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Community-based forest management in changing contexts: Forest users' perspectives on the future of community forestry in Nepal

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ABSTRACT

The Community Forestry (CF) program in Nepal is often lauded as a successful global example of the participatory forest management model, particularly for restoring degraded forest in the midhills However, recent socio-economic, demographic, ecological, and governance change have transformed forest-people relationships, creating uncertainty about the program's long-term sustainability. In this context, this study aims to identify the socio-ecological and institutional factors shaping community forest users' perceptions of the future of CF in Nepal. Using survey data from 873 households collected in 2023 in Salyan and Pyuthan districts, we employed an ordered logit regression model within a social-ecological systems (SES) framework to analyze perception outcomes. The majority of respondents (67%) expressed optimism regarding the CF program in the study region. The results suggest that long-term migration, off-farm income, raising livestock, and CFUGs' engagement with local forestry officials are significant factors that explain the positive outlook of community forestry in Nepal. Conversely, we identified wildlife crop raiding, female household heads, and local government involvement as significant negative factors affecting the perceived future of community forestry in Nepal. This study extends the SES framework to explain perception-based outcomes in CF under changing rural contexts. The findings highlight the need to adapt CF programs and policies to evolving socio-economic and governance contexts and revitalize local collective efforts for sustainable forest management. Future research could examine longitudinal perception changes and integrate ecological indicators to better assess system resilience.

1. Introduction

Community forestry (CF) is a decentralized forest management regime that involves local communities in forest management and decision-making, allowing them to use and manage forests in a sustainable manner and supporting livelihoods simultaneously (Agrawal and Gupta, 2005; Gilmour and Fisher, 1991; Oldekop et al., 2019; Smith et al., 2023). Over the past 50 years, community forestry has improved forests' ecological conditions and increased socio-economic benefits (Charnley and Poe, 2007; Race, 2019), engaging local communities to manage about one-third of the forest in developing countries (FAO, 2016; Hajjar et al., 2021) as a landscape-level governance strategy. Theoretically, CF is explained as a multi-layered socio-ecological system (SES) rooted in the interactions between forests and people through various systems, including socio-cultural, environmental, economic, and governance systems (Ojha and Hall, 2021). These community forestry subsystems, explained by Ostrom (2009) as resource units, resource systems, governance systems, and users, interact to generate outcomes. Along with internal dynamics, these interactions and outcomes are also shaped by larger social, economic, and political contexts (Ostrom, 2009; Laudari et al., 2024) that make cross-scale dynamics easier to understand.

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In Nepal, the devolution of forest management rights and legal recognition of their roles establish community forestry as a robust community-based forest management institution (Paudel et al., 2021a, 2021b). Since its inception in the 1970s in the mid-hills of Nepal, community forestry has expanded to encompass over 23,000 registered community forest user groups (CFUGs)[1] across the country, benefiting 16.6 million people and managing over 2 million hectares (35%) of forested areas (MoFE, 2020). Among these, CFUGs manage over 75% of the mid-hill forests (Acharya, 2005).

However, a growing body of literature has shown that rapid changes in Nepal's rural landscapes have altered forest-people interactions (Poudyal et al., 2023; Laudari et al., 2024). The predominant subsistence agriculture is no longer a backbone of most people's livelihood strategies in rural areas in Nepal (Poudyal et al., 2023). Households' reliance on forest-based resources for subsistence needs, such as fuelwood, fodder, and timber, is declining rapidly (Race, 2019). Increased access to roads, markets, and remittances has shifted the focus from local forest products to market commodities (Gentle and Thwaites, 2016). The reliance on off-farm activities, including remittances from migrants and commercial agriculture, has weakened the long-lasting bond between forests and subsistence livelihoods (Chhetri et al., 2013; Race, 2019).

Furthermore, increasing outmigration has induced demographic shifts, with an increase in female-headed households and a decline in working-age males in the mid-hills of Nepal (Bhattarai and Conway, 2020). While remittances have reduced the demand for and consumption of forest products (Poudel, 2019), the absence of household members hampers effective forest management and decision-making mechanisms (Bista et al., 2023). Consequently, there is a growing trend of agricultural land abandonment (Race, 2019; Zhang et al., 2018a, 2018b) and weakening of the traditional farm-forestry nexus (Laudari et al., 2024).

Similarly, despite the ecological gains, CF has faced criticism for its protection-oriented management (Paudel et al., 2021a, 2021b) and inability to provide significant economic benefits to local communities (Bhusal et al., 2020; Khatri et al., 2022). Furthermore, the adoption of the federal system in Nepal has brought substantial changes to the governance structure that originally established the CF. Local governments are emerging as authorities to monitor and institutionalize CFUGs in response to changing socio-political conditions, including considerations of social inclusion (Paudel et al., 2021a, 2021b). This evolving context of governance, shifting livelihoods, and outmigration indicates that CF has reached a "sustainability transition" phase, requiring a transformation to remain effective in the future (Ojha and Hall, 2021; Paudel et al., 2021a, 2021b).

Despite studies documenting the influence of outmigration and off-farm income on the livelihoods of forest-dependent people and governance of community-based forests (Sunam et al., 2020), a significant research gap remains in understanding how these shifts shape the sustainability perception of local users. While few studies have integrated socio-environmental dimensions to understand users' prospects (Fox, 2016; Sapkota et al., 2020), there is a lack of quantitative analysis capturing the cognitive attributes of these shifting forest-people relationships (Laudari et al., 2024).

This study addresses this gap by applying Ostrom's (2009) Socio-Ecological Systems (SES) framework to analyze the factors correlating with forest users perceived future of community forestry in Nepal. Beyond its practical policy implications, this study contributes to the SES framework by demonstrating how its four subsystems—users, governance, resource units, and resource systems—interact to shape the perceived future of the commons under rapid socio-economic change. We assert that understanding these factors that affect CF's future is critical for designing programs and revising existing policies that accommodate the changing social and environmental dynamics in the CF landscape in rural Nepal. By examining these factors from the perspective of community forest users who are key actors in CF management and decision-making (Dhungana et al., 2024), our analysis incorporates both household and CFUG-level characteristics. By empirically testing these relationships in Nepal's transitioning rural landscape, the paper advances SES theory from a static diagnostic tool to a dynamic model that explains how external shocks, such as migration and federalization, are mediated through user perceptions to influence long-term system resilience. Furthermore, these insights are relevant for community-based forest management programs around the world, where similar transitions in migration patterns and forest dependencies are currently unfolding.

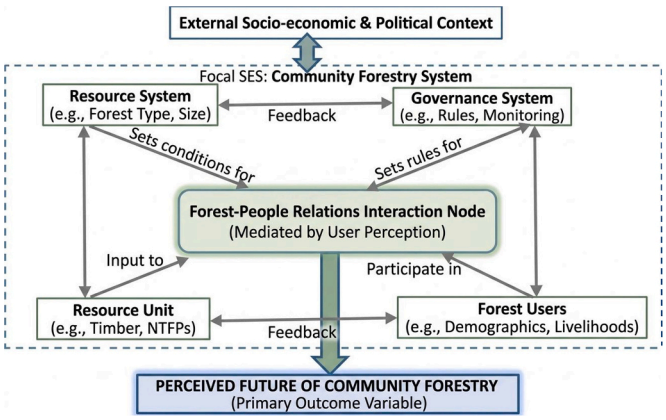

Fig. 1. Analytical framework of the study: The Social Ecological System Framework (adopted from Ostrom, 2009).

2. Methodology

2.1. Analytical framework and variable selection

We used Ostrom's (2009) social ecological system (SES) framework to understand the changing forest-people relations and select suitable explanatory variables for our empirical model that shape the perceived future of community forestry in Nepal (Fig. 1). The SES framework emphasizes the interplay of four subsystems: resource units, governance systems, resource systems, and users, which ultimately affect its outcome (Dessalegn, 2016). We hypothesize that these factors, which are a composite of user characteristics, forest attributes, and people's perceptions of CF, have a significant influence on CF's perceived future.

Developed from empirical studies on commons, institutions, and collective action, SES is the most comprehensive conceptual framework for analyzing interactions and outcomes in social-ecological systems and their sustainability (Ostrom, 2009; Partelow, 2018). Community forestry is a complex SES that supports the livelihood of millions of people globally (Hajjar et al., 2021; Ojha and Hall, 2021). While the traditional SES framework often focuses on retrospective outcomes, our study adapts this model to prioritize the "Perceived Future of Community Forestry" as the primary outcome variable (Fig. 1).

In this adapted model, the "forest-people relations" serve as the central interaction node, which is measured and influenced through users' perception. This shifts the conceptual focus from static resource metrics to the cognitive drivers of sustainability.

Guided by this framework and drawing insights from the most recent review by Laudari et al. (2024) and other studies, such as Chettri et al. (2021) and Khatri et al. (2024), we identified explanatory variables (Table 1, Supplementary Material Table S1) that capture how the four core subsystems—Resource System, Resource Unit, Governance, and Users—interact within Nepal's changing socio-economic and political context to determine long-term system trajectory. The variables

[1] CFUGs are groups of local forest users that hold legal rights to manage, use, and conserve designated areas of national forest.

Table 1
Description of the dependent and independent variables included in the ordered logistic regression model explaining the perceived future of community forestry in Nepal.

Variables	Descriptions	Exp. sign
Dependent Variable		
CF Future	Ordered categorical variables: how respondent describe given changing conditions in Nepal, the future of community forestry looks good: 1-Strongly disagree, 2-Disagree, 3-Neutral, 4-Agree, 5-Stronly agree	
Independent Variables		
Forest Users Subsystem		
Technology	Binary: households using different communication and entertainment tools (1 = Household having smartphone, or WIFI or computer or all, 0 = None of this)	−
CFUG Size	Numeric: Total number of users in community forest user groups	+
Household head gender	Binary: Gender of household head (1 = Female, 0 = Male)	+/−
Wellbeing	Binary: Wellbeing status of the household (1 = Poor, 0 = Otherwise)	+
Family size	Numeric: Total number of family members in a household	−
Household head education	Numeric: Years of formal education of household head	+
Member of community groups	Numeric: Total number of community groups that households are member of	+
Resource Subsystem		
Forest size[a]	Numeric: Total area of the community forest that households are a member of (in hectare)	+
Crop raiding by wildlife	Binary: Compared to 10 years ago, there was more, less, or the same amount of crops raiding in the past 12 months (1 = More, 0 = Otherwise)	−
Distance to road	Numeric: Walking distance to nearest paved/all-weather road (in minutes)	+
Private forest size	Numeric: Average area of a private forest of the households (in hectare)	−
Resource Unit Subsystem		
Fuelwood amount	Numeric: Amount of fuelwood that households collected from all land and forests including CF in the last 12 months (unit as Bhari)	+
Decreasing forest management involvement	Binary: Compared to 10 years ago, households contribute more, less, or a similar number of days in forest management activities in the past 12 months (1 = Less days, 0 = Otherwise)	−
Long term migration	Binary: Any household member in past 10 years, left to live away from their house for more than 6 consecutive months (1 = Yes; 0 = No)	−
Off-farm-Income	Binary: Household earned any income from working off farm in the last 12 months (1 = Yes, 0 = Otherwise)	−
Raised-livestock	Binary: households raised any livestock's (cow/buffalo/ox/goats) in the last 12 months (1 = Yes; 0 = No)	+
Governance Subsystem		
Participation in meetings	Numeric: Total days all members of households contributed in CFUG meetings including General Assembly in past 12 months	+
Average_engagement with DFO	CFUG engagement with the DFO has been increasing (1 = Agree, 0 = Otherwise)	+
Average_Local government involvement	Binary: Since 2015 (when federalism was introduced), I have noticed that the local government (municipality) has been more actively involved with my CFUG (1 = Agree, 0 = Otherwise)	+
Average_OP-followed	Binary: Management activities are carried out as per the Operation Plan (1 = Agree, 0 = Otherwise)	+

[a] This variable was obtained from the operational plans of 55 CFUGs; however, one CFUG's data was missing.

encompass both household and CFUG-level characteristics. The household-level variables comprise socioeconomic and demographic factors, while the CFUG-level variables describe CFUGs and forest attributes and how users perceive CF management and governance activities. This multi-level approach allows for a nuanced examination of the factors influencing perceptions of the CF's future, integrating both users' characteristics and perceptions. Below, we present the details of the justification of each variable for the four subsystems.

2.2. Users subsystem variables

Demographic components such as gender, well-being, education, family size, technology used by households, number of users, and community group members compose the user sub-system, reflecting the socioeconomic attributes and social capital of forest users (Ostrom, 2009). Demographic changes directly influence how people participate in forest management. For instance, a larger family implies a greater chance of participating in forest management and the use of forest resources (Oli and Treue, 2015). However, a larger family size can lead to a greater chance of migration and lower participation in forest management (Bista et al., 2023). The absence of male members in the family increases the workload for female heads, adding both challenges and opportunities for female members to CFUGs (Giri, 2022). Additionally, membership in CFUGs can enhance social capital, which promotes norms of reciprocity and fosters trust among members (Van Ha et al., 2004; Ostrom, 2009). This, in turn, influences interactions between forests and people in community forestry (Chand et al., 2015; Kimengsi et al., 2019). The size of a CFUG is also a strong factor in its success (Pagdee et al., 2006).

2.3. Resource subsystem variables

Variables such as forest size, crop raiding, distance to road, and private forest size characterize the resource sub-system, which is related to system productivity, system size, and location (Ostrom, 2009), which explains the evolving biophysical characteristics of community forestry in Nepal. For instance, proximity to roads enhances market access and economic opportunities and reduces forest dependency (Gentle and Thwaites, 2016). Similarly, crop raiding by wild animal's burdens local farmers and fosters negative attitudes toward forest conservation, leading to increased human-wildlife conflicts and cropland abandonment (Khatri et al., 2024; Priston and Underdown, 2009; Pain et al., 2021).

2.4. Resource unit subsystem variables

The resource unit subsystem in our model consists of variables that describe forest and forest users' resources, spatial and temporal distribution of resource units, economic value, and interactions among resources (Ostrom, 2009), such as the amount of fuelwood collection, forest management involvement, long-term migration,[2] off-farm income, and livestock raising. These resource units have a direct impact on forest-people interactions, ultimately affecting the sustainability of community forestry. For instance, an increase in outmigration and off-farm income has affected households' participation in forest

[2] We defined long-term migration as any household member in the past 10 years who left to live away from their house for more than six consecutive months to earn money and for education. In our case, most long-term migrants have gone to either India (39%) or Golf countries and Malaysia (38%).

management and decision-making (Mbeche et al., 2021; Poudyal et al., 2023). This has reduced forest product demand and consumption (Paudel et al., 2021a, 2021b), making them less dependent on forest-based agrarian livelihoods (Chettri et al., 2021), affecting the long-standing forest-people nexus (Shahi et al., 2022), and ultimately leading to a decrease in users' involvement in CF (Pandey and Pokhrel, 2021).

2.5. Governance subsystem variables

The governance subsystem describes the operational and collective choice rules, as well as organizational and network structures (Ostrom, 2009). This includes variables such as operational plan (OP) implementation, participation in meetings, engagement of Divisional Forest Offices (DFO),[3] and local government involvement in CFUGs. OP guides forest management and sets goals and prescriptions (Toft et al., 2015). Collective choice rules, such as developing and implementing forest management in accordance with OPs, will reduce management costs and effort and prevent others from taking their resources (Ostrom, 2009). On the other hand, regular meetings help develop better plans and increase trust among users themselves as well as between users and forest leaders (Kimengsi et al., 2019), thus fostering better forest governance. Importantly, how local governments and DFO interact with CFUGs will greatly influence the future of Nepal's forestry and people living near forests (Pokharel et al., 2020). Local governments are evolving into authorities to monitor and institutionalize CFUGs in changing contexts, including social inclusion aspects (Paudel et al., 2021a, 2021b). On the other hand, the DFO functions as the primary government institution, facilitating both technical and legal aspects of forest management and governance.

2.6. Data collection methods

2.6.1. Study area

Nepal is a mountainous country in South Asia with diverse ecological zones ranging from the Himalayas to the Terai plains, where forests play a vital role in rural livelihoods. It is widely recognized as a pioneer of community forestry, implemented through local user groups nationwide, and is currently undergoing socio-economic and institutional transitions, making it a relevant case for studying evolving forest governance and forest-based livelihood strategies (Laudari et al., 2024).

Within this context, the study was conducted in two mid-hills districts in Nepal: Salyan in the Karnali Province and Pyuthan in Lumbini Province (Fig. 2). Both districts are characterized by hilly terrain where most households engage in subsistence agriculture for their livelihood. Community forests in both districts are one of the primary sources of timber, fuelwood, fodder, animal bedding, fruits and food items, grazing forage, and medicines. However, in the last decade, dependency on forest resources has drastically reduced in this region (Poudyal et al., 2023).

In Salyan district, approximately 51% of 125,056 ha of the total forest area is under the CF program, which is managed by 611 CFUGs (DFO, 2023a). Similarly, Pyuthan has 76,299 ha of forest area, with 49% under the CF program, managed by 449 CFUGs (DFO, 2023b). Administratively, Salyan consists of three municipalities and seven rural municipalities,[4] while Pyuthan is divided into two municipalities and seven rural municipalities.

For this study, specific watersheds within each district were selected as the primary study units (Fig. 2). In Salyan, the Shardakhola watershed was selected, covering two municipalities and five rural municipalities. In Pyuthan, the Jhimruk watershed was selected, covering one municipality and four rural municipalities. These watersheds represent subregions within the districts where the household survey was conducted. The selection of these districts and watersheds was guided by: (i) a long history of community forestry implementation since the 1990s, (ii) a high concentration of CFUGs, and (iii) ongoing socio-economic transitions such as outmigration and changing forest use patterns. In addition, this study is part of a broader interdisciplinary project examining socio-environmental systems, including watershed hydrology; therefore, watersheds with reliable historical streamflow (Gautam and Acharya, 2012) and precipitation data were prioritized.

2.6.2. Household survey and sampling approach

We employed a structured household survey for data collection across the two watersheds in Salyan and Pyuthan. Our aim was to interview a statistically representative sample of 500 households from at least 25 CFUGs in each study site with a plan of collecting about 1000 observations. With an estimated population of approximately 45,000 to 50,000 households directly involved in the CFUGs within the selected watersheds, it provides a statistically sufficient basis for empirical inferences, consistence with prior empirical studies using similar sample sizes in comparable contexts (Song et al., 2017; Zhang et al., 2018a, 2018b). To achieve this, we implemented a two-stage random sampling design to select a sample of representative CFUGs and households (Adam et al., 2023; Tran et al., 2025).

In the first stage, we selected 35 CFUGs per watershed from a total of approximately 300–350 CFUGs in each watershed. We utilized an oversampling strategy (Kalton, 2009), selecting 10 additional CFUGs per site as a buffer list to ensure that at least 25 CFUGs could be surveyed, given unforeseen challenges such as inaccessibility and widespread outmigration in the region. To ensure geographical and institutional representation, we treated each municipality within each watershed as a sampling stratum. CFUGs were allocated across municipalities proportionate to their size and accessibility, with more CFUGs assigned to larger or more accessible municipalities and fewer to remote areas. CFUG lists were obtained from a national database of the Ministry of Forest and Environment and verified during a reconnaissance field visit in summer 2022.

Within each municipality, CFUGs were selected using a stratified random sampling approach. The number of strata was determined by the number of CFUGs assigned to each municipality. For instance, if three CFUGs were to be selected from a municipality, we divided them into three strata and randomly chose one CFUG from each. Stratification was based on the CFUG size (i.e., number of households) to ensure that both small and large groups had an equal probability of selection. For example, if a stratum contained 20 CFUGs and we intended to select three, we first arranged all CFUGs in ascending order by their size in terms of the number of member households. We then generated random integers between 1 and 20 representing each CFUG and selected the CFUGs corresponding to those positions in the list. For instance, if the selected random numbers were 4, 11, and 18, the CFUGs in the 4th, 11th, and 18th ranks were selected.

In the second stage, we conducted again a stratified random sampling of households within each selected CFUG. Household lists and well-being rankings were obtained from operational plans and constitutions of each CFUG maintained by the Divisional Forest Offices (DFO). From each CFUG (with an average size of approximately 110–130 households), we randomly selected 24 households, with equal representation from rich and poor household categories (See Shao et al., 2021). This balanced design was intended to ensure representation of both socio-economic groups and to enable comparison between them, rather than to reflect their actual population proportions. We aimed to complete surveys with 20 households per CFUG, allowing for some non-response and accessibility constraints. In total, we completed 873

[3] The Divisional Forest Office is a district-level government body under the Provincial Ministry of Industry, Tourism, Forests and Environment, responsible for managing, protecting, and utilizing national forests, and for providing technical and financial support to CFUGs.

[4] Nepal's local government is administratively divided into 293 municipalities and 460 rural municipalities after federalism was implemented in 2015. The democratically elected village and municipal executives are the governing bodies of the rural municipalities and municipalities respectively.

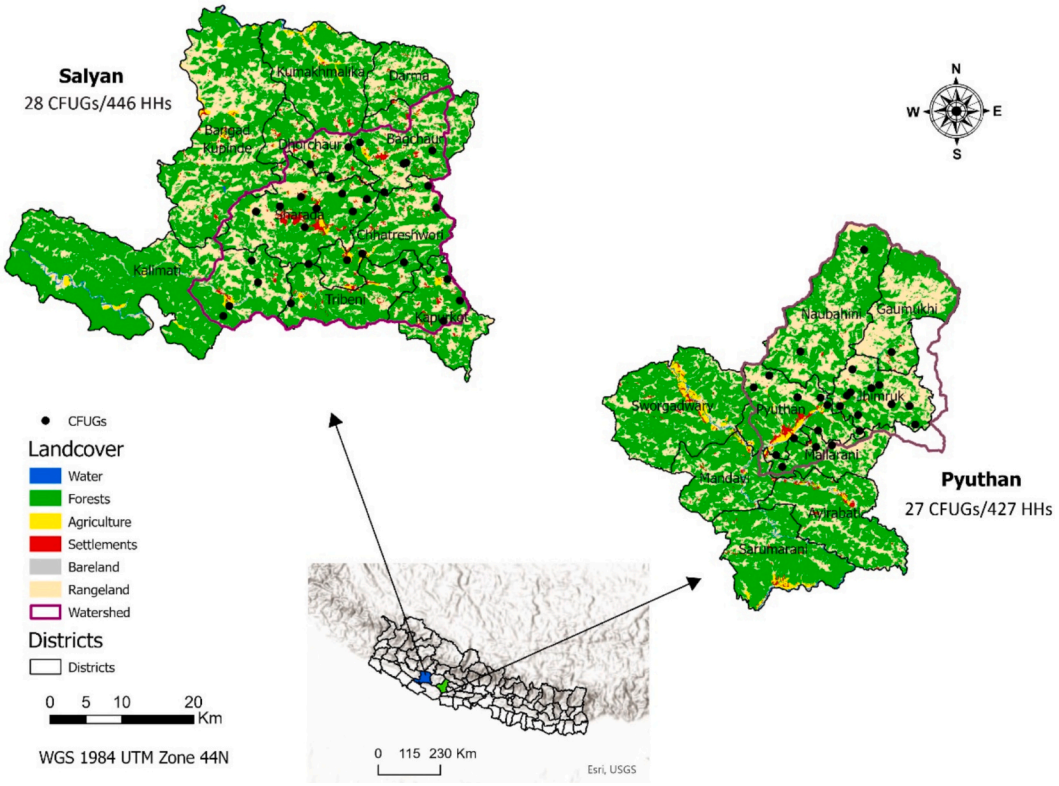

Fig. 2. Map of study sites in the midhills region of Nepal showing two watershed in surveyed districts and approximate location of community forest user groups.

households' interviews across 55 CFUGs on both sites: 446 completed across 28 CFUGs in Salyan and 427 completed across 27 CFUGs in Pyuthan.

We designed the survey questionnaire in both Nepali and English and pretested the questionnaire at the study sites before finalizing it (See Supplementary Material). Three PhD students and one postdoctoral fellow led the survey, including planning and coordination. They contacted CFUG members in advance, identified and selected households, and arranged interviews prior to field implementation. The survey was conducted between March and May 2023 with the support of ten trained undergraduate forestry students from Tribhuvan University, Nepal.

Each section of the questionnaire was discussed in detail with all enumerators during the two-day enumerator training. Specific instructors were provided to clearly describe the questions to each respondent, particularly to those that aimed to capture the broader prospects of CF, such as the future of CF. The Institutional Review Board (IRB) at the University of North Carolina at Chapel Hill reviewed and approved the survey instrument and administration procedure outlined in the Code of Federal Regulations. Before initiating the survey, we explained the purpose of the study, obtained consent from the respondents, ensured the anonymity and confidentiality of their responses, and informed the interviewees that their participation was voluntary.

We interviewed 98% of household heads who are the key decision-makers in their household. The questionnaire was designed to collect socio-economic and ecological data from forest users' households, including demographics, well-being indicators, land use, agriculture, crop raiding, livestock, migration, social capital, CF management, forest resource use, and dependency. The interviews typically lasted between 50 and 60 min for a single household. We conducted the leader's interview from all 55 selected CFUGs prior to initiating the household-level survey through a two-day leader's workshop at each district headquarters. This provided a valuable opportunity to introduce the survey team and build good rapport with CFUG leaders, understand their perspectives, the socio-economic and ecological context of CFUGs, and the impact of socio-economic and ecological changes at the user and CFUG levels. This also facilitated the effective implementation of the household questionnaire survey, as leaders from each CFUG assisted in identifying households in the selected household's rosters.

2.7. Data analysis and empirical model to explain the CF future

We begin the analysis by exploring the descriptive statistics of the explanatory variables (Table 1), followed by estimating an ordinal logistic model to examine the factors that describe users' perceptions of CF's future in Nepal. We then analyzed how users' perceptions varied according to socio-economic and demographic characteristics (Fig. 3). Then, we developed an empirical model to evaluate the factors that explain the future of community forestry in Nepal's changing socio-economic, ecological, and governance contexts. We selected these factors (Table 1) using the SES framework and recent review studies on mid-hills community forestry in Nepal.

The outcome variable, as explained in empirical model (1), is "CF Future," indicating the perceptions of CFUG members in the future of community forestry in changing contexts. The survey instrument posed the question, "Given changing conditions in Nepal, the future of community forestry looks good." We recorded the responses on a 5-point ordinal scale: 1-strongly disagree, 2-disagree, 3-neutral, 4-agree, and 5-strongly agree. Before recording the response, respondents were explained the changing socio-economic and governance context, such as increased migration, and declining forest dependency that impacted forest-people interactions. This approach was employed to ensure that respondents' answers reflect the informed opinion on the evolving dynamics of CF.

Table 1 presents the details of each of the explanatory variables. Both continuous and binary variables were used in the model. To reduce reverse causality, we used the average response from all households in

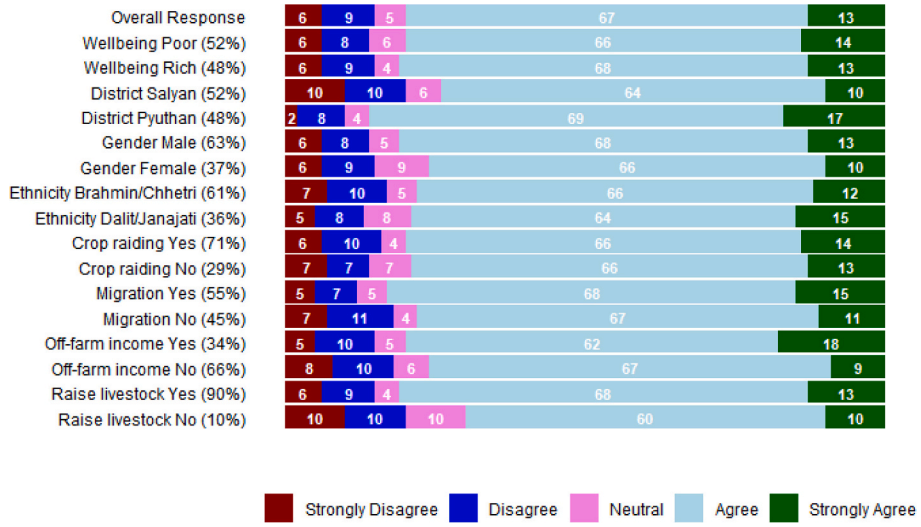

Fig. 3. Forest users' responses to the statement that the future of community forestry looks good under changing contexts, disaggregated by socio-economic and demographic characteristics (in %). The percentages in parentheses indicate the proportion of respondents in each category.

the CFUGs as a proxy for a few variables in the governance category, such as OP followed, DFO engagement, and local government involvement.

Perceived CF Future = *f(Technology, Number of users, Gender, Well-being, Education, Family Size, Member of local groups, Forest size, Crop-raiding, Distance to Road, Private forest size, Fuelwood amount, Forest management involvement, Long-term Migration, Off-farm Income, Raised-livestock, OP-followed, Local government involvement, Participation in meetings, DFO engagement) (1).*

2.8. Model estimation and selection of the best fitted model

We employed an ordered logistic regression technique to estimate the perceived future of CF, as the dependent variable of our model was recorded on an ordinal scale. The ordered logistic regression model estimates a score that is a linear function of the included independent variables and defined intercepts (Williams, 2016). In this study, the odds ratio model described the probability of a better future for community forestry when the estimated odds ratio values were higher than one. We used the Brant test to verify the proportional odds assumption (Brant, 1990). This assumption implies that the relationship between every possible pair of outcome groups should be the same (Bruin, 2006). For instance, the coefficients describing the relationship between the lowest and all higher categories of the response variable are the same as those describing the relationship between the next lowest category and all higher categories. The non-significant Brant test (Table 3) satisfies the proportional odds assumption, suggesting that ordered logistic regression is a valid statistical approach for estimating our empirical model.

The generalized model for an ordinal dependent variable with M categories is as follows (Williams, 2016):

$$P(Y > j) = \frac{\exp(\alpha j + Xi\beta j)}{1 + [\exp(\alpha j + Xi\beta j)]}, j = 1, 2\ldots, M-1 \quad (2)$$

where, P (Y > j) is the probability that response Y falls in a category higher than j, j ranges from 1 to M − 1, α_j is the intercept or threshold parameter for each category j, X_i is the vector of predictor variables for observation i, and β is the vector of regression coefficients. The equation models the cumulative probability of being in a category higher than j.

We used the likelihood ratio chi-square test to ensure that the chosen model provided a significant improvement in fitness compared to a simpler model without predictors. We also estimated the corresponding marginal effects for each predictor. We calculated the marginal effects by considering the mean of the independent variables (Greene, 2003). Marginal effects are the most intuitive because they describe the change in the predicted probability of the outcome variable with a 1-unit change in the explanatory variable (Onukwugha et al., 2014).

We identified a prior set of candidate models from all the explanatory variables we collected, assessed model fitness, and identified the best-fit model that describes the perceived future of CF. We carried out a model selection approach based on the Akaike Information Criteria (AICc) (Guthery et al., 2003). This approach identifies parsimonious models with the lowest AICs, which simultaneously minimizes the loss of information at the same time (Guthery et al., 2003). We also calculated the variance inflation factor (VIF) to detect multicollinearity, the residual degree of freedom, and the number of variables to estimate the balance between goodness of fit and model complexity.

We developed and estimated five separate ordered logistic regression models for the future of CF, starting from a full model of 32 explanatory variables. We evaluated multiple models to identify the best-fit model (Suryawanshi et al., 2013) and selected the model with the lowest AIC value, indicating the best balance between goodness of fit and model complexity (Supplementary Table S2). This process includes all

Table 2
Socio-economic and demographic characteristics of the respondents ($N = 873$).

Socio-Economic and Demographic Characteristics	Percentage
Respondent as main decision maker of households	98%
Household head gender: Male	63%
Average age of household head	54 Years
Castes (Brahmin/Chhetri)[a]	59%
Wellbeing Poor[b] (according to CFUG Operation Plan)	52%
Households' current primary source of livelihood	
	67%
• Agriculture (crops and livestock) for livelihood	27%
• Remittance from migrants	
Households with at least one-member migrated	55%
Households receiving remittances	74%
Households top two fuel sources	
	77%
• Fuelwood	42%
• LPG	
CF share of household's annual fuelwood needs	33%
Households with crop raiding	71%
Households with crop land abandoned	23%

[a] Brahmin and Chhetri are higher caste people and have relatively dominant roles in the society.

[b] Poor households typically have less agricultural land, smaller houses, and lower annual income, and are largely agriculture and forest dependent.

explanatory variables that are suitable in the model regardless of their *p*-value as described by Bursac et al. (2008). The lowest residual degree of freedom suggests a more parsimonious model, a moderate number of variables balancing model complexity with explanatory power, and a relatively lower VIF value indicating minimal multicollinearity.

3. Results

3.1. Socio-economic and demographic characteristics of survey sample

Of the 873 respondents surveyed, 98% were the main decision-makers in their households, with 63% of total being male household heads. Households also exhibit mixed livelihood strategies, with 67% of households relying primarily on agriculture and 27% depending on remittances. About 55% of households had at least one member who migrated, and 74% reported receiving remittances (Table 2). Fuelwood remains the primary energy source for most households (77%), although a notable proportion also uses LPG (42%), with an average monthly consumption of 4.46 Bhari. Livestock ownership is widespread, with average holdings of 2.04 oxen, 1.9 cows, 1.7 buffalo, and 6.4 goats per household. A considerable share of households reported crop raiding (71%) and cropland abandonment (23%). Key descriptive statistics of household characteristics and resource use are summarized in Table 2 and Appendix Table 1.

3.2. Perceived future of community forestry in changing socio-economic and governance contexts

Overall, 67% of respondents selected "agree" and 13% selected "strongly agree" with the statement that the future of community forestry looks good (Fig. 3), indicating a generally positive outlook toward community forestry in Nepal. Respondents expressed consistently a positive perception on the future of CF across socio-economic and demographic categories, with only modest variation. Households' well-being, whether poor or rich, shows a similar level of optimism on the higher-agreement side. Respondents in Pyuthan reported slightly higher optimism (81%) compared to those in Salyan (74%). Gender differences were minimal, although male respondents showed slightly higher optimism than female respondents. Similarly, households with off-farm income and those with migrant members also showed slightly higher levels of optimism, with approximately 83% indicating agreement or strong agreement with the statement.

The overall optimistic perception of CF users in the study region may reflect its historical success and the presence of well-established local governance institutions. However, some disparities across groups suggest the importance of considering heterogeneous experiences in the design of future policies and programs.

3.3. Factors explaining the perceived future of community forestry in changing socio-economic and governance contexts

We found that most of the predictors from all four subsystems were statistically significant in describing the perceived future of community forestry in Nepal (Table 3). We found a negative and significant association between predictors such as the household head's gender as female, the household experiencing crop raiding, the household collecting a higher fuelwood amount from all land and forest, households having a larger private forest area, and active local government involvement in CFUGs with the perceived future of CF (Table 3). For instance, the estimated odds value of 0.70 associated with household head gender suggests that female household heads are 30% less likely to perceive a better CF future than male household heads, holding all other variables constant. The estimated odds value of 0.698 associated with crop raiding suggests that households experiencing crop raiding are 30.2% less likely to perceive a better CF future. Similarly, the estimated odds value of 0.163 associated with the active involvement of local governments in CFUGs suggests that households agreeing that local government involvement in CFUGs is increasing are 83.7% less likely to perceive a better CF future. The estimated odds ratio and marginal effect (Table 3) for fuelwood collection and having a larger private forest area point to a minimal negative impact on the perceived future of CF.

Members of multiple local groups, such as water, agriculture, women's, micro-finance/credit, or cultural groups (predictors from the user system), and predictors from the resource unit system, such as raising livestock, households with long-term migrants, and households earning off-farm income, show significant positive associations, explaining that these households are more likely to perceive the better CF future. Similarly, the predictors from the governance system, which include participating in CFUG meetings and increasing CFUG engagement with DFOs, demonstrate significant positive associations with the respondents' perceptions of the prospects of CF in Nepal.

The consistently largest marginal effects (strongly disagree and strongly agree) are associated with engagement with DFO (positive) and local government involvement (negative). The next largest marginal effects are associated with raising livestock (positive), followed by off-farm income and long-term migration, showing a positive effect on the strongly agree category (Table 3). For instance, the marginal effect results suggest that respondents agreeing with the increasing engagement of DFO with CFUGs decreases the probability of being in the "strongly disagree" category to perceive a better CF future by 5.5% and increases the probability of being in the "strongly agree" category to perceive a better CF future by 20.2%. Similarly, the marginal effect estimates for households with long-term migrants, compared to respondents without long-term migrants, suggests that having a long-term migrant member in a household increases the probability of being in the "strongly agree" category to perceive a better CF future by 4.3%. Likewise, households with off-farm income are associated with a 4.4% higher probability of being in the "strongly agree" category regarding the perception of a positive CF future compared to households without off-farm income, holding all other variables constant.

4. Discussion

4.1. Key factors describing the perceived future of community forestry in Nepal

4.1.1. Positive significant factors

We found that households involved in multiple community groups, such as water, agriculture, women, and microfinance/credit, perceive a better future for community forestry. This may be because community groups build social capital lower transaction costs in forest management and foster social cohesion resulting in better forest management outcomes (Chand et al., 2015; Kimengsi et al., 2019; Van Ha et al., 2004; Wilkie and Painter, 2021). Our findings suggest that households with long-term migrants and off-farm income sources have strong positive perspectives on the future of community forestry. Migration-induced demographic changes and income dynamics have significantly reshaped community forest management and governance in recent years (Hecht et al., 2015). Recent studies in Nepal highlighted the negative relationship between out-migration and rural livelihood, reporting that households that rely on remittances from out-migrant members and off-farm income have relatively lower involvement in community forest management and decision-making (Lama et al., 2017). Their disengagement from farming and forest-based agrarian livelihoods, suggests shifts in priorities, forest values, and participation in forest management activities (Schmook and Radel, 2008; Chettri et al., 2021). The positive perception of households with long-term migrants on the CF future possibly indicates a growing appreciation for the long-term benefits of forests, including cultural and environmental benefits (Bowler et al., 2010). We also speculate that these households place greater value on future forest use (option value) rather than immediate subsistence benefits. Despite lower forest dependence, these households often retain

Table 3
Ordered logistic regression and average marginal effects results of the factors explaining the perceived future of community forestry in Nepal in changing socio-economic and governance contexts ($n = 569$).

Variables	Odds Ratio	Marginal Effects				
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Forest Users						
Technology	0.942 (0.173)	0.002 (0.005)	0.004 (0.013)	0.001 (0.005)	0.001 (0.003)	0.006 (0.020)
Number of Users	1.003* (0.00)	0.000* (0.000)	0.000* (0.000)	0.000* (0.000)	0.000* (0.000)	0.000* (0.000)
Household head Gender	0.700* (0.15)	0.011 (0.007)	0.025 (0.016)	0.009 (0.006)	−0.009 (0.009)	−0.037* (0.021)
Wellbeing	1. 192 (0.22)	−0.005 (0.006)	−0.013 (0.013)	−0.005 (0.005)	0.003 (0.004)	0.014 (0.019)
Household head Education	0.964 (0.02)	0.001 (0.001)	0.001 (0.002)	0.000 (0.001)	0.000 (0.000)	−0.002 (0.002)
Household size	0.965 (0.051)	0.001 (0.002)	0.002 (0.004)	0.001 (0.001)	−0.001 (0.001)	0.000 (0.000)
Member of local groups	1.175** (0.07)	−0.005** (0.002)	−0.011** (0.005)	−0.004** (0.002)	0.003 (0.003)	0.018** (0.007)
Resource System						
Community forest-size	0.999 (0.00)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.023 (0.020)
Crop-raiding	0.698* (0.15)	0.010* (0.006)	0.023* (0.014)	0.009 (0.005)	0.001 (0.006)	−0.042 (0.027)
Distance to Road	1.005*** (0.00)	0.000** (0.001)	0.000** (0.000)	0.000** (0.001)	0.000 (0.000)	0.001*** (0.000)
Private forest area	0.946* (0.03)	0.002* (0.001)	0.004* (0.002)	0.001* (0.001)	−0.000 (0.001)	−0.006* (0.003)
Resource Unit						
Fuelwood amount	0.995*** (0.00)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000 (0.000)	−0.001*** (0.000)
Forest management involvement	1.326 (0.26)	−0.009 (0.006)	−0.020 (0.014)	−0.007 (0.005)	0.006 (0.007)	0.030 (0.021)
Long term Migration	1.498** (0.28)	−0.012** (0.006)	−0.028** (0.013)	−0.010** (0.005)	0.008 (0.007)	0.043** (0.020)
Off-farm Income	1.571** (0.29)	−0.013** (0.006)	−0.026** (0.013)	−0.011** (0.005)	0.002 (0.006)	0.052** (0.024)
Raised-livestock	2.840*** (0.98)	−0.049* (0.026)	−0.091** (0.041)	−0.029** (0.012)	0.096 (0.059)	0.081*** (0.020)
Governance System						
Participation in meetings	1.060** (0.02)	−0.002** (0.001)	−0.004** (0.002)	−0.002** (0.001)	0.001 (0.001)	0.007** (0.002)
Average_Engagement with DFO	6.499** (5.56)	−0.056** (0.027)	−0.129** (0.061)	−0.047** (0.024)	0.029 (0.032)	0.203** (0.094)
Average_Local government involvement	0.163* (0.16)	0.054* (0.030)	0.125* (0.067)	0.045* (0.026)	−0.028 (0.031)	−0.196* (0.104)
Average_OP-followed	1.546 (0.88)	−0.012 (0.018)	−0.029 (0.041)	−0.010 (0.015)	0.007 (0.011)	0.045 (0.064)

LR Chi-Square (22) = 622.84****, Brant test = (p > chi2) = 65.57 (0.29).
Significant at: *$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.
Note: *We calculate the marginal effects from an ordered logit model at the mean of the independent variables (Greene, 2003). Standard errors are presented in parentheses. We used the average response from all households in the CFUGs as a proxy for a governance-related variable. The robust standard errors accounted for potential model assumptions violations, such as heteroscedasticity. The estimated model is highly significant (p-value < 0.000) and a better fit of the full model compared with the null model, with chi-square statistics of 622.84. The Brant test (P-value = 0.29) suggests that the model meets the proportional odds assumption, validating the suitability of ordered logistic regression as an appropriate estimation approach.*

CF membership, which is transferable across generations.

Moreover, migrants acknowledge the significance of CF for their offspring, suggesting a long-term investment perspective. The literature on absentee ownership[5] of forestland and agricultural land (Young et al., 2015; Petrzelka and Armstrong, 2015) indicates that, even though these households are often less engaged in forest management or farming, they maintain ownership as a future source of benefits to their families (Snyder et al., 2020).

Similarly, households engaged in livestock rearing, particularly goat farming, reported a better future prospect for CF. This is likely because traditional animal husbandry and goat farming require grazing land, daily fodder, and leaf litter. While private forests meet part of their demand, land poor and underprivileged households still depend on CF for livestock farming and grazing (Poudyal et al., 2023). On the other hand, households that rely more on forest products often participate more in CFUG meetings (Chhetri et al., 2013). These meetings served as important platforms for CF members to share, plan, discuss, and exchange issues and activities related to forest management and governance. Participants in CFUG meetings may perceive a better future due to stronger collective action and decision-making capacity. Contrary to the assumption that larger benefits positively influence the perceived outlook of CF, households collecting higher fuelwood from various sources show a weak negative association. This might stem from CF's limited supply to meet their needs, as, on average, CFs supply only 33% of households' fuelwood requirements (Table 2). Similarly, CFs often restrict fuelwood collection to a specific period, usually twice a year, which might not align with households' demands.

Importantly, CF users see the DFO's active involvement with CFUGs as a positive prospect for CF. DFO is a key government agency that provides technical and monitoring support. Legally, CFUGs are supposed to have regular interactions with DFO staff as regulatory and advisory government organizations, from CFUG registration to the handover phase for forest management and resource utilization. Government support strengthens CFUGs through legal backing, technical assistance, capacity building, and funding (Ruiz-Mallén et al., 2013). CFs can easily navigate administrative procedures and planning requirements with government support (Pulhin et al., 2010). However, studies have indicated a decrease in DFOs' engagement with CFUGs, limited technical support in forest management, and increased backlogs of operational plans (Sapkota et al., 2020; Gautam et al., 2023). Similarly, there are ongoing discussions about the introduction of administrative barriers that are not mandated by law and the recentralization of community control over forest resources by DFOs (Paudel et al., 2008; Basnyat et al., 2018). This trend is more evident when harvesting and selling timber involves multiple regulatory procedures and bureaucratic hurdles (Puri et al., 2020).

The positively correlated variables, particularly those from resource units (e.g., households engaged in livestock rearing, having migrants, and off-farm income) with high odds ratio, indicate that households recognize CF long term value beyond immediate benefits. Such positive perception from these households also reflects CF's longstanding role as a strong local institution encompassing socio-cultural, ecological, economic, and policy dimensions, as discussed by Ojha and Hall (2021). Conversely, we also found that a decrease in involvement of households in forest management in the last decade does not significantly affect perception of CF's future. This indicates that reduced forest dependency doesn't necessarily decrease the perceived value of forests, highlighting that households might value CF not only for provisional services but also for its broader institutional and ecological roles.

[5] Absentee owners are those who live any distance off their forest or farmland but have ownership of the forest and land resources.

4.1.2. Negative significant factors

Significant negative factors, such as households facing crop raiding, household head's gender being female, and the active involvement of local governments in CFUGs, affect the future of CF. This highlights the ongoing discussion and policy discourse in Nepal. Wildlife crop raiding has become a major concern in Nepal's mid-hills, disproportionately affecting poor households (Khatri et al., 2024).

This imposes an economic burden on local farmers and develops negative attitudes toward forest conservation (Priston and Underdown, 2009). Wildlife crop raiding is widely prevalent in the mid-hills, where CF successfully restored the forest cover and outmigration has changed the socio-demographic structure of households (Chhetri et al., 2021). Additionally, the growth of forests surrounding abundant croplands (Poudyal et al., 2023) and the decline in forest management interventions in CFs (Khatri et al., 2024) contribute to the increase in wildlife movement around croplands. Furthermore, the majority of these households either implement no preventive measure or rely on traditional prevention approaches, such as generating noise when confronted with instances of crop raiding.

Our results also suggest that female household heads perceive a negative future prospect for CF compared to their male counterparts. Female participation and direct engagement in CF conservation and management have increased in recent years, primarily because of the absence of male partners owing to outmigration (Fox, 2016) and inclusive policy provisions (Pandey and Pokhrel, 2021). However, female users face persistent exclusion in decision-making, which is high among the poor and Dalit women (Ota et al., 2024; Baral et al., 2024). Under current CF policies, female representation is legally required, and with changing socio-economic dynamics such as migration patterns, women's responsibilities have extended considerably beyond household chores. This shift could pose a new challenge for the future of community forestry (Giri et al., 2021), potentially increasing the negative prospects of CF for women.

Similarly, the users hold a negative perceived outlook for CF when local governments are actively involved in CFUGs. The 2015 federalism in Nepal resulted in the establishment of robust and expanded local governments that possessed a strong legislative function over local natural resources, including community forests (Ojha and Hall, 2021). Similarly, the Forest Act (2019) explicitly provides local governments with forest governance responsibilities within their jurisdictions. The expanding role of local government has challenged the traditional autonomy of CFUGs, leading to conflicts between them. Despite providing support to CFUGs, new local, provincial, and federal government laws have focused on CF as a source of revenue (Paudel et al., 2021a, 2021b). Because small-scale CFUGs in mid-hills often prioritize socio-ecological issues over economic options from community forests, taxes levied by local governments might lead to additional economic burdens and require administrative processes for CFUGs (Dahal et al., 2021), potentially leading to negative perceptions of community forestry.

5. Conclusion

This study empirically examines the factors associated with the perceived future of community forestry in Nepal under changing socio-economic, ecological, and governance contexts. Based on a household survey conducted in two mid-hill districts, the findings indicate that rural livelihood strategies have evolved from subsistence agriculture to increasing dependency on remittances and off-farm income. The households are more likely to strongly agree that the future of CF in Nepal looks good when they live in CFUGs with higher engagement with DFO but less involvement with the local government, have memberships in multiple local community groups, have long-term migrants, generate off-farm income, and raise livestock. Similarly, the head of the household being female and households experiencing crop raiding are more likely to disagree that the future of CF in Nepal is good. By empirically testing these relationships in Nepal's transitioning rural landscape, this study advances SES theory from a static diagnostic framework to a more dynamic model that explains how external processes, such as migration and federalization are mediated through user perceptions to shape long-term system resilience.

These findings highlight the need to better integrate evolving socio-economic and ecological dynamics into CF policies and practices. Targeted interventions to strengthen women's roles in CF decision-making, including leadership training, could promote greater social, cultural, and institutional inclusion. It is plausible that CFUGs may benefit from strengthening community groups to build norms and social capital. CF management plans could adapt to changing livelihood contexts, considering local resource conditions and evolving user needs, particularly in response to migration and off-farm income. The intensifying human-wildlife conflicts due to the increasing incidence of crop raiding and insufficient support mechanisms for affected households could pose a serious threat to forest-people interactions. Our results suggest that addressing these concerns may be critical to maintain the effectiveness of the CF program and facilitate continuous human-nature interaction in harmony.

CFUG members often anticipate more technical and management assistance from DFOs to utilize forest resources for income generation, job creation, and sustainable ecosystem benefits such as carbon and water. Reviving forest management activities, along with targeted economic incentives, could encourage re-engagement among forest-dependent households. Forest policies might benefit from adopting a customized approach toward CFUGs considering the heterogeneous needs of users', the specific ecological context of forests, and the diverse economic prospects inherent in each user group. This approach could be more effective than implementing a uniform, one-size-fits-all strategy. On the other hand, local governments could play a crucial role in enhancing CFUGs' leadership capacity, promoting female roles in decision-making, and strengthening and developing local infrastructure that connects CFUGs with markets and enterprises.

This study limits its scope to the analysis of user perspectives, leaving out some biophysical aspects that are crucial for a comprehensive understanding of the issue. Further, we suggest conducting a longitudinal study to more accurately track changes in resource use and to better capture the dynamics of forest-people interactions, which is one of the limitations of this study. Similarly, globalization-driven migration has multifaceted implications for socio-economic and environmental systems, potentially shaping the future of natural resource governance and policy. Future research could examine these interconnected effects to better inform policy and institutional arrangements for community-based natural resource management.

CRediT authorship contribution statement

Prabin Bhusal: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Rajan Parajuli:** Writing – review & editing, Validation, Supervision, Methodology, Data curation, Conceptualization. **Erin O. Sills:** Writing – review & editing, Validation, Supervision, Conceptualization. **Conghe Song:** Writing – review & editing, Validation, Supervision, Funding acquisition, Conceptualization. **Gregory E. Frey:** Writing – review & editing, Validation, Supervision. **Dil Bahadur Khatri:** Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Appendix 1

Table 1
Summary statistics of the dependent and independent variables included in the ordered logistic regression model explaining the perceived future of community forestry in Nepal.

Variables	Descriptions	# Obs.[a]	Mean (SD)	Exp. sign
Dependent Variable				
CF Future	Ordered categorical variables: how respondent describe given changing conditions in Nepal, the future of community forestry looks good: 1-Strongly disagree, 2-Disagree, 3-Neutral, 4-Agree, 5-Stronly agree	796	4.01 (0.99)	
Independent Variables				
Forest Users Subsystem				
Technology	Binary: households using different communication and entertainment tools (1 = Household having smartphone, or WIFI or computer or all, 0 = None of this)	872	0.45	−
CFUG Size	Numeric: Total number of users in community forest user groups	857	112 (65.6)	+
Household head gender	Binary: Gender of household head (1 = Female, 0 = Male)	872	0.37	+/−
Wellbeing	Binary: Wellbeing status of the household (1 = Poor, 0 = Otherwise)	872	0.52	+
Family size	Numeric: Total number of family members in a household	873	4.08 (1.78)	−
Household head education	Numeric: Years of formal education of household head	868	4.29 (4.68)	+
Member of community groups	Numeric: Total number of community groups that households are member of	870	1.55 (1.06)	+
Resource Subsystem				
Forest size	Numeric: Total area of the community forest that households are a member of (in hectare)	858	99.4 (100)	+
Crop raiding by wildlife	Binary: Compared to 10 years ago, there was more, less, or the same amount of crops raiding in the past 12 months (1 = More, 0 = Otherwise)	855	0.62	−
Distance to road	Numeric: Walking distance to nearest paved/all-weather road (in minutes)	772	38.2 (49.23)	+
Private forest size	Numeric: Average area of a private forest of the households (in hectare)	872	0.23 (0.17)	−
Resource Unit Subsystem				
Fuelwood amount	Numeric: Amount of fuelwood that households collected from all land and forests including CF in the last 12 months (unit as Bhari)	780	53.6 (63.78)	+
Decreasing forest management involvement	Binary: Compared to 10 years ago, households contribute more, less, or a similar number of days in forest management activities in the past 12 months (1 = Less days, 0 = Otherwise)	728	0.62	−
Long term migration	Binary: Any household member in past 10 years, left to live away from their house for more than 6 consecutive months (1 = Yes; 0 = No)	872	0.55	−
Off-farm-Income	Binary: Household earned any income from working off farm in the last 12 months (1 = Yes, 0 = Otherwise)	873	0.33	−
Raised-livestock	Binary: households raised any livestock's (cow/buffalo/ox/goats) in the last 12 months (1 = Yes; 0 = No)	872	0.89	+
Governance Subsystem				
Participation in meetings	Numeric: Total days all members of households contributed in CFUG meetings including General Assembly in past 12 months	842	4.61	+
Average_engagement with DFO	CFUG engagement with the DFO has been increasing (1 = Agree, 0 = Otherwise)	872	0.33	+
Average_Local government involvement	Binary: Since 2015 (when federalism was introduced), I have noticed that the local government (municipality) has been more actively involved with my CFUG (1 = Agree, 0 = Otherwise)	872	0.19	+
Average_OP-followed	Binary: Management activities are carried out as per the Operation Plan (1 = Agree, 0 = Otherwise)	872	0.49	+

[a] There were 873 respondents in the total survey sample. Except for off-farm income, the complete responses were at least 550. Thus, we impute missing values for off-farm income randomly based on probabilities of random distribution of observed data (Donders et al., 2006).

Appendix B. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.forpol.2026.103868.

Data availability

Data will be made available on request.

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