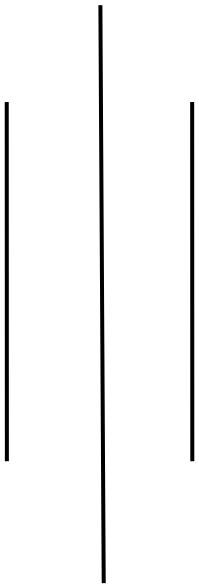
Demand and Supply of Forest Products in Gandaki Province



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Ministry of Forest, Environment and Soil Conservation

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Thank You.

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Acronyms

AFO	Assistant Forest Officer
CF	Community Forests
CFM	Collaborative Forests
CFUG	Community Forest User Group
D&S	Demand and Supply
DFO	Divisional Forest Office
FD	Forest Directorate
FPs	Forest products
FRTC	Forest Research and Training Center
FY	Fiscal Year
GD	Group Discussion
KII	Key Informant Interview
MOFE	Ministry of Forest and Environment
MOFESC	Ministry of Forest, Environment, and Soil Conservation
OWL	Other Wooded Land
PF	Private Forests

EXECUTIVE SUMMARY

Timber and fuelwoodare the importantforest products in Nepal. It is the main source of forest income. Maintaining a sustained supply of forest products- timber and fuelwood- is one of the key objectives of forest management. Despite having potential to meet the demand of the country as well as potential to trade timber, timbers are still imported from other countries. Gandaki Province is also not an exception to this situation. In this context this study aimed

- To estimate the current and future potential demand of forest products
- To estimate the current and future potential supply of forest products
- To analyze the trend in the production and consumption of forest products
- To estimate the annual production of timber and fuelwood from the forest of Gandaki Province
- To explore the problems in demand and supply of forest products

This study was carried out in the eleven districts of Gandaki Province. The Province has tremendous potential in terms of tourism and forest resources. Covered by more than 30% of its total area by forest, the Province encompasses Terai, Chure, Mid-Hills, and High-Mountain forests. Two types of data collection methods were used for this study. First, the desk review of published as well as unpublished reports of the government of Nepal was carried out. Importantly, provincial reports of Gandaki Province were consulted for data collection. Then the field survey and discussions were conducted in all Division Forest Offices (DFOs) of the Province. The timber and fuelwood demand/supply data were collected for the last three fiscal years (FY) namely FY 2075/76, 2076/77, and 2077/78. The study relied primarily on the demand and supply data recorded and documented by the DFOs in all the districts. While the quantitative data was entered into spreadsheet for the quantitative analysis in the R-software, qualitative data was entered in the document file listing the key problems and probable solutions. The quantitative data was analyzed with descriptive statistics such as mean, standard deviation, and correlation and presented through bar diagrams and plots. For the future projections on the demand and supply, the team used simple simulation model in R-software.

For timber, average quantity was 158,383±86,897.5 cft in FY 2075/76 that decreased to 122,049.5 IN FY 2077/7.The study findings illustrate that, in terms of current and future potential demand of forest products in FY 2075/76 BS, the average demand of fuelwood was 176.6±296.9chatta that decreased to 125.3±164.6chatta in FY 2077/78 BS. Districts wise,

Nawalpur had the highest demand of timber (283,333±76,376.3 cft) and Manang had the lowest demand (371.67±108.67 cft) of timber. Fuelwood demand was also highest for Nawalpur (733.33±251.66 chatta) and lowest for Manang (3.98±3.61 chatta). Similarly, the study revealed that in the next 5, 10, and 20 years, the demand will decline to 557,700.43 cft, 290,372.26 cft, and 78,716.07 cft respectively. However, this demand will exceed one million cft if demand increases by either 5% or 10% of the current amount every year. Likewise, fuelwood demand will also decrease to 452.52 chatta, 193.60 chatta, and 35.44 chatta in the coming 5,10, and 20 years respectively.

In average, CFs supplied 95.24±218.70 chatta and 61.15±113.06 chatta of fuelwood in FY 2075/76 BS and FY 2076/77 BS respectively whereas PFs supplied the highest quantity of fuelwood (58.95±84.79 chatta) in FY 2077/78 BS. Overall, FY 2075/76 observed the highest quantity of fuelwood supply (183.98±297.80 chatta) from CFs, PFs, and other types of forests. Similarly, CFs supplied highest amount (52,463±73,987 cft) of timber in FY 2076/77 BS whereas PFs supplied highest amount (51,806±47,091 cft) of timber during FY 2075/76 BS. The supply from other forests types was minimal – nearly 9,000 cft – in every FY. District wise, Nawalpur supplied the highest quantity of timber (249,719±88,376 cft) from CFs, PFs, and others combined whereas Manang supplied the lowest quantity (227±110 cft) of timber during last three fiscal years. For fuelwood, the results were similar – Nawalpur as the largest supplier (673.65±295.97 chatta) and Manang as the smallest supplier (6.18±3.08 chatta). The timber supply will be 478,897 cft, 282,368.94 cft, and 98,167.13 cft in the next 5, 10, and 20 years if the constant rate of supply remains extant. Likewise, fuelwood supply will also decrease to 306.95 chatta, 99.52 chatta, and 10.46 chatta in 5, 10, and 20 years. Across the districts, Tanahun will supply highest timber (588,242.04 cft) and Syangja will supply highest quantity of fuelwood (1497.69 chatta) in the next 5 years whereas, Manang will almost stop supplying timber. Similarly, Parbat, Lamjung, Myagdi, and Manang will also not supply fuelwood in the next 20 years.

The frequent regulatory barriers including prohibition to harvest Sal species from private forest are the major cause of problems in the supply of forest products. This has created multifaceted effects on timber supply. It has decreased the availability of Sal timber in the market while increasing the timber price. Equally, it has demotivated private forest owners to manage their forest for timber supply. Similarly, the current regulatory procedure for timber harvesting for forest user groups is tedious and demands multiple approvals from DFO. In case of fuelwood, the expensive harvesting costs in the mid-hills forest and illegal collection

and sale in Terai region has raised as a key problem including the less value given to fuelwood management and use by community and forest managers has limited the potential harvesting. The study suggests following operational and policy recommendations to ensure sustainable flow of timber and fuelwood;

- Consistence and supportive policies formulation is pivotal to enhance sustainable flow of forest resources and ensure consistency in decision making and supply of forest products.
- Province and District level annual forest products harvesting and distribution plan should be developed and implemented.
- Forest resource management plans and objectives need to be developed based on the forest resource availability, forest types, timber and fuelwood potentiality, and forest condition. It may vary between forest management regimes, within and between districts and between the geographic settings.
- The current regulatory procedure for timber harvesting from forests (community-based forests) is complicated and tedious. It needs to be revised in order to ease the harvesting and distribution of timber within appropriate time and revitalize the resource ownership of community forest user groups.
- Use of modern tools and technology and development of local forest-based enterprise to process and supply timber and fuelwood based on market demand.

CHAPTER ONE: INTRODUCTION

1.1 Background

Forest products have been integral part of Nepalese households (Oli et al., 2017).Forests provide multiple benefits and services including the timber and fuelwood for forest dependent communities across the country (Yadav et al., 2017). Utilization of forests has been differentiated across the ecological regions. Forests are critical from the tourism perspectives, greenery maintenance, sustainable supply of timber and fuelwood, and air/water regulation(Kanel and Shrestha, 2001).Though forest provides multiple ecosystem services, their management has to be implemented based on the forest type and importance (Gautam and Sivakoti, 2004; GoN, 2019). This is important not only to manage the forests but also to sustain the supply of forest products to the community. However, increasing consumption of forest products with increasing population is the major challenge in recent times(Brown and Shrestha, 2000; Bhusal et al., 2020; Nepal et al., 2021). This has directly affected forest-dependent community particularly the poor households that need regular forest resources for energy,food and as an income(Oli et al., 2017).

To minimize the impacts of increasing consumption, production should be in equilibrium (GoN, 2019; Poudyal et al., 2019).Demand and supply of forest products should be balanced. Moreover, the supply chain and demand chain amongst and between stakeholders should not be misbalanced. This scenario restrains the inflation on forest products and ultimately, reduces the illegal activities. Supporting the equilibrium alsoencourages the community-based enterprises.

Nepal has imported large quantity of timber from foreign countries in recent years (MoF, 2020; 2021; 2022). Even though 45% of total land mass is covered by forests, especially mature forests, the country has not been able to reap the benefits of its forests (Sapkota et al., 2020). Timber import by the private sector is increasing every year while our forests are decaying. The forests have stock but not utilized efficiently (Sapkota et al., 2018; Sapkota et al., 2020). Even though forest acts and policies aim to increase productivity and production of forest products (GoN, 2019), the hurdles at the implementation or community level along with time-taking procedures for timber harvesting are masking the policies (Poudyal et al., 2020). So, it is necessary to utilize our forests efficiently and effectively through analysis of current/future demand and supply scenario and identification of hurdleswiththeirprobable solutions. Such knowledge will enhance our understanding on the forest products

demand/supply and will minimize problems andchallengesobserved in the forest products industry. Moreover, support on identifying the solutions for the sustainable supply of forest products can be expected from this knowledge along with effective forest management.

1.2 Rationale

Globally, forest products play an important role in international trade. Amongst the forest products, timber is one of the commodities to be traded internationally between different countries (Adhikari et al., 2022).In Nepal, timber and fuelwood are an important source of cash earning and means to improve livelihood of local people (Oli et al., 2017). Timber and fuelwood were mainly supplied from government managed forest in the past. Recently, community forest and private forests are supplying forest products to local people and emerging to hold strong share in timber marketing (Yadav et al., 2020).

While the management objectives of both forest types – community and private – are different, their core output remains same: supplying the forest products – timber and fuelwood – in a sustainable way (GoN, 2019). Even though,the number of CFs has stepped into monetized sector of economy along with the fulfillment of the basic needs of users, still many CFs lack management and marketing of surplus timber and fuelwood (Sapkota et al., 2018; Poudyal et al., 2020). The commercial exploitation of surplus timber from CFs is still poor. In addition, most of the timber and fuelwood production through CFs are consumed domestically (Yadav et al., 2020).

Despite having potential to meet the demand of the country as well as potential to trade timber, timbers are still imported from other countriesin Nepal (MoF, 2022). Gandaki Province is also indifferent to this situation. Although 32% of total land mass is managed under multiple forest management practices, Province still imports timber from other countries. Most of the forest area in this Province lies in the mid-hill regionmanaged by communityas community based forest management or are under private forests (DFRS, 2015).

However, the growing population in the mid-hill urban areas like Kaski and Tanahun has raised the concern regarding the supply and demand fulfillment (Rai et al., 2018). Along with that, rapid urbanization hasresulted in the increasing demands for timber in various market centers of the Province (Maharjan et al., 2020).Further, the demand of timber in rural areas is also increasing because of changing economic standard of rural people (Paudel Khatiwada et al., 2018) and increased number of commercial enterprises (Dhakal and Rai, 2020).However,

this demand is mostly fulfilled through private forests that go unnoticed and unregulated by the government.

Even though forests cover large part of the Province and country, Nepal has small commercial wood production and trade compared to other countries (Saxena et al., 2022). Despite having abundant forest resources, inefficient supply of forest products has increased challenges for the country. Further, unsustainable harvesting of forest products is affecting forest stand conditions resulting in timber loss and regeneration damage (Aryal et al., 2022). This hampers the sustainable management of forest resources adopted by the government of Nepal.

Harvest of fuelwood and timber affects the area coverage, growing stock, carbon storage in the forest (Poudyal et al., 2019; Awasthi et al., 2020).Improvement of all these aspects gives sustainable supply of forest products. In line with this, the government of Nepal is expected to launch the production-based managementsystem to fulfill the timber and fuelwood demands of users (GoN, 2019). To support the upcoming forest management strategies of the government the analysis of the demand and supply of forest products is necessary. Moreover, the demand and supply data in Gandaki Province is still segregated that should be accumulated to know the overall scenario of the forest products demand and supply. In this context this study aims to analyze the demand and supply status, trend and future scenario of forest products (timber and fuelwood)of Gandaki Province. This pattern of analysis will also enhance our understanding of the current and future demand and supply of forest products. Later on, such it could support for planning and sustainable management of forest resources in the Province.

1.3 Objectives

The general objective of this study was to assess the demand and supply of forest products in Gandaki Province.

The specific objectives of this study were:

- To estimate the current and future potential demand of forest products
- To estimate the current and future potential supply of forest products
- To analyze the trend in the production and consumption of forest products
- To estimate the annual production of timber and fuelwood from the forest of Gandaki Province
- To explore the problems in demand and supply of forest products

1.4 Limitations

The study has two major limitations.

a. Emphasis on Timber and Fuelwood

Although the study mentions the forest products as key term, the study collected and analyzed the data on timber and fuelwood only. Changing livelihood in the mid-hills along with the abandonment of the agricultural lands is the key factor in recent time. The study assumes that increasing forests in the agricultural lands will increase the fuelwood resources but the intensified use of non-renewable energy sources like Liquefied Petroleum Gas LPGin the Province reduces the fuelwood demand. Although forest resources like non-timber forest products also contribute to the economy of community forests and government, focusing on the timber and fuelwood gives broader perspectives on the policy level for the production-based management practices.

b. Exclusion of Protected Areas

The report does not include the forest products collected from the protected areas of Gandaki Province. Protected areas are mostly formed for the conservation of the natural resources rather than utilization. Yet, the households within the protected areas use forest resources at the subsistence level for their daily uses.

1.5 Organization of the Report

The report is organized in five chapters excluding the front and back matters. While the front matter includes acknowledgement, acronyms, and executive summary sections, back matter covers the references and annexes. Apart from this, the report is divided into five chapters. First chapter introduces the demand and supply of forest products along with the need of this study, major objectives, and limitations. Chapter two, then, describes the reviews of earlier reports and literatures on the forest product demand and supply of Nepal. Chapter three explains the methodology of the study that contains study area, sampling strategy for data collection, and analytical structure for the data. Likewise, chapter four presents the major findings of the study and discusses them with earlier literatures. At last, chapter five concludes the major findings of the study and provides the way forwards for sustainable timber supply in Gandaki Province of Nepal.

CHAPTER TWO: LITERATURE REVIEW

2.1 Demand and Supply in Natural Resources

Demand and supply (D&S) are the integral parts for the smooth economy run. A classical theory articulates that increasing demand increases price of a product while increasing supply decreases the product price. Supply and demand, in economics, is the relationship between the quantity of a product that producers want to sell at various prices and the quantity that consumers want to buy. In the natural resources, these products are water, ecosystem services, aesthetic amenities, cultural values, and co-products of these products. While the most of the natural resource products constitute singular or one output such as aesthetic value, few products like ecosystem services constitutes more than one output such as forest products, cultural services, carbon, and tourism and non-tourism activities. The demand and supply of these products shows their importance in the economy and the community.

The demand and supply of a forest productdepends on multiple factors. Population, consumer's job status, income sources, use and need, distance,resource quality, identified institutions, and the livelihood conditions impacts a product's supply or demand. Above all of these factors, price of a forest product is the main factor (Assogba and Zhang, 2020) and the price impacts the supply and demand of each product. Based on the price of the product, its demand and supply fluctuatesfrom high to low with an intersection. This intersection of the demand and supply is called the equilibriumwhere the demand equals supply.

2.1.1 Demand and Supply Functions

Based on the important factors, the general function of the demand for forest products can be written as:

$$D = f(P, Pop, I, D, Ins, U) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(1)$$

Where: D = Demand; P = Price of the forest product, Pop = Population size, I = income, D = distance to the resource; Ins = institutions, and U = use.

While the demand decreases with increasing price, distance, and institutions, increase in demand of forest products can be expected when the use and population size increases. Here institutions mean the DFOs, AFOs, other forest offices, CFs, CFMs, several committees/ sub-committees, and checkpoints. The demand decreases when number of these institutions increases through which one has to pass the forest products.

Similarly, the supply of forest products depends on the price. The supply function is negative for the price of the product; that means upward sloping.

The supply function can be written as:

$$S = f(-P) \ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

Where S = supply of a forest product and P = Price of the product.

To measure the demand and supply of natural resources, we have to identify the chains and linkages between the production and consumption. In study assumes that forest products are sold by the community forests (CFs) and private forests (PFs) to the users directly. Based on this hypothesis, the team measured demand and supply at the resource point: CFs and PFs.

2.2 Forests as a Natural Resource

Globally, forests are identified as crucial drivers for the sustainable livelihood and national economy. As per the need, definitions of forest vary between countries and institutions. FAO, (2020) has defined forests as

"Aland spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 percent, or trees able to reach these thresholds in situ. It does not include land that is predominantly under agricultural or urban land use."

This is the simplest definitions of forest. Based on this definition, the Kyoto Protocol expands the horizon area to 0.5 - 1 hectare and canopy cover to 10-30% for a land to be identified as forest. In line with the earlier definition of FAO, government of Nepal has defined forest as an area fully or partly covered by trees and plants (*buttyan*) (GoN, 2019).DFRS, (2015) has also defined the forest as "*an area of land at least 0.5 ha and a minimum width/length of 20 m with a tree crown cover of more than 10% and tree heights of 5 m at maturity.*" These forests are categorized with climate and forest management types.

From the climate perspectives, forests are categorized into five major types: Tropical, Subtropical, Temperate, Sub-alpine, and alpine (DFRS, 2015). These forests span from lowlands to highlands in the chronological order. Tropical forests cover the hot zones and rainforests of Nepal whereas sub-alpine and alpine forests cover the cold regions of the country. The categorization of forests based on forest tenure systems stipulates two types of forests: 1) forests inside the protected areas recognized as a national park, wildlife reserve, and conservation area; 2) forests outside of the protected areas are categorized as national forests and private forests. Forests that grow on public lands are defined as national forests

while private forests are grown on private land. These forests are defined based on theirimportance to the community and government that serve different objectives of the forest management practices.

Based on management practices, forests of Nepal have been categorized in two broad categories: a) National Forests and b) Private Forests (GoN, 2019). Even more, national forest category is sub-divided into six sub-categories: a) Government-managed forests; b) Forest conservation areas; c) Community forests; d) Collaborative Forests; e) Religious Forests; and f) Leasehold forests. Gandaki Province encompasses all these types of forests (Table 1).

Table 1:Forest Types of Nepal

	Across Country	
Forest Type	**Number**	**Area (Ha.)**
Community forest	23682	2490194
Collaborative forest	31	75614
Leasehold forest	7976	45882
Religious forest	186	2896.57
Private forest	5460	4451
Forest conservation areas	10	192027.43

Source: Annual report of MoFE andMoFESC, 2019/20

Importance of these forests is defined through the objectives of management and type. The community-based forest management such as community and collaborative forest emphasizes the timber and fuelwood; religious forests emphasize the religious need of the forest. Overall, forests in Nepal are managed and utilized for timber, fuelwood, food, fodder, NTFPs, resin, tourism, boulders, riverine materials, religious needs, wilderness area, trekking and high-altitude walks, spiritual amenity, and carbon trade.

2.2.1 Forest Cover in Nepal and in Gandaki Province

Forest and Other Wooded Land (OWL) covers 44.74% of the total land area of Nepal where forest alone covers 5.96 million ha (40.36%) and Other Wooded Land (OWL) covers 0.65 million ha (4.38%) (DFRS, 2015). Within the forest category, the highest coverage is in the Middle Mountains region (37.80%) followed by the High Mountains and High Himal region (32.25%). The Churia and Terai region encompasses 23.04% and 6.90% of the total forest of Nepal respectively (DFRS 2015).Forests covers 817.29 thousand hectare (37.22%)in Gandaki

Province. Amongst the 11 districts of Gandaki Province, Nawalparasihas the largest forest cover (58.49%) and Mustang has the lowest forest cover (8%)(FRTC,n.d.).

The total growing stock (stem volume) of the forests in Nepal is 982.33 millionm^3 (164.76 m^3/ha). Within the climatic variation, high mountain and high Himal forests constitutes highest growing stock (225.24 m^3/ha) followed by Terai and Churia forests (161.66 m^3/ha). The middle mountain forests have the lowest stem volume (124.26 m^3/ha) amongst all physiographic regions (DFRS, 2015). These forests have 1054.97 million ton of carbon stock and61.53% of the total carbon is in the tree components such as living trees and 4D trees.

2.2.2Forest Products (FPs)

Forest products are the products which are contained or found in or brought from the forest. These products may (a) Timber (wood) products, (b) non-timber (wood) forest products, or (c) Boulder, soil, river and mineral substance. To make this study easier, the team focuses on the timber (wood) products (GoN, 2019). Non-timber products and riverine materials are also important for the economy but their illegal extraction and export within the community reduces their legal demand and supply. Alternatively, their calculation becomes inaccurate. Within the timber products, sale and trade of co-products of the timber may be possible. Sub-products of the timber are sawn wood, veneer and plywood while the secondary products include wooden furniture and parts, builders' joinery, construction timber, domestic/ decorative products, packaging materials and tools.However, this kind of trade mostly develops after the timber and fuelwood arrival at the mill.

2.2.3 Household Dependency on Forest resources

Dependency on the forest products is the major livelihood option for the rural households. Forest products contribute for the livelihood improvement through energy, food, trade, and use. Still now, fuelwood and forest products contribute70% of the total energy consumption in the country (Kandel et al., 2016). Although the energy transition towards more easier and accessible sources is plausible, dependency of the households on biomass for the cooking and heating purposes has not reduced in the households (Sharma, 2019). It is estimated that nearly 77% of the total rural residents use fuelwood as a primary cooking source while this percentage plummets to 33% for urban residents (Paudel et al., 2021).

In most of the parts, community forests and private forests have played vital role for fulfilling the fuelwood demand (Lamichhane, 2009). Although, the consumption quantity (235 kg/year – 3060 kg/year)in the households varies across districts of Nepal (Rijal, 2018; Kandel et al.,

2016), nearly 23% of the total fuelwood quantity was supplied from community forests and 12% from private forests in Dolakha district (Kandel et al., 2016).

For timber demand, the quantity is similar. Timber demand has grown over the years (Kanel et al., 2012; Basnyat et al., 2020). Yet, the supply has been minimal from the internal sources such as community forests and private forests (Basnyat et al., 2020) although these are the major sources of timber supply (Sapkota et al., 2018; DoFSC, 2021).

2.3 Contemporary Demand and Supply of Timber and Fuelwood

There is still a huge gap between current demand and supply of the timber and fuelwood (Basnyat et al., 2020; DoFSC, 2021). The supply from the forests of Nepal has not met the demand of the people. Although the supply has increased, ever-increasing demand from the users over the years have worsened the demand-supply ratio (Kanel et al., 2012; Basnyat et al., 2020; DoFSC, 2021).Nearly,3.99 million cft of timber was formally supplied from Nepal's forests in 2011/12 fiscal year (DoF, 2012) that increased to 19.4 million cft in fiscal year 2018/19, 14.3 million cft in fiscal year 2019/20 (MoF, 2021), and to19.4 in the fiscal year 2020/21 (MoF, 2022).

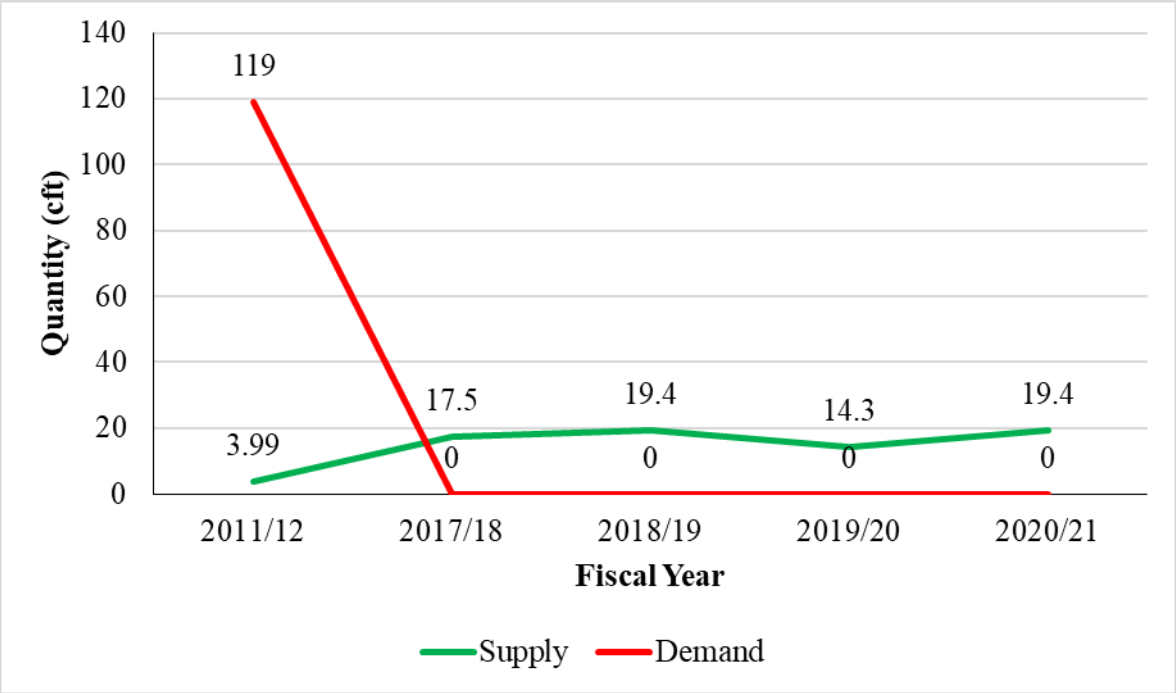

Figure 1: Demand and Supply Pattern of Timber (in million cft)

** The demand data for all other years was not accessible*

Likewise, the timber demand in 2011 was 119 million cft (Kanel et al., 2012).This amount is estimated to reach to 170 million cft in 2030 with increasing population and housing,

urbanization and construction (Kanel et al., 2012). In Nepal, domestic timber production is not enough to meet the national demand. In 2019/20, the country imported 0.78 million cft of timber. This value decreased to 0.51 million in 2020/21 (DoFSC, 2021). However, timber import volume has decreased compared to previous year, which was 0.98 million, in 2018/19(MoF 2020).

2.4 Changing Context for the Demand and Supply of Forest Products

With time, demand and supply scenario of the forest products is changing. Most importantly, socio-economic change, energy transitions, ecological change, initiation of production-based policy, andout-migration are the major factors of the changing demand-supply patterns. Change in demand-supply pattern alters the chains of supply such as mediators/suppliers and chains of demand such as laborers/job holders. Moreover, these chains are interconnected with each other and any shift in one side also fluctuate the other side.

Socio-economic change is the important dimension of the demand and supply of the forest products. Any change on the livelihood capital including the political scenario of the community shifts a household either on higher level or on lower level (Byg and Herslund, 2016). For example: increase on the income level of a household shifts the need of timber and fuelwood towards the iron and other easier accessible materials. Alternatively, this situation becomes opposite for a decreased income level of a household. Moreover, such changes also shift the livelihood strategies (Khatiwada et al., 2017).

Now, the Nepalese community is at transition phase. Small holder farmers are shifting from farm-based activities towards non-farm activities like remittance and wage labor (Khatiwada et al., 2017). Similarly, energy use by the households is moving towards the LPG from fuelwood. This transition may seemgood as it minimizes the dependency on the forest resources but in longer run, this transition will create void in the food production and fuelwood use.Increasing attraction of poor households towards the wage labor and remittance will halt the supply of the human labor in the forest-based activities. The consequences might range from agricultural land abandonment to unemployment to food insecurity.

Nonetheless, the society transition will fill the gap between rich and poor. However, increasing migration rates from rural to urban places in search of better job and livelihood conditions is also another factor that changes the demand and supply of forest products. This rapid migration pattern in the current scenario is decreasing the fuelwood demand but have not impact on the timber demand (Kanel et al., 2012). Moreover, the need of high-quality

timber and fuelwood than the inferior quality from the households also diverts the perspective towards the supply of forest products, especially timber.

At last, need of change in the forest condition followed by the initiation of production-based forest management policy also changes the demand and supply of forest products in the community. As the production increase, the supply of forest products in the market increases leading to the price decrease. However, impact of this factor is contextual and changes on the spatial scale. For example, a productive forest management may be ineffective for the hill forests where timber of inferior quality is supplied but this practice is crucial for the contexts where the timber is of high-quality and durable. Recent study on the natural forests of Terai has shown that they are degrading in their quality while the mid-hills forests are different being younger: planted during late 80s (Laudari et al., 2022).

2.5 Approaches for Understanding Demand and Supply of Forest Products

To understand the demand and supply pattern of the forest products, multiple approaches have been adopted. Ranging from analysis of price elasticity (Daniels and Hyde, 1986) and optimal theory models (Lyon and Sedjo, 1983)in mid 80s to the simple simulation model (Kanel et al., 2012) and complex forecasting modelsin early 2000s have been effective to estimate the demand and supply of the forest products. While price elasticity and optimal control theory adopts the price as a major function, simulation and forecasting models needs only the supply and demand quantity. Based on these approaches, multiple studies have forecasted the timber and fuelwood demand and supply along with their distribution dynamics from the Nepal's forests.

2.5.1 Earlier studies on the Demand and Supply of the Forest Products

Earlier studies on the demand and supply of the forest products in Nepal have been completed through either simulation models (Kanel et al., 2012) or through simple description methods (Basnyat et al., 2020). However, larger literatures have used ARIMA models and autoregressive modelsto estimate the timber production around the globe (Yin, 1999;Banaś andUtnik-Banaś, 2021).Though these models have been accurate on forecasting the potential production from univariable(Banaś andUtnik-Banaś, 2021), the requirement of larger time-series and non-requirement of mediators cancels these methods in our analysis.

In Nepal, Kanel et al.(2012) have estimated the timber and fuelwood demand on the national level. Although the government has tried to accumulate such information for the annual reports and budget (MoF, 2022; DoFSC, 2021), these estimates are mostly provided for the

national level. Yet, this accumulation at the regional level has been scarce. After the federal restructuring, an assessment of total demand and supply of the forest products in each of Province seems mandatory to develop and regulate rules for the sustainable forest management.

2.6Key Challenges for the Sustainable Supply of the Forest Products

Multiple key challenges are hovering around the timber and fuelwood supply from CF, PF, and other types of forests. The frequent regulatory barrier including prohibition to harvest Sal species from private forest has created multifaceted effects on timber supply. It has decreased the availability of Sal timber in the market while increasing the timber price. Equally, it has demotivated private forest owners to manage their forest for timber supply.

Secondly, the wavering policies within 4-5 years along with the promulgation of decree from the forest ministry for restricting certain activity of the CF, PF, and other types forest is a challenge for the forest products supply. In addition, the current regulatory procedure for timber harvesting for forest user groups is tedious and demands multiple approvals from DFO.

Thirdly, the uncontrolled illegal logging of timber from both community-managed and government-managed forests is a major challenge. The easy access to forest, good market value of timber with easy sale has increased illegal logging particularly in Terai districts. This has increased the supply of forest products in the market but through unnoticed paths. However, this situation has not solved the problem of increasing demand of timber. In addition, such illegal activities have reduced the legal supply from forests.

Fourthly, the quality of timber is low with defects and checks. Lack of proper seasoning and treatment facilities across the country has reduced the life-time of timbers and ultimately supply. On the other hand, the proper examination and treatment of disease is rarely carried out in the forests.

Lastly, traditional harvesting practices along with increasing harvesting costs are creating vulnerability to the timber and fuelwood supply. If the price of timber and fuelwood will be lower in the market in comparison to the harvesting and transportation, people will not have any motive to manage forests. Later on, this situation might create trouble in the form of human-wildlife conflict and encroachment from communities.

2.7 Policy Provisions for SustainableSupply of Forest Products

To initiate the sustainable supply of the forest products and to sustain the production-based management practice, government of Nepal has articulated provisions related to the forest products supply and forecasting in the multiple policies and acts. The major acts and their provisions related to the forest products are briefed below.

2.7.1 Forest Policies, 2000, 2015, 2019

The amendment of forest policy in 2000 AD initiated the production-based forest management practices in the Terai region. While this policy developed the foundations of the productive forests, forest policy 2015 and 2019 enhanced productive management with sustainable supply of the forest products to users. Forest policy articulated the sustainable timber and fuelwood supply through community-based management practices and sustainable forest management. Both of these policy areas were founded for the ecological balance between demand and supply of forest products. Later on, amendment of forest policy in 2019 strengthened these policy areas by specifying the key objectives related to timber production and sustainable supply. One of the major objectives of forest policy, 2019 was to become self-reliance on the forest products, which implies the sustainable supply of forest products to fulfill demand. To fulfill this objective, the government announced the implementation of sustainable forest management practices.

2.7.2 Forest Act, 2019

Forest act, 2019 stipulates the provision related to the forest products supply and demand based on the management practices. For the sustainable supply of the forest products, government has decentralized the powers to the district level officers, community, and households. While the land tenure remains to the government of Nepal, the sustainability of the supply of forest products remains on the management committee. According to the act, community forest committee decides the pre-calculated timber extraction and supply forest products through need-based approach. However, collaborative forest committee has to allocate half of the total forest products for the government of Nepal. Only after that, they are allowed to sale the forest product based on the need-based approach. Likewise, religious forests are eligible to harvest trees and supply forest products for the religious purposes, except in the DFO permission for sale. Similarly, private and leasehold forests can sell their forest products as they wish.

2.7.3 Forest Sector Strategy, 2016-2025

This strategy was formulated to guide the forest policy and development of forestry sector. For that, the strategy aimed one of its pillars at the forest management and sustainable supply of the forest products (Pillar 1). Based on this pillar, an outcome was anticipated: "*Forest productivity and sustainable supply of forest products enhanced.*" To reach this outcome, few key actions were founded such as: stable supply of the forest products, improvement on harvesting technology, and predictable forest supply. This shows the government's efforts to reduce the deficit of the forest products.

2.7.4 Scientific Forest Management Guideline, 2014

To reduce the deficit between demand and supply of forest products, government of Nepal launched the scientific forest management practices. This practice gained some momentum during early years and supplied the timber and other forest products as demanded. At one point, this practice fulfilled the demand of users of Terai region. However, poor governance and weak technical capacity of the committees led the cancellation of this practiceby the government. One key learning point of this policy can be the sustainable production of timber and forest products without hampering the ecological condition of the forests.

CHAPTER THREE: METHODOLOGY

3.1 Study Area

This study was carried out in the eleven districts of Gandaki Province. Ithas tremendous potential in terms of tourism and forest resources. Covered by more than 30% of its total area by forest, the Province encompasses Terai, Chure, Mid-hills, and High-Mountain forests. In Terai, Nawalpur district consists of the Terai Sal forests along with the Chure region of the Province. Likewise, lower belt of Syangja, Tanahun and Gorkha also covers Chure forests. Most of the hill Sal forests and Chilaune-Katus Forests are around the Kaski, Parbat, Baglung, and Tanahun district while some portion can also be found around Lamjung and Gorkha district. In addition to this, all of the orchid species that are found across Nepal can be observed in a single region – Panchase region – of Kaski district making it a hub of orchid species.The high-altitude and high Himal forests are common in Kaski, Gorkha, and Manang district.

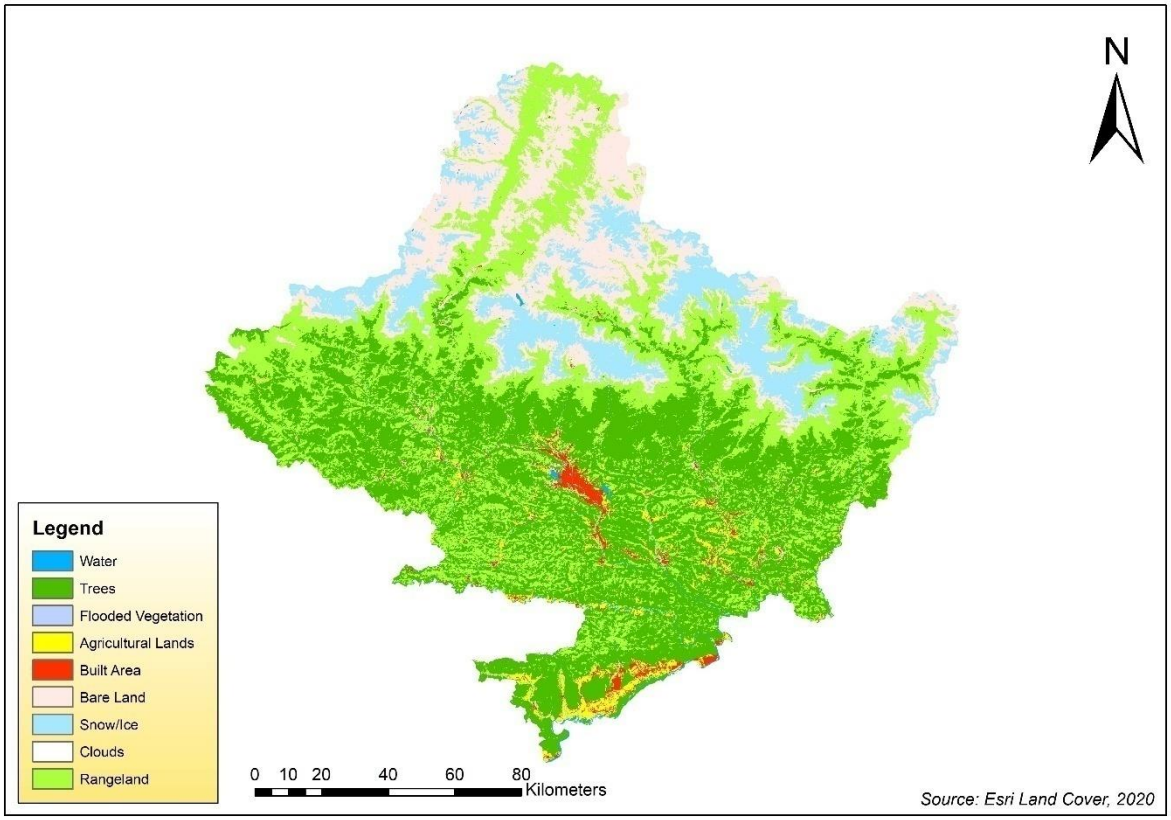

Figure 2:Land use Land cover of Gandaki Province

Regarding the rivers and streams, 10 major streams passes through this region: Kaligandaki, Budhigandaki, Marsyangdi, Modi, Madi, Daraudi, Seti, Aandhikhola, Badigad, and Uttarganga. These rivers flow from mountains like Annapurna, Dhaulagiri, Machhapuchhre, Nilgiri, Manaslu, and Ganesh Himal. This has supported nearly91% of total households for their daily water consumption. Major lakes of this region includeFewaLake, Begnas Lake, Rupa Lake, and Tilicho Lake. In addition, the cluster of 10 lakes of Kaski district has been included in the Ramsar sites as a major wetland region.

The Province is home to nearly 9% of total population of Nepal where more than 72% of the households are dependent on agriculture and forests. While Brahmins have the highest population amongst all castes, population density is highest in Terai (mean = 110/sq. km). Nearly 14% of the total population is under poverty in this region and literacy rate is above 70%.

Moreover, the Province includes largest touristic circuit – Annapurna circuit – that passes through more than 3 districts.The major income source of this region is tourism and most of the households in the high-altitude region rely on the tourism business. The only hunting reserve of Nepal – Dhorpaatan – has also been established in this Province.Major touristic destinations include Annapurna and Manaslu Conservation Areas, Mustang, Kagbeni/MuktinathChhetra, DewaghatChhetra, Dhorpatan, Manakamana/Bindabasini Temples, Gorkha Darwar, Ghalegaun, Fewa and Benas lakes of the Gandaki Province.

3.2 Sampling

Sampling was not defined for the study. As Gandaki Province encompasses 11 districts of Nepal, the team surveyed all districts and the timber/fuelwood demand and supply quantities of 10 districts. Mustang was not included in the study as this district does not have enough forests – trees – that could suffice the demand and supply pattern. The timber and fuelwood demand/supply data were collected for the last three fiscal years (FY) namely FY 2075/76, 2076/77, and 2077/78. The study relied primarily on the demand and supply data as provided by the Division Forest Offices in all the districts. Based on this, simulation of current rate, 5% increase, and 10% increase was run in R software for the future potential demand and supply quantities.

3.3 Data Collection

Two types of data collection methods were used for this study.Before initiating the data collection, the team conducted desk review/literature review to update their knowledge on the demand and supply strategies. All the necessary documents, available literature, media reports, published as well as unpublished reports of government of Nepal were consulted for the data collection strategies and report development. Importantly, provincial reports of Gandaki Province were consulted for data collection.

Major data were collected from field survey – primary data collection – whereas reports and previous literature were analyzed for the secondary data collection. The key activities inside each data collection method are provided below.

3.3.1 Primary Data Collection

The study adopted group discussion, key informant interview, and field survey for the primary data collection.

a. Group/Stakeholders Discussion

To understand the scenario of demand and supply of forest products, group discussion among and within DFO officials, CFUGs members, and committee memberswas conducted. The questionnaires were open-ended and consisted mostly about the demand and supply of the timber and fuelwood. Collecting data from group discussion on the eleven districts of Gandaki Province guided the team to understand about the problems and challenges on the demand and supply of forest products in the concerned districts. Along with that, the discussion amongst the key informants yielded key solutions for minimizing the identified challenges.

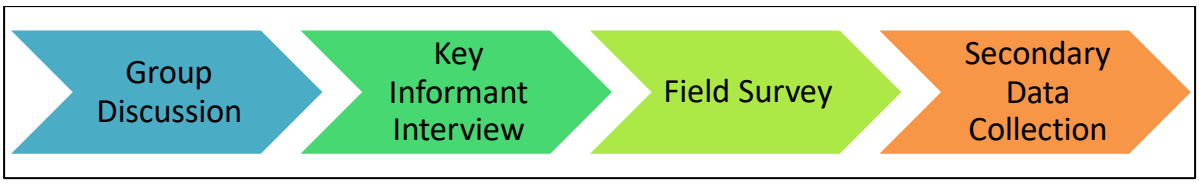

Figure 3: Key steps of the Field survey

b. Key Informant Interview

Apart from group discussion, 11 Key informant interviews (KII) were conducted. Most of the time, KIIs were higher-level authorities such as AFO, DFO, and Forest Directorate. The key informant interviews (KIIs) mostly supported the study on policy and

implementationchallenges on the production-based forest management. The questions were both close and open ended that focused on the currentdemand and supply of forest products along with future potential of the forest products supply from the province.

c. Field Survey

To cross-validate the information from group discussions and KIIs, the team conducted field survey at key locations in each district. In addition, this survey validated the identified problems and challenges along with probable solutions during the field survey. In each district, at least one community forest was visited to validate the data and inspect the problems and probable solutions on the supply of forest products.

3.3.2 Secondary Data Collection

To collect the overall demand and supply pattern data for provincial level, several annual reports of Gandaki Province, all 11 DFOs, CFUGs monitoring and evaluation reports, and occasional publications from the Province ministry were consulted. Along with this, different records regarding the demand and supply of forest products, especially timber and fuelwood, available in the districts and government offices were collected for the data analysis.

3.4 Data Analysis

After collection and validation of all the quantitative and qualitative data, the team curated the data and organized the raw data into necessary formats. While the quantitative data was entered into spreadsheet for the quantitative analysis in R, qualitative data was entered in the document file listing the key problems and probable solutions. Quantitative data was analyzed with descriptive statistics such as mean, standard deviation, and correlation and presented through bar diagrams and plots. For the future projections on the demand and supply, the team used simple simulation model in R. This model is easier and useful in providing reliable estimates for the demand and supply. Similarly, qualitative data was analyzed from the thematic analysis: similar problems were categorized under one meta-category. The description of each meta-category was strengthened through the published government reports and occasional publications.

3.5 Report Preparation and Submission

After the completion of data analysis and necessary cross validations, draft report was prepared and submitted to the Forest research and Training Center (FRTC), Gandaki Province by the consultant to gain the fruitful comments and insights on the report quality

and suggestions to improve the major findings and discussion section. After incorporating all the necessary comments and suggestions in the report, the consultant submitted the final report to the Forest Research and Training Center (FRTC).

CHAPTER FOUR: MAJOR FINDINGS AND DISCUSSION

4.1Demand of Forest Products

The current and potential future demand of forest products – timber and fuelwood – is estimated in this section for Gandaki Province and its districts.

4.1.1 Province Level Demand of Forest Products

In the three-year period, the average demand of fuelwood and timber was highest in FY 2075/76 BS followed by FY 2076/77 BS. This amount dropped to 125.3±164.6 *Chatta*[1] for fuelwood and 122,049.5±81,948.1 cft for timber in FY 2077/78.

Table 2: Demand of Forest Products in Gandaki Province in fiscal years 2075/76, 2076/77 and 2077/78*

SN	Forest Product	FiscalYear (BS)	Average Demand	Standard deviation
1	Fuelwood	2075/76	176.6	296.9
2	Fuelwood	2076/77	151.6	216.8
3	Fuelwood	2077/78	125.3	164.6
4	Timber	2075/76	158,383.0	86,897.5
5	Timber	2076/77	138,529.0	102,264.5
6	Timber	2077/78	122,049.5	81,948.1

**Fuelwood in chatta and Timber in cft*

4.1.2 Timber Demand of Districts

District wise, Manang district of the Gandaki Province has the lowest demand of timber followed by Kaski in the current stage. Likewise, Nawalpur has the highest timber demand followed by Tanahun. The reason might be the use of alternative energy in Kaski and low-quality timber along with small population of the Manang. However, Lamjung and Parbat has the similar demand pattern than others.

Table 3: District wiseTimberDemand (cft)

SN	District	Mean	Standard Deviation
1.	Manang	371.67	108.67
2.	Kaski	46,666.67	15,275.25
3.	Myagdi	76,666.67	40,414.52
4.	Gorkha	116,666.67	28,867.51
5.	Lamjung	133,333.33	57,735.03

[1]Chatta is a measurement unit for stacked wood. 1 Chatta = 5 ft*5ft*20ft OR 14.16 cubic meters.

SN	District	Mean	Standard Deviation
6.	Parbat	133,333.33	57,735.03
7.	Syangja	188,333.33	10,408.33
8.	Baglung	193,333.33	11,547.01
9.	Tanahun	224,500.00	23,574.35
10.	Nawalpur	283,333.33	76,376.26

Year wise, Nawalpur has the highest demand in two of the three FYs. Likewise, Manang has the lowest demand of the all districts in all FYs. During FY 2077/78, Tanahun observed the highest demand the timber followed by Syangja and Nawalpur. This might be attributed to the COVID-19 impact that reduced the transport along with movement. So, people may not have been able to demand the timber as required.

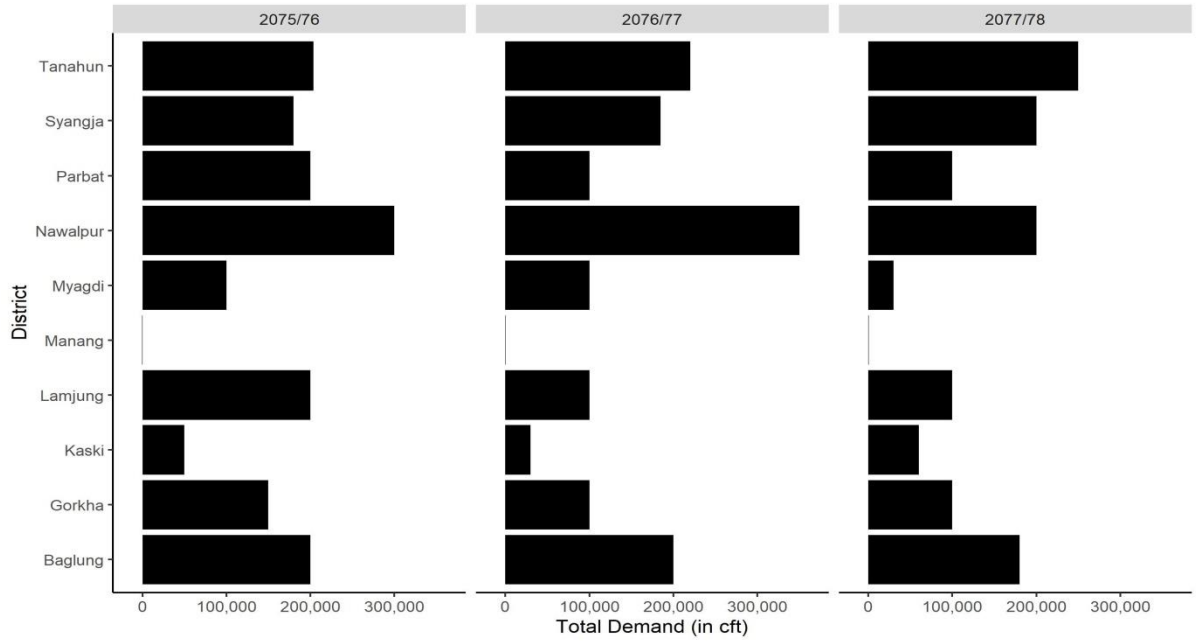

Figure 4: Year wise Timber Demand of the districts

4.1.3 Fuelwood Demand of Districts

Average fuelwood demand at current state was highest for the Nawalpur district followed by Tanahun and Syangja. Likewise, fuelwood demand was lowest for Manangfollowed by Myagdi district of the Gandaki Province. Lamjung had the wavering demand in the last three years (higher standard deviation even though mean was low) meaning that the demand might have either decreased or increased in alternate years.

Table 4: District wise Fuelwood Demand (*Chatta*)

SN	District	Average Demand	Standard Deviation
1	Baglung	23.5	2.60
2	Gorkha	115	35

3	Kaski	81.67	23.63
4	Lamjung	71.67	49.07
5	Manang	3.98	3.61
6	Myagdi	8.33	14.43
7	Nawalpur	733.33	251.66
8	Parbat	20	5
9	Syangja	216.67	87.80
10	Tanahun	237.67	54.37

Similarly, total fuelwood demand was highest for Nawalpur district in all three FYs(Figure 5) although the demand has decreased in the consecutive FYs. This demand was lowest for the Manang in FY 2075/76 BS whereas it was nearly zero in Myagdi for FY 2076/77 BS and FY 2078/79 BS. In Syangja, fuelwood demand increased over the years while Gorkhadistrict had the decreasing fuelwood demand over the years.

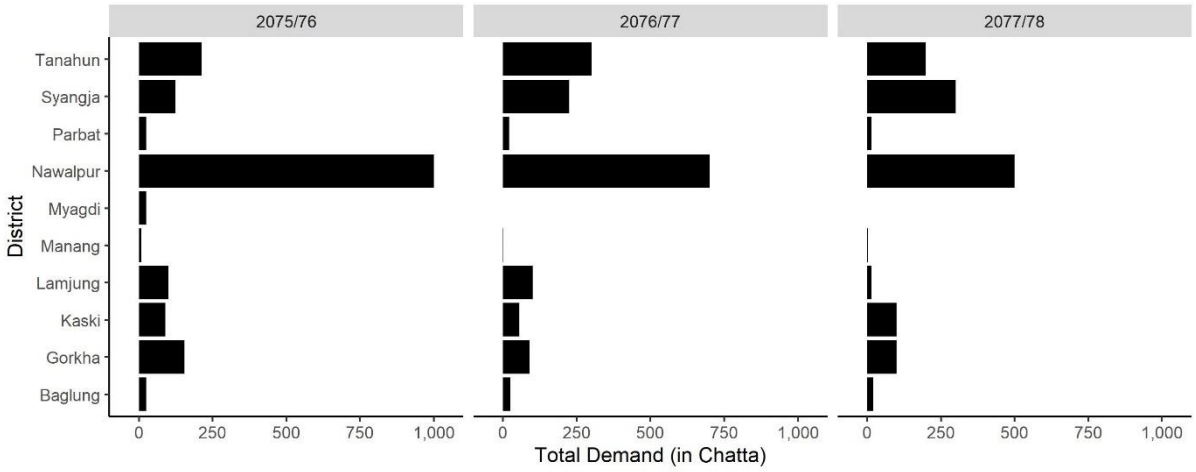

Figure 5: District wise total Fuelwood demand

4.1.4Potential Demand of Forest Products in Province

With the similar rate of the last three years, both timber and fuelwood demand willdecrease in the coming 5, 10, and 20 years with comparison to the FY 2077/78 BS.Three reasons can be ascribed for this decrease. First, the changing livelihood of communities from need-based and fuelwood dependent households to the LPG dependent households plays major role. Second, the COVID-19 impact can be observed on the demand of forest products. Strict laws and rules for constraining COVID-19 kept activities of these forests (institutions) in a dormant state. Due to which, people who demanded the timber and fuelwood in the past could not demand (maybe due to distance or strict rules) as per the requirement. Third, this study does not consider the associated activities in timber demand such as house construction. The assumption is that COVID-19 restricted much of the economic activity and house

construction. Another assumption for house construction can be attributed to the urban-rural travel during COVID-19, which minimized the timber demand in the urban areas.

At the same rate of the last three FYs, the timber demand will decrease to 557,700 cft in 5 years. Likewise, fuelwood demand will decrease to 452.52 *chatta* in FY 2083/84 BS. If the demand of forest products is expected to increase at 5% from the current demand, both timber and fuelwood demand will increase in the 5 years. At 10% increment from the current rate, the demand of timber will be more than 500,000 cft from the 5% of increase rate. Similarly, fuelwood demand will increase by 5 times than the current rate of increment if the demand is expected to increase by 10% each year.

Table 5: PotentialDemand of Forest Products inGandaki Province

Fiscal Year (BS)	Rate	Timber	Fuelwood
2083/84	At the Same Rate	557,700.43	452.52
	At 5% increase	1,635,580.03	1679.74
	At 10% increase	2,162,181.34	2220.56
2088/89	At the Same Rate	290,372.26	193.60
	At 5% increase	2,087,460.63	2143.82
	At 10% increase	3,482,214.67	3576.24
2098/99	At the Same Rate	78,716.07	35.44
	At 5% increase	3,400,253.41	3492.06
	At 10% increase	9,031,968.06	9275.84

In FY 2088/89 BS, the timber demand will decrease by nearly half than the FY 2083/84 BS amount. Likewise, fuelwood demand in FY 2088/89 BS will also decrease by more than half of the demand of FY 2088/89 BS. In 10 years, at 5% increase from the current state, the timber and fuelwood demand will exceed by 400,000 cft and 500*chatta* respectivelyfrom the FY 2083/84 BS.

After 20 years with the same rate of current state, timber demand will decrease by more than200,000 cft from the FY 2088/89 BS. The decrement of fuelwood demand will be more than 150 chatta in FY 2098/99 BS from the FY 2088/89 BS. At 5% increased simulation, the timber demand will be more than 100 million cft from the FY 2088/89 BS. Likewise, fuelwood demand will be more than 1000 chatta with constant 5% increase in each year.

4.1.5PotentialTimberDemand of Districts

District wise, timber demand will decrease in all districts in 5, 10, and 20 years except Tanahun, Kaski, and Syangja. In Gandaki Province, population is largest in these districts.In FY 2098/99 BS, Myagdi will have lowest demand of timber followed by Parbat,

Lamjung,and Gorkha. Parbat and Lamjung have the similar demand rate in the current years. Four amongst 10 districts will have the timber demand below 10,000 cft in 20 years. Higher demand for the timber in Manang district can be attributed to the population growth along with the increase in touristic activities leading to the construction of new houses. Moreover, this can also be attributed to the data availability (only 3 years) for Manang district that shows huge discrepancy in the timber demand.

Table 6: Potential Timber Demand (cft) in Districts

District	2083/84	2088/89	2098/99
Baglung	132,316.54	102,384.02	61,301.09
Myagdi	2,262.57	262.52	3.53
Parbat	8,779.15	1,156.10	20.05
Lamjung	8,779.15	1,156.10	20.05
Gorkha	26,214.40	8,589.93	922.34
Tanahun	467,096.56	786,373.53	2,228,811.38
Syangja	275,446.45	359,647.06	613,133.66
Manang	2,039.26	6,635.33	70,249.38
Kaski	121,637.19	219,194.17	711,793.83
Parasi	73,405.06	31,839.97	5,990.54

4.1.6Potential Fuelwood Demand of Districts

Regarding fuelwood, Myagdi, Lamjung, and Manang will have nearly 0 chattarequirement in 5, 10, and 20 years. In 20 years, 7 of 10 districts will demand less than 1 chatta fuelwood in the current rate. In addition, this demand will be above 100 chatta for only 2 districts: Tanahun and Kaski.Similarly, Baglung will also have more than 2 Chattafuelwood demand in 20 years.

Table 7: Potential Fuelwood Demand (Chatta) in Districts

District	2083/84	2088/89	2098/99
Baglung	11.64	7.26	2.83
Myagdi	0.00	0.00	0.00
Parbat	3.32	0.95	0.08
Lamjung	0.54	0.03	0.00
Gorkha	21.75	6.10	0.48
Tanahun	171.45	150.80	116.66
Syangja	829.17	0.00	0.00
Manang	0.02	0.00	0.00
Kaski	149.20	208.26	405.73
Parasi	61.85	10.84	0.33

4.2 Supply of Forest Products

The current and potential supply of the forest products is estimated in the following section.

4.2.1 Province LevelSupply of Forest Products

The average supply of fuelwood and timber has decreased in the last three FYs from CF (Community Forests). CF supplied 95.24 chatta of fuelwood on average during FY 2075/76 BS which was decreased by more than 30 chatta in FY 2076/77 BS and by nearly 70 chatta in FY 2077/78 BS. Similarly, CF supplied the highest quantity of timber, on average, during FY 2076/77 BS followed by FY 2075/76 BS and FY 2077/78 BS. This was not similar for PF (private forests) and others (collaborative and leasehold forests). On average, PF supplied the highest quantity of timber in FY 2075/76 BS followed by the FY 2077/78 BS. During the COVID-19 year, PFs supplied lower quantity of timber than the previous and next FY. While the COVID-19 impact is clearly observable in the CF supply that requires several meetings and discussions before ensuring supply of forest products, it seems the PFs forest products supply have not been affected by COVID-19.

Table 8: Supply of Forest Products in Gandaki Province in fiscal years 2075/76, 2076/77 and 2077/78*

Forest Product	FiscalYear	Average Supply				Standard Deviation			
		CF	PF	Others	Total	CF	PF	Others	Total
Fuelwood	2075/76	95.24	59.76	28.98	183.98	218.70	62.60	88.85	297.80
Fuelwood	2076/77	61.15	52.45	26.65	140.25	113.06	62.87	81.16	197.29
Fuelwood	2077/78	26.73	58.95	32.90	118.59	35.23	84.79	98.88	151.76
Timber	2075/76	51,475	51,806	8,009	111,291	59,271	47,091	25,145	81,285
Timber	2076/77	52,463	36,968	8,921	98,352	73,987	40,740	28,015	103,893
Timber	2077/78	34,588	47,370	8,313	90,271	40,888	39,886	26,069	74,722

**Fuelwood in Chatta and timber in cft*

4.2.2 District Wise Timber Supply

Districtwise, CFs from Nawalpur and Parbat supplied the highest amount of timber in the last 3 years. Except Nawalpur, none of the districts supplied timber from other forest types. The CFs of the Manang district supplied lowest amount amongst the all districts. In the PF category, Syangja and Baglung supplied the largest quantity of timber followed by Parbat and

Tanahun. In these districts, most of the households have private forests that they use for the personal consumption and for sale. While the Manang did not have any private forests, Nawalpur only had few private forests that could supply the timber to the communities. Likewise, PFs from Kaski district supplied more timber in the last three years than the CFs from the same district. Overall, Nawalpur supplied the most followed by Syangja and Tanahunwhile Manang district supplied the smallest quantity of timber in the last three years.

Table 9: Timber supply from Districts (cft)

District	Average Supply				Standard Deviation			
	CF	PF	Others	Total	CF	PF	Other	Total
Baglung	53,075	83,973	-	137,048	439	10,272	-	9,842
Gorkha	51,833	37,635	-	89,468	2,754	7,504	-	5,422
Kaski	3,117	40,248	-	43,365	2,920	14,930	-	13,406
Lamjung	4,529	18,408	-	22,937	2,139	6,689	-	6,128
Manang	227	-	-	227	110	-	-	110
Myagdi	19,364	18,201	-	37,565	31,140	2,773	-	32,685
Nawalpur	163,834	2,307	83,578	249,719	87,877	2,348	4,635	88,376
Parbat	-	60,363	-	60,363	-	47,828	-	47,828
Syangja	54,482	127,559	-	182,041	2,267	16,475	-	15,321
Tanahun	111,298	65,123	568	176,989	9,015	26,454	53	33,464

Year wise, Nawalpur supplied more timber than other districts of the Gandaki Province during FY 2075/76 BS and FY 2076/77 BS. However, Tanahun supplied more timber than its counterparts in FY 2077/78 BS. Timber supply did not change largely for Syangja, Manang, Kaski, Lamjung, and Gorkha districts in all three fiscal years. For Parbat district, the supply decreased in FY 2076/77 BS from previous FY. However, this supply increased in FY 2077/78 BS. Similarly, Baglung district supplied more timber during FY 2077/78 BS than the previous years.

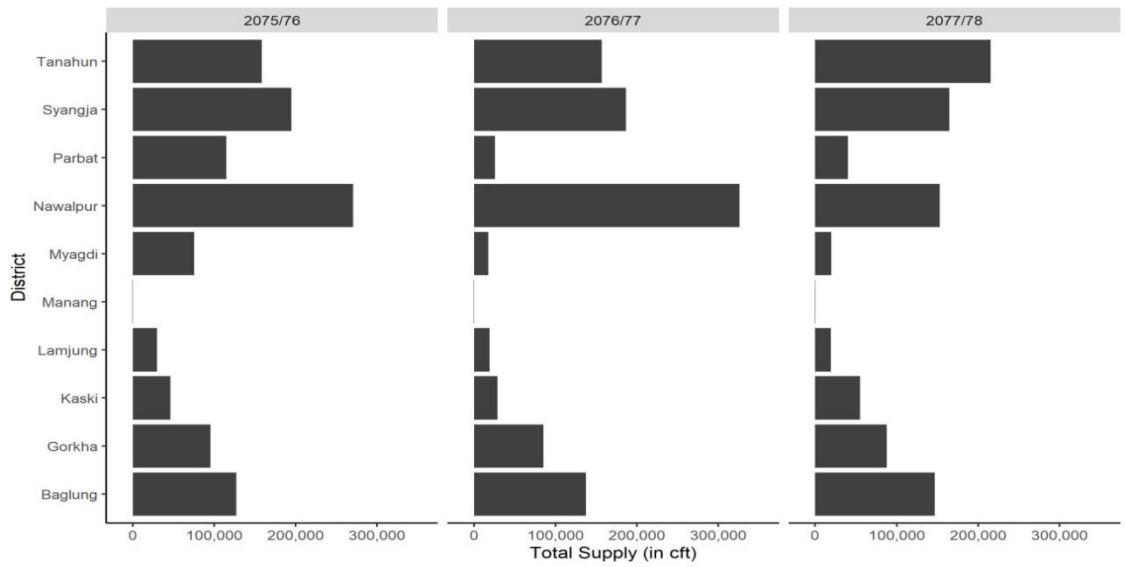

Figure 6: Total timber Supply from districts (in cft)

4.2.3 District Wise Fuelwood Supply

On average, Nawalpur supplied the highest fuelwood followed by Syangja and Tanahun. Moreover, CFs of Nawalpur supplied more fuelwood than the sum of fuelwood supply of all other districts. Similarly, Parbat and Kaski districts of the Gandaki Province supplied lowest quantity of fuelwood from CFs of respective districts. However, Kaski was one of the largest suppliers of fuelwood in PF category. From PFs, Syangja and Tanahun supplied the highest fuelwood than other districts. Manang did not supply fuelwood from the private forests. In other category, only Nawalpur and Tanahun supplied the fuelwood in the market.

Table 10: Fuelwood (chatta) Supply from Districts

SN	District	Average Supply				Standard Deviation			
		CF	PF	Others	Total	CF	PF	Others	Total
1	Baglung	9.40	9.15	0.00	18.55	0.20	3.73	0.00	3.61
2	Gorkha	26.67	69.00	0.00	95.67	16.56	1.00	0.00	16.01
3	Kaski	0.55	77.35	0.00	77.90	0.75	24.73	0.00	24.84
4	Lamjung	9.90	49.05	0.00	58.95	10.80	41.52	0.00	48.46
5	Manang	6.18	0.00	0.00	6.18	3.08	0.00	0.00	3.08
6	Myagdi	3.87	4.20	0.00	8.07	6.70	7.27	0.00	13.97
7	Nawalpur	383.83	5.40	284.42	673.65	315.91	6.85	28.34	295.97
8	Parbat	0.00	9.57	0.00	9.57	0.00	6.89	0.00	6.89
9	Syangja	70.00	181.83	0.00	251.83	15.62	59.61	0.00	67.86
10	Tanahun	100.00	165.00	10.67	275.67	26.46	15.00	3.79	37.54

Yearwise, Nawalpur supplied the highest timber in FY 2075/76 BS. This quantity decreased in the following years. While the total supply of Parbat, Myagdi, and Manang did not change largely, Syangja district supplied more fuelwood in FY 2077/78 than previous fiscal years. The fuelwood supply of all other districts did not change largely in the last 3 years.

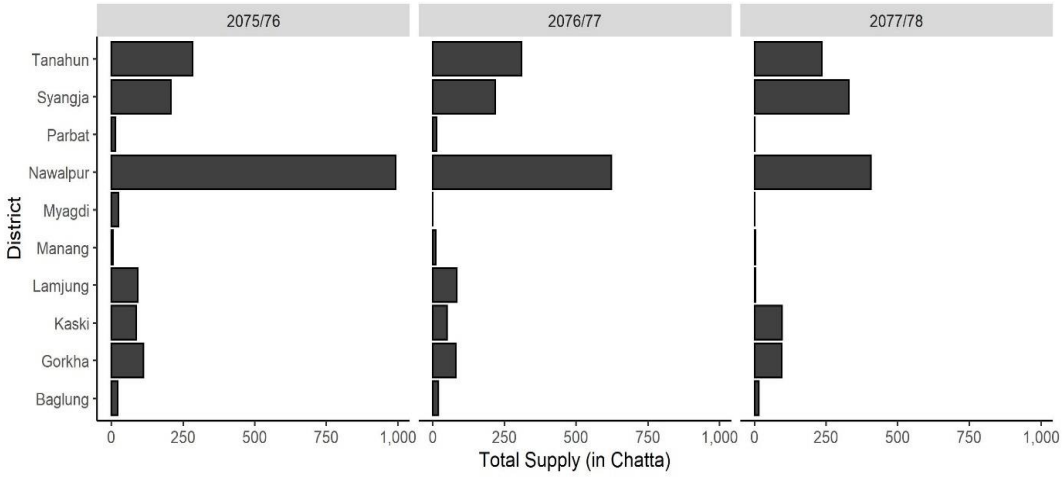

Figure 7: Total Fuelwood Supply (Chatta) from Districts

4.2.4 Potential Supply at Province Level

The potential supply of the entire Province calculated at three levels. First, the current increase or decrease on the supply of forest products in the last three years was the major criteria. Second, a simulationof 5% increase in the supply of forest products in every year was run for each forest type and product for the. Third, simulation of 10% increase in every year for the supply of forest products from each forest typewas run to estimate the future quantity of the forest products supply.

At the constant rate of last three years, timber supply will decrease from community forests of Gandaki Province in coming 5, 10, and 20 years. This result is also similar for the private forests. However, other types of forests such as collaborative and leasehold forests will supply more than the current rate. Overall, the timber supply will decrease from CF, PF and will increase from other forests.

At 5% increase from the current quantity, the timber supply will increase in each forest type: CF, PF, and others. While the PF will dominate the timber supply at this rate than CF and other forests, the total supply will also increase at 5% of the rate. At 10% increase from current quantity, results will be similar as 5% level. PF will lead the timber supply category followed by CF and others respectively.

Table 11: Potential Supply of Forest Products at Province Level

FY (BS)	Forest Type	Timber (cft)			Fuelwood (Chatta)		
		At current Rate	At 5% increase	At 10% increase	At current Rate	At 5% increase	At 10% increase
2083/84	Community Forests	119,379.69	463,519.49	612,757.05	8.42	358.25	473.59
	Private Forests	348,272.66	634,807.78	839,194.36	564.38	790.01	1044.37
	Other Forests	92,487.89	111,403.30	147,271.39	495.30	440.89	582.84
	Total	478,897.26	1,209,730	1,599,222.8	306.95	1589.15	2100.81
2088/89	Community Forests	49,195.91	591,581.38	986,851.36	0.47	457.23	762.72
	Private Forests	269,523.63	810,193.47	1,351,530.9	544.26	1008.28	1681.97
	Other Forests	101,085.07	142,181.98	237,182.05	696.51	562.70	938.68
	Total	282,368.94	1,543,956	2,575,564.3	99.52	2028.21	3383.37
2098/99	Community Forests	8,354.61	963,623.73	2,559,638.2	0.00	744.77	1978.31
	Private Forests	161,417.92	1,319,719	3,505,523.1	506.13	1642.38	4362.60
	Other Forests	120,751.17	231,599.47	615,189.14	1377.34	916.58	2434.68
	Total	98,167.13	2,514,942	6,680,350	10.46	3303.73	8775.59

As the demand of fuelwood decreases, the overall supply of fuelwood will also decrease at the constant rate of the last three years. Amongst the forest types, fuelwood supply from CF and PF will decrease while fuelwood supply from other forests will increase in 5, 10, and 20 years. In case of 5% increase from current quantity, PF will supply largest amount of the fuelwood followed by CF and others in coming 5, 10, and 20 years. This supply ratio of fuelwood will be similar at 10% increase from the current state. In FY 2098/99, the supply of fuelwood will be more than 4500 chatta at 10% increase than at 5% increase from the current state.

4.2.5 PotentialTimber Supply in Districts

District wise, Tanahun and Baglung will supply highest timber from the forests followed by Kaski and Syangja in FY 2083/84 BS. While the Baglung, Kaski, and Tanahun will increase the fuelwood supply in next 10 and 20 years, Nawalpur will decrease the timber supply from forests. For Parbat, Myagdi, and Manang, the timber supply will become nearly zero in 20 years followed by Lamjung.

Table 12: Potential Timber Supply (cft) from Districts

District	2083/84	2088/89	2098/99
Baglung	225,650.17	323,041.88	662,071.90
Myagdi	82.31	0.86	0.00
Parbat	440.46	10.17	0.01
Lamjung	4,639.29	1,401.28	127.84
Gorkha	67,919.68	54,783.20	35,641.08
Tanahun	588,242.04	1,357,594.87	7,231,001.26
Syangja	101,446.53	67,639.17	30,069.10
Manang	7.91	0.95	0.01
Kaski	105,297.49	180,935.98	534,242.91
Nawalpur	40,806.25	13,581.23	1,504.40

4.2.6 Potential Fuelwood Supply in Districts

Regarding fuelwood, six out of ten districts will supply less than 1 chatta in 20 years. In 5 years, Syangja followed by Kaski and Tanahun will supply highest fuelwood quantity whereas Myagdi will not supply any fuelwood after 5 years. This discrepancy was caused because of the data unavailability for the Myagdi district. For Manang, Lamjung, and Parbat, fuelwood supply will be lower than 1 chatta in the coming five years. Only two of the ten

districts will increase the fuelwood supply in the coming 20 years while eight of ten districts will decrease the fuelwood supply.

Table 13: Potential Fuelwood Supply (Chatta) from Districts

District	2083/84	2088/89	2098/99
Baglung	4.62	1.75	0.25
Myagdi	0.00	0.00	0.00
Parbat	0.04	0.00	0.00
Lamjung	0.05	0.00	0.00
Gorkha	54.47	34.26	13.56
Tanahun	141.49	92.71	39.80
Syangja	1497.69	5282.56	65718.81
Manang	0.74	0.23	0.02
Kaski	144.50	201.92	394.25
Nawalpur	27.27	2.87	0.03

4.3 Production and Consumption Trend of Forest Products

The production and consumption trend of forest products was calculated using linear trend.

4.3.1 Trend at Province Level

Using the given timber data of last three FYs, both consumption (red line in the below figure) and production (green line in the below figure) of the timber is expected to decrease at the Province level but at different level. While the consumption seems declining with rapid rate, production seems slightly straighter than the consumption pattern. Until FY 2091/92 BS, consumption trend remains higher than the production line. After this, the production will be surplus than the necessary consumption.

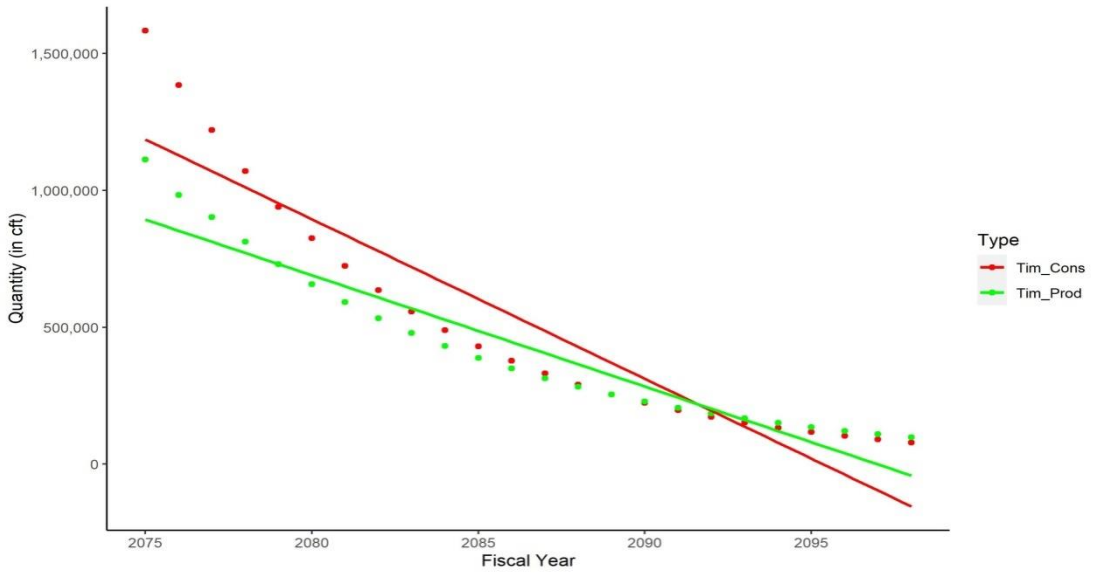

Figure 8: Trend of Timber Consumption and Production at Province Level

Regarding fuelwood production (green line in the below figure) and consumption (red line in the below figure) trend at Province level, the results are indifferent to the timber production and consumption. While both consumption and production of fuelwood will sharply decline in the next 10 years, this quantity will not change sharply in the next 10 years. Even though production will not fulfill the consumption quantity, much of this consumption will be differentiated across the districts, which will be described in the below sub-section.

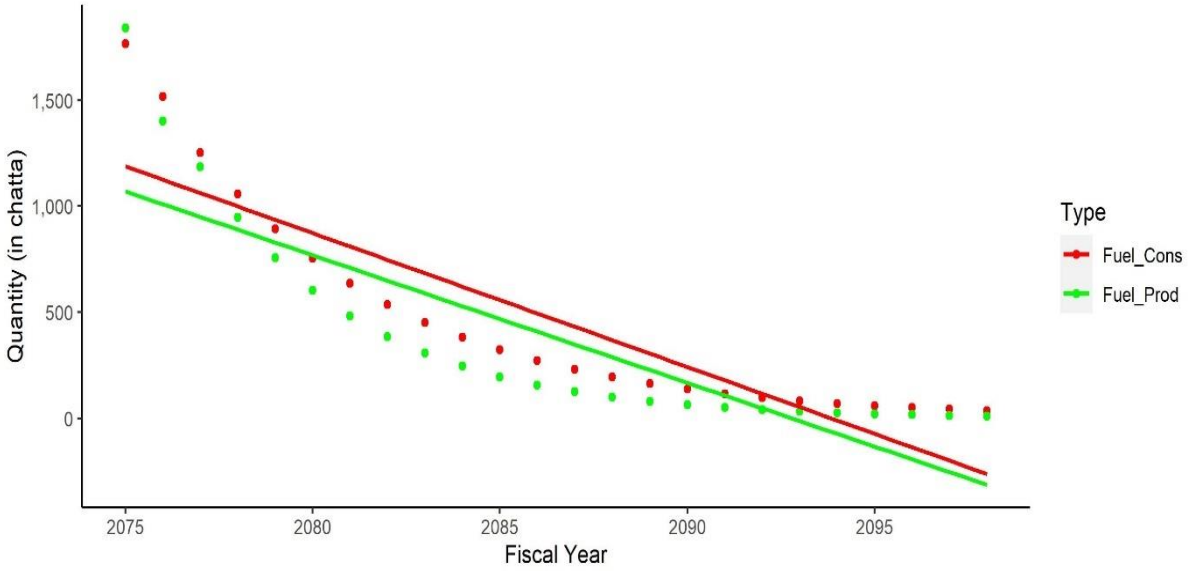

Figure 9: Trend of Fuelwood Production and Consumption at Province Level

4.3.2 Trend at District Level

The consumption and production trend at district level is differentiated. While the Kaski and Manang has similar production and consumption rate (see below figure), the consumption and production of Syangja will go in opposite direction. Baglung, Gorkha, Tanahun will fulfill the consumption of timber within 2-3 years from now on whereas, Nawalpur will have to produce higher quantity than expected to fulfill the consumption rate. Similarly, the consumption in Lamjung district will sharply decline after 3 years.

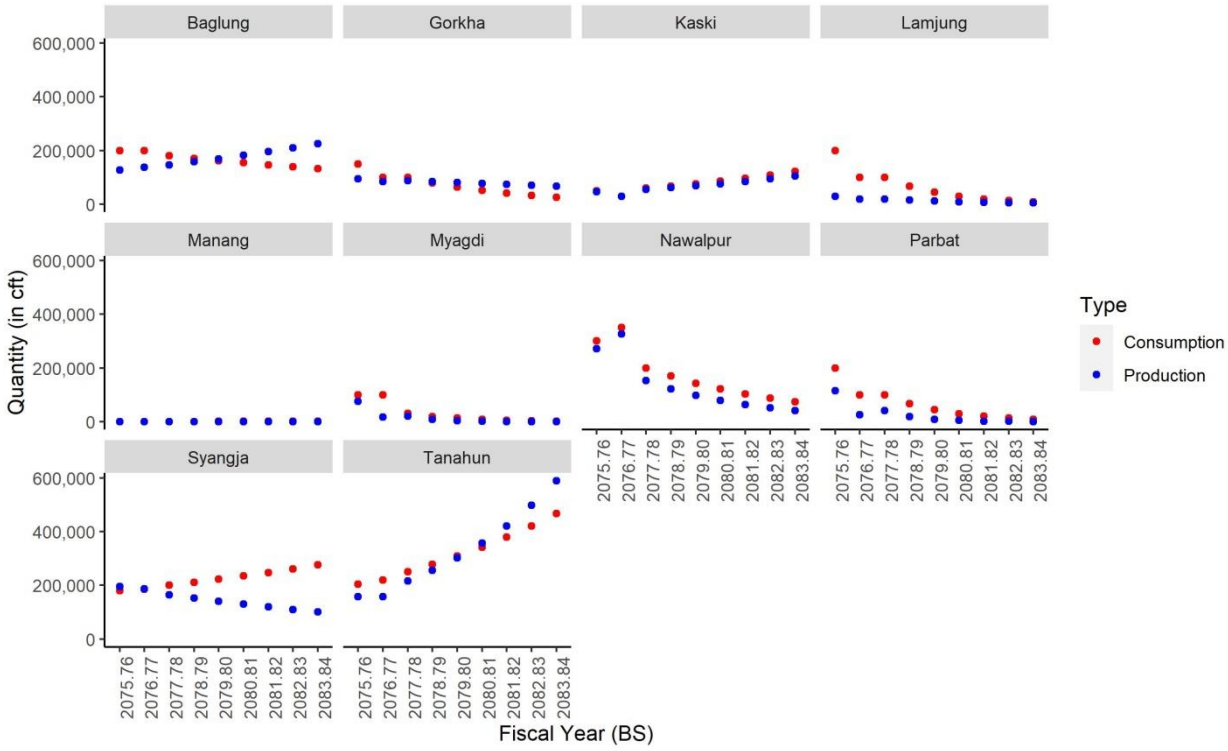

Figure 10: Production and Consumption Trend of Timber in Districts

For fuelwood, most of the districts will fulfill the consumption within 1-2 years. As the livelihood changes, the demand of fuelwood will decrease and then the constant supply of the fuelwood will be sufficient for the consumption of households. Most of the districts will have near to zero consumption in the future while Nawalpur, Syangja, and Parbat will have higher consumption rate than the production rate.

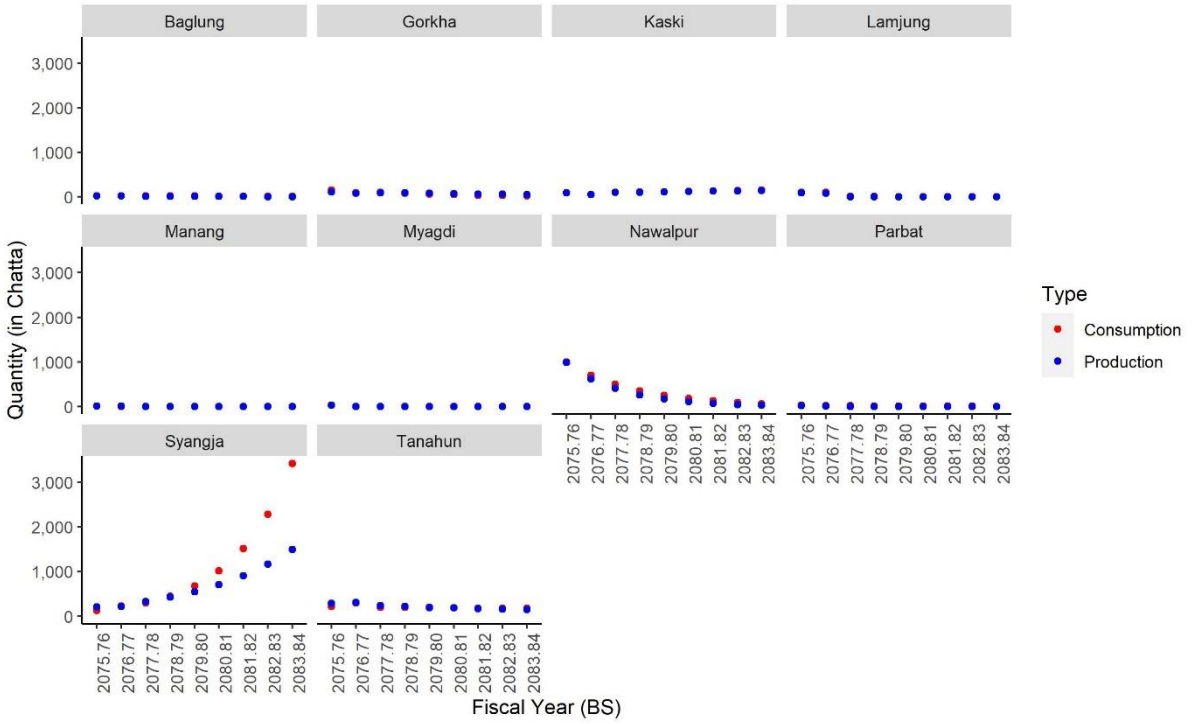

Figure 11: Production and Consumption of Fuelwood in Districts

4.4 Annual Production of Timber and Fuelwood

Even though the annual production is equal to the supply of the forest products from various sources, the average supply of last three years will provide picture of annual production for timber and fuelwood. On an average, CFs of the Gandaki Province produced higher timber and fuelwood in comparison to PF and other forests in FY 2075/76 BS and FY 2076/77 BS. However, PF exceeded the production of timber and fuelwood from CF and others during FY 2077/78 BS. The reason might be the COVID-19 impact that resulted in the strict rules for meetings and decisions for community organization. Gandaki Province produced highest quantity of fuelwood and timber in FY 2075/76 BS, which declined in the subsequent years. Based on this information, the production seems to decrease in the coming years. However, the results are overlooking the shocks of COVID-19 on the economic sector. Timber and fuelwood being one of the major economic sub-sectors of the forestry sector, contribution of these forest products should not be only visualized from the numbers and figures. Rather, the impacts of COVID-19 on the timber production and supply should be examined in the coming future.

Table 14: Annual Production of Forest Products in Gandaki Province

Forest Product	Fiscal Year	Average Annual Production				Standard Deviation			
		CF	PF	Others	Total	CF	PF	Others	Total
Fuelwood	2075/76	95.24	59.76	28.98	183.98	218.70	62.60	88.85	297.80
Fuelwood	2076/77	61.15	52.45	26.65	140.25	113.06	62.87	81.16	197.29
Fuelwood	2077/78	26.73	58.95	32.90	118.59	35.23	84.79	98.88	151.76
Sum	**All years**	183.12	171.16	88.53	442.82	-	-	-	-
Timber	2075/76	51,475	51,806	8,009	111,291	59,271	47,091	25,145	81,285
Timber	2076/77	52,463	36,968	8,921	98,352	73,987	40,740	28,015	103,83
Timber	2077/78	34,588	47,370	8,313	90,271	40,888	39,886	26,069	74,722
Sum	**All years**	138,526	136,144	25,243	299,914	-	-	-	-

4.5 Key Problems and Challenges

4.5.1 Problems in Demand and Supply of Forest Products

The demand and supply of forest products is directly linked with the forest resources context, forest management systems, socio-economic condition of forest dependents communities and the policies that regulates harvesting and distribution of forest resources. It equally varies between geographical regions and districts. In the present context the changing socio-economic characteristics of the forest dependent communities which is shifting from farm-based livelihood to off farm-based livelihood including remittance and service has also contributed to the change in the demand and supply of forest products.

4.5.2 Key Problems in Timber

Timber has always been one of the key income sources of forest management in Nepal (Bhandari et al., 2019; Chhetri et al., 2012), making it a major source of contestation in Nepal, particularly around its distribution and harvesting. Timber harvesting and distribution has always received the highest priority in terms of both policy and practices. The current timber supply in the country has failed to address the increasing demand of timber, which is similar in case of Gandaki Province. The short supply of timber is attributed to passive forest management system with blanket policy approach which contributes to loss of forest resources while increasing timber import from abroad. The traditional protection-oriented forest management approach only allows removing dead, dying, and deformed trees, causing the forest area to be dominated by over-mature trees with a lack of proper age class (Yadav et al., 2009). This, on the one hand, limited the forest product supply to the local people, and, on the other hand, led to poor forest management.

Besides these problems in the policy and forest management approaches there are other several problems around forest management practices. Some of the key problems are discussed below.

- The frequent regulatory barrier including prohibition to harvest Sal species from private forest has created multifaceted effects on timber supply. It has decrease the availability of Sal timber in the market while increasing the timber price. Equally it has demotivated private forest owners to manage their forest for timber supply.
- The current regulatory procedure for timber harvesting for forest user groups is tedious and demands multiple approvals from DFO.
- Illegal logging of timber from both communities managed and government managed forests. The easy access to forest, good market value of timber with easy sale has increased illegal logging particularly in Terai districts.
- The increasing demand of timber while supply from forest is decreasing.
- The quality of timber is low with hollows and defects. On the other hand, the proper examination and treatment of disease is rarely carried.
- Traditional harvesting practices
- Weak record keeping and documentation

4.5.3 Key Problems in Fuelwood

Fuelwood is primary and essential energy resources in Nepal. It is still the main source of cooking and heating especially in rural areas. However, the lack of efficient forest management interventions, poor distribution system and increasing demand among different category of households has added problems in implementing efficient supply of fuelwood from different forest management. This study has identified some problems around management of fuelwood in different forests management regimes of Gandaki Province.

- The expensive harvesting costs in the mid-hills forest and illegal collection and sale in Terai region.
- Less value given by community and forest managers has limited the potential harvesting.
- Difficult in categorization and systematic use
- Increasing demand of subsistence users
- Availability of easy alternatives at relatively low costs

CHAPTER FIVE: CONCLUSION AND WAY FORWARDS

5.1 Conclusion

The study attempted to analyze the timber and fuelwood demand and supply status, pattern and its future potentiality in eleven Districts of Gandaki Province, Nepal. In general both the demand and supply status and pattern of timber and fuelwood is founddecreasing in the Province in last three fiscal years.

In terms of current and future potential demand of forest products the study found that in recent three years from FY 2075/76 BS to FY 2077/78, the average demand of timber and fuelwood in the Province is decreasing. The decreasing trend on demand is with both timber and fuelwood. District wise, Nawalpur had the highest demand of timber and Manang had the lowest demand of timber. Fuelwood demand was also highest for Nawalpur and lowest for Manang. Similarly, trend of potential timber demand in the next 5, 10, and 20 years showed a declining trend.

In case of current and future potential supply of forest products, the study found that in average, supply of fuelwood is highest in CFs, followed by PFs, and other types of forests. However, in case of timber the supply from both CFs and PFs is highest in alternative years. District wise, Nawalpur supplied the highest quantity of timber whereas Manang supplied the lowest quantity of timber during last three fiscal years. For fuelwood, the results were indifferent – Nawalpur as the largest supplier and Manang as the smallest supplier. The timber and fuelwood supply will decrease if this current rate of supply remains same. Across the districts, the projection shows that Tanahun will supply highest timber and Syangja will supply highest quantity of fuelwood in the next 5 years.

The trend of production and consumption of timber and fuelwood at Province level will decrease based on the last three years' data. However, it should not be generalized for all years as COVID-19 substantially restricted the supply of forest products in these years. The linear trend of both timber and fuelwood consumption and production showed sharp decline in the coming years. For timber, the production will surpass consumption in FY 2091/92 BS whereas for fuelwood, the consumption will always higher than the timber.

The average annual production of Gandaki Province is dissimilar for the CF, PF, and other forests. In the last three years, CFs has produced highest amount of fuelwood compared with

PFs and others forests respectively. For timbers, CFs and PFs have produced similar quantity of timber while other forests have little contribution.

The problems includes, the frequent regulatory barrier including prohibition to harvest Sal species from private forest. This has created multifaceted effects on timber supply. It has decrease the availability of Sal timber in the market while increasing the timber price. Equally it has demotivated private forest owners to manage their forest for timber supply. Similarly, the current regulatory procedure for timber harvesting for forest user groups is tedious and demands multiple approvals from DFO. In case of fuelwood, the expensive harvesting costs in the mid-hills forest and illegal collection and sale in Terai region were raised as a key problem including the less value given to fuelwood management and use by community and forest managers has limited the potential harvesting.

5.2 Way Forwards

For the sustainable supply of forest products from the forests of the Gandaki Province, several way forwards have been identified.

5.2.1 Policy Recommendations

- Consistence and supportive policies formulation is pivotal to enhance sustainable flow of forest resources – consistency in decision making and supply of forest products.
- Province and District level annual forest products harvesting and distribution plan should be developed and implemented.
- Effective silviculture systems to produce sustain flow of timber and fuelwood and other forest products should be implemented.
- The forest management practices and its implementation should commensurate with the institutional, technical, financial capacity of forest bureaucracy and local communities.
- Effective and efficient monitoring and feedback system is essential to develop evidence-based forest product harvesting and distribution system.

5.2.2 Operational Recommendations

- Forest resource management plans and objectives needs to be developed based on the forest resource availability, forest types, timber and fuelwood potentiality, and forest condition. It may vary between forest management regimes, within and between districts and between the geographic settings.

- The current regulatory procedure for timber harvesting from forests (community-based forests) is complicated and tedious. It needs to be revised in order to ease the harvesting and distribution of timber within appropriate time and revitalize the resource ownership of community forest user groups.
- Use of modern tools and technology and development of local forest-based enterprise to process and supply timber and fuelwood based on market demand.
- Local forest dependents users should be encouraged to use alternatives sources such as bio-gas which doesn't harm environment and fulfill household energy needs.
- We suggest maintaining species composition of major species in the region as per their natural growth for the overall integrity and sustainability of the forest ecosystem.
- The collaborative action research on silviculture, involving forestry university, forest users and forestry officials, to experiment and demonstrate appropriate silviculture systems to produce sustainable flow of forest product is highly recommended.

REFERENCES

- Adhikari, R. K., Poudyal, N. C., &Shrestha, A. (2022). The effect of foreign remittance on timber imports: Evidence from Nepal. *Journal of Forest Research*, 1-11.
- Aryal, U., Neupane, P. R., Rijal, B., &Manthey, M. (2022). Timber Losses during Harvesting in Managed Shorea robusta Forests of Nepal. *Land*, *11*(1), 67.
- Assogba, N. P., & Zhang, D. (2020). An economic analysis of tropical forest resource conservation in a protected area. *Sustainability*, *12*(14), 5850.
- Awasthi, N., Aryal, K., Chhetri, B. B. K., Bhandari, S. K., Khanal, Y., Gotame, P., &Baral, K. (2020). Reflecting on species diversity and regeneration dynamics of scientific forest management practices in Nepal. *Forest Ecology and Management*, *474*, 118378.
- Banaś, J., &Utnik-Banaś, K. (2021). Evaluating a seasonal autoregressive moving average model with an exogenous variable for short-term timber price forecasting. *Forest Policy and Economics*, *131*, 102564.
- Basnyat, B., Baral, S., Tiwari, K. R., Shrestha, G. K., Adhikari, B., &Dahal, Y. N. (2020). Covid-19 outbreak, timber production, and livelihoods in Nepal. *Tribhuvan University Journal*, 15-32.
- Bhandari, P.K.C.; Bhusal, P.; Paudel, G.; Upadhyaya, C.P.; Chhetri, B.B.K. Importance of Community Forestry Funds for Rural Development in Nepal. Resources 2019, 8, 85.
- Bhusal, P., Karki, P., & Kimengsi, J. N. (2020). Timber distribution dynamics in scientifically managed community forests: Learning from Nepal. *Forests*, *11*(10), 1032.
- Brown, S., &Shrestha, B. (2000). Market-driven land-use dynamics in the middle mountains of Nepal. *Journal of Environmental Management*, *59*(3), 217-225.
- Chhetri, B.B.K.; Lund, J.F.; Nielsen, Ø.J. The public finance potential of community forestry in Nepal. Ecol. Econ. 2012, 73, 113–121.
- Daniels, B. J., & Hyde, W. F. (1986). Estimation of supply and demand for North Carolina's timber. *Forest Ecology and Management*, *14*(1), 59-67.
- DFRS. (2015). State of Nepal's Forests. Forest Resource Assessment (FRA) Nepal, Department of Forest Research and Survey (DFRS). Kathmandu, Nepal.
- Dhakal, A., &Rai, R. K. (2020). Who adopts agroforestry in a subsistence economy?-Lessons from the Terai of Nepal. *Forests*, *11*(5), 565.

- DoFSC. (2021). Annual Report of Fiscal Year 2019/20. Department of Forest and Soil Conservation. Kathmandu, Nepal.
- FAO. (2020). Global Forest Resources Assessment 2020. FAO Forestry Paper. 1-32.
- *Forest Research and Training Centre*. (n.d.). Retrieved June 10, 2022, from https://frtc.gov.np/downloadsdetail/25/2020/58136989
- Gautam, A. P., Shivakoti, G. P., & Webb, E. L. (2004). A review of forest policies, institutions, and changes in the resource condition in Nepal. *International forestry review*, *6*(2), 136-148.
- GoN. (2019). Forest Act, 2019. Ministry of Forests and Environment, Nepal.
- Kandel, P., Chapagain, P. S., Sharma, L. N., &Vetaas, O. R. (2016). Consumption Patterns of Fuelwood in Rural Households of Dolakha District, Nepal: Reflections from Community Forest User Groups. *Small-Scale Forestry*, *15*(4), 481–495. https://doi.org/10.1007/s11842-016-9335-0
- Kanel, K., Shrestha, K., Tuladhar, A. and Regmi, M. (2012). A study on the demand and supply of wood productsin different regions of Nepal. Kathmandu: REDD—Forestry Climate Change Cell, Babarmahal.
- Kanel, K. R., &Shrestha, K. (2001). Tropical secondary forests in Nepal and their importance to local people. *Journal of Tropical Forest Science*, 691-704.
- Lamichhane, D. (2009). Consumption Pattern of Timber and Fuelwood in Community Forests: A case study from Sindhupalchok District. *BankoJanakari*, *19*(1), 23–28. https://doi.org/10.3126/banko.v19i1.2179
- Lyon, K. S., &Sedjo, R. A. (1983). An optimal control theory model to estimate the regional long-term supply of timber. *Forest Science*, *29*(4), 798-812.
- Maharjan, A., Kochhar, I., Chitale, V. S., Hussain, A., &Gioli, G. (2020). Understanding rural outmigration and agricultural land use change in the Gandaki Basin, Nepal. *Applied Geography*, *124*, 102278.
- MoF. (2020). Economic survey: Fiscal year 2019/2020. Ministry of Finance, Nepal.
- MoF. (2021). Economic survey: Fiscal year 2019/2020. Ministry of Finance, Nepal.
- MoF. (2022). Economic survey: Fiscal year 2021/2022. Ministry of Finance, Nepal
- MoFE. (2021). Annual Report of Fiscal Year 2019/20. Ministry of Forests and Environment. Kathmandu, Nepal.
- MoFESC. (2021). Annual Report of Fiscal Year 2019/20 for Gandaki Province. Ministry of Forest, Environment, and Soil Conservation. Kaski, Nepal.

- Nepal, P., Johnston, C. M., &Ganguly, I. (2021). Effects on global forests and wood product markets of increased demand for mass timber. *Sustainability*, *13*(24), 13943.
- Oli, B. N., Treue, T., & Smith-Hall, C. (2016). The relative importance of community forests, government forests, and private forests for household-level incomes in the Middle Hills of Nepal. *Forest Policy and Economics*, *70*, 155-163.
- Pandit, B. H., Albano, A., & Kumar, C. (2009). Community-based Forest enterprises in Nepal: an analysis of their role in increasing income benefits to the poor. *Small-scale Forestry*, *8*(4), 447-462.
- Paudel, D., Jeuland, M., &Lohani, S. P. (2021). Cooking-energy transition in Nepal: Trend review. *Clean Energy*, *5*(1), 1–9. https://doi.org/10.1093/ce/zkaa022
- Paudel Khatiwada, S., Deng, W., Paudel, B., Khatiwada, J. R., Zhang, J., & Wan, J. (2018). A gender analysis of changing livelihood activities in the rural areas of central Nepal. *Sustainability*, *10*(11), 4034.
- Poudyal, B. H., Maraseni, T., &Cockfield, G. (2019). Impacts of forest management on tree species richness and composition: Assessment of forest management regimes in Tarai landscape Nepal. *Applied Geography*, *111*, 102078.
- Poudyal, B. H., Maraseni, T., &Cockfield, G. (2019). Scientific forest management practice in Nepal: Critical reflections from stakeholders' perspectives. *Forests*, *11*(1), 27.
- Putz, F. E., & Redford, K. H. (2010). The importance of defining 'forest': Tropical Forest degradation, deforestation, long-term phase shifts, and further transitions. *Biotropica*, *42*(1), 10-20.
- R Core Team (2021). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/.
- Rai, R., Zhang, Y., Paudel, B., Acharya, B. K., &Basnet, L. (2018). Land use and land cover dynamics and assessing the ecosystem service values in the trans-boundary Gandaki River Basin, Central Himalayas. *Sustainability*, *10*(9), 3052.
- Rijal, H. B. (2018). Firewood Consumption in Nepal. In T. Kubota, H. B. Rijal, & H. Takaguchi (Eds.), *Sustainable Houses and Living in the Hot-Humid Climates of Asia* (pp. 335–344). Springer. https://doi.org/10.1007/978-981-10-8465-2_33
- Sapkota, L. M., Dhungana, H., Poudyal, B. H., Chapagain, B., &Gritten, D. (2020). Understanding the barriers to community forestry delivering on its potential: An illustration from two heterogeneous districts in Nepal. *Environmental management*, *65*(4), 463-477.

- Sapkota, B. B., Bhattarai, K., &Rimal, S. (2018). Study on Internal Timber Demand Supply Ratio in Community Forest Users' Groups of Middle Mountain Region of Nepal. *International Journal of Environment*, *6*(4), 42–55. https://doi.org/10.3126/ije.v6i4.18909
- Saxena, A., Buettner, W. C., Kestler, L., & Kim, Y. S. (2022). Opportunities and Barriers for Wood-Based Infrastructure in Urban Himalayas: A review of Selected National Policies of Nepal. *Trees, Forests and People*, 100244.
- Sharma, B. P. (2019). Household Fuel Transition and Determinants of Firewood Demand in Nepal. *Economic Journal of Development Issues*, 83–95. https://doi.org/10.3126/ejdi.v25i1-2.25095
- Yadav, N.P.; Yadav, K.P.; Yadav, K.K.; Thapa, N. Facilitating the Transition from Passive to Active Community Forest Management: Lessons from Rapti Zone, Nepal. J. For. Livelihood 2009, 8, 51–66.
- Yadav, Y., Chhetri, B. K., Raymajhi, S., Tiwari, K. R., &Sitaul, B. K. (2017). Importance of trees outside forest (TOF) in Nepal: a review. *Octa Journal of Environmental Research*, *5*(2).
- Yadav, Y., Chhetri, B. B. K., Raymajhi, S., Tiwari, K. R., &Sitaula, B. K. (2020). Evaluating Contribution of Trees Outside Forests for Income of Rural Livelihoods of Terai Region of Nepal. *Open Journal of Forestry*, *10*(4), 388-400.
- Yin, R. (1999). Forecasting short-term timber prices with univariate ARIMA models. *Southern Journal of Applied Forestry*, *23*(1), 53-58.