the country. While new federal system is yet to function fully, it is too early to assess its consequences on the development of community forestry in future. However, it is apparent that complexity and fluidity of current changes in Nepal are unique to all development institutions with new avenue for research. To sum up, forestry sector in Nepal is recognized as a subset of the whole political and socio-economic systems and its future will greatly reliant on how these systems will be evolve and established in the country (MFSC 2009).

8.6. Key lessons learnt

The lessons learnt of this study are outlined in following points.

- The *relevanc*e of forests to the rural communities has changed since the community forestry programme was initiated during 1970s. Over the time, the population of user groups and the way they are using the forest resources have changed substantially. The study clearly indicates that forest is not the *only* source of fuelwood, nor fuelwood is the *only* source of household energy in rural communities. On the one hand, the trees grown in the private lands have emerged as fuelwood source and, on the other hand, use of alternative energy sources like LP gas and electricity is on increasing trends in rural communities. These changes influence the social and economic value of the forests to the rural communities. However, these changes have not well studied and reflected in the community forestry planning process and operational plans.
- Although forest based livelihood system has declined in rural communities, community forests are relevant to them for environmental, political and cultural reasons. The continuation of membership in the community forestry by the absent and migrated households indicated that local people have affinities to the forest and they desire to secure their access to the forests.
- Operational plan is one of the prerequisites of community forestry programme. However, the essence and value of these plans differ between government agencies and the local communities. For local communities, it is required for the continued access to the forest resources and perceived as a symbol of ownership over the forests. For government, it is required not only to regulate sustainable forest management and utilization but also to incorporate and achieve broader national and global objectives like biodiversity conservation and climate change mitigation. However, there is little basis for merging and

translating these broader objectives to the needs, capacity and priorities of local communities.

- Operational plans are shaped by the principles and methods of traditional large-scale forest management planning systems without their direct relevance to the context and objectives of community forestry. The contents and the technical information supplied in the operational plans are not well comprehended by rural communities to inform forest management decisions.

- Further, the study indicates that the operational plans in community forestry are neither *adequate* to represent the consumption and supply of fuelwood in rural communities (Chapter 4) nor they are *effective* to regulate management practices nor utilization patterns as prescribed in the plans (Chapter 5).

- The perception of forest user groups is critical to understand why and how the forest is managed. The perception can better reflect the social and biophysical features influencing the motivation of forest user groups to enhance forest management. It is learnt that biophysical conditions including terrain characteristics place considerable constraint to forest management operations in the forests.

- Policies and guidelines related to the community forestry do not commensurate with the skills and capacity of government agencies and rural communities to undertake scientific forest management.

- Environmental objectives upheld in the operational plans are not specific to single community forestry. Community forests can contribute to achieve these higher level objectives when integrated them with broader landscape planning strategies.

- Community forestry planning should start and synchronize with the livelihood strategies of local population. Current operational planning is not informed by the priorities and needs of local population and, hence, are less applicable in the local context.

8.7. Policy implications

The study corresponds to the period while Nepal is undergoing administrative reform shifting towards larger regional centres with three layers of government to shape overall development of the country. It includes adjustment of forest policies and institutions for ensuring active and equitable forest management. The study demonstrated that community forestry model must be context specific and anchored to the realities and demands of local communities (Alcorn 2014).

With the knowledge developed in this study, it is now essential to examine where it fits within the broader policy context. As a member country of United Nations, Nepal is committed to achieve its sustainable development goals including poverty reduction by 2030. Nepal's Sustainable Development Goals (SDGs) has recognized forestry as a productive sector with strong link to the livelihoods, land use and other development processes of the country (NPC 2015). It is reported that community forestry can contribute to as much as 80 targets of the SDGs at various scales of institutional interface and that it interacts with a range of social, economic, and environmental aspects of the SDGs. (Aryal, Laudari & Ojha 2020; Jong et al. 2018). While community forestry is the major policy in forestry, it has greater role to play in the national goal of poverty reduction and economic development. For this, community forestry should be better managed by addressing the gaps in policy, knowledge and practice identified in the study.

Current Forestry Sector Policy (2016-2025) of Nepal has committed to augment economic prosperity through the improved forest management. The policy has aspired to bring 25 percent of hill and mountain forest under intensive and scientific management. Likewise, the policy has set ambitious goals of increasing timber supply and generate employment in forestry sector (MFSC 2016). To achieve these objectives, intensive and active management of forests is required. However, at the present practices of forest management, community forestry can have limited contribution to this end. To this effect, this study explicates the following conditions that have policy implications.

Firstly, operational plans as *policy tools* are poorly designed to inform forest management decisions. These plans are poor in representing the consumption and supply of forest products in the rural communities. Secondly, operation plans as *management tools* are not effective to regulate forest management and utilization practices in the forests. Thirdly, the current flow of forest incomes and benefits are not sufficient to motivate forest users to enhance management. Instead, the local livelihood systems are delinked and delocalized from forests and increasingly replaced by the non-forestry sectors. Fourthly, the forest management in hilly region is severely constrained by the terrain conditions where exclusive protection is required in the steep slopes. As a consequence, the effective forest area for productive management can reduce significantly. Fifthly, policy guidelines and operational planning have elaborated and essentialised environmental objectives with implicit focus on conservation for biodiversity and climate change mitigation in community forestry. Finally, at present, neither government agencies nor the forest users are capable to implement technical forest management in practices. As a results, it is hard to enhance incomes from community forests of hilly region.

Therefore, forest policies need to focus on 1) building forest management capacity of both user groups and forestry staff through collaborative research initiative, 2) promoting enterprise-based forest management to enhance forest incomes. It is identified that economic incentive is one of the overarching factors for the motivation and success of community forestry programmes, 3) adjusting the forest management plans to the changing context of forest-people relationships. It is important because effectiveness of community forestry rests on its relevance to the livelihood of local communities. It requires locally adaptable “low cost models” of forest management planning that are informed by the changing socioeconomic context, priorities and capacities of local communities, 4) situating forest management planning according to the condition of the forests and objectives of management. It requires that management strategies are segregated according to the production potential of community forests, and 5) integrating the relevant social and spatial factors to derive realistic operational plans that can optimise the forest management in accordance with the needs and capacity of forest user and government agencies. It is necessary to specify the spatial extent within which multiple objectives of forest management can be realistically achieved.

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Appendices

Appendix 1a: Land, tree and livestock holding.
Average land, tree and livestock holdings of respondent households in the villages and community forests

Units	Land holding (ha)			Tree holding	Livestock				
	Cultivated	Fallow	Forest		Buffalo	Goat/Sheep	Pig/Boar	Poultry	Livestock Unit
Villages									
Nalma	0.53	0.44	0.26	132.3	1.1	4.6	0.2	10.2	2.7
Taksar	0.38	0.06	0.04	46.9	1.4	4.5	0.2	5.4	2.7
Forest Types									
Nalma-SC	0.48	0.54	0.43	175.6	1.2	4.1	0.0	11.0	2.3
Nalma-SCS	0.56	0.40	0.19	112.2	1.0	4.8	0.2	9.9	2.9
Taksar-SC	0.53	0.05	0.06	40.3	1.6	7.0	0.5	8.2	3.7
Taksar-SCS	0.34	0.07	0.04	48.9	1.4	3.6	0.1	4.5	2.4
Community Forests									
Khundrudevi	0.45	0.59	0.40	174.3	1.1	4.4	0.0	14.6	2.0
Sunkot	0.51	0.48	0.46	177.1	1.4	3.6	0.0	6.6	2.7
Kagrodevi	0.71	0.69	0.34	133.6	0.9	6.3	0.0	9.5	2.8
Langdihariyali	0.53	0.34	0.16	107.4	1.0	4.4	0.3	10.0	2.9
Adherikhola	0.33	0.00	0.08	38.3	1.7	6.7	0.0	1.7	2.6
Bholdada	1.09	0.10	0.00	35.3	2.8	11.3	0.0	12.3	5.5
Jamuna Gahira	0.22	0.03	0.00	40.7	1.3	10.0	0.0	14.7	3.6
Pisti	0.59	0.04	0.24	53.8	1.0	5.0	0.0	9.0	2.6
Samkhoriya	0.61	0.10	0.03	43.3	0.5	4.3	2.0	7.3	2.6
Tamakhani	0.32	0.04	0.00	29.2	2.3	6.5	0.7	5.3	4.7
Lampata	0.31	0.08	0.05	61.4	1.3	3.4	0.0	3.2	2.1
Nag Bhairab	0.64	0.02	0.00	22.8	1.4	3.8	0.0	8.4	2.8
Sathimure	0.27	0.05	0.01	29.1	1.5	4.0	0.3	6.1	3.0

Appendix 1b: Household size and education status of respondent households

Units	Household Size		Education	
	[1]Total	[2]Effective/ resident	[3]Total school years of all members	[4]Total school years of resident members
Villages				
Nalma	6.1	3.9	34.6	12.9
Taksar	6.0	4.1	37.0	19.8
Forest types				
Nalma-SC	5.8	3.7	34.0	12.7
Nalma-SCS	6.3	4.0	34.9	12.9
Taksar-SC	5.8	4.2	35.7	21.0
Taksar-SCS	6.1	4.1	37.4	19.4
Community Forests				
Khundrudevi	6.3	3.4	39.7	12.6
Sunkot	5.3	4.1	27.1	12.7
Kagrodevi	5.9	3.0	36.0	8.2
Langdihariyali	6.3	4.2	34.7	13.9
Adherikhola	5.5	3.5	31.8	13.3
Bholdada	6.5	5.6	37.5	27.8
Jamuna Gahira	4.0	2.8	31.7	18.3
Pisti	5.2	3.5	32.6	18.0
Samkhoriya	5.8	4.4	30.8	14.5
Tamakhani	7.2	5.0	45.2	30.0
Lampata	5.6	3.9	38.0	20.5
Nag Bhairab	7.3	4.2	42.2	15.6
Sathimure	6.9	4.5	33.6	18.3

Explanation:

1. Total members of the household
2. Resident members of the household (members residing at home for > 6 months in a year)
3. Total number of school years of all members
4. The total school year of resident members

Appendix 2: Description of forest sample plots with GPS coordinate (WGS 1984, UTM45)

Plot No	Easting	Northing	VDC	CF Name	Forest Type	nTree	gTree	nStump	gStump	Slope	Distance to road	Distance to settlement/s
N-01	233680	3121465	Nalma	Langdihariyali	SCS	800.4	57.13	240.1	4.00	50	20	259
N-02	234069	3121851	Nalma	Langdihariyali	SCS	420.2	36.93	0.0	0.00	33	20	535
N-03	234332	3122017	Nalma	Langdihariyali	SCS	1060.5	54.76	40.0	3.27	42	0	759
N-04	234572	3122078	Nalma	Langdihariyali	SCS	860.4	56.49	80.0	1.78	21	30	687
N-05	234054	3122064	Nalma	Langdihariyali	SCS	700.3	35.43	240.1	6.83	18	20	614
N-06	233817	3122069	Nalma	Langdihariyali	SCS	380.2	22.35	400.2	18.06	32	10	460
N-07	237349	3122095	Nalma	Kagrodevi	SCS	580.3	33.14	260.1	5.99	30	10	225
N-08	237137	3122156	Nalma	Kagrodevi	SCS	600.3	23.15	100.0	4.11	34	67	322
N-09	233670	3122210	Nalma	Langdihariyali	SCS	360.2	26.55	240.1	4.60	29	0	502
N-10	234999	3122219	Nalma	Langdihariyali	SCS	1300.6	53.74	0.0	0.00	31	70	552
N-11	234044	3122248	Nalma	Langdihariyali	SCS	240.1	14.90	200.1	5.31	42	28	480
N-12	234702	3122281	Nalma	Langdihariyali	SCS	900.4	41.69	20.0	1.19	25	104	454
N-13	237144	3122261	Nalma	Kagrodevi	SCS	1640.8	46.37	160.1	4.00	37	153	275
N-14	234403	3122237	Nalma	Langdihariyali	SCS	1240.6	52.58	120.1	7.16	40	171	569
N-15	235427	3122288	Nalma	Langdihariyali	SCS	1100.5	53.82	0.0	0.00	51	41	731
N-16	235768	3122319	Nalma	Langdihariyali	SCS	900.4	42.08	0.0	0.00	41	67	799
N-17	236195	3122280	Nalma	Langdihariyali	SCS	1300.6	53.12	140.1	3.99	31	10	883
N-18	234487	3122297	Nalma	Langdihariyali	SCS	880.4	47.03	140.1	4.63	23	95	503
N-19	233107	3122637	Nalma	Langdihariyali	SCS	1060.5	37.94	240.1	4.15	31	36	727
N-20	236427	3122320	Nalma	Kagrodevi	SCS	1060.5	46.80	100.0	1.72	39	0	837
N-21	236015	3122415	Nalma	Langdihariyali	SCS	640.3	34.93	0.0	0.00	34	165	710
N-22	235389	3122419	Nalma	Langdihariyali	SCS	680.3	33.19	0.0	0.00	47	171	585
N-23	237255	3122442	Nalma	Kagrodevi	SCS	480.2	8.17	160.1	2.52	42	60	122
N-24	236862	3122488	Nalma	Kagrodevi	SCS	840.4	48.83	100.0	5.27	42	170	492
N-25	233272	3122710	Nalma	Langdihariyali	SCS	1280.6	33.44	460.2	8.67	27	22	560
N-26	235292	3122512	Nalma	Langdihariyali	SCS	900.4	36.30	0.0	0.00	39	110	471
N-27	233765	3122540	Nalma	Langdihariyali	SCS	660.3	16.17	320.2	6.59	9	114	202

Plot No	Easting	Northing	VDC	CF Name	Forest Type	nTree	gTree	nStump	gStump	Slope	Distance to road	Distance to settlement/s
N-28	233602	3122576	Nalma	Langdihariyali	SCS	1040.5	21.13	240.1	4.52	28	10	280
N-29	237045	3122775	Nalma	Kagrodevi	SCS	920.5	53.04	100.0	8.50	47	275	191
N-30	235165	3122626	Nalma	Langdihariyali	SCS	520.3	31.72	100.0	4.55	29	32	350
N-31	236096	3122750	Nalma	Langdihariyali	SCS	980.5	32.21	280.1	5.06	21	383	412
N-32	235675	3122741	Nalma	Langdihariyali	SCS	960.5	30.45	80.0	2.78	45	280	430
N-33	236353	3122782	Nalma	Langdihariyali	SCS	860.4	25.96	520.3	21.19	41	202	559
N-34	235533	3122808	Nalma	Langdihariyali	SCS	940.5	22.84	120.1	2.93	38	252	302
N-35	233356	3122841	Nalma	Langdihariyali	SCS	660.3	22.74	580.3	22.31	30	40	492
N-36	237135	3122847	Nalma	Kagrodevi	SCS	360.2	31.59	80.0	1.31	42	204	163
N-37	236483	3122884	Nalma	Langdihariyali	SCS	400.2	28.61	60.0	1.57	34	54	488
N-38	236613	3122940	Nalma	Langdihariyali	SCS	480.2	26.11	20.0	0.31	32	28	351
N-39	235651	3122962	Nalma	Langdihariyali	SCS	220.1	15.32	60.0	0.96	46	63	276
N-40	235501	3123067	Nalma	Langdihariyali	SCS	120.1	13.22	40.0	0.98	29	45	98
N-41	233284	3123145	Nalma	Langdihariyali	SCS	680.3	22.54	40.0	1.39	35	352	667
N-42	233382	3123327	Nalma	Langdihariyali	SCS	440.2	29.40	20.0	0.23	41	412	670
N-43	236492	3123361	Nalma	Sunkot	SC	460.2	11.87	120.1	2.59	43	50	520
N-44	236303	3123448	Nalma	Sunkot	SC	600.3	13.07	200.1	7.06	42	14	341
N-45	236973	3123594	Nalma	Sunkot	SC	700.3	26.47	0.0	0.00	44	10	552
N-46	233564	3123448	Nalma	Langdihariyali	SCS	500.2	22.27	0.0	0.00	54	215	608
N-47	236566	3123487	Nalma	Sunkot	SC	220.1	10.50	80.0	1.35	57	42	603
N-48	234528	3123509	Nalma	Langdihariyali	SCS	440.2	10.47	0.0	0.00	38	308	262
N-49	235344	3123537	Nalma	Langdihariyali	SCS	1020.5	37.08	700.3	21.01	34	41	260
N-50	233772	3123588	Nalma	Langdihariyali	SCS	720.4	20.42	100.0	1.81	23	10	582
N-51	235984	3123571	Nalma	Sunkot	SC	320.2	16.45	180.1	9.97	43	10	120
N-52	234446	3123612	Nalma	Langdihariyali	SCS	500.2	24.52	40.0	0.52	27	380	373
N-53	236314	3123707	Nalma	Sunkot	SC	560.3	28.30	40.0	2.83	29	14	448
N-54	234870	3123640	Nalma	Khundrudevi	SC	520.3	37.05	140.1	5.47	29	40	379
N-55	233680	3123650	Nalma	Langdihariyali	SCS	640.3	30.92	60.0	1.76	41	10	688
N-56	235118	3123670	Nalma	Khundrudevi	SC	360.2	11.56	40.0	5.99	23	10	400
N-57	234787	3123674	Nalma	Langdihariyali	SCS	540.3	27.54	160.1	5.60	30	50	410

Plot No	Easting	Northing	VDC	CF Name	Forest Type	nTree	gTree	nStump	gStump	Slope	Distance to road	Distance to settlement/s
N-58	234591	3123711	Nalma	Langdihariyali	SCS	700.3	21.89	0.0	0.00	34	238	451
N-59	235277	3123746	Nalma	Khundrudevi	SC	640.3	21.98	60.0	1.21	46	54	470
N-60	236668	3123789	Nalma	Sunkot	SC	2401.2	60.85	140.1	1.71	18	110	801
N-61	234420	3123849	Nalma	Langdihariyali	SCS	320.2	23.09	20.0	2.58	43	429	614
N-62	235334	3123920	Nalma	Khundrudevi	SC	460.2	20.26	40.0	2.22	46	58	595
N-63	234720	3123964	Nalma	Khundrudevi	SC	620.3	26.73	20.0	1.01	31	113	700
N-64	235437	3124012	Nalma	Khundrudevi	SC	620.3	24.63	40.0	1.32	15	60	604
N-65	237393	3123970	Nalma	Sunkot	SC	800.4	22.24	540.3	12.24	19	30	340
N-66	236715	3124002	Nalma	Sunkot	SC	940.5	34.08	120.1	1.47	43	81	902
N-67	236829	3124020	Nalma	Sunkot	SC	980.5	38.91	80.0	1.60	30	100	801
N-68	235180	3124062	Nalma	Khundrudevi	SC	260.1	49.59	80.0	1.59	34	192	790
N-69	237520	3124064	Nalma	Sunkot	SC	780.4	24.55	760.4	14.91	13	78	391
N-70	235071	3124138	Nalma	Khundrudevi	SC	360.2	22.14	80.0	2.20	11	166	860
N-71	237041	3124118	Nalma	Sunkot	SC	560.3	26.90	40.0	4.74	32	170	674
N-72	237408	3124150	Nalma	Sunkot	SC	820.4	23.04	360.2	11.95	20	132	500
N-73	235573	3124183	Nalma	Khundrudevi	SC	720.4	24.78	60.0	2.36	26	120	718
N-74	236692	3124189	Nalma	Sunkot	SC	560.3	34.40	60.0	3.93	25	271	1005
N-75	235285	3124284	Nalma	Khundrudevi	SC	400.2	18.58	80.0	2.75	23	10	918
N-76	236552	3124315	Nalma	Sunkot	SC	420.2	46.67	120.1	1.55	16	112	1053
N-77	237323	3124334	Nalma	Sunkot	SC	560.3	17.13	80.0	1.75	34	320	699
N-78	236948	3124368	Nalma	Sunkot	SC	360.2	43.04	120.1	4.15	18	396	914
N-79	236639	3124389	Nalma	Sunkot	SC	240.1	24.03	60.0	0.82	25	106	1160
N-80	235942	3124450	Nalma	Khundrudevi	SC	360.2	39.64	0.0	0.00	26	171	961
N-81	236227	3124493	Nalma	Khundrudevi	SC	360.2	48.26	40.0	1.78	35	238	1056
N-82	237032	3124523	Nalma	Sunkot	SC	740.4	38.44	0.0	0.00	55	470	996
N-83	236908	3124555	Nalma	Sunkot	SC	320.2	35.58	60.0	1.31	32	344	1088
N-84	235834	3124566	Nalma	Khundrudevi	SC	177.5	10.97	13.1	0.56	27	80	1070
N-85	235491	3124575	Nalma	Khundrudevi	SC	240.1	16.60	20.0	3.77	26	67	1116
N-86	236069	3124614	Nalma	Khundrudevi	SC	300.1	30.98	180.1	7.71	19	314	1134
N-87	236442	3124618	Nalma	Khundrudevi	SC	520.3	41.54	120.1	3.01	36	58	1248

Plot No	Easting	Northing	VDC	CF Name	Forest Type	nTree	gTree	nStump	gStump	Slope	Distance to road	Distance to settlement/s
N-88	236415	3124791	Nalma	Khundrudevi	SC	540.3	21.84	100.0	1.02	16	41	1400
N-89	236987	3124800	Nalma	Sunkot	SC	300.1	27.54	0.0	0.00	26	494	1261
N-90	235740	3124835	Nalma	Khundrudevi	SC	640.3	19.63	160.1	2.49	17	20	1341
N-91	236108	3124807	Nalma	Khundrudevi	SC	220.1	15.72	40.0	1.89	27	342	1328
N-94	235530	3124009	Nalma	Khundrudevi	SC	440.2	21.32	80.0	2.30	36	64	566
N-12	236208	3122856	Nalma	Langdihariyali	SCS	760.4	32.04	220.1	6.54	41	275	410
T-01	231685	3114945	Taksar	Adherikhola	SC	780.4	27.98	80.0	1.32	28	180	319
T-02	231925	3114989	Taksar	Adherikhola	SC	620.3	18.08	100.0	2.22	34	192	320
T-03	231718	3113905	Taksar	Adherikhola	SC	500.2	8.00	0.0	0.00	25	206	699
T-04	231598	3114101	Taksar	Adherikhola	SC	220.1	21.67	0.0	0.00	35	200	541
T-05	231660	3114317	Taksar	Adherikhola	SC	1280.6	44.00	200.1	3.36	24	261	319
T-06	231597	3114539	Taksar	Adherikhola	SC	740.4	45.17	120.1	5.00	23	166	235
T-07	233865	3116130	Taksar	Bholdanda	SC	940.5	29.95	100.0	1.73	50	202	948
T-08	233902	3115945	Taksar	Bholdanda	SC	780.4	29.17	200.1	3.74	37	10	844
T-09	232813	3111620	Taksar	Lampata	SCS	800.4	36.02	240.1	10.21	21	90	112
T-10	233291	3111999	Taksar	Lampata	SCS	620.3	31.18	180.1	3.48	35	133	95
T-11	233191	3112850	Taksar	Lampata	SCS	420.2	26.44	280.1	10.64	32	250	292
T-12	232807	3112005	Taksar	Lampata	SCS	740.4	34.35	260.1	21.68	20	184	277
T-13	233217	3112627	Taksar	Lampata	SCS	260.1	15.19	240.1	8.17	32	102	323
T-14	232640	3111997	Taksar	Lampata	SCS	460.2	42.88	200.1	10.98	31	28	150
T-15	233295	3112177	Taksar	Lampata	SCS	280.1	19.94	80.0	1.18	26	108	271
T-16	232649	3111434	Taksar	Lampata	SCS	720.4	17.25	160.1	3.62	29	20	140
T-17	232991	3112240	Taksar	Lampata	SCS	180.1	8.46	320.2	17.23	21	165	240
T-18	232317	3113180	Taksar	Lampata	SCS	680.3	34.83	360.2	7.97	24	141	304
T-19	233111	3112007	Taksar	Lampata	SCS	520.3	37.39	220.1	5.57	17	30	204
T-20	232160	3114450	Taksar	Nag Bhairab	SC	220.1	7.63	20.0	0.63	50	108	192
T-21	231447	3115062	Taksar	Nag Bhairab	SC	460.2	13.65	0.0	0.00	33	190	566
T-22	231443	3114742	Taksar	Nag Bhairab	SC	280.1	13.43	20.0	0.94	21	72	398
T-23	231793	3114138	Taksar	Nag Bhairab	SC	1060.5	44.32	320.2	6.72	23	36	451
T-24	231466	3114886	Taksar	Nag Bhairab	SC	360.2	14.73	0.0	0.00	27	188	439

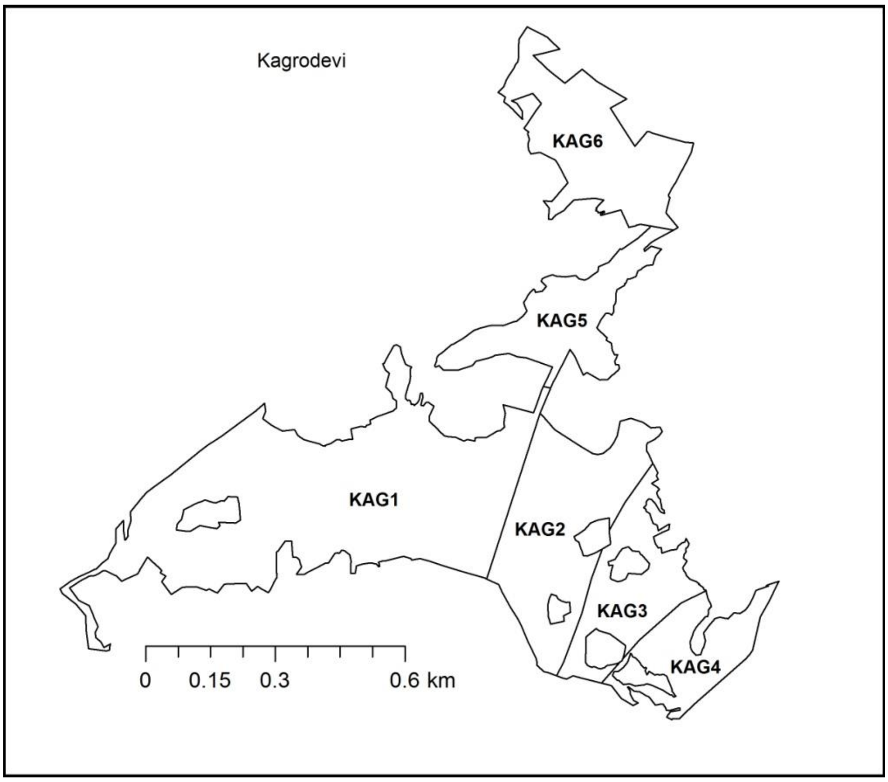
Plot No	Easting	Northing	VDC	CF Name	Forest Type	nTree	gTree	nStump	gStump	Slope	Distance to road	Distance to settlement/s
T-25	232286	3114126	Taksar	Nag Bhairab	SC	160.1	7.43	120.1	2.58	25	50	290
T-26	231883	3113882	Taksar	Nag Bhairab	SC	620.3	35.99	80.0	3.03	40	146	710
T-27	231945	3115472	Taksar	Jamuna Gahira	SC	620.3	17.08	20.0	0.35	46	67	800
T-28	233187	3115746	Taksar	Pisti	SC	520.3	19.98	100.0	2.15	30	10	301
T-29	232624	3115275	Taksar	Pisti	SC	160.1	9.03	0.0	0.00	26	85	235
T-30	233728	3115911	Taksar	Pisti	SC	680.3	26.58	0.0	0.00	40	28	694
T-31	233133	3116056	Taksar	Pisti	SC	600.3	31.25	20.0	0.31	44	242	615
T-32	232816	3115597	Taksar	Pisti	SC	640.3	23.58	80.0	1.73	54	36	353
T-33	232921	3115718	Taksar	Pisti	SC	680.3	43.00	20.0	0.98	46	130	400
T-34	233684	3116214	Taksar	Pisti	SC	600.3	37.68	20.0	0.27	43	310	902
T-35	232744	3116007	Taksar	Pisti	SC	240.1	20.14	0.0	0.00	28	437	735
T-36	233849	3115785	Taksar	Pisti	SC	520.3	39.81	140.1	8.59	16	132	716
T-37	232209	3115444	Taksar	Jamuna Gahira	SC	280.1	9.45	60.0	0.92	10	30	629
T-38	233653	3115668	Taksar	Pisti	SC	960.5	45.50	200.1	6.05	29	160	496
T-39	233350	3115858	Taksar	Pisti	SC	740.4	44.52	60.0	0.77	42	0	440
T-40	232314	3115781	Taksar	Pisti	SC	380.2	9.86	0.0	0.00	46	290	778
T-41	232642	3115397	Taksar	Pisti	SC	560.3	10.40	20.0	0.16	31	130	284
T-42	232379	3115421	Taksar	Pisti	SC	300.1	13.64	20.0	0.29	13	28	500
T-43	233161	3115619	Taksar	Pisti	SC	440.2	18.00	0.0	0.00	18	36	190
T-44	232919	3115437	Taksar	Pisti	SC	540.3	40.71	120.1	3.41	15	141	166
T-45	232057	3115834	Taksar	Jamuna Gahira	SC	380.2	42.96	0.0	0.00	42	374	1006
T-46	232950	3115944	Taksar	Pisti	SC	600.3	15.87	20.0	0.17	44	309	568
T-47	231724	3115580	Taksar	Samkhoria	SC	520.3	31.77	80.0	3.06	31	250	919
T-48	231469	3115418	Taksar	Samkhoria	SC	580.3	22.10	0.0	0.00	49	117	845
T-49	231489	3115717	Taksar	Samkhoria	SC	400.2	46.80	0.0	0.00	40	396	1113
T-50	231798	3115699	Taksar	Samkhoria	SC	400.2	29.88	20.0	0.35	37	340	1032
T-51	232114	3115262	Taksar	Samkhoria	SC	320.2	10.93	80.0	1.56	36	32	599
T-52	233492	3113283	Taksar	Sathimure	SCS	380.2	32.08	100.0	1.20	41	45	139
T-53	233693	3113035	Taksar	Sathimure	SCS	580.3	23.62	100.0	4.69	30	233	280
T-54	233474	3112985	Taksar	Sathimure	SCS	320.2	26.56	120.1	2.26	27	10	78

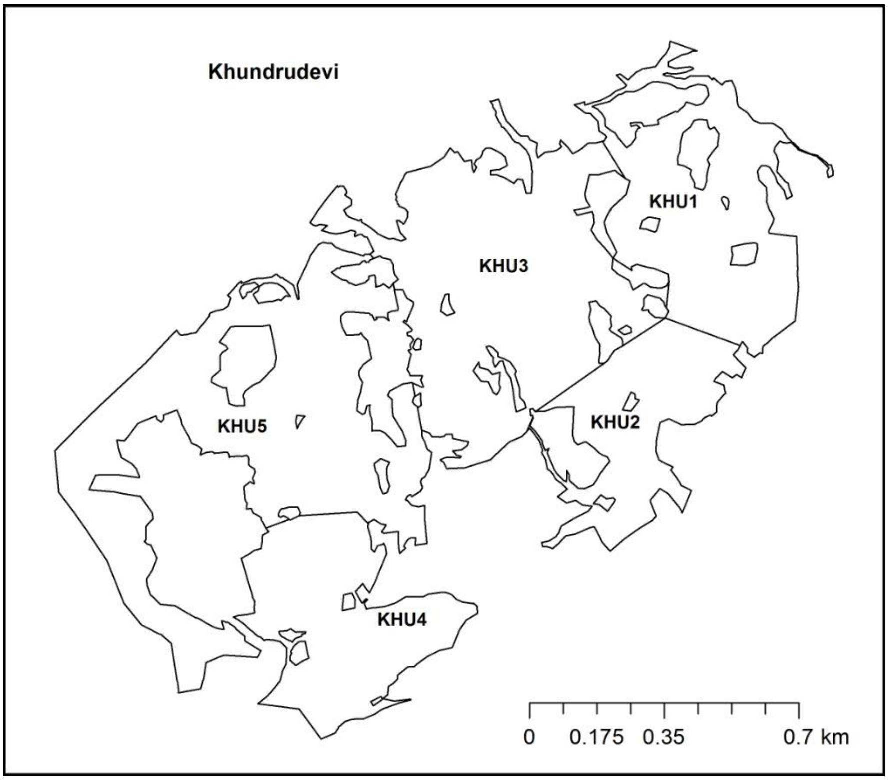
Plot No	Easting	Northing	VDC	CF Name	Forest Type	nTree	gTree	nStump	gStump	Slope	Distance to road	Distance to settlement/s
T-55	233674	3113219	Taksar	Sathimure	SCS	840.4	41.58	40.0	2.92	26	134	267
T-56	233244	3113413	Taksar	Sathimure	SCS	700.3	25.60	80.0	1.98	45	72	302
T-57	233756	3114265	Taksar	Tamakhani	SC	680.3	29.26	180.1	4.02	32	36	251
T-58	233193	3113763	Taksar	Tamakhani	SC	720.4	24.99	300.1	11.20	35	51	175
T-59	233630	3114255	Taksar	Tamakhani	SC	540.3	23.65	60.0	1.96	31	130	214
T-60	233780	3114124	Taksar	Tamakhani	SC	360.2	33.71	140.1	5.29	39	30	212
T-61	233546	3114580	Taksar	Tamakhani	SC	460.2	14.43	80.0	1.37	39	45	153
T-62	231851	3114348	Taksar	Nag Bhairab	SC	720.4	42.39	400.2	14.71	32	177	240
T-63	233507	3116084	Taksar	Pisti	SC	580.3	37.03	0.0	0.00	38	228	703
T-64	232076	3114013	Taksar	Nag Bhairab	SC	280.1	12.59	20.0	0.40	54	81	508
T-65	232354	3112562	Taksar	Lampata	SCS	40.0	0.73	0.0	0.00	25	78	250
T-98	233744	3113767	Taksar	Tamakhani	SC	740.4	49.02	40.0	1.26	26	98	219
T-99	233263	3113015	Taksar	Sathimure	SCS	540.3	27.81	260.1	7.78	23	182	149
T-100	233229	3113583	Taksar	Tamakhani	SC	380.2	23.99	140.1	3.21	15	130	297

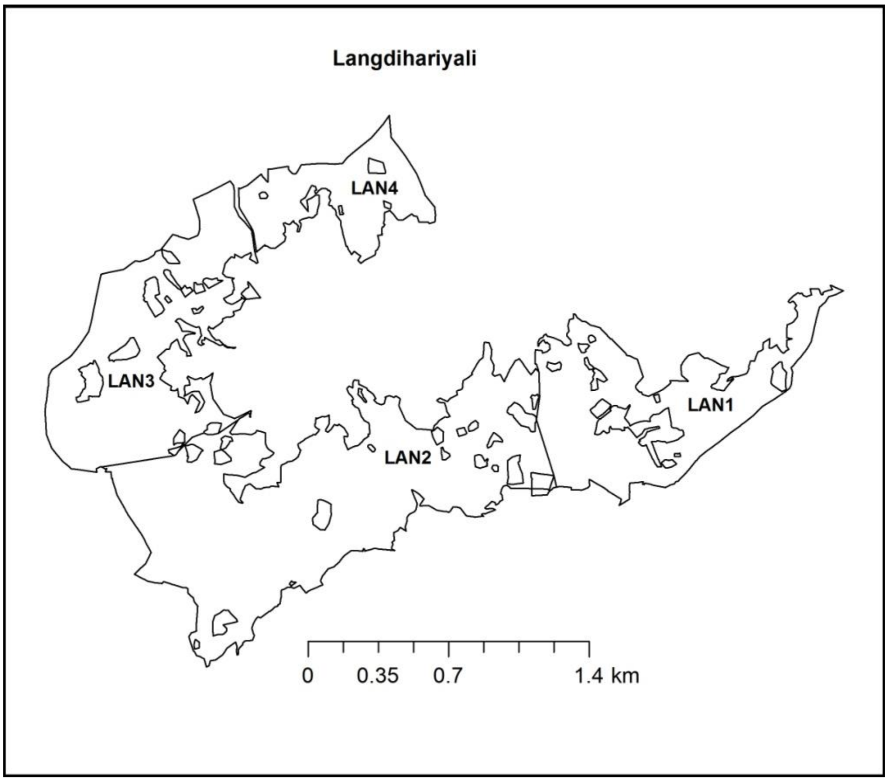
Prefixes n and g in table column heading represent density and basal area.
SC= *Schima wallichii-Castanopsis indica* mixed forest, SCS = *Schima wallichii-Castanopsis indica-Shorea robusta* mixed forest

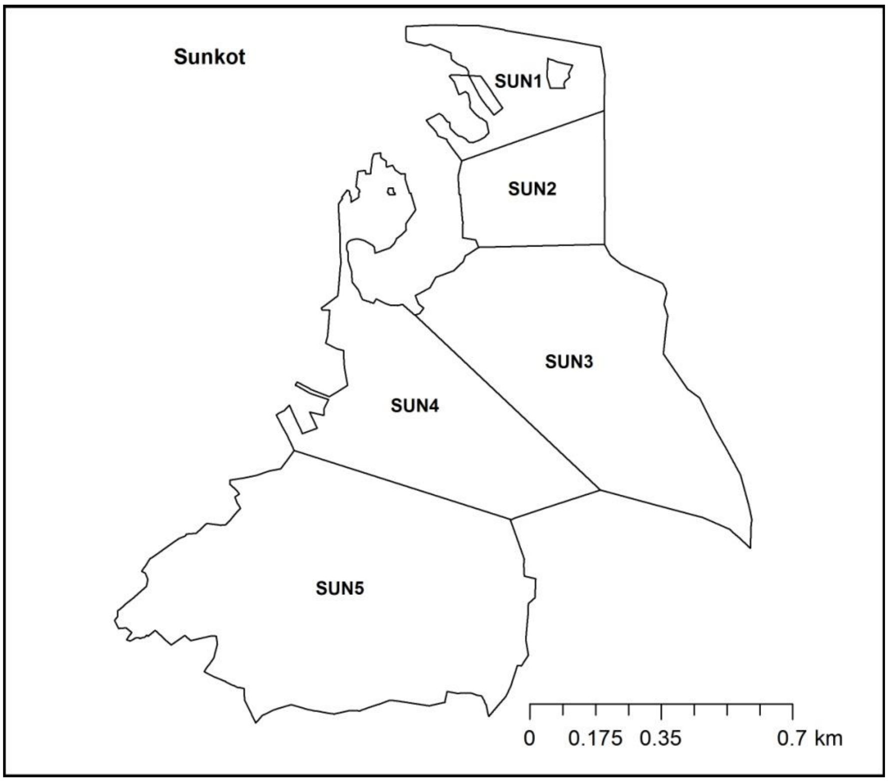
Maps of
Community Forest

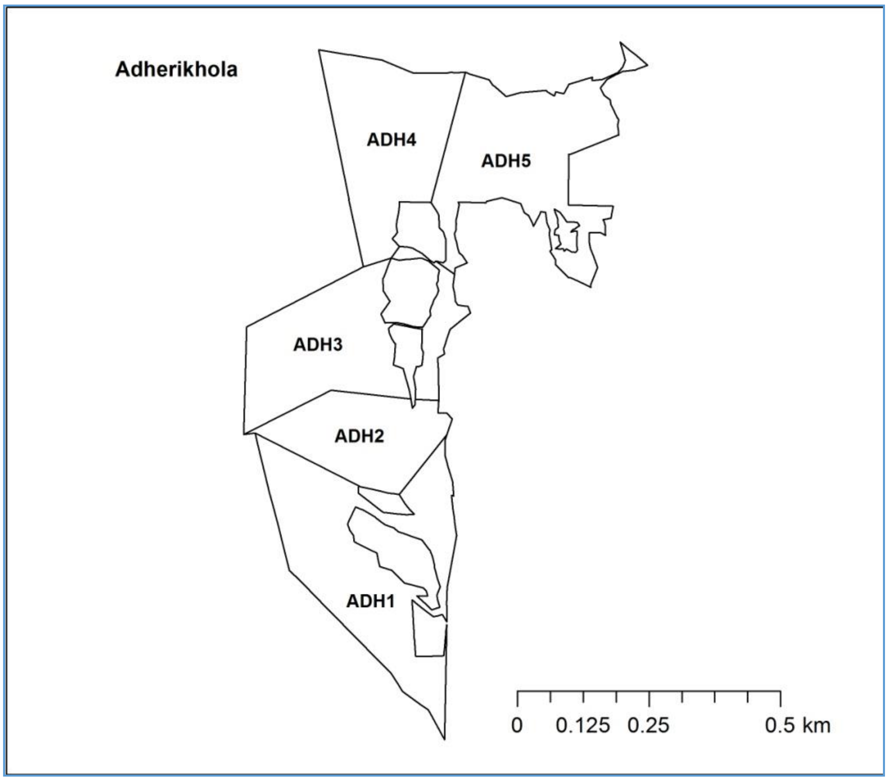
Appendix 3: Community forest maps showing management blocks

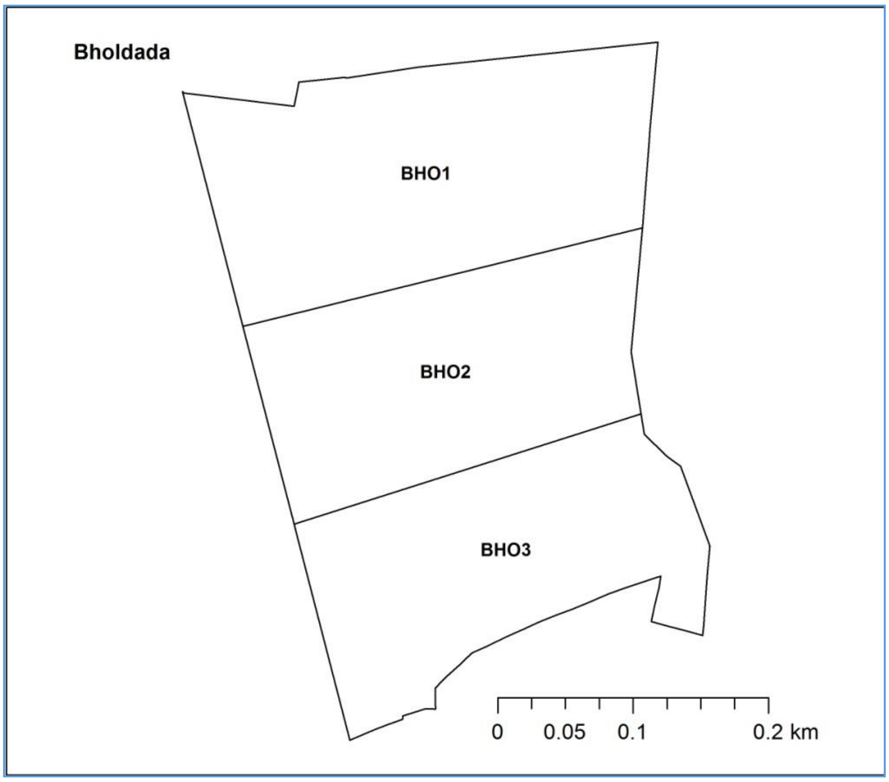


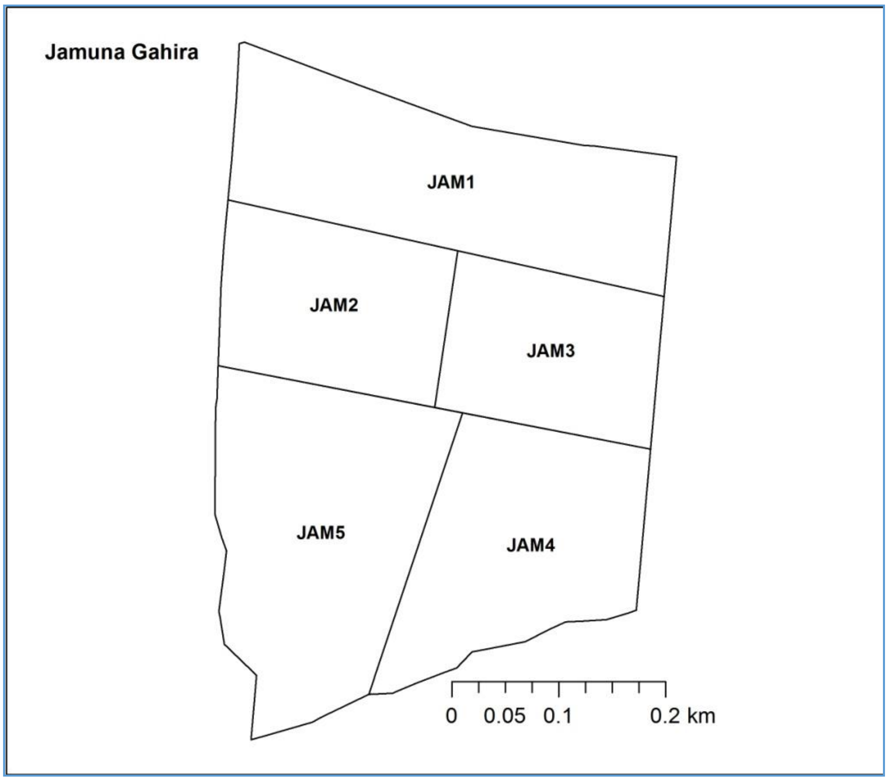


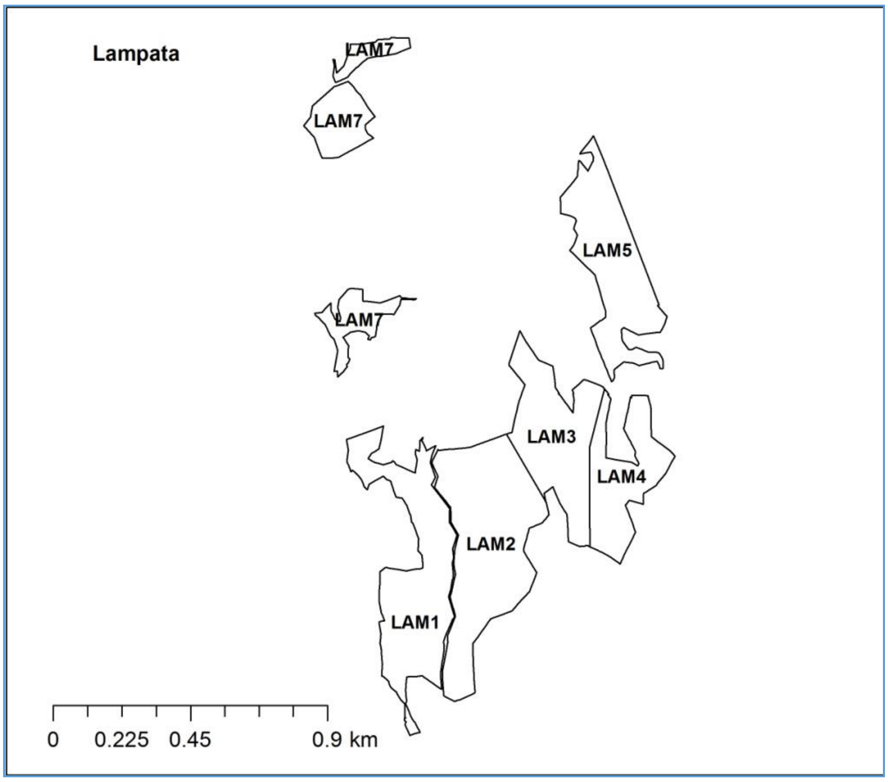

Langdihariyali
LAN4
LAN3
LAN2
LAN1
0 0.35 0.7 1.4 km

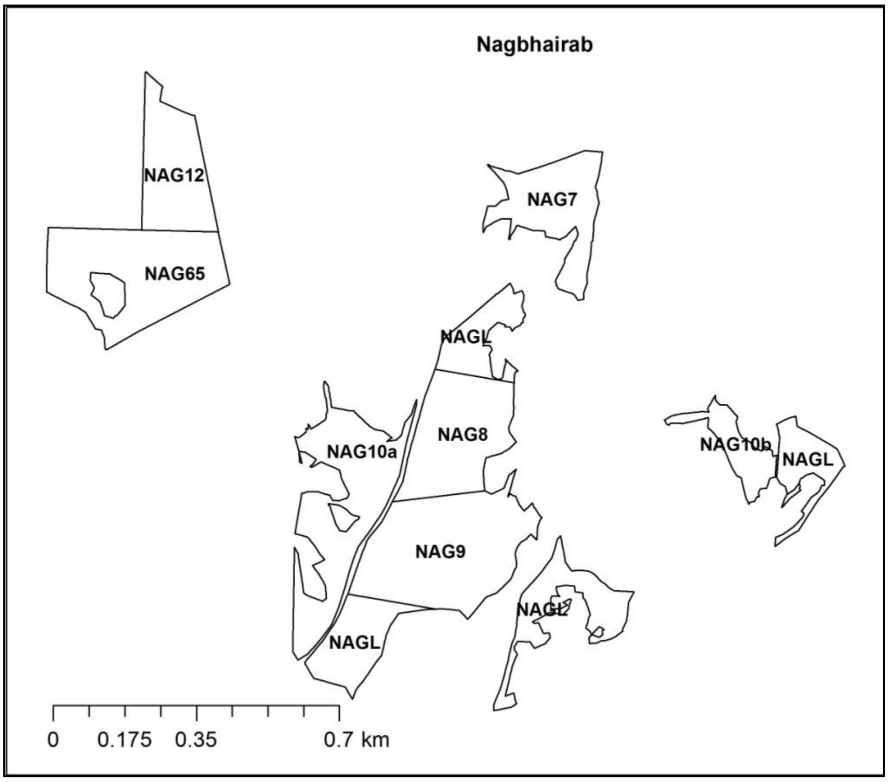

Sunkot
SUN1
SUN2
SUN3
SUN4
SUN5
0 0.175 0.35 0.7 km

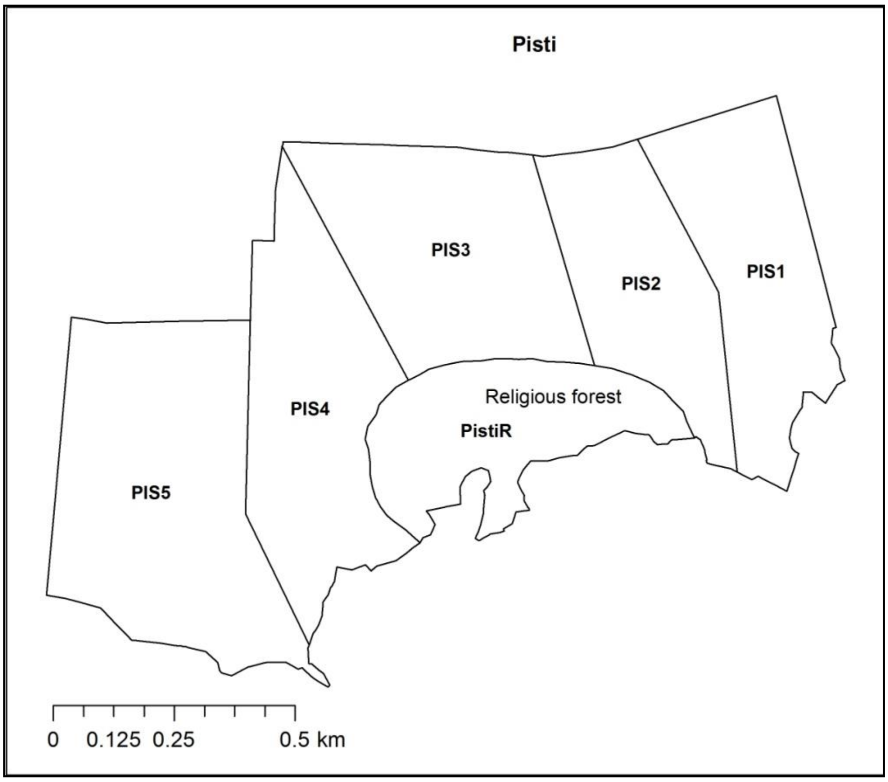

Adherikhola
ADH4
ADH5
ADH3
ADH2
ADH1
0 0.125 0.25 0.5 km

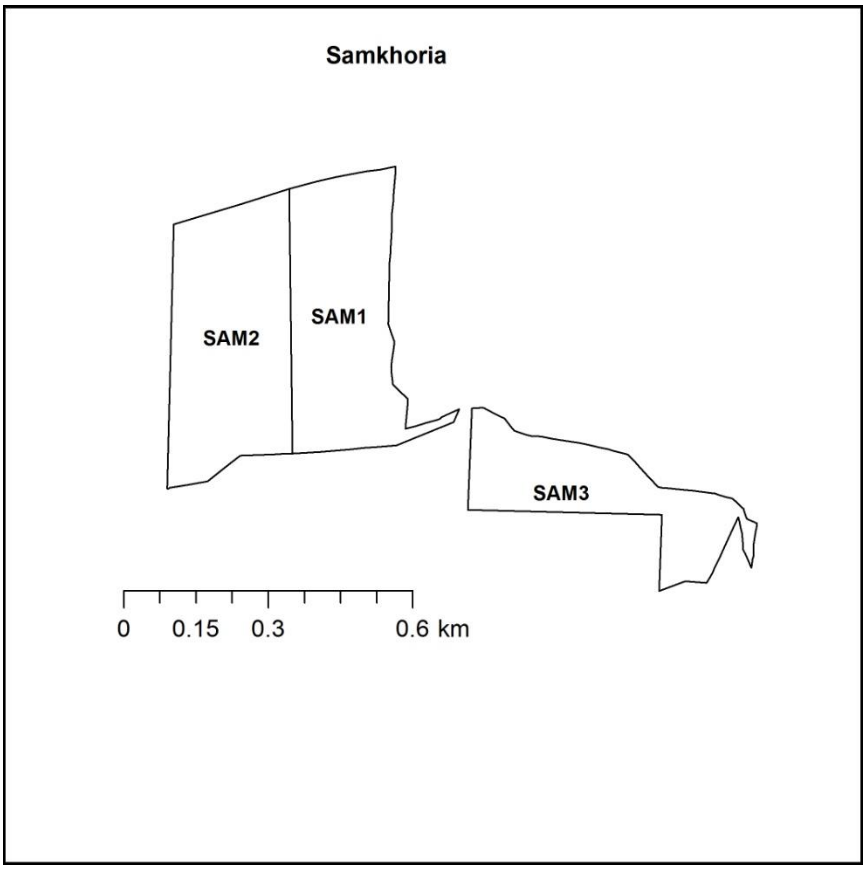

Bholdada
BHO1
BHO2
BHO3
0 0.05 0.1 0.2 km

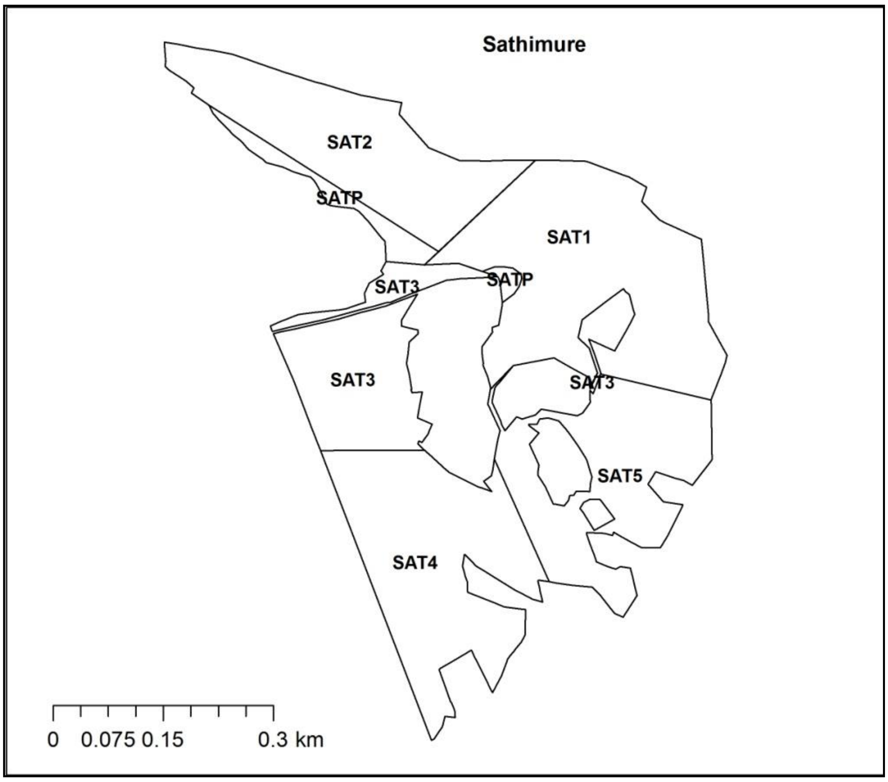

Jamuna Gahira
JAM1
JAM2
JAM3
JAM5
JAM4
0 0.05 0.1 0.2 km

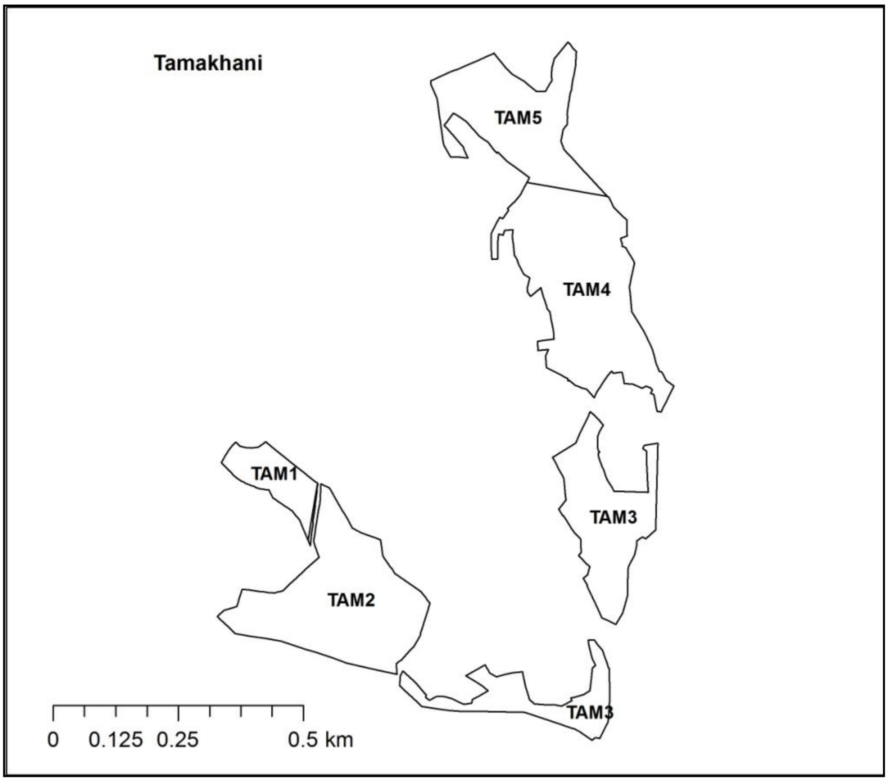

Lampata
LAM7
LAM7
LAM5
LAM7
LAM3
LAM4
LAM2
LAM1
0 0.225 0.45 0.9 km


Nagbhairab
NAG12
NAG65
NAG7
NAGL
NAG8
NAG10a
NAG10b
NAGL
NAG9
NAGL
NAGL
0 0.175 0.35 0.7 km


Pisti
PIS3
PIS2
PIS1
PIS4
Religious forest
PistiR
PIS5
0 0.125 0.25 0.5 km


Samkhoria
SAM1
SAM2
SAM3
0 0.15 0.3 0.6 km


Sathimure
SAT2
SATP
SAT1
SAT3
SATP
SAT3
SAT3
SAT5
SAT4
0 0.075 0.15 0.3 km


Tamakhani
TAM5
TAM4
TAM1
TAM3
TAM2
TAM3
0 0.125 0.25 0.5 km

Appendix 4: Questionnaire for Household Interview

Venue	Residence of sample household
Participant	Household heads, matured members, spouse can join
Activities	Interview, observation and photography
Materials	Forest and village map, operational plan
Expected time:	1.5 hours

A. Identification (identification and location of household)

Household head name and code	*Name*	
VDC Name/ward no/village	*Name/no*	
Name of primary/secondary respondent	*Name*	
GPS coordinates of HH (UTM format)	Easting:	Northing:
Contact phone number and holder		
Interview data: / /		Interviewer:

B. Household characteristics and composition

PID	Members' Name	Relation to HH head *(Code[1])*	Sex *(1=male, 2 female)*	Age (Year borne)	Education *(years completed)*	Main occupation *(Code[3])*	Residency period (months/year)
1		0=Head					
2							
3							

Code[1]: Relationship: : 0= Household head; 1= spouse (legally married or cohabiting; 2= son/daughter; 3= son/daughter in law; 4= Grandchild; 5= mother/father; 6= mother/father in law; 7= brother or sister; 8= brother/sister in law; 9= uncle/aunt; 10= nephew/niece; 11= step/foster child; 12= other family members; 13= Not related (e.g., servant).

Code[3] Occupation: 1:shop/trade; 2:agric. processing; 3:handicraft; 4:carpentry; 5:other forest based; 6:other skilled labour; 7:=transport (car, boat,...); 8:lodging/restaurant; 9:brewing; 10:brick making; 11:landlord/real estate; 12: foreign employment; 13: rural/urban Porters; 14:herbalist/traditional healer/witch doctor; 15:quarrying; 19:other, specify:

Code2: 1: Unmarried; 2: Married; 3: Divorced; 4: Widow

C. Household information

1. Roof materials of main house (*Codes: 1:thatch, 2: stones, 3: tin, 4: RCC, 5: tiles, 6: other (specify)*)		
2. Wall materials of main house *Codes: 1: wood, 2: Stones, 3: RCC, 4: bricks, 5: bamboo, 6: reeds*		
3. Two main sources of cooking and heating *(Codes: 1: LP gas, 2: electricity, 3: Firewood, 4: Kerosene, 5: Dung, 6: Solar, 7: other Specify)*		
4. Distance to community forest from where forest products are collected	km:	min:
5. Distance to other forest from where products are collected	km	min:

D. Land holding and utilization

Land types	Area	Land Units *(Code land units)*	Major products during last 12 months (Name)		
			1	2	3
1. Crop lands					
2. Fallow lands					
3. Land currently under forest/trees					
4. What type of irrigation facility do you have in your land? (M*ost important source you have access to*) *Codes: 1=Seasonal canal, 2= Perennial canal; 3=Deep well; 4=Spring (like artesian well), 5=Boring ; 6= none or monsoon*					

Code land unit: 1: Hectare; 2: Ana; 3: Dhur; 4: hal, 5. Muri, 6, Other (specify)

E. Livestock holding and trends

Livestock Type	Number *(current)*	Numbers/quantity during **last 12 months** period			
		Sold	Purchased	Self-used/gifted	New borne*
1. Cow					
2. Buffalo					
3. Ox					
4. Goats					
6. Other *(specify)*					
Trends of livestock holding over last 10 years *(codes:1: increasing, 2: stable, 3: declined)*					
How do you feed you animals? *(codes: 1: stall feed, 2: graze, 3: both)*					

**from your own stock*

F. Livelihood income sources

	Income sources	Rank
What are the most important income sources of your household? *(rank only 3 most important sources in order of 1-3)*	Agriculture (cereal crops)	
	Vegetables	
	Forest/tree products	
	Fruits	
	Livestock incomes (meat, eggs, compost, ghee etc.)	
	Aquaculture/fishing	
	Remittance/pension/salary	
	Rural causal labour	
	Urban labour	
	Other business/trade (not included above)	
	Land/house rents (land/house/other assets)	
	Other *Specify*…………..	
	Jobs/employment	

G. Access to forest and tree resources and preferences

1. Since when are you member of this community forest?		*Year*
2. Are you member of another CFUG too?		*(1,0)*
3. Why did you join FUG? *(Rank 1-3 for three most important reasons)*.	Increased access to forest products	
	Access to other benefits like training, loan	
	Forest products at subsidised price	
	Better quality of forest products	
	Securing rights over forest (for future)	
	Social respects and networking	
	Requested by fellow villagers	
	Forced by governments/chairperson	
	Being a respected person at village/community	

	Better environmental benefits like protection of river banks, water sources etc.	
	I have no idea about it	
	Other reason (*please specify)*	
	Other reason (*please specify)*	
	Categories	**Number**
4. Approximately how many trees do you own in your private lands in these categories?	Firewood	
	Fodder	
	Fruit (exclude bananas)	
	Timber	
	Bamboo clumps	
	Ornamental trees	
5. What is the status of trees on your (farm) land compared to last 10 years? *Codes: 1= decreased, 0: same/stable; 2=increased*		
6. If trees are increased *(2 above),* what are the main reasons for retaining and/or planting trees in farm lands*?(Rank 1-3 for most important three reasons)*	Firewood (own use/sale)	
	For fodder (own use/sale)	
	For fruits (own use/sale)	
	For timber/poles (own use/sale)	
	For fruits (own use/sale)	
	Land reclamation and protection	
	For land demarcation	
	Regeneration in fallow/pasture lands	
	Plantation	
7. If trees are **decreased** (*3 above*), what are the main reasons for reducing trees from farm lands? *(Rank 1-3 for most important three reasons*	Cleared for cultivation	
	Lost due to road construction/expansion	
	Cleared for own construction of e.g. house	
	Damaged by winds and fire	
	Sold for cash	
	Land with trees sold	
	Landslides, flooding	
	Infestation and pests	
	Removed due to competition with crops	
	Removed due to low return	
	Self-used	
8. What is the most important source of these forest products for your household? *Select only one for each product type) (codes: 1:This community forests, 2: other community forest, 3: government/public forests, 4:Private forest/trees, 4: purchase, 5:Never used this products, 6: others (specify)*	Timber	
	Dry firewood	
	Green firewood	
	Poles	
	Tree fodder	
	Grass	
	Bamboo	
	Leaf-litter	
	Other NTFPS *(specify)*	

9. What are the most important trees species in these categories used by your household? *(list them in order of preference)*	Rank	Timber	Firewood	Tree fodder	*NTFPs*
	1				
	2				
	3				

	4				
	5				

H. Forest product demand and sufficiency

1. How has your dependency on forest changed over last 10 years? *(Codes: 1: decreased, 2: stable, same, 3: increased,*		
2. Have you received any timber from your CF during last 5 years?		*(1,0)*
3. If *yes* above, describe following regarding your timber receipts	Name of CFUG	
	Year of purchase	
	Grade or Species	
	Quantity received (tree/cft)	
	Total price paid, if any	
	Quantity sold, if any	
	Total selling price (rs)	
4. If *no* above, what is the most important reason for not receiving timber *(tick only one reason)*	We applied for it but not allocated	
	We usually get timber from other forests	
	We usually get timber from my own private land	
	We have not needed any timber during last 5 years	
	We cannot afford for timber	
	We do not use any timber for our house	
	Other *Specify* ……………..	

	Products	**Process**
5. How do you place your demand for various forest products from your CFUG? (*Codes: 1: Quota has been fixed for each HH, 2: forest is opened for a period and we should participate, 3: we apply when needed, 4: during socio-economic survey 5: there is no regulation for this product, 6: others (specify)*	Timber	
	Firewood	
	Tree fodder	
	Poles	
	Leaf litter	
	Grass	
	Bamboo/shoots	
	Agricultural implements	
	Food/fruits	
	Other (specify)	
6. How often do you demands these products from your forest *(codes: 1 seasonally, 2:annually, 3: one in two years, 3: once in five years, 4: as we needed*	Timber	
	Dry firewood	
	Green firewood	
	Poles	
	Tree fodder	
	Ag. Implements	
	Bamboo	
	Leaf-litter	
	Forest foods/fruits	
7. Do you meet your annual household requirement of these products from your CF? *(Codes, 1: no, not at all, 2: yes, it is sufficient, 3: yes but only a part of our requirement, 4: we do not use this product from forest, 5: other (specify)……*	Fodder	
	Poles	
	Firewood	
	Leaf-litter	
	Grass	
	Bamboo/shoots	
	Agricultural implements	
	Food/fruits	
	Other (specify)……………..	

8. If your HH demands have not met from CF, what are the reasons? *Select as appropriate*	The forest does not have sufficient products	
	Collection is allowed only for limited period of the year	
	There is growing demands for these products	

	Collection is made from a part of the forest only	
	Our time and the collection period does not match	
	Others *(Specify)*………………………..	

I. Forest product collection practices

During last **12 months**, what products (other than timber) did your household collect **from community and other public forest** and sell, if any?

Forest Products	Collected Unit[1]	Total collected units	Total FUG fees paid (Rs)	Collection & processing cost (Rs)	Selling units	Total sold units	Total selling price (Rs)
Dry firewood							
Green firewood							
Poles							
Leaf litter							
Tree fodder							
Grass							
Bamboo/ shoots							
Ag. implements							
Wild food/fruits							

Code collection unit[1]: 1: Cft, 2: Tree, 3: Doko, 4: Bhari/load, 5: others (specify)

During last **12 months**, what are the different tree products your household collected from **your own land and other public lands other than forest**?

Types of product	Unit	Qty collected	Qty Self used	Qty Sold	Sold to (Code [2])	Land use[3] (product collected from)
Firewood						
Tree fodder						
Timber						
Poles						
Fruits						

Sold to codes[2]: 1: neighbour, 2: local whole seller, 3: local market, 4: other: specify in the cell
Land use codes[3]: 1: Cultivated land, 2: Private forest, 3: Pasture, 4: other public lands but not from forests

J. Spatial knowledge of forest management and utilization

1. How many (management) blocks do you have in your forest?		
2. Can you find those blocks in the forest?		*(1,0)*
3. Do you think some parts of the forest are heavily used compared to other parts of the forest?		*(1,0)*
4. If *yes* (1 above), locate the place of heavy use in accompanying map *(mention map location or name of the place)*		
5. What are the main reasons for heavy use of this/these locations? (*Select and rank three most important reasons from 1-3)*	Close to village	
	Close to road/trails	
	Easy terrain	
	Areas of conflict	
	Presence of species/products	
	Others *(please specify)*	
6. Which parts of your forest are least utilized? *Specify location name from map*		
7. What are the frequently visited sites in the forest for these products by your household? (*mention the name of location from the map)*	Timber	
	Dry firewood	
	Green firewood	
	Tree fodder	
	Ag. Implements	
	Grass	
	Leaf-litter	
	NTFPs	
	Wild fruits/foods	

Appendix 5: Questionnaire for FUG meeting

Venue	CFUG meeting place
Participant	CFUC executive members, 4-5 participants
Activities	Discussion, interview, review of office documents of CFUG
Materials	Forest and village map
Expected time:	1.5 hours

This instrument is designed to collect information related to individual community forest user group and their community forest management practices.

A. Identification and control information

CFUG name		
VDC/Ward/Hamlet		
Date of interview/discussion		
Participants		
GPS coordinates of village/hamlet centre	Easting:	Northing
Average MSL of the village/hamlet centre		*(m)*

B. CFUG formation and demography

1.	Year of first formation (FUG)	(YYYY
2.	Current CFUG size (no of HH)	
3.	How many HH migrated out from this CFUG during last 10 years?	
4.	Number of new HH as CFUG members durig last 10 years?	
5.	Origin of new CFUG member (*Codes1: splitting of existing HH, 2: Missed HH, 3: New settlers)*	
6.	If splitting of HH, do they need to pay to be a member?	*(rs)*
7.	If new settlers, how much should they pay to be a member of CFUG?	*(rs)*
8.	Who initiated this CFUG formation? *Codes: 1:local initiative; 2:initiative from NGO; 3:initiative from government; 4:by local leaders, 5: other (specify)*	
9.	Number of ethnic groups in this CFUG	*No*
10.	Major ethnic/caste group of the CFUG	*(Name of Ethnic/caste group)*

C. Village Infrastructures

1. Approximately how many of your FUG members use LPG as cooking energy					
2. Presence of at least one road usable throughout the year					*(1: yes, 0: No)*
3. If No above, number of months the road is usable					*(# of months)*
4. Distance to road that is usable throughout the year					*(Km)*
5. What is the distance from centre of this FUG hamlet to the nearest ……		Km	Min[1]	Mode of transport[2]	
	District market				
	Village centre				
	Market for major consumption goods				
	Market where agricultural products are sold				
	Market where forest products are sold				
	Forest service office (forest offices)				

[1]*Time taken by normal means of transport*
[2] *Mode of transport: 1: walking, 2: Bus, 3: bicycle 4: other*

D. **Forest management objectives, practices and perceived impacts**

1. What is the major type of forest? *codes: 1: Shorea robusta, 2: Schima-Castanopsis, 3: Acacia-Dalbergia, 4: Pinus, 5: Alnus*, 6. Others (specify)		
2. What was the status of your forest at the time of handover? *(Codes: 1: natural forest, 2: plantation forest, 3: shrub lands, 4: scrublands, 5: bare lands with few trees, 6: other (specify)*		
3. What are the main objectives of FUG formation? *(select any 3 objectives only)*	Timber production	
	Supply of basic forest products	
	Land protection/reclamation from e.g. erosion	
	Watershed conservation	
	Biodiversity conservation	
	Tourism	
	Fund generation for community development	
	Conserve cultural heritage	
	Claiming the forest land	
	Seeking incomes from environmental services	
	Special protection(like water spring)	
	Other *(specify)*	
	Other *(specify)*	
4. Have you undertaken any active or deliberate management of your forest?		*(1: yes, 0: no)*
	Types of management	*Codes*
5. If *yes* above, to what extent these management activities are undertaken in the forests? *Codes: 0=no, not at all; 1=yes, but only to a limited extent; 2=yes, they are common*	Planting of trees	
	Cutting down undesired trees/bush	
	Protection of water catchment	
	Land allocation to a group like herders, grazers or poor group	
	Forest fencing	
	Limited/restricted use of certain trees (like honey tree)	
	Promotion of regeneration	
	Forest resource mapping and inventory	
	Fire-line construction/maintenance	
	Land protection (like bamboo plantation)	
	Other (*Specify)*_ _ _ _ _ _ _ _	
6. What are the major difficulties this CFUG has experienced in managing the forest? (*select 3 most important difficulties in order of 1-3)*	Land/terrain slopes	
	Risk of land erosion	
	Paucity of useful species to motivate users in management	
	Thefts from neighbouring villages	
	Distance to the forest (i.e. far)	
	Conflicting interests of users	
	Lack of appropriate technology for felling/conversions	
	Increasing cost of management	

	Increasing cost of forest product extraction	
	Livestock grazing	
	Lack of planting stock/seeds	
	Low participation/motivation of users	
	Forest fire	
7. What are the 3 most important favourable impacts of community forests in this village *(rank any three in order of 1-3)*	Forest crime rate decreased	
	Vegetation cover increased	
	Tree size increased	
	Land slide decreased	
	Water source protected	
	Local employment opportunities increased	
	Social harmony enhanced	
	Social networking has increased	
	Community development activities	
	Support to education	
	Increased training opportunities	
8. Are there any negative impacts of community forests in this village? *(Select and rank any three impacts in order of 1-3)*	Increased risks of wildlife	
	Degradation of non-community (public) forest	
	Forest composition changed (due to plantation or selective felling)	
	Forest boundary conflicts and distrust	
	Restriction to establish forest based industries	
	Other *(specify)*_ _ _ _ _ _	
	Other *(specify)*_ _ _ _ _ _	

E. Forest resource base and perceived trends

How has the availability and status of different forest products changed over last 10 years?

		Timber or poles	Firewood or other wood	Fodder Or Grass	Other NTFP S
1. What is the most important forest product for the livelihoods of the people in this FUG (in this category)					
2. What is the most important species in this category?					
3. How has availability of this product and species changed over time? *(codes: 1: declined, 2: stable/same, 3: increased)*					
4. Do the FUG members need permission to harvest these products *(Codes: 0:no; 1:yes, users have to inform the authorities/CFUC; 2: yes, written permission needed)*					
5. If yes, do the FUG members need to pay for permission? *(codes: 1: yes, 0: no)*					
6. If availability of forest products has **declined**, what are the reasons *(please*	**Reasons**				
	Increased use by users				
	Increased use by other villagers				
	Restrictions imposed by government				

rank the three most important reasons)	Restriction imposed by CFUGs				
	Increased marketing of the products				
	Fire incidences/burnt				
	Livestock grazing				
	Invasive species				
	Available only in difficult locations of the forest				
	Other *(specify)*				
7. If availability of this product has **increased**, what are the reasons? *(please rank the three most important reasons)*	Reasons	Rank 1-3	Rank 1-3	Rank 1-3	Rank 1-3
	Only a few people use it				
	Protection of the forest				
	Presence of alternatives (like private trees)				
	Bare land revegetated				
	Decreased population				
	Improved technology of harvesting				
	Regulation of harvesting				
	Plantation				

F. Derivation of forest product demand and distribution system

	Products	**Demands derived by**
1. How do you derive user groups' demand for these products? *Codes: 1: Quantity already prescribed in OP, 2: collection periods prescribed in OP, 3: household survey/annually, 4: Application from HH, 5: Not regulated, 6: other (specify)*	Timber	
	Firewood (dry)	
	Firewood (green)	
	Tree fodder	
	Poles	
	Ground grass	
	Bamboo	
	Food/fruits	
	Agricultural implements	
	Leaf-litter	
	Grazing	
	NTFPs	
	Other *(Specify)*	

	Products	**Quantity**	**Units**	**Trends**
2. What is the current annual allowable provision for these product/service categories (in the right column)? How has this provisions for these products changed since CFUG formation? *(codes for units: 1: cubic feet, 2: duration/days, 3: whole tree, 4: Load/bhari, 5: Chatta (specify size), 6: Numbers, 7: Duration/areas, 8: Not mentioned, 8: Other (specify)*	Timber			
	Firewood			
	Tree fodder			
	Poles			
	Ground grass			
	Bamboo			
	Food/fruits			
	Agricultural implements			
	Leaf-litter			

Trend codes: 1: decreasing, 0: same/stable, 2: increasing	Grazing			
	NTFPs			
	Other *(Specify)*			

3. How has the general demand for forest products changed over last 10 years? *Codes: 1: decreasing, 2: stable, 3: increasing*	

4. What is the desired size of timber log (diameter)?		*cm*
5. What is the available size of log for timber (diameter) in your forest?		*cm*
6. Does annual quota (AAH) for timber meet users' demands?		*(1,0*
7. If timber production does not meet the users' demands, how do you deal with this issue?	Assess real HH needs	
	Demand is carried-on to the following year	
	Increase the harvest quota	
	Prioritize calamities or disasters	
	Other *(specify)*	
8. If the timber quota (AAH) exceeds the demands of CFUG, how do you distribute additional timber to customers inside/outside the CFUG? *(tick as appropriate)*	The quota never exceeds the demands from users	
	We only cut as per demands by users	
	Sold at FUG member rate	
	Sold at market prices	
	Auctioned away	
	Other *(specify)*	

G. Spatial aspects of forest management

1. Have you divided your forest into different blocks for management?		*(1,0)*
2. If *yes*, how many blocks are there in your forest?		*(No)*
3. If *yes*, what are the criteria of such blocking? *(tick **ONLY ONE** most important criteria)*	Management easiness (annually)	
	Forest types	
	Availability of products	
	There is no specific reason	
	Topography/terrain	
	Users' settlement/closeness	
	Other *(specify)*	
4. Can you find those forest blocks in the field?		*(1,0)*
5. If yes, how are these blocks demarcated in the forest? *(select as appropriate)*	The blocks follow natural boundaries like ridge, streams or creeks	
	The blocks follow human created features like foot trail, road or fire line	
	We have fixed pillars in the field	
	Blocks refers to prominent location around which blocks are defined	
	Other *(Specify)*	

	Products	**Map Locations**
6. Which parts of the forest are mostly used for these purposes in your forest? *(refer to names of locations in accompanying map)*	Firewood (dry)	
	Firewood (green)	
	Timber/poles	
	Tree fodder	
	Cattle grazing	
	Agricultural implements	

	Bamboo	
	Leaf-litter	
	Ground grass	

7. Considering all forest products, which part/area of your forest is heavily utilized/harvested? *(Locate in the map)*	*Map location*

8. Why are this/these area/s heavily utilized? *(rank 3 reasons from 1-3)*	Closeness to village	
	Presence of valuable/required products	
	Easy terrain/topography	
	Theft from non-member villagers	
	Management (utilization) intensity	
	Other *(specify)*	
	Other *(specify)*	

9. Which part/area of your forest is least utilized/harvested?	*Map location*

10. Why these parts of the forest are least utilized? (*rank 3 reasons from 1-3)*	Risky terrain	
	Absence of required forest products	
	Far from villages	
	Protected areas	
	Conflict	
	Other *(specify)*	

11. If you have these features (in right column) in or adjacent to your forest, do you have any management specifications in and around these features? *Codes: 1: fully protected, 2: protected to ….(m) distance, 3: plantation, 4: fencing, 5: regeneration promoted, 6: fire-line improvement 7: cleaning/weeding, 8: Nothing is done, 9: Other (specify)*	River/stream	
	Water spring	
	Eroded areas	
	Temples/sacred spots	
	Motor road	
	Trekking routes	
	Lake	
	Picnic spots	
	Cliff/rocks	
	Funeral sites	
	Cultivated areas inside the forest	

9. In addition to your own forest, do your FUG members collect products from other public forests?	*(1,0)*

	Products	**Rank**	**Map location**
10. If *yes* above, what are the **most important** products that your members collect from other forests? Can you locate the places in map from where selected products are collected? *(select 3 products and rank them from 1-3)*	Timber		
	Firewood		
	Fodder		
	Grasses		
	Bamboo		
	Leaf-litter		
	Fruits/wild food (Name)		
	NTFPs (name)		
	NTFPs (name)		

11. Which is the most important source of these products for user group of your CFUG? *Select only one for each categories listed in column at right* *Code: 1: private lands, 2: own community forest, 3: other public forest, 4: Other community forest, 5: Purchase, 6: Seldom used*	Timber	
	Firewood	
	Tree fodder	
	Poles	
	Grasses	
	Bamboo	
	Leaf-litter	
	Wild Fruits/food	
	Others	

H. Species preference and availability

	Rank	Timber	Firewood	Tree fodder	NTFPs
1 What are the most important species used by CFUG members in these categories? *(list them in order of preference)*	1				
	2				
	3				
	4				
	5				
	6				
	7				

I. Forest enterprises and market opportunities

1. Has the FUG received any direct benefits related to forest services during last 12 months? (Codes: *1: No, 2: yes, directly to households, 3: yes, both to village and households, 5: no idea*			
2. Do you have any forest based enterprises in this village?			*(1,0)*
3. If *yes*, name the enterprises operated in the villages	1		
	2		
	3		
	4		
4. If *no*, what are the potential forest-based enterprises for this village?	1		
	2		
	3		
	4		
5. What are the major issue/obstacles to establish these enterprises in the villages?	1		
	2		
	3		
	4		
6. Do you think products from your forest (including CF) have market potential?			(1,0)
7. If *yes*, what are the most important products that have market potential? (*select 3 most important products and rank then from 1-3)*	Timber		
	Firewood		
	Poles		
	Wild food		
	NTFPs *(name)*		
8. If *not* (0 of 6 above), what are the main reasons?	Insufficient production		
	Low quality of products		
	Absence of demanded species		
	Markets are far from the forest		
	Harvesting operation is difficult/costly		
9. What is the trend of private tree planting/growing in villages *(1: increasing, 2: stable, 3: decreasing*			

J. Access to technical support for forest management

9. From where do you receive technical supports/advises for your forest management? (*tick as appropriate)*	Government forest staff	
	Other service providers (research institutes)	
	Independent technicians	
	University students	
	Neighbouring CFUG	
	Others (specify)………..	
10. How often do you ask for technical advises from forestry staff? (*Codes: 1: monthly, 2: half yearly, 3: annually, 4: when needed.*		
11. In which of these CF activities did you ask forest office for technical advises/supports during last 5 years? (*tick as appropriate)*	For forest management operational plan preparation	
	forest boundary survey	
	Forest inventory	
	Timber harvesting operation	
	conflict resolution	
	Plantation	
	Forest management (thinning and weeding operations)	
	Others (specify)	
12. Did you get support from DFO when you asked for above activities?		*(1,0)*
13. If no, did it delay or affect your CF management activities?		*(1,0)*

Anything else you would like to add regarding CF management?

……………………………………………………………………………………………………

Thank you very much for your kind participation for this discussion.

Appendix 6: List of community forests in Lamjung District
(Source: District Forest Office, Lamjung, 2015)

SN	CFCode	Forest Name	VDC	Year Established	Area (ha)	FUG size	Population	Forest Type
1	25/02	Raniban	Archalbot	1997	54.60	172	822	Natural, Mixed
2	25/01	Raniswara	Archalbot	1996	41.44	134	754	Natural, Mixed
3	25/04	Loshapakha Ramchebhir	Archalbot	1999	41.86	98	497	Natural, Mixed
4	25/03	Chipleti Devi	Archalbot	1998	23.37	74	429	Natural, Mixed
5	11/01	Najare	Baglungpani	1994	141.20	65	413	Natural, Mixed
6	11/03	Mulabari	Baglungpani	1995	203.41	135	769	Natural, Mixed
7	11/02	Shivanari	Baglungpani	1996	188.09	61	326	Natural, Mixed
8	11/04	Rapasingh	Baglungpani	2005	164.00	52	331	Natural, Mixed
9	02/05	Chisapani	Bahundada	2006	34.81	48	278	Natural, Mixed
10	02/07	Tatopani	Bahundada	2012	28.25	38	229	Natural, Mixed
11	02/01	Raktakali	Bahundada	2000	159.98	82	462	Natural, Mixed
12	02/03	Milandanda	Bahundada	2004	36.92	26	141	Natural, Mixed
13	02/08	Mainagairi	Bahundada	2014	7.86	36	180	Natural, Mixed
14	02/04	Mahadevsthan	Bahundada	2005	52.00	48	276	Natural, Mixed
15	02/02	Maurikhola	Bahundada	2004	6.42	15	73	Natural Plantation
16	02/06	Premdada	Bahundada	2009	197.00	58	359	Natural, Mixed
17	07/12	Devi deurali	Bajhakhet	2006	159.23	45	273	Natural, Mixed
18	07/01	Sandhu murunche	Bajhakhet	1994	62.15	56	283	Natural, Mixed
19	07/04	Khanche	Bajhakhet	1994	205.86	35	169	Natural, Mixed
20	07/07	Indreni	Bajhakhet	1997	199.48	57	345	Natural, Mixed
21	07/14	Miteri	Bajhakhet	2006	139.89	49	284	Natural, Mixed
22	07/08	Kalika Thuli Khoriya	Bajhakhet	1998	31.75	47	240	Natural, Mixed
23	07/11	Baspani	Bajhakhet	2002	24.10	33	214	Natural, Mixed
24	07/03	Khasur	Bajhakhet	1994	337.25	144	831	Natural, Mixed
25	07/06	Mahakali	Bajhakhet	1996	115.57	41	231	Natural, Mixed
26	07/09	kalika	Bajhakhet	1998	30.26	62	318	Natural, Mixed
27	07/05	Dharapani	Bajhakhet	1996	11.02	57	293	Natural, Mixed
28	07/13	Mahadevstahn	Bajhakhet	2006	36.42	43	225	Natural, Mixed
29	07/10	Kerabari	Bajhkhet	2000	56.98	33	214	Natural, Mixed
30	34/05	Chandi deurali	Bangre	1999	23.50	45	266	Natural, Mixed

SN	CFCode	Forest Name	VDC	Year Established	Area (ha)	FUG size	Population	Forest Type
31	34/09	Dhumkhola Bhalu Khola	Bangre	2002	14.20	82	469	Natural, Mixed
32	34/07	Chakradevi	Bangre	2000	38.55	48	288	Natural, Mixed
33	34/04	Bhadaure	Bangre	1999	56.12	87	539	Natural, Mixed
34	34/08	Saldada	Bangre	2001	50.97	76	393	Natural, Mixed
35	34/06	Raja Rajeshowri	Bangre	2000	60.00	41	279	Natural, Mixed
36	34/02	Chandisthan	Bangre	1998	47.33	31	157	Natural, Mixed
37	34/01	Krimire swara	Bangre	1994	13.30	22	111	Natural, Mixed
38	34/03	Hariyali danda	Bangre	1999	16.24	68	396	Natural, Mixed
39	12/02	Jholunge bagar	Besisahar	2001	1.56	72	375	Natural Plantation
40	12/03	Pakhathok	Besisahar	2004	2.93	101	476	Natural, Mixed
41	12/01	Shanti	Besisahar	2001	59.75	299	1615	Natural, Mixed
42	27/06	Mandali	Besisahar	1997	125.43	127	608	Natural, Mixed
43	27/07	Patlepani	Besisahar	2002	88.54	90	501	Natural, Mixed
44	12/04	Shivashakti	Besisahar	2008	34.84	182	936	Natural, Mixed
45	27/01	Myagdipakha	Besisahar	1996	60.67	60	310	Natural, Mixed
46	28/12	Jaireni patal	Besisahar	2009	85.08	61	355	Natural, Mixed
47	44/06	Dundure Dhandpakha	Bhalayakharka	2000	16.25	47	365	Natural, Mixed
48	44/02	Odalpato/pani	Bhalayakharka	1995	14.00	78	410	Natural, Mixed
49	44/03	Kaprechaur	Bhalayakharka	1995	54.15	97	598	Natural, Mixed
50	44/04	Suryodaya	Bhalayakharka	1997	31.78	64	368	Natural, Mixed
51	44/01	Raniban	Bhalayakharka	1994	34.25	165	1002	Natural, Mixed
52	44/05	Satidevi	Bhalayakharka	1997	136.45	69	430	Natural, Mixed
53	44/07	Ekata	Bhalayakharka	2016	4.19	48	294	Natural, Mixed
54	26/03	Bhoteni	Bharte	1994	36.12	63	383	Natural, Mixed
55	26/04	jaljale Patal	Bharte	1996	45.00	62	414	Natural, Mixed
56	26/07	Kamerepani Raniban	Bharte	2000	14.34	104	625	Natural, Mixed
57	26/09	Shirubari	Bharte	2002	32.20	57	348	Natural, Mixed
58	26/02	Bigraha	Bharte	1994	100.64	102	797	Natural, Mixed
59	26/06	Jhagare Lamiswara	Bharte	1998	27.17	43	244	Natural, Mixed
60	26/08	Ichhapuri kamerepani	Bharte	2001	24.56	62	347	Natural, Mixed
61	26/05	Mahila Namuna	Bharte	1996	1.16	155	832	Natural Plantation
62	26/01	Jungepani	Bharte	1994	57.17	111	566	Natural, Mixed
63	14/02	Maping	Bhoje	2001	113.50	46	225	Natural, Mixed

SN	CFCode	Forest Name	VDC	Year Established	Area (ha)	FUG size	Population	Forest Type
64	14/01	Komro	Bhoje	1999	305.98	146	758	Natural, Mixed
65	14/03	Monhedevi	Bhoje	2009	194.54	58	315	Natural, Mixed
66	14/06	Ramledevi	Bhoje	2010	187.00	78	451	Natural, Mixed
67	14/04	Banaspati	Bhoje	2009	109.10	45	225	Natural, Mixed
68	14/05	Protara Sajhi	Bhoje	2010	79.68	57	349	Natural, Mixed
69	37/05	Raniban	Bhorletar	1996	26.08	103	538	Natural, Mixed
70	37/09	Hallesi Chapkhola	Bhorletar	1998	6.50	32	151	Natural, Mixed
71	37/07	Akala	Bhorletar	1998	21.96	21	298	Natural, Mixed
72	37/01	Gumba Halesi	Bhorletar	1994	22.22	75	364	Natural, Mixed
73	37/02	Raniban Phalane danda	Bhorletar	1994	108.10	203	1125	Natural, Mixed
74	37/06	Bhotedanda	Bhorletar	1996	82.31	60	359	Natural, Mixed
75	37/08	Rangdikhola	Bhorletar	1998	88.00	53	285	Natural, Mixed
76	37/04	Baghmare Barabise	Bhorletar	1996	22.42	75	404	Natural, Mixed
77	37/03	Rani Rihine	Bhorletar	1996	31.45	88	501	Natural, Mixed
78	42/02	Phedikuna	Bhoteodar	1997	28.67	204	1011	Natural, Mixed
79	42/05	Phulbari	Bhoteodar	2004	4.88	58	312	Natural, Mixed
80	42/04	Rainekali	Bhoteodar	2005	32.02	188	925	Natural, Mixed
81	42/04	Chandi	Bhoteodar	2000	64.12	37	291	Natural, Mixed
82	42/01	Kusunde	Bhoteodar	1997	18.49	51	289	Natural Plantation
83	42/03	Chun pahara	Bhoteodar	1998	7.75	63	322	Natural Plantation
84	42/09	Rainekali	Bhoteodar	2005	32.02	183	1031	Natural, Mixed
85	03/07	Pragati	Bhulbhule	2005	186.88	57	285	Natural, Mixed
86	03/08	Tarebhir	Bhulbhule	2008	184.63	87	507	Natural, Mixed
87	03/01	Bhirkuna	Bhulbhule	1996	80.89	82	464	Natural, Mixed
88	03/03	Sirjana	Bhulbhule	1999	52.82	70	225	Natural, Mixed
89	03/04	Baraha Pokhari	Bhulbhule	2000	338.86	126	800	Natural, Mixed
90	03/05	Saptakanya	Bhulbhule	2003	195.70	47	310	Natural, Mixed
91	03/09	Mahabhir	Bhulbhule	2008	68.89	41	281	Natural, Mixed
92	03/02	Laliguras	Bhulbhule	1999	121.70	95	537	Natural, Mixed
93	03/06	Devisthan	Bhulbhule	2004	87.62	87	530	Natural, Mixed
94	21/03	Jumli	Bichaur	2000	11.68	84	477	Natural, Mixed
95	21/01	Ajmare pachok	Bichaur	1994	28.50	48	316	Natural, Mixed
96	21/04	Aathghare	Bichaur	2006	6.93	51	256	Natural, Mixed

SN	CFCode	Forest Name	VDC	Year Established	Area (ha)	FUG size	Population	Forest Type
97	5000	Dawadi milan salghari	Bichaur	2013	17.87	165	825	Natural, Mixed
98	12/05	Baraghare	Bichaur	2013	20.08	47	284	Natural, Mixed
99	21/02	Bundhunga	Bichaur	1999	15.91	79	453	Natural, Mixed
100	45/01	Chakra tirtha	Chakratirtha	1994	64.55	281	1449	Natural, Mixed
101	45/02	Deurali	Chakratirtha	2007	37.91	242	1340	Natural, Mixed
102	45/03	Jhakristhan	Chakratirtha	2007	119.85	314	1884	Natural, Mixed
103	08/06	Barbot	Chandisthan	2000	0.45	15	91	Plantation
104	08/01	Akkar Sanad	Chandisthan	1994	6.19	75	397	Natural, Mixed
105	08/08	Bhangerthan/	Chandisthan	2006	6.12	28	188	Natural, Mixed
106	08/07	Tribeni	Chandisthan	2005	0.83	61	384	Natural, Mixed
107	08/09	Sukri	Chandisthan	2007	2.31	16	90	Natural, Mixed
108	08/05	Saldada	Chandisthan	1998	1.19	43	223	Natural, Mixed
109	08/03	Bhotechaur paleko	Chandisthan	1996	19.55	129	729	Natural, Mixed
110	08/02	Marsyngdi	Chandisthan	1995	14.21	49	302	Natural, Mixed
111	08/04	Patle	Chandisthan	1997	1.00	15	92	Natural, Shrub
112	39/02	Deutapani pariban	Chandreshwoer	2010	16.70	100	631	Natural, Mixed
113	17/01	Karki dada	Chiti	1994	96.90	115	735	Natural Mixed
114	17/04	Gauthali dhunga	Chiti	2011	2.36	37	245	Natural, Mixed
115	17/06	Deurali Thado pakha	Chiti	2005	19.34	73	329	Natural, Mixed
116	17/05	Deurali	Chiti	2004	57.67	108	650	Natural, Mixed
117	17/02	Thuli	Chiti	1994	24.22	124	674	Natural, Mixed
118	17/03	Tilahar	Chiti	1994	44.11	183	1120	Natural, Mixed
119	17/04	Satipatal Mahila	Chiti	2003	66.77	221	1192	Natural, Mixed
120	46/04	Simalchaur Naringhar	Dhamilikuwa	1994	61.84	218	1123	Natural, Mixed
121	46/05	Garambesi	Dhamilikuwa	1994	23.55	152	958	Natural, Mixed
122	46/06	Champawoti	Dhamilikuwa	1996	37.70	151	846	Natural, Mixed
123	43/06	Shilapatthar	Dhamilikuwa	2006	7.36	54	316	Natural, Mixed
124	47/04	Kalmata	Dhamilikuwa	2003	9.68	63	369	Natural, Mixed
125	46/07	Gaulitar	Dhamilikuwa	1998	28.14	103	591	Natural, Mixed
126	06/02	Tribeni patle	Dhamilikuwa	2015	104.75	77	413	Natural, Mixed
127	46/02	Lupugaub	Dhamilikuwa	1994	143.19	137	741	Natural, Mixed
128	46/01	Aapchaur	Dhamilikuwa	1994	122.50	244	1391	Natural Plantation
129	46/03	Salphedi	Dhamilukuwa	1994	21.11	53	270	Natural, Mixed

SN	CFCode	Forest Name	VDC	Year Established	Area (ha)	FUG size	Population	Forest Type
130	05/02	Chhotekhola	Dhodeni	2014	108.55	75	481	Natural, Mixed
131	05/01	Paleban	Dhodeni	1996	17.06	66	477	Natural, Mixed
132	39/01	Okharpani	Dhuseni	1999	35.75	55	373	Natural, Mixed
133	38/03	Phedipale	Dhuseni	2010	24.10	48	259	Natural, Mixed
134	38/01	Koiralaphat	Dhuseni	2002	29.75	54	293	Natural, Mixed
135	38/02	Koirala Phat Majhginda	Dhuseni	2003	14.00	44	231	Natural, Mixed
136	06/01	Majhibari Okharbot	Dudhpokhari	1997	11.13	54	267	Natural, Mixed
137	40/02	Jaade Khola	Duradada	1999	4.35	28	169	Natural Plantation
138	40/06	Asirumta	Duradada	2015	6.37	32	152	Natural, Mixed
139	40/01	Chautari	Duradada	1994	26.61	41	201	Natural Plantation
140	40/04	Bhagerthan	Duradada	2002	3.64	17	77	Natural, Mixed
141	40/05	Tika Tribeni	Duradada	2005	34.70	140	717	Natural, Mixed
142	40/03	Kali	Duradada	2000	28.15	37	185	Natural, Mixed
143	04/02	Singli gaun	Faleni	2016	83.00	20	153	Natural, Mixed
144	04/01	Jiwandhara/Amar?	Faleni	2001	50.12	168	886	Natural, Mixed
145	23/10	Budhikot	Gaunda	2012	72.77	26	155	Natural, Mixed
146	23/04	Salme	Gaunda	2002	23.24	29	194	Natural, Mixed
147	23/05	Srijanshil	Gaunda	2003	19.00	51	287	Natural, Mixed
148	23/09	Beteni	Gaunda	2010	191.80	41	254	Natural, Mixed
149	23/07	Tuje	Gaunda	2009	46.72	11	72	Natural, Mixed
150	23/03	Shivasakti	Gaunda	2002	101.40	101	585	Natural, Mixed
151	23/06	Sukdeo	Gaunda	2007	41.78	25	158	Natural, Mixed
152	23/01	Gadgade Patal	Gaunda	1994	64.62	50	363	Natural, Mixed
153	23/02	Bhirkuna	Gaunda	1997	129.87	114	648	Natural, Mixed
154	23/28	Thuloswara	Gaunda	2010	20.32	12	55	Natural, Mixed
155	28/08	Chandipauwa	Gaunsahar	2000	76.11	243	1323	Natural, Mixed
156	28/07	Bhedikharka	Gaunsahar	1999	17.12	20	132	Natural, Mixed
157	28/03	Tintale Thadikhoriya	Gaunsahar	1994	7.15	149	861	Natural, Mixed
158	28/05	Charghare	Gaunsahar	1996	8.42	33	185	Natural, Mixed
159	28/09	Paleko ban	Gaunsahar	2002	9.88	129	636	Natural, Mixed
160	28/02	Basaula	Gaunsahar	1994	7.92	38	225	Natural, Mixed
161	28/01	Kalika	Gaunsahar	1994	12.15	86	457	Natural, Mixed
162	28/04	Suryamukhi Bastale	Gaunsahar	1996	26.37	201	1084	Natural, Mixed

SN	CFCode	Forest Name	VDC	Year Established	Area (ha)	FUG size	Population	Forest Type
163	28/11	Jagreni	Gaunsahar	2003	83.87	273	1538	Natural, Mixed
164	28/10	Thulobhir Baral	Gaunsahar	2003	1.22	31	160	Natural, Mixed
165	28/06	Kirepani	Gaunsahar	1996	47.96	191	1102	Natural, Mixed
166	01/06	Amrit	Ghermu	2010	44.00	49	291	Natural, Mixed
167	01/05	Nache Thulangi Himali	Ghermu	2009	197.00	403	2274	Natural, Mixed
168	01/03	Manaslu	Ghermu	2004	97.80	133	571	Natural, Mixed
169	31/01	Amareshower	Gilung	1994	387.69	94	332	Natural, Mixed
170	31/02	Gilung	Gilung	2015	307.97	108	579	Natural, Mixed
171	200	Dudhpakha	Hiletaksar	2016	17.10	34	183	Natural, Mixed
172	15/05	Kalo Pahara	Hiletaksar	2005	6.16	37	234	Natural, Mixed
173	15/06	Sundevi	Hiletaksar	2009	107.95	77	526	Natural, Mixed
174	15/01	Nasachho	Hiletaksar	1997	20.47	123	750	Natural, Mixed
175	15/04	Chahare	Hiletaksar	2002	8.14	22	122	Natural, Mixed
176	15/03	Thanithan	Hiletaksar	2000	41.70	61	335	Natural, Mixed
177	20/07	Samghareti	Ilampokhari	2013	132.50	28	135	Natural, Mixed
178	20/04	Phulingiri	Ilampokhari	2010	178.31	112	615	Natural, Mixed
179	20/05	Thulokabre	Ilampokhari	2010	197.81	75	501	Natural, Mixed
180	20/01	Sorgabas Bhangswara	Ilampokhari	1994	164.00	48	336	Natural, Mixed
181	20/03	Gharedhunga	Ilampokhari	1996	58.94	33	164	Natural, Mixed
182	20/02	Namarkhu	Ilampokhari	1996	140.24	49	256	Natural, Mixed
183	20/06	Deurali	Ilampokhari	2011	129.69	92	465	Natural, Mixed
184	35/01	Gaurishankar	Isaneshower	1996	12.04	50	277	Natural, Mixed
185	35/06	Jiwan adhar	Isaneshower	1999	20.34	83	329	Natural, Mixed
186	35/02	Laxmi	Isaneshower	1996	89.49	116	630	Natural, Mixed
187	35/09	Jwaladevi	Isaneshower	2013	14.53	60	380	Natural, Mixed
188	35/05	Akala	Isaneshower	1997	70.98	56	286	Natural, Mixed
189	35/08	Malika	Isaneshower	2001	13.36	31	171	Natural, Mixed
190	35/03	Majha	Isaneshower	1996	84.74	57	273	Natural, Mixed
191	35/04	Deurali	Isaneshower	1997	94.22	65	364	Natural, Mixed
192	35/07	Chandisthan	Isaneshower	1999	85.10	86	492	Natural, Mixed
193	52/02	Hadikhola	Jita	1996	32.93	52	336	Natural, Mixed
194	52/07	Chisapani Kukurdhunga	Jita	1998	35.50	23	157	Natural, Mixed
195	51/10	Kalchaude	Jita	2001	21.81	22	147	Natural, Mixed

SN	CFCode	Forest Name	VDC	Year Established	Area (ha)	FUG size	Population	Forest Type
196	52/12	Janachetana	Jita	2004	17.60	43	273	Natural, Mixed
197	52/11	Kalika Kalchaude	Jita	2003	19.38	32	214	Natural, Mixed
198	52/03	Badahare Patal	Jita	1996	112.02	93	687	Natural, Mixed
199	52/04	Bagh devi	Jita	1997	19.48	49	254	Natural, Mixed
200	52/08	Rajkhoriya	Jita	1998	7.43	31	193	Natural Plantation
201	52/09	Dhodghari Dhampu	Jita	1999	9.61	22	112	Natural Plantation
202	52/01	Kalikasthan	jita	1996	40.88	45	282	Natural, Mixed
203	52/14	Kalika	Jita	2005	17.88	22	114	Natural, Mixed
204	52/13	Akala	Jita	2004	17.91	25	173	Natural, Mixed
205	52/06	Bhirpani pakho	Jita	1998	28.25	18	136	Natural, Mixed
206	52/05	Kirtipur	Jita	1997	66.45	154	865	Natural, Mixed
207	33/01	Kalyan majuwa Beteni	Karapu	2001	287.50	127	697	Natural, Mixed
208	33/05	Simebhume	Karapu	2010	198.95	166	1048	Natural, Mixed
209	33/02	Dadhuwa bhumisthan	Karapu	2006	198.50	119	818	Natural, Mixed
210	33/09	Makute	Karapu	2007	197.87	68	415	Natural, Mixed
211	33/04	Shivasundari	karapu	2007	155.66	95	492	Natural, Mixed
212	22/05	Tasyo	Kolki	2002	178.29	79	507	Natural, Mixed
213	22/01	Bansaar	Kolki	1994	82.50	86	515	Natural, Mixed
214	22/02	Bakot	Kolki	1996	69.64	65	464	Natural, Mixed
215	22/03	Phoke	Kolki	1997	64.44	57	312	Natural, Mixed
216	22/04	Simle	Kolki	1998	45.80	44	294	Natural, Mixed
217	51/05	Bhagirathi patal	Kunchha	2004	20.78	23	142	Natural, Mixed
218	51/01	Kharuke Pakha	Kunchha	1996	53.75	57	333	Natural, Mixed
219	51/07	Pauwa gutha	Kunchha	2005	4.51	18	95	Natural, Mixed
220	51/06	Kalika	Kunchha	2004	25.24	56	296	Natural, Mixed
221	51/04	Patal	Kunchha	2003	32.30	38	209	Natural, Mixed
222	51/08	Ganesh Batika	Kunchha	2007	7.25	29	204	Natural, Mixed
223	51/02	Siran gaun	Kunchha	1999	2.12	6	41	Natural, Mixed
224	51/09	Devi deurali	Kunchha	2007	12.00	27	141	Natural, Mixed
225	51/03	Deurali	Kunchha	2002	4.25	40	237	Natural, Mixed
226	32/01	Tamakhani	Maling	2004	122.40	47	247	Natural, Mixed
227	48/03	Kalika	Mohoriyakot	1997	128.00	127	708	Natural, Mixed
228	48/01	Birbhakti	Mohoriyakot	1994	102.16	181	971	Natural, Mixed

SN	CFCode	Forest Name	VDC	Year Established	Area (ha)	FUG size	Population	Forest Type
229	48/04	Manakamana	Mohoriyakot	2003	41.37	65	366	Natural, Mixed
230	30/04	Sunkot	Nalma	2007	133.02	37	184	Natural, Mixed
231	30/02	Landihariyali	Nalma	1999	275.91	164	1012	Natural, Mixed
232	30/01	Kagrodevi Hariyali	Nalma	1999	62.55	27	109	Natural, Mixed
233	30/03	Khundrudevi	Nalma	2005	158.43	44	248	Natural, Mixed
234	18/03	Sikh	Nauthar	1998	28.17	75	377	Natural, Mixed
235	18/06	Basbot	Nauthar	2004	20.75	30	164	Natural, Mixed
236	18/04	Thadi khoriya	Nauthar	2003	3.00	24	126	Natural, Mixed
237	18/05	Kawaki	Nauthar	2004	20.51	27	191	Natural, Mixed
238	7000	Simre	Nauthar	2015	124.85	53	325	Natural, Mixed
239	18/02	Koplang	Nauthar	1996	7.50	40	212	Natural, Mixed
240	18/01	Kukhure Dhunga	Nauthar	1995	74.93	59	381	Natural, Mixed
241	36/01	Pyare	Neta	2005	70.42	56	382	Natural, Mixed
242	19/02	Hundada	Pachok	1998	123.77	113	350	Natural, Mixed
243	19/01	Kamlo	Pachok	1996	58.00	74	462	Natural, Mixed
244	50/01	Kukhure	Parewadada	1997	3.16	116	626	Natural, Mixed
245	50/09	Hadepakha	Parewadada	2014	5.13	44	310	Natural, Mixed
246	50/10	Gaunsekuwa	Parewadada	2015	1.41	57	273	Natural, Mixed
247	50/02	Chandani	Parewadada	2001	38.89	52	270	Natural Plantation
248	50/06	Jamunesthan	Parewadada	2006	6.94	54	305	Natural, Mixed
249	50/04	Harse Mahabir	Parewadada	2001	26.50	224	1265	Natural, Mixed
250	50/05	Kalleri	Parewadada	2005	6.20	67	355	Natural, Mixed
251	50/07	Deurali Patlepani	Parewadada	2007	6.56	75	376	Natural, Mixed
252	50/08	Birauta	Parewadada	2007	2.65	61	322	Natural, Mixed
253	50/03	Simhaar	Parewadada	2001	33.07	209	910	Natural, Mixed
254	43/02	Lamagaun	Pyarjung	2002	57.54	42	238	Natural, Mixed
255	43/03	Salmekot	Pyarjung	2003	54.83	62	335	Natural, Mixed
256	43/01	pangote	Pyarjung	2001	40.54	81	342	Natural, Mixed
257	43/08	Patlepani	Pyarjung	2016	49.81	37	257	Natural, Mixed
258	43/07	Manichakra	Pyarjung	2009	17.24	55	340	Natural, Mixed
259	43/05	Sanipokhari	Pyarjung	2006	21.45	68	372	Natural, Mixed
260	43/04	Mandali	Pyarjung	2006	16.10	20	124	Natural, Mixed
261	56/02	Asimure uttakhoriya	Ramgha	1996	31.54	155	899	Natural, Mixed

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262	56/01	Akala	Ramgha	1996	45.92	61	347	Natural, Mixed
263	56/06	Dhudhekuna Pratibha	Ramgha	1999	14.45	45	190	Natural, Mixed
264	56/04	Deurali	Ramgha	1997	80.73	40	222	Natural, Mixed
265	56/03	Jaldevi	Ramgha	1997	59.10	281	1436	Natural, Mixed
266	56/05	Jaya thumka	Ramgha	1999	17.36	70	336	Natural, Mixed
267	56/07	Manakamana	Ramgha	2002	71.78	45	238	Natural, Mixed
268	55/04	Parajuli besi	Ramgha	1999	82.88	92	538	Natural, Mixed
269	56/08	Malika	Ramgha	2009	23.49	40	195	Natural, Mixed
270	55/03	Sitala devi	Samibhangyang	2010	82.91	18	106	Natural, Mixed
271	55/01	Kauseri	Samibhangyang	1994	39.15	36	305	Natural, Mixed
272	55/03	Purano hatiya	Samibhangyang	1998	59.12	90	480	Natural, Mixed
273	55/02	Kartapur	Samibhangyang	1996	24.55	21	124	Natural, Mixed
274	24/04	Uttapani	Shribhanjyan	2006	12.56	48	245	Natural, Mixed
275	24/02	Kisedi	Shribhanjyan	2005	12.05	89	482	Natural, Mixed
276	24/01	Kerabari	Shribhanjyan	1996	57.60	301	1865	Natural, Mixed
277	24/03	Chisaapani	Shribhanjyan	2005	7.50	56	320	Natural, Mixed
278	29/01	Thuloswara	Sindhure	2013	199.50	167	1349	Natural, Mixed
279	42/06	Satidada	Sundarbazar	2001	50.67	51	255	Natural, Mixed
280	49/08	Shital Chautari	Sundarbazar	2009	0.52	16	61	Natural Plantation
281	49/04	Niureghari	Sundarbazar	2002	23.62	65	354	Natural, Mixed
282	49/06	Purano Dihi	Sundarbazar	2004	7.28	61	348	Natural, Mixed
283	49/02	Karenge	Sundarbazar	1997	10.08	61	335	Natural, Mixed
284	49/01	Dhodsingh	Sundarbazar	1994	78.00	91	448	Natural, Mixed
285	49/03	paropakar	Sundarbazar	1999	26.00	75	382	Natural, Mixed
286	49/05	Marsyngdi Pakha	Sundarbazar	2003	4.48	157	849	Natural Plantation
287	49/07	paude Pakha Simle	Sundarbazar	2004	1.91	40	247	Natural Plantation
288	54/01	kashikhola	Suryapaal	1996	41.55	128	749	Natural, Mixed
289	54/03	Jyamire khola	Suryapaal	1996	63.60	97	512	Natural, Mixed
290	54/02	Sunepani	Suryapal	1996	54.65	147	867	Natural, Mixed
291	53/07	Andherikhola	Taksar	2004	31.36	20	113	Natural, Mixed
292	53/06	Bholdanda	Taksar	1997	16.62	17	99	Natural, Mixed
293	53/09	Tamakhani Dharni	Taksar	2014	13.23	53	320	Natural, Mixed
294	53/02	Samakhoria	Taksar	1997	35.31	21	105	Natural, Mixed

SN	CFCode	Forest Name	VDC	Year Established	Area (ha)	FUG size	Population	Forest Type
295	53/04	Jamuna Gahira	Taksar	1997	20.73	9	51	Natural, Mixed
296	53/05	Pisti	Taksar	1997	110.86	35	262	Natural, Mixed
297	53/03	Lampata	Taksar	1997	84.27	260	1490	Natural, Mixed
298	53/01	Sathimure	Taksar	1997	30.05	79	471	Natural, Mixed
299	53/08	Nag Bhairab	Taksar	2004	58.42	64	321	Natural, Mixed
300	41/05	Ghumauro bazarkot	Tarku	1994	82.60	63	370	Natural, Mixed
301	41/01	Gahate	Tarku	1994	118.00	71	361	Natural, Mixed
302	41/03	Champani Thadikhoriya	Tarku	1994	30.76	59	310	Natural Plantation
303	41/02	Thakle	Tarku	1994	34.17	72	328	Natural Plantation
304	41/06	Chorpani Rani Odaar	Tarku	1996	108.15	52	331	Natural, Mixed
305	41/04	Bhubarkhola	Tarku	1994	18.80	52	265	Natural, Mixed
306	41/07	Satidada	Tarku	2001	50.67	43	226	Natural, Mixed
307	47/05	Pipaltari	Tarkughat	2003	29.79	88	460	Natural, Mixed
308	47/06	Marsyangdi	Tarkughat	2004	49.17	98	471	Natural, Mixed
309	47/03	Nawajyoto	Tarkughat	2002	11.42	77	415	Natural, Mixed
310	47/01	Kalika	Tarkughat	1995	46.05	84	462	Natural, Mixed
311	47/02	kataharbari	Tarkughat	1996	27.30	80	421	Natural, Mixed
312	47/09	Mahadev	Tarkughat	2005	26.23	115	630	Natural, Mixed
313	47/08	Annapurna	Tarkughat	2005	38.66	75	451	Natural, Mixed
314	47/07	Taleju	Tarkughat	2004	46.93	78	410	Natural, Mixed
315	27/05	Bankali	Udipur	1997	20.43	91	520	Natural, Mixed
316	27/03	Manaki dada	Udipur	1996	20.04	40	186	Natural, Mixed
317	27/02	Jwaladevi	Udipur	1996	70.48	51	303	Natural, Mixed
318	27/04	Kalika	Udipur	1996	63.24	151	856	Natural, Mixed
				Total	**19,187.2**	**25,189**	**141,594**	